# SYRIAN ARAB REPUBLIC
# PUBLIC ESTABLISHMENT OF ELECTRICITY FOR GENERATION AND TRANSMISSION (PEEGT)

## ALEPPO THERMAL POWER PROJECT
## 2 X 250 MW

# VOLUME -IIB

# TECHNICAL SPECIFICATION
# FOR
# DRY COOLING SYSTEM

# BOOK-1 of 3

**Specification No. : PE-TS-J20 -165-N001 (REV. 0)**

**BHARAT HEAVY ELECTRICALS LIMITED**
**POWER SECTOR**
**PROJECT ENGINEERING MANAGEMENT**
**NOIDA - 201301**

**TECHNICAL SPECIFICATION VOL IIB COMPRISES OF 3 BOOKs:**

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# SECTION - A

# SCOPE OF ENQUIRY

**1.00.00 SCOPE**

**1.01.00** This enquiry covers the complete Dry cooling System including design, manufacture, assembly, inspection and testing at manufacturer's and/or his sub-contractors works, proper packing, forwarding & transport, insurance, delivery at site, unloading/handling at site, storage at site, civil construction, erection, testing, site painting, commissioning, trial operation, conducting performance test & handing over to customer of complete Dry cooling System, including Mechanical, Electrical, C&I, Civil & structural works including CW pump house with handling & maintenance facilities, complete CW piping/ducting/tunnel & other piping, CW pumps, required tanks and vessels, valves expansion joints fitting, instrumentation and controls etc, supply of spare parts, E&C spares, tools, training of PEEGT personnel externally and internally, as specified & as necessary for completeness in all respects and for efficient & trouble free operation for 2X250 MW Aleppo Thermal Power Plant at Syria on EPC basis.

The cement & steel is included in bidder's scope. Pilling (if required) shall also be included in bidder's scope.

The scope shall be on back to back basis with PEEGT, Syria for Aleppo Project.

**2.00.00 GENERAL TECHNICAL INSTRUCTIONS**

**2.01.00** It is not the intent to specify herein all the details of design and manufacture. However, the equipment shall conform in all respects to high standards of design, engineering and workmanship, and shall be capable of performing the required duties in a manner acceptable to Engineer/Owner, who will interpret the meaning of drawing and specifications and shall be entitled to reject any component, work or material, which in his opinion is not in conformity with the duty requirements.

**2.02.00** The omission of specific reference to any component/ accessory necessary for the proper performance of the equipments shall not relieve the bidder of the responsibility of providing such facilities to complete the supply/ erection / commissioning etc. of complete Dry cooling System at quoted prices.

**2.03.00** BHEL's/ owner's representative shall be given access to the shop in which the equipments are being manufactured or tested and all test records shall be made available to him.

**2.04.00** The equipments covered under this specification shall not be dispatched unless the same have been finally inspected, accepted and shipping release issued by BHEL/Customer.

**2.05.00** Bidder to also refer complete specifications of PEEGT, Syria attached in this specification.

**2.06.00** In case of any deviation from this technical specification (Vol. IIB), the same shall be indicated in the schedule of deviations. In the absence of duly filled schedules it will be assumed that the bid strictly conforms to the specification.

**2.06.00** Un priced copy of the price bid shall be furnished along with the technical bid.

# SECTION – B

## PROJECT INFORMATION
## (As per customer specification attached in Section C)

# SECTION - C

# SPECIFIC TECHNICAL REQUIREMENTS

# SECTION – C1

# SPECIFIC TECHNICAL REQUIREMENTS (MECHANICAL)

**1.00 INTENT OF SPECIFICATION:**

**1.01** This enquiry covers the complete Dry cooling System including design, manufacture, assembly, inspection and testing at manufacturer's and/or his sub-contractors works, proper packing, forwarding & transport, insurance, delivery at site, unloading/handling at site, storage at site, civil construction, erection, testing, site painting, commissioning, trial operation, conducting performance test & handing over to customer of complete Dry cooling System, including Mechanical, Electrical, C&I, Civil & structural works including CW pump house with handling & maintenance facilities, complete CW piping/ducting/tunnel & other piping, CW pumps, required tanks and vessels, valves expansion joints fitting, instrumentation and controls etc, supply of spare parts, E&C spares, tools, training of PEEGT personnel externally and internally, as specified & as necessary for completeness in all respects and for efficient & trouble free operation for 2X250 MW Aleppo Thermal Power Plant at Syria on EPC basis.

The cement & steel is included in bidder's scope. Pilling (if required) shall also be included in bidder's scope.

**In case of conflict with PEEGT specification, requirements given in PEEGT shall prevail.**

**2.00 SCOPE OF EQUIPMENTS, WORKS AND SERVICES UNDER THIS SPECIFICATION:**

2.01 The scope of supply of mechanical equipments for Dry cooling system shall be as per Customer PEEGT's specification, enclosed in Section C.

The scope of supply of various C&I, Electrical and Civil portion of Dry cooling system shall also be as per detailed customer (PEEGT's) specification of C&I, Electrical, Civil as enclosed in Section C.

The scope shall be on back to back basis as required by PEEGT, Syria for Aleppo Project.

The dry cooling system with only surface condenser option shall be offered.

**2.02** The following are also included in bidder's scope:

a) Furnishing of all basic drawings/ documents, General arrangement drawings, sectional assembly drawings, layout drawings, performance curves, design philosophy, structural design, design sizing/ calculation, foundation drawings, quality plans, E&C Methods, etc for complete Mechanical, Electrical, C&I and Civil aspects for BHEL's/ PEEGT approval.

b) Bidder's concerned design engineers shall visit BHEL at PEM, Noida and at Project site on as required basis during contract execution for engineering co-ordination and customer meetings for smooth execution of the contract.

c) Carry out cooling Water system water hammer study for complete Dry cooling system and incorporate the required design elements as per the recommendation of study.

d) Carry out wind tunnel test for the Natural draft cooling tower at a National/ internationally accredited laboratory and incorporate the required design elements as per the recommendation of study.

e) Carry out performance guarantee test of complete Dry Cooling System as per BHEL/ customer approved performance test procedure.

f) Carry out inspection and testing of all Mechanical, Electrical and C&I equipments of Dry cooling system in line with customer specification. The factory test shall be in line with clause 6.8, part 6, of customer's PEEGT's technical specification enclosed in Section C & other requirements specified elsewhere in this specification.

g) Supply of special tools & tackles required for maintenance of equipments & accessories in the Dry cooling system.

h) Supply of special erecting tools/ plant/equipment & accessories.

i) Supply of essential spare parts as per clause 6.3, part 6, main cooling system, of customers PEEGT's technical specification enclosed in Section C.

j) Supply of spare parts required during guarantee period.

k) Supply of all consumables such as lubricants, chemicals, other consumable materials, etc till guarantee period.

l) Supply of loose paints for equipments requiring painting at site along with painting procedures.

m) Training of PEEGT's personals.

n) Bidder shall furnish Engineering progress and exception report on monthly basis during contract execution stage.

o) Any item not specifically listed but required for completion of Dry Cooling system shall be deemed to be included in bidder's scope including equipment base frame/ skid, foundation bolts, etc for complete Dry Cooling system.

**3.00** This specification is intended for pre-bid tie up with the Dry cooling System supplier for quoting on back to back basis to PEEGT for the 2X250 MW Aleppo Thermal Power station.

Bidder shall furnish the technical datasheets/ details, list of clarification/ deviations w.r.t. customers specification, referring clause no./ page no. of customer specification as well as BHEL specification, drawing/ documents list for customer approval, vendor list, broad outlines of inspection/ testing plans, etc. for inclusion in BHEL's offer for the complete power station.

During implementation of the contract, technical approvals required from PEEGT on drawing/ documents/ technical discussions will be duly considered by the bidder. Bidder shall comply with customer comments (if any) during contract stage without any additional commercial implication to BHEL.

**4.00 Equipment & Services to be provided by Purchaser along with Terminal points:**

a. Surface condenser along with Condenser cooling water inlet/ outlet isolation valves and expansion joints. Two nos Condenser CW inlet pipes and two nos Condenser CW outlet pipe each of size 1800 NB (tentative) shall be terminated at A- row of columns of Power house building at an elevation of (-) 3.2 M (tentative) by BHEL for further interconnection with Bidder supplied CW pipes.

b. Dry cooling system make up water/ first fill connection shall be provided at one point, 10 M away from the periphery of each Natural draft Cooling tower, further supply of makeup/ first fill connection up to Dry cooling tower storage tanks and head tank/ surge tank along with motor operated inlet valves shall be in bidder's scope.

c. HT motors for CW pumps

d. For Electrical, C&I, Civil and E&C works refer Sections C2/ D2, C3 , C4 & C5 (along with PEEGT's specification attached in these section) respectively enclosed herein.

**5.00** The Dry Cooling System shall comply with Customer PEEGT's technical specifications of cooling system enclosed in section -'C'. In the event of any conflict between Section -'D' & section 'C', the customer's Technical specification viz. section - 'C' shall prevail.

**6.00** The scope demarcation between BHEL and Bidder for Dry Cooling System shall be as per line diagram of Dry cooling System enclosed at Annexure - 1. (BHEL will be terminating their pipes at the A row column of the power house. Beyond A row everything is in bidder scope to complete the system unless otherwise specified.

**7.00 Proveness:**

The Dry Cooling System along with its sub-system, equipments, etc supplied shall be of proven design. The system/ Equipments shall be supplied from reputed vendors. Please refer Pre Qualifying Requirements along with PEEGT specification.

**8.00 Interface engineering inputs:**

The inputs required to design the Dry cooling system are as below:

| | **100 % TMCR** | **MCR with Worst ambient Temp.** | **VWO Condition** |
|---|---|---|---|
| | **CASE I** | **CASE II** | **CASE III** |
| Heat Duty (GCal/ Hr) | 286.03 | 322.4 | 298.7 |
| Ambient Dry Bulb Temperature ($^{o}$C) | 26 | 40 | 26 |
| Cooling Water flow ($M^3$/ Hr) | 29900 | 29900 | 29900 |
| Hot Water Inlet Temperature ($^{o}$C) | 54.2 | 70 | 55.8 |
| CW Outlet Temperature ($^{o}$C) | 44.63 | 58.9 | 45.8 |
| Pressure drop across condenser between BHEL T.P. (MWC) | 5.4 | 5.4 | 5.4 |

Note: Cooling system shall be designed for MCR with worst ambient temperature (CASE II) and the same cooling system shall also meet the requirements at 100% TMCR (CASE I) and VWO condition (CASE III).

**9.00 Performance requirements:**

9.01 The cooling water outlet temp as specified in Cl. 8.0 above shall be guaranteed by the bidder for the specified design ambient conditions.

9.02 Auxiliary power consumption of all equipment in bidder's scope shall also be guaranteed.

**10.00 LD/ Penalties for shortfall in guarantees:**

10.01 Performance testing of cooling tower shall be done by bidder to demonstrate the guaranteed cooling water temperature at design ambient condition and the worst ambient condition as specified.

In case the test cold-water temperature as determined from the PG test is higher than the predicted value (based on the performance curves). Owner reserves the right to reject the tower. In the event of its acceptance by PEEGT liquidated damages of 2.62 Million Euros for each 1 $^{o}$C increase shall be levied.

Bidder to note that the liquidated damages (as specified) for shortfall in performance shall be worked out independently for each cooling tower.

10.02 In case of increase in Auxiliary power consumption liquidated damages of 2800 Euros shall be levied for increase of each 1 KW.

**11.00 DRAWINGS, CURVES AND INFORMATION REQUIRED:**

**11.01 The following documents/ information shall be furnished by the bidder in his offer:**

a) Process flow diagram of complete Dry Cooling System in bidder's scope along with descriptive write - up.
b) List of scope exclusions with each& every exclusion listed therein. Any exclusion not listed in above shall be deemed to be in bidder's scope.
c) List of terminal points for all Mechanical, Electrical, C&I and Civil equipments.

d) Cooling Tower performance curves at different ambient temperatures.
e) Guaranteed Auxiliary power consumption of complete Dry cooling system. Guaranteed Cold water temperature at Dry cooling Tower outlet at the specified design conditions.
f) List of special tools, plants and machinery (including Erection rig for cooling tower, hydraulic lifting devices, panel lifting devices, crane rails, staircases, etc.
g) -Blank-
h) Electrical load list for complete dry cooling system.
i) List of recommended spares for ten years of operation.
j) Any other document asked by PEEGT with Bid as per PEEGT's requirement specified in Section C of this volume.

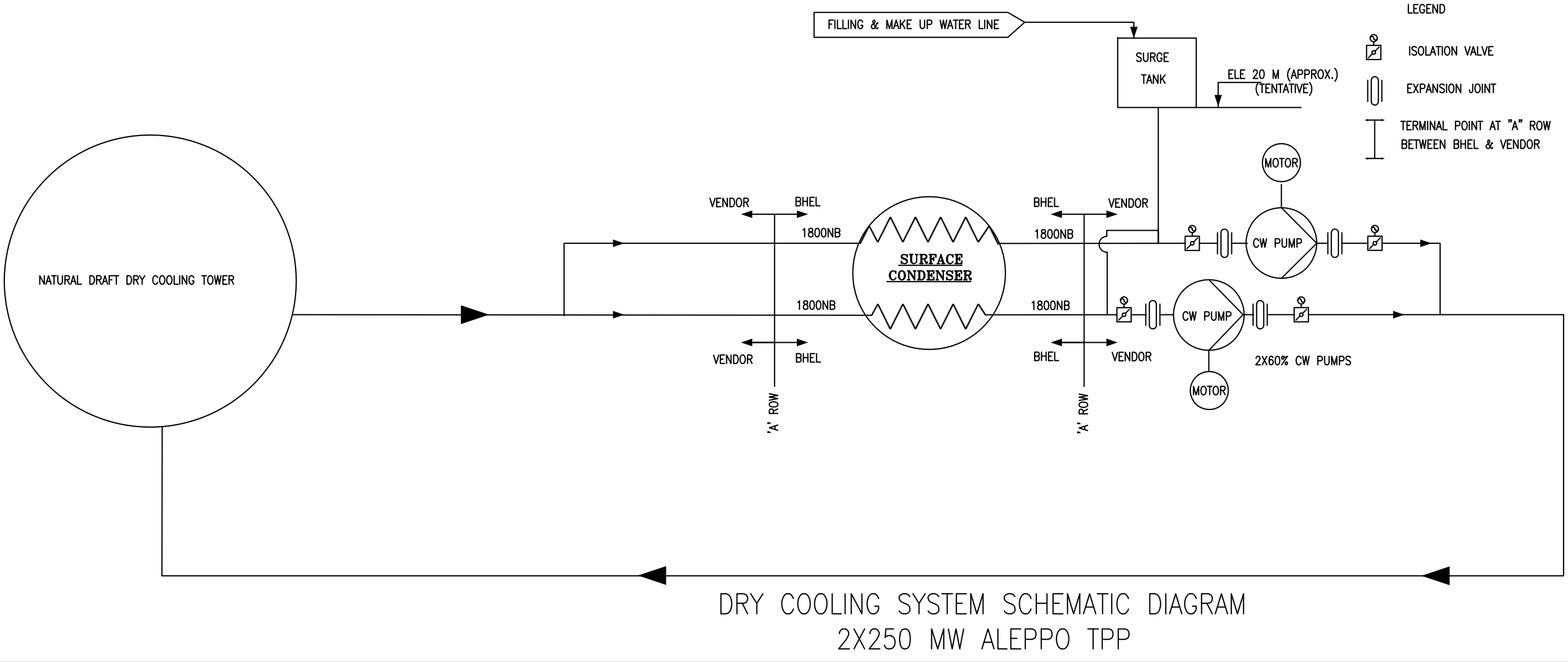
**12.02 The following documents/ information shall be furnished by the bidder in his offer for further inclusion in BHEL's offer to customer (refer relevant formats enclosed in section C):**

a) List of clarification/ deviations w.r.t customer specification, referring clause no./ page no. of specification.
b) List of drawing/ documents for Customer approval.
c) Vendor list of Dry cooling system.
d) Completely filled in Customer Datasheet/Technical schedules enclosed in Section C for the complete Dry cooling System.
e) List of temporary imports (if any).
f) Experience list of supply of complete dry cooling system with successful performance feedback from end Customer.
g) List of spare parts.
h) Any other document/information asked for in customer PEEGT's specification enclosed in section C.

**12.03 The following drawings/ documents shall be furnished by the bidder during contract stage.**

a) Process and Instrumentation diagrams for all main systems and sub systems.
b) Design philosophies with equipment sizing criteria's.
c) Descriptive write-ups with control philosophies.
d) Technical data sheets.
e) Structural design calculations.
f) General arrangement and cross-sectional arrangement drawings.
g) Layout drawings.
h) All civil foundation, civil construction drawings and civil loading details.
i) Erection and civil works field quality plans, welding procedure specifications, weld test procedures (visual/ DPT/ Radiography), log sheets, erection procedures/ manuals, commissioning procedure, etc.
j) Electrical/ C&I/ Civil drawings/ documents mentioned above.
k) Time schedule - CPM (PERT network) for complete dry cooling system.
l) PG test procedures, etc.

ANNEXURE 1




DRY COOLING SYSTEM SCHEMATIC DIAGRAM
2X250 MW ALEPPO TPP

**Syrian Arab Republic**
**Ministry of Electricity**
**Public Establishment of Electricity for Generation and Transmission**
**Contracts Department**

**External Call for Tenders No.: 305/ 2011**

Special book of juridical and financial conditions for the design, manufacture, supply, transport, insurance, testing, execution of the civil and erection works and putting into operation of the equipments, machineries and appliances for construction of steam power plant consisted of two steam units working on fuel, gas or both of them in the north area near Aleppo ( Al – Traifawi place) on turn key job basis, with total capacity of about (250±20%) M.W., for each steam unit., supply of spare parts, tools and some vehicles , training personnel from PEEGT externally and internally , connection with the substation with all needs to guarantee the safe operation and exploitation and laying pipes for bringing water from Al – Assad lake. This power plant should be responsive in future to be extended by two additional units in accordance with the quantities and technical specifications indicated in the attached technical conditions book and according to the following conditions:

**Art. 1 – Definitions:**

In addition to the expressions defined in the law No. 51 of 2004 and the book of general conditions issued by decree No. 450 of 2004 the following expressions and words are defined as shown:

PEEGT:
The Public Establishment of Electricity for Generation and Transmission.

The Sup-contractor:
Means any natural or moral person or his legal successors (except the Contractor) entitled to execute any part of the project after being approved in writing by PEEGT or its legal representatives.

The Consultant:
Means the natural or moral person named by PEEGT in the work site or in the manufacturing places and who is entitled in writing towards the contractor to represent PEEGT and to supervise the execution of the contract.

Consultant Representative:
Those persons who are entitled in writing by the consultant to perform tasks specified to the Contractor



**الجمهورية العربية السورية**
**وزارة الكهرباء**
**المؤسسة العامة لتوليد ونقل الطاقة الكهربائية**
**مديرية العقود**

**طلب عروض خارجي رقم 2011/305**

دفتر الشروط الحقوقية والمالية الخاص بتصميم وتصنيع وتوريد والنقل والتأمين والاختبار وتنفيذ الأعمال المدنية والتركيب والوضع بالتشغيل للتجهيزات والآلات والمعدات اللازمة، لبناء محطة توليد بخارية بمجموعتين بخاريتين تعملان على الفيول أو الغاز أو كليهما في المنطقة الشمالية- قرب مدينة حلب (موقع الطريفاوي) على أساس مفتاح باليد باستطاعة 250±20% ميغا واط لكل مجموعة بخارية، بما في ذلك توريد القطع التبديلية والعدد وتدريب عناصر المؤسسة داخلياً وخارجياً، وبعض الآليات الهندسية والوصل مع محطة التحويل، مع جميع ما يلزم لضمان التشغيل والاستثمار بشكل آمن، مع خط جر المياه من بحيرة الأسد، على أن تكون المحطة قابلة للتوسع المستقبلي بمجموعتين إضافيتين, وذلك وفقاً للكميات والمواصفات الفنية الواردة في دفتر الشروط الفني المرفق وحسب الشروط المبينة فيما يلي:

**المادة 1- تعاريف :**

بالإضافة إلى التعابير المعرفة في كل من القانون رقم 51 لعام 2004 ودفتر الشروط العامة الصادر بالمرسوم رقم 450 لعام 2004 يقصد بالتعابير والكلمات المدرجة فيما يلي ما هو مبين بجانب كل منها:

المؤسسة :
المؤسسة العامة لتوليد ونقل الطاقة الكهربائية.

المتعهد الثانوي :
هو كل شخص طبيعي أو اعتباري أو خلفائه القانونيين (عدا المتعهد) يعهد إليه بتنفيذ أي جزء من المشروع بموافقة خطية من المؤسسة أو ممثليها القانونيين.

المشاور:
هو الشخص الطبيعي أو الاعتباري المسمى من قبل المؤسسة في موقع العمل أو في أماكن الصنع والمخول خطيا تجاه المتعهد بتمثيل المؤسسة والإشراف على تنفيذ هذا العقد.

ممثلو المشاور:
هم الأشخاص المكلفين بشكل خطي من قبل المشاور لتنفيذ مهام تحدد للمتعهد في الرسالة الخطية التي

in the written letter that will be sent to him in this concern.

Drawings and Works:

The set of drawings to be presented and those works the Contractor is required to execute according to the contract.

Value of the contract:

The amount shown in the contract as well as any increases or decreases that may affect this amount in accordance with the terms of the contract.

Contractor's Equipment:

Mean all appliances, things, machines and vehicles of whatsoever nature which are not included, but needed for the execution and completion of the project, and/or its maintenance during guarantee period as well as the materials and other things which do not form a permanent part of it, and these equipment shall remain at the Contractor's property.

Project:

Means the machines, appliances, materials, equipment and things of all kinds required to be supplied, erected and executed in accordance with the contract, including the materials which will finally imported and are excessive for the project shall become the property of PEEGT.

Permanent Works:

Means the permanent works required to be executed and maintained according to the contract.

Temporary Works:

All temporary works of whatever kind they may be, which are required in execution, completion and maintaining of permanent works.

Turn-Key:

Mean execution of the project wholly in terms of delivery, erection, maintenance and putting into operation after testing all its parts, so that it fulfils its required function to the best.

Specifications:

Mean the specifications that are indicated in the call for tenders No.241/2007 and any modifications or additions issued by PEEGT and announced before the specified date for submitting the offers.

Drawings:

Mean those drawings indicated in the specifications and any modification of these drawings approved in writing by PEEGT.

The site:

Means land and other places on or through which works are to be executed, and any other lands or places presented by PEEGT for the execution of the project in addition to other places that may be included in the project file, and which form a part of the work-site.

ترسل له بهذا الخصوص.

المخططات والأعمال :

هي مجموعة المخططات المطلوب تقديمها والأعمال المطلوب تنفيذها من المتعهد بموجب العقد.

قيمة العقد :

المبلغ الوارد في العقد وكذلك أية إضافات أو تنزيلات يمكن أن تطرأ على هذا المبلغ عملاً بأحكام العقد.

تجهيزات المتعهد :

هي كل الأدوات والأشياء والآلات والآليات على اختلاف طبيعتها التي لا يتضمنها المشروع واللازمة لتنفيذه وإتمامه و/أو لصيانته خلال فترة الضمان، وكذلك المواد والأشياء الأخرى التي لا تشكل جزءاً ثابتا" من المشروع وتبقى هذه التجهيزات بملكية المتعهد.

المشروع :

هو الآلات والأجهزة والمواد والمعدات والأشياء من كل الأنواع المطلوب توريدها وتركيبها وتنفيذها بموجب العقد ، بما فيها المواد المستوردة نهائياً والفائضة عن المشروع وتبقى من ملكية المؤسسة.

الأعمال الدائمة :

هي الأعمال الدائمة المطلوب تنفيذها وصيانتها وفقاً للعقد.

الأعمال المؤقتة :

هي كل الأعمال المؤقتة أيا كان نوعها اللازمة لتنفيذ وإنجاز وصيانة الأعمال الدائمة.

مفتاح باليد:

يعني تنفيذ المشروع بشكل كامل من حيث التوريد والتركيب والإصلاح والتشغيل بعد اختبار جميع أجزائه بحيث يحقق الوظيفة المطلوبة منه على أحسن وجه.

المواصفات :

تعني المواصفات المشار إليها في طلب العروض موضوع البحث وأية تعديلات أو إضافات عليها تصدر عن المؤسسة ويعلن عنها قبل التاريخ المحدد لتقديم العروض.

المخططات :

تعني المخططات المشار إليها في المواصفات وأي تعديل على هذه المخططات يصادق عليه خطيا من قبل المؤسسة.

الموقع:

يعني الأراضي والأمكنة الأخرى التي ستنفذ الأعمال عليها أو ضمنها وأية أراضي أخرى أو أمكنة مقدمة من قبل المؤسسة لغاية تنفيذ المشروع إضافة للأمكنة الأخرى المحتمل تضمينها بإضبارة المشروع والتي تمثل جزءاً من موقع العمل.

Month:
Gregorian month.

الشهر:
هو شهر غريغوري.

Day:
Gregorian day.

اليوم:
هو يوم غريغوري.

Writing:
Means any letter or statement typed, written or printed and signed.

خطي:
تعني أية رسالة أو بيان مطبوع على الآلة أو منسوخ وموقع.

Approved:
Every document which is approved in writing by the PEEGT or the Contractor.

المصدّق:
هي كل وثيقة تصدّق بشكل خطي من قبل المؤسسة أو المتعهد.

Completion of the works:
Mean the completion by the contractor of all works, and the accomplishing of all tests, for all equipment individually and/or jointly for each part of any section of the project, in preparation for the declaration that this section is ready for the commercial operation.

انتهاء الأعمال:
هو إنهاء المتعهد لكافة الأعمال و إنجاز كافة التجارب لكافة التجهيزات منفردة و/أو مجتمعة ولكل جزء من أي قسم من المشروع تمهيدا" لإعلان جاهزية هذا القسم للتشغيل التجاري.

Commercial operation:
Mean the operation of each section for /24/ hours continuously without any interruption according to the requirement for the electric net work, which will be considered if succeeds as the completion of the execution period of concerned section.

التشغيل التجاري:
هو تشغيل كل قسم لمدة /24/ ساعة بصورة مستمرة وفق متطلبات الشبكة الكهربائية والذي يعتبر في حال نجاحه انتهاء مدة التنفيذ للقسم المعني.

Provisional acceptance tests:
Mean all the tests that the Contractor must carry out as specified in the technical conditions book, including the accomplishing of the preliminary performance tests and the operation of each section for /15/ days continuously without any interruption according to the requirement for the electric net work.

تجارب الاستلام المؤقت:
هي كافة التجارب المتوجب على المتعهد إجراؤها كما هو محدد في دفتر الشروط الفنية بما فيها إنجاز تجارب الأداء الأولية وتشغيل كل قسم لمدة /15/ يوماً بصورة مستمرة وفق متطلبات الشبكة الكهربائية.

Performance tests:
Those tests that include the measurement of the guaranteed rate of heat consumption and the maximum continuous capacity MCR as well as the peak capacity for a period of one hour and the maximum continuous capacity of the boiler as specified in the technical conditions book.
These tests are to be carried out in two stages:
A-A Preliminary stage, using the equipment erected at the power plant. It will be carried out before issuing the certificate of provisional acceptance.
B- A final stage in accordance with the book of Technical Conditions. It will be carried out within four months after issuing the provisional acceptance certificate.

تجارب الأداء:
هي التجارب التي تتضمن قياس معدل الاستهلاك الحراري المضمون والاستطاعة العظمى المستمرة واستطاعة الذروة لمدة ساعة والاستطاعة العظمى المستمرة للمرجل التي تجري على المجموعات وفق دفتر الشروط الفنية.

وتتم هذه التجارب على مرحلتين:
آ- مرحلة أولية وذلك باستعمال الأجهزة المركبة في المحطة، وتتم قبل إصدار شهادة الاستلام المؤقت.

ب- مرحلة نهائية حسبما هو وارد في دفتر الشروط الفنية وتتم خلال أربعة أشهر بعد إصدار شهادة الاستلام المؤقت.

Provisional Acceptance Certificate :
Means the certificate that must be issued by PEEGT for each section after the success of provisional acceptance tests, preliminary performance tests and continuous operation for /15/ days without any interruption according to the necessary load of the net work and the conditions of the normal operation of the equipment.

شهادة الاستلام المؤقت:
تعني الشهادة المتوجب على المؤسسة إصدارها لكل قسم بعد نجاح تجارب الاستلام المؤقت وتجارب الأداء الأولية والتشغيل لمدة /15/ يوم بصورة مستمرة وبدون أي انقطاع وفق الحمولات الضرورية للشبكة وفقاً لشروط التشغيل الطبيعية للتجهيزات.

Guarantee Period:

فترة الضمان:


3

Means the period during which the Contractor shall be responsible for any defect or deficiency that may appear in the executed works which were provisionally accepted.

Final Acceptance Certificate:

Means that certificate to be issued by PEEGT for all the works for each section after the expiration of the guarantee period.

Sections of the project:

The project consists of two sections as follows:

1- First section consists of the first steam turbine, boilers, generator and equipment for receiving and distribution of the fuel , gas and diesel oil inside the plant boundaries , water treatment plant, main transformer, unit transformer, main and secondary cooling system , fire fighting system , balance of plant, control system, connection with the substation , all necessary civil works, laying water pipes from Al-Assad lake and all that is necessary for safe operation of the first section.

2- Second section is consisted of the second steam turbine, boilers, generator and equipment for receiving and distribution of the fuel , gas and diesel oil inside the plant boundaries , main transformer, unit transformer, main and secondary cooling system , completion of the workers buildings and the general site , completion of the fire fighting system , control system, completion of connection with the substation , spare parts and tools , training, completion of the project and the civil works in accordance with the supplies and all that is necessary for safe operation of the second section.

**Art. 2- Object of the call for tenders:**

The object of this call for tenders is to invite the bidders to for the design, manufacture, supply, transport, insurance, testing, execution of the civil and erection works and putting into operation of the equipments, machineries and appliances for construction of steam power plant consisted of two steam units working on fuel, gas or both of them in the north area near Aleppo ( Al – Traifawi place) on turn key job basis, with total capacity of about (250±20%) M.W., for each steam unit., supply of spare parts, tools and some vehicles , training personnel from PEEGT externally and internally , connection with the substation with all needs to guarantee the safe operation and exploitation and laying pipes for bringing water from Al – Assad lake. This power plant should be responsive in future to be extended by two additional units .

وهي الفترة التي يكون المتعهد مسؤولاً فيها عن كل عيب أو نقص يحتمل ظهوره في الأعمال المنجزة والمستلمة استلاماً مؤقتاً.

شهادة الاستلام النهائي:

تعني الشهادة المتوجب على المؤسسة إصدارها لكامل الأعمال ولكل قسم بعد تاريخ انتهاء فترة الضمان.

أقسام المشروع:

يتألف المشروع من قسمين كما يلي:

1- القسم الأول: ويشمل العنفة البخارية الأولى والمرجل والمولدة وتجهيزات استقبال الفيول والغاز والمازوت وتوزيعه ضمن حدود المحطة ومحطة معالجة المياه والمحولة الرئيسية ومحولة الوحدة المساعدة ونظام التبريد الرئيسي والثانوي ونظام إطفاء الحريق والأنظمة المساعدة والملحقة ونظام التحكم والربط مع محطة التحويل وكافة الأعمال المدنية اللازمة مع خط جر المياه من بحيرة الأسد وكل ما يلزم لتشغيل القسم الأول بشكل آمن.

2- القسم الثاني: ويشمل العنفة البخارية الثانية والمرجل والمولدة وتجهيزات الفيول والغاز والمازوت وتوزيعه العائدة للمجموعة والمحولة الرئيسية ومحولة الوحدة ونظام التبريد الرئيسي والثانوي واستكمال كافة الأبنية والأبنية السكنية والموقع العام واستكمال نظام إطفاء الحريق ونظام التحكم واستكمال الربط مع محطة التحويل وكل ما يلزم لتشغيل القسم الثاني بشكل آمن وقطع التبديل والعدد والتدريب وإتمام المشروع والأعمال المدنية وفق حجم التوريدات.

**المادة 2- الغاية من طلب العروض:**

إن الغاية من طلب العروض هذا، هي دعوة العارضين لتقديم عروضهم لتصميم وتصنيع وتوريد والنقل والتأمين والاختبار وتنفيذ الأعمال المدنية والتركيب والوضع بالتشغيل للتجهيزات والآلات والمعدات اللازمة، لبناء محطة توليد بخارية بمجموعتين بخاريتين تعملان على الفيول أو الغاز أو كليهما في المنطقة الشمالية- قرب مدينة حلب (موقع الطريفاوي) على أساس مفتاح باليد باستطاعة 250±20% ميغا واط لكل مجموعة بخارية، ، بما في ذلك توريد القطع التبديلية والعدد وتدريب عناصر المؤسسة داخلياً وخارجياً، وبعض الآليات الهندسية والوصل مع محطة التحويل، مع جميع ما يلزم لضمان التشغيل والاستثمار بشكل آمن، مع خط جر المياه من بحيرة الأسد , على أن تكون المحطة قابلة للتوسع المستقبلي بمجموعتين إضافيتين.

**Art. 3- Qualification of the Bidders:**

1-The offers will be accepted only from one of the following two groups:

A- Manufacturer or Assembler of the main parts of the materials who executed similar projects.

B- Consortium where one of its members should be manufacturer or assembler of the main parts of the a/m materials and had executed similar projects.

2- The offer presented by the manufacturer or the assembler as mentioned should present the documents testifying his success in similar projects.

3- The offer presented by consortium should be enclosed with the following documents.

A- Copy of the agreement of the consortium duly approved by the special entities (the Chamber of Commerce and Industry and by the Syrian Embassy in bidder's country) clarifying in it the name of the authorized representative of the consortium.

b-The documents which prove that one of the members of the consortium had successfully executed similar project.

4-The bid bonds and the performance bonds should be presented by the names of all members of the consortium.

5-If the offer which is presented by the consortium is considered the best for PEEGT, then the contract will be signed by all members or by their representative.

6-All parts of the consortium are considered jointly and separately responsible towards PEEGT about their offer and about execution of the contractual obligation in case of concluding a contract.

7- The Bidder or any company or firm in the consortium, as well as the sub-contractors, should have a distinguished experience in the execution of the projects similar to the works described in this call for tenders.

8-The tenderer has to define the year of manufacturing the equipment which should be modern, new, not rehabilitated, not used or invested before, proven, having the same standards of design and volumes which are similar to those of successful and continuous operation and for a period to be defined by the bidder in his offer.

9- The Bidders shall take into consideration that some of the important priorities in the project are to put it at its high availability and good efficiency and should prove its success after testing.

10-The Bidder must mention his address in the offer and should notify PEEGT in case of changing his address.

11- Offers will be accepted only from the bidder who

**المادة 3- مؤهلات العارضين:**

1- لا تقبل العروض المقدمة إلا من إحدى الفئتين التاليتين:

آ- المصنع أو المجمع للأجزاء الرئيسية من التجهيزات الذي نفذ مشاريع مماثلة.

ب- ائتلاف شركات يكون أحد أطرافها مصنعاً أو مجمعاً للأجزاء الرئيسية من التجهيزات المذكورة وان يكون أيضا قد نفذ مشاريع مماثلة.

2- يجب أن يرفق بالعرض المقدم من المصنع أو المجمع على النحو المذكور الوثائق التي تثبت تنفيذه بنجاح مشاريع مماثلة.

3- يجب أن يرفق بالعرض المقدم من ائتلاف شركات الوثائق التالية:

آ- نسخة عن اتفاق الائتلاف مصدقة من المراجع المختصة (غرفة التجارة أو الصناعة و من السفارة السورية في بلد العارض) موضحاً فيه اسم الممثل المفوَّض من الائتلاف.

ب- الوثائق التي تثبت تنفيذ احد أطراف الائتلاف بنجاح مشاريع مماثلة.

4- تقدم كفالة التأمينات المؤقتة والنهائية باسم أطراف الائتلاف جميعاً.

5- إذا اعتبر العرض المقدم من ائتلاف شركات هو الأنسب لمصلحة المؤسسة يوقع العقد من أطرافه مجتمعين أو من قبل من يمثلهم أصولاً.

6- يعتبر أطراف الائتلاف مسؤولين أمام المؤسسة بالتكافل والتضامن عن عرضهم وعن تنفيذ الالتزامات العقدية في حال التعاقد.

7- يتوجب على العارض أو أية شركة أو مصنع يكون طرفاً في الكونسورتيوم وكذلك المتعهدين الثانويين أن يتمتعوا بخبرة مميزة في تنفيذ مشاريع مشابهة للأعمال الموصوفة في طلب العروض هذا ويتوجب أن تكون كافة التجهيزات المعروضة منتجة من قبل صانعين لهم خبرة مميزة.

8- يتوجب على العارض تحديد سنة الصنع للتجهيزات ، وأن تكون هذه التجهيزات حديثة وجديدة وغير مجددة ولم يسبق استعمالها أو استثمارها وأن تكون مجربة وبنفس أسس التصميم والأحجام المشابهة لتلك التي في الاستعمال المستمر والناجح ولمدة يتم تحديدها من قبل العارض في عرضه.

9- على العارضين أن يأخذوا بعين الاعتبار بأن من الأولويات الهامة في المشروع ضرورة كونه ذي جاهزية عالية ومردود جيد ويثبت نجاحه بعد التجربة.

10- على العارض ذكر عنوانه في العرض وفي حال تغييره إعلام المؤسسة بذلك.

11- لا يقبل العرض إلا من قبل العارض الذي سبق

has already purchased the file of this call for tenders.

له واشترى إضبارة طلب العروض هذا.

**Art. 4- Acquaintance of the Bidder with the tender documents and his acceptance:**

Every Bidder is considered to have had acquainted himself with the file of the call for tenders and that he has accepted its provisions. This file is considered an integral part of the contract, which will be concluded with the Bidder who is awarded the contract.

**المـادة 4- إطـلاع العـارض علـى إضـبارة طلـب العروض وقبوله لها.**

يعتبر كل من قدم عرضاً أنه اطلع على إضبارة طلب العروض وأنه قبل بأحكامها وتعتبر هذه الإضبارة جزءاً لا يتجزأ من العقد الذي سيبرم مع من سيحال عليه الالتزام.

**Art. 5- Preparation of the offers:**

The offers shall be submitted in English to the registry office of PEEGT inside an envelope containing /3/ red waxed sealed envelopes as follows:

-The first envelope: is to contain one original copy of each of the following:

1- Application for participation on which a stamp by SYP /1000/ is sticked .

2- Documents attesting obligation towards the conditions stated in article /11/ of law No. /51/ of 2004.

3- The receipt of purchasing the file of the subject by the name of the Bidder.

4- A written declaration from the bidder, in accordance with the attached sample, emphasizing his agreement to comply with all conditions and provisions of this book of conditions, without any reservations.

This declaration shall be one of the bases of determining the acceptance or non- acceptance of the offer before opening the remaining envelopes of the offer.

5 - a written declaration according to the attached sample on which the Offerer states in, if he has an Agent in Syria or not .

The Candidate Contractor has to submit a document testifying nomination of a commercial agent for him in Syria upon notifying him the award of the call for tenders ,according to the provisions of the legislative decree No.15 of 2001. This document will be considered one of the basic conditions of contracting.

The foreign company which has a permanent branch in Syria will be exempted from nominating a commercial agent. A copy of registering its branch in Syria shall be presented when awarding the contract.

6- A certificate approved by the chamber of industry or chamber of commerce and by the Syrian Embassy in the bidder's country (if there is one) indicating that the bidder is a manufacturer, producer, authorized distributor or assembler of the offered materials, or he is a commercial agent for the offering company, whose agency duly registered in Syria and effective.

Any tender, which do not include this document shall be rejected.

**المادة 5- تحضير العروض:**

تقدم العروض باللغة الإنكليزية إلى ديوان المؤسسة ضمن /3/ مغلفات مختومة بالشمع الأحمر وفق ما يلي:

-المغلف الأول: ويتضمن نسخة واحدة أصلية مما يلي:

1- طلب اشتراك بطلب العروض ملصق عليه طابع مالي بقيمة /1000/ ل.س.

2- الوثائق المشعرة بتوافر الشروط المنصوص عليها في المادة /11/ من القانون رقم /51/ لعام 2004 .

3- وصل شراء اضبارة الموضوع باسم العارض.

4- تصريح خطي من العارض وفق النموذج المرفق يؤكد فيه موافقته على الالتزام بكافة أحكام وشروط دفتر الشروط هذا دون أي تحفظ.

وسيكون هذا التصريح أحد الأسس في إقرار مبدأ قبول العرض أو رفضه قبل فض باقي مغلفات العرض.

5- تصريح خطي من العارض وفق النموذج المرفق يبين فيه العارض إذا كان له وكيل في سورية أم لا.

علماً بأن المتعهد المرشح سيلتزم بتقديم وثيقة تفيد بتسمية وكيل تجاري له مسجل في سورية، حال إبلاغه إحالة طلب العروض عليه وذلك وفقاً لأحكام المرسوم التشريعي رقم /15/ لعام 2001 وستعتبر هذه الوثيقة إحدى الشروط الأساسية للتعاقد.

وتستثنى من تسمية الوكيل التجاري الشركات الأجنبية التي لها فرع دائم في سورية على أن تقدم نسخة من تسجيل فرعها في سورية عند إحالة التعهد عليها.

6- وثيقة مصدقة من غرفة الصناعة أو غرفة التجارة ومن السفارة السورية في بلد العارض (إن وجدت) تثبت أن العارض صانعاً أو منتجاً أو موزعاً معتمداً أو مجمعاً للمواد المعروضة أو أن العارض وكيلاً تجارياً للشركة العارضة مسجلاً وكالته حسب الأصول في سورية ونافذة المفعول.

تحت طائلة رفض العرض الذي لا يقدم صاحبه هذه الوثيقة.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7-A clear statement of the origin and source of the materials .

7- بيان صريح بمنشأ ومصدر المواد.

8-A closed envelope containing the following conditions of Pre-Qualification:

8- مغلف مغلق يحتوي المعلومات التالية الخاصة بالتأهيل الأولي:

a- The financial solvency.

آ- الملاءة المالية.

b- Number of executed power projects in details during ten years.

ب- عدد مشاريع الطاقة المنفذة من قبل العارض خلال عشر سنوات.

c- Number of the similar power projects concerning capacity and type in details during ten years.

ج- عدد مشاريع التوليد المشابهة من حيث الاستطاعة والنوع بالتفصيل خلال عشر سنوات.

d- Number of the workers in the company.

د- عدد العاملين لدى الشركة.

e- Branches of the company in the world.

هـ- فروع الشركة في أنحاء العالم .

f- The business nature of the offering company ( a Contractor or manufacturer for some parts of power plants: turbine - generator - boiler).

و- طبيعة عمل الشركة العارضة (هل هي مكتب مقاول أم شركة مصنعة لأجزاء محطات التوليد الرئيسية عنفة ، مولدة ، مرجل).

i- The tenderer or any member of the consortium (if the offer is presented by consortium)has to present a document proving that he is a manufacturer of one of the main equipment of the project (turbine – generator – boiler) .

ز- على العارض أو أ حد أطراف تجمع الشركات (إذا كان العرض تجمع شركات) وتحت طائلة رفض العرض أن يقدم ما يثبت أنه مصنع لأحد التجهيزات الرئيسية للمشروع (عنفة - مولدة - مرجل) .

j- Disputes with the clients ( Arbitration ) .

ح- خلافات الشركة مع الزبائن (التحكيم).

k-The tenderer ought to have executed at least similar project concerning capacity and type out side his country and should present the supporting documents .

ط- يجب أن يكون العارض قد سبق وأنجز على الأقل مشروعاً مشابهاً من حيث الاستطاعة والنوع خارج بلده وأن يدعم ذلك بالوثائق المطلوبة تحت طائلة رفض العرض.

Any tender, which do not include these information shall be rejected.

تحت طائلة رفض العرض الذي لا يقدم صاحبه هذه المعلومات.

These informations should be evaluated before the technical evaluation of the offers.

هذه المعلومات يجب تقييمها قبل التقييم الفني للعروض.

-<u>The second envelope:</u> is to contain the technical offer with a schedule of quantities and the form of tender which is mentioned in the Technical Book of condition without prices on three copies one of which shall be original on turn key basis.

- <u>المغلف الثاني :</u> ويتضمن العرض الفني ، مع جداول الكميات وشكل العرض الوارد في دفتر الشروط الفنية بدون أسعار على ثلاث نسخ واحدة منها أصلية على أساس مفتاح باليد.

-<u>The third envelope:</u> is to contain the financial offer with the total and detailed prices and the form of tender, on three copies, one of which shall be original on a turn-key basis.

- <u>المغلف الثالث :</u> ويتضمن العرض المالي مع الأسعار الإجمالية والتفصيلية وشكل العرض مع ذكر الأسعار على ثلاث نسخ واحدة منها أصلية على أساس مفتاح باليد.

The original copy is to be stamped by the Bidder's seal and shall bear his live signature. The a/m three envelopes are to be put in a fourth sealed envelope on which is stated the number of the call for tenders and the name of the Bidder.

تمهر النسخة الأصلية بخاتم العارض ويوقعها توقيعا" حيا" وتوضع المغلفات الثلاث المشار إليها ضمن مغلف رابع مختوم يسجل عليه اسم العارض ورقم طلب العروض .

**<u>Art. 6-Evaluation Criteria of the offers:</u>**

**<u>المادة 6 - أسس تقييم العروض:</u>**

Criteria basis that will be used for tender evaluation will be as follows:

المعايير التي ستستخدم في تقييم العروض ستكون كما يلي:

The total Technical marks are 100 marks.

مجموع العلامات الفنية 100 علامة.

These marks will be distributed as follows:

موزعة على الشكل التالي:

**1-** Reference 15 marks.

1- المرجعية 15 علامات .

**2-** Mechanical & Chemical 60 marks.

2- الميكانيك والكيمياء 60 علامة.



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**3-** Electrical 14 marks.

**4-** I&C 6 marks**.**

**5-** Civil Works 5 Marks.

The Bidder who will score less than 70% marks will be rejected.

This will be according to the evaluation Criteria table attached with the Book of Financial and Technical Conditions.

3- الكهرباء 14 علامة.

4- التحكم 6 علامات.

5- الأعمال المدنية 5 علامات .

العرض الذي يحصل على علامة فنية تقل عن 70% من العلامة سوف يرفض.

وفقاً لجدول أسس التقييم المرفق بدفتر الشروط الفنية والمالية.

**Art. 7- Information to be included in the offer:**

To enable PEEGT to evaluate the offers correctly, Bidders shall present the following information inside or with each copy of the technical offer, in addition to the originally required information:

1- A list of the projects that the Bidder performed or those, under execution which are similar in nature and size to the project specified in this call for tenders, either inside his country or out of it.

This list shall include:

- Projects site.

-Number of these projects.

-Their specifications.

-Name and address of Owners.

-Date of contract's signing.

-Date of putting into operation.

2- In case the Bidder is to present equipment which are not produced by him, then he has to enclose an original document from the manufacturing company of such equipment, in which this company binds it self to supply the equipment in case this call for tenders is awarded to him.

Only one manufacturing company will be accepted for each kind of main equipments that are not produced by the bidder. In case the bidder mentions more than one company for the same equipments, then they should be in the same category and experience and subject to the approval of PEEGT.

3- Technical manuals (catalogues) and descriptive data for all the offered equipment.

4- Drawings that the Bidder finds necessary to clarify the project.

5- Site plan .

The tenderer has to present more than one alternative of the site plan putting on it the units and the auxiliaries in the best way concerning the areas, best performance and lowest loses.

**المادة 7- المعلومات الواجب تضمينها في العرض:**

من أجل تمكين المؤسسة من تقييم العروض بشكل صحيح، يتوجب على العارض تقديم المعلومات التالية ضمن أو مع كل نسخة من العرض الفني إضافة للمعلومات المطلوبة أصلاً:

1- لائحة بالمشاريع التي أنجزها العارض أو الجاري تنفيذها والمماثلة في طبيعتها وحجمها للمشروع المحدد في طلب العروض هذا سواء داخل بلده أو خارجه.

ويجب أن تتضمن هذه اللائحة:

- موقع المشاريع.

- عدد هذه المشاريع.

- مواصفاتها.

- اسم وعنوان مالكها.

- تاريخ توقيع العقد.

- تاريخ الوضع بالخدمة.

2- في حال تقديم العارض لتجهيزات ليست من إنتاجه، فعليه إرفاق وثيقة أصلية من الشركة المصنعة لهذه التجهيزات تلتزم فيها بتوريدها في حال إحالة طلب العروض هذا عليه.

لا يقبل من العارض سوى اسم شركة صانعة واحدة لكل نوع من التجهيزات الرئيسية التي لا يقوم العارض بتصنيعها، وفي حال قيام العارض بذكر أكثر من شركة واحدة لنفس التجهيزات فيجب أن تكون من نفس السوية والخبرة وتخضع لمصادقة المؤسسة.

3- النشرات الفنية (كاتلوكات) والمعلومات الوصفية لكل التجهيزات المعروضة.

4- المخططات التي يراها العارض ضرورية لتوضيح المشروع.

5- مخطط الموقع العام .

على العارض تقديم أكثر من بديل لمخطط الموقع العام موضعاً عليه المجموعات وملحقاتها بالشكل الأمثل فيما يخص المساحات والأداء الأفضل والضياعات الأقل .


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6- Alternative choices:

The tenderer can present technical alternatives for the required equipment that are specified by PEEGT in the Technical Book of Condition. They should be within the general requirement and within the following limits:

-required capacity 250±20% for each unit.

-limitation of quantily of water and way of dry cooling.

-requirements and general components of the project.

The tenderer has to state the advantages of the offered alternatives for the purpose of evalution.

**Art.8- Bidder's obligation to fill in the schedules:**

The Bidders shall fill in the technical schedules and the financial schedules with all details. This should be done clearly and understandably to avoid any misinterpretation. Any offer, which will not be in conformity with that, shall be rejected.

**Art. 9- Future Supplies, spare parts, special tools and test and calibration instruments:**

The contractor undertakes to present lists of the spare parts and tools described by PEEGT and has to present also lists of spare parts and tools suggested by him for operation of ten years with detailed prices. He has to keep these prices for two years from the date of final acceptance .

He has also to ensure all deliveries necessary for the project in future including the spare parts, special tools and instruments of testing and calibration after the expiry of the guarantee period.

The prices of these deliveries will be determined by mutual agreement, but shall not exceed in any case the prices mentioned in the price list of the manufacturer or the current prices whichever is lower at the purchasing date. These deliveries including the spare parts, should be new and not renewed and produced by the main factory from which the main equipment and parts are supplied unless this factory stopped to work. Then the two parties shall agree upon the origin of these equipment and parts.

During the validity of this contract, PEEGT has the right to conclude with the contractor a mutual separate contract to purchase some additional spare parts with the same specification and prices as mentioned in the contractor's offer that are not included in the contract.

**Art. 10 - Commitment periods:**

A- Option period :

Option period is /120/ days from the next day to the closing date for submitting the offer. In case the name of awarded Contractor is not specified during this period, then the offers shall be definitely extended for another /120/ days.

6- الخيارات البديلة :

يمكن للعارض أن يعرض بدائل فنية لأي من التجهيزات المطلوبة والمحددة من قبل المؤسسة في دفتر الشروط الفني على أن تبقى من حيث الإطار العام المطلوب وضمن الحدود التالية:

- مجال الاستطاعة المطلوبة 250±20% ميغاواط لكل مجموعة .
- محدودية كمية المياه وطريقة التبريد الجاف .
- المتطلبات ومكونات المشروع العامة .

وعلى العارض أن يبين ميزات البدائل المعروضة من قبله ليتم تقييمها.

**المادة 8- التزام العارض بملء الجداول:**

على العارضين ملء الجداول الفنية والجداول المالية مع كافة التفاصيل وبشكل واضح ومفهوم ويمنع أي التباس وذلك تحت طائلة رفض العروض التي لا تتقيد بذلك.

**المادة 9- التوريدات المستقبلية والقطع التبديلية والعدد الخاصة وأجهزة الفحص والاختبار:**

يلتزم العارض بتقديم لوائح القطع التبديلية والعدد الموصوفة من قبل المؤسسة كما يلتزم بتقديم لوائح قطع التبديل والعدد المقترحة من قبله لتشغيل المحطة لمدة عشر سنوات مع ذكر الأسعار التفصيلية وعلى أن يلتزم بهذه الأسعار لمدة سنتين من تاريخ الاستلام النهائي.

كما يلتزم بتقديم جميع التوريدات اللازمة للمشروع في المستقبل بما فيها قطع التبديل اللازمة بعد انتهاء فترة الضمان مع العدد الخاصة وأجهزة الفحص والاختبار.

وتحدد أسعار تلك التوريدات باتفاق الفريقين على أن لا يزيد بأي حال من الأحوال عن الأسعار الواردة في نشرة أسعار الشركة الصانعة أو الأسعار الرائجة أيهما أقل بتاريخ الشراء ويجب أن تكون هذه التوريدات بما فيها القطع التبديلية جديدة وغير مجددة ومن صنع المعمل الأساسي الذي تم توريد التجهيزات والقطع الأساسية من قبله ما لم يكن هذا المصنع قد توقف عن العمل حيث يتفق على مصدر هذه التجهيزات والقطع بين الفريقين.

يحق للمؤسسة خلال فترة نفاذ العقد إبرام عقد مستقل بالتراضي مع المتعهد لشراء بعض القطع التبديلية الإضافية وبنفس المواصفات والأسعار الواردة في عرض المتعهد والتي لم يتم التعاقد عليها بموجب العقد.

**المادة 10- مدد الارتباط:**

آ- مدة ارتباط العارضين بعروضهم:

مدة ارتباط العارضين بعروضهم هي/120/ يوماً تبدأ من اليوم التالي لتاريخ آخر موعد لتقديم العروض وفي حال عدم تحديد اسم المتعهد المرشح خلال هذه الفترة، تعتبر العروض ممددة حكماً لمدة /120/ يوماً أخرى.


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In case the Bidder wants to withdraw from his offer, he has to present a letter to be registered in the registration office of PEEGT within seven days that follow the expiry of the option period or its extension.

B- Commitment of the awarded contractor to his offer:

The awarded contractor is considered as committed to his offer for a period of /180/ days from the following day of the date of notifying him awardness of the contract.

**Art. 11- Place and date of submitting the offers:**

1-The offers shall be submitted to the registration office of PEEGT at the hour and on the date specified in the announcement of this call for tenders.

PEEGT shall not carry out the clearance of any offer or document relating to it from the airport or post office. Only the date of submitting the offer from the concerned side to the registration office of PEEGT shall be considered as the date of accepting the offer.

2- In case the closing date of submitting the offers happens to be a holiday or a weekend for PEEGT, then the first working day, following the day previously stated, shall be considered the closing date of submitting the offers at the same previously stated hour.

3-Considering the article /10/ of this call for tenders, one offer only shall be accepted from each bidder. After registering the offer at the registration office of PEEGT, the bidder has not the right to take it back, complete or modify.

**Art. 12-Comparison of the offers:**

1-Opening and examination of the offers will be carried out in secret meetings, by authorized committees. No information relating to the examination, clarification and evaluation of offers and recommendations concerning the award should be communicated after opening of the offers, to any person not officially concerned with this process until awarding the contract.

2-In comparing the offers, PEEGT is not obliged to award the offer to the bidder that gave the lowest prices, but it will take into consideration during the comparison of the offered prices, the technical specifications, the guarantee period, the responsibility, the costs of maintenance and operation and any other factors that may affect the final cost of the project subject of this call for offers.

3-Comparison of the prices shall be made on the basis of Euros and by converting the Syrian Pounds into Euros according to the rate in the neighboring countries which is specified in the official bulletin of the rate of exchange issued by the Central Bank of Syria on the day of opening the financial offer.

The comparison prices shall be reviewed again

في حال رغبة العارض بالانسحاب من عرضه فعليه أن يتقدم بطلب يسجل في ديوان المؤسسة خلال سبعة أيام تلي انتهاء هذا الارتباط أو تمديده.

ب- مدة ارتباط المتعهد المرشح بعرضه:

يعتبر المتعهد المرشح مرتبطاً بعرضه لمدة /180/ يوماً من اليوم التالي لتاريخ تبليغه خطياً إحالة التعهد عليه.

**المادة 11- مكان وزمان تسليم العروض:**

1- تسلم العروض إلى ديوان المؤسسة وذلك في الساعة والتاريخ المحددين في إعلان طلب العروض هذا.

ولن تقوم المؤسسة بالتخليص على أي عرض أو وثيقة خاصة به سواء ورد ذلك عن طريق المطار أو البريد ولا يعتد بأي تاريخ لقبول العرض إلا من تاريخ تسليمه من الجهة المعنية إلى ديوان المؤسسة.

2 - في حال مصادفة تاريخ آخر موعد لتسليم العروض يوم عطلة أو راحة أسبوعية في المؤسسة، فيعتبر أول يوم عمل هو آخر موعد لتسليم العروض في الساعة المحددة سابقاً.

3 - مع مراعاة أحكام المادة /10/ من طلب العروض هذا، لا يقبل من العارض إلا عرض واحد، ولا يجوز استعادة العرض أو إكماله أو تعديله بعد تسجيله في ديوان المؤسسة.

**المادة 12 - مقارنة العروض:**

1 - يتم فض ودراسة العروض في جلسات سرية من قبل لجان مفوضة بذلك وسوف لن تجر أية اتصالات بعد فض العروض تتعلق بمعلومات عن دراسة العروض أو تقييمها أو توضيحات عنها وكذلك أية توصيات تتعلق بالإحالة مع أي شخص غير معني بشكل رسمي بهذه الإجراءات ولحين إحالة العقد.

2 – لا تلتزم المؤسسة في مقارنة العروض بإحالة طلب العروض على صاحب أرخص الأسعار الفعلية لكنها ستأخذ بعين الاعتبار أثناء المقارنة الأسعار المعروضة والمواصفات الفنية ومدة الضمان والمسؤولية ونفقات الصيانة والتشغيل وأي عناصر أخرى قد تؤثر على الكلفة النهائية للمشروع موضوع طلب العروض هذا.

3– تجري مقارنة أسعار العروض باليورو وذلك بتحول العملة السورية إلى اليورو وفق الأسعار في الدول المجاورة والتي تحدد في النشرة الرسمية لأسعار العملات الصادرة عن مصرف سورية المركزي بتاريخ فض العروض المالية .

ويعاد النظر في أسعار المقارنة مرة ثانية عند الإحالة


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according to the bulletin issued by the Central Bank of Syria on the date of awarding the tender.

**Art. 13- Awarding of the call for tenders:**

1-This call for offers shall be awarded to the best bidder as soon as that may be possible.

2- Within /30/ days of notifying the contractor the award, he should come to PEEGT offices in Damascus for the purpose of acquainting himself with the text of the contract and signing it.

3-The awarded contractor shall submit the performance bond before signing the contract and within a maximum period of /30/ days after being notified of the award.

**Art. 14- Prices:**

1- The offered prices should be fixed and the offer should not include any equation for the revision of the prices, otherwise it may be rejected.

2- Prices should be offered in Euros and in Syrian Pounds to cover the value of local materials and services calculated on the neighboring countries exchange rate of the Syrian currency which is specified in the bulletin of the rate of exchange issued by the Central Bank of Syria.

3- The prices should be finally presented on turn- key job basis and any following reduction will be rejected

4- It is known that the Bidder has included the following in his offered prices:

A- All expenses, taxes and duties according to the text of article /19/ of this book.

B- Workers insurance expenses in the Establishment of Social Insurance.

C- Expenses of custom's clearance for all materials and equipment of the project and the contractor's equipment.

D-Bank charges resulting from the prolongation or modification of the letter of credit if these are due to the responsibility of the Contractor. PEEGT is bound to pay the bank expenses incurred from opening and confirming the letters of credits and remittance of the due payments to the Contractor if there are such payments.

E- Expenses and commissions of issuing the bank guarantees that the Contractor must present including their stamp duty.

F- All expenses due on presenting the consumable spare parts for operating and maintaining all equipment presented by him and also all consumable materials (oil – grease – Chemicals…) till the end of the guarantee period of the last section of the project and on his own expenses.

5- The Bidders shall submit their prices on turn – key basis.

**Art.15 - Advance payment:**

وفق النشرة الصادرة عن مصرف سورية المركزي بتاريخ الإحالة.

**المادة 13 - إحالة طلب العروض:**

1- سيحال طلب العروض هذا على العارض الأفضل بأقصى سرعة ممكنة.

2- على المتعهد المرشح وخلال /30/ يوماً من تبلغه الإحالة، الحضور إلى مبنى المؤسسة في دمشق للإطلاع على صيغة العقد وتوقيعه.

3- على المتعهد المرشح تقديم التأمينات النهائية قبل توقيع العقد وعلى الأكثر خلال مدة /30/ يوماً من تاريخ تبلغه الإحالة.

**المادة 14- الأسعار :**

1- يجب أن تكون الأسعار المعروضة ثابتة ويجب أن لا يتضمن العرض أية معادلة لمراجعة الأسعار تحت طائلة رفض العرض في حال المخالفة.

2- يجب أن تقدم الأسعار بعملة اليورو، وبالليرات السورية لتغطية قيمة المواد والخدمات المحلية محسوبة على أساس سعر التحويل للعملة السورية في الأسواق المجاورة وفق نشرة الأسعار الصادرة عن مصرف سوريا المركزي.

3- تقدم الأسعار بشكل نهائي على أساس مفتاح باليد ولا يقبل تقديم أي تخفيض لاحق عليها.

4- من المعلوم أن العارض ضمن أسعاره المعروضة ما يلي:

آ- كافة النفقات والضرائب والرسوم وفق النص الوارد في المادة /19/ من هذا الدفتر.

ب- نفقات تأمين العمال لدى مؤسسة التأمينات الاجتماعية.

ج- نفقات التخليص الجمركي على كافة مواد وأدوات وتجهيزات المشروع وتجهيزات المتعهد.

د-كافة النفقات المصرفية الناشئة عن تمديد أو تعديل الاعتمادات المستندية في حال كون طلب التعديل أو التمديد بسبب تعود مسؤوليته على المتعهد ، علماً بأن المؤسسة تلتزم بتسديد النفقات المصرفية الناجمة عن فتح وتثبيت الاعتمادات المستندية وتحويل الدفعات المستحقة للمتعهد في حال وجودها .

هـ نفقات وعمولات إصدار الكفالات المصرفية المتوجب على المتعهد تقديمها بما في ذلك رسم الطابع عليها .

و- كافة النفقات المترتبة على تقديم القطع التبديلية المستهلكة لتشغيل وصيانة جميع التجهيزات المقدمة من قبله وكذلك تقديم كافة المواد المستهلكة ( زيوت - شحوم - مواد كيماوية...الخ ) حتى انتهاء فترة الضمان لآخر قسم من المشروع وعلى نفقته الخاصة.

5- على العارضين تقديم أسعارهم على أساس مفتاح باليد.

**المادة 15- السلفة:**


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PEEGT will grant to the awarded Bidder an advance payment equal to (10%) of the total value of the contract, against submission by the contractor of a commercial invoice and a bank guarantee issued or confirmed by a Syrian bank and equal to the advance payment. The advance payment shall be paid after the commencement order.

**Art. 16- Term of payment:**

Payment of the value of the contract which will be concluded with the awarded Contractor will be according to the following :

- 10 % of the contractual value in foreign and local currencies, shall be paid as advance payment within a month from the date of submitting by the Contractor of a commercial invoice which should be approved by PEEGT and a bank guarantee equal to the advance payment and issued or confirmed by a Syrian Bank against an advice from PEEGT to the correspondence bank through the Syrian bank stating that PEEGT has received the a.m document.

This guarantee will be reduced gradually in proportion with the values of the delivered equipment and executed services and at the rate of once every three months, and upon the request of the Contractor.

- 5 % of the contractual value in foreign and local currencies, shall be paid within a month of approving the main general drawings of the project against an advice from PEEGT to the correspondence bank through the Syrian bank stating that the contractor has submitted a commercial invoice, which should be approved by PEEGT and a letter from PEEGT notifying the approval of these drawings.

- 65% of the contractual value in foreign and local currencies, shall be effected in proportion with the value of supplied equipment and performed services, upon the submittal by the Contractor of the following regular shipping documents concerning the supplied equipment:

1 - A commercial invoice in /12/ copies one of which to be original and duly certified by the Syrian Embassy or Consulate (if there is one), and by the concerned Chamber of Commerce in the country of the Contractor. These invoices should include clearly the full name of the manufacturer.

2 - Bill of lading and/or Air-way bill and/or land transporter consignment (as the case may be), in five copies, one of which to be original.

3 - Certificate of origin in /4/ copies, one of which to be original and duly certified by the Syrian Embassy or Consulate (if there is one) and by the concerned Chamber of Commerce in the country of origin or the country of export with the statement of Israel boycott.

4 - Packing and weight list in five copies.

تمنح المؤسسة سلفه لمن سيحال عليه الالتزام قدرها (10%) من القيمة الإجمالية للعقد لقاء تقديم المتعهد فاتورة تجارية وكفالة مصرفية صادرة عن مصرف سوري أو معززة من قبله معادلة لقيمة السلفة ولا تسدد السلفة إلا بعد تاريخ أمر المباشرة.

**المادة 16- طريقة التسديد:**

يتم تسديد قيمة العقد الذي سيبرم مع المتعهد المرشح حسبما يلي:

- 10% من القيمة التعاقدية بالعملة الأجنبية وبالعملة المحلية تدفع كسلفة خلال شهر من تاريخ تقديم المتعهد فاتورة تجارية وكفالة مصرفية معادلة لقيمة السلفة صادرة عن مصرف سوري أو معززة من قبله لقاء إشعار من المؤسسة إلى المصرف المراسل عن طريق المصرف السوري يفيد بأن المؤسسة استلمت الوثائق المذكورة أعلاه ومصادقة المؤسسة على تلك الفاتورة.

وتخفض هذه الكفالة المصرفية تدريجيا بالتناسب مع قيم التجهيزات الموردة والخدمات المنجزة بواقع مرة كل ثلاثة أشهر وبطلب من المتعهد.

- 5% من القيمة التعاقدية بالعملة الأجنبية والعملة المحلية تدفع خلال شهر من تصديق المخططات العامة الرئيسية للمشروع، لقاء إشعار من المؤسسة إلى المصرف المراسل عن طريق المصرف السوري يفيد بقيام المتعهد بتقديم فاتورة تجارية ورسالة من المؤسسة تشعر بتصديق تلك المخططات ومصادقة المؤسسة على تلك الفاتورة.

- 65% من القيمة التعاقدية بالعملة الأجنبية والعملة المحلية تدفع مجزأة بالتناسب مع قيمة التجهيزات الموردة والخدمات المنجزة لقاء تقديم المتعهد وثائق الشحن النظامية التالية فيما يخص التجهيزات الموردة:

1- فاتورة تجارية على /12/ نسخة منها واحدة أصلية ومصدقة حسب الأصول من السفارة السورية أو القنصلية ( إن وجدت ) ومن غرفة التجارة ذات العلاقة في بلد المتعهد وعلى أن تتضمن هذه الفواتير بيان باسم الصانع بشكل واضح.

2- بوليصة شحن بحري و/أو جوي و/أو وثيقة نقل بري (حسب الحال) على خمس نسخ منها واحدة أصلية.

3- شهادة منشأ على /4/ نسخ واحدة منها أصلية و مصدقة من السفارة السورية أو القنصلية (أن وجدت) ومن غرفة التجارة ذات العلاقة في بلد المنشأ أو بلد التصدير مع بيان بمقاطعة إسرائيل.

4-لائحة كميات وأوزان على خمس نسخ.


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5 - Manufacturing control certificate issued by the Consultant and/or the delegates of PEEGT for those equipment and materials controlled by him, if PEEGT intent to control the manufacture of the materials and equipment. The list of equipment shall be agreed upon during contracting.

5- شهادة مراقبة الصنع الصادرة عن المشاور و/أو مندوبي المؤسسة فيما يتعلق بالمواد والتجهيزات التي راقب صنعها فيما إذا رغبت المؤسسة في مراقبة صنع المواد والتجهيزات وسوف يتم الاتفاق على لائحة التجهيزات عند التعاقد.

6-Material test certificate issued by the manufacturing factory.

6- شهادة اختبار المواد الصادرة عن المعمل الصانع .

A copy of each of the above mentioned documents is to be sent directly to PEEGT – Contracts Directorate – Foreign Contracts Department in Damascus.

ترسل نسخة عن كل من هذه الوثائق مباشرة إلى المؤسسة – مديرية العقود - دائرة العقود الخارجية بدمشق .

The payments related to the accomplished services shall be effected against commercial invoices and monthly invoices duly approved by PEEGT and arranged on the basis of the schedules of the unit prices.

يتم تسديد الدفعات الخاصة بالخدمات المنجزة بموجب فواتير تجارية وكشوف شهرية مصدقة من المؤسسة ومنظمة استنادا لجداول الأسعار الإفرادية.

All above mentioned foreign currency payments will be paid through an irrevocable and confirmed L/C which allow for partial payments and shipments, and which is opened in favour of the Contractor..

يتم تسديد دفعات العملة الأجنبية عن طريق فتح اعتماد مستندي لصالح المتعهد غير قابل للإلغاء وقابل للشحن والتسديد الجزئيين ومثبت لأمر المتعهد.

All Syrian (local) currency payments will be paid by bank transfer to the account of the Contractor which is opened at a Syrian bank.

يتم تسديد دفعات العملة السورية (المحلية) عن طريق التحويل المصرفي لحساب المتعهد الذي يفتح لدى أحد المصارف السورية.

The other payments shall be effected as follows:

أما بقية المبالغ فتدفع على الشكل التالي:

- 10% of the total contracted value in foreign and local currencies shall be paid partially and in proportion with the value of each section upon the completion of the works and the commercial operation for /24/ hours continuously for each section of the contracted sections against an advice from PEEGT to the correspondence bank through the Syrian bank, stating that the Contractor submitted a commercial invoice and a letter notifying PEEGT of the completion of the works and the success of the commercial operation of the concerned section and that PEEGT approved this invoice and letter.

-10% من القيمة التعاقدية الإجمالية بالعملة الأجنبية والعملة المحلية تدفع مجزأة وبالتناسب مع قيمة كل قسم عند انتهاء الأعمال والتشغيل التجاري لمدة (24) ساعة متواصلة لكل قسم من الأقسام المتعاقد عليها لقاء إشعار من المؤسسة إلى المصرف المراسل عن طريق المصرف السوري يفيد بقيام المتعهد بتقديم فاتورة تجارية ورسالة منه تعلم المؤسسة عن انتهاء الأعمال والتشغيل التجاري الناجح ومصادقة المؤسسة على تلك الفاتورة والرسالة.

- 10% of the total contracted value in foreign and local currencies shall be paid partially and in proportion with the value of each section upon the provisional acceptance for each section of the contracted section against an advice from PEEGT to the correspondence bank through the Syrian bank, stating that the Contractor submitted a commercial invoice and bank guarantee issued by a Syrian bank or confirmed by it by 50% of the amount paid for provisional acceptance and the provisional acceptance certificate of the concerned section and the provisional acceptance certificate of the concerned section.

-10% من القيمة التعاقدية الإجمالية بالعملة الأجنبية والعملة المحلية تدفع مجزأة وبالتناسب مع قيمة كل قسم عند الاستلام المؤقت لكل قسم من الأقسام المتعاقد عليها مقابل إشعار من المؤسسة إلى المصرف المراسل عن طريق المصرف السوري يفيد بقيام المتعهد بتقديم فاتورة تجارية وكفالة مصرفية صادرة عن مصرف سوري أو معززة من قبله بقيمة 50% من القيمة المدفوعة للاستلام المؤقت وشهادة الاستلام المؤقت للقسم المعني.

The Consultant and the project manager at site nominated by PEEGT have to approve the monthly invoices and the progress reports within (15) days from the date of submitting them by the Contractor.

يتوجب على المشاور ومدير المشروع في الموقع التي تسميه المؤسسة المصادقة على فواتير وتقارير العمل الشهرية خلال (15) يوما" من تاريخ تسليمها لهما من قبل المتعهد.

The a/m monthly invoices shall be paid within (30) days from the date of their registration complete with the required legal documents mentioned in this item, in the registration office of the financial department of PEEGT.

تدفع الكشوف الشهرية آنفة الذكر خلال (30) يوما" من تاريخ تسجيلها مستكملة لوثائقها وشرائطها القانونية المنوه بها في هذه الفقرة في ديوان المديرية المالية للمؤسسة.

**Art. 17- Maritime transport:**

**المادة 17-النقل البحري:**

The Contractor is allowed to ship the supplies subject of this project between the shipping ports and destination in Syria by any shipping company that he deems suitable .

يسمح للمتعهد بأن يشحن التوريدات الخاصة بهذا المشروع بين مرافئ الشحن والوصول في سورية، عن طريق شركة الملاحة التي يراها مناسبة.

The Contractor should inform PEEGT by cable, telex or fax /48/ hours before the date of executing the shipment, about the name of the transporting vessel and its departure date as well as the expected date of its arrival.

يلتزم المتعهد بإعلام المؤسسة العامة لتوليد ونقل الطاقة الكهربائية برقيا أو بواسطة التلكس أو الفاكس قبل /48/ ساعة من تاريخ تنفيذ الشحن باسم الباخرة الناقلة وتاريخ مغادرتها والتاريخ المتوقع لوصولها.

The Contractor should mention the following information on each of the bills of lading, air way bills, parcels and shipping cases concerning the project:

على المتعهد ذكر المعلومات التالية على كل من بوالص الشحن البحرية والجوية والطرود والصناديق المشحونة الخاصة بالمشروع:

Public Establishment of Electricity for Generation and Transmission.

المؤسسة العامة لتوليد ونقل الطاقة الكهربائية.

Material for Al-Traifawi steam power station in Aleppo governorate.

مواد مشروع محطة توليد الطريفاوي البخارية – محافظة حلب.

Contract No.:

العقد رقم:

Letter of Credit No:

الاعتماد المستندي رقم:

The way of packing the supplies and the kind of the materials which will be used for this purpose shall be according to the International regulations of maritime transportation.

يجب أن تكون طريقة التغليف للتوريدات ونوع المواد المستعملة في التغليف وفقاً للقواعد الدولية للنقل البحري.

Packing materials of the materials and equipment of the project shall be the property of PEEGT except for the containers .

تعود ملكية مواد التغليف الخاصة بمواد وتجهيزات المشروع للمؤسسة عدا الحاويات .

The Contractor will be responsible for any damage incurred of the supplies due to insufficient packing.

كل ضرر يصيب المواد المتعاقد عليها من جراء تغليف غير كاف يقع على عاتق المتعهد.

**Art. 18- Land and Air Transportation:**

**المادة 18- النقل البري والجوي:**

The Contractor has the right to transport a part or the whole of the equipment from the country of origin to Syria by land, railway or by airline, provided that PEEGT shall not be charged for any additional expenses. He has the right to transport by any airline company that he deems suitable.

يحق للمتعهد أن ينقل بعض التجهيزات أو كلها من بلد المنشأ إلى سورية عن طريق البر أو السكك الحديدية أو الجو دون أن يترتب على ذلك أي نفقات إضافية على المؤسسة، ويسمح للمتعهد بالشحن الجوي عن طريق شركة الطيران التي يراها مناسبة.

**Art. 19 – Expenses of contracting and taxes and duties:**

**المادة 19- النفقات الناجمة عن التعاقد والضرائب والرسوم:**

Taking into consideration the article No. /14/, the Contractor shall bear all expenses and taxes and duties arising outside of the SAR from the execution of the contract including:

مع الأخذ بالاعتبار المادة /14/، يتحمل المتعهد كافة النفقات والضرائب والرسوم التي تترتب خارج الجمهورية العربية السورية على تنفيذ العقد بما فيها:

- Stamp duty on both copies of the contract amounting to 0.8 % (eight per thousand) of the value of the currency or currencies given in the contract shall be deducted from the L/C and will be paid in the equivalent in Syrian pounds by PEEGT to the

- رسم الطابع على نسختي العقد بواقع 0,8% (ثمانية بالألف ) من قيمة العملة أو العملات الواردة في العقد والتي سيتم حسمها من قيمة الاعتماد وستقوم المؤسسة بدفع ما يعادلها بالليرات السورية إلى وزارة المالية في الجمهورية العربية السورية

Ministry of Finance in the SAR (General Treasury Fund ) on the account No. 3541/23 opened at Central Bank of Syria during /30/ days starting from the following day of the date of commencement order.

(صندوق الخزينة العامة) على الحساب رقم 23/3541 المفتوح لدى مصرف سورية المركزي، وذلك خلال ثلاثون يوماً تبدأ من اليوم التالي لتاريخ أمر المباشرة.

- Bank charges laid on bank guarantees which shall be presented by the Contractor including their Stamp duty.

- النفقات المصرفية المترتبة على الكفالات المصرفية المتوجب على المتعهد تقديمها بما فيها رسم الطابع عليها .

- Duties of consular approval.

- رسوم التصديق القنصلي.

- All port fees and stevedoring.

- رسوم المرفأ والتجريم والتبريز.

- Indirect taxes and duties laid on materials purchased locally for the purpose of executing the project.

- الضرائب والرسوم غير المباشرة المترتبة على المواد المشتراة محليا" لغرض تنفيذ المشروع.

While PEEGT shall bear all other taxes and duties laid inside the SAR including:

بينما تتحمل المؤسسة كافة الضرائب والرسوم الأخرى التي تترتب داخل الجمهورية العربية السورية بما فيها:

- Custom duties taking into consideration the following:

- الرسوم الجمركية مع الأخذ بالاعتبار ما يلي:

a- PEEGT will pay the custom duties for all materials and equipment of the project for one time, while the Contractor will bear the custom duties in case of his compulsion to import some of them for more than one time due to defect or damage or any other reason.

أ - تقوم المؤسسة بتسديد الرسوم الجمركية على تجهيزات ومواد المشروع لمرة واحدة، بينما يتحمل المتعهد الرسوم الجمركية في حال اضطراره لاستيراد بعضها لأكثر من مرة بسبب عطل أو ضرر أو لأي سبب آخر.

b- The materials that are available locally, like Cement, reinforced stee and wood, the Contractor will bear all custom duties, expenses and fees, in case of imprting from out Syrian Arab Republic.

ب- المواد المتوفرة محلياً مثل الاسمنت، حديد التسليح والأخشاب فيتحمل المتعهد كافة الرسوم الجمركية والنفقات في حال توريدها من خارج الجمهورية العربية السورية.

- Expenses of confirming the L/C.

- نفقات تعزيز الاعتماد المستندي.

- Real profits tax laid on the Contractor.

- ضريبة الأرباح الحقيقية.

- As for income tax laid on the salaries and wages.

- ضريبة الدخل على الرواتب والأجور.

The a/m taxes, duties and expenses that are laid inside S.A.R. and which will be borne by the Contractor, will be applied according to the valid laws and rules in Syrian Arab Republic.

بالنسبة للضرائب والرسوم والنفقات المترتبة داخل الجمهورية العربية السورية التي يتحملها المتعهد والمبينة أعلاه حصرا، ستفرض وفق القوانين والأحكام النافذة في الجمهورية العربية السورية.

**Art. 20 – Bid and Performance Bond:**

**المادة 20- التأمينات المؤقتة والنهائية:**

1-Bidder shall present a bid bond by Euros /3000 000/ three million Euros only, within the specified period for presenting the offers. The bid bond is to be submitted in cash, approved cheque for the order of PEEGT or in a bank guarantee issued or confirmed by a Syrian bank according to the enclosed text. Any offer shall be definitely rejected in case the required bid bond is not presented within the period specified for submitting the offers to PEEGT.

1- على العارض تقديم التأمينات المؤقتة ضمن المدة المحددة لتقديم العروض بمبلغ /3000000/ يورو، فقط ثلاثة ملايين يورو. تقدم التأمينات المؤقتة نقداً أو بشيك مصدق لأمر المؤسسة أو بكفالة مصرفية صادرة عن مصرف سوري أو معززة من قبله وفق النص المرفق تحت طائلة الرفض الحتمي لكل عرض لا يودع التأمينات المطلوبة في المؤسسة ضمن المدة المحددة لتقديم العروض.

Bidder is bound to make the validity period of the bid bond equal to the option period of the offer. He has to extend its validity during the whole period of the option period.

يلتزم العارض بأن تكون مدة صلاحية التأمينات المؤقتة متساوية مع مدة الارتباط بالعرض كما يلتزم بتمديدها طيلة مدة ارتباطه بعرضه.

These bid bonds shall be returned to all Bidders except the awarded Bidder after announcing the result of the call for Offers.

تعاد هذه التأمينات المؤقتة إلى كافة العارضين باستثناء المتعهد المرشح بعد إعلان نتيجة طلب العروض .

2-Performance bond is defined by an amount equivalent to 5 % of the total value of every currency

2- أما التأمينات النهائية فتحدد بنسبة 5% من القيمة الإجمالية لكل عملة واردة في العقد ويجب أن تقدم


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mentioned in the award of the contract. It shall be presented by a bank guarantee in the official text and issued in Arabic by a Syrian bank within a maximum period of /30/ days from the date of notifying the awarded contractor of the award and before signing the contract.

بكفالة مصرفية بالنص الرسمي وصادرة عن مصرف سوري باللغة العربية وذلك خلال مدة حدها الأقصى /30/ يوما" من تاريخ تبليغ المتعهد المرشح الإحالة عليه وقبل توقيع العقد .

These guarantees and the guarantees which will be submitted by the Contractor against payment of the provisional acceptance shall be returned after issuing the final acceptance certificate for the whole project and after submitting to PEEGT a discharge from each of the Ministry of Finance, the Customs Administration and the Social Insurance Establishment notifying of the release of the Contractor towards them concerning the project.

تعاد هذه التأمينات وكذلك التأمينات التي يقدمها المتعهد مقابل تسديد دفعة الاستلام المؤقت بعد إصدار شهادة الاستلام النهائي لكامل المشروع وبعد تقديم كتاب إلى المؤسسة من كل من وزارة المالية وإدارة الجمارك ومؤسسة التأمينات الاجتماعية يشعر ببراءة ذمة المتعهد عن المشروع تجاهها.

In case of impossibility to submit these letters or some of them, a portion of the guarantees proportional to the amounts which will be due, shall be kept.

وفي حال تعذر تقديم هذه الكتب أو بعضها، يحجز من الكفالات جزء يتناسب والذمة التي قد تترتب على المتعهد.

**Art.21-Temporary admission and temporary import:**

**المادة 21 الإدخال المؤقت والاستيراد المؤقت:**

1- The Contractor has the right to benefit from the regulations governing temporary admission and import valid in SAR, concerning the materials, equipment, vehicles and machines required for the project execution.

1- يحق للمتعهد الاستفادة من أنظمة الإدخال المؤقت والاستيراد المؤقت النافذة في الجمهورية العربية السورية بالنسبة للمواد والمعدات والآلات اللازمة لتنفيذ المشروع.

PEEGT will render assistance to the Contractor in the formalities required in this respect but will not bear any responsibility or any additional incurred expenses.

تقدم المؤسسة إلى المتعهد المساعدة اللازمة للقيام بالمعاملات المطلوبة لهذا الغرض دون أن تتحمل المؤسسة أية مسؤولية أو نفقات إضافية نتيجة ذلك.

The Contractor shall submit the required bank guarantee to the Syrian Customs Administration for the purpose of guaranteeing the temporary admission declaration.

يقدم المتعهد الكفالة المصرفية اللازمة لصالح إدارة الجمارك السورية لضمان بيانات الإدخال المؤقت تجاهها.

When the need for these materials, equipment, vehicles and machines comes to an end, the Contractor can sell all or part of them in the local markets after paying what PEEGT had already paid for them. The provisions of foreign trade and customs shall be respected regarding that.

يمكن للمتعهد عند انتهاء الحاجة إلى هذه المواد والمعدات والآليات والآلات بيعها كلها أو جزءا منها في الأسواق المحلية بعد تسديد ما تكون قد دفعته المؤسسة عنها مع احترام الأحكام المتعلقة بالتجارة الخارجية والجمارك.

PEEGT has the preference right to buy them for a price agreed upon by the two parties.

وللمؤسسة حق الأفضلية لشرائها بسعر يتفق عليه الطرفان.

After approval of foreign currency office, the Contractor has the right to transfer the value arising from this sale outside the SAR according to the applicable laws and regulations.

وللمتعهد بعد موافقة مكتب القطع حق تحويل المبالغ الناجمة عن هذا البيع إلى خارج الجمهورية العربية السورية وفق الأنظمة والقوانين النافذة.

The vehicles, equipment and materials whose import is controlled by the Government can be sold only to the Syrian General Establishment which is concerned in this.

أما الآليات والتجهيزات والمواد المحصور استيرادها بالدولة فلا يمكن بيعها إلا إلى الجهة العامة السورية التي تتعاطى الاتجار بها.

2- The Contractor shall bear all taxes, duties and expenses due to the benefit from the temporary admission and temporary import.

2- يتحمل المتعهد كافة الضرائب والرسوم والنفقات الناجمة عن استفادة المتعهد من الإدخال المؤقت والاستيراد المؤقت.

3- The Contractor shall discharge the temporary declaration presented for the clearance of the

3- يتوجب على المتعهد تسديد البيانات المؤقتة المقدمة للتخليص على المواد التي ستوضع في


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materials which will be put in local consumption and substitute them by final declarations within a period not exceeding the period already specified by the Syrian Customs Administration. The Contractor shall bear all penalties resulting from the delay in discharging these declarations and his performance bond shall not be freed completely unless a deed of release is given by the Customs Administration indicating that the declarations were discharged.

الاستهلاك المحلي ببيانات نهائية وذلك خلال فترة لا تتجاوز المدة المحددة لذلك من قبل إدارة الجمارك السورية ويتحمل كافة الغرامات المترتبة على التأخير في تسديد هذه البيانات ولن تحرر كامل قيمة كفالته النهائية ما لم يقدم براءة ذمة من إدارة الجمارك تفيد تسديد البيانات المذكورة.

These conditions shall not be applied on the materials imported finally and were excessive for the project and shall become the property of PEEGT.

لا تطبق هذه الأحكام على المواد المستوردة نهائياً والفائضة عن المشروع وتبقى من ملكية المؤسسة.

**Art. 22- Social Insurance Participation;**

**المادة 22-الاشتراك بالتأمينات الاجتماعية:**

The Contractor shall be subjected to the labour law valid in the Syrian Arab Republic concerning employment and disemployment of Syrian workers. He shall also be subjected to the legislations concerning social insurance valid in SAR, especially those related to work accidents and illnesses of profession as a result of the work nature. He shall bear all insurance payments relating to that and also all payments of the social insurance arising from the execution of the contract.

يخضع المتعهد لقانون العمل النافذ في الجمهورية العربية السورية فيما يتعلق باستخدام وتسريح العمال السوريين كما يخضع أيضا للتشريعات الخاصة بالتأمينات الاجتماعية النافذة في الجمهورية العربية السورية وخاصة ما يتعلق منها بطوارئ العمل والأمراض المهنية الناتجة عن طبيعة العمل ويتحمل تسديد جعالات التأمين المتعلقة بذلك وكذلك الجعالات المترتبة للتأمينات الاجتماعية على تنفيذ العقد .

**Art. 23 - Insurance of the project:**

**المادة 23- التأمين على المشروع:**

The Contractor shall insure, at his own expense, the materials, equipment, tools and requirements imported for the project through one of the International insurance companies. This insurance shall be for the time extending from the date of departure of the goods of the manufacturing factories including the period of their arrival to the work site, the period spent at the work site, and the period for erection, until issuing of the provisional acceptance certificate.

يلتزم المتعهد على نفقته بالتأمين لدى إحدى شركات التأمين العالمية على المواد والتجهيزات والأدوات واللوازم الموردة لحاجة المشروع طيلة الفترة الممتدة بين مغادرتها لمعامل الصنع ولغاية وصولها إلى موقع العمل وكذلك أثناء وجودها في موقع العمل وأثناء تركيبها أيضا" وحتى تاريخ إصدار شهادة الاستلام المؤقت .

**Art. 24 -Commencement order:**

**المادة 24- أمر المباشرة:**

The Contractor is considered to be notified the commencement order from the date of notifying him the opening of the operative L/C.

يعتبر المتعهد مبلغاً لأمر المباشرة اعتباراً من تاريخ تبليغه فتح الاعتماد المستندي الفعال.

**Art. 25 - Handing over the sites:**

**المادة 25- تسليم مواقع العمل:**

After putting the contract into force, PEEGT undertakes to hand over the sites to the contractor free of any obstacles. The contractor within a maximum period of (15) days from the PEEGT's invitation date to him, has to take over them, otherwise, the sites will be considered definitely taken by him .

يتوجب على المؤسسة وبعد وضع العقد موضع التنفيذ تسليم مواقع العمل للمتعهد خالية من العوائق وعلى المتعهد خلال مدة أقصاها (15) يوما" من تاريخ دعوة المؤسسة له القيام باستلامها، وإلا تعتبر المواقع مستلمة من قبله حكما".

**Art. 26- The execution periods :**

**المادة 26- مدد التنفيذ:**

The contractor undertakes to execute the project within shortest possible period and for each section.

تحدد مدة التنفيذ الكلية للمشروع بأقصر مدة ممكنة ولكل قسم على حده، وتعتبر عنصر مفاضلة بين العارضين وليس عنصر رفض.

Execution period is considered as preference element between tenderes and not as rejection element.

The execution periods start from the next day of the commencement order.

وتبدأ مدة التنفيذ اعتباراً من اليوم التالي لتاريخ أمر المباشرة.

The shortest offered execution period will be considered the base in comparison. Any bidder will be

تعتبر أقل مدة توريد معروضة هي الأساس في إجراء المقارنة بين العارضين وكل مدة تنفيذ زيادة


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penalized an amount equal to (0.1)% (one per thousand) of his offered prices on turn key basis for each day exceeding that period. The ceiling of the penalty will not exceed 20% (twenty per cent) of these prices.
And this will be applied on each section .

**Art. 27 – Penalties:**

**1- Penalties of delay in the execution:**

The Contractor, who is late in completion of any section of the sections over the periods of execution contracted upon, shall bear a daily penalty of delay by (0.1%) one per thousand of the total value of the delayed executed Section for each day of delay.
It should be pointed out that the ceiling of the penalty of delay for each section will not exceed 20 % (twenty per cent) of the total value of the delayed executed section.
Also, the ceiling of the total penalty of delay for the sections will not exceed 20 % (twenty per cent) of the total contracting value.

**2- Penalties of delay in the submission of the execution schedule:**

In case the contractor did not present the required execution program (CPM) within the period specified in Art. (30), he will pay a penalty equal to Euros /1000.-/ for each day of delay.

**3- Technical penalties :**

The contractor shall pay the following technical penalties if it appears after tests, that the real figures are not realizing the guaranteed ones by him:
a- Penalty of excess of fuel consumption:
The contractor shall pay for each steam unit a penalty equal to Euros. /350,000.-/ for each one Kcal (or part of it) /KWh of the net heat consumption in excess of the figures guaranteed by him.
b- Penalty of decrease of peak load:
The contractor shall pay a penalty equal to Euros /200.-/ for each one K.W. (or part of it) of the peak load below than the figures guaranteed by him for each steam unit.
c- Penalty of decrease of Continuous Maximum Rating:
The contractor shall pay penalty equal to Euros /800.-/ for each one K.V. (or part of it) of the Continuous Maximum Rating below than the C.M.R. guaranteed by him for each steam unit.
d- Penalty of decrease of Continuous Maximum Rating of the boiler :
The contractor shall pay a penalty equal to Euros /100.-/ for each one K.W. (or part of it) of the Continuous Maximum Rating of the boiler below than the C.M.R. guaranteed by him for each boiler.



عن هذا الأساس يغرم عارضها بمقدار (0,1)% (واحد بالألف) من أسعاره المعروضة على أساس مفتاح باليد عن كل يوم زيادة وبسقف غرامة لا يتجاوز20% (عشرون بالمائة) من تلك الأسعار.
ويطبق ذلك لكل قسم .

**المادة 27- الغرامات:**

**1- غرامات التأخيرفي التنفيذ:**

يترتب على المتعهد الذي يتأخر في إنجاز أي قسم من الأقسام عن مدد التنفيذ المتعاقد عليها غرامة تأخير يومية قدرها (0,1)% واحد بالألف من القيمة الإجمالية للقسم المتأخر في إنجازه عن كل يوم تأخير.
هذا وتجدر الإشارة إلى أن سقف غرامة التأخير عن القسم الواحد لن يتعدى نسبة 20% (عشرون بالمائة) من القيمة الإجمالية للقسم المتأخر في إنجازه.

كما أن سقف غرامة التأخير الإجمالية للمشروع لن يتعدى نسبة 20% (عشرون بالمائة) من القيمة الإجمالية التعاقدية.

**2- غرامات التأخير في تقديم برنامج التنفيذ:**

إذا لم يقدم المتعهد برنامج التنفيذ المطلوب (CPM) ضمن المدة المحددة في المادة (30) يغرم بمبلغ /1000/ يورو عن كل يوم تأخير.

**3- الغرامات الفنية:**

يترتب على المتعهد الغرامات الفنية التالية فيما إذا تبين نتيجة التجارب أن الأرقام الفعلية لم تحقق الأرقام المضمونة من قبله لكل مجموعة:
آ- غرامة زيادة استهلاك الوقود:
يدفع المتعهد عن كل مجموعة بخارية غرامة قدرها /350000/ يورو عن كل واحد كيلو كالوري أو جزء منه لكل ك.و. س من الاستهلاك الحراري الصافي أكثر من الرقم المضمون من قبله.
ب- غرامة نقص استطاعة الذروة:
يدفع المتعهد غرامة قدرها /200/ يورو عن كل نقص في استطاعة الذروة قدره واحد كيلو واط أو جزء منه عن استطاعة الذروة المضمونة من قبله لكل مجموعة بخارية.
ج- غرامة نقص الاستطاعة العظمى المستمرة:

يدفع المتعهد غرامة قدرها /800/ يورو عن كل نقص في الاستطاعة العظمى المستمرة قدره واحد كيلو واط أو جزء منه عن الاستطاعة المضمونة من قبله لكل مجموعة بخارية.
د- غرامة نقص الاستطاعة العظمى المستمرة للمرجل:
يدفع المتعهد غرامة قدرها /100/ يورو عن كل نقص في الاستطاعة العظمى المستمرة للمرجل قدره واحد كيلوغرام بالساعة أو جزء منه عن الاستطاعة العظمى المستمرة للمرجل المضمونة من قبله لكل

مرجل .

Penalty of cost of maintenance and operation during the 25 years age of the plant including the cost of consumption of the spare parts, periods and frequency of the maintenances, cost of operation, oil, grease, chemicals and fuel. The tenderer has to present detailed schedules of change in the amounts of the guarantee in accordance with the process of aging of the units and equipment during the actual age of the plant.

هـ- غرامة تكاليف الصيانة والتشغيل على مدار عمر المحطة 25 سنة متضمنة تكاليف استهلاك القطع التبديلية ومدد الصيانات وتواترها وتكاليف التشغيل والزيوت والشحوم والمواد الكيميائية والوقود مع جداول تغير قيم الضمان وفقاً لتقادم المجموعات وتجهيزاتها على مدار العمر العملي للمحطة والتي على العارض تقديم تفاصيل لها في عرضه لغرض تقييم العرض.

The above mentioned penalties (A-B-C-D) are applied if the actual figures are worse than the guaranteed figures up-to 5% only for the capacity and maintenance and operation cost and 3% for the fuel consumption but if the difference is more than that, then PEEGT has the full right to reject the project.

إن الغرامات المذكورة أعلاه الفقرات (أ،ب،ج،د) تطبق في حالة كون الأرقام الفعلية أسوأ من الأرقام المضمونة لغاية 5% فقط بالنسبة للاستطاعة وتكاليف الصيانة والتشغيل و3% بالنسبة لاستهلاك الوقود، أما إذا كان الفرق أكثر من ذلك فإن للمؤسسة الحق الكامل برفض المشروع.

The above meutioned items of penalty (A-B-C-D) will be used for the purpose of comparison during evaluation.

سيتم استخدام بنود الغرامات أعلاه (أ،ب،ج،د،هـ) لغرض المقارنة خلال مرحلة التقييم.

3- The ceiling of the penalty of delay has no connection with the penalty in presenting the execution program or with the technical penalties and the two penalties will be added together if they are due.

3- إن سقف غرامة التأخير في التنفيذ لا علاقة له بغرامة التأخير في تقديم برنامج التنفيذ أو بالغرامات الفنية ويتم الجمع بينهما في حال تحقق هذه الغرامات.

**Art. 28- Withdrawal of the execution of the project:**

**28- سحب تنفيذ المشروع:**

PEEGT has the right to withdraw the execution of the project or any part of it and to execute the project or the withdrawn part at the expense of the Contractor.

للمؤسسة الحق في سحب تنفيذ المشروع أو أي جزء منه وتنفيذ المشروع أو جزئه المسحوب على حساب المتعهد.

In implementing the above, the provisions governing the subject as stipulated in each of the following are applied :

وتطبق في تنفيذ ذلك الأحكام الناظمة للموضوع الواردة في كل من :

A – Contracts regulations issued by law No. 51 of 2004, and especially the provisions of its articles 54,55 and 59.

آ – نظام العقود الصادر بالقانون رقم /51/ لعام 2004 ولا سيما أحكام مواده ذوات الأرقام 54 و 55 و59.

B – Book of general conditions of PEEGT issued by decree No. 450 dated 2004 and especially the provisions of the two articles No. 15B AND 42 .

ب- دفتر الشروط العامة الصادر بالمرسوم 450 لعام 2004 ولا سيما أحكام المادتين 15/ب و 42.

**Art. 29- Increase and decrease of the project size:**

**المادة 29- زيادة و إنقاص حجم المشروع:**

In accordance with article /62/ of the law /51/ of 2004 the orderer of Expense may increase or decrease the materials, equipment or works contracted upon during the execution period of the contract by a rate of 30% of each item or article of the contract by the same conditions and prices mentioned in the contract without concluding a new contract. The total value of the increase or decrease should not exceed 25% of the total value of the contract.

استناداً للمادة /62/ من القانون 51 لعام 2004 يجوز لآمر الصرف زيادة أو إنقاص المواد والتجهيزات والأعمال المتعاقد عليها خلال مدة تنفيذ العقد بنسبة لا تتجاوز30% لكل بند أو مادة من التعهد على حدة وذلك بنفس الشروط والأسعار الواردة في العقد دون الحاجة إلى عقد جديد على أن لا تتجاوز قيمة مجموع الزيادة أو النقص 25% من القيمة الإجمالية للعقد.

In the case of increase, the Contractor shall be given an additional period proportional with the nature and amount of the increase for this increase only.

يعطى المتعهد في حال الزيادة مدة إضافية تتناسب مع طبيعة ومقدار هذه الزيادة وذلك من أجل هذه الزيادة فقط.

**Art. 30 - Execution program:**

**المادة 30- برنامج التنفيذ:**

1- The Contractor has to submit to PEEGT within a

آ- على المتعهد أن يقدم للمؤسسة خلال فترة عشرة

period of ten days from the date of commencement order, a critical path method (CPM) program, indicating in it measures and steps he would like to follow in executing the project, as well as specifying the times during which he expects to fulfill each of the important stages of the contract. He has to mention the critical stages in it also

أيام من تاريخ أمر المباشرة برنامجا شبكيا (طريقة المسار الحرج CPM) يوضح فيه الإجراءات والخطوات التي يرغب بإتباعها في تنفيذ المشروع ويعين فيه الآجال التي يتوقع أن ينهي خلالها كل من المراحل الهامة المشمولة بالعقد وأن يبين المسارات الحرجة فيه.

2- PEEGT shall notify the Contractor of its approval within /30/ days from the date of being notified of this program, or shall ask him to modify it during that period, if its interest requires that according to the contract and its provisions. This request shall be suitable to the specified periods for execution of the whole works.

2- وعلى المؤسسة أن تبلغ المتعهد موافقتها خلال /30/ يوما من تاريخ تبلغها هذا البرنامج أو أن تطلب إليه تعديله خلال تلك الفترة حسبما تقتضيه مصلحتها ضمن حدود وأحكام العقد وبشكل يتناسب مع المدة المحددة لتنفيذ مجموع الأعمال.

3- The Contractor should stick to the program approved by PEEGT or modified by it and to work according to it during execution. He is not allowed to shift its limits or to change any part of it without the written approval of PEEGT.

3- يترتب على المتعهد التقيد بالبرنامج الذي وافقت عليه المؤسسة أو الذي جرى التعديل عليه والعمل بموجبه أثناء التنفيذ و لا يجوز له الخروج عن حدوده أو تغيير أي جزء منه إلا بموافقة خطية من المؤسسة.

4- The Contractor undertakes to submit periodically monthly reports to PEEGT in ten copies during the execution of the contract. He will indicate the progress of the works and their stages according to the execution program mentioned in this article.

4- يلتزم المتعهد بتقديم تقارير دورية شهرية للمؤسسة على عشرة نسخ أثناء تنفيذ العقد، يبين فيها مدى تقدم الأعمال ومراحلها وفقا" لبرنامج التنفيذ المشار إليه في هذه المادة.

5- The Contractor shall take into consideration that PEEGT will approve and/or put the comments on the general drawings of the project, within one month from the date of registering them in the registration office of PEEGT.

5- على المتعهد أن يأخذ بالاعتبار أن المؤسسة ستقوم بالمصادقة و/أو وضع الملاحظات على المخططات الرئيسية للمشروع خلال شهر من تاريخ تسجيلها بديوان المؤسسة.

**Art. 31- Completion of the works:**

**المادة 31- انتهاء الأعمال:**

Considering article /39/ of decree No. 450 of 2004:

مع الأخذ بالاعتبار ما ورد في المادة 39 من المرسوم 450 لعام 2004:

The Contractor shall inform PEEGT by letter, to be registered at its registration office, about the date of completion of the works of the first section of the project, concerning the supply and erection of all equipment of this section, and ending all pre-commissioning tests of them, as well as to indicate in the a/m letter, his readiness to hand over it to PEEGT ready for commercial operation.

على المتعهد أن يعلم المؤسسة بكتاب خطي يسجل في ديوانها، التاريخ الذي انتهت فيه أعمال القسم الأول من المشروع من حيث توريد وتركيب كافة تجهيزات هذا القسم وإنهاء كافة تجارب ما قبل التشغيل عليها، وعليه أن يبين في ذلك الكتاب استعداده لتسليمه للمؤسسة جاهزاً للتشغيل التجاري.

PEEGT shall refer this letter within one week from the date of its registration at most to the party supervising the execution to make sure that the works were actually completed on the date specified by the Contractor.

على المؤسسة أن تحيل هذا الكتاب خلال أسبوع من تاريخ تسجيله على الأكثر إلى الجهة المشرفة على التنفيذ لتتبين فيما إذا كانت تلك الأعمال قد انتهت فعلا" في التاريخ الذي حدده المتعهد.

In case of any deficiency, defect or non conformance with the terms of the contract is observed in any of the works, requirements and of the equipment relating to the operation and exploitation of this section or any part thereof. PEEGT has the right to reject the declaration of the completion of the works of this section and to ask the Contractor to complete the

يحق للمؤسسة إذا وجدت في هذا القسم أو أي جزء منه أو في أي من الأعمال واللوازم والتجهيزات المتعلقة بتشغيله واستثماره أي نقص أو عيب أو مخالفة لشروط العقد، أن ترفض إعلان انتهاء الأعمال لهذا القسم، وأن تطلب إلى المتعهد استكمال تلك النواقص و إصلاح تلك العيوب وإزالة تلك المخالفات.


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deficiencies, repair the defects, and remove the discrepancies.

If these observed deficiencies, defects and discrepancies are of the common type, which can be repaired relatively easily and which do not hinder the operation of the first section mentioned above, PEEGT will declare the completion of the work if its interests require that, and will accept the request of the Contractor to operate this section by him for /24/ hours continuously according to the requirement of the national net work. The success of this commercial operating, will be considered as the date of completion of the execution period of the first section.

أما إذا كانت تلك النواقص والعيوب والمخالفات الملحوظة من النوع العادي التي يمكن إصلاحها بسهولة نسبية ولا تعيق تشغيل القسم الأول المشار إليه، فللمؤسسة إذا وجدت أن المصلحة تسمح بذلك أن تعلن انتهاء الأعمال وتوافق على طلب المتعهد بتشغيل هذا القسم من قبله لمدة /24/ ساعة مستمرة وفق متطلبات الشبكة العامة وفي حال نجاح هذا التشغيل التجاري فيعتبر هو تاريخ انتهاء مدة التنفيذ للقسم الأول.

The same measures will be followed concerning the second section of the project .

تتبع نفس الإجراءات بالنسبة للقسم الثاني من المشروع.

**Art. 32- Provisional Acceptance:**

**المادة 32- الاستلام المؤقت:**

After the completion of the works and the successful of the commercial operation of the first section, the provisional acceptance committee which will be nominated by PEEGT will start the works for provisional acceptance, and shall record the observed deficiencies, defects and discrepancies with a special reservation in order to have them completed or performed by the Contractor during a period to be specified for him or PEEGT, according to its estimation, will deduct an amount from his due payments equal to these defects or deficiencies which will be completed by its self whenever finds that suitable.

بعد إعلان انتهاء الأعمال والتشغيل التجاري الناجح للقسم الأول تقوم لجنة الاستلام المؤقت التي تسميها المؤسسة بالمباشرة بأعمال الاستلام المؤقت وتسجيل النواقص والعيوب والمخالفات الملحوظة بتحفظ خاص ليجري إما استكمالها أو إنجازها من قبل المتعهد خلال مدة تحدد له أو حسم مبلغ من استحقاقاته يساوي حسب تقدير المؤسسة قيمة تلك العيوب والنواقص لتستكملها بنفسها في الوقت الذي تراه مناسباً.

If the protocol of provisional acceptance includes remarks concerning repair or defects, the Contractor has to execute them within a period to be specified by the committee of acceptance but it shall not exceed the guarantee period.

إذا ورد في محضر الاستلام المؤقت ملاحظات بإصلاحات أو عيوب يكلف المتعهد بإنجازها خلال مدة تحدد له من قبل لجنة الاستلام على أن لا تتجاوز مدة الضمان.

Before the provisional acceptance of the first section of the project, the Contractor shall remove all extra rubbish, debris and soils as well as the patches and dirt at his own expense in a way to be considered acceptable by PEEGT.

على المتعهد قبل الاستلام المؤقت للقسم الأول من المشروع أن يقوم بإزالة جميع الفضلات والأنقاض والأتربة الزائدة ويرفع جميع البقع والأوساخ على نفقته بالشكل الذي تعتبره المؤسسة مقبولا.

The Contractor has to execute the provisional acceptance and the preliminary performance tests successfully, in a way to be accepted by the provisional acceptance committee, before handing over the first section to PEEGT.

قبل تسليم القسم الأول إلى المؤسسة، يقوم المتعهد بإنجاز تجارب الاستلام المؤقت وتجارب الأداء الأولية بنجاح ومقبول للجنة الاستلام المؤقت.

After the success of the provisional acceptance and the preliminary performance tests, the Contractor shall put the first section into operation for /15/ days continuously without any interruption according to the required loads of the net work. In case of success of this test, PEEGT will issue the provisional acceptance certificate for the first section.

بعد نجاح تجارب الاستلام المؤقت وتجارب الأداء الأولية، يقوم المتعهد بتشغيل القسم الأول مدة /15/ يوماً بصورة مستمرة وفق متطلبات الشبكة الكهربائية، وبعد نجاح هذه التجربة تقوم المؤسسة بإصدار شهادة الاستلام المؤقت للقسم الأول.

The same measures will be followed concerning the second section of the project .

تتبع نفس الإجراءات بالنسبة للقسم الثاني من المشروع.

**Art. 33- Final Acceptance:**

– The final acceptance of the first section and also the works, equipment and requirements related to its operation and exploitation shall be effected after a period of /12/ months from the date of issuing the provisional acceptance certificate of this section.

– The final acceptance of the second section and also the works, equipment and requirements related to its operation and exploitation shall be effected after a period of /12/ months from the date of issuing the provisional acceptance certificate of this section.

The Contractor shall remain, during this period, responsible towards PEEGT for every new defect or discrepancy that may appear in the executed and provisionally accepted works during that period.

The Contractor shall perform, at his own expense, all what is needed for repairing, changing, removing of the defects and discrepancies as well as the carrying out of the maintenance works no matter how much they cost.

Repairing the damages resulting from bad usage by PEEGT of the works performed during that period, shall not be included in this maintenance responsibility.

The final acceptance of the replaced defected equipment will be carried out after the expiry of their guarantee period which is one year from the date of replacement.

**المادة 33- الاستلام النهائي :**

- يتم استلام القسم الأول من المشروع وكذلك أي من الأعمال والتجهيزات واللوازم المتعلقة بتشغيله واستثماره استلاما نهائيا بعد مدة /12/ شهراً من تاريخ إصدار شهادة الاستلام المؤقت لهذا القسم.

- يتم استلام القسم الثاني من المشروع وكذلك أي من الأعمال والتجهيزات واللوازم المتعلقة بتشغيله واستثماره استلاماً نهائيا بعد مدة /12/ شهرا" من تاريخ إصدار شهادة الاستلام المؤقت لهذا القسم.

ويبقى المتعهد مسؤولا تجاه المؤسسة طيلة هذه المدة عن كل عيب أو نقص جديد يحتمل ظهوره في الأعمال المنجزة والمسلمة تسليما مؤقتا خلال تلك الفترة.

وعلى المتعهد أن يقوم على نفقته بكل ما يستلزمه إصلاح وتبديل وإزالة تلك العيوب والنواقص وإجراء الصيانة مهما بلغت قيمتها.

ولا يدخل في مسؤولية الصيانة هذه إصلاح الأضرار التي تنشأ من جراء سوء استعمال المؤسسة للأعمال المنجزة خلال تلك المدة.

لا يتم الاستلام النهائي للتجهيزات التي حصل بها عطل وتم استبدالها إلا بعد انتهاء فترات الضمان للتجهيزات المستبدلة والتي هي سنة من تاريخ الاستبدال.

**Art. 34 – Guarantee period:**

A –The Contractor shall guarantee all equipment, materials and works subject of his obligation, as well as the supervision of PEEGT's personnel responsible for the operation and exploitation of the project during the period specified in article /33/ and which begins from the date of issuing the relevant certificate of provisional acceptance.

This guarantee includes the supply of all pieces and parts that are impaired or damaged as a result of bad manufacturing, designing or execution as well as the abnormal wearing away during those periods, free of charge.

B- A new guarantee period equaling the same previous guarantee period, concerning the replaced pieces and parts shall be valid and shall start from the date of replacement.

The guarantee period of the concerned section shall be extended for a period equaling to the period of stoppage of operation for replacing and repairing the damaged pieces and parts.

C – If an unseen hidden defect by the Contractor is

**المادة 34- فترة الضمان :**

آ - على المتعهد ضمان جميع التجهيزات والمواد والأعمال موضوع التزامه وكذلك الإشراف على كوادر المؤسسة القائمة على تشغيل واستثمار المشروع طيلة المدة المحددة في المادة /33/ والتي تبدأ من تاريخ إصدار شهادة الاستلام المؤقت لها.

ويشمل هذا الضمان تقديم كافة القطع والأجزاء التي تتلف أو تعطب نتيجة سوء الصنع أو التصميم أو التنفيذ أو الإهتراء غير الطبيعي خلال تلك الفترة مجانا .

ب- وتسري مدة ضمان جديدة تعادل نفس مدة الضمان السابقة بالنسبة للقطع والأجزاء المستبدلة فيها من تاريخ الاستبدال.

وتمدد مدة ضمان القسم المعني بكامله بمقدار مدة توقفه عن العمل لاستبدال أو إصلاح القطع أو الأجزاء المعطوبة .

ج - إذا ظهر بعد انتهاء فترة الضمان المشار إليها في


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discovered after the end of the guarantee period indicated in paragraph /A/ of this article, the guarantee remains valid for one year from the date of discovering the defect or knowing it.

In addition to the Contractor's responsibility during the guarantee period he shall remain responsible for the civil works, for ten years of any fundamental defect that may appear in the constructions and which will affect the safety of these constructions and which are incurred because of adulteration or bad execution.

**Art. 35 – Factory Tests:**

The Contractor has to execute the manufacturing tests of the materials supplied to the project out side S.A.R. Attending these tests shall be made by delegates of PEEGT and/or the consultant as specified in details in the Technical Book of Condition. The number of the tests shall be estimated by a rate of /50/ tests for the mechanical equipment and /20/ tests for the electrical and control equipment. PEEGT shall bear the expenses of attending these tests by its personnel including air ticket, accommodation and living.

**Art. 36- Inspection of roads and bridges:**

The Contractor shall, within one month from the date of commencement order, inspect all roads and bridges of destination and the work site for the purpose of determining the suitability of the vehicles traffic that are carrying the materials and equipment of the project. He shall submit a report about that. He shall also carry out another inspection two months before the arrival of any heavy load materials and equipment. A Representative of PEEGT shall participate in these two inspections.

In case these roads and bridges require repairing, supporting or leveling, then the expenses shall be borne by contractor.

**Art. 37 – Experiments and tests certificate:**

The Contractor shall submit, together with the equipment and materials of the project, the test certificate which is carried out and arranged by the manufacturing factories of these equipment and materials. The expenses shall be borne by the Contractor.

PEEGT or the Consultant appointed by it can attend the tests that are considered necessary in accordance with the book of technical conditions of this project. PEEGT shall bear the expenses of delegation of its personnel.

In this case the Consultant shall approve the test certificates which he attended if these tests are in conformity with the terms of the contract.

He also has the right to reject these tests if they do not conform to these terms.

الفقرة /آ/ من هذه المادة عيب خفي تعمد المتعهد إخفاءه فيبقى الضمان مساوياً لمدة سنة اعتباراً من تاريخ ظهور العيب أو العلم به.

بالإضافة إلى مسؤولية المتعهد خلال فترة الضمان يظل المتعهد مسؤولا بالنسبة للأعمال المدنية خلال عشر سنوات عن كل عيب أساسي يظهر في المنشآت بحيث يؤثر في سلامتها ويكون ناتجا عن غش أو سوء تنفيذ.

**المادة 35- التجارب المصنعية:**

يلتزم المتعهد بإجراء التجارب المصنعية للتجهيزات الموردة للمشروع خارج القطر وسيتم حضورها من قبل مندوبين عن المؤسسة و/أو المشاور وفق ما هو محدد بشكل مفصل في دفتر الشروط الفنية ويقدر عدد التجارب الكلي بحدود /50/ تجربة للتجهيزات الميكانيكية و/20/ تجربة للتجهيزات الكهربائية والتحكم على أن تتحمل المؤسسة تكاليف حضور هذه التجارب من قبل عناصرها متضمنة بطاقات الطائرة والإقامة والمعيشة.

**المادة 36- الكشف على الطرقات والجسور:**

يلتزم المتعهد خلال مدة شهر من تاريخ أمر المباشرة بالكشف على الطرقات والجسور في الجمهورية العربية السورية الواقعة بين مرفأ الوصول وموقع العمل لتحديد صلاحيتها لسير المركبات التي تحمل مواد وتجهيزات المشروع عليها وتقديم تقرير بذلك كما يلتزم بإجراء كشف آخر عليها قبل وصول أي من المواد والتجهيزات ذات الأحمال الثقيلة بمدة شهرين ويشارك مندوب عن المؤسسة في هذين الكشفين.

إذا تطلبت هذه الطرقات والجسور لأي عملية إصلاح أو تدعيم أو تسوية، فنفقات ذلك تقع على عاتق المتعهد.

**المادة 37 – شهادات الاختبار والتجارب:**

يتوجب على المتعهد أن يرفق مع تجهيزات ومواد المشروع شهادة التجربة التي تجريها وتنظمها المعامل الصانعة لهذه التجهيزات والمواد ويتحمل المتعهد نفقات ذلك.

ويمكن للمؤسسة أو للمشاور الذي تسميه المؤسسة حضور التجارب التي يراها ضرورية وفق دفاتر الشروط الفنية لهذا المشروع وتتحمل المؤسسة نفقات إيفاد عناصرها.

وفي هذه الحالة يقوم بتصديق شهادات التجارب التي حضرها إذا كانت مطابقة لشروط العقد.

كما يحق له رفضها في حالة مخالفتها لهذه الشروط.


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If PEEGT asks for carrying out some additional tests which, are not specified in the contract, then the relative expenses shall be borne by it.

فـي حـال طلـب المؤسسـة إجـراء بعـض التجـارب الإضافية غير المحددة في العقد فتقع نفقة ذلك على عاتق المؤسسة .

**Art. 38- The guarantee of invention and patent rights:**

**المادة 38- ضمان حقوق وبراءات الاختراع:**

The contractor shall be completely responsible for any demand of whatever nature presented by any body concerning the right of industrial property, literary property, commercial property, technical property, the patent rights, work rights or industrial methods rights, relative to the project or branches from it.

يكون المتعهد مسؤولاً مسؤولية كاملة عن أية مطالبة أو ادعاء أياً كان نوعه يتعلق بأي حق من حقوق الملكية الصناعية أو الأدبية أو التجارية أو الفنية أو حقوق الاختراع أو الأشغال أو الأساليب الصناعية لأي مرجع كان وذلك فيما يتعلق به ويتفرع عنه.

The Contractor shall also guarantee the consequences or damages of whatever nature that may befall upon PEEGT.

ويكون ضامنا عما يصيب المؤسسة من تبعات وأضرار مهما كان نوعها.

PEEGT must inform the contractor about any claim received in this concern, to enable him to take the necessary measures against it and to bear the consequences.

وعلى المؤسسة أن تبلغ المتعهد عن أي ادعاء يردها بهذا الشأن ليقوم هو بنفسه باتخاذ الإجراءات اللازمة بصددها وتحمل تبعاتها.

**Art. 39- The responsibility towards others:**

**المادة 39- المسؤولية تجاه الغير :**

The contractor will bear the responsibility of all damages which hurt others due to the execution of the contract works , and he is obliged to pay compensation of these damages according to the laws and regulations valid in Syrian Arab Republic, where such damages have occurred , PEEGT has the right to recourse upon him for any consequent obligations through clearing or any other procedures.

يتحمل المتعهد مسؤولية جميع الأضرار التي تصيب الغير من جراء تنفيذ أعمال التعهد ، ويلتزم بالتعويض عن هذه الأضرار وفقاً للقوانين والأنظمة النافذة في الجمهورية العربية السورية بالنسبة للأضرار الحاصلة فيها وللمؤسسة حق الرجوع عليه في كل ما يصيبها من التزامات من جراء ذلك بطريق التقاص أو بأي طريق آخر .

**Art. 40– The Consultant of the project:**

**المادة 40 - المشاور للمشروع :**

PEEGT has the right to appoint a consulting company, at its expense, for rendering technical, administrative and financial services to the project. This Company will be called the Consultant.

يحق للمؤسسة تعيين شركة استشارية على نفقتها والتي ستسمى بالمشاور من أجل تقديم خدمات فنية وإدارية ومالية للمشروع.

This Consultant shall work for PEEGT as an authorized representative, especially concerning the tasks of the Contractor which are shown in the file of this call for offers and the contract.

سوف يعمل هذا المشاور بالنيابة عن المؤسسة كممثل مفوض منها وخاصة فيما يتعلق بواجبات المتعهد المبينة في إضبارة طلب العروض هذا والعقد.

This Consultant shall substitute PEEGT in checking the drawings and designs of the project, and in supervising the manufacturing of the equipment and materials subject of the contract to be sure of the goodness of manufacturing. And for this purpose he has the right to inspect, control and supervise these equipment and materials in the places of manufacturing, whether these places were owned by the Contractor or the factories accredited by him.

إن هذا المشاور سوف ينوب عن المؤسسة في تدقيق المخططات والتصاميم الخاصة بالمشروع والإشراف على صنع التجهيزات والمواد موضوع العقد للتأكد من جودة الصنع ويحق له في سبيل ذلك القيام بمراقبة هذه التجهيزات والمواد في أماكن صنعها سواء أكانت هذه الأماكن عائدة للمتعهد أو للمعامل المعتمدة من قبله.

He has the right to reject what he finds necessary to reject because of non-conformance with the technical terms, provided that he notifies, in writing, the Contractor or the manufacturing Company of the cases of rejection. He shall also inform PEEGT about that.

وعليه أن يرفض ما يرى لزوماً لرفضه لمخالفته الشروط الفنية على أن يبلغ خطياً المتعهد أو الشركة الصانعة بحالات الرفض وان يطلع المؤسسة على ذلك.

And in this case the Contractor shall replace the rejected equipment and materials with equipment and materials satisfying all the required conditions.

وعلى المتعهد في هذه الحالة أن يستبدل بالمواد المرفوضة مواد تتوفر فيها جميع الشروط المطلوبة.


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He has also the right during working hours to enter freely all places of work in which the Contractor or the owners of the factories accredited by him are manufacturing or storing the materials and equipment (or any part of them relating to the project).
He also has the right at all times to enter the work site to supervise the progress of execution. The Contractor shall render all facilities and assistance required to enable him perform what he finds necessary such as examination, checks and inspections.

It should be known that the Consultant has not the right to order execution of any work that may delay the delivery of things contracted upon or that may result an additional sums to be paid by PEEGT, or may lead to changes in the technical specifications contracted upon without written approval by PEEGT.
All rights mentioned above and which the Consultant has, can of course be exercised by the appointed engineers and supervisors of PEEGT.
And the attendance of the administration delegate of the manufacturing tests does not exempt the contractor of his responsibility and his contractual obligations stipulated in this contract.

**Art. 41– Assignment of the contract and sub-contracts:**

The Contractor has not the right to waive all of his works or part of them subject of the contract, entrust or abide all or part of his obligations to other persons as subcontractors or involve subcontractors unless he obtains a written approval from PEEGT. Obtaining such approval does not give the contractor in any case the right to oblige PEEGT to enter in any relation of any kind with those people and does not exempt him from his obligations and responsibilities (Technical- administration-juridical and penal ) imposed on him towards PEEGT under the contract.
If the Contractor does not conform to this article, the execution of the contract will be withdrawn from him according to the stipulations of article /42/ of decree No. 450 of 2004.

**Art. 42– Training:**

The Contractor undertakes to train the required persons on the operation, exploitation and maintenance of the equipment of the project as specified in the technical conditions book and as follows:

a-Site training:

To provide the following training experts in the plant

1- Mechanical Eng. for one year.

2-Chemical Eng. for one year.

3- Electrical Eng. for one year.

4- C&I Eng. for one year.

5- Operation Eng. for one year.



كما يحق له الدخول بكل حرية خلال ساعات العمل إلى جميع أماكن العمل التي يقوم فيها المتعهد أو أصحاب المعامل المعتمدة من قبله بصنع أو تخزين المواد والتجهيزات أو أي جزء منها الخاصة بالمشروع.
كما يحق له أن يدخل في جميع الأوقات إلى موقع العمل للإشراف على سير التنفيذ ويتوجب على المتعهد أن يقدم كافة التسهيلات والمساعدات اللازمة لتمكينه من إجراء ما يراه ضروريا من فحص وتدقيق ومعاينة.
هذا ويجب أن يكون من المعلوم انه لا يحق للمشاور أن يأمر بتنفيذ أي عمل من شأنه أن يؤخر توريد الأشياء المتعاقد عليها أو يؤدي إلى دفع مبالغ إضافية من قبل المؤسسة ، أو يؤدي إلى تغيير المواصفات الفنية المتعاقد عليها إلا بموافقة خطية من المؤسسة.

إن جميع الحقوق المبينة آنفا للمشاور يمكن أن يمارسها بطبيعة الحال مهندسو ومراقبو المؤسسة الذين تعهد إليهم بذلك.
هذا وان حضور مندوبي الإدارة تجارب الصنع لا يعفي المتعهد من مسؤولياته والتزاماته العقدية المنصوص عليها في هذا العقد.

**مادة 41 - التنازل عن العقد والعقود الثانوية:**

لا يحق للمتعهد أن يتنازل عن مجموع الأعمال موضوع العقد أو جزء منها ولا أن يعهد بها أو يلزمها كلها أو بعضها إلى أشخاص آخرين كمتعهدين ثانويين أو أن يدخل شركاء من الباطن إلا بموافقة خطية من المؤسسة و أن حصول المتعهد على مثل هذه الموافقة لا يعني بأي حال من الأحوال إلزام المؤسسة بأن تدخل في أية علاقة من أي نوع كانت مع هؤلاء المذكورين كما لا يعفي المتعهد من التزاماته و مسؤولياته الفنية و الإدارية و الحقوقية والجزائية المفروضة عليه تجاه المؤسسة بموجب أحكام العقد .
وفي حال عدم تقيد المتعهد بأحكام هذه المادة، يسحب منه تنفيذ العقد وفقا" لأحكام المادة /42/ من المرسوم 450 لعام 2004.

**المادة 42- التدريب:**

العناصر اللازمة لتشغيل واستثمار وصيانة تجهيزات المشروع وفق ما هو وارد في دفتر الشروط الفني على الشكل التالي:

آ- التدريب الداخلي:

تقديم خبراء التدريب في الموقع كالتالي:

1- مهندس ميكانيك لمدة عام.

2-مهندس كيمياء لمدة عام.

3-مهندس كهرباء لمدة عام.

4- مهندس تحكم وأجهزة لمدة عام.

5- مهندس تشغيل لمدة عام.

b- Abroad training:

It includes receiving of /150/ man/month of the PEEGT's personnel for training at the factories of the Contractor or the factories of the sub- suppliers. The tenderer bears all costs of residence and travel according to the details in the Technical Book of Condition. External training will be executed on lots according to a program to be put previously with the contracting company and according to the requirement of the Public interest and before the expiry of the guarantee period.

**Art. 43- Syrian laws and regulations:**

The Contractor and sub-contractors shall undertake to respect the regulations, laws and provisions valid in the Syrian Arab Republic.

**Art. 44- Legal references:**

The legislation valid in the Syrian Arab Republic shall be considered the sole legal reference to be applied for all what is not stipulated in this call for offers and its documents as well as in the contract which will be concluded with the awarded contractor.

**Art. 45– Force Majeure:**

Force majeure means what hinders the course of obligation during execution as a result of circumstances out of control of the two contracting parties and the causes of which can not be dealt with by them.

In case of force majeure, the Contractor can obtain an extension of the execution period of the project if he follows the following procedures:

1-The Contractor must notify PEEGT in writing within (15) days from the date of the occurrence of the force majeure.

2 -To submit an evidence concerning the date of the occurrence of the force majeure and its duration by appropriate means such as the documents issued by the Competent Authorities and approved by the Consulates of SAR if the event of the force majeure occurred outside the Syrian Arab Republic.

3 – To prove that the events under discussion actually hindered the progress of the works of his obligation. The force majeure gives the Contractor only the right to obtain an extension of the execution period, but not the right to be exempted from some of his duties or the right to claim a compensation against any damage or loss befalling upon him.

**Art. 46– Disputes:**

Disputes which may arise between PEEGT and the Contractor are to be solved amicably and by mutual agreement, otherwise, it shall be referred to Syrian Administrative Courts specialized for these disputes.

**Art. 47– Local address:**

ب- التدريب الخارجي:

يتضمن استقبال /150/ رجل/شهر من عناصر المؤسسة للتدريب في مصانع الشركة أو مصانع الموردين الثانويين ويتحمل العارض كافة تكاليف الإقامة والسفر وذلك وفق التفصيل الوارد بدفتر الشروط الفنية، وسيتم إنجاز التدريب الخارجي على دفعات وفق برنامج زمني مسبق يتم وضعه بالتنسيق مع الشركة المتعهدة ووفق مقتضيات المصلحة العامة وقبل انتهاء فترة الضمان.

**المادة 43- القوانين والأنظمة السورية:**

يلتزم المتعهد والمتعهدون الثانويون باحترام الأنظمة والقوانين والنصوص النافذة في الجمهورية العربية السورية .

**المادة 44- المراجع القانونية:**

يعتبر التشريع النافذ في الجمهورية العربية السورية هو المرجع القانوني الوحيد للعمل به في كل ما لم يرد عليه النص في طلب العروض هذا ووثائقه وفي العقد الذي سيبرم مع المتعهد المرشح.

**المادة 45- القوة القاهرة:**

يقصد بالقوة القاهرة ما يعترض سير الالتزام أثناء تنفيذه من الأمور الناتجة عن ظروف خارجة عن إرادة الفريقين المتعاقدين ولا يد لهما في معالجة أسبابها .

يتوقف حصول المتعهد على تمديد الوقت المحدد لإنجاز المشروع في الحالة المبينة أعلاه على إتباع الأصول التالية:

1-أن يعلم المؤسسة خطيا خلال /15/ يوما من حدوث القوة القاهرة.

2- أن يبرز إثباتا ليوم وقوع القوة القاهرة ولمدتها بالطرق الملائمة كالوثائق الصادرة عن السلطات المسؤولة والمصادق عليها من قنصليات الجمهورية العربية السورية إذا كانت حادثة القوة القاهرة خارج الجمهورية العربية السورية.

3- أن يبرهن أن الأحوال المبحوث عنها قد اعترضت فعلا سير أعمال الالتزام ولا تعطي القوة القاهرة للمتعهد عدا حق الحصول على تمديد الوقت، أي حق للإعفاء من بعض واجباته أو بالتعويض عما يلحقه من ضرر أو خسارة .

**المادة 46- الخلافات:**

تحل الخلافات التي تنشأ بين المؤسسة والمتعهد بالطرق الودية وإذا تعذر حلها بهذه الطرق فيعتبر القضاء الإداري السوري هو المرجع المختص في حلها.

**المادة 47- الموطن المختار:**


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According to article /15/ of the law /51/ of 2004,
the Bidder shall state in his offer a place of residence in S.A.R. The Arab offerer unresident in Syria and the foreign offerer may state a selected place of residence out side Syria and only this address will be considered as binding even he moves to another, unless he notifies PEEGT in writing of his new address in the same town, otherwise all notifications that are sent to his first address shall definitely be considered as correct.
In all cases the Contractor should state a selected place of residence in Syria.
The selected local address of the Candidate Bidder shall be stated in the contract which will be concluded with him. This address shall not be in an embassy, consulate, hotel, P.O.BOX or telephone number or telex or fax. The address is to include the name of the city, name of the street, number of the building, number of the apartment and the name of the resident.
The Contractor must submit a written statement from the resident in the selected address, expressing his acceptance of giving his name in the address. Such a statement must be written and signed in the presence of the contracts director of PEEGT.

**Art. 48- General provisions:**

1-Upon singing the contract which, will be concluded, he to whom the tender will be awarded, will be considered to have obtained all the necessary information for executing the project after contracting.

2- In case of financing the value of the contract by any of the International Funds, the irrevocable agreement to reimburse letter or letter of commitment which will be issued by the Fund is enough and there is no need to confirm the letter of credit.

3- In case the financed amount is not enough, PEEGT will finance the shortage by its resources.

4- In case the Syrian Embassy in the country of the contractor and/or the country of origin is not available (as the case may be), the documents should be approved by the concerned chamber of commerce while the consular fees should be transferred to the account of General Treasury Fund at Central Bank of Syria under No. 2501/23 (repeated).

5- The contractor should present health certificate from the country of origin of the timber imported for the project and for other materials which the valid Syrian regulations on the date of shipping require that, if it is available in the country of origin.

6- The bidders should take into consideration, the following:

A-The contract to be concluded as a result of this call for offers with the awarded contractor, shall be

استناداً للمادة /15/ من القانون 51 لعام 2004 على العارض أن يحدد في عرضه موطناً" مختاراً" له في الجمهورية العربية السورية ويمكن للعارض من رعايا الدول العربية غير المقيم في سورية وللعارض الأجنبي تعيين موطن مختار له خارج سورية ويعتبر الموطن المذكور ملزماً" له ولو انتقل منه إلى غيره ما لم يبلغ المؤسسة خطياً"عن موطنه المختار الجديد في البلدة نفسها، وإلا تعتبر كافة التبليغات المرسلة إلى موطنه المختار الأول صحيحة حكماً.

وفي جميع الأحوال يلتزم المتعهد بتعيين موطن مختار له في سورية.
سوف يدرج الموطن المختار للمتعهد المرشح في العقد الذي سيبرم معه ويشترط ألا يكون هذا الموطن سفارة أو قنصلية أو فندق أو صندوق بريد أو رقم هاتف أو تلكس أو فاكس وإنما يحدد فيه المدينة -اسم الشارع-رقم البناء – رقم الشقة – اسم القاطن .

كما يشترط تقديم المتعهد موافقة خطية من القاطن في الموطن المختار بقبوله ذلك يتم تحريرها أمام مدير العقود في المؤسسة.

**المادة 48 - أحكام عامة:**

1- بمجرد التوقيع على العقد الذي سيبرم مع العارض الذي سيحال عليه الالتزام، يعتبر هذا الأخير أنه قد حصل على جميع المعلومات الضرورية اللازمة لتنفيذ المشروع بعد التعاقد.

2- في حال تمويل العقد من أحد صناديق التمويل العالمية، فإنه لا حاجة لتعزيز الاعتماد المستندي، ويكتفى بكتاب التعهد بالدفع غير القابل للرجوع أو كتاب الارتباط الذي يصدره الصندوق الممول.

3- في حال عدم كفاية مبلغ التمويل تلتزم المؤسسة بتمويل الفجوة التمويلية الناجمة عن ذلك بتمويل ذاتي.

4- في حال عدم توفر سفارة سورية في بلد المتعهد و/أو المنشأ (حسب الحال)، يتم تصديق الوثائق من غرفة التجارة المعنية ويتم تحويل قيمة الرسوم القنصلية إلى حساب الخزينة العامة لدى مصرف سورية المركزي على الرقم 23/2501 مكرر.

5- يلتزم المتعهد بتقديم شهادة صحية من بلد المنشأ للأخشاب المستوردة لصالح المشروع وللمواد الأخرى التي توجب الأنظمة السورية بتاريخ الشحن تقديمها في حال توفرها في بلد المنشأ.

6- على العارضين الأخذ بالاعتبار ما يلي:

آ- سوف يجري تنظيم العقد نتيجة طلب العروض هذا مع المتعهد المرشح باللغتين العربية والإنكليزية وعند


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arranged in both Arabic and English languages. Arabic will be referred to when a dispute in the interpretation of the text arises.

حصول خلاف بالتفسير يرجح النص العربي.

B-To elaborate the offer and all its correspondences in English language.

ب-تحرير العرض وكافة مراسلاته باللغة الإنكليزية.

C-All correspondences concerning the execution of the contract shall be in English for technical affairs, along with translation into Arabic for financial and juridical questions.

ج- وتجري المراسلات لأجل تنفيذ العقد باللغة الإنكليزية بالنسبة للأمور الفنية مع ترجمة إلى اللغة العربية بالنسبة للمواضيع المالية والقانونية.

D- For the aim of PEEGT's assurance that the letters of Authorization issued by the tenderer whether the Authorized person is a natural or a moral person represented by a natural person during all the several stages, starting from submitting the offer through out its study, calling the representative of the offering company and till the conclusion of the contract, the tenderer should clarify the following:

د- بغية ضمان المؤسسة لصكوك التفويض الصادرة عن العارض سواءً كان المفوَّض شخص طبيعي أم اعتباري يمثله شخص طبيعي وذلك خلال مختلف المراحل بدءاً من تقديم العرض ومروراً بدراسته واستدعاء ممثل الشركة العارضة وانتهاءً بإبرام العقد، يتوجب على العارض توضيح ما يلي:

- Name and job of the authorizing person.

- اسم ووظيفة المفوِّض.

- Name and job of the authorized person.

- اسم ووظيفة المفوَّض.

- Limits and subject of the authorization in a clear way.

- حدود التفويض وموضوعه بشكل واضح وصريح.

- Period of the authorization (start–end).

- مدة التفويض بداية ونهاية.

-Obligation of the authorizing person:

-التزام المفوِّض:

1- To inform PEEGT of any changes that may occur on the authenticity of the issuance and continuity of the validity of the act of authorization.

1- بإعلام الإدارة المعنية في المؤسسة بأي تغيير قد يطرأ على صحة صدور واستمرار نفاذ صك التفويض.

2- To consider valid before him all procedures and action that are issued by the authorized person prior to the date of cancellation, limitation and amendment of the authorization.

2- باعتبار كافة الإجراءات والتصرفات الصادرة عن المفوَّض قبل تاريخ إلغاء التفويض أو تقييده أو تعديله نافذة في مواجهة المفوِّض.

The authorizing person is considered wholly responsible for the legality and authenticity of his issuance of the act of authorization.

يعتبر المفوِّض مسؤولا" مسؤولية كاملة عن مدى قانونية وصحة إصداره صك التفويض.

E- The Contract shall be put into force after :

هـ- يوضع العقد موضع التنفيذ بعد :

- Being signed by both parties.

- توقيعه من الطرفين المتعاقدين.

-Being approved by concerned Syrian Authorities and notification of this approval to the Contractor.

- المصادقة عليه من قبل السلطات السورية المختصة وإبلاغ هذه المصادقة للمتعهد.

F- The Syrian law is the sole reference for all what is not mentioned in the book of conditions, and for all what is related to the correctness of the contract, as well as the interpretation of its provisions and for any dispute that may arise due to its execution.

و- إن التشريع السوري هو المرجع الوحيد في كل ما لم يرد عليه النص في دفتر الشروط وفي كل ما يتعلق بصحة العقد وتفسير أحكامه وفي أي نزاع ينشأ نتيجة تنفيذه.

**Art. 49 – The file documents:**

**المادة 49- وثائق الإضبارة :**

The file of this call for offers consists of the following documents which are considered a part and parcel of it:

تتألف إضبارة طلب العروض هذا من الوثائق التالية وتعتبر جزءا" لا يتجزأ منه:

- The announcement of the tender.

- إعلان طلب العروض.

-Book of Juridical, Financial and Technical conditions.

--دفتر الشروط الحقوقية والمالية والفنية.

- Contracts regulations issued by law No. 51 for 2004.

-نظام العقود الصادر بالقانون رقم 51 لعام 2004


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-The General conditions book issued by Decree No. 450 of 2004.
-The priority of the a/m documents is as they are listed above.
-Every participant is considered to have acknowledged of the file of the tender and have accepted its provisions.
-This file is considered an integrated part of the contract which will be concluded with whom the tender shall be awarded.
Damascus, on 7/8/2011.

-دفتر الشروط العامة الصادر بالمرسوم رقم 450 لعام 2004.
تعتبر أفضلية الوثائق آنفة الذكر، حسب تسلسلها المبين أعلاه
يعتبر كل من قدم عرضاً أنه اطلع على إضبارة طلب العروض وأنه قبل بأحكامها.

تعتبر هذه الإضبارة جزءاً لا يتجزأ من العقد الذي سيبرم مع من سيحال عليه الالتزام.

دمشق في 2011/8/7

**General Director of**
**المدير العام**
**Public Establishment of Electricity for Generation and Transmission**
**المهندس هشام ماشفج**
**Eng Hisham Mashfej**

**PUBLIC ESTABLISMENT OF ELECTRICI1Y**
**FOR GENERATION AND TRANSMISSION ( PEEGT )**

# ALEPPO STEAM POWER PLANT

## INVITATION TO BID

## PART 2

## GENERAL SPECIFICATION

G 1. The Project

General Specification

| | |
|---|---|
| G1 | The Project |
| G2 | Application requirements |
| G3 | General technical requirements |
| G4 | Guarantees |
| G5 | Test and inspection |
| G6 | Documentation |
| G7 | Services |
| G8 | Spare parts and special tools |
| G9 | Maintenance management |
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| G 11 | Description of the site |

## G1 The Project

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# G 1. The Project

## G1.1 Introduction

Public Establishment of Electricity for Generation and Transmission (PEEGT) has decided to build Aleppo – AL Trieffawi power plant close to Aleppo city north of Syrian Arab Republic.

This technical specification outlines the minimum requirements regarding design, engineering, manufacturing, delivery, civil works, erection, commissioning, testing and training of plant personnel for Aleppo Steam Power Plant.

The nominal output will be 250 MW ± 20 % at each generator terminals so the total output of the plant will be 500 MW. However, the specified output of the plant is not exact, because the aim of PEEGT is to get as standardized plant as possible and the standard plant size from manufacturer to each other is varying. The specified output range for one unit is 250 MW ± 20 % and the offered plant must be in this range.

The main fuel for the power plant is residual oil, but the plant can be continuously used with nominal load also with natural gas, or with a mixture of residual oil and gas.

## G1.2 Terms, Words and Expressions

The following terms, words and expressions used in the invitation to bid (ITB) documents have the meaning hereby assigned to them, except where the context otherwise requires terms, words and expressions have been specified also in ITB , Book of Special Conditions which shall have higher priority in a case of any contradiction.

DCS means digital control system of the power plant the power plant for each unit.

ITB means Invitation To Bid.

PEEGT means Public Establishment of Electricity for Generation and Transmission.

Performance Test means all the tests required to verify that the work meets the given performance guarantees of individual equipment of installations and to check performance and assess the values guaranteed by the Contractor as specified in the Contract.

Preliminary Check-out and Running tests means necessary inspections, check out, functional tests and test runs of all individual equipment, instruments, devices and systems supplied under the Contract. The corrections and adjustments of equipment, instrument systems or circuits which are required during such preliminary Check -out and Running Test period shall he included in the work.

G 1. The Project

The project the project has been divided into two sections .In each section certain specified systems of the power plant have to be ready. These systems have been specified in ITB.

Trial Operation or Trial Run means the performance of 15 continuous days of automatic operation within the range of nominal rated output load and according to the requirement of the national network after the Initial Loading Test.

G1.3 Scope of Work

The Contract will be a turn key contract, and the work shall specially include the following among other:

(1) Design and engineering work.
(2) Manufacturing, fabrication and factory test.
(3) Supply of material, machinery and equipment which shall include at least, but shall not be limited to the following systems and facilities
3.1 Two (2) steam generating units.
Each unit shall consist of:

1. One (1) boiler with accessories.
2. Two (2) air preheaters.
3. Two (2) steam air heaters.
4. Two (2) forced draft fans.
5. Two (2) gas recirculation fans.
6. One (1) set of air and flue gas ducts.
7. One (1) stack.
8. One (1) set of burner and ignitors and flame detectors.
9. One (1) set of burner control system.
10. One (1) set of soot blowers.
11. One (1) blow down equipment.
12. One (1) seal and cooling air system.
13. One (1) set of structures, platforms, stairs, ladders and walkways.
14. One (1) set of control and alarm system.
15. One (1) boiler drain tank.
16. Two (2) boiler drain pumps.

3.2 One (1) Fuel systems:

<u>A- Fuel gas system :</u>

One (1) fuel gas system consisting of such as but not limited to the following:

1. One complete gas reducing station from ( 70 – 30 ) bar to the operation

pressure with all necessary.

The system shall consist of but not limited to the following:

- One de electric joint.
- One isolating valves.
- Emergency shut down valve.
- Knock Out Drums.

The system shall consist of two (2) identical trains each train shall consist of:

a) Leak test device

b) Complete set of measuring and protection systems according to NFPA

c) One (1) set of N2 purging system

d) Electrical line insulation against electrostatic

e) Pressure control regulation station (2x100%) each line include filters, heating system ,control valves ,isolating valves, non return valves, heating system , filters…

f) Control & Instrumentation.

g) Condensate drainage piping.

h) Vents.

i) Cold flare.

2. One main header isolating valve.
3. One isolating valve for each boiler.
4. Emergency shut down valves for each boiler.
5. Shut off valves.
6. Pressure reducing stations.
7. Control valves with by-pass.
8. Burner shut off valves with vents.
9. Leak test device.
10. Complete set of measuring and protection systems according to NFPA.
11. One (1) set of flare system with pressure relief and control valve.
12. One (1) set of N2 purging system.
13. Electrical line insulation against electro static.
14. Filters and separators.

<u>B- Residual fuel and gas oil system:</u>

The system shall consist of:

1. One (1) unloading system by railway wagons and trucks for both residual and gas oil with filling pumps and all required auxiliaries.
2. One (1) set of flow measuring system.

3. Five (5) residual oil storage tanks of 25.000 m3 each.
4. Two (2) gas oil storage tanks of 5.000m3.
5. Two (2) fuel oil transfer pumps for each unit (one Stand by).
6. Two (2) gas oil pumps for the boilers.
7. Two (2) fuel oil heaters for each unit (one stand by).

3.3 Two (2) steam turbine units

Each unit shall consist of:

1. One (1) steam turbine with accessories.
2. One (1) gland sealing system.
3. One (1) turning equipment.
4. One (1) governing system.
5. One (1) hydraulic and lubrication system.
6. One (1) protection system.
7. One (1) set of turbine supervisory instruments.
8. One (1) turbine bypass system for both **HP & LP** cylinders.

3.4 Two (2) condensing plants each plant shall consist of:

1. One (1) water cooled surface or jet condenser.
2. One (1) starting air ejector and two (2) air ejectors for normal operation (one standby).
3. One (1) condensate tank.
4. Two (2) condensate pumps.
5. One (1) drain tank.
6. Two (2) drain pumps.
7. One (1) polishing plant.

3 .5 Two (2) indirect type dry cooling systems with natural draft cooling tower (for each system) complete with necessary auxiliaries and accessories suitable for surface or jet condenser.

3. 6 Two (2) complete auxiliary wet type evaporative cooling water systems with all auxiliaries for auxiliary cooling.

3.7 Three (3) feed water pumps 3 × 60% for each unit.

3.8 One (1) deaerating heater for each unit.

3. 9 Five (5) feed water heaters for each unit.

3.10 One plant water system the system descript in the ITB Chemical section.

3.11 One plant instrumentation and control system, the system shall consist of:

1. One (1) set of instrumentation and control system for each boiler, turbine and generator and auxiliary systems.
2. The central control panels for each of the boiler, turbine and generator and common auxiliaries.
3. Sets of local control panels as needed for the individual control of boiler, turbine and any other major equipment of the plant.

4. (3) data loggers (fault recorders).

3.12 One (1) compressed air equipment.
3.13 One (1) auxiliary boiler with axillaries.
3.14 One (1) steam converter with auxiliaries for each unit.
3.15 One (1) turbine house bridge crane.
3.16 One (1) work shop and store bridge crane.
3.17 Sets of hoists and monorails.
3.18 One (1) service elevators for each boiler.
3.19 One (1) elevator for control room.
3.20 One (1) fire protection and alarm system
3.21 One (1) completely equipped work shops
3.22 One (1) completely equipped laboratory
3.23 One (1) waste water treatment system
3.24 Vehicles

3.25 Complete Black start system which should descript in full detail in the offer.

3.26 Water pumping station in Assad Lake and the pipeline from Assad Lake to the power plant according to shown route in the drawings about 30 K.m.
3.27 Piping
3.28 Insulation
3.29 One (1) generator and exciter for each unit, consisting of:

- One (1) generator with accessories.
- One (1) brushless or static exciter with accessories.
- One (1) hydrogen and oxygen gas supply unit (if applicable)
- One (1) carbon dioxide system
- One (1) seal oil unit

3.30 One (1) generator main circuit systems for each unit each system shall consist of:

1. One (1) isolated phase bus duct.
2. One (1) potential transformer cubicle.
3. One (1) surge absorber cubicle.
4. One (1) generator neutral grounding resistor cubicle.
5. One (1) generator circuit breaker cubicle

(Optional) the bidder can offer for one startup transformer without generator circuit breaker system.

3.31 One (1) set of power transformers
The power transformers shall consist of:

1. One (1) main transformer with accessories for each unit.
2. One (1) unit transformer with accessories for each unit.
3. One (1) generator circuit bracker for each unit.

4. One set of intercommunication system the system shall consist of :
   - One (1) set of interphone and broadcasting system.
   - One (1) set of telephone system.

3.32 One (1) hydrogen and oxygen generating system (if applicable)

3.33 Not Used

3.34 One (1) set of connection from step up transformers to the GIS 400 K.V. substation by XLPE copper under ground cable ( about 600 meters for each phase ) (see single line diagram attached).

3.35 One (1) set of lighting system.

3.36 One (1) set of cable and wiring material.

3.37 One (1) set of earthing system.

3.38 One (1) set of lightning protection system for P. S.

3.39 Arrange the necessary signals for the dispatching center according to the attached lists in ITB.

3.40 The scope of work of the civil work shall be referred to in ITB

(4) Packaging, transportation, delivery to site, customs clearance and forwarding.

(5) Storing of the material and equipment at site.

(6) Supply of documentation of the work.

(7) Training of the PEEGT's personnel (Site and abroad).

**(8) All necessary equipments to reduce the emissions Sox & Nox to meet the international standards should be offered as an option, PEEGT will take the decision during the evaluations and contracting stages concerning the installations of these equipments. The equipments should be fully descripted in the technical offer and the prices should be separately offered.**

**The equipments should be shown in the offered plot plan, and the necessary space for the equipments should be considered in the plot plan for future installation if PEEGT postpond the installation at this stage.**

(9) Construction and erection, including civil works.

(10) Insurances during overland, maritime and air transportation and during storage and erections until Provisional Acceptance Certificate.

(11) The Contractor shall improve the existing roads and reinforce the bridges along the adopted route from Tartous port to the site. However, PEEGT and Contractor shall inspect and survey all available routes to choose the suitable one which will be used for heavy equipment transportation (the first inspection will be within two months after the commencement order and the second inspection will be one month befor the heavy equipment arrival).

(12) Responsibility, design, engineering and supervision of the following part of the Work.

- Construction and erection.
- Cleaning.
- Testing and commissioning.
- Initial loading test, trial operation and performance tests.

(13) Guarantee for one (1) year operation.

(14) Supervision of operation and maintenance during guarantee period.

The sole responsibility of the successful completion of the work ties to the Contractor.

The contractor shall include also all standard and special tools, instruments and equipment needed for maintaining the equipment on the Plant (Equipment including in the Contract).

The Tender shall include all spare parts and tools according to what is specified in the Book of Special Condition (Part 1)

All necessary initial fillings like oils, resins, grease, etc are included in the scope of work till the FAC issuance (except raw water and fuels which will be provided by PEEGT) are included in the scope of work.

All equipment, facilities, buildings and infrastructure inside the power plant boundary according to ITB.

Should equipment or works be essential for the proper operation of the work implied in the Technical Specification of the complete power plant of this type, although not expressly mentioned in the ITB documents, such equipment shall be deemed to be included in the scope of work.

The Contractor shall recommend the most suitable maintenance programme for different equipment to maintain the high level of availability and reliability of the plant.

G1.4 Delivery limits

| Item | Delivery limit |
|---|---|
| Access road | The access road from the main road is included in the scope of work of the contractor. |
| Natural gas | At the site boundary. |
| Outgoing High Voltage KV feeders. | Terminal structures complete with necessary insulators shall be supplied by the contractor up to the GIS substation by HV cable. |
| Raw water | From ASSAD Lack, and from the wells. |
| Telecommunication | PEEGT will bring the telecommunication lines to the administration building. |

| | |
|---|---|
| Electricity during construction | 20 KV line for the construction period of the plant has already been assembled by the PEEGT. The delivery point will be situated in the transformer so that the transformer includes to the scope of work of the PEEGT. The maximum continues capacity needed for the construction work is ___ KVA (the Contractor will specify).<br><br>The Contractor will be informed that in the 20 KV line there can be voltage drops for time to time (especially during the peak demand of electricity in S.A.R). If the contractor has some critical equipment which will not tolerate voltage drops it is the Contractor's responsibility to arrange necessary equipment and facilities to compensate these possible voltage drops.<br><br>The Contractor will pay for the electric power consumed by him. |

G1.5 Contractor responsibility

The Contractor shall provide the PEEGT with the Work specified in the ITB documents in accordance with the terms and conditions of the ITB documents as regard to technical design criteria and construction requirements, warranties and guarantees and time schedule.
The Contractor shall provide the site services and temporary facilities which are required and specified in more detail in Enclosure G1.1.
The Contractor shall follow the Syrian laws and regulations or directives by the authorities deemed to do so.
The Contractor shall work in close co-operation with the PEEGT or its authorized representative. These shall have full access to the Contractor's facilities to verify the progress of work or to witness testing of equipment of machinery. The Contractor shall also work in close cooperation with other contractors and provide all necessary data for their work and what is requested by the PEEGT.
The Contractor shall establish specific programmes for maintaining activities related to availability, preparation for operation and maintenance, safety, protection of environment etc. in the Project
The Contractor shall implement set reliability and maintainability requirements in his design and predict availability respectively.
The Contractor shall, within his scope of work, provide PEEGT's maintenance purposes all requested technical information and data.

G 1. The Project

The Contractor shall submit daily, weekly and monthly progress reports in where the progress of the Project is presented. The progress of the Project shall also be presented and discussed in regularly project meetings organized by the Contractor and attended by the PEEGT, the Contractor and the Consultant.

G 1.6 Project schedule

The contractor shall start the commercial operation of the power plant after the following execution periods:

- Unit 1 to be define by the bidder \ months
- Unit 2 to be define by the bidder \ months

The Tenderer shall submit with his bid a detailed time schedule for the main items. It shall specify the critical path(s). That shall monthly be up-dated during the implementation phase along the requested progress reports.

The Tenderer shall give in this bid the shortest possible delivery time for the main boiler plant, the turbine generator plant, the main cooling system and the complete project.

G 1.7 Exceptions and deviations

Any deviations from ITB shall be outlined, specified in detail and argumented.

## G 1.8 Insurances

The Contractor shall insure the Project, as specified in the Book of Special Conditions (Part 1).

## G 1.9 Structure of the ITB documents.

The ITB documents are structured in six parts as follows:

| | |
|---|---|
| Part 1 | Book of Special Conditions |
| Part 2 | General Specification |
| Part 3 | Technical Specification |
| | - Mechanical |
| | - Chemical |
| | - Electrical |
| | - I & C |
| Part 4 | Civil Works |
| Part 5 | Drawings and Technical Schedules |
| Part 6 | Itemized price list of spare parts |

Numbering

In the ITB documents the main chapters are numbered and by so mean identified by following capital letters:

| | |
|---|---|
| G | General Specification |
| M | Technical Specification, mechanical |
| E | Technical Specification, electrical |
| I | Technical Specification, instrumentation and control |
| C | Civil Works |

G 1. The Project

G 1.10 References

The Tenderer or the supplier to the Tenderer shall present his latest (10 years') references with similar type and size of power plants or of power plant major parts (conventional type, natural gas / residual oil fired, not critical steam parameters, turbogenerator with power output of about 250 MWe. indirect natural draft dry cooling system, surface/jet condenser, etc.).
Reference power plants and parts operating on similar conditions as the Aleppo power plant.

**The bidder should define the year of the main equipments manufacturing (turbines, generators. Transformers and boilers) and it will be taken into consideration during evaluation stage**
**The contractor should not use any equipments manufactured three years before putting the contract into force for the main equipments and one year for the control system.**

**PUBLIC ESTABLISMENT OF ELECTRICI1Y**
**FOR GENERATION AND TRANSMISSION ( PEEGT )**

# ALEPPO STEAM POWER PLANT

# INVITATION TO BID

## PART 2

## GENERAL SPECIFICATION

| G2 | Application requirements |
| --- | --- |

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## G2. Application requirements

### G2.1 Site

The site will be descried in the relevant section.

### G2.2 Ambient conditions

Will be descried in the relevant section
The monthly and yearly variation is presented in the Annexes

#### G2.2.2 Relative humidity

The monthly and yearly variation is presented in the Annexes

#### G2.2.3 Rain fall

The monthly and yearly variation is presented in the Annexes

#### G2.2.4 Wind data

The monthly and yearly variation is presented in the Annexes

#### G2.2.5 Water availability

Raw water for make-up water for the power plant process, cooling and domestic services will be taken from the ground water and ASSAD lack.

Ground water will be taken from new wells which will be digged by PEEGT and fully equipet by the contractor.

#### G2.2.6 Suitability of the soil

The suitability of the soil for building of a large power plant must be confirmed by the Contractor to the approval of the Purchase before works commence on site. This shall include all necessary soil investigations.

The PEEGT has carried out soil investigations on the Aleppo site. The work included field investigations, laboratory tests and foundation analysis. The results of these investigations are provided in Annexes. However, this just as a reference it will not release the Contractor from the responsibility of the suitability of the soil and he has to make his own soil investigation report to design accordingly.

G2. Application requirements

The Contractor shall study carefully the effect of the environment on the power plant especially for the cooling towers.

G2.2.7 Design conditions

The equipment shall be designed based on the following design ambient conditions:

Ambient temperature (dry bulb)

- for Turbine Generator performance 30ºC
- for Boiler performance 30ºC
- for unit Maximum Continuous Rating and peak load 45ºC
- for Main and aux. Cooling Towers max capability 40ºC
- for Fan and Compressor 45ºC
- for Electrical equipment 45ºC
- for Instrument 45ºC
- for all outdoor installations -10ºC

All electrical and instrumentation devices shall operate without failure in a case of no air-conditioning

Ambient temperature (wet bulb)

- Cooling tower design temp. 45ºC
- Cooling tower design wind speed 5 m/ sec at 10 meters height

Barometric pressure (refer to the altitude of the Plant)

Relative humidity

- for turbine generator performance 50%
- for fan and compressor 80%
- for electrical equipment 95%
- for instrument 95%

Wind pressure (refer to wind data)
- For cooling tower max capability 34m/s

For Guaranteed performance:

G2. Application requirements

- Ambient temperature 26º C
- Relative humidity 60 %

G2.3 Conditions for electrical design

G2.3.1 Tie to the National Grid

G2.3.1.1 High Voltage KV connections

The Plant shall be tied to national grid through 400 K.V. GIS Substation , the contractor shall execute the connection (see attached single line diagram)

G 2.3.1.2 Not Used

G2.3.1.3.1 Design and operational requirements

Frequency conditions

The power plant machinery shall stand the following frequency variations in the national grid when the generator voltage simultaneously varies from 90% to 105% of the nominal value:

| | |
|---|---|
| Nominal frequency: | 50 Hz |
| Variations | 47.5 – 52.5 Hz. for the worst condition and usually varies within + 0.2 Hz. |

Load rejection

When the Plant load is rejected for example through opening the generator High Voltage kV circuit breaker. The plant shall continue to run with its auxiliaries and the turbine is running under speed governing mode.

In addition it shall be possible to run the unit with the National Grid in different speed/load control modes

G2.3.2 System voltage

The following 3-phase 50 Hz. voltages shall be used:

1. Plant primary distribution voltage: 6 kV (max 7.2 kV)
2. Plant secondary distribution voltage: 400/230 V
3. Control voltages: 230 V uninterruptible Ac, 220 V DC, and 48V V DC or 24 V DC.

G2.3.3 Temporary power during construction

The Contractor will be completely responsible for supplying. Installing and maintaining all the electrical facilities including 20 kV temporary power substations. Low voltage distribution system. Lighting system and welding outlets etc. for the temporary power required during construction of the Plant.

The electricity taken from the national grid and used fit Site shall be paid by the Contractor according to the price given by the PEEGT.

G2.4 Water
G2.4.1 Raw water

G2. Application requirements

The Tenderer shall present its estimate for the normal consumption of raw water ($m^3$/day) divided as follows:

- Make-up water to the process (demi water)
- Other make-up water (filtered water)
- Drinking water
- Service water
- Make-up for cooling water
- Other
- Total

### G2.4.2 Waste water

Waste water discharged from the Plant is used mainly for irrigation inside the plant site therefore the quality of the waste water must meet the international standard requirements

Table 2.8. Maximum values for the waste water

| Item | |
|---|---|
| As | 0.1 mg/l |
| Ba | 3.0 mg/l |
| B | 2.0 mg/l |
| Cd | 0.5 mg/l |

| | | |
|---|---|---|
| Cr | 5.0 | mg/l |
| Cu | 1.0 | mg/l |
| Pd | 5.0 | mg/l |
| Hg | 0.01 | mg/l |
| Ni | 5.0 | mg/l |
| Se | 1.0 | mg/l |
| Ag | 5.0 | mg/l |
| Zn | 10.0 | mg/l |
| Phenol | 0.5 | mg/l |
| Cn | 0.5 | mg/l |
| BOD | 1000 | mg/l |
| COD | 3000 | mg/l |
| T.T.S | 2000 | mg/l |
| Cl | 600 | mg/l |
| F | 8 | mg/l |
| Pesticide | 0.005 | mg/l |

G2.5 Fuels

G2.5.1 Natural gas

The natural gas will be led from the gas fields to the plant through the gas network

The analysis data of natural gas from various fields are presented in Table 2.9.

Table 2.9. Natural gas analysis data

## Gas Analysis

The gas is mixture of the following gases :

| Gas | Omar gas Mol % | Conoco gas Mol % | Arak gas Mol % | AL Jbossa gas Mol % | Egyptian gas Mol % | NMRPS Mol % |
|---|---|---|---|---|---|---|
| N2 | 0.66 | 3.468 | 3.782 | 2.69 | 0.01 | 4.77 |
| CO2 | 10.14 | 5.274 | 0.92 | 0 | 0.55 | 1.04 |
| C1 | 73.58 | 77.729 | 92.964 | 89.22 | 92.24 | 87.11 |
| C2 | 10.14 | 8.39 | 1.701 | 5.51 | 4.09 | 3.82 |
| C3 | 4.94 | 3.675 | 0.249 | 1.96 | 1.87 | 2.12 |
| I-C4 | 0.22 | 0.595 | 0.061 | 0.25 | 0.41 | 0.27 |
| n-C4 | 0.32 | 0.449 | 0.062 | 0.19 | 0.43 | 0.64 |
| I-C5 | 0 | 0.06 | 0.039 | 0.05 | 0.15 | 0.11 |
| n-C5 | 0 | 0.01 | 0.029 | 0.07 | 0.15 | 0.1 |
| C6+ | 0 | 0.35 | 0.121 | 0.06 | 0.1 | 0.02 |
| | 100% | 100% | 100% | 100% | 100% | 100% |
| H2S | <30 ppm | <30 ppm | <30 ppm | <30 ppm | 10 ppm | 0 |

Guaranteed gas specifications

| Component | Max./Min. | Specification Limit |
|---|---|---|
| H2S Content | Maximum | 30 ppm (by Volume) |
| Total Sulfur Content | Maximum | 150 mg /SCM |
| Mercapten Sulfur | Maximum | 40 mg/SCM |
| Carbon Dioxide | Maximum | 15 mol % |
| Water Dew point | Maximum | 0 C at 70 bara. |
| Hydrocarbon Dew Point | Maximum | +5 C at 70 bara. |
| Gross Heating Value | Minimum | 950 BTU/SCF |
| | Maximum | 1180 BTU/SCF |
| Individual Trace Metal | Maximum | 2 ppm (by Weight) |
| Mercury | Maximum | 40 micrograms/SCM |

G2. Application requirements

| | | |
|---|---|---|
| Specific Gravity | Minimum | 0.5 |
| | Maximum | 0.7 |
| Pressure | Maximum<br>Minimum | 70 bar<br>30 bar |

**Note:** Natural Gas commercially contain of sand, dust, gums and liquids

G2.5.2 Residual oil

In the situations when natural gas is not available at the Site residual oil will be used in the main boilers and the black start diesel.

The analysis data of residual oil is presented in Table 2.10.

Table 2.10. Residual oil analysis data

| Item | |
|---|---|
| Specific gravity at 15ºC | 0.940 kg /$dm^3$ |
| Lower heating value (LHV) | 38.52 Mj/kg<br>9.200 kcal/kg |
| Viscosity at 80ºC max | 12 E |
| Pour point | Max 25 ºC |
| Flash point (open) | Min 100 ºC |
| Analysis<br>-sulphur (for continuous operation)<br>-sulphur (for design of the equipment)<br>-water and sediment<br>-ash (for design)<br>-ash (for continuous operation) | <br>Max 3.5 wt%<br>Max 5 wt%<br>Max 0.5 wt%<br>Max 0.1 wt%<br>0.03 wt % |

G2.5.3 Distillate oil

Distillate oil will be used as a start-up fuel for the main boilers and as a back-up fuel for the auxiliary boiler and the Black start diesel.

The analysis data of distillate oil is presented in Table 2. 11

Table 2.11 Distillate oil analysis data

| ASME or IP No. | Specification | Value |
|---|---|---|
| D1298/67 | Specific Gravity at 15 Cº (60 F) | 0.82-0.85 |
| D93/66 | Flash Point Cº min. | 55 Cº |
| D44/65 | Viscosity at 37.8 Cº(100F) in Cst | 2.5-4.5 |
| D1266/70 | Total Sulphur wt % max. | 1.2 |
| D611/64 | Aniline Point Cº min. | 65 |
| IP21/53 | Diesel index | 53-65 |
| D97/66 | Pour point Cº max. | Summer -4 Cº<br>Winter -10 Cº |
| D482/63 | Ash Content wt % max. | 0.01 |
| D130/68 | Cu test 3hrs at 50 Cº max. | No. 3 |
| D2709/68 | Water and sediment vol% max. | 0.05 |
| D664/58 | Acids and alkalise | Nil |
| D189/65 | Carbon Residue ( Conradson ) wt% max. | 0.1 |
| D86/76 | Distillation:<br>-Volume recovered at 35 Cº vol% min.<br>-50% recovered at max.<br>-90% recovered at min. | <br>85<br>280 Cº<br>283 Cº |

Start-up of the boilers with distillate oil shall he possible without steam or air atomization.

G2.6 Emissions

G2.6.1 Air pollutants

In S.A.R there are no regulations for stack emissions nowadays, so according to the law there are no requirements which must be fulfilled by the power plant. S.A.R. has, however, the environmental regulation to protect the atmosphere from contamination. The authority requires to satisfy the one called "Standard or Regulation of Circumstances" which refers to WHO's "Environmental Health Criteria". The said regulation prescribes ground level concentrations of pollutant as presented in Table 2.12.

Table 2.12. Ground level concentration limits prescribed in "Standard or Regulation of Circumstances"

| | Sulphuroxide (ppm) | Nitrogen oxide (ppm) | Suspended Particulate matter ($ug/m^3$) |
|---|---|---|---|
| Within 1 hr | 0.13 | 0.21 | - |
| Within 24 hours | 0.047 | 0.079 | 150 |
| Within 1 year | 0.030 | 0.054 | 90 |

the contractor shall design and construct the plant in such manner that it meets the requirements presented in Table 2.11 taking into account the climatical conditions in the neighborhood of the plant.

Space reservation for electrostatic precipitators and desulphurization plant for each unit shall be made.

G2.6.2 Noise

The sound levels generated by the Contractor furnished equipment during normal operation shall not exceed 85 dB(A) weighted, slow response, at a horizontal distance of one (1) meter from all surfaces of the equipment and at a height of 1,5 meters above or below the platform or floor on which the equipment is located, If there will be equipment having a higher noise level than previously specified they shall be encapsulated,

The control room and the offices shall have a maximum noise level of 55 dB(A),

The outdoor noise level along the power plant boundary shall not exceed 50 dB(A) as composite rating noise,

Special consideration shall be paid to the functions close to the area reserved for housing,

G2.6.3 Other emissions

The plant shall meet all emission limits set by the Syrian Environmental Authorities what regards to harmful substances in the air or water. No vibration shall be conveyed through the soil to other occupants of the area.

G2.7 Wastes

As presented in Chapter G2.4 the discharged water from the Plant will be used mainly for irrigation. Therefore the waste water treatment equipment must fulfill the requirements which are set as a form of water quality requirements for the waste water.

G2. Application requirements

Sludge - if any - from the waste water treatment will be removed from the Site with trucks, The final form of utilization of the sludge will he fixed by the PEEGT later. But preliminary the sludge will be used for fertilization purposes.

## G2.8 Telecommunication

The plant shall have internal communication facilities (broadcasting station, interphone, etc).
The tenderer shall include the communication facility to the neighboring substations through a fiber optic ground wire (OPGW) which shall be mounted on the existing or new power lines.
The power lines shall be protected by a teleprotection system transfered by communication system to the other end.

## G2.9 Chemicals

The water treatment chemicals are mostly imported to S.A.R. Sulphuric acid and lime are produced in S.A.R. Lime is used in power plants in powder form.

The Contractor shall design the equipment according to chemicals widely used in power plants all over the world if not specified in the Technical Specifications.

## G2.10 Auxiliary steam System

The auxiliary steam system is provided to supply the auxiliary steam requirements for fuel oil heating, fuel oil atomization, steam air heaters at start up, deaerator offload heating, station heating during the winter months, and any other service which may require auxiliary steam.

The auxiliary steam is extracted from the cold reheater line and supplied to auxiliary steam header through a pressure reducing station.

An emergency back-up steam supply is arranged from the superheater intermediate header to the auxiliary steam header through a pressure reducing station.

Each auxiliary steam header is connected by an interconnection header.

An auxiliary boiler is provided to supply the auxiliary steam at plant start-up. The steam from auxiliary boiler is connected to the interconnection header so as to supply the auxiliary steam for either auxiliary steam header.

Steam required for fuel oil heating, fuel oil atomizing, fuel oil unloading system steam trace, water treatment plant and station heating is supplied from the steam converter.

The steam converter is provided for each unit. The primary steam for steam converter is supplied from each auxiliary steam header and its condensate is returned to each deaerator or main condenser through a steam converter feed water heater.

The secondary steam generated by the steam converter is distributed with each unit auxiliary steam supply manifold.

The converted steam condensate from its consumers (e.g. fuel heater) is collected with each unit condensate recovery manifold and is brought to the steam converter feed water tank which is vented to atmosphere. The feed water from the steam converter Two 100% capacity feed water pumps are provided. The make up to the steam converter is supplied to the steam converter feed water tank from the demi water tank by the demi water pump.

The steam required for the equipment or system to be used in common such as fuel storage tanks, fuel unloading system and water treatment plant is distributed with common auxiliary steam supply manifold and its condensate is collected with the common condensate recovery manifold.

The common auxiliary steam supply manifold is connected to each of unit auxiliary steam supply manifold so that steam can be supplied from any of the unit auxiliary steam supply manifold.

The common condensate recovery manifold is connected to each of unit condensate recovery manifold so that condensate can be returned to any of the unit condensate recovery manifold.

The steam converter is provided with a bypass of the auxiliary steam side to ensure heating and atomizing steam supply even when the steam converter is under maintenance.

## G2.11 Auxiliary cooling water

Water for equipment cooling purposes is supplied in a closed auxiliary cooling water system and as filtered water from the filtered water reservoir to be used for cooling of the atmospheric blow down buffer tanks and for make-up water for the closed cooling water system.

## G2.12 Pressurized air

The Plant shall have a pressurized air system including service air and instrument air systems. Service air is used for purposes in which the quality requirements for the air are not very tight (air mixing. working air for pneumatic tools. cleaning. etc.). Instrument air has to meet tighter requirements, which will be specified by the Contractor.

The working pressure in the instrument air system shall be kept at the suitable level not depending on the consumption or on the consumption changes in the pressurized air system.
During operation of the Plant pressure of the instrument air shall not be lower than 4 bar (g).

## G2.13 Drainage, sewage water systems

The contractor shall design and provide all the necessary drainage systems to keep the plant site from flooding. The discharge of rain water shall be done together with waste water.

All the drainage shall meet the Syrian regulations regarding harmful elements like fly ash, etc. If found necessary, setting ponds of similar devices shall be included in the delivery. Also the possibility for common ponds for drainage water and waste water must be taken into account in this case.

The sewers possibly contaminated with oil shall he equipped with oil separation systems.

The quality requirements for the discharged water is presented in Chapter G2.4.2,

## G2.14 O&M personnel of the Plant

The contractor shall specify the suitable numbers of personnel for different sectors.

**PUBLIC ESTABLISMENT OF ELECTRICI1Y**
**FOR GENERATION AND TRANSMISSION ( PEEGT )**

# ALEPPO STEAM POWER PLANT

# INVITATION TO BID

## PART 2.

## GENERAL SPECIFICATION

G3. General technical requirement

**ITB,** PART- 2

General Specification

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| G3 | General technical requirements |
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| G5 | Test and inspection |
| G6 | Documentation |
| G7 | Services |
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# G3 General technical requirement

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# G3. GENERAL TECHNICAL REQUIRMENT

## G3.1 codes and standards

All well known international standards and codes are acceptable provided that the quality of design and safely is not reduced and they are not in conflict with the design criteria as set forth in local codes and standards.

Electrical equipment and installations must be designed and built in accordance with the IEC (Intell1ational Electrotecnical Commission) norms or equivalent.

The firing equipment and fire fighting systems and their layout shall comply with the requirements of the NFPA Standards (National Fire Protection Association) or equivalent.

The standards, codes and regulations to be applied shall be in accordance with the latest revisions at the time of Tender.

Properties of water and steam in the performance test calculations or the Plant will be calculated according to the international standards.

The Tenderer shall list all codes, standards and regulations which he intends to apply.

Upon request from PEEGT, the Tenderer and/or the contractor shall give to the PEEGT free of charge a copy or any standard and code which he is using in English.

## G3.2 Sizing, design and materials

The figures such as the dimensions, size and capacity stated in the ITB documents are for guidance only unless otherwise specified, Therefore, the Contractor shall make the sizing of the equipment and its components based on the service and operating conditions specified herein,

The project delivery shall correspond to the latest proven technology prevailing at the time of signing the contract and meet the high requirements for operational economy and availability.

The power plant shall be designed to facilitate inspection, cleaning and case of maintenance and for operation in which continuity of service and reliable operation is the first consideration, All apparatus shall be designed to ensure satisfactory operation under such sudden variations of load and voltage as may be met under working conditions on the system and short circuits, within the rating of the apparatus.

The design shall incorporate every reasonable precaution and provision for the safety of all those concerned in the operation and maintenance of the power plant and of associated works supplied by the Contractor.

All material used shall be new and of the best quality and of the class most suitable for working under the conditions specified and shall withstand the variations of temperature and atmospheric conditions arising under working conditions without distortion or deterioration or the selling up of undue stresses in any part. and also without affecting the strength and suitability of the various parts for the work which they have to perform. No welding, filling or plugging of defective parts will be permitted without the permission in writing of the PEEGT. All components shall be new and shall be manufactured from sound materials. Completely free from all visible imperfections such as cracks. flaws. blow holes etc... No easting, forgings or other material will be accepted in condition known to be faulty.

## G3.3 Standardized components or procedure

### G3.3.1 General

It is the intention of the PEEGT to maximize the uniformity of equipment or component to minimize spare parts requirements where practical. Therefore corresponding parts liable to renewal shall be interchangeable within the power plant.

The following subsections will outline standards or procedures for Mechanical, Electrical, Instrumentation and control or Civil works.

### G3.3.2 Mechanical components or designs

Some requirements of the mechanical design of the major item are listed below:

Clearance for crossing and passageways

The minimum over-head clearances shall be as follows:

| | | |
|---|---|---|
| - Above main roads or railroads | m | 6.0 |
| - Roads and accesses within | | |
| - Power plant property | m | 5.0 |
| - For passage of fork lift | m | 3.0 |
| - For passage of personnel | m | 2.1 |

The minimum horizontal clearances are follows:

| | | |
|---|---|---|
| - For passage of mobile equipment | m | 3.0 |
| - For passage of personnel | m | 0.9 |
| - For one way stairs | m | 0.8 |

Equipment and machinery shall be located in such manner that it is easy to operate and maintain. There shall be permanent access to locations frequently visited ample space for withdrawal of equipment internals / tube(s) etc.

Height of baseplate

Height of baseplate for a pump, tank or any other equipment shall be 250 mm including final grout. Deviations are allowed for items with particular

dimensions, with respect to maneuverability of isolation valves and to case or maintenance, respectively.

Arrangement of pumps or fans

Pumps and fans shall be arranged in such a manner that the drives are most preferably facing the access. In multiple installations of parallel pumps the suction flanges shall be in direct line,

Pumps and drives

All other centrifugal pumps except the boiler feed water pumps shall be selected in such a manner that there is n possibility to insert a new impeller which is one step larger than the original one.

The baseplate for an electric motor of a pump shall be selected in a manner which enables to install another electric motor having one step larger frame (IEC) than the original one.

Ways, Stairs, Ladders, Balustrades, Signs

The Contractor shall supply all data necessary (design data, drawings, etc.) for the construction of all platforms, galleries and stairways necessary for providing safe and proper access to the plant and all equipment for operation and efficient maintenance. Due allowance shall he made in the design for thermal expansion. The Contractor shall ensure that the type of flooring stair treads and handrails conform to a uniform pattern throughout the whole of the plant.

Flooring

All platforms and galleries shall be constructed using open grid floor panels (gratings) of the rectangular pattern, pressure locked and welded or the welded pressed bar pattern. The minimum depth of the floor panel shall not be less than 32 mm. All floor panels shall be not dip galvanized.

All platforms and galleries shall be designed with a minimum headroom clearance of 2.1 m and a minimum width of 0.9 m. All platforms and gallery floors shall be provided with toe plates having a minimum height of 100mm above floor level. Toe plates shall have a minimum thickness of 8 mm and shall not be fixed to the flooring pan

Balustrades

All platform, galleries and stairways shall be provided with balustrades on each side. Handrail heights, measured vertically between the top of handrails and the floor level or in the case of a stairway, the pitch line shall not be less than:

| | Top Rail | Lower Rail |
|---|---|---|
| Platforms and stairways | 1000 mm | 600 mm |

the bases of standards shall be the flat or side palm type for use on platform and the flat base type for steel stairways.

Handrails shall be of tube having minimum 34 mm outside diameter.

Stairs (only for equipment maintenance )

The under mentioned stairs are necessary for the access to the plant and all equipment for operation and maintenance purposes. They are mainly steel stairs and shall not be used for normal access and/or escape purposes.

Wherever possible the angle of slope for stair shall be standardized at 38 or 42º to the horizontal. Angles exceeding 42º shall not be used.

Stairs in frequent use in both directions shall have an angle of slope of 38º.

The minimum width of stairs shall accommodate stair treads having a length of 700 mm. The widths of stairs shall increase in increments of 100 mm. No flight shall have more than 16 risers with a maximum height of 3.36 m for a slope of 42º or 3.15 m for a slope of 38º.

Where a stair height exceeds 16 risers, each flight shall be equal and separated by a landing. Where a stair comprises more than two flights, a change of direction shall be made between adjacent flights and all changes of direction shall be in the same direction either left hand or right hand.

Hazardous Areas, Fire Protection Provision

The Contractor shall take full account of any special requirements concerning the nature, handling and storage of all fuel oils, gases and chemicals etc.. And provide plant, equipment buildings and other services accordingly including all facilities to ensure the safety of the operating and maintenance personnel.

Unless otherwise specified, the following design principles should be observed as minimum fire prevention requirements:

- Pipeline insulations and the stuffing of cable and pipeline wall penetrations are to be of incombustible material.

- All pipelines or vessels with internal temperatures of more than 180 ºC should be arranged so as to avoid any contact with flammable liquids if fuel or lube oil lines should leak

- Particular care should be taken to eliminate any risk of hot pipeline insulating material becoming impregnated with flammable liquids in the case of fuel or lube oil line leakage.

- Cable and pipeline ducts must be arranged so as to avoid the risk that they will be flooded with fuel oil, lube oil or any other flammable liquid.

- Covered floor ducts must be easily accessible for inspection and cleaning.

- All parts of plant and equipment are to be arranged so that no corners or pits difficult to inspect and clean are formed, where flammable matter could collect.

- For the paneling of walls and ceilings, for floor covering as well as for cubicles and cabinets, incombustible materials are to he used.

Maintenance Isolation

All major equipment shall be arranged to facilitate safe isolation from all hazards for maintenance purposes and on steam services above 40 bar (a) nominal pressure, double valve isolation shall be provided.

To the extent that steam or hot water can occur in shut off sections provided for repair purposes, dump pipes with hand operated shut off valves are to be provided for the safety of the personnel.

All equipment is to be provided at its highest and lowest points with a sufficient number of venting, drain and pump points, All air vents drains or dump points with more than 40 bar (a) operating pressure are to be provided with double stop valves.

Drain pipes are to be grouped together as far as possible and led into tunnels with covers at visible points or to the drain tanks.

### G3.3.3 Electrical components or design

Requirements are presented along the detailed design requirements in chapters E2...E15.

### G3.3.4 Instrumentation and control

Requirements are presented along the detailed design requirements in chapter 11.

### G3.3.5 Architectural and structural standardized components or structures

These are presented along the detailed design requirements in ITB part 4.

### G3.3.6 parking and marking

The contractor shall be entirely responsible for the safe transport of all materials, and the standard of packing shall be not less than as specified below.

Each item is to be packed properly or protected for shipment and transport from the place of manufacture to the Site.

Tube ends and other similar open ends are to be protected from both external damage and ingress or dirt and moisture during transit and while awaiting erection al Site. Flanged pipes are to have their open ends protected by adhesive tape or jointing and then be covered with a wooden blank flange adequately secured

Handing of instruments and associated equipment can be done according to ISA RP 60.11 or equal.

Precautions are to be taken to protect shafts and journals where they rest on wooden or other supports likely to contain moisture. At such points wrapping impregnated with anti-rust composition or vapor phase inhibitors are to be used of sufficient strength to resist chafing and indentation due to movement which is likely to occur in transit. The form of the protective wrappings and impregnation are to be suitable for a minimum period of twelve months.

Lids and internal cross battens of all packing cases are to be fixed by screws and not nails.

Hoop metal bindings of cases are to be sealed where ends meet and if not or ruslless material are to be painted,

Contents of cases are to be bolted securely or fastened in position with struts or cross battens and not with wood chocks wedged in place, unless they be fastened firmly in place. All struts or cross battens are preferably to he supported by cleats fixed to the case above and below to form ledges on which the batten may rest. Cases are to be upended after packing to prove that there is no movement of contents.

Where parts are required to be bolted to the sides of the case, large washers are to be used to distribute the pressure and the timber is to be strengthened by means of n pad.

Waterproof paper and felt linings are to overlap at seams by at least 13 mm and the seams secured together in an approved manner, but the enclosure is to be provided with openings to obtain ventilation.

Where practicable, all indoor items such as electric motors, switch and control gear, instruments and panels, matching components, etc. are to be "cocooned" or covered in polyethylene sheeting, sealed at the joints and the enclosures provided internally with an approved desiccators.

In the case of ball or roller bearings installed in any item of plant, the Contractor is to ensure that adequate protection against brinelling is give during the shipment of any plant incorporating ball or roller bearing. If replacement of any bearings are required due either to indentation during shipment or other causes during the maintenance period the bearing are to be replaced by the Contractor, free of charge, so that at the end of the period the plant is in full running order.

The Contractor is to be entirely responsible for ensuring that the packing is suitable for transit. The Contractor shall be responsible for any loss or damage due to faulty packing.

Each crate or package is to contain a packing list in a waterproof envelope. All items of material are to be clearly marked for' easy identification against the packing list.

All cases, packages etc. are to be clearly marked on the outside to indicate the total weight. to show where the weight is bearing and the correct position of the slings. Also, they shall have an identification mark relating to the appropriate shipping documents.

All stencil marks on the outside of cases are to be either of a waterproof material or protected by shellac or varnish to prevent obliteration in transit.

All members comprising multipart assembly's e.g: steel frame works, piping installations storage tanks etc.. shall be marked prior to shipment with distinguishing numbers and/or letters corresponding to those on the approved drawings or material lists. The Contractor shall provide suitably marked any temporary supports or bracing required to facilitate erection of the works.

In addition to warning signs appropriate black-yellow strips markings should also be used where necessary.

### G3.3.7 Pre-Service Cleaning and Protection of Plant Equipment

#### General

This section covers mechanical and chemical pre-service cleaning and protection of the plant items and equipment that are not subsequently to be painted.

Cleaning of fabricated component items shall be carried out after fabrication and final heat treatment or welding at manufacture's works or at Site as appropriate.

Mechanical cleaning as opposed to alternative chemical cleaning is the preferred method for works cleaning except where this is precluded by design or access considerations.

Machined surfaces shall be protected during the cleaning operations.

For recleaning small areas, hand cleaning by wire brushing may be permitted. Wire brushes used on austenitic materials shall have austenitic steel bristles,

Austenitic stainless steels, copper and aluminum alloys, cast iron, bimetallic and metallic/plastic items, and components fabricated by spot welding or riveting shall not be chemically cleaned, Stress relief heat treatment should be given to places where residual stresses might cause stress corrosion cracking or localized corrosion during chemical cleaning. Where chemical cleaning and passivation of stainless steel is necessary it shall be done in accordance with ASTM A 380 or equivalent

At an appropriate time, the Contractor has to submit detail drawings of temporary pipe work necessary to carry out the pre-service chemical cleaning simultaneously with a list of works to be carried out on the high-pressure pipelines and vessels in the workshops of the boiler and pipeline makers to conduct the temporary pip work with the parts of equipment to be cleaned.

Not less than nine months prior to the commencement of any Site cleaning, the Contractor has to submit detailed programs covering all procedures, lists of chemicals, supporting calculations which quote the velocities, temperatures and compositions or the chemical solutions as well as pipe work forces and movements imposed during Site cleaning operations.

The Contractor shall specify all the equipment that must not be chemically cleaned, All necessary temporary protective internals for valves shall be specified and included in the delivery.

Mechanical cleaning of manufacturer's work

Mechanical cleaning shall preferably be carried out by abrasive blasting. The PEEGT is prepared to consider alternative methods provided they achieve the necessary surface condition.

Acceptable surface condition:

- The metal surfaces shall be clean and free of mill scale. rust, dirt, grease and any other deleterious matter.

- Where metal surfaces are to be painted the surface profiles shall conform with the painting specification requirements.

- Where this does not apply surfaces shall have a surface texture not coarser than Grade 80 abrasive paper.

Allowable abrasives:

-Abrasives containing silica. Silicates or slag residues shall not be used for water/steam side surfaces of plant except for cleaning sand castings where hydro blasting with sand may be used.

- For austenitic materials only abrasives containing 98 % or more of alumina. $Al_2O_3$ shall be used.

Removal of abrasive and debris:

- After cleaning abrasive and debris shall be thoroughly removed for components.

Alternative chemical cleaning at manufacturer's work

the procedure shall comprise:

- Pre-treatment

- Acid treatment

- Neutralization rinsing and drying to achieve cleanliness equivalent to that specified for mechanical cleaning, the procedure to be adopted must meet with the Engineer's approval.

As soon as all items have been cleaned and within fours hours of the subsequent drying they shall be given suitable anticorrosion protection.

All water air and steam side surfaces of piping shall be protected by the application or approved water soluble corrosion inhibitors, or vapor phase inhibitors that can be subsequently removed by water washing or steam blowing at site.

The gas side or steam generating plant items shall be protected by the application of temporary protective that do not require to be removed before commissioning but which are removed during initial firing.

The rate or application of volatile corrosion inhibitors shall be at least 10 grams per square meter or 35 grams per cubic meter, whichever is the greater except for pipes up to 300 mm diameter for which the minimum application rates shall be 5 grams per square meter.

Immediately after the protective treatment has been applied all vessels and pipes shall be suitably sealed off by discs or caps or approved alternatives to prevent ingress from the surrounds, cylindrical plugs shall not he driven into the ends or pipes. These protective covers shall not he removed until immediately before final connection is made to the associated equipment.

Cleaning at site

The Contractor shall take all necessary precautions to ensure that the internal surfaces of all the plant are kept clean and free from injurious matter during erection.

When all plant has been erected and lagged or at such other time as may be agreed with the PEEGT for sub-assemblies, the installation shall undergo a procedure for Site cleaning in accordance with the requirements and associated schedules as approved by the PEEGT. If several methods are listed, the procedure adopted shall be according to the PEEGT's approval.

G3.3.8 Signs

General

Safety colors, safety symbols and safety signs shall comply in construction, geometrical from color and meaning with the local regulations.

Signs or plant identification during the erection period shall be to the PEEGT's approval.

The signs shall be made of material which is weather resistant and of sufficient durability for the conditions prevailing on site.

The positions for the signs shall be chosen so that they are within the field of vision of the persons to whom they apply. The signs shall be permanently attached. Temporarily dangerous areas (e.g. construction sites, assembly areas) shall also be marked by movable signs and fence railing or rope guard. The safety signs shall be mounted or installed in such a manner that there is no possibility of misunderstanding.

The text in the signs shall be in English language.

Information signs

Information signs shall supply the necessary information to acquaint personnel with the physical arrangement and structure of the site buildings and equipment.

Signs for emergencies

In the event or accidents, all necessary information shall be available immediately to those affected. Thus a sufficient number of signs of appropriate size shall be installed. e.g. escape routes (including marking of floor areas). Emergency exits, fire alarms, fire extinguishers, instructions for special fire-extinguishing agents, warnings against fire-extinguishing agents ($CO_2$ ) first aid equipment etc.

Signs obligatory

Signs indicating obligatory actions shall be provided and installed wherever certain action is necessary, e.g. Do Not Obstruct the Entrance; Keep Right. etc.

Signs shall also indicate when the wearing of protective clothing and equipment is necessary and obligatory. E.g. protective goggles, protective clothing, helmets, head guards, breathing equipment, ear muffs, etc.

Warning Signs

Warning signs shall refer to the existence or possible existence of danger, e.g. inflammable substances, corrosive substances, corrosive or noxious

Substances, suspended loads, general danger, width/height restrictions, steps, risk of trapping, slipping, falling etc.

The formats of these signs shall comply with the requirements of the relevant authorities. The inscription language shall be English and Arabic.

In addition to warning signs, appropriate black-yellow strip markings shall also be used where necessary.

Prohibition signs

The following are examples of prohibition signs: No Smoking; No Fires; No Naked lights or Smoking; No Entry for Pedestrians; No Entry; Do Not Start; etc,

These signs shall agree with local regulation and be placed so they are visible from reasonable distance when approaching.

## G3.4 Fabrication and assembly

### G3.4.1 Workmanship

All equipment shall be neatly finished and all metal parts shall be free of burrs and fins. Castings shall be sound and free of blowholes and cold shuts. Workmanship shall be first class in all respects, and all parts are to be fitted and finished in accordance with the best known modern practice.

### G3.4.2 Fabrication and assembly

All shop connections shall be welded unless otherwise agreed to by the PEEGT. All welded connections shall be in accordance with the applicable codes and standards.

If bolted connections are substituted, they shall be in accordance with the above reference,

If there is any danger that vibration or other occasional loads may make a bolted connection loose, such connections shall be secured by spring washers, lock washers or by other acceptable type of locking mechanism.

All plates and structural shapes shall be curved to the proper radii. Shaping shall be done by pressure and not by blows. Plates shall be curved cold with the grain in the circumferential direction. The edges of all plates for welding shall be bevelled and planed to true lines. Workmanship shall be in accordance with the best or recognized correct practice.

All steel shall be initially straight and true to line. Cuts shall be made by saw, shear, or mechanically guided torch. Surfaces to be welded shall be free of all foreign matter. All steel 6 mm or more in thickness to be butt welded shall be bevelled.

Insofar as is consistent with good shipping practice, all components shall be fabricated in as large assemblies as practicable.

All rubbing or wearing surfaces shall be machine surfaced. Joints employing a gasket material shall be so constructed that the, packing is maintained under sufficient compression in all parts, so that an efficient joint can be made without the use of jointing compounds. Gasket material shall be of the minimum thickness and of approved composition.

### G3.4.2.1 Bedplates anchor bolts and grouting

All fabricated bedplates shall after preliminary machining be stress relieved before final machining or seatings of plant mounted thereon.

The Contractor shall set each piece of equipment on its foundations or supporting structure. The Contractor shall assemble equipment as required. All equipment shall be installed with parallel. vertical and horizontal alignment by skilled craftsmen. The Contractor shall furnish shims and wedges required to level and align the equipment within the tolerances specified by the Contract and/or the equipment manufacturer's written installation instructions. Grout shall completely fill all voids in any bellow bedplate. Grout mixture and placement shall be in accordance with the requirements or this specification.

### G3.4.2. Alignment and installation

In order to facilitate the lining-up of large and heavy units, all bedplates shall incorporate jacking screws which shall be arranged to facilitate the movement or driving motors both in the axial direction and the transverse direction. Motor seating pads on bedplates shall be machined in such a manner that after lining up and leveling, the shims at each side shall be removed and replaced with a single machined packer or requisite thickness under each motor foot or alternatively under each pair or motor feet.

Each piece of rotating equipment shall be installed and aligned according to the instructions of the manufacturer's Field Engineer and/or Superintendent and/or manufacture's written instructions. Alignment shall be checked after leveling, after grouting, after connection of piping and after initial operation of the rotating equipment. If any check indicates misalignment the Contractor shall immediately realign the equipment before proceeding with the next installation step.

The arrangement of the platforms, catwalks and stairways shall be approved by the PEEGT. The platforms and catwalks shall have open grid or chequer plate type floors designed for a distributed load of at least 500 kg/$m^2$. Suitable reinforcement shall be provided at those points where during erection or maintenance. The likelihood of supporting heavy parts of machinery exists or where the floor is cut away for pipe work

All the necessary supports from floors and building steelwork shall be supplied.

Where welded fabrication is adopted, individual pieces shall be restricted to such sizes as will facilitate easy removal for overhaul purposes. All pieces shall be joined together and to their supports by bolted connections.

## G3.5 Welding

The Contractor's attention is drawn to the following requirements on welding.

Welders employed on any work under the Contract, either at works or on Site shall be proved to be competent to carry out the type and standard of welding required prior to commencing work. This shall be done by carrying out the appropriate tests.

Only welders who have prepared approved samples or produced Certificates of Competence shall be employed on the Works and, if in the opinion of the PEEGT the welding is not being carried out in a satisfactory manner for the class of work involved. Further tests may be called for at any time. Defective work shall be rectified to the PEEGT's satisfaction.

Each approved welder shall have an identification number which shall be indicated on all welds made by him. Adequate records of welders' performance, consumable storage, treatment issue and return of electrodes shall be maintained.

Welders engaged on welding at site shall be under the supervision of a competent welding engineer who must he able to demonstrate, to the PEEGT's satisfaction a complete system for the control and treatment of consumables, deployment of welders, and use of approved procedures, heat treatment, nondestructive testing, repairs and general quality control for site welding.

### Welder's tests

Sample welds shall be carried out on specimens of similar shape, thickness and chemical analysis to the material to be welded, and in a position which shall represent as far as possible the worst conditions under which actual welding shall take place.

The method of preparation of the test pieces, and the standards to be used in examination of them shall be according to the ASME Code or equivalent. All welding procedures shall be submitted for the approval of the PEEGT. All expenses of every kind in connection with welders' tests and procedure tests shall be borne by the Contractor.

### Welding

Where necessary, the work shall be heated in an approved manner, prior to welding and the temperature maintained throughout the operation. A record of the metal temperature attained shall be made, certified and available to the PEEGT.

G3. General technical requirement

Stress Relief

Where appropriate, the joints shall be stress relieved, and the required temperature recording extended to cover the healing and cooling periods.

Records shall be certified and available for inspection by the PEEGT.

Inspection of Welding

The extent of weld inspection, the final weld quality and the method of examination shall be as slated in the agreed standards or codes, The Contractor shall maintain available to the PEEGT both at works and on site adequately indexed records or all welding, weld inspection and repairs.

Safety precautions in the use of gamma ray units shall be followed and adequate safe storage facilities shall be provided for them.

Welding Electrodes

Before any welding is commenced the Contractor shall submit a list of all electrodes to be used to the PEEGT, for approval. Electrodes shall comply with the agreed standard and be suitable for the metals to be joined, the quality, size and type of weld and the welding position.

All electrodes shall be stored and dried in an approved manner prior to their use and the issue, use and return of the electrodes to store shall be to the approval of the PEEGT. If the flux covering has deteriorated to the extent that it cannot be restored by drying out, the electrode shall not be used. Electrodes with mechanically damaged coatings shall not be used

Weld Repairs

Where repairs on major items of plant are found to be necessary by welding dimensioned sketches of the excavated areas shall be prepared and the proposed repair procedure submitted for approval to the PEEGT before any repair is commenced. Under no circumstances shall the repair be commenced until the approval of the PEEGT has been obtained. The areas shall be subjected to a suitable non-destructive test and on completion of the weld will again be non-destructively tested. In the event that the repair requires all or any part of the item to be stress relieved, the non-destructive tests shall be repeated on any part deemed to have been affected by the stress relief.

## G3.6 Quality assurance program

The Contractor is responsible for planning and developing a program which verifies that specified requirements are met. The program is aimed primarily at detecting and disposition non-conforming items.

Planning and written descriptions are essential for stating what shall be done in such activities as the following affecting the quality to verify that items meet contract requirements:

1. Purchasing
2. Special processes
3. Measuring and testing equipment
4. Inspection and testing
5. Preservation, packaging and traceability
6. Documentation and quality records
7. Disposition or non-conforming items

The Contractor's responsibilities are:

1. To develop and implement the activities specified herein that will detect and disposition non-conformance to jurisdictional and contractual requirements
2. To satisfy jurisdictional and customer requirements which shall be specified in the contract
3. To prepare and submit a Quality Assurance Manual including system function descriptions before the work start
4. To prepare and submit an Inspection and Test Checklist before the work starts
5. To update and resubmit the Quality Assurance Manual including documented system function descriptions and Inspection and Test Checklist when needed to improve the effectiveness of the program or

G3. General technical requirement

reflect current practices

G3. General technical requirement

To implement the requested quality assurance program the Contractor shall:

Regarding the Organization

1. Define the responsibility and authority for quality of those managing and performing the work and of those verifying conformance to quality requirements, and show their relationships on organization charts

2. Appoint a representative who shall report regularly to management at a level which ensures quality verification requirements and who is not subordinated to manufacturing, construction or delivery and define his authority to resolve quality matters. Notify the PEEGT of the appointment in writing

3. Define the responsibility and authority of personnel primarily responsible for quality verification and their organizational freedom to:

   - Identify and record non-conformance;
   - Initiate or recommend disposition of non-conforming items;
   - Verify correction of non-conforming items;
   - Prevent further processing delivery or installation of non-conforming items or services until the deficiency or unsatisfactory condition has been dispositioned;

4. Use competent persons for inspection, other than those performing or directly supervising the work being inspected. Such persons shall not report directly to immediate supervisors responsible for producing the work being inspected unless specifically designated otherwise in the Inspection and Test Checklist and permitted in writing by the jurisdiction and the PEEGT before the Contract is let.

Regarding Quality Assurance Manual

1. Prepare a Quality Assurance Manual in compliance with the requirements of the ITB specifications, approved and signed by a senior management official, and submit it for acceptance to the PEEGT

2. Periodically review and update the Manual to reflect the current requirements

3. Upon acceptance, implement the program according to the Manual

The Manual shall include an Inspection and Test Checklist which may be of any format to suit the Contractor's system, but it shall, as a minimum:

1. Indicate each inspection and test point and its relative location in the manufacturing and construction cycle including incoming, preservation of items, packaging and site inspection and testing. The Contractor may include additional process inspection points for his own evaluation of quality which will not be subject to customer or jurisdiction acceptance. These shall be so indicated

2. Indicate where subcontractors' services will be employed

3. Identify the characteristics to be inspected, examined, and tested at each point and specify acceptance criteria to be used

4. Indicate mandatory hold points established by a jurisdiction or customer or both which require their witnessing or verification of selected characteristics of an item or process and beyond which the work shall not proceed

5. Define or refer to sampling plans if proposed and indicate where they will be used

6. Specify the quality program standards to be applied to subcontracted items or services

7. Detail how the Contractor will verify quality at subcontractors' plants during manufacture or at site during construction by one or more of the following methods:

   Inspection by the subcontractor as defined in his Inspection and Test Checklist; Source inspection by the Contractor; Surveillance by the Contractor; Incoming inspection

8. Define or refer to how verification or compliance to special process procedures will be accomplished and documented

9. It shall also specify the following functions:

   Document Control
   Measuring and Testing Equipment

Purchasing
Incoming Inspection
In Process Inspection
Final Inspection
Inspection Status
Identification and Traceability Special Processes
Preservation, Packaging and Shipping
Quality Records
Non-conformance

Each system function description shall document as applicable, such things as its purpose and scope; who is responsible for what; and an outline of what shall be done,

Form used shall be exhibited in the Tender

## G3.7 Nameplates and identification system

The Contractor shall adapt an uniform identification system for machinery, equipment. pipelines electrical systems or cables, instruments and control devices as well as for auxiliary equipment.

It shall be approved by the PEEGT prior to its introduction to use. The system shall be such that it can be used in highly advanced computerized maintenance or cost control procedures. on the other hand it shal1 be easy to learn and remember which is of utmost importance in operation while calling a certain function on the computer keyboard.

All apparatus plant and equipment shall be clearly and permanently labeled to the approval of the PEEGT. Where labels are provided for making clear the method of operation of apparatus they shall be concise and preferably diagrammatic in form. They shall be of such size as to be readable at normal operating positions.

Each item of plant or equipment covered by the ITB specifications shall be supplied complete with an identification nameplate clearly stating the manufacture’s name, plant and date, together with any other such information that will assist future maintenance and the PEEGT of spare parts. In the case or pumps, motors etc.. the duty for which they are designed and the maker's production number shall also be stated.

Vessels which have been hydraulically tested at the manufacturer's works must also have the test pressure and the date of test indicated on the plate.

Nameplates, labels and their fixing screws shall be of suitable material to last the whole life time of the Plant (normally stainless steel).

Instrument control and electrical panels shall be fitted externally with approved identification labels at the front and rear of all units, and internally where access is provided.

Each circuit breaker panel, electrical control panel, relay panel. etc. shall have a circuit designation label on the front as well as on the rear panels engraved with white lettering in accordance with the circuit designation system. Circuit designations shall be precise and convey complete information. Corridor type panels shall in addition have circuit designation labels within the panels.

Where polyphase power lines exist within the same cubicles, switchgears or machinery, the phases of the different terminals of the cables shall be identified by colors to be approved by the PEEGT.

Labels for similar equipment shall be of uniform appearance and size.

Identification discs of stainless steel or other approved material shall be provided on the hand wheels of all valves and shall be suitably engraved to denote the duty or service for which the valve is installed, Large characters to identify the valves with the number or letter group appearing on the system diagram shall also be engraved prominently on the discs,

The language in the nameplates shall he English.

## G3.8 Piping

The general technical requirements for piping are presented in ITB (mechanical)...

## G3.9 Cleaning, painting and preservation

General technical requirements for cleaning, painting and preservation are presented in Enclosures G3.1 and G3.2

## G3.10 Units

The following units (mainly based on SI units) shall be used in all the documents:

| | |
|---|---|
| Angle | $^{o}$ (degree) |
| Area | $m^2$ |
| Density | $kg/m^3$ |
| Energy | kWh, MWh |
| Enthalpy | kj/kg, kcal/kg |
| Frequency | Hz |
| Heat Rate | kWh/kWh, kj/kWh, kcal/kW |
| Length | m, mm |
| Mass | kg |
| Mass flow rate | kg/s, $Nm^3/s$ |
| Power | kW, MW |
| Pressure | bar(a), bar (g), $mmH_2O_2$, Pa, $kg/cm^2$ |
| Specific volume | $m^3/kg$ |
| Temperature | $^{o}C$ |
| Time | s, min, h, day, year(one year is 8760 h) |
| Vacuum | mmHg, bar(a) |
| Velocity | m/s |
| Volume | $m^3$ or l |
| Volume flow rate | $m^3$ /s or l/s or l/ min |

Items not mentioned in the above list shall be in accordance with SI units.

G3.11 Protection classes of electrical equipment

G3.11.1 General

Electrical equipment shall be protected at least in accordance with following classes. Lower classes are not allowed to use. However, technical specifications may determine higher classes in special cases.

G3.11.2 Protection classes of enclosures

G3.11.2.1 Indoor installations

Processing areas

Protection classes of installations in processing areas shall be IP54.

Ventilated dry rooms (e.g. control rooms, marshalling rooms)

Protection classes of installations in ventilated dry rooms which are protected against harmful dust shall be IP 2x for < 1000 V installations or IP 3x >1000 V installations

G3.11.2.2 Outdoor installations

Protection classes of outdoor installations shall be IP 54.

G3.11.3 installations in hazardous areas

G3.11.3.1 General

Electrical apparatus should as far as possible, be located in non-hazardous areas. Where it is not possible to do this it should be located in the least hazardous area.

Electrical installations in hazardous areas shall comply with following

Standard and recommendations:

- National Standards

and

- IEC79 series or equivalent

(or

- APE RP 500 serie appropriate NFPA series or equivalent.

G3.11.3.2 Area classification and selection of electrical equipment

Area classil1cnlion and selection of electrical equipment shall be made in accordance with IEC 79 series (or alternatively in accordance with APERP 500 and NFPA series).

G3.11.3.3 The approval of the classification

The Contractor shall make area classification descriptions. These descriptions shall contain the classification of hazardous and non-hazardous areas. Drawings where different zones are determined shall be included in the description.

The preliminary area classification description shall be included in the Tender.

The final area classification description shall be submitted for approval to the PEEGT.

G3.11.3.4 the approval of selected equipment for hazardous areas

The Contractor shall make a list of equipment for hazardous areas, all equipment which will be installed in hazardous areas shall be listed, and the list sorted by zones shall contain zones, equipment in them and protection class or the equipment.

The preliminary list shall be included in the Tender.

The Final list shall be submitted for approval to the PEEGT

# Painting and Coating

Enclosure G3.1

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Enclosure G3.1

1. General

This specification covers the general requirements for painting work of the Project.

This specification shall be used as basis for the preparation of coating schedules, engineering drawings, specification and requisitions of materials and labor.

The Contractor shall furnish all labor, materials and equipment of the best quality. .

Painting and coating specification to be submitted shall comprise the following with detailed description:

1. Scope of work
2. Quality standards
1. Submittals
4. Materials
5. Shipping handling and storage
6. Surface preparation
7. Mixing and application
8. Inspection and testing
9. Remedial work
10. Coating systems and schedule
11. Color scheme

The number of paint supplier's/manufacturers shall be kept to the very minimum.

The same type of structures/items shall be coated with the material of one manufacturer only.

The terms used herein are defined as follows:

- "Outdoor" shall mean surface area exposed to the weather

- "Indoor" shall mean surface area enclosed within a structure

- "Exterior" shal1 external surface of apparatus, equipment, vessels, tanks or pipe

- "Interior" shall mean internal surface of apparatus, equipment, vessels, tanks or pipe

- "Coating system" shall mean one or several coating materials to be applied onto a prepared surface in a specific sequence (prime, intermediate and final) with a required thickness for each coat

- "Unidentifiable coating" shall mean a coating that is not traceable due to lack of documentation or a coating that has not been qualified

In principle primers and other undercoat paint shall be produced by the same manufacturer as finish coat. When the use of products from different manufacturers cannot be avoided, providing on obvious evidential documents to ensure compatibility of total coating system is essentially required.

2. Description of work

The principle work to be performed by the Contractor under this section includes the furnishing of all engineering/design, labor, equipment, supervision and applying all coatings of corrosion protective or decorative purpose the work includes, but is not limited to:

1. Establishing design requirements for purchasing items needed shop prime or finish coating and supervising manufacturer's compliancy to the requirements

2. Furnishing of coating materials for field painting

3. Preparation of surfaces to be coated and protection of adjacent surfaces

4. Application of coating materials for the following items:

All items requiring painting as indicated on coating schedule to be submitted/approved

All areas requiring painting as indicated on architectural finish schedule and exterior elevation drawings to be submitted/ approved

Finish painting of equipment and material which have prime coat only

Equipment and material which has shop finish coat but does not match with the color scheme to be submitted/approved

5. Inspection and testing of surface preparation and coating operation

6. Coating of buried piping and vessels, internal coating or protection for tank, pipe and equipment by qualified manufacture or installer's recommendation

7. Touch-up and repair of defective prime or finish coating

8. Prime coating of uncoated material or field fabricated items

9. Labeling of piping system and equipment

10. Galvanizing of applicable miscellaneous metal and steel assemblies

Unless otherwise indicated coating shall not be applied over:

- Factory finished item
- Machined surface
- Finished metal surface such as galvanized steel, anodized aluminum, stainless steel, chromium plate, copper, bronze, etc.
- Code required labels

Items with unidentifiable coatings and in need of repair shall be completely recoated according to applicable coating system.

- Quality standards
- The Contractor shall purchase materials only from suppliers who have previously been qualified by the Contractor in accordance with the contractor’s quality program.

The well-known standards are incorporated as a part of this specification to control the quality of items and services.

For specific items requiring particular process of surface preparation and coating application, the manufacturer's standard procedure or specification can be regarded as a standard.

1. Design drawings
2. Construction specification
3. Product data including:

   Product data sheet

Coating manufacturer's application instruction
Manufacturer’s quality assurance program

4. List or coating materials
5. Certificate of compliance
6. Samples

Adequate size of complete coated item substrate as requested by the PEEGT, which shows each coat in a sequential manner

**5. Job conditions**

Apply water-base paints when temperature of surfaces to be painted and surrounding air temperatures are between l0 °C and 32 °C, unless otherwise permitted by paint manufacturer's printed instructions.

Apply solvent-thinned paints only when temperature or surfaces to be painted and surrounding air temperatures are between 7 °C and 35 °C, unless otherwise permitted by paint manufacturer’s printed instructions.

Do not apply paint in snow, min, fog or mist, or when relative humidity exceeds 85%, or to damp or wet surfaces, unless otherwise permitted by paint manufacturer's printed instructions.

Painting may be continued during inclement weather, if areas and surfaces to be painted are enclosed and healed within temperature limits specified by plant manufacturer during application and drying periods.

**6. Materials**

**6.1 Coating material**

Coating material shall be the best quality grade of various types of coatings as regularly manufactured by acceptable coating manufacturers. Materials not displaying manufacturer’s identifications as a standard, best-grade product will not be acceptable.

Syrian standards and regulations establish minimum acceptable quality for paint materials. Written certification from paint manufacturer that materials provided meet or exceed these minimums shall be provided.

Manufacturer's product which comply with coating qualitative requirements of applicable standards, yet differ in quantitative requirements, may be considered for use when acceptable to the PEEGT. Furnish material data and manufacturer’s certificate of compliance to the PEEGT for any proposed substitutions.

6.2 Solvents, thinners and cleaners

Solvents, thinners: and cleaners used for coating shall he those recommended by the paint manufacturer and shall also be certified to contain no chlorides or fluorides.

6.3 Abrasive materials

Abrasive material shall be clean, dry and identifiable.

Types, sizes and proportions of abrasive material shall be suitable to produce the required surface profile

6.4 Equipment

Mixing and application equipment shall be or the same type as recommended by the coating manufacturer.

7. Surface Preparation

7.1 Protection of surfaces and equipment

The following items and surfaces shall be masked otherwise protected from damage and overspray during surface preparation and coating operations:

- Sides or expansion or construction joints to be caulked or sealed with sealant
- Machined surfaces
- Galvanized steel, stainless steel, non-ferrous metal, unless otherwise specified
- Rubber or plastic
- Name and instruction plates
- Adjacent surfaces and factory finished items and equipment ,unless otherwise

Permission shall be obtained from the PEEGT prior to removing or disconnecting any items or equipment Reinstallation and reconnection following the completion of all coating work shall be subject to acceptance by the PEEGT

Provisions shall be made prior to the start of work to prevent liquids and waste entering the plant drainage system during cleaning and coating operations,

Dust and loose particles shall be removed from prepared surfaces by vacuuming or compressed air after blast cleaning and immediately before coating, Floor shall be swept clean and vacuumed.

7.2 Abrasive blast cleaning or steel

Prior to blast cleaning, oil, grease, and other contaminants shall be removed from steel surfaces by solvent cleaning.

Unprimed surfaces shall be prepared according to the designated surface preparation grade given in the coating system prepared by the Contractor and approved by the PEEGT.

Burrs, slivers, scabs, and weld spatter that become visible after blast cleaning shall be removed, Repaired areas shall be reprepared to bright metal.

Prepared surfaces that have become rusted, wet, or otherwise contaminated prior to coating shall be recleaned to specification.

7.3 Chemical Treatment

Phosphatizing is suitable for steel, zinc and light-alloy surfaces. A thin firmly adherent, fine-crystal phosphate layer is formed over the surface to be treated. The surface must be primarily cleaned and/ or blast cleaned before the treatment and a suitable chemical shall be used in accordance with the instructions of the chemical manufacturer.

After the treatment the surface must be painted before it becomes dirty or rusty

Chromatizing is suitable for zinc and light-alloy surfaces. A thin chromate layer is formed over the surface. The surface must be primarily cleaned before the chromatizing. The chromatizing liquid is spread in accordance with the instructions given by the liquid manufacturer

7.4 Shop-coated or galvanized steel

Dirt-oil. grease, and other contaminant shall be removed by solvent cleaning,

Welds and burned, rusted, or damaged coating shall be prepared.

7.5 Concrete and concrete unit masonry

Fins shall be leveled and sharp interruptions in the surface shall be tapered to the surrounding surface. .

Oil, grease, and other contaminants shall be removed by scraping off heavy deposits and washing or scrubbing the contaminated area with cleaning solution of 30 g of trisodium phosphate to each liter of warm water. Following washing, the surface shall be thoroughly flushed with clean water and allowed to dry. This procedure shall be repeated until all contaminants are removed.

7.6 Plaster

Nibs and other sharp protrusions shall he removed using n scraper or putty knife.

Cracks and gouges shall be patched flush with a plaster patching compound, to match the texture of the surfac

Oil, grease, and other contaminants shall be removed by scraping off heavy deposits and washing the contaminated area with a cleaning solution of 30 g of trisodium phosphate to each liter of warm water. Following washing, the surface shall he thoroughly flushed with clean water and allowed to dry. This procedure shall be repeated until all contaminants are removed.

7.7 Drywall construct ion

Nicks, scratches, and gouges shall be filled flush with a plaster patching compound and allowed to dry.

Filled tape joints, fastener heads, and repairs shall be sanded before priming to provide a smooth, even surface, and, after the primer coat is dry, shall be lightly scuff sanded, without sanding through the primer, to remove any raised paper knap. Dust shall be removed after each sanding operation by wiping with clean rags or other means.

8. Mixing and application

Coating materials shall be mixed, thinned, applied, and cured according to the manufacturer instructions and the requirements of this section.

Each item or surface shall be coated as shown on the approved coating schedules. Each coat shall be applied at the dry film thickness specified in the Coating System Description. Edges and corners of steel surfaces shall receive a double application to ensure adequate film thickness.

Each coat shall have dried sufficiently before recoating. Succeeding coats shall be applied within the manufacturer’s recommended time and temperature limits.

Edges shall be clean and sharp where work joins other materials or colors. Semi-concealed surfaces such as tops of doors shall receive the same coating as exposed adjacent surfaces.

Before application of the finish coat, the Contractor shall sand and smooth the touch-up, prime coat, or undercoat on all surfaces, as required to attain a smooth coat or paint.

Paint shall not be applied to steel surfaces that are at a temperature higher than the permitted by the written instructions of the coating manufacturer for the application or the specific product being applied. When steel is painted in hot weather, precautions shall be taken to ensure that the specified dry film thickness is obtained.

No coating application will be permitted when the surface temperature is less than 3 above the dew point. All surfaces shall be dry before painting.

All metal lagging on equipment and piping and all cable trays (which are not to b painted), shall be protected and kept free of paint.

Care shall be exercised to keep valve stems, motor shafts, and other such moving parts clean and unpainted in order to not impair their free movement Any paint deposited on these parts shall be removed.

Extreme care shall be exercised to avoid tripping or circuits while painting around switches and controls. It is imperative that all switches remain unmoved and undisturbed.

9. Touch-up painting or metal surfaces

The following items/areas shall receive a field touch-up prior to application of a full field coat of paint:

- Surfaces where the shop coat of paint has been marred, scratched or otherwise damaged due to shipping, handling, erection, installation, or weathering

- Heads of field bolts and nuts, and adjacent surfaces left unpainted in the shop
- Surfaces around field welds
- Surfaces of any ferrous fasteners not otherwise protected

- Surfaces of any ferrous fasteners not otherwise protected

- Exposed fabrication, erection, or shipping marks

After completion of surface preparation, the coating shall be applied as required to bring the coated surface to a dry film thickness equal to the adjacent sound coating, keeping over coating of sound areas to a minimum.

10 Field prime, intermediate and finish coat painting of metal surfaces

Where a prime coat is required, such prime painting shall be one complete coat applied after the surface of the equipment have been cleaned, as; specified under chapter 7. "Surface Preparation" of this enclosure, The prime coat of inorganic zinc rich paint or suitable wash primer shall be applied within 4 hours after completion of the specified surface preparation. If the prime coat or wash primer is not applied before corrosion is evident. The Surface shall be reprepared.

All equipment and accessories, when cleaned, prime coated. and/or touched-up, shall receive an intermediate and/or finish coat of paint as specified in the approved coating schedule.

11 Remedial works

Touch-up and repair shall be done according to the manufacturer's written instructions and/or applicable requirements of this section. Adjacent surfaces shall be protected from damage and overspray during repair operations.

Pinholes, skips, and areas less than the specified dry film thickness shall be touched-up or recoated to specification.

Unacceptable runs, Sags, dry overspray, orange peel, and embedded dust shall be removed by sanding. The surface shall be vacuumed or blown off with compressed air and touched-up or recoated to specification.

Coating that is damaged, blistered, cracked, peeling, or delaminated shall be removed to the bare substrate and the surrounding sound coating tapered to a feather edge. Dust and loose particles shall be removed and the prepared surface recoated to specification.

Shop applied coatings not scheduled for top coating shall be prepared and touched-up as specified in the approved Coating Schedule to match the gloss and color of the surrounding surface.

12. Labeling of piping systems

All piping shall he identified with painted labels indicating direction of flow and flowing substance. Labels shall be on a white color field with identification characters in English letters. Letters shall be painted in black. Labels and arrows shall be located as follows:

- All elbows, bends and branch tees
- All valves
- Where pipes enter or leave walls and ceilings
- At maximum 30 meter intervals

Labels shall be painted over final coat of piping.

13. Galvanizing

Miscellaneous metal and steel assemblies not requiring subsequent coating shall be designed to receive a hot-dip process or galvanizing.

Bolts, nuts and washers, including general grade high tensile friction grip bolts for all open-air structures shall be hot-dip galvanized and subsequently centrifuged.

Galvanizing work shall conform in all respects to ASTM or equal for assembled products.

All surfaces to b galvanized shall be cleaned in accordance with SSPC-SP6 or equal. The height of profile shall be within the range or 37.5 microns to 75 microns.

The blast cleaned surfaces shall be galvanized within four hours after blasting or before visible rusting occurs.

The weight or zinc coating shall average not less than 750 $g/m^2$ of actual surface.

The coating thickness will he measured by a magnetic thickness gauge and weight computed on the basis of 100 g of zinc per1 $m^2$ having a coating thickness of 0.015 mm.

Each fabricated assembly shall be totally immersed in the galvanized bath. Dipping of assemblies in more than one operation will not be permitted without prior acceptance by the PEEGT.

Assemblies shall not be distorted by the galvanizing procedure. Straightening of members after galvaniz.ing will not be permitted.

Assemblies shall be held in the galvanizing bath until the temperature of the assembly is equal to the temperature or the bath.

Any galvanized surface which has the coating removed for any reason shall be touched-up with a zinc rich paint, so that the entire surface has a uniform coating of 750 g/$m^2$ of zinc

## 14. Inspection and Testing

### 14- 1 General

Each phase of the work shall be inspected. Unacceptable conditions shall be corrected and reinspected before proceeding with the next phase.

For performing inspection and testing, the contractor shall provide the PEEGT's inspection personnel with all necessary inspecting equipment (thermometers, hydrometers, etc.) and pictoral surface preparation standards (SSPC-Vis 1 or equal)

The contractor shall correct, to original specification, any defects disclosed by the preceding tests. The contractor shall notify the PEEGT in writing of such defects and obtain approval from the PEEGT of the proposed repair procedures. Upon completion, the repaired area shall be retested for acceptability.

Test records shall be maintained and delivered to the PEEGT.

Compressed air shall he tested for oil and moisture by holding a piece of clean, dry, absorbent material in the airstream for 1 minute. If' the test material becomes moist or soiled, remedial action shall be taken and the air-stream retested. Tests shall be made prior to use and at 4-hour intervals during continuous compressor operation.

Recirculated shot and grit shall be tested for oil by putting a small handful of the working mix into a container of water. If an oil film forms on the surface of the water, the contamination abrasive shall be cleaned or replaced with clean abrasive and retested before use. All steel blasted since the previous satisfactory test shall be recleaned. Tests shall be made at the start, at least once every four hours thereafter, and at the end of blast cleaning operations.

During the surface preparation and coating application operations, work shall be inspected on a random basis and documents prepared to verify compliance with the following requirements:

14.2. Inspection of surface preparation

Before starting surface preparation, the condition of the surface shall be verified. Conditions that would adversely affect the work shall be collected.

Concrete, concrete masonry unit or plastered surfaces shall be examined to verify that they are clean, dry, and free from contaminants, and that fins ,and protrusion are level, concrete shall be verified to be cured prior to coating.

Verification of blast cleaned steel surfaces shall be made according to SSPC- Vis 1or equal. Grease-free chalk shall be used to mark local areas that do not meet the specified standards.

Preparation of rusted areas and damaged coatings shall be verified by inspection prior to touching-up primed or galvanized steel, and the surface shall he examined prior to field coating to verify that it is clean, dry, and free from contaminants.

Power tool or hand tool cleaned surfaces shall he visually inspected to ensure satisfactory cleanliness and roughness.

Where requested, the surface profile shall be checked with a method and equipment approved by the PEEGT's representative.

14.4 Inspection of coatings

The dry film thickness on ferrous metal surfaces shall be verified to be within the specified limits by measuring the thickness with according to SSPC-PA2 or equal.

Each coat shall be examined for specified application defects and evidence of imbedded dust, cracking, blistering, peeling, and delamination. The total dry-film thickness of sags and runs shall not exceed 200 % of the specified maximum nor be less than the specified minimum.

On non- ferrous surfaces, wet- film thickness shall be monitored the specified dry-film

thicknesses.

Each coat shall be examined before recoating to verify that the surface is clean, dry, and free from contaminants.

The color of the finished coat shall be verified as correct by comparison with the accepted color sample.

15. Coating System

A color scheme has to be established by the Contractor and approved by the PEEGT.

Based on the enclosure G3.2 "Coating system" the Contractor shall prepare complete coating systems, which specify all necessary information such as:

- one or more coating products per each coat, per each system
- Minimum and maximum dry-film thickness to be allowed per each coat
- Substrate or item to be coated by the system
- Finish grade
- Exposure condition '.
- Service temperature limit and/or specific resistive condition
- Surface preparation procedure to be adopted
- Application procedure to be adopted
- Inspection procedure to be perfor

G3. General technical requirement

**PUBLIC ESTABLISMENT OF ELECTRICI1Y**
**FOR GENERATION AND TRANSMISSION ( PEEGT )**

**ALEPPO STEAM POWER PLANT**

# INVITATION TO BID

**PART 2**

**GENERAL SPECIFICATION**

G4. Guarantees

General Specification

| | |
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| G3 | General technical requirements |
| G4 | Guarantees |
| G5 | Test and inspection |
| G6 | Documentation |
| G7 | Services |
| G8 | Spare parts and special tools |
| G9 | Maintenance management |
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| **G4** | **Guarantees** |

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# G4.GUARANTEES

## G4.1 General

This section specifies the guarantees which the Contractor shall give for the main boilers, the steam turbines and for the whole Plant.

The contractor is responsible for design, engineering, manufacturing, material, construction, erection, start-up, commissioning and test run or the specified equipment.

The contractor guarantees the professional designed engineering, the proper selection of the materials and the first class workmanship of the Work.

The contractor himself is especially liable to familiarize himself with the information about the valid statutes and orders of S.A.R. The Contractor guarantees the compliance to these statutes and orders (especially those regarding safety, noise, vibration and emissions).

The Work shall be designed and built to facilitate inspection, cleaning and case of maintenance and for operation where the continuity of service and reliable operation is the first consideration.

## G4.2 Warranty

The contractor shall guarantee that the supplied equipment, material or part thereof shall be in compliance with the specifications hereto (however, guarantees for performance are stipulated in other parts of this section) and shall be brand new manufactured products, free from any defects in design, material or workmanship. Spare parts furnished shall he identical to original parts.

In general, the warranty will be according to what is mentioned in this Book or Special Conditions.

## G4.3 Performance guarantees

### G4.3.1 General

The contractor shall carry out the performance test to demonstrate that performance or the Plant complies with the requirements or the specifications and with the performance guarantees given in the Enclosure G4.1.

In order to enable each overall unit performance to be calculated, the following individual performance shall be measured:

- Boiler efficiency
- Turbine-generator heat rate
- Power consumption or auxiliaries

No aging for the equipment of the Plant is allowed to take into consideration for the minimum period or five (5) months from the PAC concerning the performance values. After that the Contractor shall specify the aging factor (per cent figure or curve).

### G4.3.2 Guarantee conditions

All performance guarantees at each loading shall be valid at the same time.

The guarantee basis is as follows:

| | |
|---|---|
| Ambient conditions | As in ITB |
| Fuels | As in ITB |
| Feed water | As in ITB |
| Steam | As in ITB |
| Combustion air | Ambient temperature as specified in ITB entering the air inlet of F.D.fan |
| Electricity | As in ITB |
| Auxiliary Steam | As in ITB |

G4. Guarantees

The reference temperature of the heat balance is 0 °C

The terminal points in the heat balance for the boiler are the following

| | |
|---|---|
| Combustion air | Air inlet of F.D fan |
| Natural gas | Before the emergency stop valve for each boiler |
| Heavy fuel oil | Boiler house,before heaters |
| Feed Water | Economizer inlet |
| HP Steam | Superheater outlet |
| Auxiliary steam | Auxiliary steam header |
| Fuel gas | Duct leaving the last heat transfer surface |

G4.3.3 Guarantee items

G4.3.3.1 Net Unit Heat Rate

The contractor shall guarantee the Net Unit Heat Consumption at the condition specified in ITB with 100 % natural gas firing ,with 100 % residual oil firing and with mixed firing ( 50/50 % )

The Net Unit Heat Rate ($N_0$) shall be calculated from the following formula:

$$N_0 = \frac{N_t}{N_b * \left(1 - \frac{W_a}{W}\right)}$$

Where:

$N_0$ =Overall net unit heat rate (KJ/KWh)

$N_t$ =Turbine heat rate (KJ/KWh) as defined below

$N_b$ =Boiler efficiency as defined below

W =Electrical power measured at generator terminals (KW)

$W_a$ =Auxiliary power consumption (KW) as defined below

The turbine heat rate ($N_t$) is defined as follows:

$$N_t = \frac{Q_{ms} * H_{ms} - Q_{fw} * H_{fw} + Q_{th} * H_{to} - Q_{th} * H_{ti} - Q_{fws} * H_{fws} - HAS}{W}$$

$Q_{ms}$ =Main steam flow at superheater outlet (kg/s)

$H_{ms}$ =Main steam enthalpy at turbine inlet (kJ/kg)

$Q_{fw}$ = Boiler feedwater flow (kg/s)

$H_{fw}$ = Boiler feed water enthalpy (kJ/kg).

$Q_{th}$ =Steam flow through reheater (kg/s)

$H_{to}$ =Enthalpy of steam entering IP turbine (kJ/kg)

$H_{ti}$ = Enthalpy of steam leaving turbine (kJ/kg)

$Q_{fws}$ = Boiler desuperheater spray water flow (kg/s)

$H_{fws}$ = Spray water enthalpy (kJ/kg)

HAS =Heat extracted from turbine cycle for steam air preheater and steam converter (KW)

W = Electrical power measured at generator or terminals (k W)

The boiler efficiency ($N_b$) measured by the heat loss, is defined as follows:

$$N_b = 1 - \frac{L}{LHV}$$

where:

L = Heat Loss from the boiler established in accordance with test code from the test in kilo – calories ( KJ ) per kilogram of fuel

$$= \frac{\text{Total heat losses (K cal/h)}}{\text{Boiler fuel fired (kg/h)}}$$

LHV = Lower heating value of fuel (K cal/ Kg)

The auxiliary power consumption shall consist or the electrical power consumed by the auxiliaries listed below and the electrical losses in the generator and unit transformers and e1ectrical losses in the starting transformer where auxiliaries are supplied from the starting transformer.

The auxiliary power consumption shall include the following electrical power consumers

- Boiler forced draft fans
- Boiler gas recirculation fans
- Boiler seal air fan
- Flame scanner cooling air fan
- Air preheater drive motors
- Air preheater lubricating oil pumps
- Fuel oil pumps (unloading and transferring
- Boiler feed water pumps
- Condensate pumps

- Drain pumps.
- Reserve feed water pumps.
- Cooling water pumps (circulating).
- Auxiliary cooling pumps and fans.
- Gland condenser fan.
- Oil tank vapor extractor.
- Oil purifier.
- Pressurized air compressor (one compressor).
- Steam converter Pumps.
- Any other auxiliary essential for the unit operation (the tenderer shall specify which are these equipments)

All drains, blow down and vents which will be opened during normal operation shall be opened also during performance test of the net unit heat rate. The contractor shall prepare list of these valves

G4.3.3.2 Unit Maximum Continuous Rating and Peak Load

The contractor shall guarantee the unit maximum continuous rating (MCR) at the conditions specified in ITB, This shall be done also with high pressure preheater out of operation.

The contractor shall guarantee the MCR at fully open position of the turbine control valves.

The unit shall guaranteed peak load for one hour to he defined by the Tenderer according to the conditions specified in ITB

G4.3.3.3. Boiler maximum continuous rating

The contractor shall guarantee the boiler maximum continuous rating at the conditions specified in ITB
During residual oil firing the steam air preheater shall be supplied with steam led from the turbine extraction. The sum of the airpreheater cold end temperature shall

be maintained at less than 226 °C.

During natural gas firing the steam air preheaters can be out of operation and the sum of the air preheater cold and temperature shall be lowered.
However, to avoid corrosion after a period of residual oil firing and to maintain the availability or the steam air preheaters it is recommendable to lower cold end temperature slowly. Also some specification for example soots blowing or washing or the air preheater shall be taken. With clean boiler the sum of he air preheater cold end temperature shall be maintained at not less than 166 °C.

G4.3.4 Technical penalties

If the equipment is found unable to meet the guarantee performance the contractor shall remedy, repair and/or replace such defects within the period considered reasonable, and shall re-verify the guarantees

If the Contractor fails to remedy, repair and/or replace within the period mentioned above, the contractor shall pay to the PEEGT technical penalties.

The technical penalties for the guarantee items as mentioned in the part (1).

The cost of operation and maintenance will be guaranteed at the life time of the plant (25) years including:
The cost of consuming the spare parts, period of the maintenance and repetition, cost of operation, oil, grease, chemicals…

For tender evaluation purposes the PEEGT will take into the consideration the guarantee figures in the evaluation stage according to the Book of Administrative Juridical and Commercial Conditions part (1)

**All the cost of Fuels, spare parts, chemicals, water, any other consumables will added to the economical prices at the evaluation stage for evaluation purpose to enable PEEGT to choose the best offer, the bidder should submit all the necessary information about and any other information.**

G4.3.5 Performance test

The test shall be conducted in accordance with ASME, DIN or equal norm.

The contractor shall make the detailed procedure which covers all guarantee items based on this norm, and shall submit it to the consultant /PEEGT for approval

The detailed procedure shall include the following items

- The sequence of the test to be conducted.
- The duration time of each test
- List of the instruments which shall be used for each test.
- The list shall designate which instrument are (a) special test instruments (b) certified, (c) to be calibrated before and after each test, (d) check instruments and (e) station supply instruments.
- All formulas, calculations, conversion factors, curves, correction curves. etc., to be used in the conductance of the tests and calculations of the test results.
- Sample test reports or data sheets and all specific result sheet forms that will be used in the tests.
- Correction factor curves shall be submitted as part of the detailed procedure. Such curves will be used, if necessary, for correction variations in test conditions from the specified conditions. The correction curves shall cover the complete range of variations that may be conducted

The Contractor shall provide sufficient and skilled supervisory staff and services to perform all tests.

The Contractor shall provide all necessary instruments and work for the tests such as calibration of instruments, recording, calculation and other related work.

The Contractor shall make the performance test also with following partial load: 30, 50 and 75 % of the MCR and give the complete results of these tests to the PEEGT.

G4.3.5.1 Boiler efficiency test

The test shall be carried out for obtaining the boiler efficiency at load at which .the associated turbine-generator is tested. The method of calculation, the boiler efficiency shall be by the heat loss method as defined in DIN, ASME or equivalent and the tests shall be carried out generally in accordance with this specification.

The input output method of calculating the boiler efficiency shall be used as a check but the results calculated by the heat loss method shall be used for determination of the overall plant performance, as a basis for

Guarantees, penalties and rejection. The lower heating value of the fuel shall he used.

The boiler efficiency test shall be made with natural gas, with residual oil and with mixed firing (50/50 %).

The test shall be for a minimum duration of four (4) hours with control period of one hour before and after each test during which full readings of lest instruments shall be recorded.

The lower heating values of the fuels shall be determined in any authorized laboratory chosen by the Contractor and approved by the PEEGT. Three samples of the fuel shall be taken. One shall be analyzed and two shall be kept for the case of any disagreement between the parties concerning the analysis of the fuel.

G4.3.5.2 Turbine-generator heat rate test

The test shall be carried out to determine the heat rate of the turbine generator and the conditions specified in Chapter G4.3.2 ,The test shall be generally in accordance with DIN, ASME or equivalent and in accordance with requirements of this specification.

The duration of the lest shall be a minimum of two (2) hours with test instruments, with the exception of flow measuring devices, being read and recorded every five (5) minutes and the flow measuring devices shall be read :and recorded every one (1) minute. To ensure that the test conditions are steady, the instruments shall be read and recorded for one hour before the commencement of the tests.

G4.3.5.3 Auxiliary power consumption

During the test of the boiler and the turbine-generator, the electrical power consumed by the auxiliaries shall be measured. All unit auxiliaries shall be supplied from the unit transformer and the power shall be measured at the high voltage side of the unit transformer using calibrated kilowatt hour meter unless otherwise agreed in writing with the PEEGT.

N.B: -All correction curves to be submitted with the offer.

-Heat Balance sheets must he given for MCR, Peak Load, and Partial Load and for different types of firing (R.O, gas, mixture).

## G4.4 Availability guarantees

The Contractor shall guarantee the availability of the units during the guarantee period.

The availability of the unit is defended by the following formula:

$$\text{Availability (\%)} = \frac{A+B}{A + B + C1 + C2}$$

where:

A = hours of operation
B = hours or readiness for operation
C1 = hours of unavailability due to scheduled maintenance and inspections
C2 = hours of unavailability due failures of the unit

## G4.5 Noise guarantees

The sound levels generated by the Contractor furnished equipment during normal operation shall not exceed 85 dB (A) weighted, slow response, at a horizontal distance or one (1) meter from all surfaces of the equipment and at a height or 1.5 meters above or below the platform or floor on which the equipment is located. If there will be equipment having a higher noise level than previously specified they shall be encapsulated.

The control room and the offices shall have a maximum noise level or 55 dB (A).

The outdoor noise level along the power plant boundary shall not exceed 50 dB(A) as composite rating noise.

## G4.6 Guarantee for surface temperature of insulation

The surface temperature of insulation must not exceed the air temperature in the Plant by more than 20 °C when the air temperature is measured at one meter's distance from the insulation.

# Performance characteristics

**Enclosure G4.1**

Performance characteristic (shall be filled separately for natural gas, residual oil and mixed firing 50 / 50%)

A. Main boiler

1-Flow

| | | Turbine | | | | |
|---|---|---|---|---|---|---|
| | | 30% | 50% | 75% | 100% | 100% Boiler |
| Superheated steam | kg/s | | | | | |
| Reheat flow | kg/s | | | | | |
| Feedwater | kg/s | | | | | |
| Steam for auxiliary | kg/s | | | | | |
| Intermittent blowdown | kg/s | | | | | |
| Continuous blowdown | kg/s | | | | | |
| Superheater,desuperheater spray | kg/s | | | | | |
| 1st stage-superheater desuperheater spray | kg/s | | | | | |
| 2nd stage -reheater, desuperheater spray | kg/s | | | | | |
| Air at F.D fan outlet (each) | $Nm^3/s$ | | | | | |
| Excess air (windbox) | % | | | | | |
| $O_2$ content in flue gases at air preheater inlet | % | | | | | |
| $O_2$ content in flue gases at air preheater outlet | % | | | | | |
| Fuel consumption | Kg/s | | | | | |
| Flue gas flow | $Nm^3/s$ | | | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| Flue gas flow at the air preheater outlet | $Nm^3/s$ | | | | | |
| Excess airinfiltation over air preheater | % | | | | | |
| Gas recirculation quantity | $Nm^3/s$ | | | | | |
| Burner tilt (if any) | degree | | | | | |

2.Water and steam temperatures

| | | Turbine | | | | Boiler |
|---|---|---|---|---|---|---|
| | | 30% | 50% | 75% | 100% | 100% |
| Feedwater at economizer inlet | °C | | | | | |
| Feedwater at -economizer outlet | °C | | | | | |
| Saturated steam at drum | °C | | | | | |
| Superheated steam at desuperheater no.1 outlet | °C | | | | | |
| Superheated steam at desuperheater no.2outlet | °C | | | | | |
| Superheater steam at boiler outlet | °C | | | | | |
| Reheat steam inlet | °C | | | | | |
| Reheat steam outlet | °C | | | | | |

3.Water and steam temperatures

| | | Turbine | | | | Boiler |
|---|---|---|---|---|---|---|
| | | 30% | 50% | 75% | 100% | 100% |
| Feedwater at economizer inlet | bar(a) | | | | | |
| Pressure drop in economizer | bar(a) | | | | | |
| Saturated steam at drum | bar(a) | | | | | |
| Pressure drop in superheater and attemperaters no.1 | bar(a) | | | | | |
| Pressure drop in superheater and attemperaters no.1 | bar(a) | | | | | |
| Superheater steam at boiler outlet | bar(a) | | | | | |
| Reheat inlet pressure | bar(a) | | | | | |
| Reheat outlet pressure | bar(a) | | | | | |

4.Air and gas temperatures

| | | Turbine | | | | Boiler |
|---|---|---|---|---|---|---|
| | | 30% | 50% | 75% | 100% | 100% |
| ambient air | °C | | | | | |
| air at steam air preheaters outlets | °C | | | | | |
| air at air preheaters outlets | °C | | | | | |
| Flue gas at furnace outlet | °C | | | | | |
| Flue gas at reheater inlet | °C | | | | | |
| Flue gas at reheater outlet | °C | | | | | |
| flue gas at superheater outlet | °C | | | | | |
| Flue gas at economizer inlet | °C | | | | | |
| Flue gas at economizer outlet | °C | | | | | |
| Flue gas at air preheater outlet | °C | | | | | |
| Anticipated gas temperature at stack outlet | °C | | | | | |

4.Air and gas pressures

| | | Turbine | | | | Boiler |
|---|---|---|---|---|---|---|
| | | 30% | 50% | 75% | 100% | 100% |
| Air at F.D.outlet | $mmH_2O$ | | | | | |
| Air at steam air preheaters outlet | $mmH_2O$ | | | | | |
| Air at air preheater outlet | $mmH_2O$ | | | | | |
| Windbox pressure | $mmH_2O$ | | | | | |
| Furnace pressure | $mmH_2O$ | | | | | |
| Flue gas at superheater outlet | $mmH_2O$ | | | | | |
| Flue gas at economizer outlet | $mmH_2O$ | | | | | |
| Flue gas at air preheater outlet | $mmH_2O$ | | | | | |
| Flue gas at economizer outlet | $mmH_2O$ | | | | | |
| Flue gas at stack inlet | $mmH_2O$ | | | | | |

6.Heat losses based on LHV of the fuel

| | | Turbine | | | | Boiler |
|---|---|---|---|---|---|---|
| | | 30% | 50% | 75% | 100% | 100% |
| Loss due to dry gas | % | | | | | |
| Loss due to $H_2O$from combination of $H_2$ | % | | | | | |
| Loss due to radiation | % | | | | | |
| Unaccounted losses | % | | | | | |
| Total losses | % | | | | | |
| Efficiency | % | | | | | |

**B.Turbine –generator**

**1.Output**

| | | Turbine | | | | Boiler |
|---|---|---|---|---|---|---|
| | | 30% | 50% | 75% | 100% | Peak load |
| Output at generator terminals | KW | | | | | |

**2.Flow**

| | | Turbine | | | | Boiler |
|---|---|---|---|---|---|---|
| | | 30% | 50% | 75% | 100% | Peak load |
| Steam at HP turbine inlet | Kg/s | | | | | |
| Steam at LP turbine inlet | Kg/s | | | | | |
| Extraction no.1 | Kg/s | | | | | |
| Extraction no 2. | Kg/s | | | | | |
| Extraction no.3 | Kg/s | | | | | |
| Extraction no.4 | Kg/s | | | | | |
| Extraction no.5 | Kg/s | | | | | |
| Extraction no.6 | Kg/s | | | | | |
| Extraction no.7 | Kg/s | | | | | |
| Extraction no8 | Kg/s | | | | | |
| Steam to condenser | Kg/s | | | | | |

3.Temperatures

| | | Turbine | | | | Boiler |
|---|---|---|---|---|---|---|
| | | 30% | 50% | 75% | 100% | Peak load |
| Ambient air | °C | | | | | |
| Steam at HP turbine inlet | °C | | | | | |
| Steam at LP turbine inlet | °C | | | | | |
| Extraction no 1. | °C | | | | | |
| -Extraction no.2 | °C | | | | | |
| Extraction no.3 | °C | | | | | |
| Extraction no.4 | °C | | | | | |
| Extraction no5 | °C | | | | | |
| -Extraction no.6 | °C | | | | | |
| Extraction no7 | °C | | | | | |
| -Extraction no.8 | °C | | | | | |
| Steam to condenser | °C | | | | | |
| Condensate | °C | | | | | |

G4. Guarantees

3.Temperatures

| | | Turbine | | | | Boiler |
|---|---|---|---|---|---|---|
| | | 30% | 50% | 75% | 100% | Peak load |
| Steam at HP turbine inlet | Kg/s | | | | | |
| Steam at LP turbine inlet | Kg/s | | | | | |
| Extraction no.1 | Kg/s | | | | | |
| Extraction no 2. | Kg/s | | | | | |
| Extraction no.3 | Kg/s | | | | | |
| Extraction no.4 | Kg/s | | | | | |
| Extraction no.5 | Kg/s | | | | | |
| Extraction no.6 | Kg/s | | | | | |
| Extraction no.7 | Kg/s | | | | | |
| Extraction no8 | Kg/s | | | | | |
| Steam to condenser | Kg/s | | | | | |

G4. Guarantees

4.pressures

| | | Turbine | | | | Boiler |
|---|---|---|---|---|---|---|
| | | 30% | 50% | 75% | 100% | Peak load |
| Steam at HP turbine inlet | bar(a) | | | | | |
| Steam at LP turbine inlet | bar(a) | | | | | |
| Extraction no.1 | bar(a) | | | | | |
| Extraction no 2 | bar(a) | | | | | |
| Extraction no.3 | bar(a) | | | | | |
| Extraction no.4 | bar(a) | | | | | |
| Extraction no.5 | bar(a) | | | | | |
| Extraction no.6 | bar(a) | | | | | |
| Extraction no.7 | bar(a) | | | | | |
| Extraction no8 | bar(a) | | | | | |
| Condensate pressure | bar(a) | | | | | |

C.Feedwater heating system

1.Low pressure heater no.1

| Turbine | | | | | | Unit |
|---|---|---|---|---|---|---|
| | | 30% | 50% | 75% | 100% | Peak load |
| Water inlet temperature | °C | | | | | |
| Water outlet temperature | °C | | | | | |
| Shell side pressure | bar(a) | | | | | |
| Drain outlet temperature | °C | | | | | |

2.Low pressure heater no.2

| Turbine | | | | | | unit |
|---|---|---|---|---|---|---|
| | | 30% | 50% | 75% | 100% | Peak load |
| Water inlet temperature | °C | | | | | |
| Water outlet temperature | °C | | | | | |
| Shell side pressure | bar(a) | | | | | |
| Drain outlet temperature | °C | | | | | |

3.Low pressure heater no.3

| Turbine | | | | | | unit |
|---|---|---|---|---|---|---|
| | | 30% | 50% | 75% | 100% | Peak load |
| Water inlet temperature | °C | | | | | |
| Water outlet temperature | °C | | | | | |
| Shell side pressure | bar(a) | | | | | |
| Drain outlet temperature | °C | | | | | |

4.Low pressure heater no.4

| Turbine | | | | | | unit |
|---|---|---|---|---|---|---|
| | | 30% | 50% | 75% | 100% | Peak load |
| Water inlet temperature | °C | | | | | |
| Water outlet temperature | °C | | | | | |
| Shell side pressure | bar(a) | | | | | |
| Drain outlet temperature | °C | | | | | |

5. Deaeratng heater

| Turbine | | | | | | unit |
|---|---|---|---|---|---|---|
| | | 30% | 50% | 75% | 100% | Peak load |
| Water inlet temperature | °C | | | | | |
| Water outlet temperature | °C | | | | | |
| Deaerator pressure | bar(a) | | | | | |

6.High pressure heater no. 6

| Turbine | | | | | | unit |
|---|---|---|---|---|---|---|
| | | 30% | 50% | 75% | 100% | Peak load |
| Water inlet temperature | °C | | | | | |
| water outlet temperature | °C | | | | | |
| Shell side pressure | bar(a) | | | | | |
| Drain outlet temperature | °C | | | | | |

7.High pressure heater no.7

| Turbine | | | | | | unit |
|---|---|---|---|---|---|---|
| | | 30% | 50% | 75% | 100% | Peak load |
| Water inlet temperature | °C | | | | | |
| Water outlet temperature | °C | | | | | |
| Shell side pressure | bar(a) | | | | | |
| Drain outlet temperature | °C | | | | | |

8.High pressureheater no.8

| Turbine | | | | | | unit |
|---|---|---|---|---|---|---|
| | | 30% | 50% | 75% | 100% | Peak load |
| Water inlet temperature | °C | | | | | |
| Water outlet temperature | °C | | | | | |
| Shell side pressure | bar(a) | | | | | |
| Drain outlet temperature | °C | | | | | |

G4. Guarantees

D.Auxiliary power consumption

| Turbine | | | | | |
|---|---|---|---|---|---|
| | | 30% | 50% | 75% | 100% |
| Forced draft fans | kw | | | | |
| Gas recirculation | kw | | | | |
| Seal air fans | kw | | | | |
| Flame scanner cooling air fan | kw | | | | |
| Air preheaters | kw | | | | |
| Air preheaters (L.O. pump) | kw | | | | |
| Fuel oil pumps | kw | | | | |
| Boiler feed water pumps | kw | | | | |
| Condensate pumps | kw | | | | |
| Drain pumps | kw | | | | |
| Reserve feed water pumps | kw | | | | |
| Steam converter feed water pumps | kw | | | | |
| Cooling water pumps | Kw | | | | |
| Auxiliary cooling pumps and fans | Kw | | | | |
| Gland condenser fan | Kw | | | | |
| Oil tank vapor extractor | Kw | | | | |
| Oil purifier | Kw | | | | |
| Pressurized air compressor (one compressor) | Kw | | | | |
| Battery chargers and inverters | Kw | | | | |
| Cable and busbar losses | Kw | | | | |
| Transformer losses | Kw | | | | |
| Jokey pump | Kw | | | | |

G4. Guarantees

| | | | | | |
|---|---|---|---|---|---|
| Any other auxiliary essential for the unit | Kw | | | | |
| Total | Kw | | | | |

E. Net unit heat consumption

| Turbine | | | | | |
|---|---|---|---|---|---|
| | | 30% | 50% | 75% | 100% |
| Boiler efficiency | % | | | | |
| Turbine-consumption ($N_{b)}$ | KJ/kwh | | | | |
| Output at generator terminals (W) | Kw | | | | |
| Total auxiliary power consumption ($W_a$) | Kw | | | | |
| Net unit heat consumption ($N_0$) | Kw/ KWh | | | | |

**PUBLIC ESTABLISMENT OF ELECTRICI1Y**
**FOR GENERATION AND TRANSMISSION ( PEEGT )**

**ALEPPO STEAM POWER PLANT**

# INVITATION TO BID

**PART 2.**

**GENERAL SPECIFICATION**

G5.Test and inspection

General Specification

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| G5 | Test and inspection |

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# G5.TEST AND INSPECTION

## G5.1 General

This section contains general requirements for testing and inspection of materials, parts, equipment and workmanship of the work during manufacture, assembling and erection and upon completion to demonstrate compliance with specification, codes and standards to ensure overall reliability of the prescribed operation and performance

The contractor has sole responsibility for ensuring the quality of the work to be supplied under this specification and remains accountable when manufacture or erection is sub-contracted

It is therefore important that work is only sub-contract to companies with effective quality control organization s and that the contractor monitors the performance of these by attendance at tests of experienced inspectors employed by the contractor

### G5.1.1 Codes and standards

The type and extent of testing and inspection shall generally be in accordance with internationally adopted standards.

If more than a single degree of quality or accuracy is permitted within the scope of a particular code or standards, the highest quality shall be applicable and the degree of accuracy commensurate with the intended function shall be selected, but with the understanding that the final decision will be made by the PEEGT.

Where no appropriate standard is available tests shall be conducted in accordance with the manufacturer's standard practice, subject to the approval of the PEEGT. If the proposed procedures are accepted, the, contractor shall provide the PEEGT with ten additional copies of the test procedure in English before any test is performed.

## G5.1Quality assurance program

All materials and equipment shall be manufactured, supplied, erected and tested within the requirements of a properly designed; and constituted Quality Assurance Programe, which will reflect the specific quality standards for each piece of equipment. The details of this Quality Assurance Program are listed in Chapter G3.6

G5.Test and inspection

The Quality Assurance Program shall encompass a comprehensive inspection and testing program, which shall be carried out by the contractor during manufacture. It is the responsibility of the Contractor to draw up and implement such a program and the contractor should allow for this in his Tender.

The inspect ion and testing program should include those specific tests and inspections which are required by the manufacturing code, as agreed with the PEEGT and the tests listed in the following chapters of this section.

G5.1.3 Executing Agency

The con tractor has the sole responsibility to take care of the testing and inspections requested by the local laws Regulations, specified codes or standards. However, the contractor has the right to employ independent agencies to provide testing and inspection services. The Contractor shall cover all cost caused by independent agencies.

The independent agencies shall be approved by the PEEGT. Any test or inspection carried out by these independent agencies shall be attended by the consultant

G5.1.4 Notification

Before manufacture commences and no later than 60 days after award of contract, the contractor shall submit an outline of his proposed inspection and testing program in accordance with the requirements of Chapter G3.6

The PEEGT will return a copy of the contractor's proposed inspection program indicating those inspection stages for which notification is required. Notification shall be by telex or letter in a format to be agreed and shall be sent at least 30 days prior to the intended test.

If the PEEGT's officer intends to witness the test he will inform the contractor about his attendance at least 48 hours before the test and if his representative does not attend on the notified date the test may proceed unless an alterative date has been requested by the PEEGT.

During the erection of all mechanical, electrical, control and monitoring equipment as well as during the civil construction the Contractor shall make the plant items available at any reasonable time for inspection by the PEEGT, if so required.

G5.Test and inspection

To assist the PEEGT and his representative in their review of the quality or the work being performed, the Contractor's senior field representative shall provide the PEEGT with a schedule of the specific areas and items of work that will be performed during each work week. The list shall be presented to the PEEGT prior to the start of work on a day agreed by the PEEGT. All work is executed prior to such notification shall, at the PEEGT’s option, be subject to removal and replacement by the con tractor at his expense.

In particular, the contractor shall mark on his implementation schedule all stages of erection or commissioning which are subject to the PEEGT's acceptance. The schedule shall include, but not be limited to the items indicated in this specification.

G5.1.5 Access and assistance

The PEEGT and/or his authorized agents shall, at any time, be allowed free and ready access to the Contactor's premises and those of his suppliers for the purpose of inspecting the specified equipment components: and obtaining information as to the progress of the Work.

No inspection shall be valid unless the contactor is in possession of relevant approved drawings and procedures for the item to be tested. The contractor shall on request supply the PEEGT or his representative with a copy of drawings and procedure at the time of the test in addition to the already delivered copies.

G5.1.6 Test facilities or equipment

All instruments and apparatus required for the inspection or used for the performance of tests shall be subject to the approval of the PEEGT at his direction and shall be calibrated and certified to an agreed standard in the laboratories approved by the PEEGT (in S.A.R or abroad). Calibration certificates of the equipment shall be valid during the time of testing and they shall be given to the PEEGT. The cost of making such calibrations shall be borne by the Contractor in all cases.

If the contractor wishes to use a method which is not in accordance with an approved procedure or standard, this shall be made in writing with full information substantiating the technical acceptability of the proposed change. The PEEGT will have the sole right to accept or reject the proposed change. The decision shall be final.

G5.1.7 Test certificate documentation

The results of all tests shall be certified by the Contractor, his sub-supplier or independent agency as appropriate.

Document files containing material certificates, welding procedures, test reports, etc. shall be compiled for each item of the Work and shall be suitably identified (including equipment classification reference) and bound.

Each document file containing test and inspection reports and certificates of site erection testing activities of a particular item of the work shall be supplied to the PEEGT prior to commissioning.

Number of copies shall be in accordance with the requirements of Section G6 “Documentation”.

G5.2. Mechanical equipment

G5.2.1 General

Materials and partially completed components of equipment shall be subject to appropriate tests during manufacture

Equipment shall wherever practical be subject to tests on completion at the contractor's works to prove that the reliability, operation and performance conform to the requirements of this specification and the provisions of the appropriate standards or codes.

G5.2.2 Rotating units

G5.2.2.1 Balance testing of rotating units

Each rotating unit shall be first statically balanced and then dynamically balanced (in the case of impellers this shall be done before and after mounting of the service rotor shaft). A check balance of items that have undergone overspeed testing shall also he made.

The standards for dynamic balance shall be specified by the Contractor subject to agreement by the PEEGT.

The overspeed tests for the rotors of the turbine and generators are to be performed according to the IEC 34-3 standard or an approved equivalent.

The vibration of rotating units shall be measured during the test.

G5.2.2.2 Pumps

Running tests and unless otherwise agreed with the PEEGT performance tests shall be conducted on all pumps.

The performance test shall be conducted through the full operating range of the pump to closed valve conditions and. in close accordance with the standards of the Hydraulic Institute (Standards-Centrifugal Pumps, Section Test Code) or equal.

Graphs indicating Flow/Head. Flow/Power absorbed. Flow/ Efficiency, Flow/NPSH shall be provided for each pump.

The lubricating oil used in the test shall be of the same brand and grade as that recommended by the manufacturer for service use.

Dismantling of the pump for visual examination of parts for damage, following test shall be done when required by the inspection standard, when considered necessary by the contractor, or when requested by the PEEGT witnessing the running or performance tests.

Replacement of parts following test shall unless otherwise agreed with the PEEGT necessitate repeat testing.

G5.2.2.1 Steam turbine

The turbine shall be completely assembled with the control; stop and governing valves on a suitable erection rig at the Contractor's works and shall be carefully inspected and measured for manufacture and assembly tolerances. Functional tests shall be performed on the safety equipment.

Important items of turbine control equipment which can not be adequately tested during the shop tests shall be separately tested.

The contractor shall on request forward to the PEEGT details for the equipment to be separately tested together with the tests proposed. Included in the tests shall be governor droop characteristics, governor position /speed, governor oil pressure, throttle valve servo-system position / oil pressure and emergency stop valve closing speed

G5.2.2.4 Fans

G5.Test and inspection

All fans shall be tested in accordance with the applicable standard. The particular test procedure to be applied to each type of fan shall be agreed with the PEEGT. The tests shall be conducted strictly to the requirements of the agreed test procedure so that all points on the performance curves are within agreed tolerances.

G5.2.3 Firing equipment

The fuel oil pumps shall be tested in accordance with the applicable standards to be approved by the PEEGT.

The contractor shall provide type test certificates for identical burners or shall arrange one complete assembly to a rig test to prove flame shape, stability, atomization and turn -down- ratio of the equipment

G5.2.4 Other shop fabricated equipment

Generally shop fabricated equipment and machinery shall be subject to dimensional and functional testing prior to its delivery to the Site.

G5.2.5. pressure or vacuum containing parts

All the items which in service are subject to internal pressure or vacuum shall, unless otherwise agreed, be pressure-tested in the Contractor's works or at the Site prior to any internal or external coating. Where practical and unless otherwise agreed by the PEEGT, vacuum containing parts shall also he vacuum-tested.

Test procedures shall be subject to approval by the PEEGT on request. Unless otherwise agreed hydrostatic pressure testing shall be used.

G5.2.5.1 Hydrostatic testing

Water shall be used as the test medium unless otherwise agreed, and test pressures shall be in accordance with the applicable construction standard and codes, but ' none is specified then the test pressure shall be 1.5 times the design pressure but not less than 3.5 bar (g). Test pressure of vacuum containing parts shall be agreed with the PEEGT.

The test pressure shall be maintained for sufficient time to permit complete visual examination of all surfaces and joints and in no case less than specified in the applicable construction standard.

The chloride content of water used for testing austenitic stainless steel items subject to subsequent high temperature service shall not exceed 30 ppm unless immediate flushing with water of this quality is done after the test

Water temperature shall not be less than 1.0 °C during tests and the use of higher temperatures to avoided brittle fracture in heavy walled vessels shall be considered by the contractor

Precautions shall be taken to avoided damage of expansion bellows and other fittings during testing.

Adequate drying and cleaning of items to prevent deterioration shall be made in appropriate cases following testing. Alternatively, the use of inert gas or water (most preferably demineralized water) with corrosion inhibitors shall be properly considered

Valves shall be pressure tested in accordance with the applicable construction standard and unless otherwise agreed. This shall include both body and seating.

Concrete pipes shall be tested at the maximum working pressure (sustained plus transient pressure).

Apparent leakages shall be measured and shall not exceed 0.02 liters per hour per square meter of pipe surface during a period of at least 6 hours.

Large storage tanks shall be tested in accordance with applicable construction standard and shall include vacuum checking of floor welds before and after the water test.

G5.2.5.2 Pneumatic testing

The contractor shall propose pneumatic testing in cases where hydrostatic testing is impractical or undesirable. Safety precaution, test pressures/ duration and degree of prior non-destructive examination of the items shall be agreed with the PEEGT

Pneumatic or gas leak testing supplementary to hydrostatic testing shall be supplied in appropriate cases where specified by the applicable construction standard.

G5.2.5.3. Alternatives to Hydrostatic and pneumatic Testing

Alternative methods to hydrautic or pneumatic testing for providing the integrity of pressure and vacumm containment plant shall be subject to agreement with PEEGT

G5.2.6. Testing of surface coatings

G5.2.6.1 Galvanized Zinc coatings

Surfaces shall be visually inspected. Bare patches, lumps, blisters or inclusions of

foreign matter shall be cause for rejection.

Zinc coating thickness shall be determined non-destructively in accordance with ASTM or equivalent standard.

G5.2.6.2 Hard rubber linings

The thickness or hard rubber linings shall be in accordance with ASTM or equivalent.

A tolerance of + 40 % is permitted for rubber coatings of 3 mm nominal thickness.

The absence of pores shall be proved by the induction sparking test method. The potential used shall be 5,000 volts for each mm of thickness plus an additional 5,000 volts (e.g. potential of 20,000 volts 3 mm thick lining).

G5.2.6.3. Painting

The inspection requirements are presented in Section G3 Enclosure G3.1 and Enclosure G3.2

G5.2.7 Alignment of rotating equipment

The correct alignment of equipment which is to be coupled on Site installation with other rotating parts (e.g. motors, generators, reduction gears, etc) shall be demonstrated by the Contractor to the satisfaction of the PEEGT. The alignment results shall be entered into a appropriate alignment report sheet which shall be counter-signed by the PEEGT's and the contractor's representatives.

G5.2.8 Additional testing

After completion of the erection, non-destructive and pressure testing as appropriate further tests including precommissioning function trials shall be made on individual items of equipment and their alarm and shut-down systems to satisfy the PEEGT that the work may be safety commissioned.

Testing shall include all equipment and shall not be limited to the following items of plant and tests mentioned.

G5.2.8.1 Boilers and associated equipment

Following hydrostatic testing of the boiler pressure parts but before lagging, the gas duct shall be temporarily blanked of off at the inlet to the stack and a smoke test

performed using a forced fan at maximum discharge pressure to demonstrate the gas tightness of the boiler casings, associated fillings and flues. Defects revealed by this test shall be rectified and the smoke test repeated before the plant is lagged.

Individual precommissioning runs or all rotating auxiliary equipment such fuel oil pumps,fans sootblowers, etc. shall be performed following erection.

G5.2.8.2 Steam turbines

Mechanical and electrical function tests shall be performed on all parts of the turbine, lubricating oil governor and associated systems

G5.2.8.3. Feedwater pumps

Mechanical and electrical function tests shall be performed in order to verify the proper working.

G5.3.Electrical equipment

G5.3.1 General

The Contractor shall furnish qualified experienced personnel for checking out and testing equipment and materials,

The purpose of the tests and checkouts is to assure proper installation, settings. connections and functioning of all electrical equipment and systems in accordance with the drawings, specifications and the manufacturer's recommendations. The tests and checkouts shall be performed during the progress of the work, as suitable increments of the equipment and systems installations become available, and as further directed by the PEEGT.

The contractor shall be responsible for, any damage to equipment or material resulting from improper procedures or test execution on his part, and shall repair or replace such damaged equipment or materialat no additional expense to the PEEGT, correct any faulty or substandard installation and repair or replace any resultant dmnage, as may be proven by the testing procedures.

G5.3.2 Safety procedures

The contractor shall furnish ,and use safety devices, such as rubber gloves and blankets, protective screens and barriers, danger signs, protective grounding electrical isolation, other any other devices required to adequately protect find warn all personnel who may be endangered by electrical and shall verify that the test will not damage or prematurely activate equipment.

Energization of equipment, or the initiation of any tests or checkouts, shall only be made with the prior consent and full knowledge of the PEEGT .and in accordance with approved safety and operational procedures. The contractor shall provide sufficient notification to the PEEGT, of the availability of equipment for testing or of a requirement for energization, to allow proper preparation to be made

G5.3.3 Test records

The contractor shall provide copies of written test records on each test performed. All data shall be recorded on forms prepared by the Contractor for the PEEGT's approval. Data included shall be. date of test, names of personnel making the tests, signature of the PEEGT’s designated witness, equipment or material tests with serial number or other unique Identification, manufacturer and serial number of test equipment, test results, any pertinent factors affecting tests such as humidity or temperature and test equipment calibration data, where applicable

One copy of the test records shall be retained by the Contractor and 2 copies furnished to the PEEGT

G5.3.4 Test equipment

The contractor shall have readily available, in good repair, sufficient test equipment of verifiable accuracy to fully carry out his testing responsibilities.

G5.3.5 Electrical tests

Generally, tests b the Contractor on electrical systems and functional devices shall be made to determine the following:

a) Proper connection and operation or equipment including rotation of motors.

b) Correct voltage at the terminals of all electrical devices.

c) Lighting systems operate as designed.

d) Verification that all field connection are in accordance with the drawings be furnishing to the PEEGT one set of drawings (yellow-lined or similarly marked) showing all connections that have been checked.

The contractor shall furnish personnel for testing and calibration or relays and other adjustable protective or signal devices.

The insulation resistance testing of the cables shall be performed after cable installation.

G5.Test and inspection

All conductors shall have an insulation resistance megger test performed as described in IEEE standard 48 or equal

Each cable shall be tested with the circuit completed, except for collections to the equipment.

Phase identification tests shall be performed to verify proper connection of all power leads.

The freeze protection testing shall be performed on each freeze protection circuit prior to the installation or the insulation. All equipment shall be checked for proper operation. Current monitoring device settings and designed current flow for all cables shall be tested. The Contractor shall maintain a current set of drawings for the complete system, marked to indicate the extent of the tested installation, for the PEEGT's use. The installation and testing shall co-ordinate with the insulation Contractor's schedule

All electric motors shall have a megger test as soon as received and at maximum intervals of one month during storage and construction periods. Motor space heaters shall be kept energized, checked weekly, and where megger readings indicate the need, additional supplemental heating for the windings shall be provided. The Contractor shall notify the PEEGT of any motor which insulation resistance is less than standard, or is substandard in any other manner. Any motor which is substandard on receipt that is not so reported, shall be repaired at the Contractor's expense. A 1000 V megger shall be used for 440 V motors and a 2500 V megger or higher voltage motors.

Insulation resistance tests shall be in accordance with the applicable portions or IEEE Standard 43 or equal.

Motor rotation versus phase relationship shall be verified with a biddle rotation tester prior to connection on all except large motors on which the manufacturer has a ffixed an identification plate allowing them to be properly phase connected.

G5.4 Instrumentation and Control

The testing and inspection of instrumentation and controls is specified in ITB (electrical)

G5.5 Commissioning period

G5.5.1 General

After the erection work and precommissioning checks "Preliminary Check-out and Running Test" of the individual equipment have been completed, the Contractor shall apply for permission to commence the commissioning period ("Initial Loading Test, Trial Operation, performance Test").

This is the period in which the power plant shall be prepared, operated and adjusted to obtain specified performance so as to ensure an undisturbed subsequent operation of the entire plant or units of the Work which may independently be operated.

The contractor shall give sufficient detail in his commissioning program to satisfy the PEEGT that:

- the sequence and duration or the proposed activities are logical, realistic and in accordance with safety and permit regulations in force on the site

- the commissioning or any item of plant would not interrupt the normal operation of any previously commissioned item

- he has allowed for sufficient training of the PEEGT's operators during this period

G5.5.2 Commissioning activities

Commissioning shall be performed in accordance with the procedures contained in the commissioning program approved by the PEEGT. The correct functioning of the plant and the given performance guarantees or individual equipment and installation as specified in the Contract shall be verified.

On completion or each commissioning activity to the satisfaction of the PEEGT, the commissioning schedule shall be signed and dated by the Contractor and countersigned by the PEEGT.

G5.5.2.1 Specific items of the Work

All the work shall be commissioned and trials shall include, but not be limited to, the following items and activities.

Boilers and Associated Equipment

- check of all safety and interlocking systems and adjustment of control equipment before and during the first firing or the boiler
- check of each individual burner and of automatic burner start-up and shut - down systems
- boil out of pressure parts
- steam purging of high pressure piping

Steam Turbine and Generator

As soon as steam is reliably available from the boilers, the steam turbine shall be run and the following tests shall be made:

- functional tests of the safety equipment
- mechanical running tests

The measured data (pressure, temperature, vibration data, adjustable speed range, etc.) shall be observed and recorded.

- noise and vibration level tests
- load rejection and governor tests

The operation of all controls Safety devices, fire dampers, alarms and standby equipment shall also be demonstrated.

G5.5.2.2 Performance test

The Contractor shall demonstrate by means of performance test that the work is fit for commercial operation. The overall outputs under various operating conditions, the consumption rates of fuel power, chemicals, etc. shall be determined .and the performance guarantees specified in Chapter G4.3 shall be proven.

The performance test shall be carried out with natural gas and residual oil and with a mixture of a gas, and with different load levels as specified in Section G4

In the event of any of the performance guarantees not being achieved, the concerned equipment or unit shall he made available to the Contractor, as system requirements and operation permit, so that he can make it good by modifying or replacing defective part. To enable the PEEGT to identify the individual item of plant which is causing the overall plant performance to fail to meet the guaranteed figure, the Contractor shall perform acceptance tests as requested by the PEEGT, for any item of plant that the later suspects. Such acceptance tests shall be conducted in accordance with the relevant approved standards. Facilities shall therefore be provided on the plant for the installation of the Contractor's test instrumentation at the appropriate locations to enable such acceptance tests to be performed.

The Tenderer shall submit with the Tender all correction curves and formula which he intends to use for compensating the differ between the test circumstances and those specified in Section G4, Guarantees. These correction curves and formula shall be approved by the PEEGT.

The method of measuring all quantities and qualities and the measurement tolerances shall be in accordance with the appropriate international or national standards, which shall be approved by the PEEGT before the test.

During the design stage of the work, the Contractor shall give details of measurements to be made to substantiate that the performance of the power plant and other parts of the work meets the requirements of the specification, and in particular he shall submit for approval a schedule of performance test instrumentation necessary to verify the given guarantees.

The test instrumentation schedule shall quote a test tolerance for each parameter, including the calorific value of the fuels, and, derived therefrom, an overall test tolerance for each guarantee value. These tolerances shall be included in the Tender.

The definitive conditions required for establishing whether the guarantees are met, including the fuel, water and electric power consumption and boiler evaporation, shall be measured by precision test equipment to be installed by the Contractor in addition to the permanent measuring equipment.

All measurement devices which will be used in performance tests shall be calibrated and certified. The calibration shall be done before and after the test period. All devices shall have valid calibration during the test period, and the certificates shall be supplied to the PEEGT for approval.

## G5.Test and inspection

The overall design of the works shall provide for the installation and use of test equipment so as not to interfere with the plant loading or delay the guaranteed completion dates.

In case where the electrical power consumption or output of items of plant is required to be measured, a high-quality integrating wall-hour meter with Class 0.2 accuracy shall be used.

All services required for the instruments, e.g. air, electricity supplies, shall be adjusted to the values required by the instrument manufacturer's specification prior to the commencement of the acceptance and performance test and shall be kept at these values for the whole duration of the test.

During each performance and acceptance test run the measured values will be recorded jointly by the Contractor and the PEEGT. After completion of the performance test the data sheets will be jointly initiated and copies distributed to each part.

**PUBLIC ESTABLISMENT OF ELECTRICI1Y**

**FOR GENERATION AND TRANSMISSION ( PEEGT )**

# ALEPPO STEAM POWER PLANT

# INVITATION TO BID

## PART 2

## GENERAL SPECIFICATION

G6.Documentation

General Specification

| | |
|---|---|
| G1 | The Project |
| G2 | Application requirements |
| G3 | General technical requirements |
| G4 | Guarantees |
| G5 | Test and inspection |
| G6 | Documentation |
| G7 | Services |
| G8 | Spare parts and special tools |
| G9 | Maintenance management |
| G10 | Sections of the project |
| G 11 | Discription of the site |

| | |
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| **G6** | **Documentation** |

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G6.2 Drawing and document submittal schedule

# G6 DOCUMENTATION

## G6.1 General

The Contractor shall submit all information documentation, calculations, drawings, schedules, etc., within such periods or at such dates which are required to guarantee a smooth handling of the work without any delays. The Contractor is responsible for submitting all documentation in accordance with a program to be prepared by him acceptable to the PEEGTallowing all participants sufficient time to check, assess, comment and eventually approve the documents. The quality of the submitted documents must be in accordance with acceptable international practice and allow a speedy checking procedure. Documents not fulfilling these requirements will be returned to the Contractor without comments for improvement and resubmission. It is solely at discretion of the PEEGT to decide whether or not documents are acceptable.

The documents prepared and submitted by the Contractor shall be in accordance with the requirements of the Contract Documents.

Documentation in different stages of the project is discussed in more detail below. Also, guidelines for the preparation of document material as well as approval procedures for drawings and documents are given.

The sheet sizes of the documents shall follow the standards ISO latest revision, where trimmed sizes are:

| | |
|---|---|
| A0 | 841 x 1189 mm |
| A1 | 594 x 841 mm |
| A2 | 420 x 594 mm |
| A3 | 297 x 420 mm |
| A4 | 210 x 297 mm |

All drawings shall be to scale and fully detailed with the maximum size of A0. All important dimensions shall be given and the material of which each part is to be constructed shall be indicated

The scale of outline and layout drawings shall be as follows:

1. Buildings and pipelines connecting them:
- Plans, sections and elevations to a scale of1:100 or 1:50 for architectural, civil, structural, electrical and mechanical works.

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- Principal details to a scale of 1:20, 1:10 other scales for architectural, structural, electrical and mechanical works.

2. Roads
- Plans to a scale of 1:500 or other scales, as relevant
- Sections to scale of 1:50 or 1:20
- Longitudinal profile to a scale of 1:200 and 1:20 or other scales, as relevant

3. Sewage and water supply

- Plans to scale of 1:500 or other scales, as relevant

- Profiles showing dimensions, slopes and inverts to scale of 1:200 and 1:20 or other scales

- Details of manholes, manhole covers, thrust blocks, valves etc

Sectional drawings (of big size) for all main equipment shall be delivered
Test certificates and inspection reports shall be provided

G6.2 Bid Documents

G6.2.1.Documents given with technical specification

The drawings issued by the PEEGTwith the specification and forming part of the documents for bidding purposes are intended to be descriptive of the character of the work and used in conjunction with the requirements of the specification and shall in no way limit the responsibility of the character to supply all plant equipment, material and services necessary to provide for a complete and functional complex. Any omission from both drawings and the specification or express reference to any detail or work necessary and obviously intended shall not relieve the contractor of his responsibility to include such details or work in his supply

The final sizes and locations of the buildings shown on the specification drawings have not been fixed by the PEEGTsince these are dependent on the size and shape of the contractor's plant, equipment and materials forming the works and the space required for installation ,maintenance ,lay-down ,storage ,access ,etc .They are, however, to be considered as minimum requirements .The deviations have to be specified in detail and argumented Deviations shall be listed in form shown in Enclosure G6.1.

When measurements are affected by conditions already established, the contractor shall take and be responsible for field measurements notwithstanding any information set forth on the specification drawings.

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The specification drawings portray the basic layout of the scope of works and the contractor shall incorporate these requirements in his specification drawings.

With regard to the interconnection to installations supplied, the drwings and descriptions included in this specification shall be assumed to be descriptive to the extent necessary for bidding purposes. In this respect, the contractor has to request the information in due time before starting with his detailed engineering works referring to the equipment and the corresponding section and clause of the specification.

After the bid has been submitted the contractor is deemed to have checked all these documents and drawings and they are without any restriction accepted by him. NO claim resulting out of omissions or discrepancies in this respect will be accepted by the PEEGT. In case the contractor proposes any departure or variation from this technical specification he shall provide a statement of his reasons for proposing such alternatives, modifications or qualifications.

Notwithstanding any description, drawings, or illustrations which may be submitted with the bid, only those departures or variations listed may be considered, and apart from these it will be deemed that the contractor complies entirely with the requirements of the technical specification.

G6.2.2. Documents required with the bid

The Tenderer shall submit together with his bid drawings, diagrams, graphs, curves and all such information which are necessary to fully understand the Bid from technical, financial and administrative point of view.

Technical requirements for the Bid Documents are listed and described in the following:

06.2.2.1 General

The Tenderer shall submit with his bid all the documents, drawings, samples, etc. requested in the this ITB documents. In this list there are given additional or more specific requirements regarding the documentation to be submitted with the bid.

The Tenderer shall also submit the following information and data of each proposed equipment:

1. References
2. Brochures
3. Supply limits (of the subcontractor)
4. General technical specification
5. Guarantees
6. Spare parts and special tools

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7. Main subcontractors proposed
8. Main manufacturers proposed.
9. Origin
10. Quality control/tests: factory/shop tests and site tests (including data on extent or radiographic examination, hydrostatic tests, etc.)
11. Correction curves, formulae etc. to be used in correction concerning performance tests
12. Protection prior to commissioning; cleaning, protection, painting.

The following requirements have to be presented for each equipment or system:

1. Technical schedules
2. Drawings
3. P&I and other diagrams
4. Performance data and curves
5. Schemes and safety interlocking
6. Specifications of equipment details
7. Material specifications Manufacturer(s)
8. Other

The technical schedules to be filled are presented in ITB Part 5.

G2.2.2 Boiler with its auxiliaries and the feed water system

Technical schedules

Boiler technical schedules and feedwater system technical schedules including technical schedules for feedwater pumps, other pumps, P.D. fans, flue gas recirculation fans, deaerator, feed water storage tank and sealing air fan, etc.

Drawings

1.General arrangement drawings of the boilers (plans, elevations, cross-sections) with auxiliaries

2. Boiler supporting structures

3. Assembly drawings of boiler showing fill pressure parts (including boiler drum, economizer, air heater, superheater, main piping connections, etc.).

4. Dimensioned drawings of drum and details of steam separators.

5. Dimensioned drawings of superheaters, economizer, furnace wall structure and air heater (including supporting structures).

6. Dimensioned drawings of the F.D. fans and gas recirculation fans (also combined arrangement drawings of fan and motor/turbine including coupling).

7. Dimensioned drawings of soot blowers and also drawings showing location fit soot blowers.

8. Detailed drawings of gas/oil burners showing details, igniter's flame viewing etc. (dimensioned)

9. Detailed drawings of boiler sealing arrangements

10. Dimensioned drawings of feed water tank and deaerator, feedwater pumps (also combined arrangement of pump and motor) (including supports)

11. Detailed arrangement drawings of the feed water system (plans, elevations, cross-sections).

P&I and other diagrams

1. Steam/feedwater cycle (including piping and valves for blow-down and soot blowers)

2. Fuels, air and flue gas

3. Feed water system

4. Boiler auxiliaries

Control schemes

1. Possible modifications compared to the proposed schemes in the Technical specification.

Performance data and curves

Boiler performance data with varying load between 30% and 100% of the turbine load and the boiler MCR will be submitted by the Tenderer by filling the performance characteristics sheets presented in Enclosure G4.1 in Section G4.

Following boiler performance curves with varying load between 30% and 100% of boiler MCR shall be submitted in graphic format (separately for natural gas and residual oil, and for a mixture of oil and gas):

1. Efficiency

2. Feed water temperature and pressure at economizer inlet and outlet

3. Boiler drum pressure

4. Steam temperature and pressure at the inlet and outlet of each superheater stage fit the inlet and outlet of each superheater stage

5. Air temperature at the following points F.D fan inlet, steam coil air heater inlet, air heater and outlet, burner inlet

6. Flue gas temperature at the following points: furnace outlet, inlet and outlet of each superheater and reheater stage, economizer inlet and outlet, air heater and outlet

7. Pressure loss of the flue gas system

8. Pressure loss of the air heater

9. Spray water flow for each desuperheating stage

10. Oxygen content in the flue gases at air heater inlet and outlet

11. $SO_2$ and $NO_x$ -emission

Start-up curves for cold, warm and hot start-up of boiler giving full details of temperature, pressure and flow

Performance curves of feed water pumps

1. Capacity-differential pressure

2. Efficiency-capacity

3. NPSH-capacity.

4. Power requirement-capacity

Performance curves of all other pumps

1. Efficiency-capacity

2. Power requirement-capacity

Performance curves of F.D. and flue gas recirculation fans

1. speed-torque

2. power-volume

3. head-volume

Schemes Including Logic Diagrams and Safety Interlocking

Complete boiler safety schemes and logic diagrams covering purging prior to start-up, normal operation, covering all possible mal-operation of the boiler or the plant

Specifications of equipment details

Complete description of spray attemperaters with sketches.

Material specifications

A table with details of materials including material and standard with particulars or any special alloy and chemical analysis

Other

Loading diagram for boiler foundations

G6.2.2.3 Steam turbine plant

The Tenderer shall include in the Bid the following technical schedules filled:

1. Turbine-generator

2. Main cooling system
   - Condenser and the cooling tower with auxiliaries
3. Heat Exchanger (tubular heat exchangers)
   - Low pressure preheate
   - Make-up water preheater
   - High pressure preheater
4. Vessels

Deviations

Deviations from the proposals and technical values given in this specification shall be clarified in form of a list (Enclosure G2.6.1).

Turbine and accessories

- Cross-section drawings of the turbine and the accessories
- Detail drawings concerning the blades, shrouding and seals

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- List of materials
- Codes find standards
- Constructional description of
- Casing
- Rotor
- Balding
- Glands
- Bearings
- Turning gear
- Governing system
- Trip valves
- Heaters
- Condenser
- Description of
- Control system with diagrams
- Protection devices
- Lubricating and control oil system with flow sheets
- Drain system
- Insulation
- Flow sheet for the sealing and leakage steam
- Design values for the main steam pipes ND and NP
- Requirements for the oil and the oil quantity
- Erection procedures description of the turbine

Thermodynamic and operational data

- Heat balance flow sheets with values for pressures, temperatures and flows in the Turbine Plant, also in the wheel chambers, in all guarantee points
- Steam expansion lines at guarantee points
- Curves of specific heat consumption with load variations
- Turbine temperature and start-up limits curve vs, time curve for cold, warm and hot start
- Correction curves
- Cv-values of all related control valves
- Bearing and gear losses
- Turbine start-up and load change characteristics
- Resistance to grid disturbances

Description of construction of the generator:

- Stator housing
- Line and neutral terminals and arrangements for connection to bus-duct system
- Stator core
- Stator winding

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- Coil assembly in the slots
- Slot wedging
- End-winding supporting
- Insulation materials
- Insulation systems and impregnation method

- Rotor body
- Rotor winding
  - winding material
  - Insulation materials
- Bearings

Description of the generator cooling system

- Cooling air/or hydrogen circulation in the generator showing the cooling of the rotor and cooling of stator windings in the slot and at the end–winding area as well as the cooling of the core

- Hydrogen water heat exchangers
  -Location
  -Loading capability if one of the coolers is out of service
  -Quantity of water required at water temperature of 40 °C
  - Inlet air temperature before and after the cooler at water temperature 40 °C

-Filling and emptying procedures of the hydrogen circulation in the generator

Description of the excitation system and voltage regulation system:

- A detailed description with system diagrams showing the functional components included in the bid.
- Supervision system for the diodes.

Description of generator protection:

- Information on protection system for generator and transformers with list of relays included.

Current and voltage transformers:

- Recommendation for a number and location of current and voltage transformers needed for voltage regulation, protection and metering.

Additional generator information:

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-Capability diagram.
-Single line diagram including protective relay system.
-Erection method description of the generator.
-Electrical and mechanical loss curves for the generator.
-Saturation, short-circuits and zero power factor curves.
-Negative phase sequence capability of generator, i.e. permissible single phase and phase-to-phase loadings plotted against time.
-Generator current decrement curves with and without voltage regulator in service
-P-Q diagram of the generator at voltages $U_N$, 0.9 x $U_N$ and 1.05 x $U_N$
-Factory test certificates.
-Inspection reports covering all guaranteed data.

Heat exchangers and vessels (in addition to the technical schedules)

-Dimensional drawings
-Description of
- Construction
- Operation principle
- Maintenance procedures
- Installation requirements
- Erection procedure

Layout drawings

General and turbine

- General arrangement drawings of the turbine hall (plans, elevations, cross-sections)
- General layout of steam pipes to and from turbine
- Dimensioned drawings of turbine and Layout of turbine condenser and generator
- Sectional arrangement drawings of turbine blading
- Sectional assembly drawings of turbine control and stop valves and associated actuators
- Sectional arrangement of turbine pedestals (indicating all equipment located therein) and drawings of casing support (keys, etc.)
- Detailed assembly drawings of the following: gland arrangement, turning gem, shaft coupling
- Drawings of lifting equipment (cranes, etc.)

Generator

- Dimensioned drawings of generator

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- Sectional arrangement drawings of generator and exciter
- Layouts and arrangement of generator terminations, main connections and associated equipment
- Ventilation arrangement of generator and exciter and details of cooling systems
- Sequence drawings showing method of insertion and withdrawal or rotor from stator
- Cross-section of stator and rotor slots, coils find end windings bracing and blocking and of rotor up-shaft connections

Condenser:

- Dimensioned drawings of condenser
- General layout of condenser showing steam, condensate and cooling water pipeline connections
- Sectional arrangement drawings of condenser

Cooling tower:

- Dimensioned drawings of cooling tower
- General layout of cooling tower showing cooling water pipeline connections
- Sectional arrangement drawings of cooling tower

P&I and other diagrams

- Steam turbine extractions
- Condensate system and heaters
- Main cooling water system,
- Gland sealing system
- Lubrication oil systems (also generator and gearbox if necessary)
- Governing and control oil system
- Turbine drain system
- Schematic diagrams of excitation find voltage regulation equipment reactive capability
- Control schemes: possible modifications compared to the proposed schemes in the Technical Specification

Schemes including logic diagrams and safety interlockings

- Complete turbine safety schemes and logic diagrams covering all required operational modes and all possible mal-operations of the turbine or the plant
- Assembly and setting details of turbine governors and all turbine protective devices
- Description of method and calculations for selection of generator earthing

equipment

- Description of stator and rotor winding insulation systems and materials

Pressure reducing station

- Cross-section drawings with dimensions
- Description of
  - Construction
  - Operation principle
  - Maintenance procedure
  - Installation requirements
- Characteristic curves
- Noise at design operating conditions

Material specification

A table with details of materials; including material and standard with particulars of any special alloy and chemical analysis, minimum ultimate tensile strength ($kg/cm^2$), min. yield strength ($kg/cm^2$), min. 0.2 % proof stress at design temperature ($kg/cm^2$), average stress to produce rupture in $10^5$ hours at design temperature ($kg/cm^2$), average stress to produce 0.2 % elongation in $10^5$ hours at design temperature ($kg/cm^2$), design temperature ($kg/cm^2$) design pressure ($kg/cm^2$) stress ($kg/cm^2$), bend tests (angle, radius) elongation %.

Other

Loading diagram for boiler foundations.

G6.2.2.4 Fuel handling (for gas, residual oil and distillate oil)

Technical schedules

1. Fuel handling system

Drawings

1. Arrangement drawings of natural gas, residual and distillate oil systems (plans, elevations, cross-sections)

2. Dimensioned drawings of t he following equipment:
- Natural gas filters
- Residual and distillate oil pumps, heaters

G6.Documentation

P&I and other diagrams

1. Natural gas supply (not including the M/R station)
2. Fuel oil storaging system
3. Control schemes: possible modifications compared to the proposed schemes in the Technical Specification.

Performance data and curves

1. Oil pumps:
   Capacity - differential pressure
   Efficiency - capacity

   Power requirement - capacity

Schemes Including Sequence Diagrams and Interlockings

Complete fuel handling system safety schemes and sequence diagrams covering all operational situations.

Material Specification

A table with details of materials: (including material and standard with particulars of any special alloy and chemical analysis, minimum ultimate tensile strength ($kg/cm^2$), min. yield strength ($kg/cm^2$), min. 0.2% proof stress at design temperature ($kg/cm^2$)

G6.2.2.5 Control and instrumentation

Technical schedules

- Technical schedules for field instruments

Drawings

- Arrangement drawings or the main control room, sub control rooms and marshalling rooms

Diagrams

- System structure of the DCS-system

Performance data and curves

G6.Documentation

- Cv-values for the control valves (nominal and calculated).
- Electrical power consumption of the whole control and instrumentation system for all different voltages.
- Compressed air capacity requirements (normal operation and peak)

Safety Interlocking System

- Specification

Specifications

- DCS-system
- PLC sub-systems
- EMS-system
- Control valves
- Actuators
- Analyzers
- Transmitters, measuring equipment
- Installation material

G6.2.2.6 Electrical power sending and receiving system

1. Filled technical schedules

2. Single line diagrams for overall in the Plant

3 Electrical power consumption lists

4. Internal single line diagrams for control panels within the Plant

5. Schematic diagrams for control panels

6. Preliminary interconnection wiring diagrams between equipments

7. Hazardous area plan

G6.2.2.7 Civil works

Specified in this ITB.

G6.3 Contract documents

The cost of providing the contract documents shall be deemed to be included in the

G6.Documentation

Bid price.

The contractor shall provide to the PEEGTwithin twelve (12) weeks of the date for acceptance of his bid twelve (12) bound copies of the contract documents

The contract consists of the general terms and conditions (GTC) and the appendices specified in the Book of Conditions to GTC and with PEEGT's Contract Conditions

G6.4 Documentation for general project administration

Documentation for general project administration is hereby defined to include (but not limited to) notices, claims, waivers, requests, cost estimates and proposals, payments, applications and sworn statements , affidavits, performance and payment bonds, statements of business organizations ,copies of subcontracts, insurance certificates ,assignments, records of costs and change orders ,inspection reports and certifications from governing authorities, permits, accident and loss reports, daily activity reports ,sequence and time schedule and monthly progress reports and listing, schedule values, unit prices, listing of principal products, schedule of required submittals ,listing of subcontractors and suppliers, and similar administrative submittals as applicable to the work

G6.4.1 Planning of Work

According to the requirements stipulated in the Contract, the contractor shall ,within time specified in the Book of Special Conditions from the award of the contract submit a detailed contract program for the work to the PEEGTfor comments or approval. The contract program shall be in the form of horizontal bar charts. It shall be in compliance with the overall contract program the contractor has to include in his bid.

The contract program shall indicate for each item of the work the various phases of the work from the commencement of the contract to its final completion ,e.g. design, ordering of materials, manufacture, delivery ,erection ,construction ,commissioning, trial operation and testing.

A further program shall be provided as a critical path network or similar and shall show the interfaces between the respective phases and sections of the work. In addition, during the execution of the contract the Contractor shall prepare and submit detailed sub-networks of certain phases of the contract program as required by the PEEGTcovering erection, commissioning and testing. The up-dating period shall be four (4) weeks. .

If at any time during the execution of the Contract it is found necessary to modify the approved program, the Contractor shall inform the PEEGTand submit the modified programs for his approval. Any approval of changes to the approved

programs shall not constitute approval of an extension to the guaranteed completion date.

Sub-Contractor and Sub-Orders

As soon as practicable after entering into the contract the contractor shall, having obtained the PEEGT's consent in accordance with the conditions of contract, enter into the sub-contracts he considers necessary for the satisfactory completion of the work. Unpriced copies of the Contractor's sub-orders shall be supplied to the PEEGT.

Copies of any drawing to which the sub-order refers shall also be submitted at the request of the PEEGTor with the sub-order as appropriate.

Each sub-order and drawing shall contain the reference (name of the PEEGTand name of the project) and the instruction that the plant is subject to inspection by the PEEGT's representatives.

It is the responsibility of the Contractor that all information requested will be submitted in sufficient time to allow time enough for examination and approval.

G6.4.2 Program of work and reports

Monthly progress report

At monthly intervals latest on the 5th day of the following month during the contract the contractor shall submit detailed progress reports. The reports shall show clearly and accurately the position of all activities associated with design, material procurement, manufacture, work tests, shipping, site erection, testing and commissioning with regard to the agreed contract program

The design aspect of the progress report shall include a comprehensive statement of drawings, calculation, proposals
And schemes submitted for approval, up-dated in the above mentioned intervals.

The position on material prominent shall give the date and details of orders placed and indicate the delivery quoted by the manufacturer. If any delivery has an adverse effect on the Work program the Contractor shall state the remedial action taken to ensure that delays do not occur.

The portion on manufacturer shall indicate the arrival of material, the progress of manufacture and date at which the equipment will be ready for transport The information recorded shall also indicate all special occurrences (such as accidents, defects, etc.), which will affect the date of completion in the manufacturer's works.

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All work tests executed shall be listed and the test results shall be remarked. Special indication shall be given to equipment having not fulfilled the test requirements. The workshop tests intended for the following month shall be remarked.

The shipping of each order or part order shall be monitored on the progress report giving the date by which the equipment will be available for shipping, the estimated time or arrival on site and the dates actually achieved.

The site erection portion of the progress report shall be segregated into the main and ancillary items of mechanical, electrical. Instruments and automation and civil works and each item of work shall be monitored giving the percentage completion and the projected completion date of the work in accordance with the agreed contract program.

Any delay which will affect the completion, testing and commissioning dates of any item of Plant shall be detailed by the Contractor who shall state the action he is taking to effect completion to the contract program.

The contractor shall report in respect of the various groups of the works the erection

equipment in user held in readiness, labor and supervisory staff, and details of any

matters arising which may generally affect the progress of site work

The commencement of testing and commissioning, its duration details of any matters occurring during that period and the remedial action taken, the completion dates, etc. shall be noted and segregated for each group of the works.

The Contractor shall give a summary of the detailed progress report giving the position with regard to the agreed contract program.

The progress reports shall be set out in a format to the approval of the PEEGT.

Ten (10) copies of the progress report shall be forwarded promptly to the PEEGTso that on receipt the information contained therein is not more than fourteen (14) days out of date.

I f during execution of t he contract the PEEGTconsiders the progress position of any section of the Work to be unsatisfactory, or for any other reason relating to the contract, he will be at liberty to convene a meeting and the Contractor's representatives shall attend at such meetings.

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Weekly Progress Report

The Contractor's site office shall prepare and submit six (6) copies of a weekly progress report to the PEEGT. This report shall summarize site activities and record any details where difficulties in maintaining the agreed program are being experienced or likely to cause subsequent delay.

Daily Activity Report

The Contractor's site office shall also prepare and submit to the PEEGTsix (6) copies of a daily activity report surmising the main activities to be undertaken each day, noting special activities such as hydraulic tests, alignment checks, motor rotational checks, etc.

The contractor shall be responsible for expediting the delivery of all material and equipment to be provided by him and his sub-contractors

The daily activity shall also include the number of employees on site, whether, maximum and minimum
temperatures, information about the water levels, etc. and also sub-divided according to the Technical specification, the progress of the principal works, arrival of material, structures and plants on site, the type of manner of their construction (plant and equipment used) and the quantities of work performed for concrete works, all information relating to times and technical matters which are of importance to the quality and condition of the structure shall be included. The information recorded shall also include all special occurrences (such as accidents and the like), defects of all types agreements and instructions of the PEEGTabout the execution of the works, variations and settlements of accounts where these have not been recorded elsewhere in writing, and references to written instructions. The entries may be amplified by written appendices and drawings.

The report shall be submitted to the PEEGTfor his signed approval at least once a week. This approval signifies that the Contractor also undertakes the fulfillment of the duties and obligations arising from the agreements and instructions recorded. If the Contractor is not in agreement with specific points in the entries, he shall draw attention to this fact and shall state his objections in writing to the PEEGT, accompanied by his reasons, within 3 working days; if this is not done, the entries shall be considered as approved.

Access to the Contractor's and sub-Contractor's works shall be granted to the PEEGTor his duly authorized representative at any reasonable time for the purpose or ascertaining progress.

G6.4.3 Correspondence

All technical correspondence related to the Work shall be addressed to the PEEGTin the

English language as agreed between Contractor and the PEEGT.

All correspondence shall be numbered in accordance with a procedure to be agreed with PEEGT.

G6.4.4 Documentation of the permits

The Contractor being responsible in obtaining all the permits that are required in fulfilling his obligations, duties and the work stipulated in the contract shall keep good record of the status of each and every permit required. The procedures and the related documents have to be filed for easy and accurate monitoring to guarantee a smooth and cost-effective project implementation, plant start-up, commissioning and finally the planned commercial operation according to the requested time-schedule.

G6.4.5 Inventory lists

The Contactor shall establish a system-orientated stock keeping control and recording system for all spare parts, wear and tear parts, chemicals, lubricants and other consumables on the plant and equipment identification system used by the PEEGT.

A card index shall be used allowing to hold in readiness all necessary materials in the required quantity and quality and making sure, that ordering can be placed in due time without interruption of operation particularly with regard to unforeseen defects

G6.5 Technical implementation documentation

G6.5.1 Design and manufacturing stage

The Contractor has to submit drawings, diagrams, graphs, curves and all such information which is necessary to verify that the goods he intends to manufacture comply in every respect fully with the requirements of the Contract. Unique information required on each shop drawing is indicated in individual sections of this Technical specification for individual units of work. General information required specifically on shop drawings at the time of submittal includes dimensions, special notation of dimensions which have been established by way of field measurements, identification of specific products and materials which are included in the Work shown by the shop drawings, compliance with standards, and notations or required interfaces with other work (coordination requirements).

All documents submitted for the approval of the PEEGTshall bear the following remark (stamped and signed).

"The Contractor declares that this submission is strictly in accordance with the requirements of the contract

Signature

The drawings and documents to be submitted during this stage comprise, but are not limited to the attached "Drawing and document submittal schedule" (Enclosure G6.2).

G6.5.2 Erection stage

Six (6) months prior to the start-up of each unit, the Contractor shall forward to the PEEGTfor his approval twenty (20) copies of Operation Manuals and Stock keeping lists in the English language.

After checking and approval by the PEEGT the Contractor has to provide for twenty (20) copies of the final version in two months time after the approval of the PEEGT.

Up-dating and maintaining the required documentation for the training of the PEEGT's personnel and the instruction of the PEEGT's personnel in the use and handling of the documents remain the responsibility of the Contractor until Completion.

G6.5.3 Training

The Contractor shall monthly prepare a separate report describing the executed training program of the PEEGT's personnel. Judgments shall be indicated on each individual personnel describing the training performed and the progress achieved with regard to the requirements necessary. Based on the minimum requirements specified in Section G7, the Contractor shall propose the scope of the training program in the Bid.

G6.5.4 Testing and commissioning

The Contractor shall submit in accordance with his Qualilty Assurance Manual (Chapter G3,6) for the approval of the PEEGTthree months prior to testing, detailed test procedures for equipment, subsystems and complete systems being part of the work. These procedures shall include details of the performance tests either conducted in the manufacturer's works or at site. Detailed lists shall be provided which shall specify applicable codes, financial and other tests to be carried out on each item of the equipment, each subsystem and each unit. The lists shall be supplemented with logic diagram to show the correct plant functioning requirements together with system flow diagrams showing all point of measurement for both functional and performance tests.

The procedures, lists, logic diagrams and flow diagrams together with test results shall be correlated and presented as a single bound document to form a comprehensive set of test procedures and records of the tests conducted on the

plant.

Test reports shall be supplied according to the Document Schedule.

06.5.5 Record and as-built drawings

At a time to be agreed between the PEEGTand the Contractor but before handing over the spare parts and wear and tear parts and not later than on the date of completion, the Contractor shall provide, free of charge to the PEEGT, the following:

1. One transparency from which first class prints can be made of all drawings provided for the works. The transparencies shall include drawings of all equipment, pipework, cabling, etc. as finally installed and approved by the PEEGT.

2. Four (4) sepia and ten (10) paper prints of all drawings for the PEEGT's records

3. Two sets of microfilms of all as-built drawings, diagrams, graphs, plans, lists, manuals, etc. including a detailed table of contents and all the necessary installations such as two microfiche readers, replacement parts, operating instructions, etc

   These documents shall be deemed to form part of the work for the purpose of the certificate on the Completion.

G6.5.6 Operation and maintenance manuals

The Contractor shall forward to the PEEGTfor his approval, twenty (20) copies of his draft Operating and Maintenance Instruction Manuals in English Language. Draft copies of the manuals shall be submitted in sufficient time to allow approved copies to be available on site six months prior to commissioning.

The Contractor shall arrange his manuals in two separate parts, namely operation and maintenance. The layout of each part should, as far as possible, be consistent throughout each of the parts, with the units, systems, plant and equipment described in the same order in each section.

Precautions and warnings relative to the safety of life and equipment shall be included.

The manuals shall be divided into volumes for convenient handling and reference.

G6.Documentation

All plant and equipment identification shall be by means of description and numbering systems specific for the work as approved by the PEEGT.

A master index covering both parts of the manuals shall be included in each volume, in addition to the detailed index for the particular section.
The manual format shall be on standard metric A4 sheets. Drawings and schedules which are to be bound into the manual shall also be A4 or A3 folded to A4.

The manuals shall include instructions only for the actual equipment supplied.
Instructions for alternative or optional equipment are not to be descried in the manuals.

Use shall be made of drawings, diagrams pictures or actual photographs when they add to the understanding and clarity of the text.

Upon approval of the amended draft Operating and Maintenance Instruction Manual and no later than after the Approval of the PEEGT, the Contractor shall provide a completed sets of manuals delivered according to the Document Schedule and the supplier shall submit to the PEEGTtwenty (20) copies of manufacturer's own MIM for each item of the equipment supplied by the supplier or his sub suppliers.

The Contractor shall provide the final operation and maintenance manuals including as-built drawings information not later than two months after the Completion of the Work.

The minimum requirements of the contents of the operation and maintenance manuals and GTC are as follows:

Operation Manual:

The operation and maintenance documents shall contain the following:
Description equipment operation

- Operation purpose of equipment
- Description of equipment
- Design basis of the equipment
- Control principles, measurements, interlockings operation principles

Instructions for use

- measures and inspections before starting, operation at different modes and shutdown (stopping)
- operation in cases of interruptions and emergency
- measures during interruptions
- condition monitoring related to operation and performance monitoring
- troubleshooting and separation of failure from the process
- safety rules related to operation

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## Maintenance manual

Description of equipment structure'

Assembly and part assembly drawings needed for repair and maintenance works
Maintenance principles

- performance testing
- disassembly and assembly instructions
- control instructions
- troubleshooting instructions conditionl11onitoring tasks, measurements and measurement points
- instructions for use of special tools
- welding regulation; and material data for welding repairs
- thermal treatment instruction
- instructions for lining and transfer on site storage instructions

Safety regulations

- safety precautions (per working place and task) with regard to maintenance
- protectors and protective equipment

Maintenance program

In addition to the working instructions included in the maintenance manual, a summary of recommended, periodic maintenance operations must be prepared by the Contractor. This maintenance program should include, for example, the following:

- Basic inspections
- Lubricating program
- Maintenance to he performed during storage
- Inspection and condition monitoring
- Official inspections by authorities
- Corrosion monitoring

Spare parts list

The spare parts list shall he prepared according to the model proposed by the Contractor and approved by the PEEGT.

Complete instructions for ordering replacement parts in a manner that would prevent errors or misunderstanding.
Recommended forms for tabulating replacement part information and instructions for returning material to the factory shall also be included. Special storage or handling procedures required for any particular parts shall be noted.

Equipment cards

Equipment cards shall be delivered according models proposed by the Contractor and approved by the PEEGT.

Technical data for such equipment which have no equipment card model shall be the data according to the technical specification of the delivery contract.

If it shall emerge during the erection, commissioning or warranty period of the equipment that the operating and maintenance instructions are inadequate or faulty the Contractor shall carry out and supply the necessary corrections and supplements. This shall be handled in the following manner:

Deletions

One sheet of errata, printed on pink paper, shall be issued showing the pages which are to be deleted and are no longer valid. This sheet shall be given the same date and shall be of the same size as the original sheet.

G6.5.7 Break-down reports

During the commissioning period before the Completion the Contractor is to prepare a special report for each interruption of operation or extraordinary case of disturbance indicating in detail the failure occurred, the reason for its occurrence and the operational consequences. The Contractor shall further describe the special activities carried out and his preventive measures to allow an undisturbed future operation.

G6.6 Documentation in electrical format

The Contractor shall produce and submit certain documentation and data in addition to the copies specified in Chapter G6.5 in electrical format as proposed by the PEEGT.

At least the following documents shall be delivered in electrical format:

- system descriptions
- equipment lists
- equipment cards
- motor lists
- instrument lists
- cable lists
- functionnl diagrams (control schemes, sequence; schemes Interlocks, software documents)

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- measuring point lists

- P&I-diagrams
- lay-out drawings
- cross-sections
- operation manuals
- maintenance manuals
- training manuals
- teachers training material

The material in the above-mentioned documents shall be delivered as PC files and suitable to handle with following programmes (latest Windows versions if possible):

- texts with Word for Windows, or PDF
- spreadsheets wit Excel or PDF
- database with Oracle, or Paradox, or data Base
- drawings AutoCAD, or PDF
- presentation slides with Microsoft PowerPoint

The documentation in electrical format (PC-files) shall be delivered in CD. For every CD there shall be a table of content in which the names and the descriptions of the files have been presented. This table of content shall be printed out on paper.

G6.7 Approval procedure for drawings and documents

The PEEGT reserves the right to ask the Contractor to submit copies of drawings and other documents for his approval. If the PEEGTis satisfied with the drawing, one copy will be returned to the Contract, marked with an "Approved" stamp. If the PEEGTis not satisfied with the drawings one copy stamped "Not Approved" will be returned to the Contractor with
Comments marked thereon and the drawing shall be amended and resubmitted for approval.

When submitting drawings for approval, including any prepared by a Sub-Contractor, the Contractor shall certify that he has fully examined such drawings and that they fully comply with the requirements of the contract.

For the purpose of this clause the term "drawing" shall include diagrams, schedules, performance curves, etc.

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Approval of a drawing by the PEEGT will imply that:

1. General arrangement and layout drawings and key diagrams have been examined and appear to be in accordance with the basic design concept of the work and meet the requirements of the specification.

2. Other drawings of plant and equipment have only been examined in relation to compatibility of the items and equipment with the specification and in respect of interconnections with other items and equipment.

3. Any approval given by the PEEGT shall in no way relieve the Contractor of his responsibility under the Contract.

The PEEGThas the right to ask copies for detailed manufacturing drawings or calculations, and the Contractor shall make these available to the PEEGT.

Any such drawing or document serving the purpose of information will not be stamped "Approved" but "seen by the PEEGTonly.

On receipt of approval by the PEEGT, the Contractor shall arrange for the revision column of the drawings to be marked" Approved by the PEEGTon (date)" and revise the issue letter or number in accordance with the GTC's "Drawing for Approval".

The Contractor shall ensure that drawings, calculations, design, etc. for approval are forwarded to the PEEGTin sufficient time enough for examination of the drawings. The contractor shall also ensure that drawings are submitted early enough prior to the date required for approval to permit amendments to be made and the drawings resubmitted for approval without delaying the program deliveries or the guaranteed completion dates of the work

Note: Approved drawings must be available before any equipment is workshop tested or before any erection work is started at the Site.

I f during the contract period, the Contractor is required to increase the size of any buildings, foundations, etc. from what has been shown on his bid drawings to accommodate the finally approved arrangement of the works provided under the contract (with due allowance for access, lay-down, maintenance, etc.), such increases shall be deemed to be included in the scope of the contract.

Enclosure G6.1

# Deviations from the Technical Specification

## EXCEPTION AND DEVIATION LIST

| ITEM<br>( Chapter, Page) | ORGINAL | DEVIATION | REMARK |
|---|---|---|---|
| | | | |

# Drawing and Document Submittal Schedule

Enclosure G6.2

**Drawing and Document Submittal Schedule**


| | | Page |
|---|---|---|
| Part I | Project Management | 3 |
| Part II | Plant General | 5 |
| Part III | Mechanical Equipment | 6 |
| Part IV | Piping | 7 |
| Part VII | Electrical | 9 |
| Part VIII | Control and Instrumentation | 11 |


Abbreviations used in
Document Schedules:

| | |
|---|---|
| A | : After Receipt of Order |
| AT | : After Test |
| ATP | : Authorization to proceed |
| BF | : Before Fabrication |
| BS | : Before Start-up |
| BT | : Before Test |
| M | : Microfilm |
| R | : Reproducible |
| WS | : With Shipment |
| 30 | : 30 Days after ATP |
| 60 | : 60 Days after ATP |
| 90 | : 90 Days after ATP |
| 120 | : 120 Days after ATP |
| 150 | : 150 Days after ATP |
| 180 | : 180 Days after ATP |
| 210 | : 210 Days after ATP |
| 240 | : 240 Days after ATP' |
| 270 | : 270 Days after ATP |
| * | : 10 Copies |
| + | : R+10 Copies |

Final versions of the documents specified in chapter G6.6 shall be delivered also in electrical format.

If the PEEGTneeds more copies of some specific drawings, the Contractor has to provide these free of charge.

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Part Project Management

| No. | Document Description | Submittal For prior Approval | Schedule Final | Quantity Required Draft/final | Remarks |
|---|---|---|---|---|---|
| 1 | Organization Charts<br>-The contractor<br>-Subcontractors | | <br>30<br>30 | <br>* +<br>* + | |
| 2 | Time schedules<br>-Master<br>-Detail engineering<br>-Major equipment<br>-Civil works<br>-Erection<br>-Commissioning<br>-Training<br>-permitting<br>-Others as required | <br>30<br>30<br>30<br>30<br>30<br>30<br>30<br>30 | <br>60<br>60<br>60<br>60<br>150<br>150<br>150<br>60 | <br>* +<br>* +<br>* +<br>* +<br>* +<br>* +<br>* +<br>* + | |
| 3 | Itemized Drawing & Document Schedule | 30 | 60 | * + | |
| 4 | Progress Reports<br>-Daily<br>-Weekly<br>-Monthly | | | <br>6<br>6<br>10 | |
| 5 | Project Instructions<br>-General<br>-Site specific | <br>30<br>30 | <br>60<br>60 | <br>* +<br>* + | |
| 6 | Permitting<br>-Application<br>-Permitting process<br>-Permit | | | <br>* +<br>* +<br>+ | <br>As required by law or applicable codes or authorities |
| 7 | Training<br>-Plan<br>-Training material<br>-progress reports | <br>90<br>210 | <br>150<br>270 | <br>5 25<br>10 50<br>+ | |
| 8 | Manuals for Operation And Maintenance<br>-Draft<br>-Final | <br>180BS | <br><br>90BS | <br><br>20<br>20 | |

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| No. | Document Description | Submittal For prior Approval | Schedule Final | Quantity Required Draft/final | Remarks |
|---|---|---|---|---|---|
| 9 | Quality Assurance Manual | 30 | 60 | * + | Updating and resubmission as required in section G3.6 |
| 10 | Quality Verification Reports<br>-Prior notice on test<br>-Test procedure specification<br>-Test records<br>-Test report<br>-Non-Conformance report<br>-Other | <br>60BT<br>60BT | <br>30BT<br>60BT<br>AT<br>10AT<br>10AT | <br>10<br>+<br>+<br>+<br>+ | |
| 11 | Loss of production reports | | | 10 | After each event or at least monthly |
| 12 | Manuals for Erection | 120 | 180 | 5 | |
| 13 | List of Consumables Required for Start-up | 120 | 180 | * + | |
| 14 | Invoice with supporting documents | | | | As stipulated in the contract |
| 15 | As built drawings | | 90A | +M | |
| 16 | Inventory file cards | 30A | 90A | * + | |
| 17 | Insurance etc Certificates | | 30 | 10 | As stipulated in the contract |
| 18 | Subcontracts<br>-Request for approval<br>-Contract/purchase order<br>-Expediting reports | <br>30 | <br><br>60 | <br>5<br>10<br>10 | <br><br><br>At least monthly |

G6.Documentation

| No. | Document Description | Submittal For prior Approval | Schedule Final | Quantity Required Draft/final | Remarks |
|---|---|---|---|---|---|
| 1 | P&I -diagrams | 45 | 90 | * + | |
| 2 | Required for site plan | 15 | 45 | * + | |
| 3 | Arrangement drawings | 30 | 60 | * + | |
| 4 | Detailed heat and material balances | 45 | 90 | * + | |
| 5 | Plant data book | 120 | 180 | * + | |
| 6 | Identification system manual | 45 | 90 | * + | |
| 7 | Equipment and Machine cards | 270 | 30A | * + | |

G6.Documentation

| No. | Document Description | Submittal For prior Approval | Schedule Final | Quantity Required Draft/final | Remarks |
|---|---|---|---|---|---|
| 1 | Arrangement drawings | 45 | 90 | * + | |
| 2 | Design calculations (required e.g. By applicable codes) | | 90 | 10 | As required by codes, authorities ,etc |
| 3 | Erection drawings& manuals | 150 | 180 | 10 + | |
| 4 | Major structural details | 90 | 120 | 10 + | |
| 5 | Shop drawings | 90 | 120 | 10 + | |
| 6 | Standard Components<br>-Arrangement drawing<br>-Sectional view with itemized list of components<br>-Performance curves | <br>60<br>60 | <br>90<br>90 | <br>* +<br>* + | |
| 7 | Building Design information drawings(loads,etc | 30 | 60 | * + | |
| 8 | Process data sheets for instrumentation | 60 | 90 | * + | |
| 9 | Equipment data sheets | 60 | 90 | * + | |
| 10 | Connection data (size | | | | |
| 11 | List of electrical drives or power consumers | 30 | 60 | * + | |
| 12 | Specifications for all kind of consumables like chemicals, lubrication oil ,etc | 150 | 180 | * + | |

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Part IV Piping

| No. | Document Description | Submittal For prior Approval | Schedule Final | Quantity Required Draft/final | Remarks |
|---|---|---|---|---|---|
| 1 | Piping Installation drawings 1:50 plans and sections | 90 | 120 | * + | |
| 2 | Isometric drawings for piping DN 65 and over | 180 | 210 | * + | |
| 3 | Pressure drop analysis | 120 | 150 | * + | |
| 4 | Stress analysis of critical piping | 120 | 150 | * + | |
| 5 | Support and hanger location drawings | 180 | 210 | * + | |
| 6 | Support and hanger detail drawings with stress calculation | 180 | 210 | * + | |
| 7 | Bill of Materials<br>-pipelines<br>-Valves<br>-Hangers and supports<br>-Other fittings and components | 180 | 210 | * + | |
| 8 | Safety and relief valve capacity check | 90 | 120 | * + | |
| 9 | Structural details | 90 | 120 | * + | |
| 10 | Standard components | 180 | 210 | * + | |
| 11 | Specification for all kinds of relative piping components (e.g. Piping valves, specialty, insulation, hanger & supported.) | 120 | 150 | * + | |
| 12 | Calculation sheets for pip wall THK ,line sizing& Insulation thickness | 120 | 150 | * + | |
| 13 | Piping erection drawings(spools,etc) | 245 | 270 | * + | |

G6.Documentation

Part VII Electrical

| No. | Document Description | Submittal For prior Approval | Schedule Final | Quantity Required Draft/final | Remarks |
|---|---|---|---|---|---|
| 1 | Single Line Diagram<br>-Lighthing and Service power panel boards | 30 | 60 | * + | |
| 2 | Arrangement Drawings<br>-Busbars,trays and conduits<br>-Grounding system of generator<br>-Freeze protection<br>-Generator/starpoint | <br>30<br>30<br>30<br>30 | <br>60<br>60<br>60<br>60 | <br>* +<br>* +<br>* +<br>* + | |
| 3 | Face and Section drawings<br>-Switchboards and panels<br>-Marshaling boxes<br>-Large motors<br>-busbars,trays and conduits | <br>45<br>45<br>45<br>45 | <br>90<br>90<br>90<br>90 | <br>* +<br>* +<br>* +<br>* + | |
| 4 | Components Drawings and Specifications | | 30 | * + | |
| 5 | Schematic and Wiring Diagram<br>-Each type of circuit at each voltage level<br>-Protection<br>-Tripping<br>-Control<br>-Metering<br>-Interlocking<br>-Alarms<br>-Synchronizing<br>-Freeze protection | <br>60<br><br>60<br>60<br>60<br>60<br>60<br>60<br>60 | <br>90<br><br>90<br>90<br>90<br>90<br>90<br>90<br>90 | <br>* +<br><br>* +<br>* +<br>* +<br>* +<br>* +<br>* +<br>* + | |
| 6 | Type Test Certificates and Performance Curves<br>-Circuit breakers<br>-Contractors<br>-Switches<br>-Relay Characteristics<br>-Fuse Characteristics<br>-Motors<br>-Power cables | | <br>30<br>30<br>30<br>30<br>30<br>30<br>30<br>30 | | |
| 7 | Motor Lists | 30 | 60 | * + | |
| 8 | Cable | 45 | 90 | * + | |

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| | | | | | |
|---|---|---|---|---|---|
| | Lists | | | | |

| | | | | | |
|---|---|---|---|---|---|
| 9 | Calculations<br>-Fault levels<br>-Grounding system<br>Voltage regulation | <br>30<br>20<br>30 | <br>60<br>40<br>60 | <br>* +<br>* +<br>* + | |
| 10 | Component Specifications | | 60 | + | |
| 11 | Bill Of Materials | 90 | 120 | * + | |
| 12 | Component Data Sheets | | 60 | + | |

## Part VIII Control and Instrumentation

| No. | Document Description | Submittal For prior Approval | Schedule Final | Quantity Required Draft/final | Remarks |
|---|---|---|---|---|---|
| 1 | System Block Diagram and Description | | 30 | * + | |
| 2 | Control Schemes | 60 | 120 | * + | |
| 3 | Safety Interlocking Diagrams | 60 | 120 | * + | |
| 4 | Sequence Diagrams | 60 | 120 | * + | |
| 5 | Arrangement Drawings<br>-Control room<br>-Marshalling room<br>-Cable trays Conduits<br>Field instruments and associated equipment | | | | |
| 6 | Panel and Cubicle Drawings<br>-Face<br>-Internals<br>-Internal wiring | 60 | 90 | * + | |
| 7 | Installation Drawings | 150 | 210 | * + | |
| 8 | Specifications<br>-DDC System<br>-Control Valves<br>-Actuators<br>-Analyzers<br>-Transmitters, Measurements<br>-Installation material | <br>60<br>60<br>60<br>60<br><br>60<br>150 | <br>90<br>90<br>90<br>90<br><br><br>180 | <br>* +<br>* +<br>* +<br><br><br><br>* + | |

| | | | | | |
|---|---|---|---|---|---|
| 9 | Lists<br>-Alarms<br>-Measurements<br>-Cables | <br>60<br>60<br>90 | <br>90<br>90<br>120 | <br>* +<br>* +<br>* + | |

| No. | Document Description | Submittal For prior Approval | Schedule Final | Quantity Required Draft/final | Remarks |
|---|---|---|---|---|---|
| 10 | Bill of Material<br>-Control System Components<br>-Installation Material | <br>120<br>150 | <br>180<br>210 | <br>* +<br>* + | |
| 11 | Programs for DDC<br>-Closed Loop Control<br>-Open Loop Control<br>-Plant Overall Control<br>-Sequence Recording<br>-Data Recording<br>-Graphic Display<br>-Other | 150 | 210 | * + | |
| 12 | CRT Displays<br>-process Flow Sheets<br>-Operating parameters<br>-Trends<br>-Alarms | 150 | 210 | * + | |
| 13 | Component Data Sheet | 60 | 90 | * + | |
| 14 | Calibration certificates for instruments which will be used in the performance tests | | 30BT | 10 | |

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**GENERAL SPECIFICATION**

G 7. Services

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## G7. SERVICES

### G7.1 Commissioning start-up and trial run

The Contractor will carry the responsibility for the commissioning, start-up and trial run.

During commissioning all necessary equipment, safety devices, interlocks etc. will be tested and adjusted. The end of erection will be accepted when the 24 hours start-up run has been successfully carried out. The power output during shut-up will be defined by the PEEGT. The start-up will be accepted if no failures have occurred which could prevent the continuous operation of the equipment.

The scope of the supply includes a 360-hour trial run as an uninterrupted operation period without any disturbances on any operation mode and load the PEEGT requires. This trial run can he carried out after the successful completion of all commission tests (official and unofficial).

The Contractor shall provide the start-up and trial run in three shifts.

The contractor shall provide a qualified expert to lead the start-up and trial run. The PEEGT's normal operating personnel will be available for the operations, but the operation will be on the responsibility or the Contractor until PAC

### G17.2 Training

The Contractor shall train the PEEGT's staff to operate and maintain the equipment included in the delivery. Training is based on training manuals, operation and maintenance manuals and drawings. The training shall be performed during erection, commissioning, trial run and guarantee period and includes practicing.

The Contractor shall include a training program in the Tender. The training shall include at least the following:

- General training for all personnel
- Operation training for the operating staff of the plant Maintenance training
- Automation, instrumentation and electrical training

## G 7. Services

The number of man months of training abroad to be included as required in the Book of Special Conditions.

The training shall he given in English languages.

Concerning operation and maintenance training, the contactor shall provide all information the PEEGT will need for his related planning, scheduling and monitoring purposes.

The Contractor shall submit training material and resources regarding to his delivery in extent form and schedule defined by the PEEGT.

The Contractor shall introduce his trainers in advance for PEEGT's approval.

### G7.1 Maintenance support

The Contractor shall provide maintenance support as requested by the PEEGT.

Contractor's maintenance support shall cover installation, testing and commissioning phases, and also on-call services and spare part supply during operation phase.

The Contractor is responsible (included in the scope of Work) for the supervision of operation and maintenance during guarantee period. During this time the team of the Contactor's experts shall be on Site to assist the personnel of the PEEGT. The team shall consist of experts according to what is mentioned in the Book of Special conditions, e.g.:

1. Operation engineer for one year
2. Mechanical engineer for one year
3. Electrical engineer for one year
4. Control engineer for one year
5. Chemical engineer for one year

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# G8. SPARE PARTS AND SPECIAL TOOLS

## G8.1 Spare parts

The Tenderer shall include in the scope of Work following:

- First fillings of lubrication oil, chemicals, etc. (excluding fuels)
- Consumables for up to the end of guarantee period
- Spare parts specified by the PEEGT (technical schedules in ITB Part 6)

Spare parts recommended by the Contactor in accordance to what is mentioned in the Book of Special Conditions.

The spare part lists shall include also the name of the manufacturer of each spare part or spare parts group.

The meaning of word "set" in the spare part lists must be specified (if used for example "1 set of tools")

Spare parts recommended by the Contactor shall be delivered ( if any ) according to same PEEGT's requirements and instructions as Contractor's main delivery.

The Contactor is responsible for preservation and packing of spare parts, as well as for providing necessary handling and storing instructions for PEEGT. All parts shall be packaged in containers, labeled for identification and suitably packed and treated to prevent deterioration due to climatic conditions during storage and rehandling.

The Contractor shall supply specifications for each type of lubricant and shall endeavor to minimize the number of lubricants required.

## G8.2 Special tools

The Tenderer shall include in the Tender all the necessary tools including standard tools and special tools, which are necessary or convenient in the operation, maintenance or overhauling or equipment under his supply.

Complete lists of tools shall be submitted to the Consultant/PEEGT soon after completion of manufacture of equipment and before its actual shipment.

Shipping containers shall be suitable for permanent storage of tools by the PEEGT.

All tools must be new and unused.

Standard tools

The Contractor shall specify the number of standard tool sets and what is included in one set.

Special Tools

The Contractor shall prepare a list of those equipment which need special tools for maintenance and overhaul. The name of the special tools shall be mentioned in the list. The Tender shall include in the Tender at least one set of these special tools. The number of the special tools must be sufficient for two units.

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G9 Maintenance management

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# G9 Maintenance management

## G9.1 General

### G9.1.1 Purpose of the system

It is the intention of the PEEGT to utilize a sophisticated computerized maintenance management system at Aleppo power plant. The objectives of such system are:

- reduce operational losses
- reduce maintenance costs
- optimize maintenance activities by predictive means reduce capital costs bound to storage
- reduce outage costs
- reduce emissions
- improve maintenance routines
- improve spare parts management
- improve downtime administration
- improve reporting and analysis of plant problems

### G9.1.2 Users of the system

The system will mainly be used by the engineers who are responsible for the maintenance of the power plant units, but also one very important group of users is the people who are responsible for the spare part store.

The main part of the users are working in the maintenance building ( work shops and stores). Some of the users are working in the power plant building and in the administration building.

### G9.1.3 Main functions of the system

Maintenance management system (MMS) shall be a modular system consisting at least of the following modules:

Component register
Scheduling system
Work order system
Job planning system
Preventive maintenance system (PM)

History system inventory system

Following modules shall include in the MMS:

Purchasing system cost calculation system

Component register is the heart of the MMS. It includes the basic technical data and list of documents of all plant equipment and components. The results of the component maintenance system such as lists of spare parts and basic data for preventive and predictive maintenance systems are included.

The basic function of the scheduling system is to make a realistic plan by optimizing personnel, craft and other recourse allocations. That means to generate work order schedules based on resource leveling techniques.

Work orders are the central element of maintenance management. Work order system module shall give all functions necessary for processing daily work load.

A job plan is a detailed description of work to be performed for a job. A job plan typically includes procedual description and lists of parts, items of work and tools estimated to he used on the job and work orders and preventive maintenance reference job plans for their resource estimates.

PM is used to generate work orders for regularly performed tasks on either an elapsed time or metered basis. A predictive maintenance capability must he provided through linking PM to preset alarm conditions (condition monitoring).

History system enables to keep and update records of equipment, track maintenance costs, and enter and review meter readings. It records every equipment failure and downtime occurrence. Failure code hierarchies can be build and viewed for use in the work orders module in order to record equipment problems for future analysis. By tracking and analyzing equipment availability, total equipment downtime, and operational downtime to identify to root causes and frequency of failures and downtime, preventive maintenance or permanent solutions can be undertaken.

Managing inventory is an important part of maintaining any facility or plant .An inventory system keeps track of stocked and non-stocked parts, indicates when stock falls below user-defined minimum levels, creates purchase requisitions to restock needed parts, and tallies parts received. Costs and balances must be updated instantly so that the latest figure is always available. When parts me reported on work orders, current balances me decremented. When parts are received through the purchasing module, current balances me incremented and costs recalculated.

The purchasing module provides tools for preparing and printing purchase requisitions and purchase orders. When parts are received, quantities and costs me updated in inventory.

A cost calculation system collects data from all MMS modules and other sources where the costs me incurred (operation, chemistry, etc..). It can also include a budgeting element and other elements depending on the chosen cost calculation policy. .

The MMS should include a progmmme for arranging spare parts in the store.

The purchasing system should provide all the technical specifications for the parts to he ordered in order to buy it from different manufactures.

The MMS should include a programme depending on Debse system for all the power plant equipment including its tag number, piece number and drawing number.

G9.2 Scope of supply

The scope of supply shall include a common MMS for all power plant units.

The scope of supply shall include all hardware and software necessary for the proper operation of the MMS.

The Contractor shall install the necessary software and prepare the MMS ready for operation.

The contractor shall have the component register of the MMS filled with the data of the delivered equipment of the Plant.

The PCs included in the scope of supply shall he used also for other purposes as word processing and spread sheet calculations.

## G9.2 Design and operational requirements

The MMS shall he based on a standard program package of the supplier.

The simultaneous use of the system by different users shall be possible. The technical solution for that shall be proposed by the Contractor (local network, etc.).

The authorized users of the system shall be divided into groups each of which has different rights to do actions in the system.

The hardware of the MMS shall consist of following equipment:

Main computer
PC for every user
Matrix printer for every user laser printer (postscript) local network (if required)

The type and the capacity of the main computer are purely depending on the technical solution proposed by the Contractor.

The minimum requirements for the PCs are up to date.

The manuals for the PCs shall be in English and in Arabic.

Matrix printers shall be connected direct to the PCs.

The PCs shall be equipped with all programs which me used for documentation delivery in electrical format as specified in Chapter G6.6.

## G9.4 performance guarantees

The indication for the performance of the MMS is the response time for various actions. General requirement for the response time is that the result of the action must be seen on the screen in few seconds after the action. The response time shall in any case he not more than 30 seconds.

In the end of the guarantee period there shall he 30 % of free space in the disk memory.

## G9.5 Training of the staff

Training for the personnel shall be divided into two phases:

Principles of the MMS and the affect of effective maintenance to the economony of the

power plant (two groups, two weeks per group, in English)

Practicing the functions of the MMS (two groups, 15 hours per group, in English)

The Contractor shall specify a more detailed program for the training days and submit it to the PEEGT for its approval

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# G 10 Sections of the project

## G10.1 General

The project is divided into two sections. These sections shall be ready according to the project schedule presented in Chapter G1.7. The scope of work of each section is specified in this document.

## G 10.2 Section one

Section one (1) of the project shall be the first generating unit along with all necessary facilities, structures and equipment to have it ready for commercial operation.

This section shall include the following scope of work in addition to the generating unit itself with all its complementary equipment and accessories:

- Natural gas system with necessary accessories from the M&R station to the boiler and the pressure control unit of the relevant boiler.
- Fuel oil and D.O.systems with unloading stations.
- Boiler drain tank.
- Two (2) boiler drain pumps.
- Water treatment plants.
- Instrumentation and control system for the relevant unit compressed air equipment.
- Auxiliary boiler.
- Steam converter.
- Chemical injection equipment for the relevant unit and common facilities.
- Sampling system of the relevant unit.
- Crane in the steam turbine building.
- Fire alarm and protection system for the plant.
- Power transformers necessary for the relevant unit.
- 6.3 kV, 380 V and D.C. switchgears required for the relevant unit.
- Common electrical switchgear and distribution.
- Control and protective relay panel system required for the relevant unit.
- Hydrogen generating unit (in a case of hydrogen cooled generators).
- Diesel generating set.

- Three (3) Residual oil tanks.
- Light oil tanks.
- Water supply systems along with the raw water reservoir, pumping station in Assad Lake and all necessary piping.
- The connection to the GIS Substation.
- All civil work structures, works and installations necessary for the operation of the unit without obstacles.

And the necessary to run this section connected to the grid in normal and safe operation.

G 10.3 Section two

Section two (2) of the project shall be the second generating unit along with all necessary facilities, structures and equipment to have it ready for commercial operation.

This section shall include the generating unit itself with all its complementary equipment and accessories. In addition to those also following equipment and accessories shall be included in the scope of work of this section:

- Natural gas system with necessary accessories from the M&R station to the boiler and the pressure control unit of the relevant boiler.
- Fuel oil system for the relevant unit.
- Instnllnentation and control system for the relevant unit.
- Chemical injection equipment for the relevant unit and common facilities.
- Sampling system of the relevant unit.
- Fire alarm and protection for the relevant unit.
- Power tramsformers necessary for the relevant unit.
- 6.3 kV, 380 V and D.C. switchgears required for the relevant unit.
- Control and protective relay panel system required for the relevant unit.
- Emergency diesel generating set.
- Two (2) Residual oil tanks.
- The connection to the GIS Substation.
- Workers housing area.
- Wokshop.
- Warehouse.
- Chemical store.
- Car park.
- Roads and sidewalks.
- The rest of Substation.
- In general all civil works described under the project.
- Spare parts.

G 10 Sections of the project

- Standards and special tools.
- Training.
- All other remaining items to complete the power plant.

And all necessary to run this section in normal and safe operation.

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G11.1 Introduction

Public Establishment of Electricity for Generation and Transmission (PEEGT) has decided to build Aleppo power plant in AL Treffawi Aleppo city north of Syrian Arab Republic.

The site located south east of Aleppo about 135 Km
The site level is 385 Meters a.m.s

Drawing attached in the Annexes shows the site map

The tenderer before he submit his offer should visit the site and check its suitability and collect all necessary information

**PUBLIC ESTABLISMENT OF ELECTRICITY FOR GENERATION AND TRANSMISSION (PEEGT)**

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# PART 3

# TECHNICAL SPECIFICATION MECHANICAL

# **M7** Cooling water system

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# M7 COOLING WATER SYSTEM

## M7. 1 General

This specification covers the design, manufacture, construction, testing, transportation, erection and supervision of erection of the dry cooling system consisting of indirect type dry cooling system with natural draft cooling tower complete with auxiliaries and accessories as specified herein and as necessary

However, the Tendered may complete these requirements based on special features and design particulars of his equipment as well as his experiences as necessary and incidental to the proper, reliable, safe and efficient operation and control of the system, subject to approval.

## M7.2 Scope of equipment

### M7.2.1 Definitions

This section specifies the scope of supply as a minimum requirement covered by this specification Supply, services and necessary works which are not mentioned explicitly but required for safe and efficient operation shall be also included in the scope of supply.

The two units shall be equipped with identical cooling water systems as described hereafter.

The scope of supply comprises all equipment such as cooling water circulating pumps with motors, recovery hydro turbines , cooling water mains, air cooler bundles, drain tanks, head tanks (if applicable), filling pumps, pipes, valves, nitrogen blanketing system (if applicable), instrumentation, performance control equipment, supporting steel structure of cooling tower and cooling tower shell structure.

Platforms, stairs and ladders required for operation or maintenance shall form part of the equipment and be included in the scope of supply

For running and supervising of the system, detecting of opera ling faults, for equipment protection and safety measures all necessary instruments and controls shall be provided.

The steam condenser is of surface condenser type or of direct contact (DC) jet condenser type. Both condenser types are mentioned several times in this specification, since the different types or condenser require occasionally different designs or equipment of the dry cooling system.

The design fill direct contact jet condenser type shall be offered

The scope of supply shall consist of, but shall not be limited to the following:

M7.2.2 Cooling water circulation hydro machine groups

The cooling water shall be circulated between the condenser and the cooling tower by circulating pumps driven by electric motors coupled directly to the pumps may be of vertical or horizontal type

At least 2 (two) pumps of 2 X 60 % flow capacity shall be operated in parallel connection for each unit. Other number of pumps is also acceptable if more feasible and economical.

In case of jet condenser the remaining head of the cooling water returning from the tower can be utilized by recovery water turbines In this case 2 (two) horizontal Common shaft turbine-motor-pumps groups of ( 2 X 60% ) capacity can be applied other alternative technically suitable solution are also acceptable The sequence and arrangement of the machines shall be determined by the tender as most feasible

M7.2.2.1 Cooling water pumps

The cooling water pumps shall be equipped with the following components:

- Base flame with anchor bolts
- Bearing temperature indication and alarm
- Indication and signal of pumps inlet and outlet pressures
- Coupling to motor and/or hydro turbine
- Flanges with counter flanges, bolts, nuts and gaskets
- First filling of lubricants

M7.2.2.2 Cooling water pump driving motors

The driving motors shall be equipped with the following components:

- Base frame with anchor bolts
- cooling of windings via suitable cooling method
- Indication and protection of bearing and winding temperature
- coupling to pump and hydro turbine
- First filling of lubricants

M7.2.2.3 Recovery water turbines

Recovery water turbines are applicable only in case of jet condenser, where 2 (two) turbines of 60 % flow capacity each should be coupled by a horizontal common shaft to the two pumps or motors Alternative solutions are permitted.
The turbines shall be equipped with the following components

- Base frame with anchor bolts
- Adjustable inlet control guide, vanes with suitable control
- Oil or grease lubricated antifriction
- Bearings with water cooling if required bearing temperature
- Indication and alarm
- Coupling to electric motor and/or pump, generator
- Flanges with counter flanges, bolts, nuts and gaskets
- First filling of lubricants

M7.2.3 Piping, ducts and valves

The piping system with relevant valves distribute the cooling water to and collect it from the circulating pumps, recovery turbines, tower sectors, air coolers, storage tanks, head tanks, etc respectively.

The piping system shall be complete with the necessary

- Stiffening
- Drains and vents
- Manholes (if necessary)
- Expansion joints, supports and fix points with relevant
- Base plates and anchor bolts
- Elbows, reducers, flanges, bolts, nuts, gaskets
- Valves, check valves, safety valves, vacuum breakers, rupture discs
- Instruments
- Surface protection
- Cathodic protection (if any)

The cooling system shall include at least the following valves of adequate size:

- Isolating valves for each pump
- Check valves for each pump
- Inlet, outlet and drain valves for aircoolers
- At least two cooling tower bypass valves
- Make up water valve

- Excess water valve (from cooling water system to drain tanks)

M7.2.4 Air coolers

Air coolers shall have the necessary number and size for proper cooling being complete with

- Fin tube bundles inlet, outlet and return headers respectively (if any)
- Flexible connections to cooling water piping
- Flexible connection to vent piping
- Framework structure (if necessary)

M7.2.5 Drain tanks

Underground drain tanks shall leave the capacity to store the water content of all aircoolers, head tank (if any), and aboveground piping within the cooling tower

The drain tanks shall be complete with the necessary

- Stiffening
- Vents and drains manhole(s)
- Level indication and control

M7.2.6 Head tank

In case of surface condenser one head tank shall be installed, having the capacity to store the necessary water content to be determined on the basis of the design of the cooling water circuit.

The head tank shall be complete with:

- Venting, draining, overflow
- Manhole with ladder
- Support, stairs and platform
- Level indication and control

M7.2.7 Nitrogen blanketing system

In case the internal surface of the fin tubes is of carbon steel a nitrogen blanketing system shall be used for inside corrosion protection during periods, when the unit is out of operation.

The system should be complete with:

- Safe storage for bottles and, reducing station in the tower
- Nitrogen bottles of suitable capacity
- Pressure reducing station
- Pressure indication on high and low pressure side
- Connection to the piping system
- Pressure relief valve

M7.2. 8 Air venting system

Cooling system with aluminum heat exchanger tubes no nitrogen blanketing system is required
In this case an air venting system via air vent stand pipes shall be applied

The sector air vent systems shall be complete with

- Sector air vent collector
- Sector air vent stand pipe
- Fixing to tower structure

M7.2.9 Transfer pumps

At least 2 (two) transfer pumps of 2 x 60 % capacity for the cooling water circuit shall be installed for each unit complete with

- Base frame with anchor bolts
- Electric motor
- Pressure indication at outlet

M7.2.10 Instrumentation and control systems

The instrumentation system shall locally and/or remotely indicate temperatures, levels, flows and pressures as well as provide signals thereof to the control system as necessary, and shall be complete in every respect to ensure proper, reliable, safe and efficient operation of the whole cooling system

The control system shall control manually and/or automatically the cooling performance, command sequences, maintain levels, provide protection from improper operation, indicate alarm signals and the status of the cooling system, and record important events The control system shall be complete in every respect to ensure proper, reliable, safe and efficient operation of the cooling system

M7.2.11 Electrical equipment

The electrical equipment shall be complete in every respect with all cables, switches. relays, protections, safety devices, cable trays, accessories, etc… to ensure proper, reliable, safe and efficient operation or the cooling system.

M7.2.12 Cleaning equipment

1 (one) movable water jet cleaning equipment per cooling lower, being complete with

- Water connections
- Flexible hoses
- Pumps
- Valves
- Nozzles
- Framework structure
- Rails

M7.2.13 Natural draft cooing tower structure

To ensure the necessary natural draft through the aircoolers, a tower shell of appropriate height and bottom and top diameter shall be installed above the aircoolers in the natural draft tower.

The towers which made of steel structure covered with aluminum sheeting are preferable

Besides the tower foundation, legs and shel1, the towers shall be complete with

- aircooler support structure
- entrance gate for vehicles
- stairs and/or ladders up to the top
- walkway on the top around the tower
- aviation warning lights and signs
- lightning protection
- dust free covering or inside and outside or tower
- cable tray and/or tunnels
- telephone connection to the control room

- lighting facilities
- height of the cooling tower shall be about 135 m

Concrete tower could be offered.

M7.2.14 Further equipment

All other equipment necessary fen the proper, reliable, safe and efficient operation, repair and maintenance of the dry cooling system and associated equipment.

M7.3 Design and operational requirements

M7.3.1 Definitions

The dry cooling system has the function to reject the condensation heat of the condensing plant to the atmosphere

In the indirect dry cooling system this function is to be carried out by , circulating cooling water in a closed circuit between the turbine condenser (surface or jet) and the natural draft dry cooling tower, whereas the cooling water is warmed up in the condenser by the condensing exhaust steam and cooled back in the dry cooling tower by finned tube water-In-air heat exchangers without evaporation, whereas the cooling ambient air is forced through the heat exchangers by natural] draft induced by the cooling tower stack.

The cooling water system shall be dimensioned for 100 % steam turbine bypass steam flow.

M7.3.2 Cooling performance

The dry cooling system shall be designed to meet the following requirements

- proper, reliable and safe operation at ambient air range specified in Chapter G2. Application requirements, ITB,

- heat rejection as specified in the technical schedules at 40 C dry bulb ambient air temperature, being the design point of the cooling system.

- heat rejection, as specified in the technical schedules besides the design point load conditions

The cooling system shall be dimensioned to meet the cooling requirements during warm weather (40 °C) and high velocity wind 5 m/s and at 10 meters height

M7.3.3 General design

The plant shall be designed to facilitate easy accessibility for inspection, cleaning, maintenance, and repairs and shall be designed to ensure continued efficient operation under the atmospheric and other conditions prevailing at the site, without replacement of cooling elements and/or other major plant items, during the required life of the plant.

All those components of the cooling system and auxiliaries under vacuum in operation shall be designed for full vacuum and the entire such system shall be vacuum tight correspondingly .As higher pressures above atmospheric pressure may occur, those systems shall be designed for 0.5 bar (g) as well.

M7.3.4 Site conditions

All equipment and components of the cooling system shall be designed and manufactured with due regard to the climatic and environmental conditions prevailing at the site, at which the cooling system and its components shall operate properly, reliably, safely and effectively under full or part loads

M7.3.5 Cooling tower

The aircoolers bundles of one cooling tower can be divided into groups if safe and reliable operation makes it reasonable The purpose of the modularization is to ensure the continuous operation of the cooling system even if a certain portion of the aircoolers is out of service for maintenance.
All modules or sectors shall incorporate approximately the same number of aircoolers bundles.

Each module or sector can have its own cooling water distributor to and cold water collector piping from its aircoolers bundles. Each module or sector can be filled, connected to the system and drained through its own inlet, outlet and drain valves respectively.

Venting of the aircoolers of one module or sector shall be through a common module or sector vent stand pipe via a module or sector vent collector in case of indirect systems.

The number of modules or sectors within one cooling tower shall be selected in regard of safe filling, connection lo the system and draining, optimum number and size of module/sector valves and piping In case of surface condenser optimum head tank capacity shall be considered

M7.3.6 Protection against condensate subcooling

The design of the cooling system shall avoid condensate subcooling under all operating conditions including part load. The method applied to achieve this target is to be proven by practical operation in similar plants under comparable climatic conditions and shall be clearly described by the Tendered in his offer.

Special attention shall be paid to avoid freezing during cold weather and when the unit is not in operation.

M7.3.7 Vibration and surge

Plant and equipment shall be designed and constructed to eliminate, reduce and withstand the impact of vibration generated by the cooling system components themselves and other equipment

Plant and equipment shall be designed and constructed to:

(a) Eliminate or reduce the impact of vibration generated by internal components, such as in control valves, by-pass valves and similar devices.

(b) Withstand the effects of vibration induced from other sources such as piping connecting to structural steel supports, or rotating and/or oscillating machinery.

(c) Withstand the effects of vibration and/or mechanical or thermal shock induced internally, such as in blowdown vessels, by-pass steam dumping devices.

Mechanical vibration at gearboxes, pumps, motors and hydro turbines shall not exceed the limit of the "acceptable" assessment level of generally accepted technical standards under normal operating conditions.

M7.4 Layout

The cooling water circulating hydro machine group should possibly be placed (especially in case of jet condenser) in the basement of the main building, near the condenser.

The cooling water mains shall be laid underground and routed as straight as possible, with due regard to other power plant buildings and structures
The drain tanks shall be placed underground, inside the cooling tower.

The head tanks shall preferably be placed inside the cooling tower but the Tendered may place them somewhere else if proved to be more suitable

M7.5 Other design criteria

M7.5.1 Cooling water circulation pumps with motors in case of surface condenser

The cooling system shall have at least two cooling water pumps of 2 x 60 % capacity each.

The operating characteristics of the pumps and the rated capacity of their motors shall be such that the motor shall not exceed its rated temperature rise or nominal capacity under any conditions within the full operating range, as well as during starting of the pump'

The pump and motor units shall be designed so as to withstand being driven in reverse rotation for a limited period of time if the pump discharge valve fails to close on pump trip.

M7.5.1.1. Circulation pumps

The pumps shall be vertical or horizontal, single stage, vortex type with split casing. The pumps shall operate without problem in parallel or independently within the full operating range.

They shall be designed for continuous service and satisfactory operation under the atmospheric and climatic conditions prevailing at site. The head characteristics shall be such that the head will steadily increase with decrease in quantity delivered, and maximum head is generated at zero flow.

The completed rotating elements of the pumps shall be statically and dynamically balanced and the pump shall be free from abnormal vibrations or noise under all conditions of load.

The pump casing shall be made of cast iron, the impeller, shaft and, the shaft sleeves of stainless steel. Renewable wearing rings shall be provided at points of running clearances.

Thrust bearings shall be of oil or grease lubricated antifriction type with temperature indication and alarm, and water cooling if required. The pumps shaft shall be sealed by sliding ring packing.
The pumps shall be furnished with a local panel of instrument s for monitoring the bearing temperatures and the system cooling water inlet and outlet pressures.
The pumps shall be furnished with valves to enable complete venting and draining.

The pumps shall have isolating valves at the inlet and at the discharge side The pumps and the whole cooling water system shall be capable of withstanding the transient pressures caused by starting or stopping the pumps.

M7.5.1.2 Driving motors

The driving motors shall be of induction type, being designed for continuous service and satisfactory operation under the atmospheric and climatic conditions prevailing at site. They shall have grease or oil lubricated bearings, and shall directly be coupled to the pumps by flexible (e. g. rubber plug) couplings

The motors shall be equipped with bearing and winding temperature indication and alarm

The completed rotors of the motors shall be statically and dynamically balanced and the motors shall be free from abnormal vibration and noise under all conditions of load.

M7.5. 2 Cooling water circulating hydro machine group in case of jet condenser

In case of jet condenser the remaining head of the cooling water returning from the cooling tower can be recovered and utilized by hydro turbines to assist the driving motors of the cooling water circulating pumps

In this case for each unit two horizontal hydromachine groups of 2 x 60 % capacity shall be applied, each consisting of one hydroturhine, one pump and one motor coupled to each other by flexible (e.g. rubber plug) couplings, thus forming a common shaft assembly.

The sequence and arrangement of the machine groups shall be determined by the Tendered. Other alternative hydromachine group arrangement is also allowed if it is found more suitable.

The machine groups shall operate without problems in parallel or independently within the full operating range. They shall be designed for continuous service and satisfactory operation under the atmospheric and climatic conditions prevailing at site.

The operating characteristics of the hydrormachines and the rated capacity of their motor shall be such that the motor shall not exceed its rated temperature raise or nominal capacity under any condition within the full operating range, as well as during starting of the machine group.

The machine groups shall be designed so as to withstand being rotating in reverse direction if the pump discharge valve fails to close on machine group trip.

The pumps and hydroturbines with their accessories shall be vacuum tight in every respect, and both machines shall be designed for low NPSH values and cavitations free operation while extracting the cooling water from and discharging it to the condenser being under vacuum, respectively.

M7.5.2.l Hydroturbines

The hydroturbines shall have adjustable control vanes for automatic pressure control in the return line of the cooling water system The turbines shall also be furnished with a suitable control device to actuate the control vanes.

The turbines shall be designed for continuous service and satisfactory operation under the atmospheric and climatic conditions prevailing at site.

The completed rotors of the turbines shall be statically and dynamically balanced and the turbines shall be free from abnormal vibration and noise under all conditions of load.

The casing shall be made of welded carbon steel plates, the impeller and the control vanes of stainless steel, the shaft of stainless steel and the shaft sleeves of stainless steel.

The thrust bearings shall be of oil or grease lubricated anti friction type with temperature indication and alarm, and water cooling if required The turbine shaft shall be sealed by sliding ring packing with closing water supply for vacuum tightness.

The turbines shall be furnished with a local panel of instruments for monitoring the bearing temperatures and the system cooling water inlet and outlet pressures.

The turbines shall be furnished with sufficient valves to enable complete venting and draining.

The turbines shall have isolating valves at the inlet and outlet.

The turbines shall be capable of withstanding the transient pressures caused by starting or stopping the machine group

M7.5.2.2 Circulating pumps

For the pumps the same requirements prevail as for the pumps in case of surface condenser listed under Para M7.5.1.1, with the difference that here only vacuum tight, horizontal shaft type can be used and that the sliding ring sealing shall have closing water supply for vacuum tightness.

Thrust bearings shall be of oil or grease lubricated antifriction type with temperature indication and alarm, and water cooling if required. The pumps shaft shall be sealed by sliding ring packing.

The pumps shall be furnished with a local panel of instruments for monitoring the bearing temperatures and the system cooling water inlet and outlet pressures.

The pumps shall be furnished with suf1icient valves to enable complete venting and draining.

The pumps shall have isolating valves at the inlet and at the discharge side. The pumps and the whole cooling water system shall be capable of withstanding the transient pressures caused by starting or stopping the pumps.

M7.5.2.3 Driving motors

For the driving motors the same requirements prevail as for the motors in case of surface condenser listed under Para M7.5.1.2.

M7.5.3 Piping, ducts and valves

The ducts and the piping system together with the relevant valves, expansion joints shall establish all such connections between the equipment which are necessary for the proper and safe operation of the cooling system.

The pipes are welded from carbon steel, shot blasted inside above DN 500 and painted / coated outside. Underground pipes shall be protected suitably against outside corrosion and connected to the cathodic protection system of the power plant.

Compensation of thermal movements in the piping system and ducts shall reduce the stresses in the piping to a minimum, and protect the flanges of hydromachines, valves and other equipment from unacceptable loads. Forces and movements exerted by the pipework at all valves, pumps, etc. shall be reduced to the minimum level by means of expansion joints where required.

Bellows installed in pipes and ducts where vacuum may occur shall be vacuum proof Bellows shall be restrained for axial forces resulting from internal pressure or vacuum. Stainless steel or rubber bellows shall not be painted.

Sliding or packing type expansion and assembly joints are not acceptable Sliding supports shall be made of dry, low friction, non-rusting materials.

All pipe sections which can be isolated from the system shall have their own drains and vents. The tower piping shall be able to be drained at least to the empty drain tanks as much as applicable Low "sumps" and high "air pockets" in the system shall be avoided as much as possible. Unavoidable "air pockets" shall be vented by air vent valves.

Pipe and duct sections shall lye designed and delivered as to minimize the number of site welds

Remote or automatically controlled valves shall be driven electromechanically or electro hydraulically. Valves with electro hydraulically drives shall be applied only where absolutely necessary.

Valves shall be of butterfly type, wherever applicable, small valves (less than DN 100) shall be of ball valve type, wherever applicable.

Open, closed or intermediate position of the valves shall be visible from outside.

Underground valves shall be accessibly and irremovably placed in pits, buried valves are not accepted.

Connection to the condenser and to the tanks shall be made by welding, connections to valves and hydromachines by flanges, to the aircoolers by flexible joints.

The piping shall be designed and routed for optimum water side pressure loss.

The aboveground tower piping, especially the sector piping shall be absolutely self draining to the drain tanks in every respect, even if the drain tanks are fully filled.

The cooling water is circulated between condenser and the cooling tower via underground cooling water mains. The cooling water mains shall have circular cross section, be made of welded carbon steel plates and have appropriate stiffening Bridging by concrete structures or extra stiffening shall be provided at traffic crossings.

The cooling tower mains shall be designed and routed for optimum water side pressure loss, routed as straight as possible, but also in regard to interference with other power plant structures. The mains shall be able to drained at least to the empty drain tank as much as applicable .

The mains shall be shot blunted inside and suitably protected outside against corrosion the cooling water mains shall be integral part of the cathodic protection system.

The cooling water mains shall be designed and delivered as to minimize the number of site welds.

M7.5.4 Aircoolers

The aircoolers bundles shall consist of fin tube bundles and frames The cooling deltas shall be rigid, self contained and designed for handling as a complete assembly if possible.

The aircoolers can be arranged in the cooling tower either in vertical, conical or nearly horizontal position.

In either of the above positions proper, undisturbed cooling air flow through the bundles shall be ensured and the aircoolers bundles shall have good access for installation, inspection, maintenance and cleaning. The self-draining arrangement of the aircoolers has to ensure that the tube bundles could be drained by gravity

The fin tubes shall be of monometal structure, i.e. both the tubes and the fins shall be of the same material

The fin tube airside surfaces shall be protected against corrosion and the tube bundles in case of steel tubes shall be hot dip galvanized In the latter case the fin tubes shall be hot dip galvanized after fitting the fins to the tubes.

Fins shall be of plate fin type and have a good metallic bond with the tubes.

Dangerous vibrations of the aircooler/condenser bundle tubes shall not be possible during operation.

Appropriate methods shall be used to prevent corrosion inside the cooling tubes during transportation. The stress calculation and design of steel tubes shall comply with the relevant approved standards.

In case of hot dip galvanized carbon steel fin tubes the galvanizing of the fin tubes shall be carried out by the manufacturer of the fin tubes only in order to ensure the proper quality.

There shall be no compounds containing ammonium chloride in the galvanized coating or at the steel interfaces.

The ends of the tubes at the header plate and exposed to the atmosphere shall be adequately protected against corrosion during transport and storage.

The framework structure shall be made of hot dip galvanized carbon steel and shall properly and safely carry and support the fin tube bundles during assembly, handling and transport as well as during and after installation, allowing free thermal expansion of the bundles.

Tubes shall be guided and supported to prevent sagging and meshing or deformation of tins under all modes of handling, assembly, installation and operation.

Special tools, lifting beams, rigs, etc for the site assembly of the deltas shall be provided by the Tendered.

The bundles shall have their cooling water inlet and outlet stubs on the end of the bundle and a venting connection at the highest point of the bundles .The connection of the bundle inlet outlet and venting stubs to the piping system shall be detachable and flexible.

The air venting of the bundles shall be done via stand pipes The bundles of one tower module/sector shall be connected to one common stand pipe ,By no means shall automatic venting valves or any other valves with this purpose be used for venting.

In case of steel fintubes (i.e. when nitrogen blanketing system is applied) the module/sector stand pipes shall be connected either to the head tank (in case of surface condenser) or to the drain tank These connections shall be routed so that under normal and stable operating condition no water can remain in or flow through them.

The bundles shall be disconnect able from the piping during raw washing of the piping system.

M7.5.5 Drain tanks

The drain tanks shall be cylindrical vessels placed inside the cooling tower, welded of carbon steel with appropriate stiffening, and designed as to minimize site welds. The drain tank of the tower shall have the capacity to store the water content of all cooling bundles, aboveground piping and the head tank (in case of surface condenser) of the system.
The tanks shall be shot blasted inside and properly protected against corrosion outside, as well as connected to the cathodic protection system of the power plant.

The tanks shall have vents to the atmosphere in case of aluminum fintubes. In case of steel fintubes (i.e. in case of nitrogen blanketing system) the vents shall be connected 10 the head tank

(in case of surface condenser) or to the sector vent stand pipes.

Each tank shall have an aboveground manhole with ladder, corresponding tanks shall have one common sump, from where the content of the tanks can be drained completely by the transfer pumps.

M7.5.6 Head tank

In case of surface condenser the possibility of thermal expansion of the cooling water must be provided, for which a head tank shall be installed, \which shall keep the cooling water system under slight overpressure

The head tank shall be placed higher than the highest poil1l of the cooling bundles and shall be equipped with a support structure, stairs and platform The head tank shall have a manhole with ladder .The head tank shall be welded of carbon steel, shot blasted inside and painted outside.

By no means shall a valve or whatever alike be installed in the corresponding pipe between the head tank and the cooling water system. The head tank shall have an overflow to the drain tank.

The vent of the head tank shall be connected to the vent of the drain tank in case of steel fintubes (i.e. in case of nitrogen blanketing system) or, in case of aluminum fintubes, to a standpipe with appropriate height to prevent escape of cooling water during stable operating conditions The head tank shall be equipped with level indication and control system.

M7.5.7 Nitrogen blanketing system

In case of using carbon steel fin tubes in the aircoolers bundles a nitrogen blanketing system shall be used for inside corrosion protection of the fll1tubes during drained periods.

The nitrogen shall be stored in commercially used high pressure bottles securely stored in the cooling tower The bottles shall be equipped with a pressure reducing station and all accessories for proper and safe operation including pressure indication on the high and low pressure side.

The nitrogen shall be connected to the vent of the head tank (in case of surface condenser), or to the vent of the drain tank (in case of jet condenser) in the indirect dry cooling system variants

The blanketing system and the operation mode of the cooling system shall be such as to save as much nitrogen as possible.

The cooling system shall be equipped with a suitably sized nitrogen pressure relief valve to prevent the system from overpressure higher than 1.5 bar abs under any operating conditions.

All connections of the nitrogen station to the cooling system shall be designed as to no cooling

water or condensate can enter the nitrogen system.

M7.5.8 Air venting system

In case of using aluminum fintubes in the aircoolers no nitrogen blanketing system is required. In this case an air venting system of the aircoolers shall be applied which allows the proper air venting of the bundles

The vents of the bundles of one tower module/sector shall be connected to one common module/sector air vent stand pipe. Each module/sector shall have its own separate air venting system By no means shall automatic venting valves or any other valves with this purpose be used for venting of the bundles and modules/sectors. The module/sector stand pipes shall be vented to the atmosphere and shall have a height to prevent escaping of cooling water under normal and stable operating conditions.

The module/sector air vent systems shall be self-draining in case the module/sector is drained.

M7.5.9 Transfer pumps

Cooling water from the drain tanks shall be filled brick to the cooling water system by at least two remote controlled transfer pumps of 2 x 60 % capacity. The pumps shall also be able to deliver the water either to the condensate storage tank of the power plant or to another reservoir.

The pumps shall be of single stage vortex type, driven directly by electric motors. Pump and motor shall be mounted on a common base plate. The pumps may be of submersible type with built in enclosed motor

M7.5.10 Instrumentation and control

The I&C system shall be designed for proper, reliable, safe and efficient operation of the cooling system
Temperatures, levels and pressures important for operation, position and status of the mechanical equipment such as pumps, valves, louvers (if any), drives and motors as well as alarm signals shall be indicated on the control panel in the main control room. The cooling system shall be operated manually and/or automatically from the control desk in the main control room The control system shall be free programmable.

M7.5.10.1 Water pressure control

In case of jet condenser the water level on the top of the aircoolers shall automatically be maintained by pressure control in the cooling water system via the control vanes of the hydro turbines.

M7.5.10.2 Cooling performance control, and protections

The cooling tower performance and thus the condenser temperature (steam turbine back pressure) shall be controlled by controlling the cooling air flow rate and/or cooling water flow rate. The adjustment of the cooling air flow can be carried out by means of louvers or rolling shutters. Cooling water flow rate can be adjusted by shutdown and start-up the cooling water pumps.

In order to optimize the power plant unit net output signal shall be provided by the control system of the cooling system.

Temperature control of cooling water circulating pump, hydroturbine and motor bearings and winding temperatures shall give alarm and tripping signals.

Protection against freezing shall be an essential function of the control system.
One cooling water cell shall be capable of being isolated with the unit full MCR

M7.5.10.3 Level control

The levels in the water cooled condenser, condensate lank, flash tank, drain tank and the head tank (if any) shall be indicated and too high or low levels shall automatically initiate the necessary protection measures (e.g. pump stopping in case of too 1ow level, etc )

M7.5.10.4 Sequence controls

The sequences of at least the following operating procedures shall be automated:
- Hydromachine group start/stop
- Tilling/draining
- Air extraction equipment start/stop

M7.5.10.5 Interlocks

Automatic interlocks shall prevent certain operations, either manual or automatic, which would endanger the safety of the equipment in whatever way.

M7.5.10.6 Event recorder

An event recorder together with the control system shall monitory the cooling system and record and print all events or disturbances. The event recorder of the cooling system can be combined with the event recorder of the power plant if suitable.

M7.5.10.7 Hard wired backups

Besides the normal control system the most important procedures for operation and safety (e.g. cooling tower emergency draining, etc.) shall be additionally backed up by hard wiring, in order to ensure safe operation even if the programmable control system fails.

M7.5.10.8 Indications, signals

At least the following parameters shall be measured, indicated in the main control room and/or signaled to the control system as necessary:

- Cold water temperatures at modules/sectors
- Tower in- and outlet temperatures
- Drain tank level
- Head tank level (if any)
- Ambient air temperature
- All necessary alarms

M7.5.11 Electric equipment

The electric equipment shall include all electric power supply equipment which are necessary to operate properly and safely all electric consumers of the cooling system.

M7.5.12 Cleaning equipment
The cleaning equipment shall be used for regular cleaning of the airside surface of the aircoolers. Cleaning shall be effected by water jets. The equipment shall be movable from aircooler to aircooler. The water jets shall reach the complete face area of the aircoolers achieved by fixed or movable water jet nozzles. The water pressure shall be recommended by the Tendered based on his experience gained with previous similar equipment.

The Tendered shall also specify the necessary frequency of the cleaning, and the quantity and quality of cleaning water to be used.
The cleaning equipment shall include the pressurizing pump with driving motor and the necessary connections fix water and electricity.

M7.5.13 Natural draft cooling tower structure

The cooling towers shall be circular and shall have a bottom diameter sized to incorporate the aircooler, with accessories and a height to achieve the necessary draft though the aircoolers

The tower shell shall be made of steel structure or could by concrete.

The steel structure tower shall be constructed of welded or bolted carbon steel beams and aluminum cladding the steel structure shall be equipped with suitable surface protection (coating by multi-layer paint)

The steel towers shall be provided with all special auxiliary equipment (e. g. rigs, scaffolds, hoists, cranes, platforms, other special tools, etc) which are necessary for the assembly and erection of the tower and its accessories

Appropriate supporting structure made of steel shall be provided for the aircoolers.

Adequate aluminum, hot dip galvanized or painted steel sheeting shall be provided to prevent cooling air from bypassing the aircoolers

The horizontal sheeting, wherever accessible, shall be dimension as to carry the weight of personnel.

All mechanical, control and electrical equipment in the tower which may need maintenance, adjustment, repair, operation, checking, etc shall be accessible by walkways, stairs or ladders.

The towers shall be equipped with lighting protection system .The towers shall carry aviation warning lights and signs according to the relevant local standards The cooling towels shall be equipped with lightning arrestors as specified in ITB.

The tower shall have an entrance where mobile cranes, trucks or other vehicles may get to the tower inside.

The tower shall be furnished with cable trays and/or tunnels

M7.6 Training of the O&M staff

Training requirements of the O&M staff are presented in ITB.

M7.7 Spare parts

Spare parts requirements of the equipments are presented in ITB .

# M13 Cranes

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## M13: CRANES

### M13-1 General

Adequate cranes shall be provided throughout the power station for the maintenance of power station equipment.

All cranes shall be designed and manufactured to applicable generally accepted industrial standards.

### M13-2 Scope of Work

The following items are covered by the scope:

- Steam Turbines house crane and ancillary equipment
- Ware house crane and ancillary equipment
- Cooling water pumping house

All equipment within the delivery limits necessary for a complete unit is included in the supply package. Equipment or work essential for the proper operation of the supply, although not precisely mentioned, shall be considered as included in the scope of the supply.

### M13-3 Design Criteria and Capacity Requirements

The lifting equipment shall consist of, but not be limited to, the following cranes:

- One electrically operated bridge crane shall be provided for installation, dismantling and maintenance purposes. The crane should serve both gas turbines and the steam turbine which they are installed in the same building. The crane shall be capable of lifting and accurately positioning all loads within its specified rating. The capacity of the main hoist shall be enough to be able to lift the heaviest single piece included in each turbine generator delivery; in addition the crane shall also be fitted with an auxiliary hoist with a capacity of 10 tons.

- One electrically operated overhead bridge crane shall be provided for the CW Pumps housing the crane capacity shall be not less than 25 tons

***Electrical Equipment***

The electrical equipment shall consist of necessary motors with solenoid brakes for bridge, trolley and hoist drive, controllers, resistors, magnetic contractors, protective equipment, limit switches, runway conductors and current collectors or traveling cable, and any other equipment necessary for the proper operation of the crane.

Bridges and trolleys shall be fed from current collectors or by means of cables adequately supported and provided with self-winding reels.

A separate motor shall be provided for each motion of the crane. The motors shall have ample capacity for the duties and speeds specified. The motors shall be specifically designed for crane and services. The degree of protection afforded against the ingress of solid foreign bodies and moisture shall be in accordance with the requirements of IEC 529 Type IP 55 or equal.

The crane shall be suitable for operation from the electrical auxiliary low voltage supply.

The electrical equipment shall comply with the relevant clauses of the technical specifications.

***Control***

The controllers shall be of a type approved by the PEEGT. It shall meet the requirements of the occupational safety.

All cranes shall be equipped with a pendent control unit. The pendent control unit shall be suspended from the crane bridge so that it can travel along the bridge independently of the crab. A suitable cradle shall be provided to secure and safety store the pendent control unit the crane is not in use.

The hoisting and long travel controllers shall be interlocked with the hoist lower and travel limit switches. A “dead man’s” interlock shall also be provided to prevent continuous operation of the control when the hands have been released.

Loss of voltage supply to the control equipment or motors shall cause the crane to hold its position.

## M13-4 Detailed Design and Capacity Requirements

### *M13-4-1 Turbines bridge Cranes*

#### *a. General*

The turbines bridge cranes shall be of a double girder type with the crab running on the top. All parts of the equipment subject to wear and tear shall be easily exchangeable.

The turbines house crane shall not be used for erection purposes unless operated by qualified personnel who have been approved by the PEEGT. The contractor shall verify the exact dimension of the overhead crane.

Precision speed control shall be provided for all crane drives. The precision speed control of lifting gears shall have a ratio of about 1:10 and that of drives about 1:4.

In general the main hoist of the crane must have two speeds one of them is slaw inching speed.

### *b. Crane Over-load Warning*

An audible alarm shall be given when the crane is mechanically over-loaded. This may be actuated by a mechanical strain-measuring unit or by an electrical over-load device.

### *c. Access to Bridge*

At each turbine there shall be an access to the bridge of the crane furnished with necessary handrails and toe boards, etc.

The bridge shall have a 600 mm wide platform at least on one side for maintenance. It shall have the necessary safeguards for occupation by a man.

The free height between the maintenance platform of the crane and the lower parts of the turbine-house roof support beams shall be at least 2 meters.

## *M13-4-2 CW pumping house crane*

The C W pumping crane shall be of a single girder type and shall be equipped with a standard production electric hoist of the short headroom type. All parts of equipment subject to wear and tear shall be easily exchangeable. And shall be equipped with a pendent control unit. The pendent control unit shall be suspended from the crane bridge so that it can travel along the bridge independently of the crap. A suitable cradle shall be provided to secure and safely store the pendent unit when the crane is not in use.

Precision speed control shall be provided for the shop crane drive. The precision speed control of lifting gears shall have a ratio of about 1:10 and that of drives about 1:4.

## *M13-4-3 CW Ware house crane*

The crane shall be capable of lifting and positioning all loads within its position all loads within its specific rating the capacity of the hoist shall be 20 tons

# M14. HOISTS AND MONORAILS

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**Clause**

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M14-2 Scope of supply

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M14-4 Hoisting rail with trolley:

# M14 Hoists and Monorails

## M14-1 General

In addition to the cranes specified hoists, monorails and other adequate lifting equipment should be provided throughout the power station for the maintenance of power station equipment.

All lifting equipment shall be designed and manufactured to applicable generally accepted industrial standards.

## M14-2 Scope of Work

The following items are covered by the scope:

- Hoisting equipment and hoisting rails:

All equipment within the delivery limits necessary for a complete unit is included in the supply package. Equipment or work essential for the proper operation and maintenance of the supply, although not precisely mentioned, shall be considered as included in the scope of the supply.

## M14-3 Design Criteria and Capacity Requirements

The lifting equipment shall consist of, but not be limited to, the following hoists:

| | |
|---|---|
| - Boilers | 2 sets |
| - Fire water pumps | 1 set |
| - BFP , FDF & GRF | 1 sets for each type of pump |

The hoists shall be electrical and equipped with a pendant control device and have an electric motor driven trolley.

The power plant shall be provided also with hoisting rails (including trolley) as specified at the end of this section.

***Electrical Equipment***

The electrical equipment shall consist of necessary motors with solenoid brakes for trolley and hoist drive, controllers, resistors, magnetic contractors, protective equipment, limit switches, runway conductors and current collectors or traveling cable, and any other equipment necessary for the proper operation of the hoist.

Trolleys shall be fed from current collectors or by means of cables adequately supported and provided with self-winding reels.

A separate motor shall be provided for each motion of the hoist. The motors shall have ample capacity for the duties and speeds specified. The motors shall be specifically designed for hoist service. The degree of protection afforded against the ingress of solid foreign bodies and moisture shall be in accordance with the requirements of IEC 529 Type IP-55 or equal.

The hoist shall be suitable for operation from the electrical auxiliary low voltage supply.

All electrical equipment shall comply with the relevant clauses of the technical specifications.

***Control***

The controllers shall be of a type approved by the PEEGT, It shall meet the requirements of the occupational safety.

All hoists shall be equipped with a pendent control unit. The pendent control unit shall be suspended from the hoist so that it can travel independently along the hoist. A suitable cradle shall be provided to secure and safely store the pendent control unit when the hoist is not in use.

The hoisting and long travel controllers shall be interlocked with the hoist lower and travel limit switches. A “dead man’s interlock shall also be provided to prevent continuous operation of the control when the hands have been released.

Loss of voltage supply to the control equipment or motors shall cause the crane to hold its position.

**M14-4 The following locations shall be furnished with a hoisting rail with trolley**:

- BFP motor — 1 set for each boiler
- Condensate pumps and their motors — 1 set for each boiler
- Air compressors — 1 set
- Pumps at the water treatment plant — 1 set
- Air heaters — 2 set for each boiler
- Any other heavy equipment that would require quite frequent maintenance work or is located in such a place that it is inaccessible to a forklift truck.

The hoists, hoisting rails and other lifting equipment specified in this chapter shall be designed with a capacity that is at least 25% greater than the weight of the heaviest piece of equipment required to be serviced in their respective areas after installation.

# M20 Piping

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# M20. PIPING

## M20.1 General

This specification covers the following items regarding to the piping of the power plant:

a) Design
b) Manufacturing and delivery of pipe material
c) Manufacturing and delivery of valves and fittings and other components
d) Erection
e) Cleaning, testing and inspection

## M20.2 Design Requirements

### M20.2.1 Pipes

#### M20.2.1.1 Codes and standards

Codes and standards to be used shall be as specified in ITB Part 2, Chapter G3.

Design Pressure

The design pressure of a piping system subject to internal pressure is defined as the highest of the following:

- Design pressure of the equipment to which the piping is connected

- Set pressure of a relief valve of the piping or equipment system

- Pressure not lower than the shut-off pressure resulting from tile sum of the maximum suction pressure plus 1.5 times the design differential pressure, for discharge lines of centrifugal pumps not protected by a relief valve

- Pressure corresponding to absolute vacuum for piping systems under vacuum. All steam lines shall be designed for full vacuum or properly safeguarded.

- Liquid lines, which may have vacuum, shall be designed for vacuum or properly safeguarded

The design pressure as defined above shall be assumed in the design of the whole piping beginning from the operating machine (or equipment) upstream up to the last valve (included) located before the inlet into the equipment with a lower design pressure.

In the systems including control valve by-pass sets, the isolating valves and the by-pass valve shall always be provided for the design pressure upstream.

Design Temperature

The design temperature of a fluid in a piping system is the maximum temperature expected for the fluid in the equipment, machine or other pipe, which feed the piping in question.

If exact data on max. fluid temperature are missing, the normal operating temperature plus 20-30 °C shall be used.

The design temperature of the piping material is the same as that of the fluid.

The operating temperature, thus defined can be used for the purpose of determining the insulation thicknesses and the design temperature for thermal stress analysis and flexibility of the piping.

M20.2.1.2 Piping Arrangements

Clearance for Crossings and Passageways

The following minimum headroom clearances shall be provided under all piping taking into account covers, supports etc., and both hot and cold positions:

| | |
|---|---|
| Outdoor: | |
| Roads and accesses within power plant property | 5.0 m |
| Indoor: | |
| For passage of fork lift | 3.0 m |
| For passage of personnel | 2.1 m |

The minimum horizontal clearances are as follows:

| | |
|---|---|
| For passage of mobile equipment | 3.0 m |
| For passage of personnel | 0.9 m |

| | |
|---|---|
| For one-way stairs | 0.8 m |

Piping arrangement

In general, the branches shall be located at the bottom or at the side of lines conveying liquids, and at the top of lines conveying gases or vapors. A branch having a considerable length shall be furnished with an isolating valve close to the branching point.

The pipes shall be arranged in such a manner that thermal expansion does not cause any undue stresses on the piping. The same requirement applies to vent and drain pipes.

Piping shall be supported so as to minimize the loads on pump and equipment nozzles.

Piping for connection to equipment shall be installed so as to leave a sufficient clearance for access and maintenance operations.

Steam lines shall have at least a gradient of 1:500, sloping downwards in the direction of the flow. Drip legs with steam traps shall be installed at every low point. Also closed valves and orifices shall be taken into account, when locating drip legs.

In steam lines at the points of drainage, drain pockets of size big enough and approved construction shall be fitted. Each drainage pipe shall be separately run to blow-down vessels, drain tanks or flash vessels as may be appropriate.

All condensate and water lines shall be run with a gradient of 1:500 sloping downwards in direction of flow.

High points of steam, condensate and water lines shall be vented.

Pump suction pipes shall be routed in such a manner that no air can be trapped in the suction piping. The top of the suction branch lines shall be in no place lower than the top of the manifold at the point of their interconnection.

In developing the general arrangement drawings, particular attention shall be given to access and egress throughout the plant:

- Pipes shall be routed so that clearances around the pipe are adequate to meet installation and field welding requirements, and furthermore valve, instrument, and support maintenance requirements.

- Pipes shall be routed to reserve space for cable trays between the bottom of the floor steel and the top of the pipe (or the top of the pipe insulation) taking into account the worst condition, either hot or cold

Interference with pipe supports shall be prevented, the electrical designers should be alerted not to route trays directly over the top of any pipe, except where cable trays run cross pipe runs.

High-Pressure Steam and Water Piping

Generally cold pull-up/cold spring should be avoided, especially in high temperature piping.

The piping configuration shall be such that while taking into consideration the movements of the turbine, boilers, boiler feed-pumps or other items of plant, or the effects of applying possible cold pull-up, resulting loads imposed by the pipe work when hot or cold shall in no way have an adverse effect on the items of the plant. Particular attention is required to ensure that the piping itself is not locally overstressed.

The magnitude and direction of the thrust on the turbine steam chest, boiler superheater outlet header, economizer inlet header, feed-pumps and feed-heaters both in the hot and cold condition shall be submitted to the PEEGT for approval.

For high temperature lines bosses in suitable corrosion resistant material and/or suitably prepared pipe outside surface shall be provided for the purpose of creep checking. Reference measurements and/or analyses shall be taken and recorded before the plant goes into service.

Valve arrangements

All manual isolating valves shall be maneuverable, in order of precedence, in the following manners:

- From grade
- From walkway or from a special platform
- By extension

- By chain.

The height of handwheel axis from maneuvering floor shall preferably be 1200 or 1400 mm; in any case, it shall not exceed 2200 mm.

Normally, the valves shall not be installed with the stem below the horizontal position. .

All valves with one end non-connected shall be equipped with blind flanges or plug.

Safety and/or Relief Valves arrangements

These shall be located as close as possible *to* the equipment they are *to* protect, and be accessible for checking and maintenance purposes.

Relief *or* safety valve venting *to* atmosphere shall be arranged as follows:

- Steam vent pipes shall be routed to free atmosphere outside the building. Preferably the vent pipes shall be separate for each valve.

- Condensate and water vent pipes shall be routed to the nearest trench on ground floor. Special attention shall be paid to flashing fluids. Vent pipes shall be arranged and dimensioned also for the flashing.

If relief or safety valves are vented inside the building with PEEGT's approval, the following requirements shall be noticed:

- Minimum height from ground floor 5 meters

- Height 3 meters higher with respect to any equipment or service platform which are located within a range of 5 meters

Preferably each valve shall be oriented to discharge parallel to the axial centerline of the pipe it is protecting

Each pipe discharging to atmosphere shall have a 1/2" (min.) diameter drain pipe at the lowest point.

Relief valves shall always be installed on those lines which may be intercepted at ends, when the line internal fluid, at max. ambient temperature, may reach conditions higher than the rating of the line itself.

Vents and Drains

The sizes of vent and drain valves shall be selected as a function of the characteristics of the liquid to be drained; in any case, they shall not be lower than the following:

| | |
|---|---|
| Lines DN 50 and smaller: | size of vent/drain: DN 15/15 |
| Lines DN 65...0N 250: | size of vent/drain: DN 20/25 |
| Lines DN 300 and larger: | size of vent/drain: DN 25/50 |

High pressure vents and drains shall always be fitted with two shut-off valves at the connection point.

Air, Water Service Stations

For maintenance and cleaning purposes, service stations shall be provided, consisting of hose connections for compressed air and water.

Compressed Air Lines (instrument and service air)

Compressed air lines shall, if possible, be run with a slope 1:500 away from compressors.

Drip legs with drain valves shall be provided at junction points, and if necessary, at approximately 50...100 m intervals along the main line.

All compressed air branch lines shall be taken from the top of the compressed air main.

Service Piping

Service piping headers shall be provided with an isolating valve from the main.

Underground piping

The outer surfaces of all underground (directly in contact with soil) steel pipes, fittings, valves and specialties shall be coated with two coats of an approved bituminous coating. Both surface preparation and coating shall be as specified in General technical requirements, ITM Part 2, Chapter G3.

All underground pipe work shall be protected by a suitable cathodic protection system. The design shall be submitted to the PEEGT for approval.

Heat tracing

All pipelines and equipment in liquid or slurry service that will stiffen at ambient temperature shall be properly heated (traced) and insulated.

Temporary Strainers

The Contractor shall provide temporary strainers on the inlet side of all major pieces *of* equipment where permanent strainers are not provided. Strainers that slip between flanges shall be provided. The strainers shall remain in place until their removal is approved by the PEEGT.

Wall Boxes and Collars

To the penetrations through walls, floors and roofs, wall boxes and collars shall be provided.

Pipes passing through roof collars shall be provided with an approved weather hood and cowl. Floor collars shall extend *to* 200 mm on concrete floors and 100 mm on steel grating above the floor level and the pipes shall be fitted with hoods where required. Weather flashings shall be fitted where required.

The boxes and collars shall not restrict any thermal expansion of piping.

M20.2.1.3 Drawings

Plan and section drawings will be made in scale 1:50.

Pipes DN $\geq$ 50 will be drawn with three lines. Pipes DN < 50 will be drawn with one line.

Pipes hall be dimensioned to the nearest column centerline and elevation shall be shown.

Position numbers *of* pipelines and valves shall be marked.

Following connections and details shall be shown with tag numbers:

- measurement points

- local measurement points
- sampling points
- dozing points
- drain and vent points

Piping drawings will be furnished with:

- cable routes
- heating and ventilation ducts

During detail engineering piping design shall be finalized.

Following documents and tasks shall be done:

- isometric drawings, DN $\geq$ 50
- pipe support locations (piping drawings)
- pipe support drawings
- fabrication drawings for special fittings

## M20.2.1.4 Erection

### General

All piping shall be accurately installed according to the approved drawings. The joints and connections shall be accurately aligned and parallel without stress. At the assembly of the piping no stress shall be imposed on the equipment except the forces necessary to preset any expansion devices.

All piping shall be installed in a manner such that expansion will take place in the direction desired and so that vibrations will be minimized. No piping shall be cold sprung unless so indicated on the drawings. Cold spring (pull up cold) shall be clearly indicated on drawings submitted for approval.

Standard "Factory Made" fittings shall be used in all piping. Shop or site fabricated mitered fittings shall not be used.

No pipe work shall be run in trenches carrying electrical cables.

All pipes, valves, fittings and specialties shall be properly protected. All damaged coatings shall be rectified after installation.

In general, no valves shall be installed with their stem directed downward. Valves with weld ends shall not be welded straight together. Intermediate pipe shall be used.

Welded connections shall be used as much as possible. The use of flanged or threaded connections is allowed only in cases where erection, maintenance, cleaning of pipe so demands.

Prior to assembly of various piping components it shall be confirmed that any piping component confirms with the specifications and the drawings.

Structures shall not be cut, removed or damaged to make piping installation work easier.

When welding the valves to the piping the valve manufacturer's recommendations shall be followed, valve position etc.

In instal1ing, flanged joints shall be fitted up, after checking for the alignment of flange center and the paral1ellness of flange face, so that the gasket contact faces bear uniformly on the gasket, and then made up with relatively uniform bolt stress.

The bolt holes of the flanges to be welded *to* pipes shall be located symmetrically from vertical center line in horizontal pipeline, and from plant north in vertical piping line, unless otherwise indicated in the drawings.

When declination exceeds any of the following limitations, flanged connection shall not be performed.

- 3º angle difference between flange faces

- 5 mm declination of horizontal direction between flange center line

- 5 mm distance between facing bolt hole, when a pair of bolt holes shall be faced and rolled.

Threads of bolt-nuts and contact surfaces of gaskets shall be plastered with paste to prevent adhering, leakage, etc. These pastes shall be selected according to service fluids and/or temperatures.

Openings, such as flanged joints of pump, compressor etc., shall be covered with thin plate or other blinds, until final connection, to prevent dust and other foreign matters from entering into the machinery.

Pipe supporting elements for pipes DN 50 and over shall comply with the indicated location and equal to the shape shown on the drawings.

If temporary supports are required at the field, except those indicated in the drawings, they are subject to the approval by the PEEGT.

During the instal1ation of each pipeline the following measurement shall be Made according to the drawings, In the presence of the PEEGT. All measurements shal1 be recorded.

- For cold spring gap the pipeline shall be supported and anchored according to the drawings before the cold spring gap is recorded, and before the pipelines are drawn together for the final connection.

- For expansion joint space the pipeline shall be supported and anchored according to the drawings before the measurement between the two flanges is taken and the expansion joint installed.

M20.2.1.5 Storage and Protection

Pipes in storage shall be dry and free from corrosion, shall be protected internally in an approved manner and shall be stored off the ground. Prior to fabrication in the shop or in the field, scale or any foreign material shall be blown or swabbed from the interior of the pipe. After fabrication all open ends shall again be plugged, capped or otherwise sealed. All loose fillings, slag, sand, dirt, oil, grease or other foreign substances shall be removed from the interior and the exterior surfaces of all pipe fabrication prior to installation and/or coating.

Internal surfaces of valves shall be suitably protected and protectors shall be installed on valve ends or other specialties ends at the factory- Protection shall not be removed until the valves or specialties are installed. Valves and specialties shall be stored off the ground and protected from foreign elements.

During erection open ends of pipework shall be protected by temporary covers which shall be securely fixed.

M20.2.1.6 Cleaning, Testing and Inspection

General

Local Codes and Authorities having jurisdiction over any part of the work covered in this specification shall apply.

Hydrostatic leak tests shall conform to ANSI latest revision or equal.

Pneumatic leak tests shall conform to ANSI latest revision or equal.

Radiographic inspection of welds shall conform to ANSI latest revision or equal.

Requirements for Testing and Cleaning

Before commencing the testing and cleaning of pipelines, the procedures to be used shall be submitted to the PEEGT for approval.

Pipelines that are to be hydraulically leak tested shall have temporary air vents and vacuum breakers located where, necessary.

Pipelines, that exceed the pressure limits of the equipment or vessel to which they are attached, must be isolated from these items during the pressure test.

When the PEEGT is satisfied that the requirements for testing and cleaning of the pipelines, as set out by the Contractor, are correct according to the specification this shall be recorded on the" Pipeline Check-out Record" and after that the Contractor may proceed with the testing and cleaning.

Cleaning

All pipelines shall be cleaned.

Cleaning shall generally consist of flushing the pipe hydraulically, or blowing the pipe with air or steam.

Care shall be taken to protect the Site and all facilities on the Site from damage resulting from the cleaning operation.

The following pieces of equipment shall be left out1during erection and replaced by temporary spool pieces before cleaning:

- Flow nozzles and lined magnetic flow meters
- All control valves except butterfly valves DN 150 and larger and V-ball valves D N 100 and larger.

The following pieces of equipment shall either be left out during erection or removed from pipelines before cleaning:

- Orifice plates
- Desuperheater nozzles
- Rupture discs
- Spray nozzles

The following pieces of equipment shall be blanked-off or isolated before cleaning:

- Safety relief valves
- Instrument connections
- Equipment inlets and outlets.

Flushing

Flushing shall consist of running clean water or flushing oil as specified through the pipeline either by gravity *or* by pump at a sufficient velocity to remove the dirt in the pipe, such flow to continue until in the opinion of the PEEGT the pipeline is discharging a clean fluid.

When pipelines are flushed into a vessel, the vessel shall be drained, cleaned and inspected by the Contractor, witnessed by the PEEGT, *on* completion of the flushing, and if such vessels are to be used as a source of supply *for* flushing another pipeline, the cleaning and inspection of the vessel shall be completed before such use.

Piping systems that require pickling and passivating shall have this done immediately prior to start-up, and after the pickling and passivating shall be flushed with a fluid that contains a rust inhibitor.

Air Blowing

Plant air supply lines and headers shall be blown with air from the plant air compressors or a similar source approved by the PEEGT.

Instrument air supply lines and headers shall be blown with oil- and water-free air.

Lines that are to be air blown shall be blown at a sufficient velocity to loosen all dirt and shall be blown until in the opinion of the PEEGT the discharge is entirely free from dust.

Steam Blowing

Steam lines and other lines that are to be steam blown shall be blown in the following manner and sequence:

I) Check that all spring hanger blocks are removed and the cold load spring setting is according to the drawings

2) Install temporary atmospheric vents and drains, anchors and quides and have the installation approved by the PEEGT before commencing a steam blow

3) Close the shut-off valves to steam trap assemblies

4) Heat the pipe or system slowly to operating temperature and while the pipe or system is being heated, check that all expansion joints are working, that all expansion shoes and roller saddles are of the proper length and that floor and wall opening clearances are adequate

5) As the pipe is being heated open all pipeline drains and slag pocket drains and clean them if necessary

6) Steam blow the lines for sufficient times at a sufficient velocity to loosen and remove dirt and scale

7) Cool the pipe until atmospheric temperature is received.

Repeat steps 4), 6) and 7) above at sufficient times until in the opinion of the PEEGT the pipes are clean.

The disturbance factor shall be sufficient ( $\geq 1.2$). Target plates made of copper or aluminum shall be used to determine the results of the HP-steam blows.

Records

When the Contractor has completed the cleaning operations, he shall Record the operation, and if the cleaning is to the satisfaction of the PEEGT, the PEEGT will sign the Record.

If any pipelines or vessels are flushed or blown into a. pipeline or system that has been previously cleaned the pipeline or system shall be re-cleaned as set out herein, and a new Record shall be filled out for the cleaning operation

Testing

All pipelines shall be tested. Without limit to the requirements of the specifications which in all cases shall govern, or if testing is not described in the specification, testing shall, generally be hydraulic or pneumatic leak test except for pipelines which are open to atmosphere at one end. These shall be tested under working conditions.

Inspection

On completion of the installation each pipeline or pipeline system shall be inspected then tested as specified on the pipeline nomenclature drawing and flushed or blown according to the procedures set out in the specifications, all in the presence of the PEEGT.

All inspections shall be recorded on a "Pipeline Check-out Record" which shall be approved by the PEEGT.

When the Contractor has completed the installation he shall initiate the "Pipeline Check-out Record" sheet by filling in the pipeline number or system description; indicate the completion of installation by signing the Record; setting out the testing and cleaning required by the specification; and if inspection or testing is required by special authorities such as Government or Insurance Agencies, naming the authority and stating the date that the testing is to take place ("independent agency").

After the Contractor has initiated the "Pipeline Check-out Record" sheet for a pipeline or pipeline system, the PEEGT shall inspect the pipeline or system to ensure that it meets all the requirements of the specification. The inspection shall be recorded on the "Pipeline Check-out Record".

In the case of inspection by a special authority the record sheet shall be submitted to the PEEGT at least 2 weeks in advance of the date of testing, and if necessary in this circumstance the sheet may be presented before the installation has been completed.

Independent Agency (Government, Insurance, etc.)

Where the specifications require the inspection, testing and/or cleaning to be performed in the presence of any authority having jurisdiction over the work, the Contractor shall determine the authorities having jurisdiction and shall notify them of the inspection, testing and/or cleaning in advance according to the requirements of the authority and shall obtain the signature of such authority on the sheet to indicate their satisfaction and approval.

The Contractor shall bear all costs caused by any independent agency.

PEEGT's Acceptance

When the testing and cleaning are completed and approved by the PEEGT and by any special authority the Contractor shall remove all temporary piping and re-install the parts removed, and shall close valves to isolate the pipeline or section.

When the PEEGT is satisfied that all of the requirements for testing and cleaning have been properly completed, all of the parts re-installed, the PEEGT will indicate his satisfaction and approval by signing the inspection Record, and will mark the pipe to indicate that it has been completed and accepted.

M 20.2.2 Valves

General Requirements

All valves specified with weld ends shall have ends prepared for butt-welding and the end internal diameter shall be the same as the internal diameter of the pipes to be joined. Where valves are accepted with flanges they shall comply with the requirements of the approved Code for the respective pressure and temperature conditions of the piping system. Minimum flange boring shall be according to ANSI B 16.5 Class 150 or equal.

All valves shall be of well-known manufacture and receive tests at the Manufacturer's or Contractor's works in accordance with the specific requirements of the approved Code. Certificate shall be provided.

The valves submitted to chemical cleaning after erection shall be designed to withstand the cleaning operation. If necessary the packing boxes and gaskets shall be changed after chemical cleaning.

Approved means (safety or check valve) shall be provided to prevent any accumulation of pressure between the discs and the bonnet of any high-

pressure wedge-gate valve, when condensate can collect between the bonnet and the gate. The discharge pipe from the safety or the check valve shall be connected to the in-flow side of the wedge-gate valve.

The stops which limit the travel of any valve in the "Open" or "Shut" position shall if appropriate be arranged exterior to the valve body.

Large valves for high and medium pressure steam shall be furnished with by-pass valves to enable warming up of the pipelines and to reduce the pressure difference over the main valve.

*All* high-pressure steam and feed water valves shall be of full bore type. The valve materials shall be forged steel, and manufactured with weld end connections suitable for the piping without any transition pieces.

All globe steam valves shall be designed to prevent erosion of the valve seats when the valves are operated partially opened.

All valves operating under vacuum shall have water-sealed stem packages or shall be equipped with an internal sealing bellow.

All valves shall be fitted with indicators so that it may be clearly seen whether the valves are open or shut. In the case of those valves fitted with extended spindles, indicators shall be fitted both to the extended spindles and to the valve.

All valves shall be closed by rotating the handwheel in a clockwise direction when looking at the faces of the handwheel. The face of each handwheel shall be clearly marked with the words "Open" and "Shut" with arrows adjacent to indicate the direction of rotation to which each refers.

Each valve handwheel shall be fitted with a permanent nameplate of stainless steel or of an approved material indicating the valve reference number and the function of the valve. The nameplates shall incorporate the colour code corresponding to the service of the piping.

Special attention shall be given to the operating mechanism for large size valves in order that quick and easy operation is obtained and maintenance is kept to a minimum.

Where required by the PEEGT, valve pedestals shall be provided with a lug in order that the handwheel can be locked by means of a padlock and chain.

All gaskets, valve stem packing materials and other sealing components shall be asbestos free.

The following valve types are recommended to be used for the Work:

| Fluid | Size range DN | Type |
|---|---|---|
| Steam and condensate | 80 and over | Gate |
| | Below 80 | globe |
| Demineralized water | 65 and over | gate |
| | Below 65 | Ball |
| District heating at Site | 250 and over butterfly | gate |
| | Below 250 | ball |
| Cooling water | 250 and over butterfly | gate |
| | Below 250 | ball |
| City water | 250 and over butterfly | gate |
| | Below 250 | ball |
| Fuel oil | 65 and over | gate |
| | Below 65 | ball |
| Natural gas | 65 and over | ball |
| | Below 65 | balls |
| Compressed air | 65 and over | gate |
| | Below 65 | Ball, globe |
| Chemicals | 100 and over | ball, gate |
| | Below 100 | Ball, globe |
| Sampling lines | All sizes | Globe, needle |
| Chemicals dosing | All sizes | Globe, needle |

1) Diaphragm valves allowed only for ion-exchange filters and diluted sulphuric acid

The valves shall be according to the following standards or equal:

- Gate valves ANSI B 16.34 (API Std. 600)
- Globe valves ANSI B 16.34
- Ball valves ANSI B 16.34

Manual Gear Operators for Valves

Valves shall normally be actuated by gear operator in the following cases:

| | | | |
|---|---|---|---|
| - | Gate and globe valves | 150 lb | with size DN300 and over |
| | | 300 lb | with size DN200 and over |
| - | Ball valves | 150 lb | with size D N200 and over |
| | | 300 lb | with size DN150 and over |
| - | Butterfly valves | 150 lb | with size DN200 and over |

Operating Devices

Handwheels may be of forged steel or malleable iron; levers of ball valves and butterfly valves shall be of forged steel.
Plastic or bakelite valve handwheels will not be accepted.

Motor Operated Valves

Motor operated valves shall be fitted with both hand and motor operating gear and where a by-pass valve is provided this also shall be provided with both hand and motor operating gear. Each valve shall be complete with a device for automatically stopping the motor when the valve gate has reached the "full open" or "full closed" position. The actuator shall be placed in such a position relative to the valve that there is no possibility of leakage of liquid, steam or corrosive gas from valve joints onto the motor or control equipment. .

The hand and motor operating mechanisms shall be so interlocked that the hand operating mechanism is disconnected before the motor is started. Valves shall be provided with seating control and torque limiting device shall be incorporated in the motor drive.

Actuators for motor operated valves are specified in Chapter 11.

Float Operated Valves

The valves for the level control of vessels and tanks shall be of an approved design and manufacture, floats shall be made from suitable corrosion resistant material, the float rods shall preferably be of approved stainless steel.

Where the float rods pass through the tank top they shall have a suitable dust excluding guide of corrosion resisting material.

Check (non-return) Valves

Check valves shall be made of similar materials as the isolation valves for the service in question. They shall have a cover to provide an access to the internals without removing the valve from the adjoining piping. If the operation of a valve is questionable by the gravity the valve shall be furnished with a spring or counterweight closing mechanism. If the quick-closing of a check valve by the existing pressure differential would cause a possibility of a water hammer or extensive stresses on the valve and on the adjoining piping the valve shall be furnished with a shock absorbing device.

Safety (relief) Valves

All safety valves intended for high-pressure steam, feedwater, steam, condensate or other process services subjected to high-pressure or temperature shall be of approved make and shall have cast or forged steel bodies with covers and glands of approved construction. The materials of the internal parts shall be subjected to approval. Prior to any machining all valve bodies shall be subjected to the tests according to the respective codes.

The valves shall be adjusted and tested at their final operating parameters at the manufacturer's works.

The piping to the safety valve shall conform with the requirements of ANSI B3 1.1 or equal. The discharge piping shall in general be of the closed type.

Steam Traps

Steam traps from heat exchangers shall be of float type, unless specified otherwise.

Steam traps for condensate removal from steam lines shall in general be of the thermal or thermodynamic type. At places, where a large amount of condensate is expected, i.e. steam headers and piping downstream of steam coolers, the steam traps shall be large enough to drain the pipe. If necessary, float type traps shall be used at these points.

The materials and design of the steam traps shall be equal to the valves specified for the service. The traps shall be of proven type and manufactured by a well known manufacturer.

M20.2.3 Instrument valves and connections

Connections

Connections covering this specification are:

- remote pressure transmitter probes
- local pressure transmitter probes
- remote temperature transmitter probes
- local temperature probes
- chemical dosing connections
- sampling probes

Arrangement

Connections for instruments, chemical dosing and sampling shall be attached to the piping at locations shown in the final PI-diagrams. The location of probes shall carefully be considered as to process demands, accessibility and mechanical strength. Probes shall not be placed in bends, elbows and other fittings.

High pressure connections shall always be fitted with two shut-off valves at the connection point.

Local pressure gauges shall be fitted with a separate pressure gauge valve with connection for test gauge.

Chemical dosing connections shall be fitted with shut-off valve and check valve and sampling points with a shut-off valve at the connection point.

Local pressure gauges shall be installed at suction and pressure sides at all pumps and fans, pressure vessels, steam headers, heat exchangers, tanks and vessels.

Local temperature gauges shall be installed at both sides of all heat exchangers, pressure vessels, steam headers, tanks and vessels.

Local level indicators shall be installed on all tanks, vessels and tube heat exchangers.

Materials

Materials of the probes shall be of the same quality as the pipe.

All probes and connections shall designed according to the pressure and temperature specified for the pipe to which they are connected. Strength calculations shall be performed for the probes.

M20.2.4 Stress Analysis

For checking the stresses due to thermal expansion and mechanical loads in the piping systems and the selection of the type of supports, criteria according to ANSI Codes or equal shall be followed.

As a minimum requirement the following pipe systems shall be checked:

- All high-pressure steam

- All high-pressure feed water excluding small sized lines (≤ DN 50)
- Steam lines connected to the turbines
- 10 bar (g) main and over steam headers with the associated piping (incl. safety valves)
- Steam lines DN 200 and over in plant piping.
- Steam lines under DN 200 in plant piping resumed necessary by the PEEGT.

For the cases not covered by said codes, solutions suggested by experience and good design practice shall be adopted each time. In general, it is recommended to avoid, as far as possible, the use of expansion joints and the cold spring.

The basic assumptions for check shall be as follows:

One piping system shall be considered as a structure properly supported, which works at the operating conditions stated in the specifications of respective equipment.

If the flexibility of the pipe is insufficient, the expansion shall be absorbed adopting the procedures hereinafter listed by order of precedence:

- Spring or constant supports

- Guides or restraints
- Change in piping routing
- Insertion of loops built from pipe and bends
- Installation of expansion joints

Accuracy of calculation

The calculation methods applied shall have an accuracy degree proportioned to the importance of the piping and the operating conditions. The Contractor shall submit calculation sheets for all required piping systems for the PEEGT's approval

Adjusting Temperature for Stress Analysis Calculations

The adjusting temperature shall be the temperature difference between the design temperature and + 15º C for indoor piping and -10º C for outdoor piping.

Additionally the following requirements shall apply:

- The turbine exhaust piping shall be checked also at idle load temperature

- The bleed-of piping shall be checked also at the highest possible temperature

- The exhaust pipes after desuperheating stations shall be checked also in a case in which the cooling water is lost.

For circuits with one normal operating temperature and a second different temperature for transitory periods, both conditions shall be analyzed.

Lines Temporarily Closed

For lines connected to two or more items of equipment, of which one is operating and the remaining ones are still standing, the temperature established in the dead sections shall be analyzed and considered in the flexibility analysis.

Stresses on Equipment

The stresses produced by piping (due to weight, expansion forces, etc.) on shells and heads of vessels, shall be checked for being limited within the allowable values accepted by the equipment manufacturer.

M20.2.5 Supports

General Requirements

In general pipe supports and anchors shall be located at those points in the building where provision has been made for the loads imposed. The cutting of floor or roof beams or the reinforcement in slabs will not be permitted. Piping attached to a plant item shall be supported in such a way that the undue part of the weight of the piping is not taken by the plant item. All supports shall be shop fabricated and positioned before erection.

Supports, guides and anchors shall be designed so that excess heat will not be transmitted to the building steel.

Designs generally accepted as exemplifying good engineering practice, using stock or standardized prefabrication parts, shall be utilized wherever possible. Accurate weight balance calculations shall be made to determine the required supporting force at each hanger location and the pipe weight load at each equipment connection.

Pipeline Support Locations

Supports shall be provided for the pipeline at the following locations as well as such other points which are required:

- At or near changes of direction on horizontal lines
- At or near branch connections on horizontal lines
- Both sides of flanged joints on horizontal lines, unless otherwise specified
- Both sides of flanged valves or instruments on horizontal lines, unless otherwise specified
- *On* one side of welded valves DN 80 and larger on horizontal lines.

Structural connections for pipeline supports shall be preferably at the following locations:

- Bayline beams (beams between building columns)
- Building columns
- Underside of floor steel or top of curbed openings for vertical lines.

Pipeline supports shall not be attached to:

- Floor opening pipe-sleeves
- Concrete block walls
- Grating or checker plate
- Equipment support steel
- Large pipe line, except when approved by the PEEGT
- Fittings, welding point and branch point, except when approved by the PEEGT

Supports for overhead pipe shall not be located on the floor below unless there is no capability to otherwise support the pipe.

Pipe support attachments to existing beams, which would cause tensional stresses in beams, shall be avoided.

Pipe support attachments to existing columns, which would cause bending about the weak axis, shall be avoided.

All large pipes and all long pipes shall have at least two supports each arranged so that any length of pipe or valve may be removed without any additional supports being required.

Variable springs shall be furnished with travel stops. The travel stops shall be factory installed at the "cold" position.

For low temperature, non-critical systems, where vertical movements up to 50 mm are anticipated, precompressed variable springs design may be used. Where critical movement is greater than 50 mm a variable spring hanger may be used. Where movements are of a small magnitude, spring hangers may be used.

Constant and variable support spring hangers shall have a minimum reserve movement of 15 mm beyond the minimum and maximum settings representing the calculated movement of the pipe from its cold position to its hot position.

All rigid hangers shall be provided with means for vertical adjustment after erection.

Where the piping system is subject to shock loads, such as thrust imposed by the actuation of safety valves, etc., hanger design shall include provision for shock absorbing devices of approved design.

Selection of vibration control devices shall be part of the Contractor's work. If vibration is encountered after the piping system is in operation, appropriate vibration control equipment shall be installed by the Contractor after PEEGT's approval.

M20.3 Materials

Pipe may be seamless or welded. For welded pipes the welding types provided are as follows (these welding types should be approved by the PEEGT) :

| | |
|---|---|
| - Electric-resistance welded | E.R.W. DN 150 to 600 |
| - Electric-fusion welded | E.F.W. DN 650 and over |

All carbon-steel and alloy-steel pipes shall have a minimum corrosion allowance of 1.0 mm, except high pressure steam pipes where no corrosion allowance is needed.

Possible higher allowances shall be adopted based on the process requirements, for instance large cooling water piping made from carbon steel should have 3.0 mm corrosion allowance.

Stainless steel piping does not need any corrosion allowance.

Materials used in piping shall be equal to or better than the following:

- For design metal temperatures up to and including 400º C, carbon steel

- For design metal temperatures above 400º C an approved low alloy steel of the chrome molybdenum type.

M20.4 Welding

All welders to be engaged in the welding or equal operation shall have the qualification of welders Grade II and the Contractor shall submit the welding test procedures and results of test welds to the PEEGT. The recommended welding procedures for the qualification test for welder is ASME Section IX or equal.

Unless otherwise specified in the drawings, welding shall be carried out in accordance with the requirements presented in ITB Part 2, Chapter G3.

Heat treatment

Heat treatment prior to welding and welding post heat treatment shall be carried out in accordance with the codes and material manufacturer's recommendations.

Unless otherwise specified in the drawings. heat treatment shall be carried out in accordance with the requirements presented in ITB Part 2, Chapter G3.

Inspection

Unless otherwise specified in the drawings, inspection shall be carried out in accordance with the requirements presented in ITB Part 2, Chapter G3.

All welds shall be subjected to one or more of the following tests or examinations:

- visual inspection
- liquid penetration
- magnet particle
- ultrasonic
- radiographic
- pressure test

Radiographic Inspection

The extent of radiographic inspection of the welds is the following (followings are not mandatory but recommendation, therefore the covered percent of R.I. should be approved by the PEEGT):

| | Coverage % |
|---|---|
| High pressure steam | 100 |
| High pressure feedwater | 100 |
| Low pressure steam | 100 |
| Low pressure feedwater | 100 |
| Turbine extractions and bleed offs | 100 |
| Turbine exhaust up to the list isolating valve | 100 |
| Any other pipe | 10* |

* For every weld found to be unacceptable two additional welds shall be radiographed by the Contractor.

If radiographic inspection is not possible due to wall thickness, access to the weld etc., it can be substituted by Ultrasonic, liquid penetration or magnet particle inspection.

High pressure steam line welds shall be grinded before the inspection is carried out.

Welded connections to the pipelines shall be inspected by liquid penetration or magnet particle.

# M-21 INSULATION

# M-21 Insulation

**Clause** **DESCRIPTION**

**M-21 Insulation**

**M-21.1 Intent of specification**

**M-21.2 Design requirements:**

**M-21.2.1 Hot thermal insulation and insulation against freezing and stiffening**

**M-21.2.2 Design temperature**

**M-21.2.3 Insulation against condensate Dripping (anti sweat, insulation).**

**M-21.2.4 Technical information**

## M-21 Insulation

### M-21.1 Intent of specification

This specification is intended to outline minimum requirements, acceptable materials and methods of application for external thermal insulation and finishing.

### M-21.2 Design requirements:

#### M-21.2.1 Hot thermal insulation and insulation against freezing and stiffening

All outdoor piping and equipment shall be isolated by hot thermal insulation or by insulation against freezing and stiffening and all indoor equipment and piping with an operating temperature is over 50°C shall be insulated hot thermal insulation

When T 150 °C, the following items of the line are not to be isolated unless otherwise stated in the contract or drawings

-Coolers and condenser as well as piping adjoining to them

-Nameplates vessel data plates, approval marking, etc

Regardless above all equipment operating at °50 C or above shall be insulated, where personal contact is possible

Besides, in order to do personal protection, this type of insulation is applied to lines that are normally 50 °C or less, but may reach a higher temperature as a result of abnormal condition or intermittent operation

Insulation for personal protection shall be applied only to parts of the lines that are within 2.0 m above any floor, or other normal walking surface or within 0.9 m horizontally and up to 2.0m above the edge of any walking surface

Insulation against freezing is applied whenever the danger of freezing is suspected to be possible during normal operation, during disturbances or during plant shut–down.

#### M-21.2.2 Design temperature

The design temperature of a fluid in a piping system is the maximum temperature expected for the fluid in the equipment, machine or other pipe, which feed the piping in question.

If exact data on maximum Fluid temperature are missing the normal operating temperature plus 20-30 °C shall be used.

The design temperature of the material is the same as that of the fluid.

The operating temperature, thus defined can be used for purpose of determining the insulation thickness and the design temperature for thermal stress analysis and flexibility of the piping.

### M-21.2.3 Insulation against condensate Dripping (anti sweat, insulation).

Cold and cooling water pipes and tanks as well equipments, where condensate dripping is expected, shall be insulated.

Pipe DN 100 (4”) and smaller in size shall be insulated against condensate dripping only when they cross passage ways and equipments where dripping is considered to be inconvenient.

**Lining of insulation**

Sheet metal lagging of the insulation shall be used. Selection of the metallic lining material is upon the applicable .The applicable lagging materials are aluminum or galvanized steed.

-The insulation for piping and equipment shall include the following:

*Insulation, metal lagging.

*Refractory if necessary.

*Brick work if necessary.

*Personnel safety insulation.

*The contractor shall furnish the tools, scaffolding, cleaning materials, and all other things required for satisfactory completion of the work.

*The following piping system shall be insulated with calcium silicate board and/or equivalent materials.

*All valves, flanges, expansion joints, specialties, drains, vents, blow and instrument primary piping, shall be insulated and shall be covered by metal lagging.

*All lines for which personnel safety insulation is specified shall be insulated with silica board and/or suitable materials lagging

*The insulation materials and thickness shall be designed to keep the surface temperature of lagging for personnel safety insulation at less than 50°C unless otherwise specified.

### M-21.2.4 Technical information

-The insulation materials shall be of best quality and health safe and shall be of the international standard. They shall be of uniform composition and shall be capable of withstanding the temperature and environmental conditions to which they are subjected without deterioration, shrinkage, calculation, and change of form, setting or putting or pulverization.

-Only non-combustible & free asbestos insulation materials shall be used.

-The insulation covering all piping shall be of the molded sectional type, unless otherwise specified. Molded sectional insulation shall be furnished in standard lengths not less than 610 mm long.

- Pipe insulation materials shall consist of calcium silicate of molded sectional type.

-The bolted fittings, flanges, valves and specialties shall be insulated with either molded pipe insulation, mitered to fit, or glass wool blanket insulation of the thickness specified for the piping.

-The welded fitting valves and specialties shall be insulated with reinforced rock-wool insulation, and shall be covered by an aluminum sheet lagging, properly shaped as a box of lagging with strong locking device to facilitate quick open/close of the box for maintenance purposes.

-In general all the insulation cladding shall be of suitable aluminum or aluminum alloy sheet except the areas that are more liable to be damaged by passing foot traffic or during maintenance, then the galvanized sheet steel shall be used.

-Aluminum metal lagging for piping shall be corrosion resistant aluminum alloy sheet of (0.4) mm thickness or more, and shall be fastened with bend over or stainless steel bands.

-Aluminum metal lagging for the flat face shall be corrosion resistant aluminum alloy steel or galvanized steel not less than 1mm thick, and shall be fastened with tapping, screws bolts or bend over.

-At least 25 mm over lapping shall be required for joints of jacketing and lagging, taking into consideration the thermal expansion of piping.

-When double or multi-layer insulation is applied, both circumferential and longitudinal joints of two layers shall be staggered not less than 25mm with relation to each other.

-Mastic insulation materials or equivalent material shall be filled in each joint.

-The insulation materials shall be fixed to the piping by stainless wire so as not to slip down. Adequate fixtures shall be attached to the vertical piping to support the insulation materials, and shall be tightened with stainless wire.

-Block insulation shall be applied for bolted fittings flange, valves, specialties so as to be able to overhaul without removing the body insulation.

-Piping heat insulation shall be of calcium silica board of sufficient thickness fitted by stainless wire, and the joints of boards shall be filled with mastic insulation materials, jacketing shall be fixed by means of bend over, stainless steel band or screw fixing. For vertical piping, collar band shall be fitted at adequate distances to avoid slip down.

-Collar band shall be fixed by screw fittings so as not to damage the piping surfaces.

-The insulation shall be applied only after the piping system and equipment has been hydrostatically tested.

Before any insulating material is applied, all surfaces shall be thoroughly cleaned of foreign material, such as scale dirt, grease or rust by wire brushing or scraping.

-Equipment insulation shall include the insulation of associated drain lines and other accessory piping connected to equipment. The type and thickness of insulation shall be adequate for the service of specified working temperature.

-Name plate, such as equipment serial No. and equipment service identification markings attached to equipment, shall be legally written.

-Where insulation is applied to equipment having bolted or screwed heads which may be removed periodically for inspection and maintenance, the part of fastening of equipment shall be left exposed, and insulation shall be applied in such a way that it may not be damaged by removal of bolts, screws heads, covers or plates.

- On high vertical vessels, insulation support angles or plate rings shall be provided to support the insulation.

- On irregular shaped equipment areas, such as heater heads and pumps, special provisions shall be made for securing the tie wires supporting block insulation. In order to secure the tie wires, Stainless steel wire netting shall be placed around the shell of the vessel.

- The lagging and jacketing for the top surface of equipment shall be fixed by screw setting.

- The supporting rods, which directly contact piping or equipment, shall be insulated.

- The insulation for Boilers, steam turbine, feed water heaters feed pumps, heat exchangers, etc… shall be executed in accordance with the recommended manufacturer's practices and the said practices shall be approved by PEEGT.

- The test well on piping for thermometer or thermocouple shall not be concealed under the insulation.

- Special provisions must be taken to avoid freezing of water inside pipes during winter time.

**PUBLIC ESTABLISMENT OF ELECTRICITY**
**FOR GENERATION AND TRANSMISSION (PEEGT)**

# ALEPPO STEAM POWER PLANT

# PART 5

# TECHNICAL SCHEDULES & DATASHEETS

Aleppo Steam Power Plant.

part:5-1Technical schedule

Item: T7- Main cooling system

| Item | MAIN COOLING WATER SYSTEM TECHNICAL | Unit | |
|---|---|---|---|
| | Cooling Tower Plant | | |
| 1 | General | | |
| | Manufacturer | | |
| | Identification number | | |
| | Type | | |
| | additional information | | |
| 2 | Thermal Design Data at Rated Condition | | |
| | Total Heat transferred | Mw | |
| | Total Mass Flow | Kg/s | |
| | Wind Velocity | m/s | |
| | Warm Water Temp.(in) | C | |
| | Cold Water Temp.(Out) | C | |
| | Cooling Air ,in (ambient air) | C | |
| | - Dry Air Temp. | C | |
| | Cooling Air ,Out | C | |
| | - Dry Air Temp. | C | |
| | Pressure Drop on Air Side | mmH2O | |
| | Approach Temp. | C | |
| | Minimum Design Temp. | | |
| | - Dry Air Temp. | C | |
| | Maximum Design Temp. | | |
| | - Dry Air Temp. | C | |
| | - Total heat Transfer area /Tower | m2 | |
| 3 | Dimensional Data | | |
| | Tower Type | | |
| | Quantity | | |
| | Dimensional Output/Tower | Mw | |
| | Maximum Output /tower | Mw | |
| | Dimensional Mass Flow/Tower | Kg/S | |
| | Maximum Mass Flow/Tower | Kg/S | |
| | Elevation of the inlet Delivery | m | |

Aleppo Steam Power Plant.

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Item: T7- Main cooling system

| | | | |
|---|---|---|---|
| | In tower coming Water minimum Press. | bar(g) | |
| | In tower coming Water maximum Press. | bar(g) | |
| | Total Output Fluctuation | Mw | |
| | Mean Temp. Difference | | |
| 4 | Technical Data | | |
| 4.1 | Natural Draft Cooling Tower | | |
| | Dimension | | |
| | Overall Height | m | |
| | Bottom Dimeter Of Founation Ring | m | |
| | Tower throat Diameter | m | |
| | Material of Skeleton | | |
| | Material of Cladding an Thickness | mm | |
| | Surface Protection of Structural Mterials | | |
| | No. of reinforcement rings | | |
| | Interconnection Facility between towers(yes/No) | | |
| | Aviation Warning Light | | |
| | Lightning Arrestor | | |
| 4.2 | Heat Exchangers | | |
| | No. of bundels per cooling tower | | |
| | Water-to-air Heat exchanger Type(cross flow/cross counter flow/etc ) | | |
| | Main Size of Bundle (length×width×depth) | | |
| | Bundle Design | | |
| | Tube Material | | |
| | No. of Tubes per bundle | | |
| | No. of passge per bundle | | |
| | Tube Dimensions (dia.×wall thick.×length) | mm×mm ×mm | |
| | Fin material | | |
| | Fin Dimension (dia.×length× thickness) | mm×mm ×mm | |
| | No. of fins per 1 meter Tube | | |
| | Fin-to-tube connection (expanded/galvanized/etc) | | |
| | Surface Protection method | | |

| | | | |
|---|---|---|---|
| | Total air-side surface of heat exchangers | | |
| | Design air-flow per bundle unit face area | ton/h sqm | |
| | Air side friction loss of bundle | | |
| | tube bundle cleaning method | | |
| | Presure of cleaning water to air | | |
| | Nitrogen blanketing system provided (required for steel-tube heat exchangers only) | | |
| | Volume of stored nitrogen | | |
| | Bundle frame Material | | |
| | Air Control louvers provided | | |
| | Number of Sector in tower | | |
| | Method of overcoming high wind speed | | |
| 4.3 | Recuperating hydroturbine (with spray type condenser only ) | | |
| | Type of turbine | | |
| | No. of Turbine | | |
| | Flow rate of water per turbine | | |
| | Static head recuperated (in design point) | | |
| | Efficiency | | |
| | Speed | rpm | |
| | Materials of : | | |
| | casing | | |
| | Shaft | | |
| | Impeller | | |
| | Bearing Lubrication type(self contained or circulating) | | |
| | Shaft position (hor./vert.) | | |
| | Shaft Sealing type | | |
| 4.4 | Main Ducts | | |
| | Material | | |
| | Thickness | mm | |
| | Cathodic protection | | |
| 5 | Drawing & Documents | | |
| | Dimentional and lay-out drawing | Drw No. | |
| | | Drw No. | |

Aleppo Steam Power Plant.

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Item: T7- Main cooling system

| | | | |
|---|---|---|---|
| | | Drw No. | |
| | Process Flow Sheet including instrumentation and delivery limits | | |
| | Characteristcs and Specific Curves | | |
| | Characteristcs diagram of the cooling system from -10 C to +45 C ambient Temp. | | |
| | Turbine backpres pressure verus ambient air | | |
| | Heat Rejection verus ambient temp. | | |
| | General view of cooling tower | Drw No. | |
| | Cross Section of Cooling tower | Drw No. | |
| | General arrangement of Piping Ducts and equipment above and underground in the cooling tower | | |
| | General arrangement of Piping Ducts and equipment in the machinr hall and pumphouse | Drw No. | |
| | Outline drawing of condenser | Drw No. | |
| | Description of maintenance including at least | | |
| | Normal maintenance<br>(equipment needing service and service intervals) | Doc No. | |
| | Corrosion and errosion Prevention and control | | |
| 6 | Other information | | |
| | Pumps | | |
| | the following data wll be filled for each pump of the main cooling water system | | |
| | name of the pump | | |
| | Identification number | | |
| | Manufacturer | | |
| | Type | | |
| | Number of pumps | pcs | |
| 1 | Process design data | | |
| | Flow rate | Kg/s | |
| | Delivery lift | | |
| | - design | m | |
| | - max (zero flow) | m | |
| | NPSH | m | |
| | Rotating Speed | r/min | |
| | Power demand at pump shaft | Kw | |

| | | | |
|---|---|---|---|
| | Efficiency | % | |
| | Operation data | | |
| | Min. rotating Speed | rpm | |
| | Min.allowable flow | Kg/S | |
| | Cooling Water Demand | Kg/S | |
| | Sealing Water Demand | Kg/S | |
| 3 | Construction | | |
| | Flanges | | |
| | - Suction | DN/PN | |
| | - Discharge | DN/PN | |
| | Weight | Kg | |
| 4 | Pump Drive | | |
| | Manfacturer | | |
| | Type | | |
| | Number of motors | | |
| | Weight | Kg | |
| | Rated Power | Kw | |
| | Rated Voltage | V | |
| | Frequency | Hz | |
| | Rated current | A | |
| | Rotating Speed | rpm | |
| | Cooling Water Demand | Kg/S | |
| | Protection class | | |
| | Temperature control | | |
| 5 | Base plate | | |
| | for pump & motor | | |
| | Material | | |
| | Weight | Kg | |
| 6 | Document & Drawing | | |
| | the contractor shal supply at least the following documents of the above mentioned pumps | | |
| | Outline drawing with dimensions of the pump | Drw No. | |

Aleppo Steam Power Plant.

part:5-1Technical schedule

Item: T7- Main cooling system

| | | | |
|---|---|---|---|
| | Constuction drawings including list of components | Drw No. | |
| | Material of Components | Doc No. | |
| | Analyses and description of special material and alloy metals | Doc No. | |
| | Specification of surface protecion | Doc No. | |
| | Characteristics and specific curves | Doc No. | |
| 7 | Other information | | |
| | Tanks | | |
| | the following data wll be filled for each tank of the main cooling water system | | |
| 1 | General | | |
| | name of the tank | | |
| | Identification number | | |
| | Manufacturer | | |
| | Type | | |
| | Number of tanks | | |
| 2 | Process design data | | |
| | Volume | m3 | |
| | OperatingTemperature | C | |
| | Operating Pressure | bar(a) | |
| 3 | Construction | | |
| | Main dimensions | | |
| | - Diameter | m | |
| | - Length of shell | m | |
| | Weight | | |
| | - Empty | Kg | |
| | Operation Condition | Kg | |
| | Design Value | | |
| | - Temperature | C | |
| | Pressure | bar(a) | |
| | Tank material | | |
| | - Shell | | |
| | - ends | | |

| | | | |
|---|---|---|---|
| | Wall Thickness | | |
| | -shell | mm | |
| | - ends | | |
| | Heatr (if any) | | |
| | - heater type | | |
| | - heating capacity | Kw | |
| 4 | Drawing & Documents | | |
| | the contractor shal supply at least the following documents of the above mentioned tanks | | |
| | Outline drawing with dimensions of the tank | Drw No. | |
| | Constuction drawings including list of components | Drw No. | |
| | Material of Components | Doc No. | |
| | Analyses and description of special materials and alloy metals | Doc No. | |
| | Specification of surface protecion | Doc No. | |
| 5 | Other information | | |

Aleppo Steam Power Plant.

part:5-1Technical schedule

Item: T-13 cranes

| 1 | **CRANES** | Unit | |
|---|---|---|---|
| | Manufacturer | | |
| | Identification number | | |
| | Type | | |
| | add.infornmation | | |
| | number of units | | |
| | capacity: | | |
| | main | ton | |
| | auxiliary | ton | |
| | speed: | | |
| | # hoisting | m/min | |
| | # traversing | m/min | |
| | # travelling | m/min | |
| | # inching speed | m/min | |
| | net weight/shipping weigth | | |
| | operated from | | |
| | control system/ controller location | | |
| | | | |
| | | | |
| | electrical supply | V/ph/A | |
| | span | m | |
| | height from first to top of rail | m | |
| | length of rail | m | |
| | lifting height | m | |
| | type of hook: | | |
| | main | | |
| | auxiliary | | |
| 1.1 | cranebridge-travelling gear | | |
| | travelling speed: | | |
| | # rated | m/min | |
| | # creep | m/min | |
| | wheel load (max/min) | kg | |

| | | | |
|---|---|---|---|
| | longitudinal force | kg | |
| | traverse force | kg | |
| 1.2 | travelling limit switches | | |
| | type | | |
| 1.3 | travelling motors | | |
| | number | pcs | |
| | manufactureer | | |
| | type | | |
| | enclosure class | | |
| | power requirement | kw | |
| | rotation speed | rpm | |
| 1.4 | travelling brakes | | |
| | type | | |
| 1.5 | travelling gear box | | |
| | type | | |
| | bearing | | |
| | lubricating system | | |
| **2** | **CRAB** | | |
| | Type | | |
| | Dimension(length/width) | mm | |
| 2.1 | Crab traviling gear | | |
| | Traveling | | |
| | - Rated | m/min | |
| | -Creep | m/min | |
| | Total number of running wheel and type | | |
| | No.of driven wheel | | |
| | type of bearingsLubrication system | | |
| 2.2 | Traviling limit switcges | | |
| | Type | | |
| 2.3 | Traviling motors | | |
| | number | pcs | |
| | manufactureer | | |

| | | | |
|---|---|---|---|
| | type | | |
| | enclosure class | | |
| | power requirement | | |
| | rotation speed | kw | |
| 2.4 | Traviling brakes | | |
| | type | | |
| 2.5 | travelling gear box | | |
| | type | | |
| | bearing | | |
| | lubricating system | | |
| 3 | Hoisting gear | | |
| | - Rated | m/min | |
| | -Creep | m/min | |
| | -falls of ropes | | |
| 3.1 | Ropes: | | |
| | Type | | |
| | Diameter | mm | |
| 3.2 | Winding drum | | |
| | number | pcs | |
| | bearing | | |
| | lubricating system | | |
| 3.3 | Hoisting limit swithes | | |
| | type | | |
| 3.4 | Hoisting Motor | | |
| | number | | |
| | manufactureer | | |
| | type | | |
| | enclosure class | | |
| | power requirement | kw | |
| | rotation speed | rpm | |
| 3.5 | Hoisting gear box | | |
| | number | | |

| | | | |
|---|---|---|---|
| | bearing | | |
| | lubricating system | | |
| 3.6 | Electrical equipment | | |
| | number of control cubicles | | |
| | type of enclosure | | |
| 3.7 | Pendant control unit | | |
| | type | | |
| | type of enclosure | | |
| 3.8 | Power supply line | | |
| | Type | | |
| | Main | | |
| | Crab | | |
| 3.9 | Weight | | |
| | Cranebridge-incl travelling gear | kg | |
| | Crab,incl,traversing and hoisting gear | kg | |
| | Total weight of crane | kg | |
| 4 | Bridge | | |
| | Cross-sectional shape | | |
| | Total width of bridge | m | |
| | Type of buffer | | |
| | Impact power at buffer | kg | |
| | platforms rear | | |
| | platforms front | | |
| | Wheels | | |
| | Type | | |
| | Diameter /number | | |
| | Span conductors | | |
| | Additional information | | |
| | | | |
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| | | | |
| 5 | Trolley | | |

Aleppo Steam Power Plant.

part:5-1Technical schedule

Item: T-13 cranes

| | | | |
|---|---|---|---|
| | Main hoist | | |
| | Type | | |
| | Capacity | tons | |
| | Available lift | m | |
| | Speed | m/min | |
| | Drum diameter | mm | |
| | Motor | | |
| | number | pcs | |
| | manufactureer | | |
| | type | | |
| | enclosure class | | |
| | power requirement | kw | |
| | rotation speed | rpm | |
| | Brakes | | |
| | manufactureer | | |
| | type | | |
| | Additional information | | |
| | | | |
| | | | |
| | Auxiliary hoist | | |
| | Type | | |
| | Capacity | | |
| | Available lift | ton | |
| | Speed | m | |
| | Drum diameter | m/s | |
| | | | |
| | Motor | | |
| | -number | pcs | |
| | -manufacture | | |
| | -type | | |
| | -enclosure class | | |
| | -power requirment | KW | |

| | | | |
|---|---|---|---|
| | -rotation speed | rpm | |
| | | | |
| | Brakes | | |
| | -manufacture | | |
| | -type | | |
| | | | |
| | Additional information | | |
| | | | |
| | | | |
| | | | |
| | Torolley frame | | |
| | Spared | m/s | |
| | Wheels | m | |
| | Type | | |
| | Diameter/number | | |
| | | | |
| | | | |
| | Motor | | |
| | -number | pcs | |
| | -manufacture | | |
| | -type | | |
| | -enclosure class | | |
| | - power requirement | KW | |
| | -rotation speed | rpm | |
| | | | |
| | Brakes | | |
| | -manufacture | | |
| | -type | | |
| | | | |
| | Additional information | | |
| | | | |

Aleppo Steam Power Plant.

part:5-1Technical schedule

Item: T-14 Hoists & monorails

| | | | |
|---|---|---|---|
| Item | Hoist and monorail data sheet shell be filled separatelty for each hoist and monorial | | |
| | | | |
| | Installation | | |
| | Number of hoists | | |
| | type | | |
| | Capacity,each | ton | |
| | Lifting height | m | |
| | Hightest position of hook | m | |
| | Hook design | | |
| | | | |
| | Crab | | |
| | type | | |
| | Profile of runway | | |
| | Total weight of one hoist | | |
| | | | |
| | Drawing & documents | | |
| | The contractor shall supply at least the following documents of the above mentioned equipment | | |
| | Dimensional drawings | Drw No. | |
| | Delivery limits | Drw No. | |
| | Description of maintenace including at least: | | |
| | -normal maintenace | doc.no | |
| | -corrosion and erosion prevention and control | doc.no | |
| | description of maintenace inenglish | doc.no | |
| | other information | | |
| | | | |

Aleppo Steam Power Plant.

part:5-1Technical schedule

Item: T20 - PIPING

| | | | |
|---|---|---|---|
| | **PIPING** | | |
| A | **Main steam Piping** | | |
| 1 | Material | | |
| 2 | Velocity at turbine MCR | m/s | |
| 3 | Product form | | |
| 4 | Design standard | | |
| B | **Hot Reheat Piping** | | |
| 1 | Material | | |
| 2 | Velocity at turbine MCR | m/s | |
| 3 | Product form | | |
| 4 | Design standard | | |
| C | **Feed water dicharge piping** | | |
| 1 | Material | | |
| 2 | Velocity at turbine MCR | m/s | |
| 3 | Product form | | |
| 4 | Design standard | | |
| D | **Feed water suction piping** | | |
| 1 | Material | | |
| 2 | Velocity at turbine MCR | m/s | |
| 3 | Product form | | |
| E | **Condensate discharge piping** | | |
| 1 | Material | | |
| 2 | Velocity at turbine MCR | m/s | |
| 3 | Product form | | |
| F | **Residual oil pumping** | | |
| 1 | Material | | |
| 2 | Velocity at turbine MCR | m/s | |
| 4 | Design standard | | |
| G | **Gas oil piping** | | |

Aleppo Steam Power Plant.

part:5-1Technical schedule

Item: T20 - PIPING

| | | | |
|---|---|---|---|
| 1 | Material | | |
| 2 | Velocity at turbine MCR | m/s | |
| 3 | Product form | | |
| G | **Fuel Gas piping** | | |
| 1 | Material | | |
| 2 | Velocity at turbine MCR | m/s | |
| 3 | Product form | | |

Aleppo Steam Power Plant.

part:5-1Technical schedule

Item: T21-INSULATION

| | | | |
|---|---|---|---|
| | **INSULATION** | unit | |
| A | **Thermal insulation of boiler** | | |
| 1 | Material of insulation | | |
| 2 | Material of lagging | | |
| 3 | Thickness of lagging | mm | |
| B | **Thermal insulation of ducts and wind boxes** | | |
| 1 | Material | | |
| 3 | Thickness | mm | |
| C | **Thermal insulation of Piping** | | |
| 1 | Material | | |
| 2 | Thickness | mm | |
| D | **Thermal insulation of turbine HP and LP casing** | | |
| 1 | Material | | |
| 3 | Thickness | mm | |

## PAINTING TECHNICAL DATA

The Tenderer shall state the painting requirements for all equipment supplied by him.

| Material Specification | | | | |
|---|---|---|---|---|
| Item | External Work | Internal Work | High Temperature Work | Special Paint Schedule (Floors) |
| Code/Standard | | | | |
| Method of Cleaning | | | | |
| Cleaning Material | | | | |
| Paint First Coat | | | | |
| Paint Second Coat | | | | |
| Paint Third Coat | | | | |
| Paint Fourth Coat | | | | |
| Total Dry Film | | | | |
| Thickness | | | | |

Note: The Tenderer shall note the attached reference rejection of the work.

The Tenderer shall state the corrosion protection provided for all equipment supplied by him.

| **Corrosion Protection** | | | | |
|---|---|---|---|---|
| **Equipment** | **Codes / Standards** | **Method of Cleaning** | **Cleaning Material** | **Corrosion Protection Provided** |
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## PAINTING TECHNICAL DATA

| Equipment | Codes / Standards | Method of Cleaning | Cleaning Material | Corrosion Protection Provided |
|---|---|---|---|---|
| | | | | |
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**SYRIAN ARAB REPUBLIC**

**MINISTRY OF ELECTRICITY**

**Public Establishment of Electricity for Generation & Transmission (PEEGT)**

**Invitation To Bid No.**

**For**

**Aleppo Steam Power Plant Project**

# 6.1 Form of tender and performance sheet

**To:** General Director

Public Establishment of Electricity for Generation and Transmission

Damascus – Syrian Arab Republic

Dear Sir:

Having examined the Administrative Juridical and Commercial clauses, Technical specification, Technical schedules, Price schedules and Drawings for the Aleppo Steam Power Plant.

1- The undersigned offers to design, manufacture, supply, test in works, pack for export, ship, transport, deliver to site, unload at site, execution of civil works, erect, paint, commission and put into normal operation, test for performance and reliability on completion, train the PEEGT personnel and maintain the plant during the guarantee period according to the scope of supply, for the whole of said works in strict conformity with the said tender documents, for the total sum of:

( ) Euro ( or any currancy which is freely convertible on the base of officially rate of exchange ).

Plus

( ) Syrian Pounds.

2- The undersigned undertakes to complete the whole of the works in strict conformity with the said tender documents and rare ready for commercial operation of the steam power plant within:

- First section ( ) months.
- Second section ( ) months.

after the date of effectiveness of the contract.

3- The undersigned guarantees the Performance of Steam Power generating set at site conditions stated in ITB and at 400 K.V. side to be as follows:

3.a. The Guaranteed Net Unit Heat Consumption at site of each steam turbine unit based on the fuel consumed and measured at 400 K.V. side determined as described in ITB of the Specification shall not be more than:

- Natural gas firing……kcal/kWh.
- Fuel oil firing……kcal/kWh.

3.b The Guaranteed Net Peak Load output for each Steam turbine unit measured at 400 K.V. side determined as described in ITB of the Specification shall not be less than:

- Natural gas firing……..……K.W.
- Fuel oil firing……..……K.W.

3.c The Guaranteed Unit Maximum Continuous Rating for each steam turbine unit ( the net base load output measured at 400 K.V. side ) determined as described in ITB of the Specification shall not be less than:

- Natural gas firing……..……K.W.
- Fuel oil firing……..……K.W.

3.d The Guaranteed Unit Maximum Continuous Rating for the each Boiler K.g. / hour determined as described in ITB of the Specification shall not be less than:

- Natural gas firing……..……K. g. /hour.
- Fuel oil firing……..…… K. g. /hour.

4- The undersigned agrees to pay to the PEEGT the following sum total for each unit:

4.a. (3 500 00) Euro for each Kcal/kWh or fraction that the Net Unit Heat Consumption is worse than the above guaranteed value, item 3-a.

4.b. (200) Euro for each K.W. or fraction that the Unit Peak Load for one hour for the steam turbine is less than the above guaranteed value, Item 3-b.

4.c. (800) Euro for each K.W. or fraction that the Unit maximum continuous rating for each steam turbine is less than the above guaranteed value, Item 3-c.

4.d. (100) Euro for each K.g. /hour steam or fraction that the Unit maximum continuous rating of each Boiler is less than the above guaranteed value, Item 3-d.

5- The undersigned acknowledges receipt of the following documents pertaining to the Specification together with the drawings referred to herein:

- **Part 1:** Adminstrative,Juridical and Financial Book.
- **Part 2:** General Specification.
- **Part 3:** Technical Specification ( Mechanical , Chemical , Electrical and Instruments & Control )
- **Part 4:** Civil Work.

- **Part 5:** Technical Schedules.
- **Part 6:** Form of tender , Itemized Prices Lists, Specified Spare Parts , Tools, water analysis, codes and standareds, dispatishing center signals, test equipments, vendor list, the cost of operation and maintenance, Meteorological data , performance shedules, single line diagram, layout drawing and Site information.

| | | |
|---|---|---|
| Signed | : | …… |
| Name and Occupation | : | …… |
| For | : | …… |
| Address | : | …… |
| | | …… |
| | | …… |
| Fax Number | : | …… |
| Date | : | …… |

# 6.2 PRICE SCHEDULE

The tenderer is required to provide a detailed breakdown of the tender prices by completing schedule 1 these prices will be as a basis for the preparation of a detailed Contract price breakdown to be finalized within one month from commencement order.

The contract prices breakdown will be the basis for payments.

The prices breakdown has been arranged to facilitate the spilt into a CIF portion paid in the contract currency (F.C) and two local portions paid in the Contractors currency (F.C) and in Syrian pounds (s).

## Schedule - 1 - Summary of Tender Prices x 1000

| Item | Description | Unit | FOB Euro | CIF Euro | Price for Local Transport | | Price for Erections & Commissioning | | Currency Total | | Remark |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Euro | SP | Euro | SP | Euro | SP | |
| **1** | Boilers and Associated Equipment. | 2 | | | | | | | | | |
| **2** | Fuel systems (residual oil, natural gas and distillate oil). | Lot | | | | | | | | | |
| **3** | Steam Turbine and Associated Equipment. | 2 | | | | | | | | | |
| **4** | Condensing and Feed Water System. | 2 | | | | | | | | | |
| **5** | Cooling Water System. | 2 | | | | | | | | | |
| **6** | Water Treatment Systems. | 1 | | | | | | | | | |
| **7** | Control & Instrumentation. | Lot | | | | | | | | | |
| **8** | B.O.P. Mechanical. | Lot | | | | | | | | | |
| **9** | Generators and Associated Equipment. | 2 | | | | | | | | | |
| **10** | Step up transformers. | 2 | | | | | | | | | |
| **11** | Unit transformers, Switchgear and Associated Equipment. | Lot | | | | | | | | | |
| **12** | B.O.P. Electrical. | Lot | | | | | | | | | |
| **13** | Connection to Substation. | Lot | | | | | | | | | |

| Item | Description | Unit | FOB Euro | CIF Euro | Price for Local Transport | | Price for Erections & Commissioning | | Currency Total | | Remark |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Euro | SP | Euro | SP | Euro | SP | |
| **14** | Training of PEEGT ( local & abroad ). | Lot | | | | | | | | | |
| **15** | Specified Spare Parts. | Lot | | | | | | | | | |
| **16** | Vehicles | | | | | | | | | | |
| **17** | Recommended Spare Parts. | Lot | | | | | | | | | |
| **18** | Total without Civil Works. | | | | | | | | | | |
| **19** | Total Civil Works. | | | | | | | | | | |
| **20** | Tender Price with Civil Works. | | | | | | | | | | |
| **21** | Nox & Sox Low emission equipments. | Lots | | | | | | | | | Option |

SP Syian Pound

# 6.3 SPARE PARTS

| | | |
|---|---|---|
| | | |
| | | |
| **M3 MAIN COOLING SYSTEM (for one unit)** | | |
| **(1) Specified Spare Parts** | | |
| a) Cooling tower...NONE | | |
| b) Circulating Water Pumps (for one pump) | | |
| Pump bearings | 4sets | |
| Motor bearings | 4sets | |
| Coupling | 2 sets | |
| Impellers | 4sets | |
| Shaft | 4sets | |
| Wearing rings | 4sets | |
| c) Auxiliary Cooling Water Pumps: | | |
| Complete pump and motor | 1 | |
| Pump bearings | 2sets | |
| Motor bearings | 2sets | |
| Impellers | 2sets | |
| Shaft | 2 | |
| Wearing rings | 2sets | |
| d) Spare Parts for each Pump used in the system | 1 set | |
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| **(2) Spare Parts recommended by Tenderer** | | |
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| **Hoist and monorail** | | |
| **(1) Specified Spare Parts** …NONE | | |
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| **(2) Spare Parts recommended by Tenderer** | | |
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| **Insulation** | | |
| **(1) Specified Spare Parts** ….NONE | | |
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| **(2) Spare Parts recommended by Tenderer** | | |
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| **M4.6 PLANT PIPING** | | |
| **PIPING** | | |
| **(1) Specified Spare Parts** | | |
| Valves, traps and strainers, joints and gaskets | 1 set of each type and size | |
| (2) pipes (100 m) of each type of each thermal circuit excluding piping between boiler and turbine (for one unit) | 1 set | |
| (3) 100 m of each type and size for the fuel cycle | 1 set | |
| (4) 100 m of each type and size of auxiliary cooling water | 1 set | |
| (5) 100 m of each type and size of fire fighting pipes | 1 set | |
| (6) 100 m each type and size for air, hydrogen, control and transmitter pipes | 1 set | |
| (7) For valve of similar size and types one valve of each type and size to be provided | 1 set | |
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| **(2) Spare Parts recommended by Tenderer** | | |
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# 6.4 Tools

The tenderer shall include in his tender all necessary tools including standard tools and special tools, which are necessary for the maintenance and overhauling:

- Special and standard tool for Boiler and auxiliaries.
- Special and standard tool for Steam Turbines and auxiliaries.
- Special and standard tool for Electrical equipment.
- Special and standard tool for C & I equipment.

# 6.6 CODES AND STANDARDS

## 6-6 CODES AND STANDARDS

Except where otherwise specified, implied or agreed the Works and each individual portion thereof shall comply with agreed internationally accepted standards such as the appropriate British Standard, DIN, ASME, ISO or IEC.

Codes and Standards governing the Design of the Plant shall be to the PEEGT's Approval. The tenderer shall include with the tender the list of proposed standards to be used on a Plant System basis. The tenderer shall also stipulate what safety design margins he is adopting for each system.

The Codes, Standards, General Specifications or Guidelines referenced in this Specification (including any addendum, amendments and errata) shall govern in all cases where references there to are made. In case of conflict between these Codes or Standards or Guidelines or General Specifications and the requirements specified in this Specification the latter shall take precedence. Where tenderers propose alternative Codes or Standards these shall be included in the tender. The tenderer shall itemize the points of difference between the proposed Standard and the Standard quoted in this Specification. The tenderer shall prove to the satisfaction of PEEGT that in respect of points of difference the proposed Standard is equal to or better than the Specified Standard.

The Code, Standard, General Specification or Guidelines applied in each case shall be the latest revision adopted and published at the tender Closing date. Any conflicts between standards shall be referred to the PEEGT who will decide which standard shall govern and the PEEGT's decision will be final.

Where no internationally accepted standard is applicable the tenderer shall give particulars and details of the Plant or relevant portion of the Plant relating to type, properties, quality, performance, materials and accompanied by such analysis as necessary to enable the PEEGT to identify all of the Plant in the same detail as would be possible had there been a Standard Specification for the Plant or part of the Plant in question.

Material specifications shall conform to the appropriate National or International Code or Standard applicable to the plant system, design criteria etc.

The Contractor will provide a copy of all standards used during the design Stage.

### 6.6.1 Codes for GRP Pipes & Fittings

AWWA C950 Fiberglass Pressure Pipe
ASTM D638 Test Method for Tensile Properties of Plastics.
ASTM D2290 Test Method For Apparent Tensile Strength of Ring or Tubular Plastics and Reinforced Plastics by Split Disk Method.
ASTM F477 Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe.
BS 2782 Methods of Testing Plastics.
BS 2494 Specification for Elastomeric Seals for Joints in Pipe work and Pipelines.
BS 3063 Specification for Dimensions of Gaskets for Pipe Flanges.
BS 5354 Specification for Laminated Pressboard for Electrical Purposes.
BS 5480 Specification for Glass Reinforced Plastics (GRP) Pipes, Joints and Fittings for Use for Water Supply or Sewerage

### 6.6.2 Codes for Mechanical Plant

API 500 Recommended Practice for Classification of Electrical Installations.
At Petroleum Facilities Classified as Class 1, Division 1 and Division 2.
API 598 Valve Inspection and Testing.
API 610 Centrifugal Pumps for Petroleum, Heavy Duty and Gas Industry Services.
ASME B31.1 Power Piping.
ASME 1792.
ASME Section IX, Welding and Brazing Qualifications A of the ASME Boiler and Pressure Vessel Code.
ASME Section VIII, Boiler and Pressure Vessel Code.
AWWA C300.
BS 4504 Specification For Flanges and bolting for Pipes, Valves and Fittings. Metric Series.
DIN 1944 Acceptance Tests on Centrifugal Pumps (VDE Rules For Centrifugal Pumps).
DIN 2501 Flanges.
DIN 28055 Organic Linings for Application to Metallic Components of Chemical Apparatus.
DIN 50891 Measurement of Coating Thickness – See ISO 2808.
ISO 1940 Balancing quality of Rotating Rigid Bodies
ISO 1996 Acoustics – Description and Measurement of Environmental Noise
ISO 2808 Paints & Varnishes – Determination of Film Thickness
ISO 3740 Acoustics – Determination of Sound Power Levels of Noise Sources.
ISO 3741 Acoustics – Determination of Sound Power Levels of Noise Sources
ISO 3742 Determination of Sound Power Levels of Noise Sources – Now.
ISO 3741
ISO 3744 Acoustics - Determination of Sound Power Levels of Noise Sources Using Sound Pressure
ISO 3745 Acoustics – Determination of Sound Power Levels of Noise Sources.
ISO 3746 Acoustics - Determination of Sound Power Levels of Noise Sources Using Sound Pressure.
ISO 3791 Office Machines and Data Processing Equipment.
IS0 9002 quality Systems.

PN 10 Flanges.
VDI 2539 Now DIN 28055.
VGB-R450Le VGB Guideline for Boiler Feed water , Boiler Water and Steam Of Steam Generators with a Permissible Operating Pressure Greater Than 68 bar.

### 6.6.3 Codes for Electrical and Control and Instrumentation

ASTM DA059-PCB Testing
BS 3031 Specification for Sulpheric Acid used in Lead Acid Batteries.
BS 4066 Tests on Electric Cables under Fire Conditions Part 3 NMV (1.5).
BS 4360 Mild Steel Grade 43A or 50C High Tensile Steel or Equivalent.
BS 4533 Luminaries.
BS 4944 Reactors. now BS EN 60289.
BS 5266 Emergency Lighting.
BS 5354 Specification for Laminated Pressboard for Electrical Purposes. Superseded by BS EN 60763.
BS 5372 Cable Terminations.
BS 6290 Lead Acid Stationary Cells and Batteries.
BS 6425 Methods of Test for Gases Evolved During Combustion of Electric Cables – Superseded by BS EN 50267.
BS 6742 Electrostatic Painting and Finishing Equipment using Flammable Materials.
BS 6878 Cast Aluminum Alloy Enclosures for Gas Filled HV Switchgear and Control Gear.
BS 7822 Insulation Coordination for Equipment Within Low Voltage Equipment.
BS 7430 Code of Practice for Earthing.
BS EN 50267 Common Test Methods for Cables under Fire conditions.
BS EN 60289 Reactors Supersedes BS 4944.
BS EN 60763 Supersedes BS 5354.
BS EN 60896 Stationary Lead Acid Batteries.
DIN VDE 0141 Earthing Systems for Power Installations with Rated voltages above 1 kV.
DIN 43668 Key for Doors of Electrical Switchgear Cubicles and Cabinets – Double Bit Key.
DIN 43688 Horizontal Pressure Tanks for Air Pressure Generating Stations in Electrical Switching Plants.
DIN 41773 Static Power Converters.
EN 50068 Wrought Steel Enclosures for Gas Filled High Voltage Switchgear and Control Gear.
EN 50069 Welded Composite Enclosures of Cast and Wrought Aluminum Alloys for Gas Filled High Voltage Switchgear and control Gear.
IEC 60034 Rotating Electrical Machinery
IEC 60037 Surge Arrestors
IEC 60044 Current transformers
IEC 60051 Direct Acting Indicating Analogue Electrical Measuring Instruments and Their Accessories
IEC 60056 High Voltage Alternating Current Circuit Breakers
IEC 60060 High-voltage Test Techniques
IEC 60071 Insulation Coordination
IEC 60072 Dimensions and Output Series for Rotating Electrical Machines

IEC 60073 Basic and Safety Principles for Man Machine Interface, Marking And Identification – Coding Principles for Indication Devices and Actuators
IEC 60076 Power Transformers
IEC 60079 Electrical Apparatus for Explosive Gas Atmospheres
IEC 60086 Primary Batteries
IEC 60099 Surge Arresters
IEC 60617 Recommended Graphical Symbols
IEC 60129 Alternating Current Disconnectors (Isolators) and Earthing Switches
IEC 60137 Insulated Bushings for Alternating Voltages Above 1000V
IEC 60144 Degree of Protection of Enclosures for Low Voltage Switch Gear And Control Gear. Superseded By IEC 60947
IEC 60146 Semiconductor Converters.
IEC 60158 Low Voltage Control gear.
IEC 60169 Radio Frequency Connectors.
IEC 60186 Voltage Transformers.
IEC 60189 Low Frequency Cables and Wires with PVC Insulation and PVC Sheath
IEC 60214 On Load Tap Changers
IEC 60228 Conductors of Insulated Cables
IEC 60255 Electrical Relays
IEC 60269 Low Voltage Fuses
IEC 60270 Partial Discharge Measurements
IEC 60287 Electric Cables Calculation of the Current Rating
IEC 60292 Low Voltage Motor Starters
IEC 60296 Specification for unused Mineral Insulating Oils for Transformers and Switchgear Rated Voltages above 1 kV and up to and including 52 kV
IEC 60298 AC Metal Enclosed Switchgear and Control Gear for Rated Voltages above kV and up to and including 52 kv
IEC 60332 Fire Test for a Single Insulated Vertical Wire or Cable
IEC 60354 Loading Guide for Oil Immersed Power Transformers
IEC 60358 Coupling Capacitors and Capacitor Dividers
IEC 60364 Electrical Installations of Buildings
IEC 60376 Specification and Acceptance of New Sulpher Hex fluoride
IEC 60439 Low Voltage Switchgear and Control Gear
IEC 60445 Basic and Safety Principles for Man Machine Interface, Marking and Identification – Identification of Equipment Terminals and of Terminations of Certain Designated Conductors, Including General Rules for an Alphanumeric System.
IEC 60480 Guide to the Checking of Sulpher Hex fluoride (SF6) taken from Electrical Equipment.
IEC 60502 Extruded Solid Dielectric Insulated Power Cables for Rated Voltages from 1 kV up to 30 kV
IEC 60507 Artificial Pollution Tests on High-Voltage Insulators to be used on A.C. Systems
IEC 60529 Degrees of Protection Provided by Enclosures (IP Code)
IEC 60542 Application Guide for On-Load Tap changers
IEC 60551 Determination of Transformer and Reactor Sound Levels
IEC 60567 Guide for the Sampling of Gases and of Oil From Oil-Filled Electrical Equipment and for the Analysis of free and Dissolved Gases
IEC 60598 Luminaries

IEC 60599 Mineral Oil Impregnated Equipment in Service – Guide to the Interpretation of Dissolved and free Gases Analysis
IEC 60606 Application Guide for Power Transformers
IEC 60616 Terminal and Tapping markings for Power Transformers
IEC 60617 Recommended Graphical Symbols
IEC 60651 Sound Level Meters
IEC 60694 Common Specifications for High Voltage Switchgear and Control Gear
IEC 60722 Guide to Lightning Impulse and Switching Impulse Testing of Power transformers as Reactions
IEC 60754 Test on Gases Evolved During Combustion of Electric Cables
IEC 60794 Optical Fiber Cables
IEC 60801 Electromagnetic Compatibility for Industrial Measurement and Control Equipment
IEC 60896 Stationary Lead Acid Batteries
IEC 60947 Low Voltage Switchgear and Control Gear
IEC 61000 Electromagnetic Compatibility (EMC)
IEEE Std. 142 Recommended Practice for Grounding of Industrial and Commercial Power Systems (Green Book)
IEEE Std. 80 1986 Guide for Safety in AC Substation Grounding.
IS0 8501 Preparation of Steel Sub states before Application of Paints and Related Products
NEMA PE5 Utility Type Battery Chargers
NFPA 780 Lightning Protection Systems

### 6.6.4 Codes for Corrosion Protection and Painting

BS 729 Specification for Hot Dip Galvanized Coatings on Iron and Steel Articles. now BS EN ISO 1461
BS 5493 Code of Practice for Protective Coatings of Iron and Steel Structures against Corrosion. Partially Superseded by BS EN ISO 12944.
BS EN ISO 1461 Specification for Hot Dip Galvanized Coatings on Iron and Steel Articles . Superseded by BS 729
BS EN ISO 12944 Paints and Varnishes . Partially Superseded by BS 5493
BS EN 22063 Metallic and other Inorganic Coatings – Thermal Spraying –Zinc, Aluminum and their Alloys
IS0 8501/2 Preparation of Steel Sub states before Application of Paints and Related Products
SIS 05 59 00 Preparation of Steel Sub states before Application of Paints & Related Products

# 6.8 Factory Tests

# Inspection List (Factory Tests)

## Mechanical

| Category | No | Name of equipment | test and inspection item | Witness by PEEGT &/or his representative | Test report to be submitted to the Owner and /or his representative | Remarks |
|---|---|---|---|---|---|---|
| **General** | | | Material Inspection | - | - | Material certificates will be available for consultation at workshop. |

# Inspection List (Factory Tests)

## Mechanical

| Category | No | Name of equipment | test and inspection item | Witness by PEEGT &/or his representative | Test report to be submitted to the Owner and /or his representative | Remarks |
|---|---|---|---|---|---|---|
| **Boilers ( pressure parts)** | 1 | Steam Drum | 1) Material Inspection<br>2)RT( for longitudinal and circumferential butt welds)<br>3) Post-weld heat treatment<br>4)Hydrostatic test<br>5) Dimensional Check<br>6) Visual Inspection | Yes<br>Yes<br>-<br>-<br>-<br>- | Yes<br>Yes<br>Yes<br>Yes<br>Yes<br>Yes | For each Boiler<br>Forgings for drums will be ordered in accor-dance with code requirements, without the sup-plementary surface crack detection, UT and RT of weld preparations. However note that after welding, nozzle welds are subjected to NDT: 10%MT and UT: 10% on set-in nozzles, 100% set-on nozzle welds.<br>Only locations of Drum shell plate at location of set-on nozzles shall have 100% UT check on laminations.<br>100%RT performed before PWHT. 100% MT will be performed after PWHT on vessels with wall thickness over 29mm.<br>After welding, nozzle welds are subjected 10%MT and on set-in nozzles, 100% UT set-on nozzle welds.100%MT is performed after PWHT on welds not subjected to RT. |
| | 2 | Headers | 1) Material Inspection<br>2)RT for circumferential butt welds<br>3) Post-weld heat treatment<br>( Where required by applicable code)<br>4)Dimensional Check<br>5) Visual Inspection | Yes<br>Yes<br>-<br><br>-<br>- | Yes<br>Yes<br>Yes<br><br>Yes<br>Yes | For one BOILER<br>Weld preparations do not receive RT before welding. The weld end preparation is a part of the joint and will be subjected to (code) required NDE after welding.<br>End cap forgings shall be 100%UT and 100% MT tested. Nozzle and weld end to header welds will have 10%MT.<br>Nozzle pipe is hydrostatically tested according code or will have electric eddy current test instead.<br>One visit only. |

# Inspection List (Factory Tests)

## Mechanical

| Category | No | Name of equipment | test and inspection item | Witness by PEEGT &/or his representative | Test report to be submitted to the Owner and /or his representative | Remarks |
|---|---|---|---|---|---|---|
| | 3 | Superheaters and reheaters tubes | 1) Material Inspection<br>2) Eddy current test on tubes<br>3) Post-weld heat treatment<br>( Where required by applicable code)<br>4)Dimensional Check<br>5) Visual Inspection | Yes<br>Yes<br>-<br><br>-<br>- | Yes<br>Yes<br>Yes<br><br>Yes<br>Yes | For each Boiler<br>Where TV-Xray is applied ,test certificate will furnished |
| | 4 | Economizer tubes | 1) Material Inspection<br>2) Eddy current test on tubes<br>3) Post-weld heat treatment<br>( Where required by applicable code)<br>4)Dimensional Check<br>5) Visual Inspection | Yes<br>Yes<br>-<br><br>-<br>- | Yes<br>Yes<br>Yes<br><br>Yes<br>Yes | For each Boiler |
| | 5 | Evaporator tubes | 1) Material Inspection<br>2) Eddy current test on tubes<br>3) Post-weld heat treatment<br>( Where required by applicable code)<br>4)Dimensional Check<br>5) Visual Inspection | Yes<br>Yes<br>-<br><br>-<br>- | Yes<br>Yes<br>Yes<br><br>Yes<br>Yes | For each Boiler<br>Where TV-Xray is applied ,test certificate will furnished |
| | 6 | Boiler supporting structure. | 1) Material Inspection<br>2)Dimensional Check | -<br>- | Yes<br>- | |
| | 7 | Materials (pressure parts) | Material inspection, material certificates | - | - | Code does not require reduction of area and impact values for Boiler materials. |
| | 8 | Materials (non-pressure parts, e.g. dampers, pumps, casing, stack, monitoring equipment, …) | Material inspection, material certificates | - | - | Only main parts of these items have an EN10204 3.1 certificate with tensile properties and chemical analysis. Reduction of area and impact values are not tested. Other parts come with EN10204 2.2 test report. |

# Inspection List (Factory Tests)

## Mechanical

| Category | No | Name of equipment | test and inspection item | Witness by PEEGT &/or his representative | Test report to be submitted to the Owner and /or his representative | Remarks |
|---|---|---|---|---|---|---|
| | 9 | Boiler tubes | Material inspection, transferable marking | - | - | Labeling and marking used to prevent mix-up of alloy tubes. |
| **Boilers ( Tanks)** | 1 | Pressure tank<br>(Design pressure >= 1 kg/cm**2**G)<br>( Blow Flash tank ) | 1) Material Inspection<br>2)NDE<br>( Where required by applicable code)<br>3)Hydrostatic test<br>4) Dimensional Check | -<br>-<br>-<br>-<br>- | Yes<br>Yes<br>Yes<br>Yes<br>Yes | Only locations of tank shell plate at location of set-on nozzles shall have 100% UT check on laminations.<br>100%RT performed before PWHT.<br>After welding, nozzle welds are subjected 10%MT and on set-in nozzles, 100% UT set-on nozzle welds. |
| | 2 | Blow down Tank | 1) Material Inspection<br>( for shell Plate only)<br>2) Dimensional Check | -<br><br>- | Yes<br><br>Yes | Only locations of Drum shell plate at location of set-on nozzles shall have 100% UT check on laminations.100%RT performed before PWHT.<br>100% MT will be performed after PWHT on vessels with wall thickness over 29mm. After welding, nozzle welds are subjected 10%MT and on set-in nozzles, 100% UT set-on nozzle welds. |
| LP anh HP heaters | 3 | LP anh HP heaters | 1)Material inspection | - | Yes | |
| **Fuel Handling System ( Natural Gas System)** | 1 | ESD Valve | 1) Material inspection<br>2) Hydrostatic test<br>3) Performance test | Yes<br>Yes<br>Yes | Yes<br>Yes<br>Yes | 2) and 3) will be witnessed at different period of the manufacturing process |
| | 2 | Filter Separator | 1)Material inspection<br>2) Hydrostatic test * | -<br>Yes | Yes<br>Yes | * for one filter only |
| | 3 | Knock out Drum | 1)Material inspection | - | Yes | |
| | 4 | Natural Gas Flow Meter | 1) Hydrostatic test<br>2) Accuracy test<br>3) Dimensional Check | -<br>-<br>- | -<br>Yes<br>- | |

# Inspection List (Factory Tests)

## Mechanical

| Category | No | Name of equipment | test and inspection item | Witness by PEEGT &/or his representative | Test report to be submitted to the Owner and /or his representative | Remarks |
|---|---|---|---|---|---|---|
| **Fuel Handling System ( Fuel Oil)** | 1 | Unloading Pump<br>Forwarding Pump<br>Transfer Pump<br>( if any) | 1) Material Inspection<br>2) Hydrostatic test<br>3) Performance test<br>4) Dimensional Check | Yes<br>-<br>Yes *<br>Yes | Yes<br>Yes<br>Yes<br>Yes | * one visit for the forwarding pumps only |
| | 2 | Gas oil Flow Meter | 1) Hydrostatic test<br>2) Accuracy test<br>3) Dimensional Check | -<br>-<br>- | -<br>Yes<br>- | |
| | 3 | Distillate oil tanks | 1) Material Inspection<br>2) Hydrostatic test (site activity) | -<br>- | Yes<br>Yes | |
| **Steam Turbine** | 1 | Assembled turbine rotor ( HP & IP ) | | Yes | Yes | |
| | 2 | HP/IP rotor balancing test | | Yes | Yes | |
| | 3 | HP/IP rotor overspeed test | | Yes | Yes | |
| | 4 | Assembled turbine rotor ( LP) | | Yes | Yes | |
| | 5 | LP rotor balancing test | | Yes | Yes | |
| | 6 | LP rotor overspeed test | | Yes | Yes | |
| | 7 | Turbine rotor | 1) Material Inspection<br>2)Non Destractive Examination( UT-MT) | Yes | Yes<br>Yes | |
| | 8 | Rotating blades | 1) Material Inspection<br>2)Non Destractive Examination(MT) | | | |
| | 9 | Stationary Blades | 1) Material Inspection<br>2)Non Destractive Examination(MT or PT) | | | |

# Inspection List (Factory Tests)

## Mechanical

| Category | No | Name of equipment | test and inspection item | Witness by PEEGT &/or his representative | Test report to be submitted to the Owner and /or his representative | Remarks |
|---|---|---|---|---|---|---|
| | 10 | Turbine Casing | 1) Material Inspection<br>2)Non Destractive Examination( UT-MT-PT)*1<br>3) Hydrostatic Test *2 | -<br>-<br><br>Yes | Yes<br>Yes<br><br>Yes | *1 UT,Mt,PT are applied to casting for HP/IP casing.MT is applied to welds for LP fabricated Casing<br>*2 Applied to HP/IP outer Casing |
| | 11 | Main stop valve and Governing valve body | 1) Material Inspection<br>2) Non Destractive Examination( UT-MT) | Yes<br>- | Yes<br>Yes | |
| | 12 | Main oil pump | 1) Material Inspection<br>2)Balance test * | -<br>- | -<br>Yes | * Applies for Impeller /Shaft |
| | 13 | Auxiliary oil pump<br>Emergency oil pump | 1) Hydrostatic test<br>2) Performance test | -<br>- | Yes<br>Yes | |
| | 14 | Oil Reservoir | Fill water test | - | Yes | |
| **Condensate plant** | 1 | Main Condensate pump | 1) Material Inspection<br>2) Performance test | -<br>Yes * | Yes<br>Yes | * For one pump only |
| | 2 | Water fill-up pump | 1) Material Inspection<br>2) Performance test | -<br>- | Yes<br>Yes | |
| | 3 | Direct cooling -Jet condenser | 1) Material Inspection<br>2) Dimensional Check (site activity) | -<br>- | Yes<br>Yes | |
| | 4 | Main CW pump | 1) Material Inspection<br>2) Performance test | Yes<br>Yes * | Yes<br>Yes | * For each pump |
| | 5 | Water turbine pump | 1) Material Inspection<br>2) Performance test | Yes<br>- | Yes<br>Yes | Performances will be established by iterations of the results obtained during the test of a similar range. |
| | 6 | Dry cooling tower deltas | 1) Material Inspection<br>2)Hydrostatic Test | Yes<br>Yes | Yes<br>Yes | One visit only. |
| | 7 | Ejectors | 1) Hydrostatic Test | Yes | Yes | for each type (2 witness tests in total) |
| **Feed Water pumps** | 1 | Feed Water pumps* | 1) Material Inspection<br>2) Performance test | Yes<br>Yes * | Yes<br>Yes | * one for each types |

# Inspection List (Factory Tests)

## Mechanical

| Category | No | Name of equipment | test and inspection item | Witness by PEEGT &/or his representative | Test report to be submitted to the Owner and /or his representative | Remarks |
|---|---|---|---|---|---|---|
| **Air heaters** | 1 | **Air heaters** | 1) Material Inspection<br>3) Dimensional Check | Yes<br>- | Yes<br>Yes | One visit only. |
| **Steam heaters** | 1 | **Steam heaters** | 1) Hydrostatic ar Pnuematic test<br>2) Dimensional Check | -<br>- | Yes<br>Yes | |
| **GRF** | 1 | Fans | 1) Material Inspection<br>2) Performance test | Yes<br>Yes * | Yes<br>Yes | * one for each types |
| **FDF** | 1 | Fans | 1) Material Inspection<br>2) Performance test | Yes<br>Yes * | Yes<br>Yes | * one for each types |
| **Air Compressed System** | 1 | Air Compressor with integrates dryer* | 1) Pressure test<br>2) Running type test *<br>3) Dimensional Check | Yes<br>Yes<br>- | Yes<br>Yes<br>Yes | 1) and 2) will be witnessed at different period of the manufacturing process |
| | 2 | Air receiver | 1) Hydrostatic ar Pnuematic test<br>2) Dimensional Check | -<br>- | Yes<br>Yes | |
| **Auxiliary Boiler** | 1 | Auxiliary Boiler | 1) Material Inspection<br>2) Hydrostatic test *<br>3) Dimensional Check | Yes<br>Yes<br>- | Yes<br>Yes<br>Yes | * for pressure Part<br>One visit only. |
| **Fire Protection System** | 1 | Pump<br>( Fire pump,<br>Jockey Pump) | 1) Hydrostatic Test<br>2) Performance Test *<br>3) Dimensional Check | -<br>Yes<br>- | Yes<br>Yes<br>Yes | * one for each types |
| | 2 | Diesel pump set | 1) Material Inspection<br>( for main part only)<br>2) Performance Test<br>3) Dimensional Check | -<br><br>-<br>- | -<br><br>Yes<br>Yes | |
| **Piping** | 1 | Main piping<br>( Main steam,Hot and Cold Reheat Steam and Turbine Bypass steam Pipe) | 1) Material Inspection<br>2) Eddy current test on piping<br>3) PT or MT<br>4) Dimensional Check | -<br>-<br>-<br>- | Yes<br>Yes<br>Yes<br>Yes | In accordance with the code requirement |

# Inspection List (Factory Tests)

## Mechanical

| Category | No | Name of equipment | test and inspection item | Witness by PEEGT &/or his representative | Test report to be submitted to the Owner and /or his representative | Remarks |
|---|---|---|---|---|---|---|
| | 2 | Other Piping ( Design Press>= 10kg/cm2 G (150 psi) and >6") | 1) Material Inspection<br>2) Eddy current test on piping<br>3) PT or MT<br>4) Dimensional Check | -<br>-<br>-<br>- | Yes<br>Yes<br>Yes<br>Yes | In accordance with the code requirement |
| **Valves** | 1 | Safety and pressure Relief Valve for Boiler | 1) Material Inspection<br>2) NDE<br>( Where required by applicable code)<br>3) Hydrostatic Test<br>4) Function test<br>5) Seal Leakage test<br>6) Dimensional Check | -<br>-<br><br>Yes<br>-<br>-<br>- | -<br>-<br><br>Yes<br>Yes<br>Yes<br>- | Valves body shall be in accordance to ASME B16.34 standard class or special class for ≥900lb. Witnessed are the HP superheater and HP Economizer safety valves (2 witness test in total) |
| | 2 | Other safety and Pressure Relief Valve | 1) Material Inspection<br>2) NDE<br>( Where required by applicable code)<br>3) Hydrostatic Test<br>4) Function test<br>5) Seal Leakage test<br>6) Dimensional Check | -<br>-<br><br>-<br>-<br>-<br>- | -<br>-<br><br>Yes<br>-<br>-<br>- | Valves body shall be in accordance to ASME B16.34 standard class or special class for ≥900lb. |
| | 3 | General Service Valve Class >=900 lb & Nominal size > 6" | 1) Material Inspection<br>2) NDE<br>( Where required by applicable code)<br>3) Hydrostatic Test<br>4) Function test at no load<br>( for motor and air operated valve only)<br>5) Dimensional Check | -<br>-<br><br>-<br>-<br><br>- | -<br>-<br><br>Yes<br>-<br><br>- | Valves body shall be in accordance to ASME B16.34 standard class or special class for ≥900lb. |

# Inspection List (Factory Tests)

## Mechanical

| Category | No | Name of equipment | test and inspection item | Witness by PEEGT &/or his representative | Test report to be submitted to the Owner and /or his representative | Remarks |
|---|---|---|---|---|---|---|
| **Plant Water System** | 1 | Pump<br>(Raw water pump,Filtered water pump,Demi water make up pump,Demi water transfer pump,Drinking water pump) | 1) Hydrostatic test<br>( for casing)<br>2) Performance test *<br>3) Dimensional Check | -<br><br>Yes<br>- | <br>Yes<br>Yes<br>- | <br><br>* for one demin water pump only |
| | 2 | Pump<br>( Acid pump and Caustic pump,Dilution Pump) | 1) Hydrostatic test<br>( for casing)<br>2) Performance test<br>3) Dimensional Check | -<br><br>-<br>- | -<br><br>Yes<br>- | <br><br>Standard performance type test of the pump model will be provided if applicable (mainly for loading pumps). |
| | 3 | Tank<br>( Acid Tank and Caustic Tank,Dilution Tank and Drinking water Storage Tank) | 1) Hydrostatic test<br>( water filling up test)<br>2) Dimensional Check | -<br><br>- | Yes<br><br>Yes | |
| | 4 | Mixed bed exchanger | 1) Hydrostatic test *<br>2) Dimensional Check | Yes<br>- | Yes<br>- | * for one mixed bed exchanger only |
| | 5 | Sand filters (pre-treatment) | 1) Hydrostatic test *<br>2) Dimensional Check | Yes<br>- | Yes<br>- | * for one filter only |
| | 6 | Chlorine Injection Equipment | 1) Performance test<br>2) Dimensional Check | -<br>- | Yes<br>- | |

# Inspection List (Factory Tests)

## Mechanical

| Category | No | Name of equipment | test and inspection item | Witness by PEEGT &/or his representative | Test report to be submitted to the Owner and /or his representative | Remarks |
|---|---|---|---|---|---|---|
| **Sampling System** | 1 | Sampling Rack | 1) Material Inspection<br>( for coil of sampling cooler)<br>2) Hydrostatic Test for heat exchangers<br>( for sampling cooler)<br>3) Dimensional Check | -<br><br>-<br><br>- | Yes<br><br>Yes<br><br>- | |
| **Waste Water Treatment System** | 1 | Pump | 1) Material Inspection<br>( for Impiller and Shaft only)<br>2) Hydrostatic Test ( for casing)<br>3) Performance Test<br>3) Dimensional Check | -<br><br>-<br>-<br>- | Yes<br><br>Yes<br>Yes<br>Yes | Standard performance type test of the pump model will be provided. |

* Reference " For one unit " or "For one pump " referes only to the witnessing process .Reports are always required for all units or pumps.

# Inspection List (Factory Tests)

## Electrical

| No. | Name of equipment | test and inspection item | Witness by PEEGT &/or his representative | Test report to be submitted to the Owner and /or his representative | Remarks |
|---|---|---|---|---|---|
| 1 | ST generator | Rotor overspeed and balancing test (Comprises the following sequence: Rotor balance and overspeed test followed by rotor winding shortage turn detection test and insulation test at rated speed) | Yes | Yes | |
| 2 | ST generator | Inspection of assembled stator (Dimension check, measurement of winding and insulation resistance, withstand voltage test) | Yes | Yes | |
| 3 | Excitation System for ST generator | 1) high voltage test acc. IEC 60034-1<br>2) functional test:<br>- SEE ON/OFF in manual and automatic mode<br>- demonstration of fault indication/ check of alarms and trips<br>- demonstration of channel c/o auto - manual, first auto channel - second auto channel<br>3) voltage test<br>4) current test | Yes | Yes | |

| No. | Name of equipment | test and inspection item | Witness by PEEGT &/or his representative | Test report to be submitted to the Owner and /or his representative | Remarks |
|---|---|---|---|---|---|
| 4 | ST main transformer | 1)measurement of winding resistance<br>2)measurement of voltag ratio and check of voltage relationship<br>3)measurement of insulation resistance<br>4)measurement of no load loss and current<br>5)measurement of impedance and load losses<br>6)lightning impulse test<br>7)switching impulse test<br>8)separate source voltage withstand test<br>9)induced over-voltage withstand test with partial discharge measurement<br>10)test on OLTC | Yes | Yes | |
| 5 | Auto transformer | 1)measurement of winding resistance<br>2)measurement of voltag ratio and check of voltage relationship<br>3)measurement of insulation resistance<br>4)measurement of no load loss and current<br>5)measurement of impedance and load losses<br>6)lightning impulse test<br>7)switching impulse test<br>8)separate source voltage withstand test<br>9)induced over-voltage withstand test with partial discharge measurement<br>10)test on OLTC | Yes | Yes | |
| 6 | ST aux. transformer | 1)measurement of insulation resistance<br>2 )ratio test<br>3)polarity and phase relationship test<br>4)measurement of winding resistance<br>5)measurement of exciting current and no load test<br>6)measurement of impedance voltage and load loss<br>7)separate source voltage withstand test<br>8)induced over-voltage withstand test | Yes | Yes | |

| No. | Name of equipment | test and inspection item | Witness by PEEGT &/or his representative | Test report to be submitted to the Owner and /or his representative | Remarks |
|---|---|---|---|---|---|
| 7 | MV motor | 1) Routine test<br>- dimensional and visual inspection<br>- winding resistance measurment<br>- insulation resistance measurment<br>- withstand voltage test<br>- locked rotor test<br>- no-load test<br>- noise measurments<br>- vibration measurment<br>- temperature rise test | Yes | Yes | For boiler feedwater pump motor only |
| 8 | MV switchgear for GT No1 | - power frequency voltage test<br>- dielectric tests of aux. Circuits<br>- mech. operation test<br>- tests of aux. electr. devices<br>- verification of correct wiring | Yes | Yes | |

| No. | Name of equipment | test and inspection item | Witness by PEEGT &/or his representative | Test report to be submitted to the Owner and /or his representative | Remarks |
|---|---|---|---|---|---|
| 9 | Protection relay panels for power station | - Functional test of all active functions acc. Prot. Single Line diagram from cubicle input terminal to cubicle output terminalincluding<br>- supervision of aux. voltage supply<br>- marshalling of LED`s<br>- settings according the plant specific settings | Yes | Yes | |
| 10 | Protection relay panels for Substation | - Functional test of all active functions acc. Prot. Single Line diagram from cubicle input terminal to cubicle output terminalincluding<br>- supervision of aux. voltage supply<br>- marshalling of LED`s<br>- settings according the plant specific settings | Yes | Yes | |
| 11 | Black start diesel generator | - Visual check<br>- Functional Test with specific control equipment<br>- Load test<br>- Load rejection test / load surge test / Verification of transients<br>- Noise pressure Level | Yes | Yes | |

# Annex 9

## Inspection List (Factory Tests)

I&C

| No | Name of equipment | test and inspection item | | Witness by PEEGT | Test report | Remarks |
|---|---|---|---|---|---|---|
| 1. | instrumentation and control Main Distributed control system(DCS),programmable logic control system including Boilers control system | Final Test as discribed in Annex 2 'C&I item 385' | | yes | yes | |
| 3. | steam turbine control system, programmable logic control system | Final Test as discribed in Annex 2 'C&I item 385' | | yes | yes | |
| 4. | local control instrument | functional test | | - | yes | Part of site activities only |

# Inspection List (Factory Tests)

## I&C

| No | Name of equipment | test and inspection item | | Witness by PEEGT | Test report | Remarks |
|---|---|---|---|---|---|---|
| 5. | Man machine inter face system(HMI computers and VDU for (operator station ,ES, servers..) | Final Test as discribed in Annex 2 'C&I item 385' | | yes | yes | |
| 6. | printers | 1)visual check<br>2)installation completed | | - | - | Part of site activities only |
| 7. | instrumentation and control( valve significant control valves (.HP Bypass hydraulic actuators, actuator of 100% feed water control valve ) | functional test of the actuator | | yes | - | One for HP Bypass<br>One for feed water actuator |
| 8. | other contro. valve | functional test of the actuator | | - | yes | Part of site activities only<br>Not referring to Steam Turbine (ST) and Gas Turbine (GT) |
| 9. | other (miscellaneous equipment)<br>water level gauge for steam drum | 1)material inspection (for body)<br>2)hydrostatic test | | - | yes<br>yes | |

# 6.9 Vendor Lists

## Manufacturer and Country of Origin

| | Equipment | Manufacturing Company | Country of Manufacture |
|---|---|---|---|
| **A** | **Main Equipment** | | |
| 1 | Steam Turbines | | |
| 2 | Boilers | | |
| 3 | Auxiliary Boiler | | |
| 4 | Condensers | | |
| 5 | Dry Cooling Tower | | |
| 6 | Generators | | |
| 7 | Step up Transformers | | |
| 8 | Generator C.B.s | | |
| 9 | High Voltage C.B.s | | |
| 10 | DCS | | |
| **B** | **B.O.P.** | | |
| 1 | Distellate system | | |
| 2 | Fuel oil System | | |
| 3 | Gas Fuel System | | |

| | | | |
|---|---|---|---|
| 4 | Emergency deisel generator | | |
| 5 | Fire fighting system | | |
| | | | |
| | | | |
| **C** | **Component of the Boiler and its ancillaries** | | |
| 1 | Gas Duct | | |
| 2 | Expansion Joints | | |
| 3 | Economizer | | |
| 4 | Evaporator | | |
| 5 | Steam Drum | | |
| 6 | Superheater | | |
| 7 | Reheater | | |
| 8 | Attemperator | | |
| 9 | Safety Valves | | |
| 10 | Main Steam Piping | | |
| 11 | Steel Structure | | |

| | | | |
|---|---|---|---|
| 12 | Stack | | |
| 13 | Cladding | | |
| 14 | F.D.Fans | | |
| 15 | G.R.Fans | | |
| 16 | Deaerator | | |
| 17 | Drum | | |
| 18 | Steam air heaters | | |
| 19 | Soot blower system | | |
| 20 | Burners | | |
| 21 | Drum level | | |
| 22 | Air heaters | | |
| 23 | F.W.Pumps | | |
| 24 | Sampling system | | |
| 25 | Chemical Dosing Equipment | | |
| | | | |
| | | | |

| D | Component of steam turbines and its ancillaries | | |
|---|---|---|---|
| 1 | Main Stop Valves | | |
| 2 | Control Valves | | |
| 3 | Governing System | | |
| 4 | Journal Bearing | | |
| 5 | Steam turbines | | |
| 6 | Thrust Bearing | | |
| 7 | Lube Oil Cooler | | |
| 8 | Lube Oil Purifier | | |
| 9 | Main Lube Oil Pump | | |
| 10 | Aux.Oil Pump | | |
| 11 | Emergency Oil Pump | | |
| 12 | Control Oil Pump | | |
| 13 | Jacking Oil Pump | | |
| 14 | Turning Gear | | |
| 15 | Gland Steam Condenser | | |
| | | | |

| | | | |
|---|---|---|---|
| **E** | **Condensate Plant** | | |
| 1 | Condensate Pump | | |
| 2 | Air Ejectors | | |
| 3 | Polishing System | | |
| **F** | **Main Cooling Water System** | | |
| 1 | C.W. Pump | | |
| 2 | Hydraulic Turbine | | |
| 3 | Cooling elements | | |
| 4 | Steal structure | | |
| 5 | Main Piping | | |
| | | | |
| **G** | **Aux. Cooling Water System** | | |
| 1 | Forwarding Water Pump | | |
| 2 | C.W. Pump | | |
| 3 | Coolers | | |
| **H** | **Water Treatment Plants** | | |
| **1** | Demi | | |

| | | | |
|---|---|---|---|
| **2** | Drinking | | |
| **3** | Sewage | | |
| **4** | Laboratory equipments | | |
| | | | |
| **I** | **Miscellaneous** | | |
| | | | |
| | | | |
| | | | |

| | | | |
|---|---|---|---|
| 1 | Air Compresser | | |
| 2 | Air Dryer | | |
| 3 | Fire Protection System | | |
| 4 | Elevators | | |
| 5 | Turbine Overhead Crane | | |
| 7 | HVAC System | | |
| 8 | Steam Convertor | | |
| 9 | Vehicles | | |
| 9-1 | Telescopic crane | | |
| 9-2 | Trucks | | |
| 9-3 | Fire fighting Truck | | |
| 9-4 | Ambulance | | |
| 9-5 | Fork lift | | |
| 9-6 | Excvator | | |
| | | | |
| **J** | **Electrical Equipment** | | |

| | | | |
|---|---|---|---|
| 1 | Unit Aux. Transformers | | |
| 2 | Start up transformer | | |
| 3 | Generator Isolated Phase Bus –Bars | | |
| 4 | Mv/Lv Swithgear | | |
| 5 | Cables to Substaions. | | |
| | I & C systems | | |

| K | **Design and Engineering** | Designer Company | Country |
|---|---|---|---|
| 1 | Steam plant Conceptual Design | | |
| 2 | Thermal Cycle Design | | |
| 3 | Heat Balance | | |

# Operation and maintenance cost during the life time of the plant (25 years)

| Year | Expected power generation MW | Expected net power generation MW | Fuel consumption Tons | Costs of consuming the spare parts € | Periods of maintenance and repetition hr. | Cost of operation (O&M Manpower and corresponding salaries and wages) € | Water consumption $m^3$ | Cost of consumable (oil , grease and chemicals) € | Others € |
|---|---|---|---|---|---|---|---|---|---|
| 1 | | | | | | | | | |
| 2 | | | | | | | | | |
| 3 | | | | | | | | | |
| 4 | | | | | | | | | |
| 5 | | | | | | | | | |
| 6 | | | | | | | | | |
| 7 | | | | | | | | | |
| 8 | | | | | | | | | |
| 9 | | | | | | | | | |
| 10 | | | | | | | | | |
| 11 | | | | | | | | | |
| 12 | | | | | | | | | |
| 13 | | | | | | | | | |
| 14 | | | | | | | | | |
| 15 | | | | | | | | | |
| 16 | | | | | | | | | |
| 17 | | | | | | | | | |
| 18 | | | | | | | | | |
| 19 | | | | | | | | | |
| 20 | | | | | | | | | |
| 21 | | | | | | | | | |
| 22 | | | | | | | | | |
| 23 | | | | | | | | | |
| 24 | | | | | | | | | |
| 25 | | | | | | | | | |
| **Total** | | | | | | | | | |

**SYRIAN ARAB REPUBLIC**

**MINISTRY OF ELECTRICITY**

**Public Establishment of Electricity for Generation & Transmission (PEEGT)**

**Invitation To Bid No.**

**For**

**Aleppo Steam Power Plant Project**

# 6.11 Meteorological data(for informatin)

**MINISTRY OF DEFENCE**
**METEOROLOGICAL DEPARTMENT**
**DAMASCUS**

## MONTHLY AVERAGE AND EXTREMRES

**Station: MASKNE / 30 / Km from the site Latitude : 36 03 00 N Longitude : 035 54 00 E Elevation : 8.0 M**

| Elements / Monthly | JAN. | FEB. | MAR. | APR. | MAY. | JUN. | JUL. | AUG. | SEP. | OCT. | NOV. | DEC. | Yearly | Period |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Monthly average dry bulb temperature C° | 6.0 | 7.2 | 10.6 | 15.8 | 21.0 | 25.3 | 28.4 | 28.0 | 24.3 | 19.3 | 11.9 | 7.5 | 17.1 | 1986- |
| Monthly average max temperature C° | 10.4 | 12.8 | 16.9 | 23.0 | 29.2 | 33.9 | 36.8 | 36.3 | 33.1 | 26.9 | 18.0 | 12.1 | 24.1 | 1978- |
| Monthly average min temperature C° | **1.7** | 2.0 | 4.6 | 8.5 | 12.7 | 16.9 | 19.8 | 19.3 | 15.6 | 11.4 | 5.8 | 2.9 | 10.1 | 1978- |
| Monthly absolute max temperature C° | 18.0 | 23.0 | 28.5 | 35.5 | 40.5 | 42.5 | 45.5 | 45.0 | 41.0 | 36.0 | 27.6 | 21.5 | 45.5 | 1978- |
| Monthly absolute minimum temperature C° | -9.0 | -8.6 | -9.0 | -1.6 | 2.3 | 7.0 | 13.0 | 9.0 | 4.8 | 0.5 | -7.0 | -11.5 | -11.5 | 1978- |
| Monthly average relative humedity % | 77.0 | 65.0 | 65.0 | 59.0 | 52.0 | 45.0 | 45.0 | 47.0 | 50.0 | 58.0 | 68.0 | 77.0 | 59.0 | 1986- |
| Absolute max relative humedity % | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 96.0 | 92.0 | 95.0 | 98.0 | 100.0 | 100.0 | 100.0 | 100.0 | 1986- |
| Absolute min relative humedity % | 14.0 | 8.0 | 7.0 | 3.0 | 2.0 | 4.0 | 2.0 | 4.0 | 2.0 | 5.0 | 5.0 | 9.0 | 2.0 | 1986- |
| Daily average evaporation in mm | 1.1 | 1.6 | 2.3 | 3.6 | 5.8 | 8.4 | 9.5 | 8.3 | 5.8 | 3.5 | 1.7 | 1.1 | 4.4 | 1978- |
| Monthly average of precipitation in mm | 42.1 | 32.5 | 34.4 | 23.1 | 8.2 | 1.2 | 0.1 | 0.8 | 0.3 | 12.3 | 26.2 | 37.0 | 218.6 | 1957- |
| Maximum fall in one day mm | 25.2 | 36.9 | 56.4 | 40.5 | 16.6 | 11.0 | 2.1 | 33.6 | 5.6 | 27.5 | 60.0 | 38.5 | 60.0 | 1957- |
| Monthly average daily sunshine duration in h | 4.5 | 5.6 | 6.4 | 8.5 | 9.9 | 11.7 | 12.3 | 11.8 | 10.3 | 7.9 | 6.0 | 4.0 | 8.3 | 1986- |
| Monthly average wind speed m/s | 1.6 | 1.7 | 2.4 | 2.5 | 2.0 | 3.6 | 4.2 | 3.1 | 2.1 | 1.0 | 0.8 | 1.1 | 2.2 | 1997- |
| Maximum wind speed m/s | | | | | | | | | | | | | | |

**Maximum wind speed and prevailing wind direction in Al Thowra station**

**Station: Al Thowra / 45 / Km from the site**

| CLIMATE ELEMENT | JAN. | FEB. | MAR. | APR. | MAY. | JUN. | JUL. | AUG. | SEP. | OCT. | NOV. | DEC. | Yearly | Period |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Maximum wind speed (m/s)** | 23 | 20 | 23 | 23 | 23 | 20 | 16 | 16 | 16 | 20 | 23 | 20 | 23 | 1971- |
| **Prevailing wind direction** | NE | NE | W | W | W | W | W | W | W | W | ENE | ENE | W | 1971- |

## 6.12 Performance Test

## PERFORMANCE SHEET

**Conditions of Steam turbine:**
**New and clean conditions, unit performance is net at the bus bars H.V. k.v. side.**

| | Description | ISO Conditions | | Site conditions | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | 15 ºC | | 15 ºC | | 25 ºC | | 40 ºC | |
| | | Base load | Peak load | Base load | Peak load | Base load | Peak load | Base load | Peak load |
| 1 | Barometeric pressure :<br>mmHg<br>.m bar. | | | | | | | | |
| 2 | Ambient pressure ( mmW.C ) | | | | | | | | |
| 3 | Relative humidity % | | | | | | | | |
| 4 | Fuel L.H.V. ( Kcal/kg) | | | | | | | | |
| 5 | Temperature of gas fuel<br>ºC | | | | | | | | |
| 6 | Boiler fuel oil consumption:<br>( Kg/h) | | | | | | | | |
| 7 | Steam turbine net power out put.<br>(K.W) | | | | | | | | |

## PERFORMANCE SHEET

**Conditions of Steam turbine:**
**New and clean conditions, unit performance is net at the bus bars H.V. k.v. side.**

| | Description | ISO Conditions | | Site conditions | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | 15 ºC | | 15 ºC | | 25 ºC | | 40 ºC | |
| | | Base load | Peak load | Base load | Peak load | Base load | Peak load | Base load | Peak load |
| 8 | Terminal temperature difference of the steam turbine condenser ºC | | | | | | | | |
| 9 | Dry cooling tower initial temperature difference ºC | | | | | | | | |
| 10 | Heat load rejected by the dry cooling tower kcal/h | | | | | | | | |
| 11 | Relevant heat balance sheets shall be attached with the answer | | | | | | | | |
| 12 | Total electrical auxiliary losses used to calculate the net power output | | | | | | | | |
| 13 | Wind speed m/s | | | | | | | | |
| 14 | Auxiliary C W. Temperature leaving the existing aux. Cooling tower ( C ) | | | | | | | | |

## PERFORMANCE SHEET

**Conditions of Steam turbine:**
**New and clean conditions, unit performance is net at the bus bars H.V. k.v. side.**

| | Description | ISO Conditions | | Site conditions | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | 15 ºC | | 15 ºC | | 25 ºC | | 40 ºC | |
| | | Base load | Peak load | Base load | Peak load | Base load | Peak load | Base load | Peak load |
| 15 | Generation frequency ( Hz ) | | | | | | | | |
| 16 | Generator power factor | | | | | | | | |

**SYRIAN ARAB REPUBLIC**

**MINISTRY OF ELECTRICITY**

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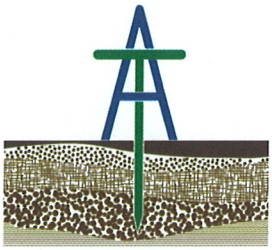
**Invitation To Bid No.**

**For**

**Aleppo Steam Power Plant Project**

# 6.14 Layout and Site information

Doctor Engineer
**Mhd.Ayham Toutoungi**
Soil Mechanic & Foundation Consultant



الدكتور المهندس
محمد أيهم توتنجي
ميكانيك تربة - إستشاري اساسات

# GEOTECHNICAL SURVEY

# NEW ELECTRICAL POWER PLANT

# AT TREFAWI SITE

**JUNE 2011**

Tel: 311 11 60 - Mobil: 0933 234 611 - Email: toutoungi@heartmail.com

# GEOTECHNICAL SURVEY
# NEW POWER PLANT
## TREFAWI SITE

**CONTENTS:**

1-Introduction
2-Site Description
3-Programme of Subsurface Investigation
4-Geological Context
5-Subsurface Strata and Ground Water
6-Geotechnical Key Properties
7-Foundation types and bearing capacity
8-Aggresivity on concrete
9-Excavation

9/1-Slopes
9/2-Means of Excavation

10-Seismicity
11-Thermal resistivity
12-Unforseen Conditions

**APPENDICES:**

-General Layout and boreholes locations
-Logs of boreholes
-Unconfined compression tests on rock samples
-Direct shear tests
-Data tables deduced from In labo an In Situ tests
-Soil chemical analysis
-Sheet calculation
-Photos

## 1-Introduction:

The main purposes of this geotechnical survey are:
- to provide a general description of the subsurface soil strata
-to submit the allowable bearing capacity of the different strata
-to present the required parameters necessary to make a preliminary design of foundation types, foundation levels and the expected settlements
-to propose the means of excavation

The geotechnical survey is carried out during June 2011.

## 2-Site Description:

The site is located at (# 100)km East of Aleppo city, in a large semi arid plain.
The ground surface is covered with light brown clayey to sandy silt with sub-rounded gravel and boulders.

## 3-Programme of the Subsurface Investigations:

The performed investigations included the following works:

**-In -Situ:**
(20) boreholes drilled by means of a drilling rig type Saturne, equipped with a (48)H.P. diesel engine; boreholes depths extend to (10)m and SPT, standard penetration test are performed in the upper layers.
Boreholes are distributed over the entire area of the power plant in order to assure the maximum representation of the soil and rock conditions; sampling was continuous and undisturbed soil and rock samples are selected for laboratory tests.
The locations of boreholes are presented on the drawing 1.

**In-Labo:**
Including the following tests:
-water content
-dry density
-specific density
-liquid and plastic limits (Atterberg limits)
-unconfined compression
-direct shear tests
-chemical analysis (organic content, soluble salt & sulfate SO3)

The tests are performed according to the ASTM results are presented in appendix..

The results are presented in the appendices.

## 4-Geological Context:

From geological point of view, the site is belonging to the Neogene/ Pliocene system; the substratum is composed mainly from marly limestone and conglomerate rocks.

The site is not affected by any types of faults.

## 5-Subsurface Strata and Ground Water:

Regarding the subsurface investigations results, the following strata are encountered in all the boreholes, their occurrences are illustrated by the geological sections:

-Top soil: dense mixture of medium plastic sandy to clayey silt with (20)% of sub-rounded gravel and boulders; thickness are (# 35)cm

-Caliche: conglomeration of clay, silt, sand and gravel bounded by carbonates, it extends from (1)m up to (# 1.75)m depth, however in boreholes (11, 17 and 18) caliche thickness exceed (4)m.

-In some locations, as in boreholes (9, 10, 12, 13 and 20) a lightly cemented conglomeration of gravel and boulders of (# 1.75)m thickness is detected..

-Marly limestone intermeddled with layers of limestone and flint; the thickness of this layers extend to (10)m depth and appear over all the boreholes.
Refer to the geological map this layer represent the "substratum" of the area.

All boreholes are free from any cavities.

Refer to the available hydraulical data, water table is located at (>650)m depth , all borings are free from any underground water, furthermore , North of the site some of the existing wells, at (25)m depth, contain water of high salinity, while other wells remain dry..

## 6-Geotechnical Key Properties:

### _Caliche:

| | |
|---|---|
| -dry density | 1.40g /cm3 – 1.55.g/cm3 |
| -Moisture content | Low (12)% |
| -Atterberg limits: | |
| Liquid limits | 40% - 47% |
| Plastic limits | 19% - 23% |
| -Modulus of elasticity (proposed) | 300kg/cm2 |
| Modulus of subgrade reaction (proposed) | 3kg/cm3 |
| -Simple shear test in saturated condition | |
| Internal friction angle | 15 |
| Cohesion | 0.4kg/cm2 – 0.5kg/cm2 |
| -Classification according to the U.S.C. | ML – CL |
| -California Bearing Ratio | 15 |
| -SPT | N = 40 |

### _The marly limestone rock:

| | |
|---|---|
| -dry density | 1.85g /cm3 - 2.15g/cm3 |
| -Moisture content | Low (5)% |
| -Modulus of elasticity (proposed) | 600kg/cm2 – 700kg/cm2 |
| -Modulus of subgrade reaction (proposed) | 6kg/cm3 |
| -Compression failure | 450kg/cm2 – 650kg/cm2 |
| -Simple shear test | |
| Internal friction angle | 25 |
| Cohesion | 0.6kg/cm2 |
| -RQD | 40% - 50% |
| -SPT | N > 60 |

**_The cemented conglomeration of gravel and boulders:**

| | |
|---|---|
| -Modulus of elasticity (proposed) | 500kg/cm2 |
| -Modulus of subgrade reaction (proposed) | 7kg/cm3 |
| -Simple shear test | |
| Internal friction angle | 25 |
| Cohesion | 0.4kg/cm2 |

**(Proposed ) values are based on our technical experience in selection of different parameters.**

## 7-Foundation types and bearing capacity:

The allowable bearing capacity will be estimated from Terzaghy equations, according to the permafrost regulation, the minimum depth of any foundation should be not less than (1)m. Calculation sheest are presented in the appendix.

### 7-1 -The caliche:

The caliche presents medium bearing capacity and a moderate sensibility to water fluctuations:

Spread and continuous foundation can be adopted.

Allowable bearing capacity must not exceed (2.75)kg/cm2

The settlements should remain within the acceptable limits (< 2cm) and the differential settlements should not override (1/300).

### 7-2 -The marly limestone:

As a rule, in rock mechanics, the final foundation design is controlled by the consideration of "deformation/settlement"; nevertheless the bearing failure capacity of the marly limestone rock will be evaluated in this report.

The bearing failure capacity of structures founded on rock are dependent upon joint spacing with respect to the foundation width, joint orientation, joint conditions and rock type; the marly limestone is considered as ductile rock with negligible amount of joints.

, the allowable bearing capacity is (4)kg/cm2 and the expected normal and differential settlements will be negligible.

### 7-3 Conglomeration of gravel and boulders:

The conglomeraion presents medium-high bearing capacity and a negligible sensibility to water fluctuations:

Spread and continuous foundation can be adopted.

Allowable bearing capacity must not exceed (3)kg/cm2

The settlements should remain within the acceptable limits (< 2cm) and the

differential settlements should not override (1/300).

The following recommendations must be strictly observed :
-Any non-structural backfilling can be completed from the same excavated material , it must be compacted to a density similar to the surrounding soil ;however ,any fill requires compaction in thin layers by means of an adequate compactor with good supervision and testing in order to achieve a homogeneous fill of a specified density ;
-Concrete for footing bases (lean concrete) must be poured directly against the adjoining undisturbed soils in at least (10)cm of a hand made excavation without use of formwork

.

**8-Aggressively on concrete:**
Chemical analysis of soluble salt in the soil layers from (0.5)m to (5)m detected (0.8)% of sulfate (SO3), sulfate resisting cement type should be used in concrete mix for all the elements of structure in contact with soil, although it requires dense ,fully compacted concrete with a defined water cement not exceed (60)% .

## 9-Excavation:

### 9/1-Slopes:

In general the following slopes of excavation may be envisaged:
80 - 90 degree
These slopes are applicable for cuts of temporary duration and total height of (5.5)m , deeper cuts required flatter slopes ,depending on detailed analysis and inspections .

### 9/2-Means of excavation:

For confined excavations ; the backhoes equipped with jackhammer can be used , for large cuts the bulldozer D7 with ripper will be suitable .

## 10=Seismicity:

The site is located in a minor events zone, we recommend, referring to the Syrian building specification – issued by the Syrian Engineer Syndicate - 2005 the following items will be adopted:
-Seismic zone factor Z=0.15
- Soil Profile type $S_B$
-The near source factors: Na= 1 Nv= 1

## 11- Thermal resistivity

The thermal conductivity varies with soil texture, water content, salt concentration and organic matter content.
For all type of soils, an increase in bulk density at a given moisture content increased the thermal conductivity, and increasing moisture content at a given bulk density increase the thermal conductivity.
Silty and clayey soils exhibit slight increases in thermal conductivity beyond a certain bulk density threshold.
Clayey soils generally had lower thermal conductivity than did the sandy and gravely soils.
For Syrian soils, information on thermal properties has been lacking.
Based on the fact that the "quartz sand" extracted from Syrian quarries present (4) time lower resistivity than the clayey soil minerals electrical cables should be covered with a suitable layer of quartz sand.
**In case that the above recommendations are respected, the value of the thermal resistivity = (0.9mC/w) should be retained for design purposes.**

## 12-Unforseen Conditions:

A soil engineer before the execution of concrete work must make a further observation of the final footing excavations.

The conclusions and recommendations contained in this report are based on reasonable, but limited amount of subsurface investigation work .

We assume a continuity of subsoil and rock conditions between holes to make an economical conclusions and recommendations.
Our recommendations are prepared in accordance with the generally accepted professional engineering practices.

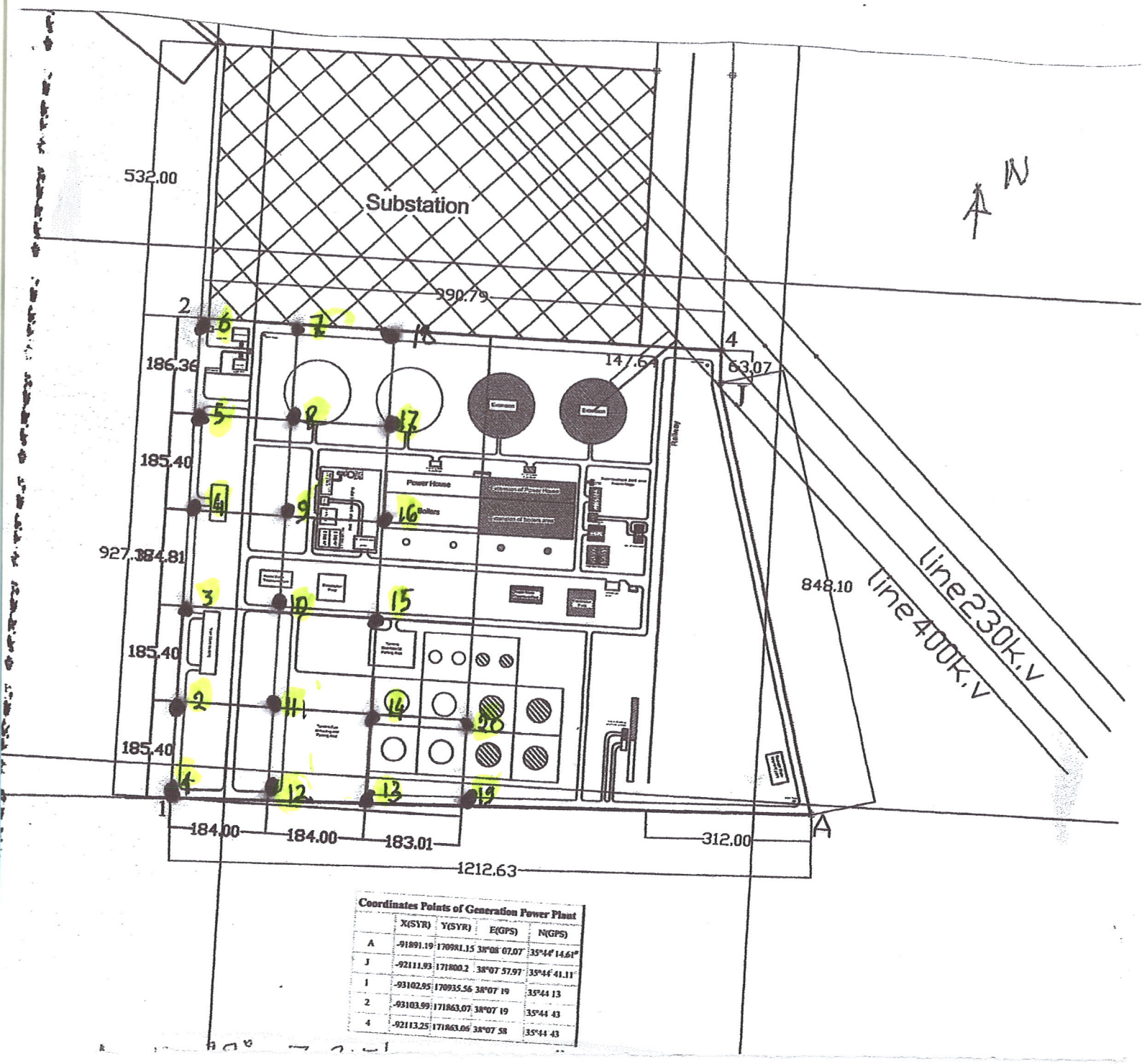
If, during construction some of the soil conditions appear different from those described in this report, they must be immediately reported, so that supplementary recommendations can be made.

GEOTECHNICAL CONSULTANT
Doctor Engineer
M.A. TOUTOUNGI

**Doctor Engineer**

**M.A. Toutoungi**

# Al Trefawi Site




| Coordinates Points of Generation Power Plant | | | | |
|---|---|---|---|---|
| | X(SYR) | Y(SYR) | E(GPS) | N(GPS) |
| A | -91891.19 | 170981.15 | 38°08' 07.07" | 35°44' 14.61" |
| J | -92111.93 | 171800.2 | 38°07 57.97" | 35°44' 41.11" |
| 1 | -93102.95 | 170935.56 | 38°07 19 | 35°44 13 |
| 2 | -93103.99 | 171863.07 | 38°07 19 | 35°44 43 |
| 4 | -92113.25 | 171863.06 | 38°07 58 | 35°44 43 |

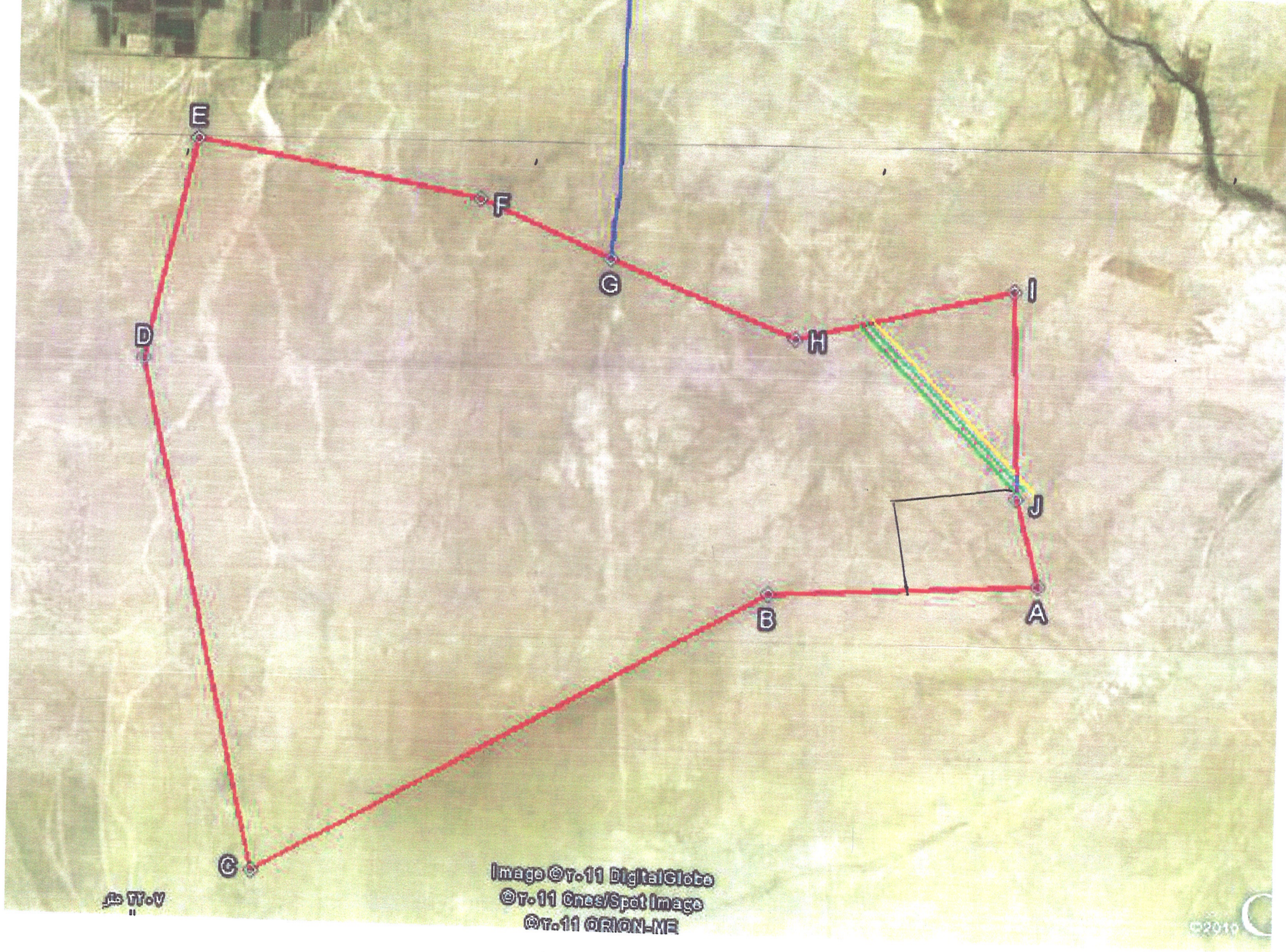

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Image ©۲۰۱۱ DigitalGlobe
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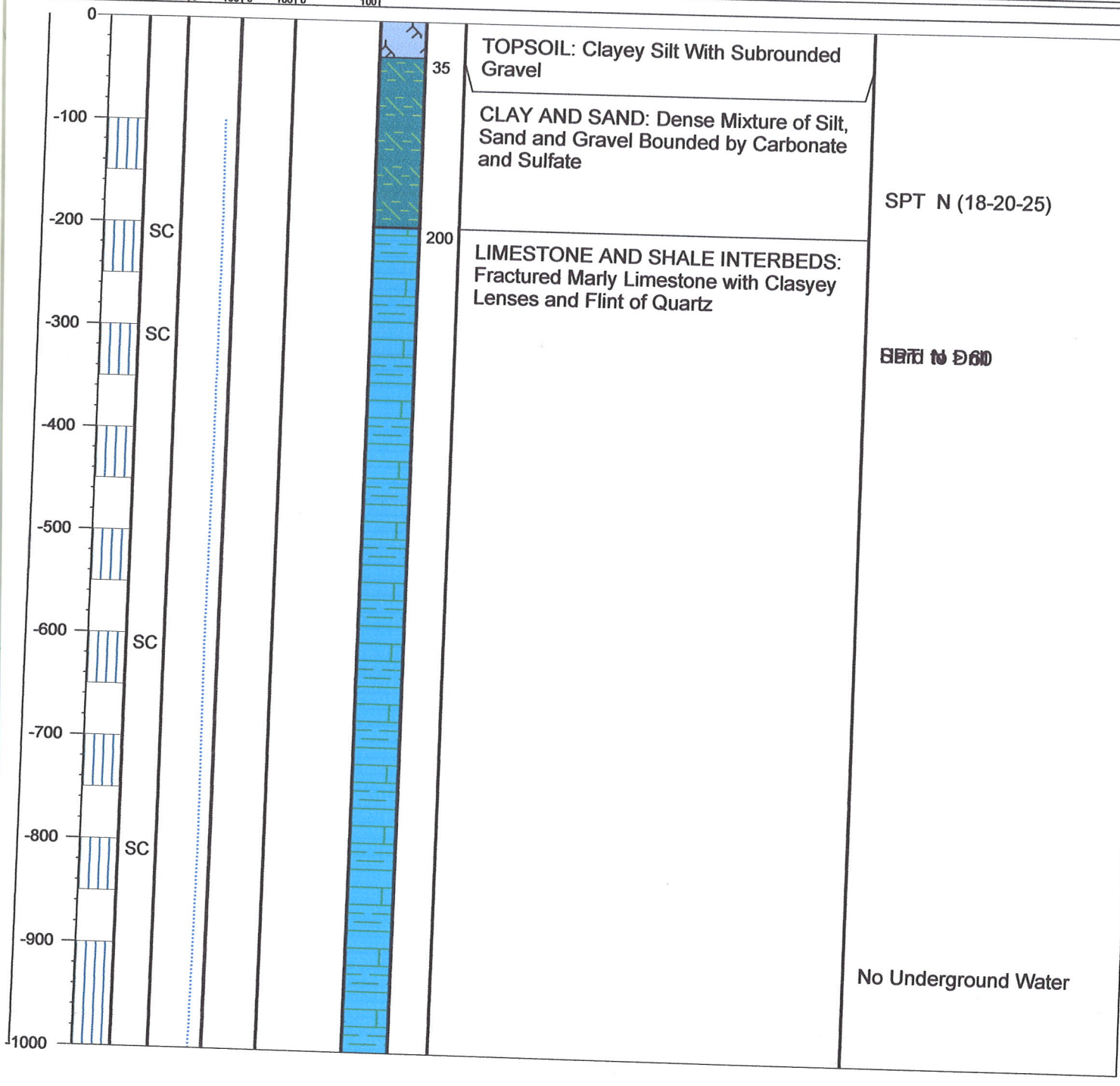
Doctor Engineer
**Moh. Ayham Toutoungi**
Soil Mechanic & Foundation Consultant

**Project :** Al Trefawi Sjte
**Drilling Rig:** Drilling Rig
**Supervised by :** Dr. Toutoungi M.A.

**Borehole : No 1**
**Date: 15 June 2011**

Sample Condition: US Undisturbed; D Disturbed; L Lost; SPT
Type of Sampler: DC Double Core Barrel; S Single Tube; SS Split Spoon; ST Shelby Tube

Chainage :
Location : E 38 07,317
N 35 44,217




| DESCRIPTION | OBSERVATIONS |
|---|---|
| TOPSOIL: Clayey Silt With Subrounded Gravel | |
| CLAY AND SAND: Dense Mixture of Silt, Sand and Gravel Bounded by Carbonate and Sulfate | SPT N (18-20-25) |
| LIMESTONE AND SHALE INTERBEDS: Fractured Marly Limestone with Clasyey Lenses and Flint of Quartz | [illegible] |
| | No Underground Water |

Doctor Engineer
**Moh. Ayham Toutoungi**
Soil Mechanic & Foundation Consultant

**Project :** Al Trefawi Sjte
**Drilling Rig:** Drilling Rig
**Supervised by :** Dr. Toutoungi M.A.

**Borehole : No 2**
**Date: 15 June 2011**

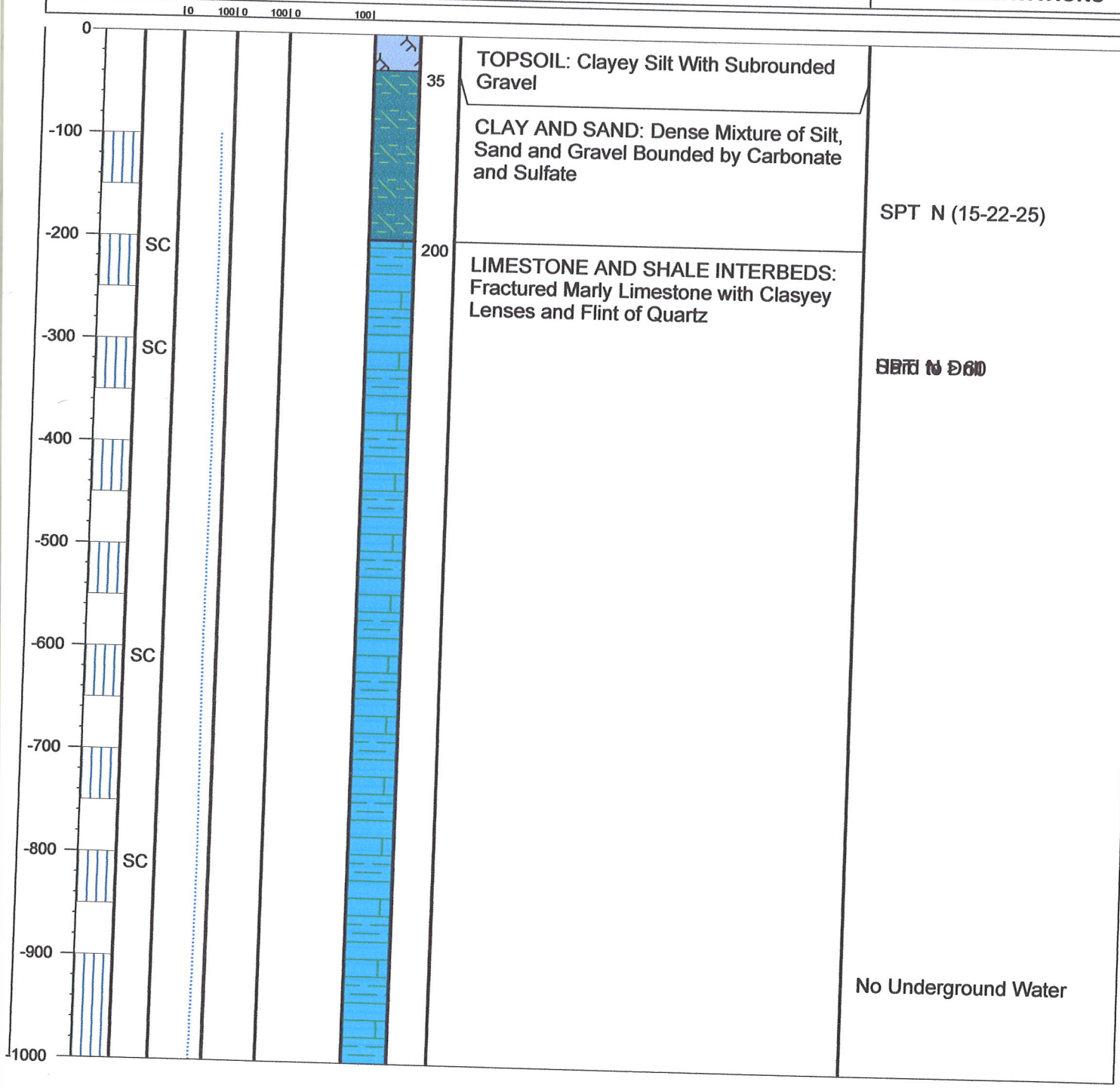
Depth (cm) | Sample | Type of Sampler | REC | RQD | N Values Graph | Lithology

Sample Condition: US Undisturbed; D Disturbed; L Lost; SPT

Type of Sampler: DC Double Core Barrel; S Single Tube; SS Split Spoon; ST Shelby Tube

Chainage :
Location :

| DESCRIPTION | OBSERVATIONS |
|---|---|
| TOPSOIL: Clayey Silt With Subrounded Gravel | |
| CLAY AND SAND: Dense Mixture of Silt, Sand and Gravel Bounded by Carbonate and Sulfate | SPT N (15-22-25) |
| LIMESTONE AND SHALE INTERBEDS: Fractured Marly Limestone with Clasyey Lenses and Flint of Quartz | No Underground Water |



Doctor Engineer
**Moh. Ayham Toutoungi**
Soil Mechanic & Foundation Consultant

**Project :** Trefawi Site
**Drilling Rig:** Star
**Supervised by :** Dr. Toutoungi M.A.

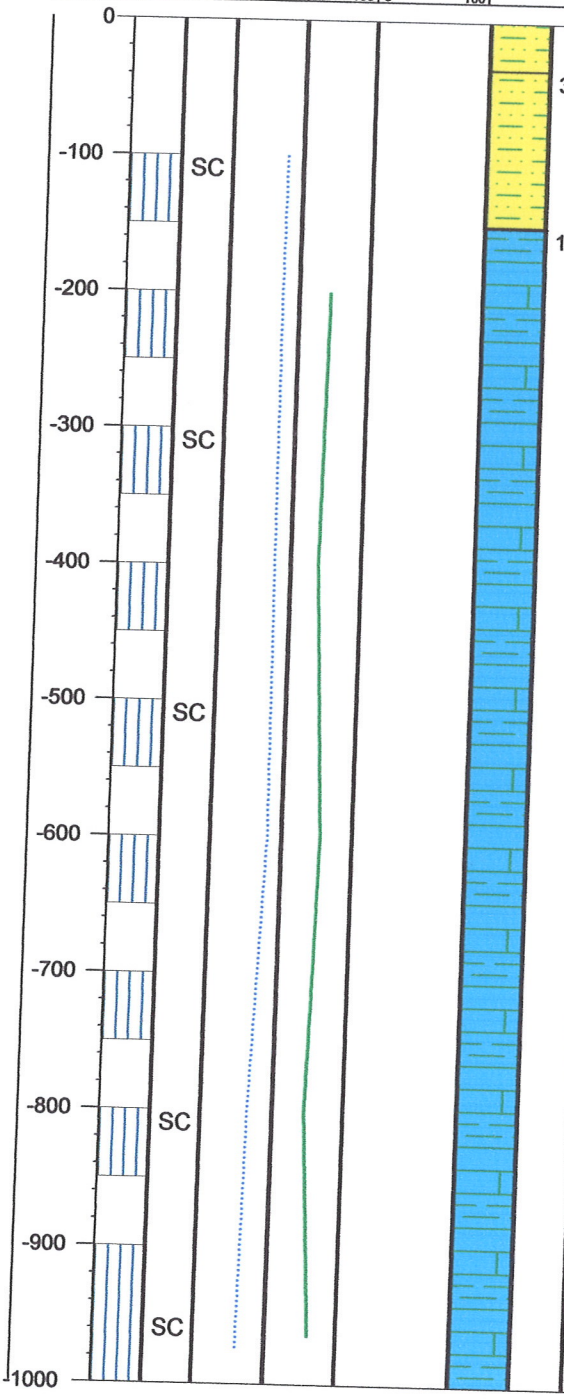
**Borehole : No 3**
**Date: 15 June 2011**

Depth (cm) | Sample | Type of Sampler | REC | RQD | N Values Graph | Lithology

Sample Condition: US Undisturbed; D Disturbed; L Lost; SPT

Type of Sampler: DC Double Core Barrel; S Single Tube; SS Split Spoon; ST Shelby Tube

Chainage :
Location :




| DESCRIPTION | OBSERVATIONS |
|---|---|
| CLAYEY SAND: Mixture of Silty Clay & Sand | |
| CLAYEY SAND: Dense c& Plastic Mixture of Clayey Silt with (25)% Gravel bounded By Carbonate & Sulfate | |
| LIMESTONE AND SHALE INTERBEDS: Marly Limestone interbedded with lenses of stiff calcareous clay | SPT N>60<br>Hard To Drill |
| | No Underground Water |

Doctor Engineer
**Moh. Ayham Toutoungi**
Soil Mechanic & Foundation Consultant

**Project :** Trefawi Site
**Drilling Rig:** Star
**Supervised by :** Dr. Toutoungi M.A.

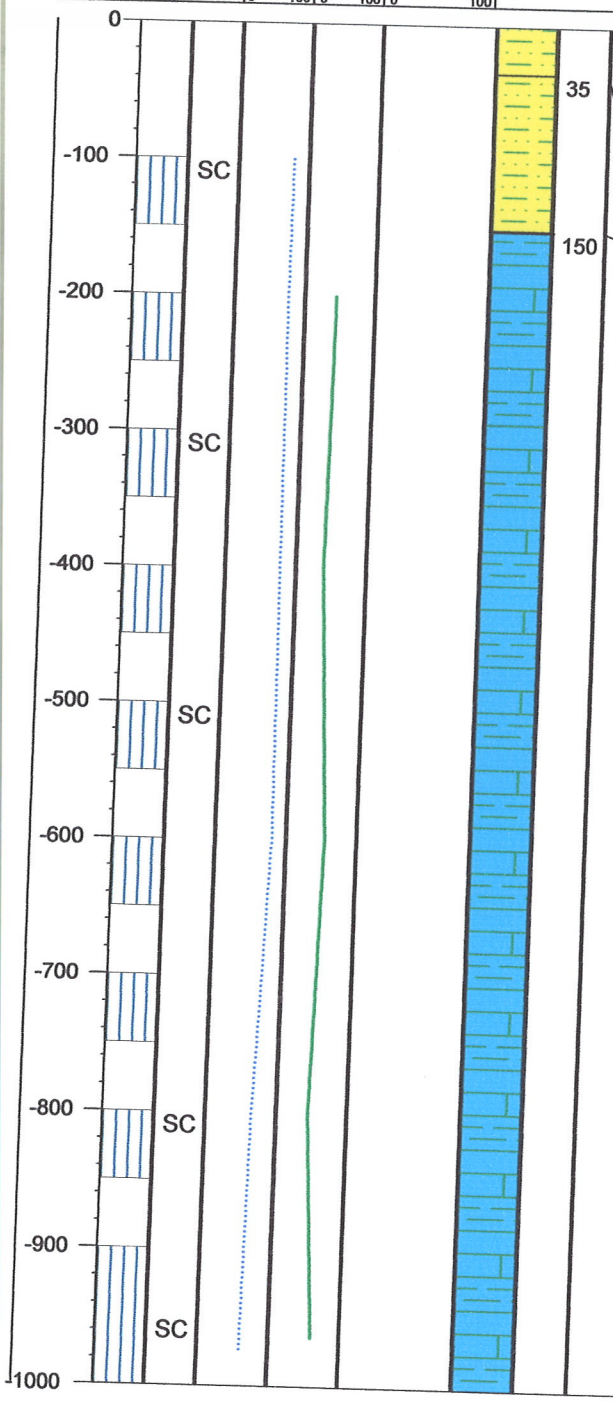
**Borehole : No 4**
**Date: 15 June 2011**

Depth (cm) | Sample | Type of Sampler | REC | RQD | N Values Graph | Lithology

Sample Condition: US Undisturbed; D Disturbed; L Lost; SPT

Type of Sampler: DC Double Core Barrel; S Single Tube; SS Split Spoon; ST Shelby Tube

Chainage :
Location :




| DESCRIPTION | OBSERVATIONS |
|---|---|
| CLAYEY SAND: Mixture of Silty Clay & Sand | |
| CLAYEY SAND: Dense c& Plastic Mixture of Clayey Silt with (25)% Gravel bounded By Carbonate & Sulfate | |
| LIMESTONE AND SHALE INTERBEDS: Marly Limestone interbedded with lenses of stiff calcareous clay | SPT N>60<br>Hard To Drill |
| | No Underground Water |

Doctor Engineer
**Moh. Ayham Toutoungi**
Soil Mechanic & Foundation Consultant

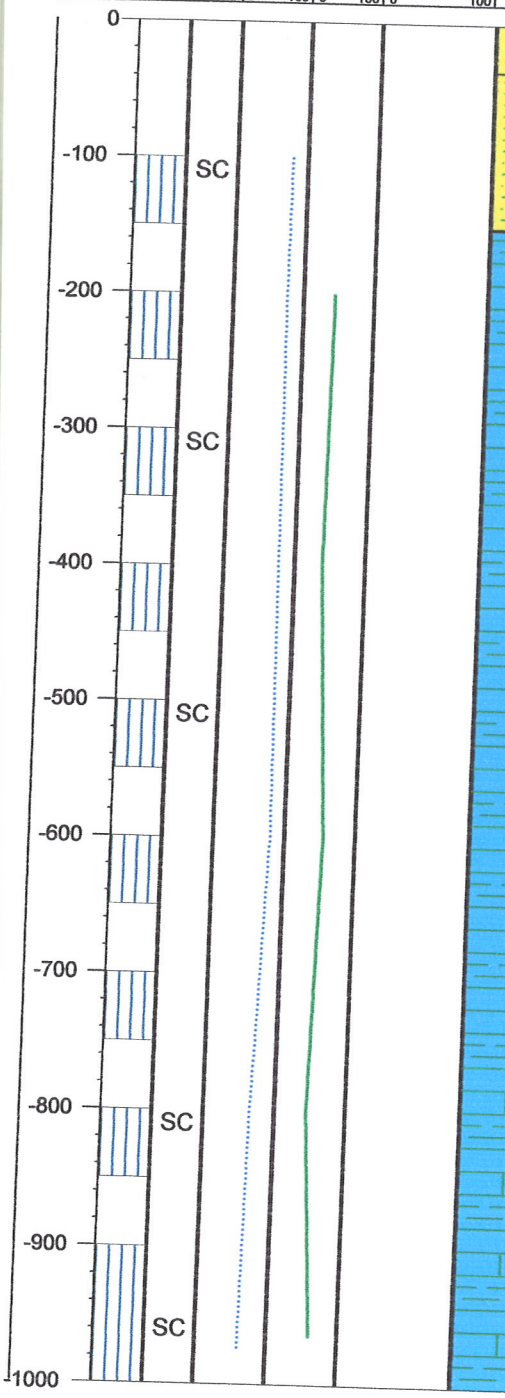
**Project :** Trefawi Site
**Drilling Rig:** Star
**Supervised by :** Dr. Toutoungi M.A.

**Borehole : No 5**
**Date: 15 June 2011**

Depth (cm) | Sample | Type of Sampler | REC | RQD | N Values Graph | Lithology

Sample Condition: US Undisturbed; D Disturbed; L Lost; SPT
Type of Sampler: DC Double Core Barrel; S Single Tube; SS Split Spoon; ST Shelby Tube

Chainage :
Location :




**DESCRIPTION**

CLAYEY SAND: Mixture of Silty Clay & Sand

CLAYEY SAND: Dense c& Plastic Mixture of Clayey Silt with (25)% Gravel bounded By Carbonate & Sulfate

LIMESTONE AND SHALE INTERBEDS: Marly Limestone interbedded with lenses of stiff calcareous clay

**OBSERVATIONS**

SPT N>60

Hard To Drill

No Underground Water

Doctor Engineer
**Moh. Ayham Toutoungi**
Soil Mechanic & Foundation Consultant

**Project :** Trefawi Site

**Drilling Rig:** Star

**Borehole : No 6**

**Supervised by :** Dr. Toutoungi M.A.

**Date: 15 June 2011**

Depth (cm) | Sample | Type of Sampler | REC | RQD | N Values Graph | Lithology

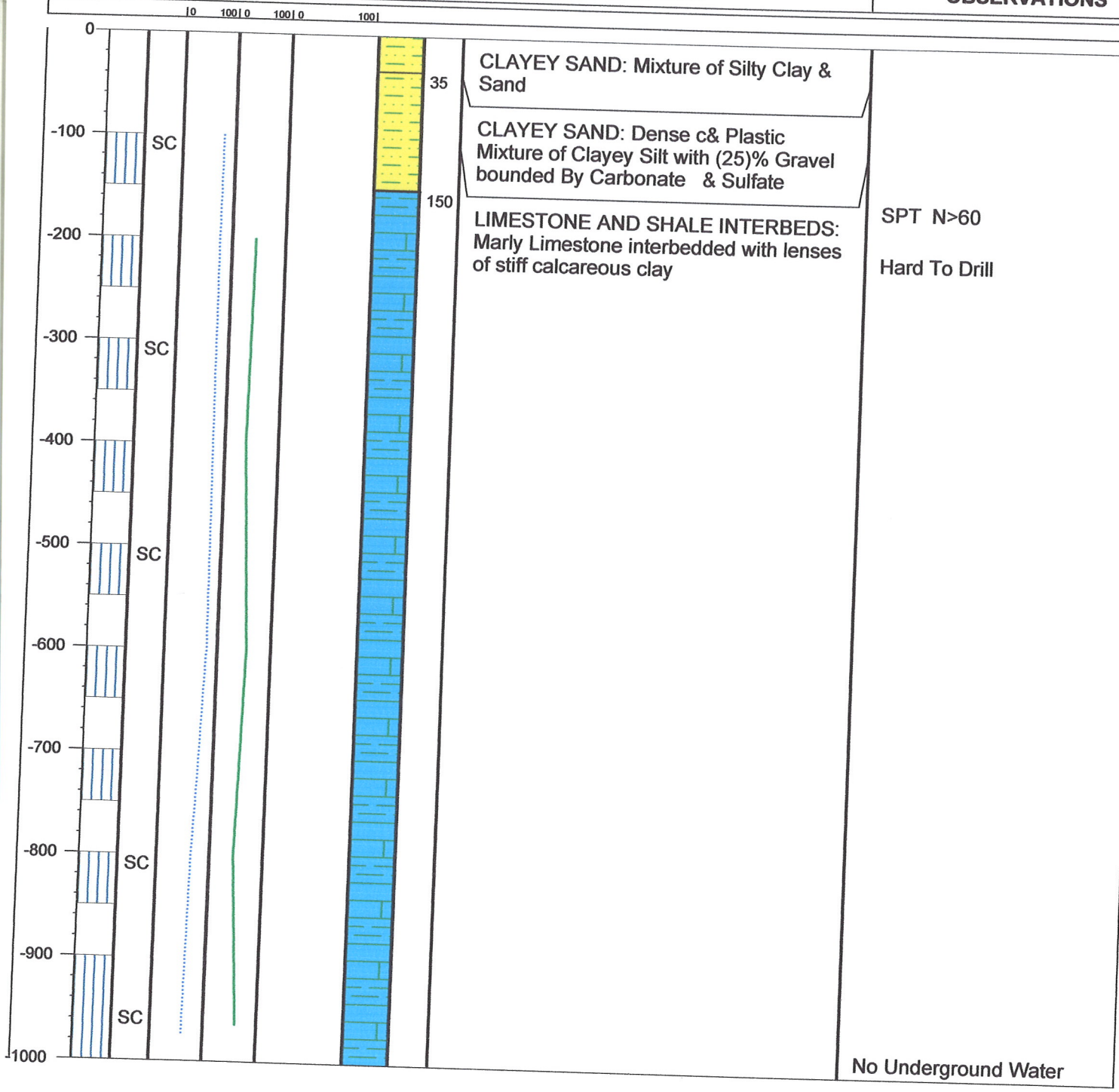
Sample Condition
- US Undisturbed
- D Disturbed
- L Lost
- SPT

Type of Sampler
- DC Double Core Barrel
- S Single Tube
- SS Split Spoon
- ST Shelby Tube

Chainage : E 38 07,317

Location : N 35 44 ,717

| DESCRIPTION | OBSERVATIONS |
|---|---|
| CLAYEY SAND: Mixture of Silty Clay & Sand | |
| CLAYEY SAND: Dense c& Plastic Mixture of Clayey Silt with (25)% Gravel bounded By Carbonate & Sulfate | |
| LIMESTONE AND SHALE INTERBEDS: Marly Limestone interbedded with lenses of stiff calcareous clay | SPT N>60<br>Hard To Drill |
| | No Underground Water |



Doctor Engineer
**Moh. Ayham Toutoungi**
Soil Mechanic & Foundation Consultant

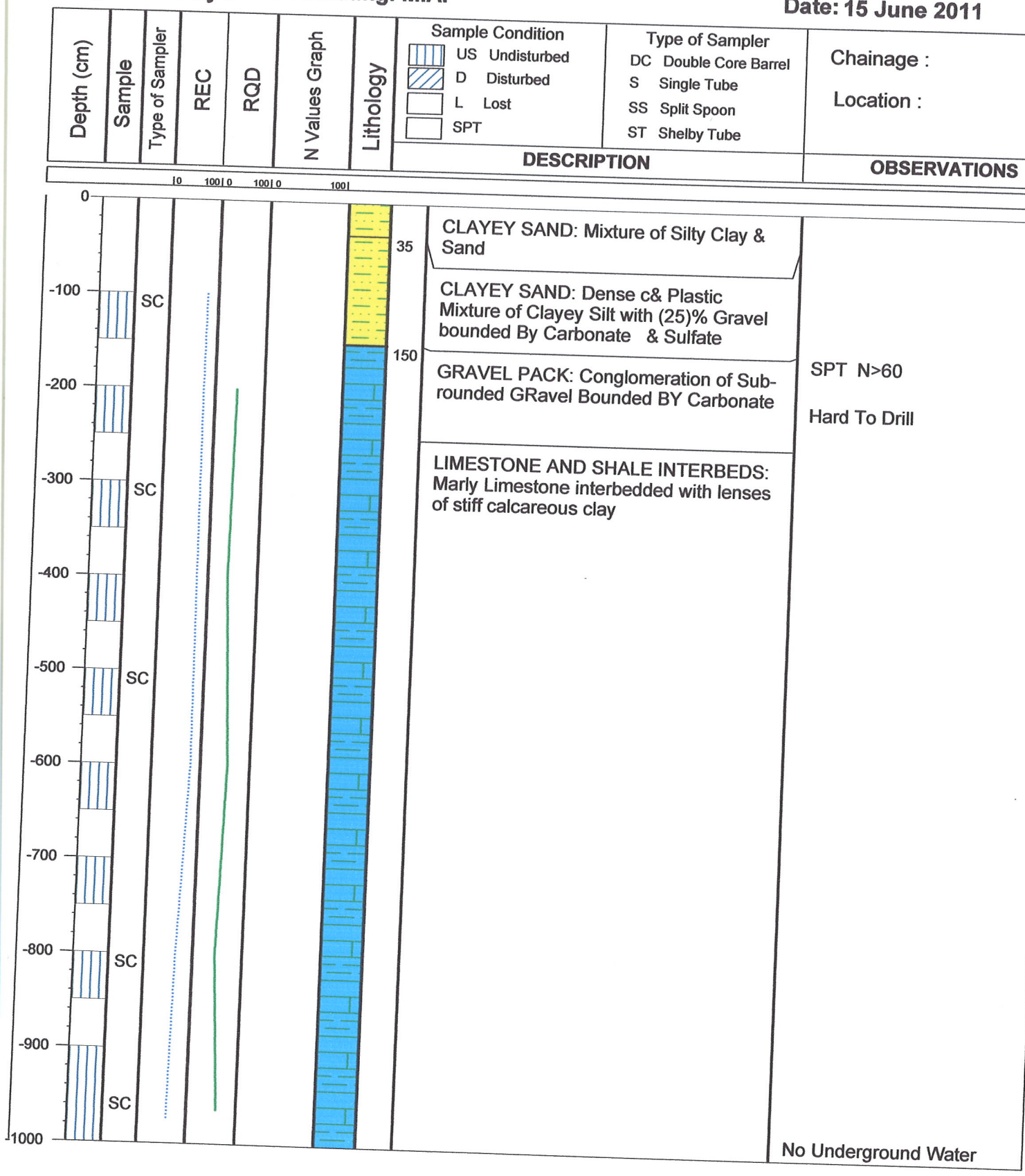
**Project :** Trefawi Site

**Drilling Rig:** Star

**Borehole : No 7**

**Supervised by :** Dr. Toutoungi M.A.

**Date: 15 June 2011**



Doctor Engineer
**Moh. Ayham Toutoungi**
Soil Mechanic & Foundation Consultant

**Project :** Trefawi Site

**Drilling Rig:** Star

**Borehole : No 8**

**Supervised by :** Dr. Toutoungi M.A.

**Date: 15 June 2011**

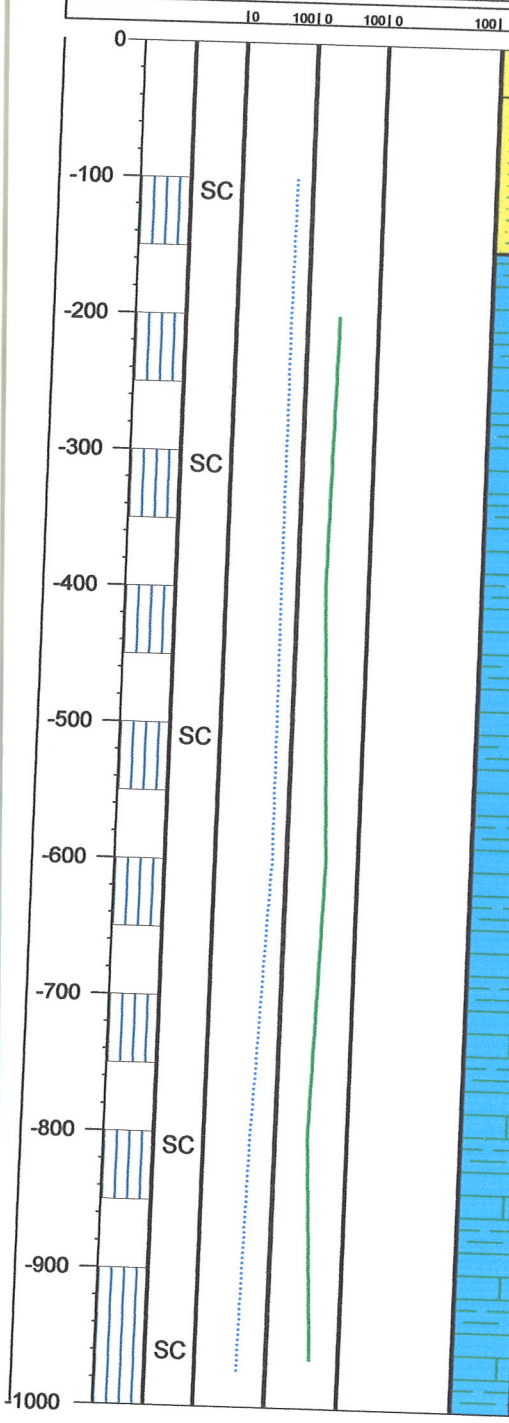
Depth (cm) | Sample | Type of Sampler | REC | RQD | N Values Graph | Lithology

Sample Condition: US Undisturbed; D Disturbed; L Lost; SPT

Type of Sampler: DC Double Core Barrel; S Single Tube; SS Split Spoon; ST Shelby Tube

Chainage :

Location :




| DESCRIPTION | | OBSERVATIONS |
|---|---|---|
| CLAYEY SAND: Mixture of Silty Clay & Sand | 35 | |
| CLAYEY SAND: Dense c& Plastic Mixture of Clayey Silt with (25)% Gravel bounded By Carbonate & Sulfate | 150 | |
| GRAVEL PACK: Conglomeration of Sub-rounded GRavel Bounded BY Carbonate | | SPT N>60<br>Hard To Drill |
| LIMESTONE AND SHALE INTERBEDS: Marly Limestone interbedded with lenses of stiff calcareous clay | | |
| | | No Underground Water |

Doctor Engineer
**Moh. Ayham Toutoungi**
Soil Mechanic & Foundation Consultant

**Project :** Trefawi Site

**Drilling Rig:** Star

**Borehole : No 9**

**Supervised by :** Dr. Toutoungi M.A.

**Date: 15 June 2011**

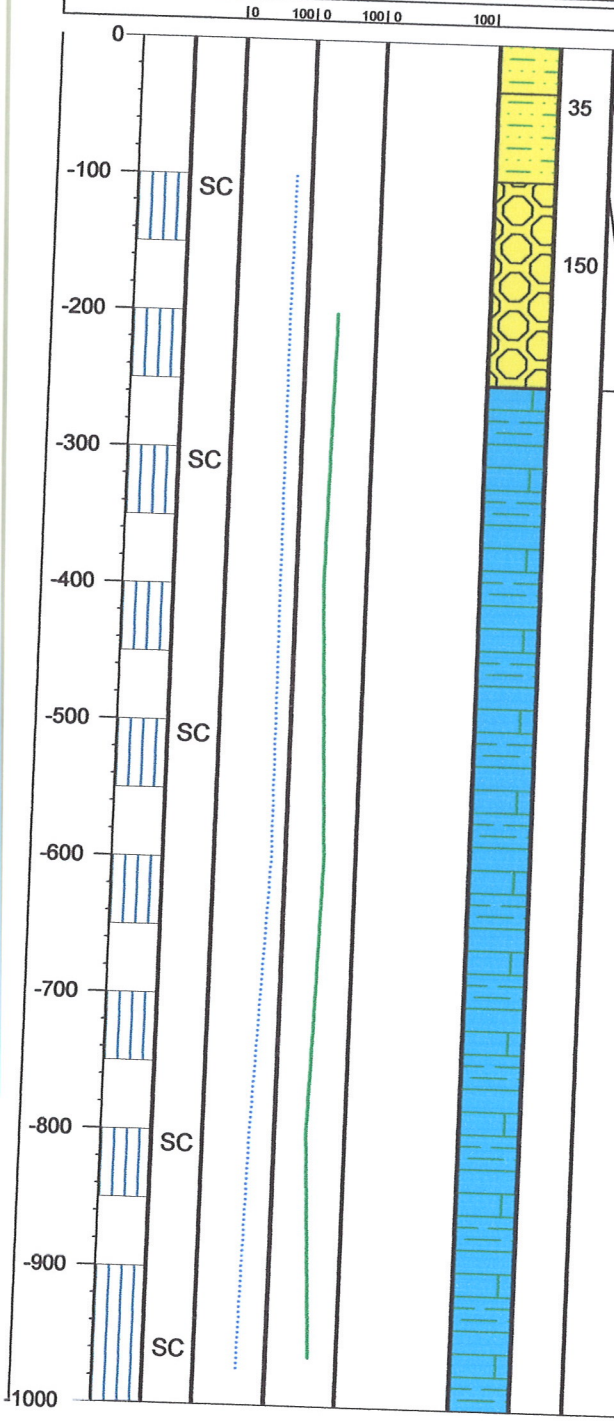
Depth (cm) | Sample | Type of Sampler | REC | RQD | N Values Graph | Lithology

Sample Condition: US Undisturbed; D Disturbed; L Lost; SPT

Type of Sampler: DC Double Core Barrel; S Single Tube; SS Split Spoon; ST Shelby Tube

Chainage :

Location :




| DESCRIPTION | OBSERVATIONS |
|---|---|
| CLAYEY SAND: Mixture of Silty Clay & Sand | |
| CLAYEY SAND: Dense c& Plastic Mixture of Clayey Silt with (25)% Gravel bounded By Carbonate & Sulfate | |
| GRAVEL PACK: Conglomeration of Sub-rounded GRavel Bounded BY Carbonate | SPT N>60<br>Hard To Drill |
| LIMESTONE AND SHALE INTERBEDS: Marly Limestone interbedded with lenses of stiff calcareous clay | No Underground Water |

Doctor Engineer
**Moh. Ayham Toutoungi**
Soil Mechanic & Foundation Consultant

**Project :** Trefawi Site

**Drilling Rig:** Star

**Borehole : No 10**

**Supervised by :** Dr. Toutoungi M.A.

**Date: 16 June 2011**

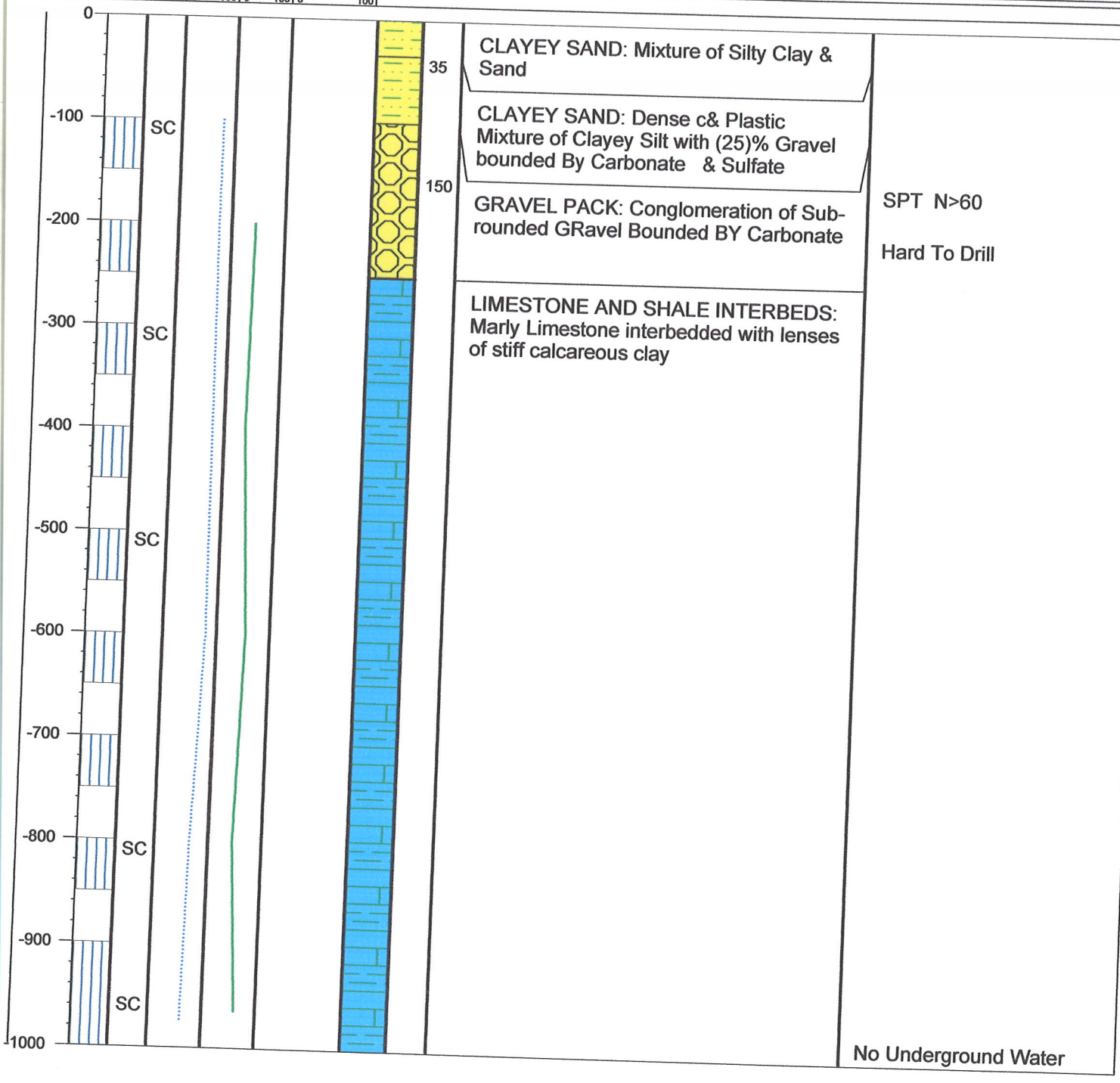
Depth (cm) | Sample | Type of Sampler | REC | RQD | N Values Graph | Lithology

Sample Condition: US Undisturbed; D Disturbed; L Lost; SPT

Type of Sampler: DC Double Core Barrel; S Single Tube; SS Split Spoon; ST Shelby Tube

Chainage :

Location :




**DESCRIPTION**

CLAYEY SAND: Mixture of Silty Clay & Sand

CLAYEY SAND: Dense c& Plastic Mixture of Clayey Silt with (25)% Gravel bounded By Carbonate & Sulfate

GRAVEL PACK: Conglomeration of Sub-rounded GRavel Bounded BY Carbonate

LIMESTONE AND SHALE INTERBEDS: Marly Limestone interbedded with lenses of stiff calcareous clay

**OBSERVATIONS**

SPT N>60

Hard To Drill

No Underground Water

Doctor Engineer
**Moh. Ayham Toutoungi**
Soil Mechanic & Foundation Consultant

**Project :** Trefawi Site
**Drilling Rig:** Star
**Supervised by :** Dr. Toutoungi M.A.

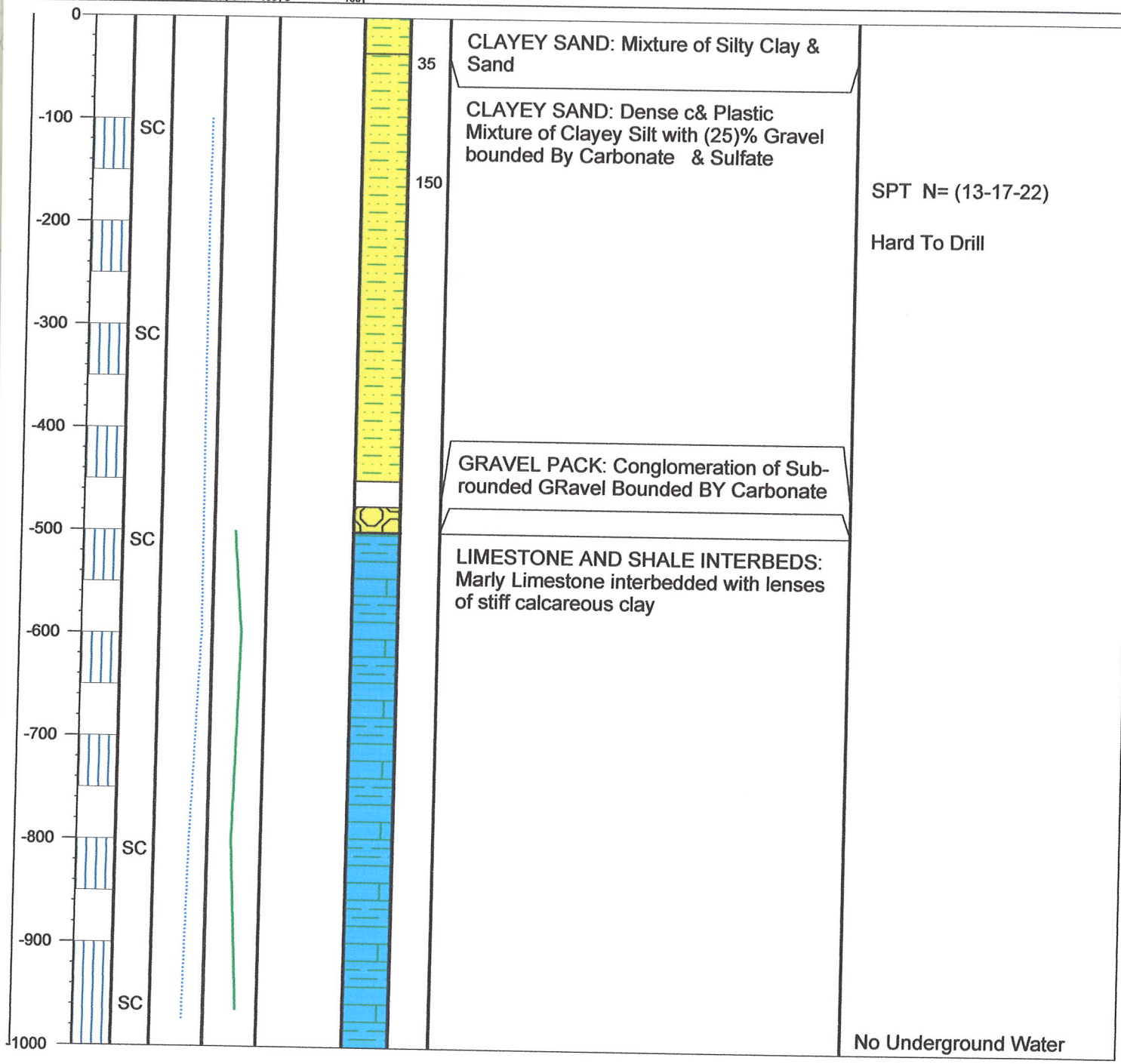
**Borehole : No 11**
**Date: 16 June 2011**

Depth (cm) | Sample | Type of Sampler | REC | RQD | N Values Graph | Lithology

Sample Condition: US Undisturbed; D Disturbed; L Lost; SPT

Type of Sampler: DC Double Core Barrel; S Single Tube; SS Split Spoon; ST Shelby Tube

Chainage :
Location :




| DESCRIPTION | OBSERVATIONS |
|---|---|
| CLAYEY SAND: Mixture of Silty Clay & Sand | |
| CLAYEY SAND: Dense c& Plastic Mixture of Clayey Silt with (25)% Gravel bounded By Carbonate & Sulfate | SPT N= (13-17-22)<br>Hard To Drill |
| GRAVEL PACK: Conglomeration of Sub-rounded GRavel Bounded BY Carbonate | |
| LIMESTONE AND SHALE INTERBEDS: Marly Limestone interbedded with lenses of stiff calcareous clay | No Underground Water |

Doctor Engineer
**Moh. Ayham Toutoungi**
Soil Mechanic & Foundation Consultant

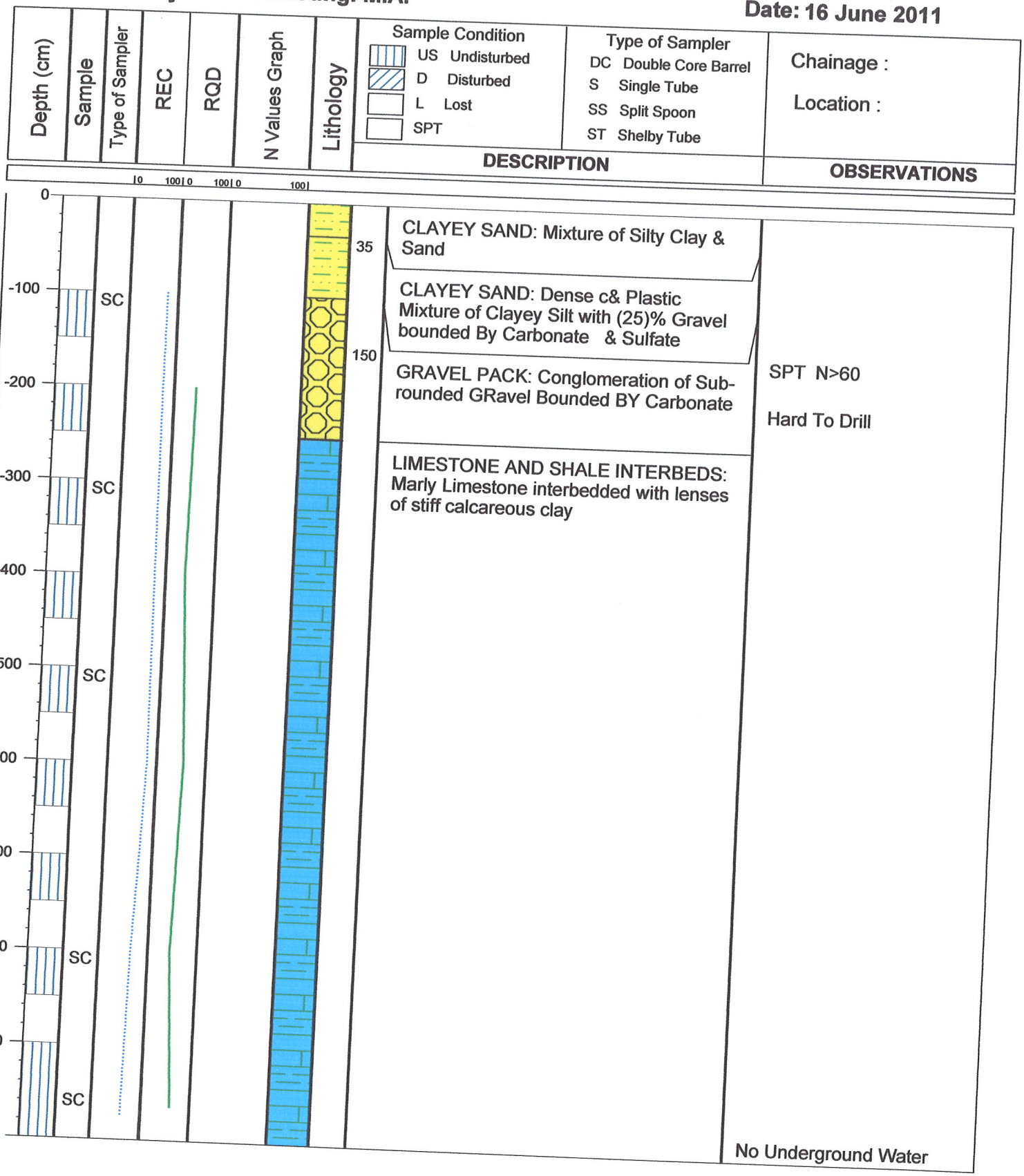
**Project :** Trefawi Site

**Drilling Rig:** Star

**Borehole : No 12**

**Supervised by :** Dr. Toutoungi M.A.

**Date: 16 June 2011**



Doctor Engineer
**Moh. Ayham Toutoungi**
Soil Mechanic & Foundation Consultant

**Project :** Trefawi Site
**Drilling Rig:** Star
**Supervised by :** Dr. Toutoungi M.A.

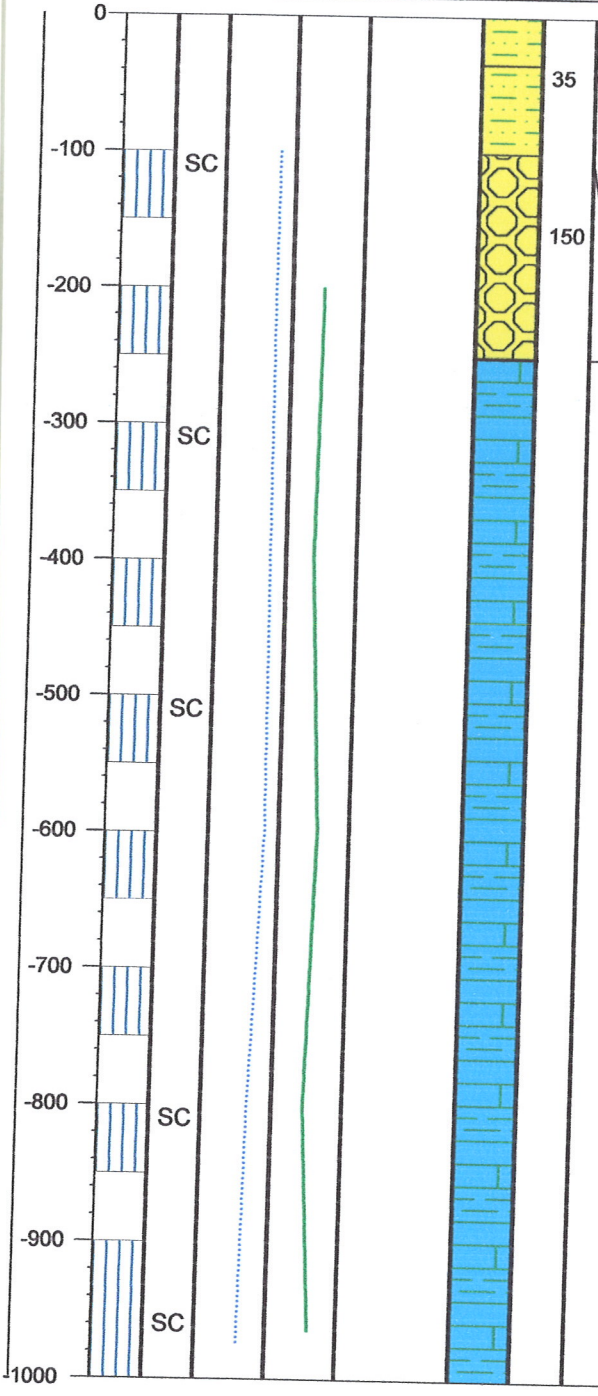
**Borehole : No 13**
**Date: 16 June 2011**

Depth (cm) | Sample | Type of Sampler | REC | RQD | N Values Graph | Lithology

Sample Condition: US Undisturbed; D Disturbed; L Lost; SPT

Type of Sampler: DC Double Core Barrel; S Single Tube; SS Split Spoon; ST Shelby Tube

Chainage :
Location :




**DESCRIPTION**

CLAYEY SAND: Mixture of Silty Clay & Sand

CLAYEY SAND: Dense c& Plastic Mixture of Clayey Silt with (25)% Gravel bounded By Carbonate & Sulfate

GRAVEL PACK: Conglomeration of Sub-rounded GRavel Bounded BY Carbonate

LIMESTONE AND SHALE INTERBEDS: Marly Limestone interbedded with lenses of stiff calcareous clay

**OBSERVATIONS**

SPT N>60

Hard To Drill

No Underground Water

Doctor Engineer
**Moh. Ayham Toutoungi**
Soil Mechanic & Foundation Consultant

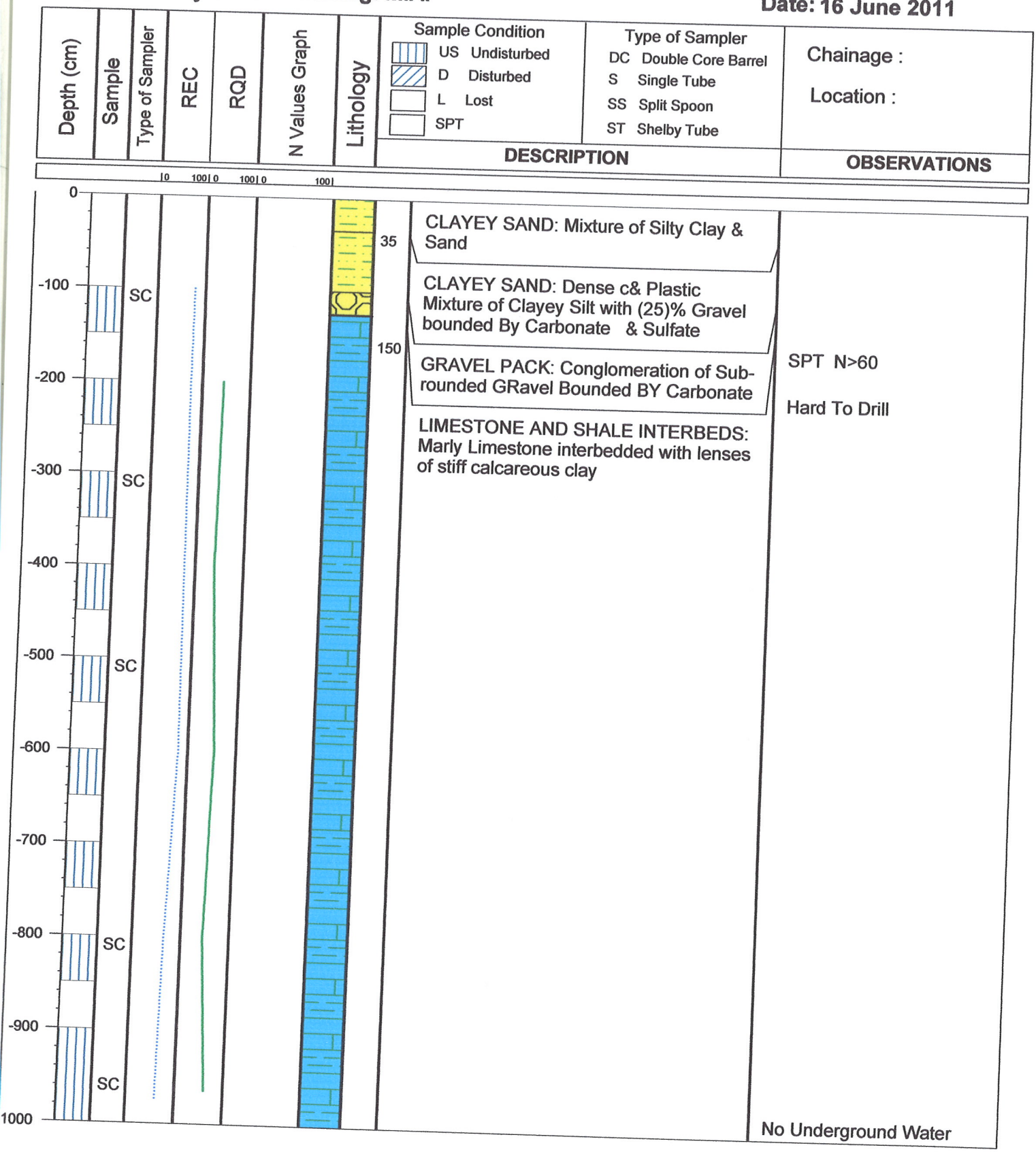
**Project :** Trefawi Site

**Drilling Rig:** Star

**Borehole : No 14**

**Supervised by :** Dr. Toutoungi M.A.

**Date: 16 June 2011**



**Doctor Engineer**

# Moh. Ayham Toutoungi

**Soil Mechanic & Foundation Consultant**

**Project :** Trefawi Site

**Drilling Rig:** Star

**Supervised by :** Dr. Toutoungi M.A.

**Borehole : No 15**

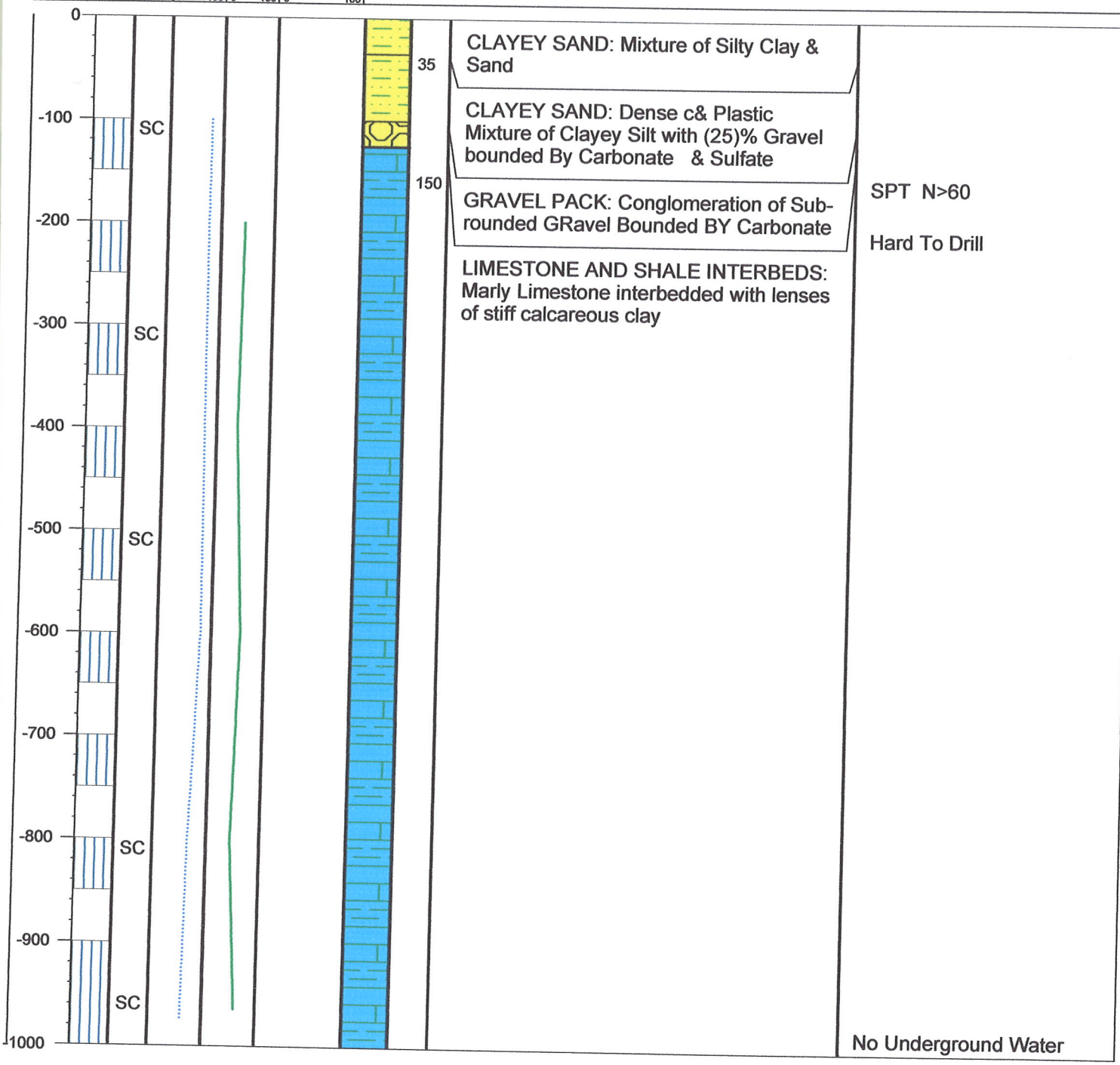
**Date: 16 June 2011**

Sample Condition: US Undisturbed; D Disturbed; L Lost; SPT

Type of Sampler: DC Double Core Barrel; S Single Tube; SS Split Spoon; ST Shelby Tube

Chainage :

Location :




| DESCRIPTION | OBSERVATIONS |
|---|---|
| CLAYEY SAND: Mixture of Silty Clay & Sand | |
| CLAYEY SAND: Dense c& Plastic Mixture of Clayey Silt with (25)% Gravel bounded By Carbonate & Sulfate | SPT N>60 |
| GRAVEL PACK: Conglomeration of Sub-rounded GRavel Bounded BY Carbonate | Hard To Drill |
| LIMESTONE AND SHALE INTERBEDS: Marly Limestone interbedded with lenses of stiff calcareous clay | No Underground Water |

**Doctor Engineer**

# Moh. Ayham Toutoungi

**Soil Mechanic & Foundation Consultant**

**Project : Trefawi Site**

**Drilling Rig: Star**

**Borehole : No 16**

**Supervised by : Dr. Toutoungi M.A.**

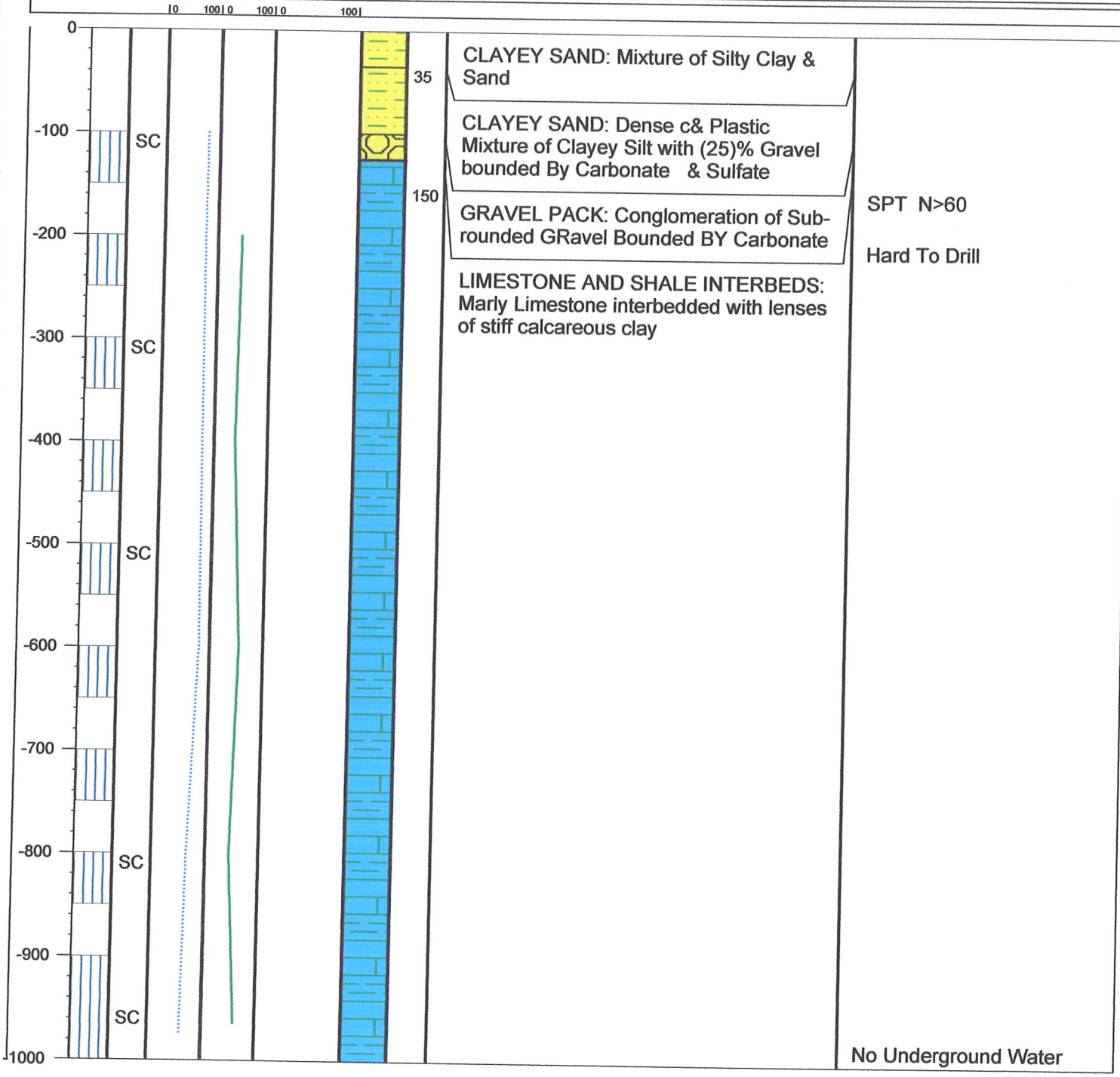
**Date: 16 June 2011**

Sample Condition: US Undisturbed; D Disturbed; L Lost; SPT

Type of Sampler: DC Double Core Barrel; S Single Tube; SS Split Spoon; ST Shelby Tube

Chainage :

Location :




**DESCRIPTION**

CLAYEY SAND: Mixture of Silty Clay & Sand

CLAYEY SAND: Dense c& Plastic Mixture of Clayey Silt with (25)% Gravel bounded By Carbonate & Sulfate

GRAVEL PACK: Conglomeration of Sub-rounded GRavel Bounded BY Carbonate

LIMESTONE AND SHALE INTERBEDS: Marly Limestone interbedded with lenses of stiff calcareous clay

**OBSERVATIONS**

SPT N>60

Hard To Drill

No Underground Water

Doctor Engineer
**Moh. Ayham Toutoungi**
Soil Mechanic & Foundation Consultant

**Project :** Trefawi Site
**Drilling Rig:** Star
**Supervised by :** Dr. Toutoungi M.A.

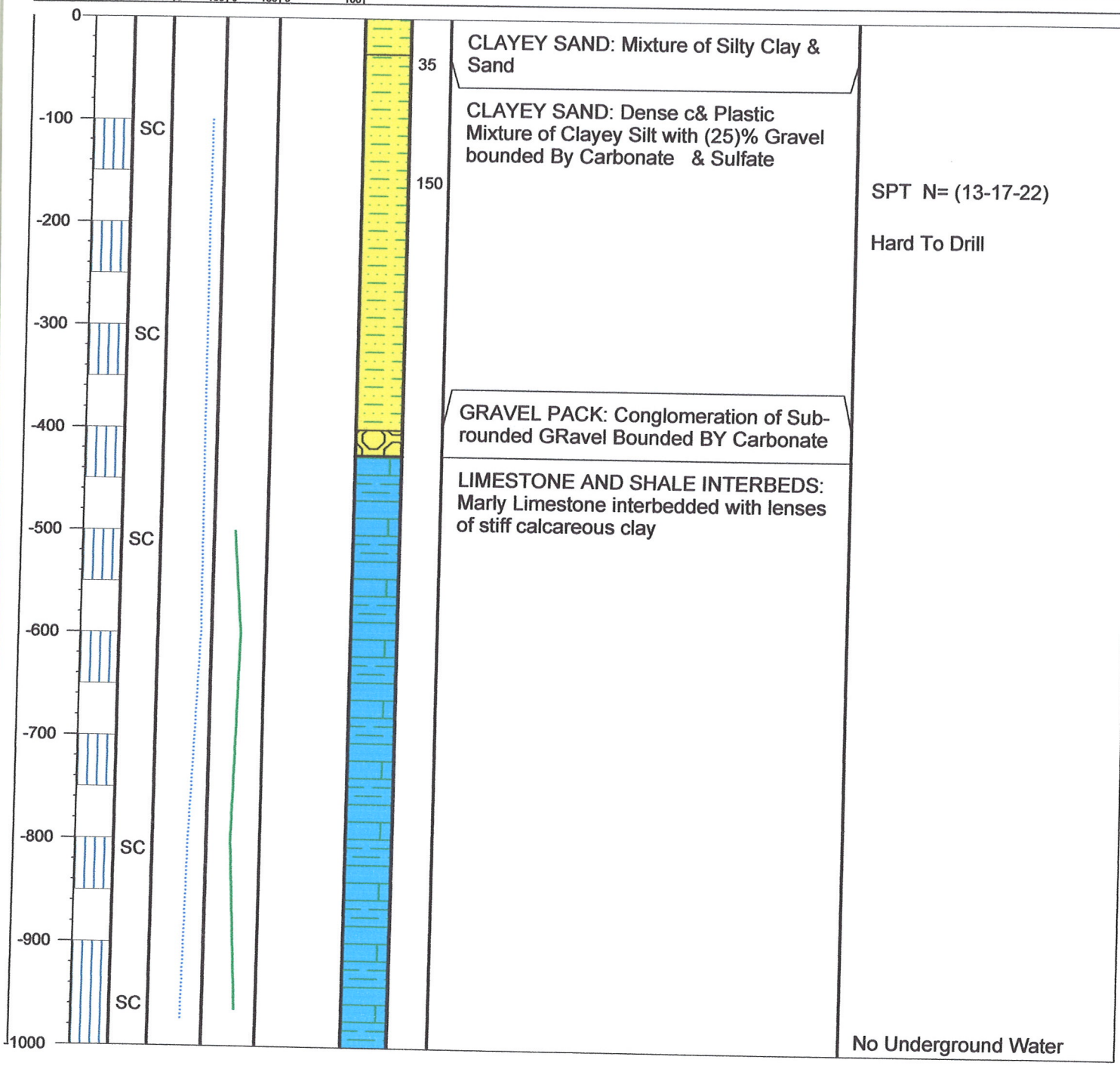
**Borehole : No 17**
**Date: 16 June 2011**

Depth (cm) | Sample | Type of Sampler | REC | RQD | N Values Graph | Lithology

Sample Condition: US Undisturbed; D Disturbed; L Lost; SPT
Type of Sampler: DC Double Core Barrel; S Single Tube; SS Split Spoon; ST Shelby Tube

Chainage :
Location :

| DESCRIPTION | OBSERVATIONS |
|---|---|
| CLAYEY SAND: Mixture of Silty Clay & Sand | |
| CLAYEY SAND: Dense c& Plastic Mixture of Clayey Silt with (25)% Gravel bounded By Carbonate & Sulfate | SPT N= (13-17-22)<br>Hard To Drill |
| GRAVEL PACK: Conglomeration of Sub-rounded GRavel Bounded BY Carbonate | |
| LIMESTONE AND SHALE INTERBEDS: Marly Limestone interbedded with lenses of stiff calcareous clay | No Underground Water |



Doctor Engineer
**Moh. Ayham Toutoungi**
Soil Mechanic & Foundation Consultant

**Project :** Trefawi Site
**Drilling Rig:** Star
**Supervised by :** Dr. Toutoungi M.A.

**Borehole : No 18**
**Date: 16 June 2011**

Depth (cm) | Sample | Type of Sampler | REC | RQD | N Values Graph | Lithology

Sample Condition: US Undisturbed; D Disturbed; L Lost; SPT

Type of Sampler: DC Double Core Barrel; S Single Tube; SS Split Spoon; ST Shelby Tube

Chainage :
Location :

| DESCRIPTION | OBSERVATIONS |
|---|---|
| CLAYEY SAND: Mixture of Silty Clay & Sand (0 – 35) | |
| CLAYEY SAND: Dense c& Plastic Mixture of Clayey Silt with (25)% Gravel bounded By Carbonate & Sulfate (35 – 150) | SPT N= (13-17-22)<br>Hard To Drill |
| GRAVEL PACK: Conglomeration of Sub-rounded GRavel Bounded BY Carbonate (150 – 500) | |
| LIMESTONE AND SHALE INTERBEDS: Marly Limestone interbedded with lenses of stiff calcareous clay (500 – 1000) | No Underground Water |

0 | -100 | -200 | -300 | -400 | -500 | -600 | -700 | -800 | -900 | -1000

SC | SC | SC | SC | SC

Doctor Engineer
**Moh. Ayham Toutoungi**
Soil Mechanic & Foundation Consultant

**Project :** Trefawi Site
**Drilling Rig:** Star
**Supervised by :** Dr. Toutoungi M.A.

**Borehole : No 19**
**Date: 16 June 2011**

Depth (cm) | Sample | Type of Sampler | REC | RQD | N Values Graph | Lithology

Sample Condition: US Undisturbed; D Disturbed; L Lost; SPT

Type of Sampler: DC Double Core Barrel; S Single Tube; SS Split Spoon; ST Shelby Tube

Chainage :
Location :

| DESCRIPTION | OBSERVATIONS |
|---|---|
| CLAYEY SAND: Mixture of Silty Clay & Sand (0 – 35) | |
| CLAYEY SAND: Dense c& Plastic Mixture of Clayey Silt with (25)% Gravel bounded By Carbonate & Sulfate (35 – 150) | |
| GRAVEL PACK: Conglomeration of Sub-rounded GRavel Bounded BY Carbonate (150 – 200) | SPT N>60 |
| LIMESTONE AND SHALE INTERBEDS: Marly Limestone interbedded with lenses of stiff calcareous clay (200 – 1000) | Hard To Drill |
| | No Underground Water |

0 | -100 | -200 | -300 | -400 | -500 | -600 | -700 | -800 | -900 | -1000

SC | SC | SC | SC | SC

Doctor Engineer
**Moh. Ayham Toutoungi**
Soil Mechanic & Foundation Consultant

**Project :** Trefawi Site
**Drilling Rig:** Star
**Supervised by :** Dr. Toutoungi M.A.

**Borehole : No 20**
**Date: 16 June 2011**

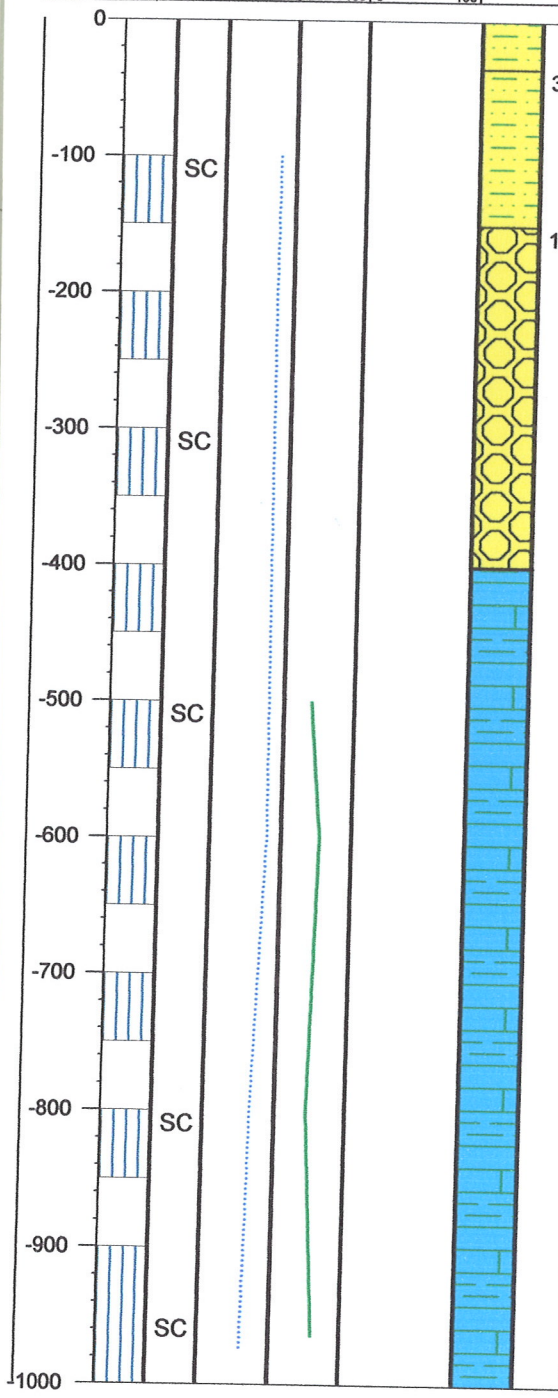
Depth (cm) | Sample | Type of Sampler | REC | RQD | N Values Graph | Lithology

Sample Condition: US Undisturbed; D Disturbed; L Lost; SPT

Type of Sampler: DC Double Core Barrel; S Single Tube; SS Split Spoon; ST Shelby Tube

Chainage :
Location :

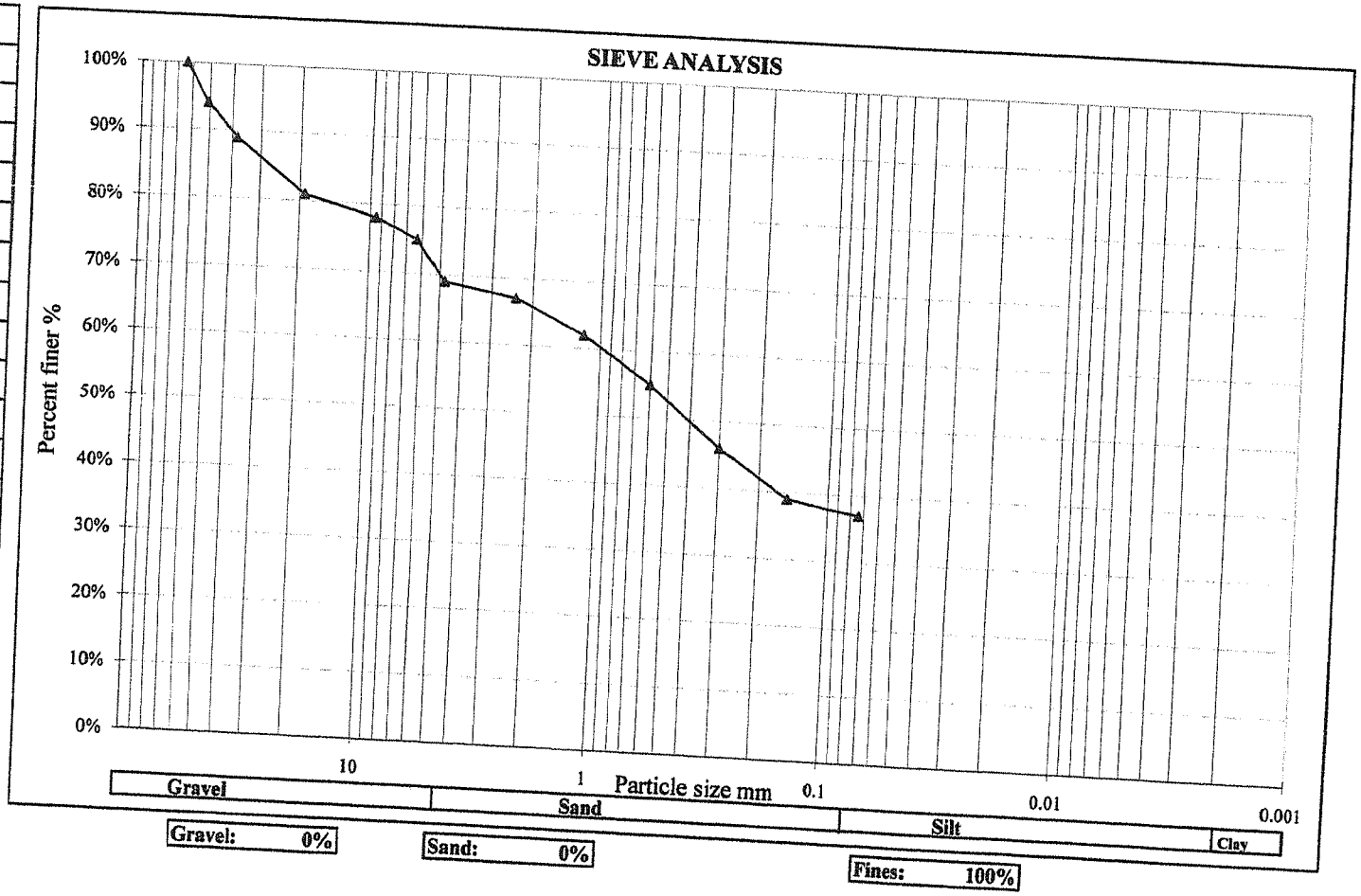
| DESCRIPTION | OBSERVATIONS |
|---|---|
| CLAYEY SAND: Mixture of Silty Clay & Sand (0 – 35) | |
| CLAYEY SAND: Dense c& Plastic Mixture of Clayey Silt with (25)% Gravel bounded By Carbonate & Sulfate (35 – 150) | |
| GRAVEL PACK: Conglomeration of Sub-rounded GRavel Bounded BY Carbonate (150 – 400) | SPT N= (1`1-15-20)<br>Hard To Drill |
| LIMESTONE AND SHALE INTERBEDS: Marly Limestone interbedded with lenses of stiff calcareous clay (400 – 1000) | No Underground Water |



**Project :** Trefawi power plant

**Borehole 1**
**Depth: m**

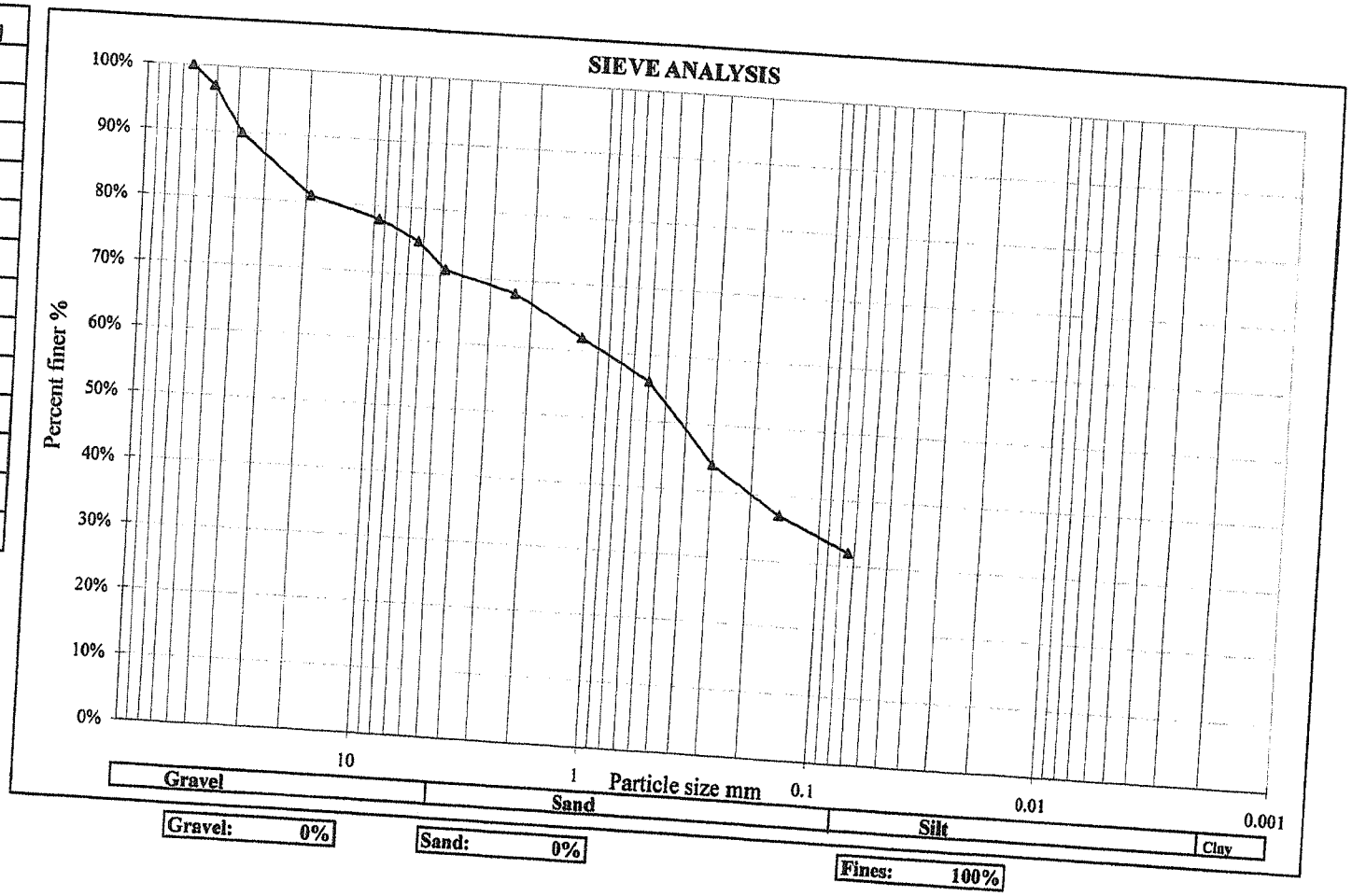
| no. | Opening | Passing |
|---|---|---|
| 2.5" | 63.5 | 100% |
| 2" | 50.8 | 94% |
| 1.5" | 38.1 | 89% |
| 3/4" | 19.1 | 81% |
| 3/8" | 9.52 | 78% |
| 1/4" | 6.35 | 75% |
| No. 4 | 4.76 | 69% |
| No. 8 | 2.36 | 67% |
| No. 16 | 1.18 | 62% |
| No. 30 | 0.6 | 55% |
| No. 50 | 0.3 | 46% |
| No. 100 | 0.15 | 39% |
| No. 200 | 0.074 | 37% |



**Project :** Trefawi power plant

**Borehole 15**
**Depth: 1m**

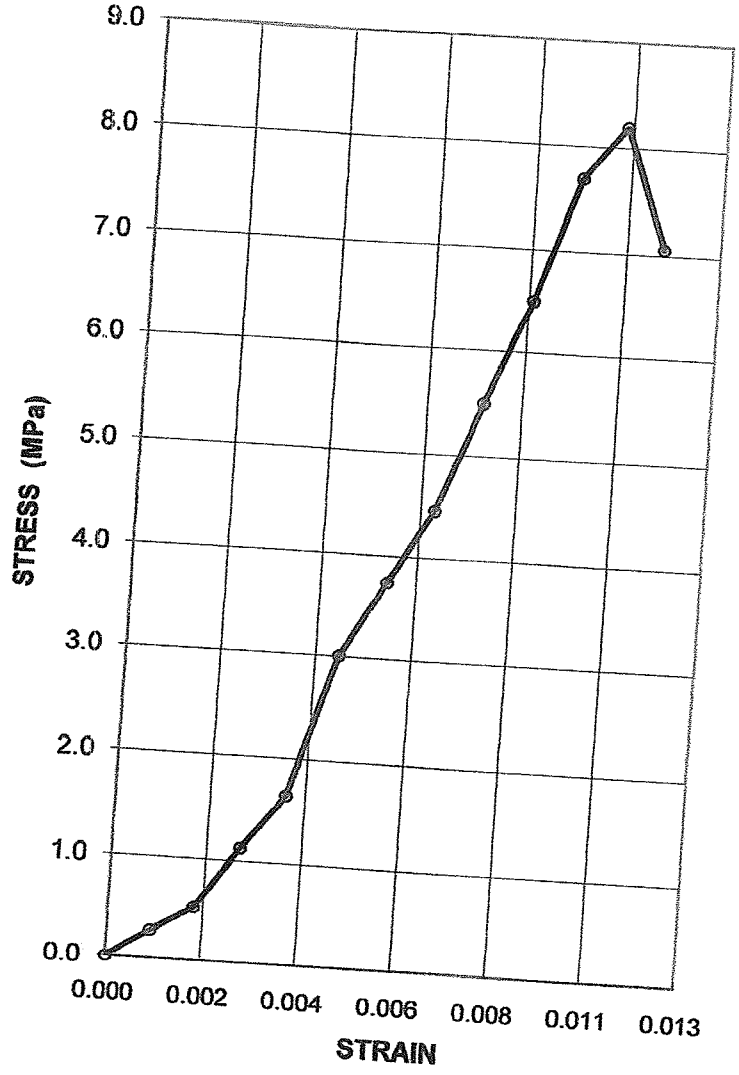
| no. | Opening | Passing |
|---|---|---|
| 2.5" | 63.5 | 100% |
| 2" | 50.8 | 97% |
| 1.5" | 38.1 | 90% |
| 3/4" | 19.1 | 81% |
| 3/8" | 9.52 | 78% |
| 1/4" | 6.35 | 75% |
| No. 4 | 4.76 | 71% |
| No. 8 | 2.36 | 68% |
| No. 16 | 1.18 | 62% |
| No. 30 | 0.6 | 56% |
| No. 50 | 0.3 | 44% |
| No. 100 | 0.15 | 37% |
| No. 200 | 0.074 | 32% |



# UNCONFINED COMPRESSIVE STRENGTH OF ROCK DUCTILE CORE SAMPLES

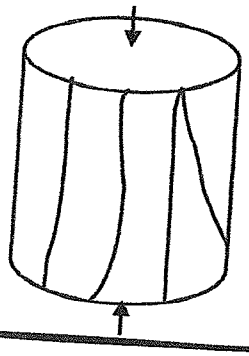
| | | | |
|---|---|---|---|
| PROJECT | Trefawi Power Plant | REF No. | |
| CLIENT | PEEGT | Diameter | 61 mm |
| LOCATION | Trefawi area | Height | 106.0 mm |
| SAMPLE No. | BH -2 - (Depth 2.25 M) | Test Ref | ASTM D3148 |
| DESCRIPTION | Light yellow marly limestone | | |

## STRESS VS STRAIN




| STRAIN | STRESS |
|---|---|
| - | (Mpa) |
| 0.0000 | 0.00 |
| 0.0009 | 0.28 |
| 0.0019 | 0.53 |
| 0.0028 | 1.12 |
| 0.0038 | 1.65 |
| 0.0047 | 3.01 |
| 0.0057 | 3.74 |
| 0.0066 | 4.46 |
| **0.0075** | **5.50** |
| 0.0085 | 6.50 |
| 0.0094 | 7.70 |
| **0.0104** | **8.20** |
| 0.0113 | 7.06 |
| | |
| | |
| | |
| | |
| | |

FAILURE PATTERN

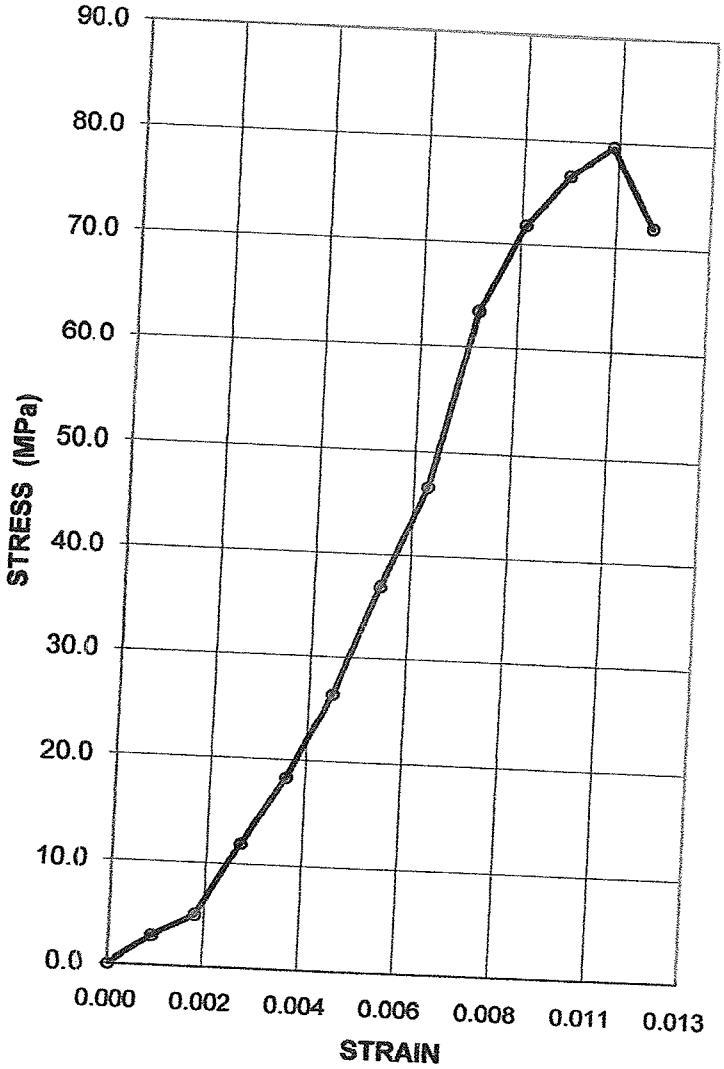


| Unconfined Compressive Strength (Mpa) | Young's Modulus Stress/strain, MPa | Natural Moisture Content, % | Dry Unit Weight ($g/cm^3$) |
|---|---|---|---|
| 8.20 | 947 | 0.56 | 2.270 |

# UNCONFINED COMPRESSIVE STRENGTH OF ROCK CORE SAMPLES

| | | | |
|---|---|---|---|
| **PROJECT** | Trefawi power plant | **REF No.** | |
| **CLIENT** | PEERGT | **Diameter** | 61 mm |
| **LOCATION** | Trefawi area | **Height** | 106.0 mm |
| **SAMPLE No.** | BH - 7 - (Depth 2.20 M) | **Test Ref** | ASTM D3148 |
| **DESCRIPTION** | Marly limestone | | |

## STRESS VS STRAIN




| STRAIN | STRESS |
|---|---|
| - | *(Mpa)* |
| 0.0000 | 0.00 |
| 0.0009 | 2.80 |
| 0.0019 | 4.99 |
| 0.0028 | 12.00 |
| 0.0038 | 18.32 |
| 0.0047 | 26.42 |
| 0.0057 | 37.00 |
| 0.0066 | 46.63 |
| **0.0075** | **63.50** |
| 0.0085 | 71.80 |
| 0.0094 | 76.70 |
| **0.0104** | **79.60** |
| 0.0113 | 71.90 |
| | |
| | |
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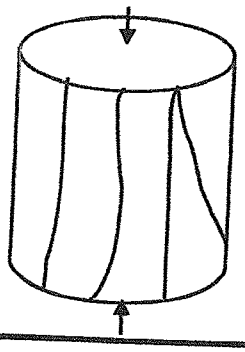
| | |
| | |

FAILURE PATTERN



| Unconfined Compressive Strength (Mpa) | Young's Modulus Stress/strain, MPa | Natural Moisture Content, % | Dry Unit Weight ($g/cm^3$) |
|---|---|---|---|
| 79.60 | 9031 | 0.56 | 2.270 |

**Project :** Trefawi Power Plant

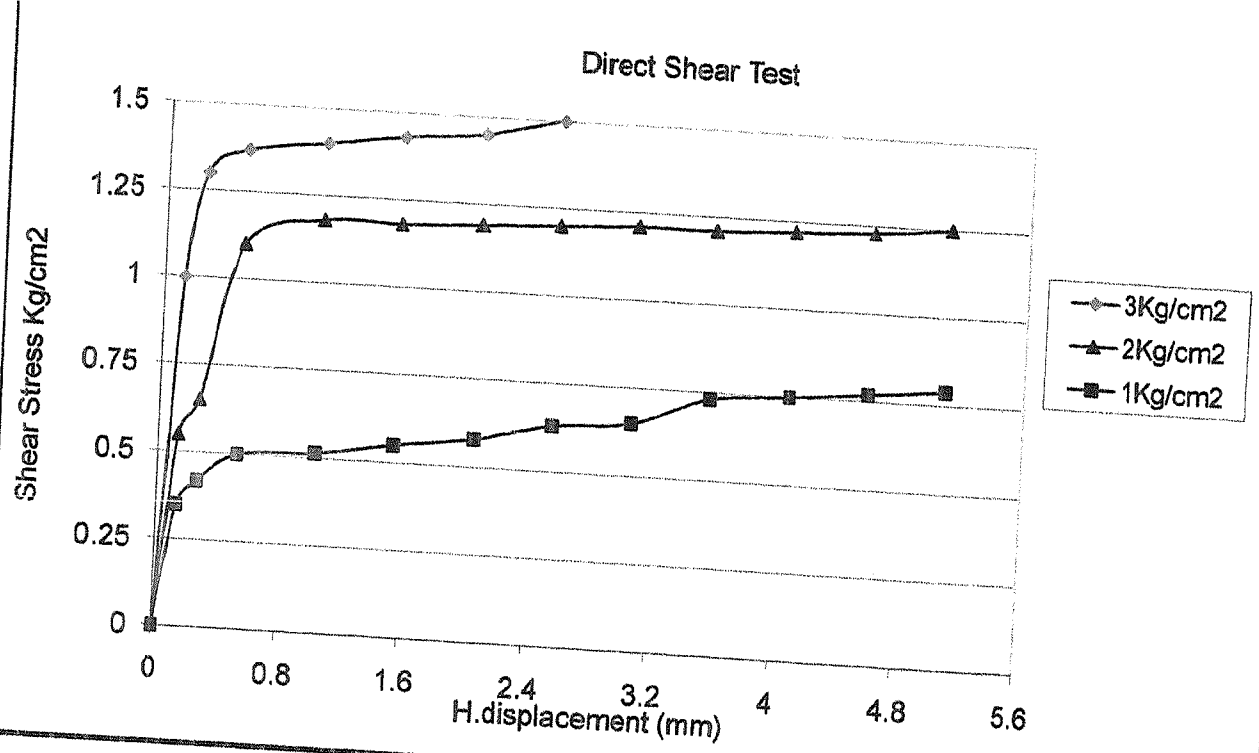
**Borehole N2**

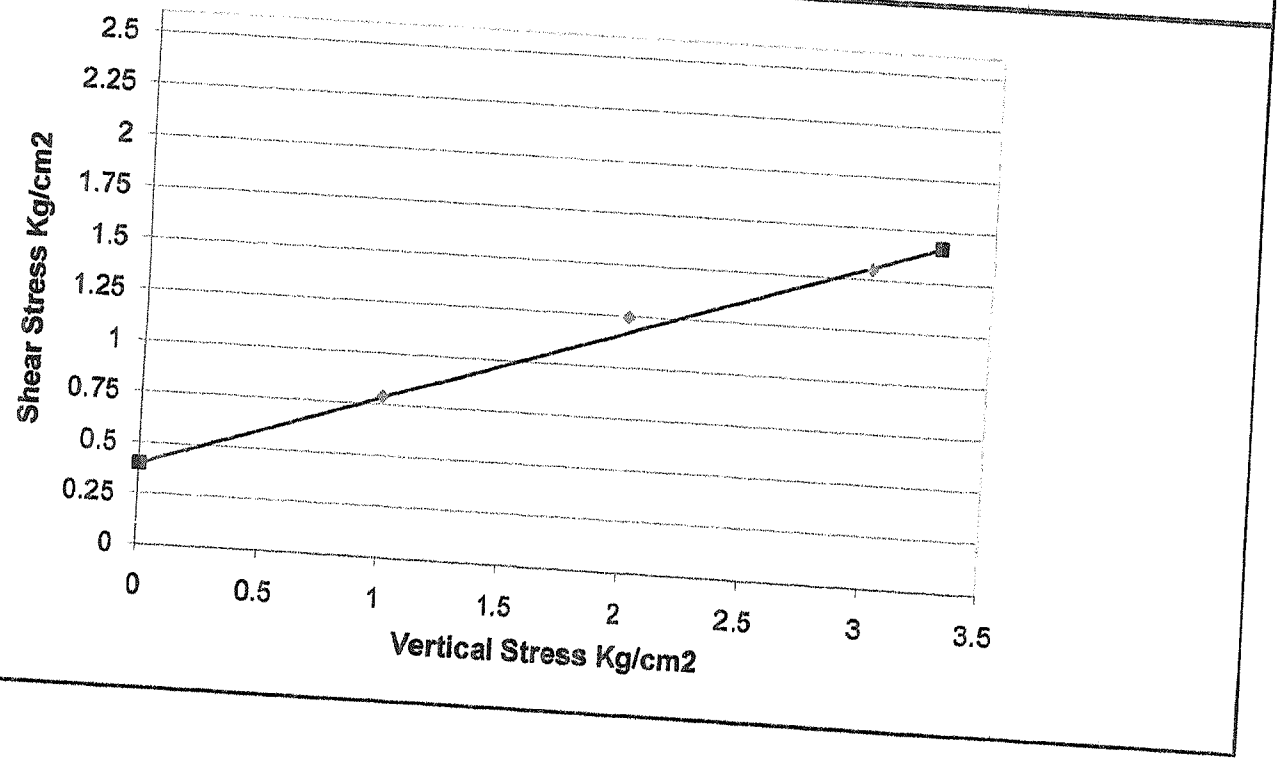
**DEPTH :** 3m

***Remoulded Submerged Sample***

**C=0.30 kg/cm2**

**Φ (deg)= 20**



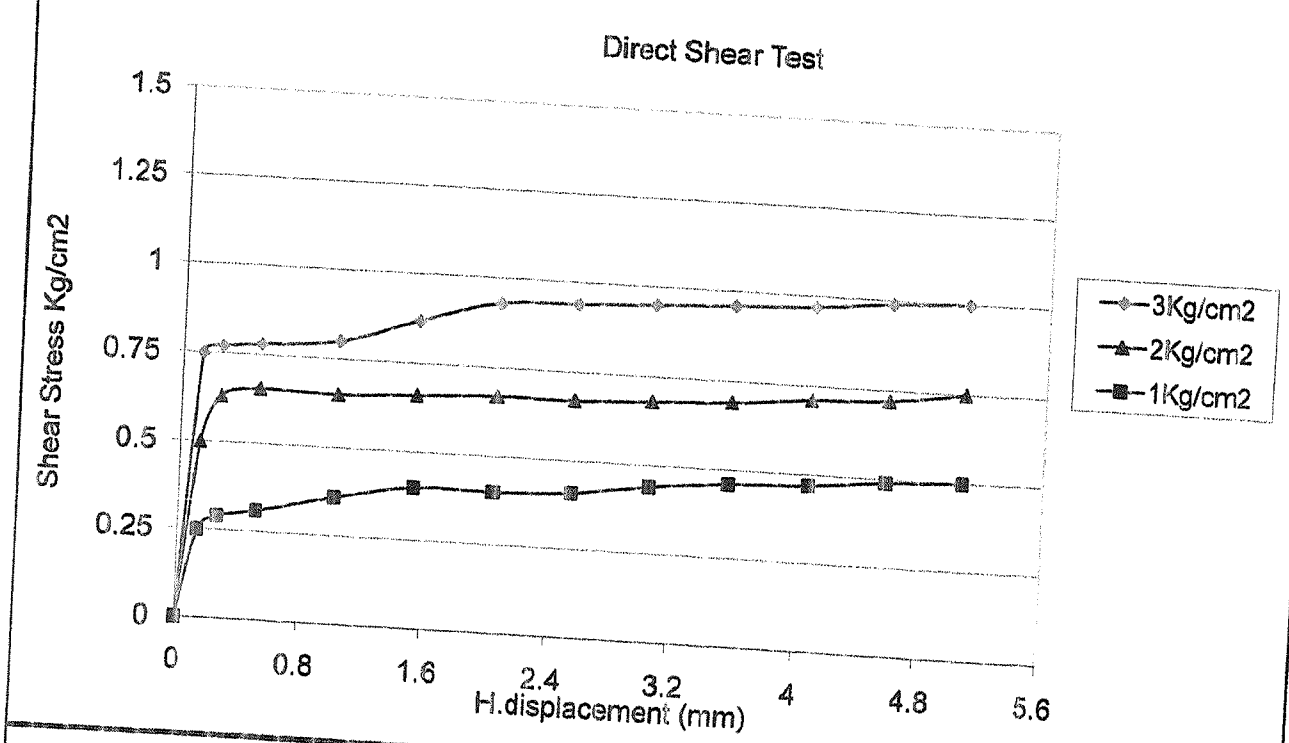
Project: Helawi Power Plant

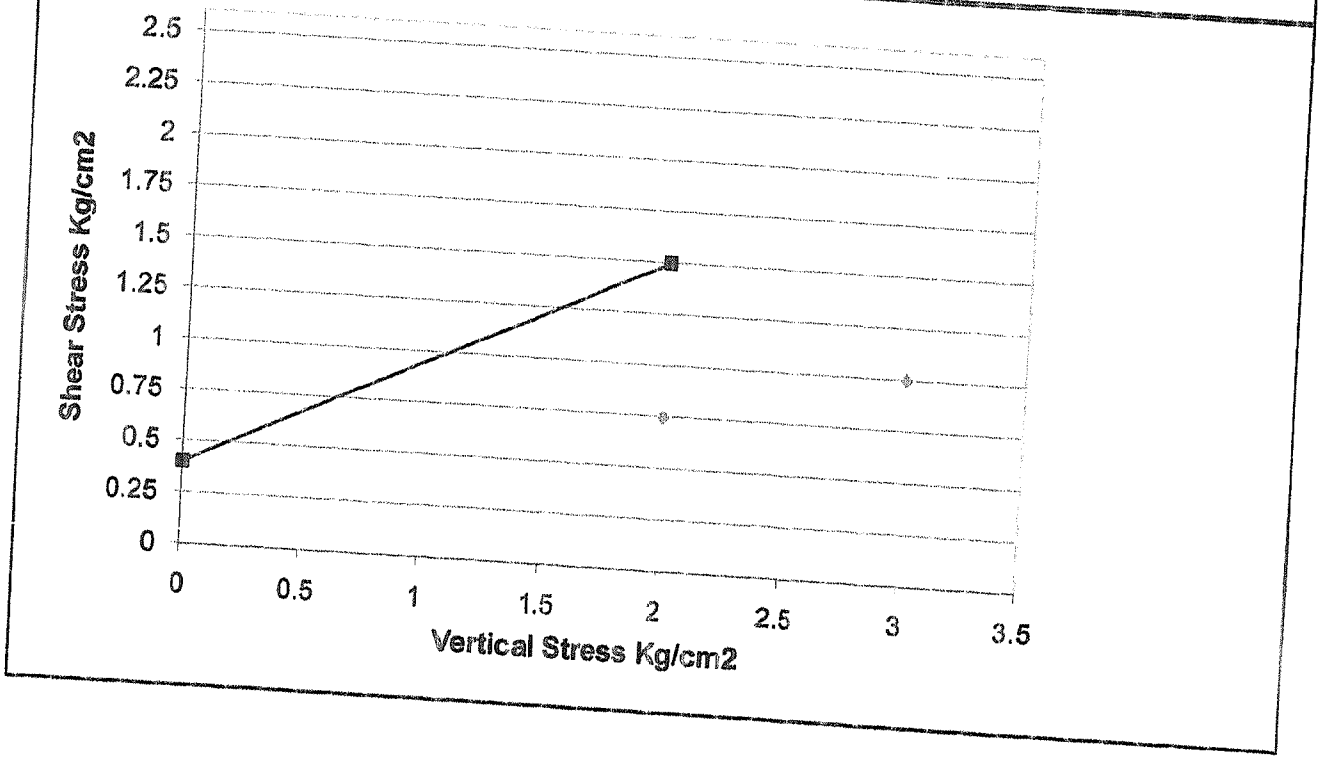
**Borehole N 20**
**Depth: 2m**

***Remoulded Submerged Sample***

**C= 0,4kg/cm2**

**Φ (deg)= 25**



**Project :** Trefawi Power plant

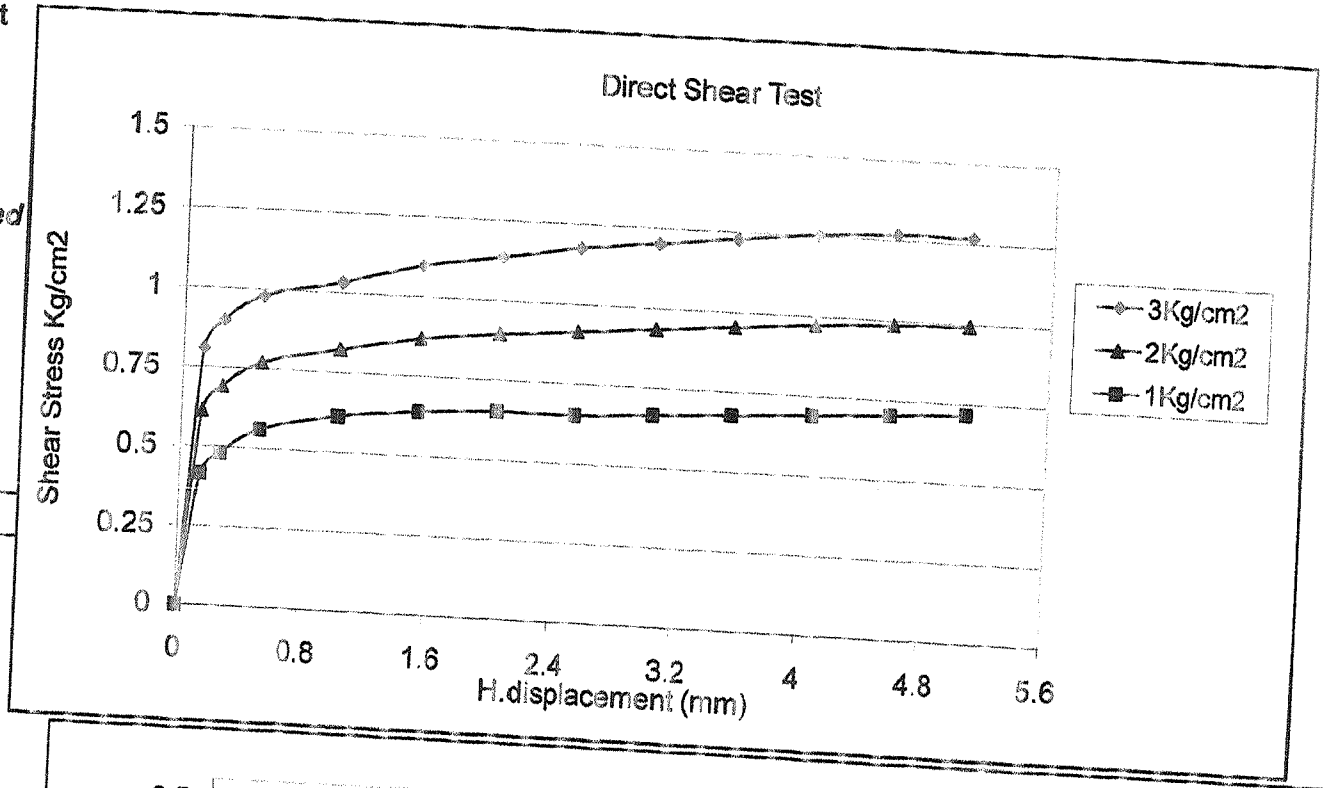
**Borehole N 1**

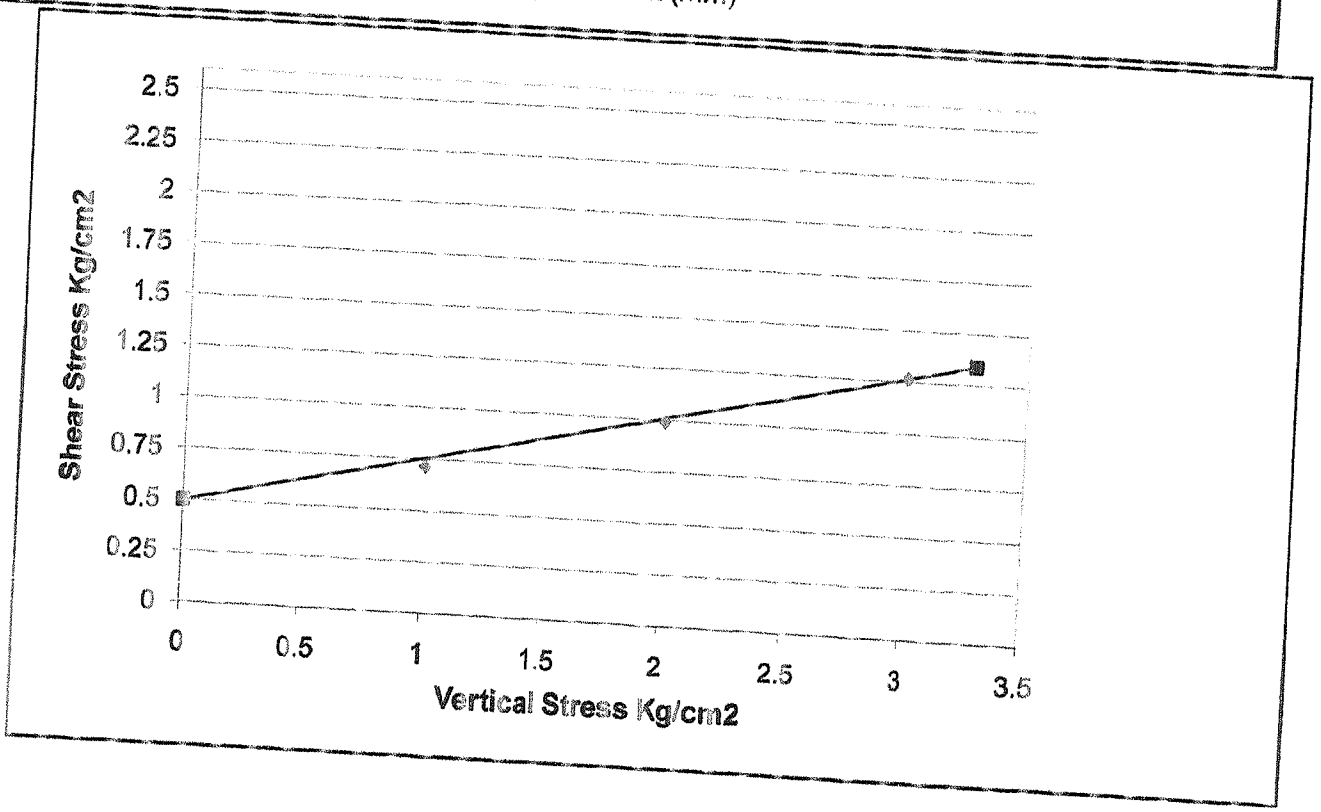
**Depth :** 1.25 m

***Satutated Ubdrained Unconsolidated***

$C_{uu}$=0.50 Kg/cm2

Φ (deg)= 15



## SHEET CALCULATION

### Bearing Capacity:

Terzaghi theory:

$q_{adm} = 1/3[\ 1.3\ cN_c + q\ N_q + 0.4\ \&BN\&\ ]$

where:

c =cohesion =0.4kg/cm2

&=density =1.8g/cm3

q=surcharge =0.3 kg/m2

I B=foundation width =150cm

$N_c$ =12.9 $N_q$ =4.4 N&=2,5 Bearing Capacity Factors for Q=15

| q # 2.50 kg/cm2
| adm |

### Settlement:

Elasticity Theory:

DH= qB(1-u2)Iw /E

where:

u =Poisson ratio =0.3

E =Elasticity Modulus =350kg/cm2

Iw=Shape factor =0.82

|DH <2.0cm|

**SHEET CALCULATION**

For the MARLY LIOMESTONE

**Bearing Capacity of the Foundation**

**Terzaghi theory FOR SQUARE FOOTING:**

$q_{adm} = (1/3)[\ 1.3\ cN_c + q\ N_q + 0.4\ \&BN\&]$

where:

c =cohesion =0.60kg/cm2

&=density =2g/cm3

q=surcharge =100cm * 2g/cm3 * 10-3 # 0.2 kg/cm2

B=foundation width =200cm

$N_c$ =25.1 $N_q$ =12.6 $N\&$=9.7 Bearing Capacity Factors for Ø=25

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| $q_{adm}$ #7.5 kg/cm2

---

**We recommand to use (4)kg/cm2**

**Settlement:**

Elasticity Theory:

$\Delta H = qB(1-\mu 2)Iw / E$

where:

$\mu$ =Poisson ratio =0.3

E =Elasticity Modulus =650kg/cm2

Iw=Shape factor =0.82

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|ΔH #1.0cm|

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# SECTION – C2

# SPECIFIC TECHNICAL REQUIREMENTS (ELECTRICAL)

1.0 EQUIPMENT & SERVICES TO BE PROVIDED BY BIDDER

Scope for SUPPLY and E&C of various equipments forming part of electrical system for this package shall be as per Annexure–1 (enclosed with this section - C)

The equipment and services to be provided by Tenderer under this specification shall be as detailed here below and as also specified in Electrical equipment Data sheets but shall not be limited to the following:

a) Supply and installation of all lighting fixtures for illuminating the cooling tower and surrounding areas including 15 Amp receptacles and 63 Amp welding sockets as per specification **No PE-DG-J20-558-0001.** Aviation lighting as per statutory requirements is also to be provided.
This includes supply & installation of necessary lighting accessories, lighting panels, cables, conduits, wires, junction boxes etc.

b) Supply and installation of all cable racks, trays, cable supports, galvanised steel conduits etc. From top to the bottom of cooling Tower area as necessary for routing of all cables as per Erection Cabling ,grounding and lightning protection spec**.** Laying & termination of all cables.

c) Supply and installation of the complete above ground Earthing System in the cooling tower area and connecting individual drives, local control stations, panels etc with the ground mat through risers as per Erection Cabling, grounding and lightning protection**.**

d) Supply and installation of air terminals for lightning protection of cooling tower including down comer connection of air terminals with the grounding mat as per Erection Cabling, grounding and lightning protection spec**.**

e) Supply and installation of all drive motors and base plates required for fan and other drives for cooling tower and CW system as per Technical specification. 6.0 kV motors shall be supplied by BHEL. Rain hood shall be provided for all drive motors.

f) Any item of work either supply of equipment or erection material which have not been specifically mentioned but are necessary to complete the work for trouble free and efficient operation of the plant shall be deemed to be included within the scope of this specification and shall be provided by the tenderer without any extra charge.

g) Erection of push button station including support structure shall be carried out by Bidder. Supply of the same shall be by BHEL.

h) Supply and installation of cathodic protection system for buried pipes/tanks/structures is in vendor's scope as per Technical Specification No. PE-SS-999-509-E001.

i) Various drawings, data, calculations, test reports, test certificates, operation and maintenance manuals etc shall be furnished as specified.

j) All equipment offered shall have suitable provision for termination and connection of power, control and special cables and shall also be complete with cable boxes, double compression Ni-Cr plated brass cable glands, cable lugs (Heavy duty) etc.

k) Bidder to furnish list of supplier for each equipment along with the offer. Which shall be subject to customer /BHEL approval during detail engineering.

l) Supply of mandatory spares as specified in the specifications of electrical equipments. Bidder to furnish unpriced list for the same.

m) List of recommended spares for 3 years for all Electrical equipments with unit price.

n) Erection and commissioning spares list.

o) List of Erection & maintenance tools & tackles.

p) All equipment shall be suitable for the power supply fault levels and other climatic conditions mentioned in the enclosed project information.

q) Bidder to furnish electrical load requirements for cooling tower in the enclosed format E01-1.

2.0 EQUIPMENT & SERVICES TO BE PROVIDED BY PURCHASER FOR ELECTRICAL & TERMINAL POINTS:

Refer Annexure-I (Electrical scope between BHEL & Vendor).

3.0 SPECIFIC REQUIREMENTS

3.1 All electrical equipment shall be suitable for the power supplies, fault levels and other climatic conditions indicated in project information enclosed with the specification

3.2 All drive motors for the plant shall be supplied as per PEEGT spec. E-9, Datasheet-A and specification no. PE-SS-999-506-E101 Sec-D.

3.3 Various other materials' supply and installation in bidder's scope shall conform to the following specification:

a) PE-SS-999-507-E021 Cable trays & accessories
b) PE-SS-999-507-E013 Cable Tray support system (Boltable)
c) PE-SS-999-507-E014 Cable Trefoil Clamps
c) PE-SS-999-558-E001 Lighting System (Supply)
d) PE-SS-999-558-E002 Lighting System (Conduits)
e) PE-SS-999-558-E003 Lighting System (Installation)
f) PE-SS-999-509-E003 Above ground earthing & Lightning Protection
g) PE-SS-999-509-E001 Cathodic Protection System
h) PEEGT spec. E13 Power Cables

i) PEEGT spec. E14 Cable Tray System
j) PEEGT spec. E15 Lights, Small Power & HVAC
k) PEEGT spec. E16 Earthing & Lightning Protection

3.4 Various electrical equipments in bidder's scope shall conform to the following applicable quality plans in all respects.

a) PED-506-00 –Q-006/0 A.C elect. Motors below 75kw
b) PED-506-00 –Q-007/2 A.C elect. Motors 75kw& above (L.V & M.V)
c) PED-507-00 –Q-005/02 Cable trays & accessories
d) PED-507-00 –Q–006/01 Rigid steel conduits & pipes
e) PED-509-00 –Q-001/02 Earthing & Lightning Protection Conductor
f) PED-506-00 –Q-002/01 Quality plan for bought out items
g) PED-507-00 –Q-013/00 Cable Tray support material & accessories
h) PED-558-00 –Q-001/01 Illumination
i) PED-506-00 –Q-005/01 LCCs/M. Boxes/Junction Boxes

The Bidder shall submit the above quality plans duly signed & stamped along with the offer as a token of acceptance. Deviations, if any, shall be brought out separately.

3.5 In case of any deviation from the Specifications & QPs, the bidder shall indicate the same clause by clause in enclosed deviation schedule. In the absence of dully filled in schedules, it will be construed that the offer confirms strictly to the specification. Hidden deviation in the form of data sheet , tech. Leaflet, write up etc. shall not be treated as valid.

3.6 Bidder shall furnish dully filled in data sheets-B for all electrical equipments during detail engineering, which shall subject to BHEL /Customer approval.

3.7 Bidder shall be responsible for the following engineering deliverables after award of the contract:

I. Electrical equipment layout.
II. Cable trench/tray layout
III Power and control cable schedules showing routing details.
IV. Equipment earthing layout and below ground earthing layout.
V. Lighting layout and its conduit layout.
VI. Cable termination details, interconnection drawings etc.
VII. Load Data.
VIII. BOQ of Power, Control, Screened Control Cables required.

3.8 In case of any conflict between various sections of this specification, the order of precedence shall be PEEGT specification over Datasheet-A over Sec-D standard specification.

3.9 Any other material required for completeness of all electrical work (though not mentioned specifically) is in Bidder's scope.

3.10 Bidder shall furnish the following along with the offer :

a) Duly signed and stamped copy of this section-C (4 sheets).

b) Duly signed and stamped copy of Annexure-I to Section C (Scope between BHEL & Vendor)

c) Electrical load data for various drives and loads in the format enclosed as Annexure – 2 along with the offer to enable the purchaser to design the MCC.

d) **Tentative quantity of power, control & screened control cables required.** Bidder shall furnish final schedule of power, control & screened control cables, indicating quantity of cables required, within 4 (four) weeks of award of contract, to enable procurement of the same by purchaser. Any significant addition with respect to inputs furnished at tender stage shall be chargeable to the bidder.

e) All drawings/data/catalogues as indicated in different electrical equipment specifications along with the offer in sufficient nos. as indicated in mechanical part.

IT IS CONFIRMED THAT OUR TECHNICAL OFFER COMPLIES WITH THE SPECIFICATION IN TOTO, & THAT THERE ARE NO TECHNICAL DEVIATIONS.

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BIDDER'S STAMP & SIGNATURE

ANNEXURE – I TO SECTION – C : ELECTRICAL SCOPE BETWEEN BHEL AND VENDOR

PACKAGE : DRY TYPE COOLING SYSTEM

| S.NO | DETAILS | SCOPE SUPPLY | SCOPE E&C | REMARKS |
|---|---|---|---|---|
| 1 | 6.3 kV & 400 V Switchgear (PCC/ PMCC, MCC) | BHEL | BHEL | 1. 6.0 kV/380 V AC/220 V AC supply shall be provided by BHEL based on load data provided by vendor at tender stage and again at contract stage for all equipment supplied by vendor as part of contract. DC supply (battery bank, charger etc) and any other supply (like UPS) as required for PLC/control panel (as applicable) shall be provided by vendor. For lighting of cooling tower , 380 V AC supply feeder upto LDBs located in the cooling tower shall be provided by BHEL for further distribution by vendor.<br>2. Interposing relays (RE 302 of Jyoti make or equivalent), if required for PLC and microprocessor based systems, shall be provided by BHEL in MCCs. Requirement of these relays shall be furnished by vendor during detailed engineering stage. |
| 2 | Local Push Button Station | BHEL | Vendor | Located near the motors |
| 3 | Power cables, control cables and screened control cables for<br>a) both end equipment in BHEL's scope<br>b) both end equipment in vendor's scope<br>c) one end equipment in vendor's scope | <br>BHEL<br>BHEL<br>BHEL | <br>BHEL<br>Vendor<br>BHEL | 1. Sizes and quantity of cables required shall be informed by vendor at tender stage and again at contract stage (based on inputs provided by BHEL). Finalisation of cable sizes shall be done by BHEL. Vendor shall provide lugs & glands accordingly.<br>2. Termination at BHEL equipment terminals by BHEL.<br>3. Termination at Vendor equipment terminals by Vendor. |
| 4 | Any special type of cable like compensating, co-axial, prefab, MICC, optical fibre etc. | Vendor | Vendor | |
| 5a | Cable trays, accessories & cable tray supporting system for CW Pump House | BHEL | BHEL | Layout details between vendors supplied equipment & installation dwgs by vendor. |
| 5b | Cable trays, accessories & cable tray supporting system for cooling tower | Vendor | Vendor | 1. Layout details between vendors supplied equipment & installation dwgs by vendor.<br>2. BHEL will provide cable trench along with cabling material up to the terminal point approx. 10 m away from cooling tower. |
| 6 | Cable glands and lugs for equipment supplied by vendor | Vendor | Vendor | 1.Double compression Ni-Cr plated brass cable glands.<br>2. Solder less crimping type heavy duty tinned copper lugs for power cables |
| 7 | Grounding of equipments located in cooling tower & lightning protection of cooling tower | Vendor | Vendor | |
| 8 | Below grade grounding | BHEL | BHEL | |
| 9a | 6.0 kV Motors with base plate and foundation hardware | BHEL | BHEL | Rated voltage for motors shall be 6.0 kV for motor ratings above 200 kW. |

ANNEXURE – I TO SECTION – C : ELECTRICAL SCOPE BETWEEN BHEL AND VENDOR

PACKAGE : CW SYSTEM & DRY TYPE COOLING TOWER

PROJECT :

| | | | | |
|---|---|---|---|---|
| 9b | LV Motors with base plate and foundation hardware | Vendor | Vendor | Rated voltage for motors shall be<br>-380 V above 200 W and upto 200 kW<br>- 220 V for ratings upto 200 W.<br>Makes shall be subject to customer/ BHEL approval at contract stage. |
| 10 | Lighting System of cooling tower | Vendor | Vendor | In addition to other lighting system items, vendor shall consider lighting distribution board (LDB) with 50kVA transformer, aviation lights, Emergency LDB for Aviation lights & their control as per statutory requirement and Lighting panels (LP) with 8 outgoings & timer control as per requirement. For lighting of cooling tower , 380 V AC supply feeder upto LDBs located in the cooling tower shall be provided by BHEL for further distribution by vendor. Cables/wires required for the purpose by vendor are not to be included in the BOQ furnished by vendor as per S.no. 3 above.<br>Lighting of buildings other than dry type cooling tower by BHEL. |
| 11 | Cathodic Protection for buried pipes / tanks / structures | Vendor | Vendor | Vendor shall provide required insulation joints (depending on no. of pedestals and overhead bridges/ trestles installed to support pipeline) for isolating the cathodically protected system from the systems / equipment / structure facilities that are not cathodically protected like BHEL scope above ground CW condenser hot and cold water piping. |
| 12 | Any other equipment/ material/ service required for completeness of CW system and Cooling Tower but not specified above. | Vendor | Vendor | |
| 13 | Engineering activities during detailed engineering stage, including those listed below:<br>a. Electrical load data submission in PEM format<br>b. Electrical equipment GA drawings and layout drawings<br>c. Cable trench/ tray layout drawings<br>d. Control cable schedules showing routing details [including cables supplied by PEM for CT equipment]. | Vendor | -- | 1. Documentation shall be submitted as per project schedule for BHEL/ customer approval.<br>2. Vendor shall be responsible for necessary coordination with BHEL for required engineering interfacing during contract stage.<br>3. Any approval required from electrical inspection authority for electrical equipment shall be arranged by vendor.<br>4. Vendor to furnish Electrical load data in PEM format and BOQ of cables required along with offer. |

ANNEXURE – I TO SECTION – C : ELECTRICAL SCOPE BETWEEN BHEL AND VENDOR

PACKAGE : CW SYSTEM & DRY TYPE COOLING TOWER

| | | | | |
|---|---|---|---|---|
| | e. Grounding and lightning protection system layouts<br>f. Lighting layout and its conduit layout<br>g. Cable termination/ interconnection details (diagram)/ Cable block diagram | | | |

NOTES:

1. Make of all electrical equipments/items supplied shall be reputed make & shall be subject to approval of BHEL/customer after award of contract.
2. All QPs shall be subject to approval of BHEL/customer after award of contract without any commercial implication.

| LOAD TITLE | RATING (KW / A) | | UNIT (U)/STN (S) | Nos. | | VOLTAGE CODE* | FEEDER CODE** | EMER. LOAD (Y) | CONT.(C)/ INTT.(I) | STARTING TIME >5 SEC (Y) | LOCATION | BOARD NO. | CABLE | | BLOCK CABLE DRG. No. | CONTROL CODE | REMARKS | LOAD No. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | NAME PLATE | MAX. CONT. DEMAND (MCR) | | RUNNING | STANDBY | | | | | | | | SIZE CODE | NOs | | | | |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 |
| | | | | | | | | | | | | | | | | | | |
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ANNEXURE-II

NOTES: 1. COLUMN 1 TO 12 & 18 SHALL BE FILLED BY THE REQUISITIONER (ORIGINATING AGENCY); REMAINING COLUMNS ARE TO BE FILLED UP BY PEM (ELECTRICAL)

2. ABBREVIATIONS : * VOLTAGE CODE (7):- (ac) A=11 KV, B=6.6 KV, C=3.3 KV, D=415 V, E=240 V (1 PH), F=110 V (cc): G=220 V, H=110 V, J=48 V, K=+24V, L=-24 V

: ** FEEDER CODE (8):- U=UNIDIRECTIONAL STARTER, B=BI-DIRECTIONAL STARTER, S=SUPPLY FEEDER, D=SUPPLY FEEDER (CONTACTER CONTROLLED)

| | | | | | |
|---|---|---|---|---|---|
| BHEL | LOAD DATA (ELECTRICAL) | JOB NO. | 307 & 318 | ORIGINATING AGENCY | PEM (ELECTRICAL) |
| | | PROJECT TITLE | 2x600 MW NORTH CHENNAI TPS, UNIT#1,2 | NAME | DATA FILLED UP ON |
| | | SYSTEM | | SIGN. | DATA ENTERED ON |
| | | DEPTT. / SECTION | ELECTRICAL | SHEET 1 OF 1 REV. 00 | DE'S SIGN. & DATE |

# E-9 TECHNICAL PARTICULARS OF MOTORS

# Table of Contents

| Clause | Description |
|---|---|
| E-9 | MOTORS |
| E-9.1 | Scope of Supply |
| E-9.2 | General Conditions |
| E-9.3 | MV Motors Design |
| E-9.4 | 380V ac, 220V ac and dc Motors Design |

## E-9 MOTORS

### E-9.1 Scope of Supply

Motors shall be supplied at one of the following service voltages for all the drives where motors are required:

MV ac 3 phase 50Hz for motors above 250kW

380V ac 3 phase 50Hz for motors below 250kW

220V ac 1 phase 50 Hz for motors up to 1kW

D.C. motors

### E-9.2 General Conditions

**The ambient conditions and the operating design conditions are listed in the ITB t**

Hazardous locations for motors would include those where flammable gas or vapor may be present but usually only under conditions such as leaking pipes etc.

Motors shall have a facility to be isolated locally. This local isolation shall be lockable. Contacts shall be provided from this local isolation for the DCIS.

Platforms shall be provided for all MV motors to carry out maintenance work.

### E-9.3 MV Motors Design

The medium voltage system neutral of the supply transformers may be isolated or earthed through a high resistance. Refer to paragraph Neutral Earthing.

Induction motors shall be squirrel cage design.

The system shall allow direct on line starting.

The Tenderer shall quote an option price for motors couplings and driven machines designed for switching on after supply failure, with a residual voltage of 40% and 180° out of phase with the supply.

Indoors motors shall have as a minimum enclosure IP54, Outdoors motors shall have enclosure IPW54 with particular reference to the gaskets and the prevention of water entering along the shaft.

Each motor shall have a single-phase heater suitable for 220V 50Hz. and wired to a totally enclosed terminal box. The heater shall be switched automatically to switch in when the motor circuit breaker is switched out.

All motors shall have Class F insulation but the rating shall be based on Class B temperature rise.

All motors shall be of the totally enclosed fan cooled type.

Windings shall preferably be star connected but the star point shall only be brought out for motors above 2MW where it shall be brought out and fully insulated to make provision for current transformers for differential relay protection. For motors over 2MW at least two embedded resistance thermometers shall be provided to indicate the stator winding temperature to DIN PT100.

The Tenderer shall indicate terminal box clearances and creep ages in conformance with IEC Standards.

These clearances apply to cable screens, stress cones etc.

Any terminals required for offload heaters, thermostats etc. should be accommodated in one totally enclosed terminal box which should be separate from the main terminal box.

Motors in hazardous locations shall be specially designed not to produce an arc or spark or surface temperature to which a flammable substance would have access and which would create an ignition hazard. Ventilation should also be adequate to disperse flammable gases effectively and building design shall avoid the possibility of gas accumulating in pockets.

The Tenderer shall give details of where in the plant those hazards occur and the action to counteract this with increased safety motors and good ventilation.

Tenderers shall state the standard specification for increased safety to which they manufacture motors.

Flameproof enclosures shall be in accordance with IEC 60079.

Tenderers shall quote an option price for motors capable of 10 minutes satisfactory operation at rated torque with the voltages at 75% of rated value.

Tenderer shall quote an option price for motors designed to start against the rated load torque of the driven machine at 80% of rated voltage.

### E-9.4 380V ac, 220V ac and dc Motors Design

The Specification for the above motors is similar to MV motors with the following modifications/variations.

*AC System* 3 Phase 50 Hz, 380V + 10% - 15% neutral solidly earthed

Single Phase ac 50 Hz 220V± 10% neutral solidly earthed.

*DC System Battery* voltage supply range

Nominal Voltage ±10%

Direct on line starting is required but resistance starting may be employed for some dc motors rated higher than 1kW.

Motors shall have a facility to be isolated locally. This local isolation shall be lockable. Contacts shall be provided from this local isolation for the DCIS. This is a "red mushroom head" emergency push button within one-meter distance of the motor (which can be reset by key).

Continuous operation of dc motors at rated torque with the voltage at 85% of the nominal value.

# E-13 POWER CABLES

# Table of Contents

| Clause | Description |
|---|---|
| E-13 | POWER CABLES |
| E-13.1 | Scope of supply |
| E-13.2 | Ambient and Operating Conditions |
| E-13.3 | Broad Design Parameters |

# E-13 POWER CABLES

## E-13.1 Scope of supply

All power cables shall be supplied including all the 6 KV cables between 6 KV . and common service in the plant and emergency diesel if necessary

All LV power cables accessories shall be provided such as for example crimped connections and lugs to BS 5372 or equivalent. Refer to paragraph Cable Tray Systems.

Control cables are specified

## E-13.2 Ambient and Operating Conditions

The ambient conditions are listed in ITB operating conditions

All outdoor cables shall be laid in air in covered concrete troughs or in cable tunnels, which may be flooded with brackish water for extended periods. Short lengths of cable may be in PVC ducts. Cables in concrete troughs, in cable tunnels or within buildings will be supported by cable trays/ladders for their entire length.

If it proves desirable to lay cable direct in the ground provision shall be made for ease of installation inspection and maintenance through the provision of manholes, ducts etc. Backfill shall be provided that matched the soil thermal resistively or else design allowance be made for the type of backfill available.

## E-13.3 Broad Design Parameters

Cables shall be low smoke and fume type and all cables shall be screened.

Cables shall be designed for continuous operation between +10% and –15% of nominal voltage value.

Cable testing shall be done in accordance with IEC Standards.

A load factor of 100% shall be assumed for sizing calculations. Short circuits to be withstood by cables shall be calculated by the Tenderer for the agreement and approval of P.E.E.G.T. The Tenderer shall use all the necessary information based on his knowledge of plant sizes, impedances and reactance’s etc.

Refer neutral earthing.

The 380V cables will be used on a three-phase 50Hz system with a solidly earthed neutral. They shall have an insulation rating of 1000 volts between phases and 600V between phase and earth.

**Sheath Material**: The outer sheath of all cables shall be low smoke and fume (LSF) material.

**Screens**: Each core of the medium voltage cables shall have a copper tape screen.

**Semi-Conducting Layers**: Semi-conducting layers where required for stress relief, shall be applied between the conductor and the insulation, and between the insulation and the screen, of all medium voltage cables.

Cables shall not be jointed to each other.

# E-14 CABLE TRAY SYSTEMS

# Table of Contents

**Cluase** **Description**

**E-14** **CABLE TRAY SYSTEMS**

**E-14.1** **Scope of Supply**

**E-14.2** **Design**

# E-14 CABLE TRAY SYSTEMS

## E-14.1 Scope of Supply

All cable tray systems including cable ladders, cable trays, covers and a support system shall be provided. These shall be of the heavy duty type.

## E-14.2 Design

The components shall all be bolted together to form a rigid structure, which shall safely support the cable loadings and, where appropriate, extra loadings imposed during erection and cable pulling.

The Tenderer shall detail his method of fixing to any structural steel including buildings. Welding to structural steel shall not be permitted as a method of fixing.

Segregation of power, control and instrumentation cables by voltage level shall be provided by means of separate tray/ladder runs for each level according to ANSI/IEEE 518.

Spacing between cable tray/ladder runs shall be sufficient to allow ease of maintenance/pulling.

The cable tray should have spacing reserve not lees than 10%

All material used for the construction of the cable tray system shall be hot dip galvanized after manufacture.

The cable tray and ladder rack systems shall be fully earthed between all joints.

# E-15 LIGHT, SMALL POWER AND HVAC

# Table of Contents


| Clause | Description |
|---|---|
| **E-15** | **LIGHT, SMALL POWER AND HVAC** |
| **E-15.1** | **Scope of Supply** |
| E-15.1.1 | Lighting |
| E-15.1.2 | Small Power |
| E-15.1.3 | HVAC |
| **E-15.2** | **Lighting** |
| E-15.2.1 | General |
| E-15.2.2 | Illumination Levels |
| **E-15.3** | **Small Power** |
| E-15.3.1 | Small Power Boards |
| E-15.3.2 | Power Supply for Sockets |
| E-15.3.3 | 380V Sockets |
| E-15.3.4 | 220V Sockets |
| E-15.3.5 | 110V Sockets |
| E-15.3.6 | Emergency Lighting Central Test Unit |
| **E-15.4** | **HVAC** |
| E-15.4.1 | HVAC Boards |

# E-15 LIGHT, SMALL POWER AND HVAC

## E-15.1 Scope of Supply

### *E-15.1.1 Lighting*

The Tenderer shall offer a highly efficient lighting system including emergency lighting suitable for the inside and outside environment of all buildings and the site including entrance thereto. All outdoor lighting shall be controlled by photocells.

### *E-15.1.2 Small Power*

The Tenderer shall offer sufficient 380V, 220V and 110V sockets for the efficient operation and maintenance of the plant. Small power boards shall include a sufficient number of transformers 380/110V for the 110V sockets. The 110V shall be 55-0-55 center tapped to earth.

### *E-15.1.3 HVAC*

The Tenderer shall include a suitable number of dedicated HVAC boards and sub boards which boards shall be 380/220V 50 Hz 3 phase 4 wire.

## E-15.2 Lighting

### *E-15.2.1 General*

The type of lighting fitting used must be suitable both functionally and aesthetically.

The lighting system power supply shall be from 380/220V, 50 Hz, 3 phases, 4 wire dedicated Light & Small Power Boards These shall comply generally where applicable with the requirements Emergency DC lighting shall also be provided

All indoor lighting shall be controlled by wall-mounted switches located near the entrance doors to the lighted areas. Multi way switches shall be used as required. Switch enclosures shall be suitable for the area.

All equipment shall be accessible for maintenance from walkways or platforms.

Alternate lighting luminaries for an area and multi-lamp luminaries shall be fed from two alternate lighting sources so that the tripping of a lighting circuit shall not result in the loss of more than 66% of the lighting in an area.

All luminaries shall be located so that the lamps and ballasts can be changed without encroaching on safe working clearances.

### *E-15.2.2 Illumination Levels*

Lighting source types and minimum illumination levels for various areas shall meet international standards, however they shall not be less than those shown on the following table:-

All locations shall be provided with emergency lights complete with internal batteries. Main exit doors from operational and work areas shall have illuminated exit signs complete with internal battery. Fixed fire fighting system deluge points shall also have an emergency light.

ILLUMINATION LEVEL

| LOCATION | LUX |
|---|---|
| HRSG Building | 150 |
| Battery Room | 150 |
| Turbine Operating Floor | 200 |
| Unloading Bays | 200 |
| Alternator | 200 |
| Switchgear – Indoor | 350 |
| Switchgear – Outdoor | 300 |
| Local Control Panels | 300 |
| Central Control Room, Relay Rooms | 500 |
| Outdoor Working Area | 150 |
| Outdoor General Area | 20 |
| Walkways, Stairs | 70 |
| Road | 30 |
| Workshop | 300 |
| Pump house | 150 |
| Mess Rooms | 150 |
| Toilets/Washrooms | 300 |

| | |
|---|---|
| Offices | 400 |
| Transformer's | 100 |
| Laboratoires | 500 |
| Boliers | 30 |
| Emergency Lighting | 10 |
| Water Treatment | 150 |
| Stores | 150 |
| Lobby | 100 |
| Cable Basement | 100 |
| Entrance | 200 |

The values shown above are minimum values. A depreciation value allowance should be added to these values for lamp deterioration etc.

Additionally, all local push button stations, control stations and panels, instrument racks, hand-operated equipment like valves etc, shall if required due to the low surrounding illumination levels, be lit separately by means of suitable fluorescent

lamps, mounted on poles or at adjacent structures, so as to obtain at least 200 lux illumination level.

The illumination level of indoor lighting shall be measured horizontally at a height of 1 metre above the floor; outdoor lighting of roads and floodlit areas at the surface. The ratio of the average to the minimum illumination level shall not be higher than 1.3; the ratio of the maximum to the minimum illumination shall not be higher than 1.6. The whole lighting system shall be designed to produce adequate visual performance and safety and shall not have excessive glare, stroboscopic effects and flicker from discharge lamps. The Contractor shall coordinate, where necessary, the lighting installations with the suppliers of interfering equipment e.g. suspended ceilings, firefighting, air conditioning etc.

## E-15.3 Small Power

### *E-15.3.1 Small Power Boards*

These shall comply generally where applicable with the requirements stated

### *E-15.3.2 Power Supply for Sockets*

The sockets in the heat recovery boiler and the steam turbine buildings shall be supplied from dedicated Light, and HVAC boards in the respective buildings. Sockets in smaller buildings may be fed from a dedicated section of an adjacent sub-board. The number and location of sockets will be subject to the approval of P.E.E.G.T. In Plant areas 380V, 220V and 110V sockets shall be provided at a maximum distance of 10 m from any location. In office buildings, switchgear and relay rooms 110V and 220V sockets shall be provided at a maximum distance of 5 m from any location but this should be reduced in rooms where a greater density of sockets is required.

### *E-15.3.3 380V Sockets*

A 63A 3P+N+E switched industrial type round socket coloured red shall be provided. The switch shall be interlocked with the socket cover such that the socket cannot be withdrawn unless the switch is open. Each 380V socket shall have O/L protection and an Residual Current Device ( RCD ) adjacent to the socket. Five core cables (typically 5 x 16mm2) in ring main circuits shall be used to supply the 380V sockets. The 220V sockets may also be fed off these ring mains, however, the 380V and 220V sockets must have separate RCD.

### *E-15.3.4 220V Sockets*

A 16A P+N+E un switched industrial type round socket coloured blue shall be provided. Each 220V socket shall have overload protection and an RCD at the socket.

### *E-15.3.5 110V Sockets*

A 32A 2P+E un switched industrial type round sockets, coloured yellow, shall be supplied. Each 110V socket shall have O/L protection at the socket. A minimum 3 x 10mm2 cable shall be used and a ring main shall be complete for all circuits. The 110V sockets shall be fed from 380V/55-0-55V centers tapped to earth transformers mounted in the HVAC boards.

### *E-15.3.6 Emergency Lighting Central Test Unit*

Central test units shall be provided to allow the emergency lighting systems to be tested for a pre-set period of half an hour functional or a three-hour discharge without disrupting the normal lighting supply. The unit shall be suitable for door mounting, as it will be installed in a light, heat and power board. The unit shall be capable of operating at least six 4 pole 220V AC contactors, which will be installed in the light, heat and power boards to control lights.

## E-15.4 HVAC

### *E-15.4.1 HVAC Boards*

These shall comply generally where applicable with the requirements.

# E-16 EARTHING AND LIGHTNING PROTECTION

# Table of Contents

| CLAUSE | DESCRIPTION |
|---|---|
| **E-16** | **EARTHING AND LIGHTNING PROTECTION** |
| **E-16.1** | **Scope of Supply** |
| **E-16.2** | **Broad Design Parameters** |
| E-16.2.1 | General |
| **E-16.3** | **Earthing Connections** |
| E-16.3.1 | Motors |
| E-16.3.2 | Transformers |
| E-16.3.3 | Electrical Equipment |
| E-16.3.4 | Cable Sheaths and Shielding Tapes |
| E-16.3.5 | Lighting |
| E-16.3.6 | Miscellaneous Equipment |
| E-16.3.7 | Reinforcing Bars |

# E-16 EARTHING AND LIGHTNING PROTECTION

## E-16.1 Scope of Supply

The scope of supply shall include provision of all materials and complete installation.

The earthing and lightning protection shall include but not be limited to the following:

Installation of a comprehensive meshed earth grid, enhanced by driving rods and by connection to reinforcing steel in concrete piles and foundations and to steel pipes to ensure that the earth resistance on site is not greater than 0.5 ohms or less. The Contractor shall verify by test that the earth resistance is less than about 0.5 ohms or less, that touch, step and transfer potential requirements are met. Means of verification shall be submitted for comment.

Standardization on the use of 95-mm² bare stranded copper for buried conductors and insulated cable when laid on cable tray shall be implemented.

Structural support steel of the buildings and structures shall be connected to ground riser cables at the support steel foundations.

The proper installation and bonding of pipes (e.g. deluge systems on

transformers) cable trays, conduits, steel structures etc. shall be included.

Grounding of all electrical equipment and enclosures and accessories to the earth grid shall be included.

The Tenderer shall include a facility to isolate major sections of the earthing grid such that the earth resistance of each section can be measured at any time in the future.

It is the responsibility of the Tenderer to measure the soil Resistivity level.

Lightning protection for all structures shall be included.

The Contractor shall provide lightning systems for the boiler stack and any other structures as necessary. At least two independent copper down conductors (95mm² minimum) shall be provided per non metallic stack and they shall be adequately protected.

Any systems deemed to be specifically for lightning protection shall be strongly interlinked with the earthing system at two or three points.

## E-16.2 Broad Design Parameters

### *E-16.2.1 General*

All buried ground conductors shall be stranded copper conductor minimum 95mm².

The minimum main ground conductor and safety ground conductor sizes for motors and equipments, shall be calculated in accordance with IEEE Standards or other equivalent or better standard and subject to P.E.E.G.T.'s review.

Medium voltage switchgear, 380V Switchgear and 380 Volt Motor Control Center (MCC) and Power Distribution Center (PDC) earth buses shall be earthed using two conductors, one at each end of the switchgear internal earth bus.

Prior to the connection of earthing conductors, the Contractor shall ensure that connection surfaces are clean and free from contamination.

The Contractor shall protect all joints between dissimilar metals against

corrosion. The Contractor shall submit, for P.E.E.G.T.'s review, a detailed description and/or drawings showing the manner in which this requirement will be complied with.

Earth connection shall be made by double crimp below ground and endothermic welding or bolting above ground. In general, earth connections at equipment shall be by bolting. Bolted connections shall use the NEMA "two-hole" or "four-hole" pattern.

The Contractor shall design and install a system of supplementary copper earth conductors in large buildings with no structural steel.

The supplementary earth conductors shall be copper bars or cable. The supplemental earth conductors shall be bonded to the reinforcing steel at each floor and shall be interconnected so that there are at least two independent paths to the outdoors earthing system from any piece of equipment. The size of the copper bars and/or cable shall be calculated by the Contractor and subject to review by P.E.E.G.T.

Cable trays shall be connected to earth with copper bonding jumpers at 30 metre intervals or in at least two places for shorter runs.

Copper bonding jumpers, with suitable cross sectional area (subject to P.E.E.G.T.'s review) shall be used at expansion joints or sections of the cable tray system to ensure that an electrically continuous path to the power source neutral and a substantial metal ground is established.

All joints and connections in conduit systems shall be clean and tight to provide an adequate electrically continuous path.

Suitable earthing jumpers shall be installed at all junction boxes, pull boxes, expansion fittings, and at flexible conduit sections in the conduit run to establish adequate earth continuity in the conduit system.

The perforated trays carrying control cables shall have one 35 mm2 copper earth wires running the length of the trays on both sides. These cables shall be bonded to each tray length.

Bare copper cable shall not be laid directly on the cable trays.

## E-16.3 Earthing Connections

### *E-16.3.1 Motors*

Motor frames shall be connected to the earth grid at the nearest practical location by a bare copper safety ground conductor capable of carrying double earth fault for 0.5 sec for MV equipment. This connection is intended to prevent a potential difference between the equipment enclosure and the building steel at the equipment location.

Small motor frames (>5 kW) may be earthed through an extra conductor of the power cable.

### *E-16.3.2 Transformers*

Power transformer 380V neutrals shall be connected directly to the 380V switchgear. Connection of the 380V neutral to earth shall be made at the 380V switchgear. The medium voltage neutral shall be isolated or connected to earth through a high resistance.

### *E-16.3.3 Electrical Equipment*

All electrical equipment provided with an earth busbar such as switchgear, motor control centres, distribution panels and control cubicles, etc., shall be provided with earthing conductors bolted to both ends of the earth busbar and connected to the main earth grid.

### *E-16.3.4 Cable Sheaths and Shielding Tapes*

The isolation shield and metallic amour for three phases and single phase power cables and multi-conductor power cables shall be earthed at both ends of the cable.

The Tenderer shall state his earthing proposals for the double screened control cables specified in ITB.

Tenderer shall indicate any other installation practices to reduce EMI.

### *E-16.3.5 Lighting*

Separate earth wires shall be run to all lighting fittings. Conduit is not considered to be a sufficient earth connection.

### *E-16.3.6 Miscellaneous Equipment*

Bonding jumpers and/or grounding conductors (as part of control cable) shall be used, as required, for control stations and other accessories.

The neutral of instrument transformers and/or relays shall be earthed only at one location, as close to the transformers or relays as possible.

All crane rails shall be connected to the earth grid in at least two places.

All metal doors shall be connected to the earth grid where necessary.

### *E-16.3.7 Reinforcing Bars*

The Contractor shall where required for his earthing design ensures that the structure reinforcing bars in any concrete work are electrically continuous from the top to the bottom of the structure. Isolated sections of reinforcing will not be acceptable.

The normal lapping and wiring together of the reinforcing is considered adequate for electrical continuity, provided that each successive level of rebar is wired to the lower level at each junction.

As soon as erection of the structure reinforcing is started, the contractor will make permanent electrical earthing connections to earth risers furnished in place next to the structure foundations.

# PEEGT

# ALEPPO STEAM POWER PLANT

# TECHNICAL SCHEDULES & DATASHEETS

# ELECTRICAL

# E9 TECHNICAL SCHEDULE

# ELECTRIC MOTORS TECHNICAL DATA

## Summary - MV Motors:

| Service | No | Maker | Type | Bearing Grease (y/ n) | Type of Insulation | Voltage droop on terminal During starting | Frame Size | Power | | Speed | Voltage | Power Factor | Current | | Max. Starting Torque % of F.. T. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | Duty | Rated kW | rpm | v | | Full Load A | Starting A. | |
| | | | | | | | | | | | | | | | |

# E9 TECHNICAL SCHEDULE

# ELECTRIC MOTORS TECHNICAL DATA

## Summary - 380V Motors (Large)

| Service | No | Maker | Type | Bearing Grease (y/ n) | Type of Insulation | Voltage droop on terminal During starting | Frame Size | Power | | Speed | Voltage | Power Factor | Current | | Max. Starting Torque % of F.. T. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | Duty | Rated kW | rpm | v | | Full Load A | Starting A. | |
| | | | | | | | | | | | | | | | |

# E9 TECHNICAL SCHEDULE

# ELECTRIC MOTORS TECHNICAL DATA

## Summary - DC Motors

| Service | No | Maker | Type | Bearing Grease (y/ n) | Type of Insulation | Voltage droop on terminal During starting | Frame Size | Power | | Speed | Voltage | Power Factor | Current | | Max. Starting Torque % of F.. T. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | Duty | Rated kW | rpm | v | | Full Load A | Starting A. | |
| | | | | | | | | | | | | | | | |

# E11 TECHNICAL SCHEDULE

## UPS & INVERTER EQUIPMENT OFFERED TECHNICAL DATA

| Item | Description | Unit | Required | Offered |
|---|---|---|---|---|
| 1 | | kVA | | |
| 2 | | kVA | | |
| 3 | | kVA | | |
| 4 | | kVA | | |
| 5 | | kVA | | |
| 6 | | kVA | | |

## E11 TECHNICAL SCHEDULE

## UPS & INVERTER EQUIPMENT OFFERED TECHNICAL DATA

| Item | Description | Unit | Required | Offered |
|---|---|---|---|---|
| **7** | Output Voltage | V | | |
| **8** | Frequency | Hz | | |
| **9** | Power Rating | kW | | |
| **10** | Power Factor Range | Pf | | |
| **11** | Overload Capacity/Time | kW/min | | |
| **12** | Step Load Pick-Up | kW | | |
| **13** | Transient Response Time | ms | | |
| **14** | Voltage Regulation | % | | |
| **15** | Voltage Transient Response | % | | |
| **16** | Voltage Adjustability | % | | |
| **17** | Voltage Unbalance | % | | |
| **18** | Phase Separation/Tolerance | o % | | |
| **19** | Voltage Waveform (THD) | % | | |
| **20** | Crest Factor | | | |
| **21** | Frequency stability (free running) | % | | |
| **22** | Frequency Slew Rate Range | Hz./sec | | |
| **23** | Frequency Adjustability | % | | |
| **24** | Battery Recharge Time | mins | | |
| **25** | Overall AC to AC Efficiency | % | | |
| **26** | Cable Entry | | | |
| **27** | Noise Level | dBA | | |
| **28** | Input Distortion | % | | |
| **29** | Main Repercussion | % | | |
| **30** | Common Mode Transient Attenuation between Input and Output | %. | | |

# E11 TECHNICAL SCHEDULE

## UPS & INVERTER EQUIPMENT OFFERED TECHNICAL DATA

| Item | Description | Unit | Required | Offered |
|---|---|---|---|---|
| **31** | Manufacturer | | | |
| **32** | Specification | | | |
| **33** | Type | | | |
| **35** | **RECTIFIER (INPUT DATA)** | | | |
| **36** | Input Voltage | V | | |
| **37** | Tolerance | % | | |
| **38** | Frequency | Hz | | |
| **39** | Tolerance | % | | |
| **40** | Rated Input Power | kVA | | |
| **41** | Rated Input Current | A | | |
| **42** | Max. Input Power | kVA | | |
| **43** | Max. Input Current | A | | |
| **44** | Input Power Factor (100% Load) | | | |
| **46** | **RECTIFIER (OUTPUT DATA)** | | | |
| **47** | Control Characteristic | | | |
| **48** | Rated Output Voltage on Float | V | | |
| **49** | Rated Output Voltage on Boost | V | | |
| **50** | Range of Adjustment of Float Voltage | % | | |
| **51** | Range of Adjustment of Boost Voltage | % | | |
| **52** | Soft Start | | | |
| **53** | Tolerance of Floating Voltage | % | | |
| **54** | Tolerance of Boost Voltage | %. | | |

## E11 TECHNICAL SCHEDULE

## UPS & INVERTER EQUIPMENT OFFERED TECHNICAL DATA

| Item | Rectifier | Unit | Required | Offered |
|---|---|---|---|---|
| **55** | Ripple Content | % | | |
| **56** | Max. Battery Charging Current | A | | |
| **57** | Battery Charging Current Limitation | A | | |
| **58** | Max. Continuous Output | A | | |
| **59** | Max. Reverse Withstand Voltage | V | | |
| **60** | Time to Charge Storage Battery | mins | | |
| **61** | Maximum Variation of DC Voltage Between No-Load and Full-Load | % | | |
| **62** | Max. Permissible AC Voltage Variation for Above | % | | |
| **63** | Type of Fuses for Protecting Rectifier Cell | | | |
| **64** | Percent Residual AC Voltage in DC Output at Full-Load and No-Load Peak-to-Peak | % | | |
| **65** | Rating of Fuses on DC Output | A | | |
| **66** | Are Cooling Fans Fitted | | | |
| **67** | Is Fuse Failure Monitoring Fitted | | | |
| **68** | Method of Voltage Control | | | |
| **69** | Is Rectifier Charger Fail Alarm Fitted | | | |
| **70** | Overload Capacity | % | | |
| **71** | Battery Monitoring Fitted | Yes/No | | |

## E11 TECHNICAL SCHEDULE

## UPS & INVERTER EQUIPMENT OFFERED TECHNICAL DATA

| Item | Inverter | Unit | Required | Offered |
|---|---|---|---|---|
| **72** | Manufacturer | | | |
| **73** | Specification | | | |
| **74** | Type | | | |
| **75** | Permissible DC Voltage Range | V | | |
| **76** | Input Power at Rated Load | kW | | |
| **77** | Inverter Input Current | A | | |
| **78** | Output Current | A | | |
| **79** | Efficiency at Rated Load | % | | |
| **80** | Load Power Factor Range | Pf | | |
| **81** | Output Voltage Distortion (THD) | V | | |
| **82** | Voltage Adjustment Range | % | | |
| **83** | Phase Displacement/Tolerance | % | | |
| **84** | Voltage Tolerances | | | |
| **85** | Voltage Transient Recovery Time | % | | |
| **86** | Short Circuit Proof | ms | | |
| **87** | Short Circuit Current | Yes/No | | |
| **88** | Frequency Adjustment Range | kA | | |
| **89** | Max. Frequency Variation During Synchronization | % | | |
| **90** | Frequency Tolerance (free running) | % | | |
| **91** | Voltage Waveform | %. | | |

## E11 TECHNICAL SCHEDULE

## UPS & INVERTER EQUIPMENT OFFERED TECHNICAL DATA

| Item | Storage Battery | Unit | Required | Offered |
|---|---|---|---|---|
| **92** | Manufacturer | | | |
| **93** | Specification | | | |
| **94** | No. of Cells | | | |
| **95** | Type of Plates | | | |
| **96** | Ampere Hour Capacity at 10 hour rate 1.85V/cell and … ºC | Ah at ºC | | |
| **97** | Emergency Period | mins | | |
| **98** | Amp-Hour Capacity for Emergency Period | Ah | | |
| **99** | Terminal Voltage following Emergency Period | | | |
| **100** | Ampere-hour Efficiencies at 10 hour Rate | % | | |
| **101** | Total Weight of Complete Cell | kg | | |
| **102** | Material Composition of Separators | | | |
| **103** | Cell Internal Resistance | Ohm at ºC | | |
| **104** | Surface Treatment of Battery Rack and Panels | | | |
| **105** | One Minute Test Voltage for Insulators | kV | | |
| **106** | Material of Cell Container | | | |
| **107** | Short Circuit Current at Battery Terminals (1 second rms) | kA | | |
| **108** | Life Expectancy years | | | |

## E11 TECHNICAL SCHEDULE

## UPS & INVERTER EQUIPMENT OFFERED TECHNICAL DATA

| | | | | |
|---|---|---|---|---|
| **109** | Maximum Permissible Charge Rate | A | | |
| **110** | Battery Capacity | Ah | | |
| **111** | Total Weight of Battery and Panel | kg | | |
| **112** | Dimensions of Battery Panel | mm | | |
| **113** | Life Expectancy | years | | |

# E14 CABLE TRAY SYSTEMS

# E15 TECHNICAL SCHEDULE

## LIGHT, HEAT AND POWER TECHNICAL DATA

| Item | Description | Unit | Required | Offered |
|---|---|---|---|---|
| **1** | Location of Fitting | | | |
| **2** | No. Of Fittings | | | |
| **3** | Type of Fitting | | | |
| **4** | Ref. Catalogue No. | | | |
| **5** | Dimensions | | | |
| **6** | Weight | Kg | | |
| **7** | Mounting Details | | | |
| **8** | Power consumption | Watts | | |
| **9** | Efficiency | % | | |
| **10** | Output (Lux Diagram) | | | |
| **11** | Output of Emergency Fitting | Lumens | | |
| **12** | Output of Emergency Fitting under battery operation | Lumens | | |
| **13** | Is fitting suitable for industrial use? | Yes/no | | |
| **14** | Enclosure Rating | IP | | |
| **15** | Are fittings anti-corrosive and suitable for the ambient conditions at site | Yes/no | | |
| **16** | Humidity limit of fitting | % | | |
| **17** | Temperature rating of fitting | ºC | | |
| **18** | Temperature rating of battery pack | ºC | | |
| **19** | Autonomy period of battery pack | Hours | | |

## E15 TECHNICAL SCHEDULE

## LIGHT, HEAT AND POWER TECHNICAL DATA

| Item | Description | Unit | Required | Offered |
|---|---|---|---|---|
| **20** | Is battery pack housed in separate enclosure? | Yes/No | | |
| **21** | Enclosure rating of battery pack enclosure. | IP | | |
| **22** | Is explosion proof fittings offered? If yes supply all details. | Yes/No | | |
| **23** | Standard to which fitting is manufactured | | | |

# E16 EARTHING AND LIGHTNING PROTECTION TECHNICAL SCHEDULE

| DESIGN PARAMETERS | |
|---|---|
| Stander copper conductor | **Minimum 95 mm²** |
| Earthing connections<br><br>-Motors > = 5 kW<br><br>-Transformer 380V neutral to earthed through a high resistance<br><br>-Equipment connect to earth busbar to main earth grid<br><br>-Cable sheaths &shielding tapes according to IEC | |
| Method of connection (bolts or pres ) | |
| Reinforcing Bars | |

# PEEGT

# ALEPPO STEAM POWER PLANT

# SPARE PARTS

# ELECTRICAL

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| **Electric motors** | | |
| **(1) Specified Spare Parts** | | |
| One motor of each type 380 V only | 1 set | |
| 2 motor bearings for each type of motor | 1 set | |
| One motor of each type 6.3k V only | 1 set | |
| One motor of each type DC only | 1 set | |
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| **(2) Spare Parts recommended by Tenderer** | | |
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| **<u>Lighting system</u>** | | |
| **(1) Specified Spare Parts** | | |
| Circuit breaker of each type | 1 set | |
| 10 mini. circuit breakers of each type | 1 set | |
| Contactor/relays of each type | 2 sets | |
| Main switch/control switch of each type | 1 set | |
| Key switches/switches with pilot lamp | 1 set | |
| Time switch | 1 set | |
| Terminals (4/6/10/16/35/70 mm2) | 500 pcs | |

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|---|---|---|
| Lighting fitting of each type | 1 set | |
| Lighting poles of each type | 1 set | |
| Lighting bulbs of different type | 4000 pcs | |
| Floodlights bulbs (if any) | 60 pcs | |
| Gear boxes | 6 pcs | |
| Sockets 10 A | 20 pcs | |
| Sockets 20 A/3-poles/220 V AC. | 10 pcs | |
| Sockets 50 A/3-poles/220 V AC. | 10 pcs | |
| Cables of different cross sections | 4000 m | |
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| **(2) Spare Parts recommended by Tenderer** | | |
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| **<u>Cable wiring materials</u>** | | |
| **(1) Specified Spare Parts** | | |
| H.V. kV connection (2 % of the quantity erected in the plant but not less than one piece) | 1 lot | |
| 380 V power cable and accessories (2 % of the quantity erected in the plant but not less than one piece) | 1 lot | |
| Control and instrument cables and accessories (2 % of the quantity erected in the plant but not less than one piece) | 1 lot | |

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| **(2) Spare Parts recommended by Tenderer** | | |
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# SECTION – C3

# SPECIFIC TECHNICAL REQUIREMENTS (C&I)

## Specific C&I requirement for Dry Cooling Tower

1. The controls for Dry Cooling Tower system shall be realized in PLC based control system which shall be independent system for each unit. (Specification of PLC enclosed as Annex 1)
2. PLC based control system shall be provided with hot redundant processor.
3. PLC system for each unit shall be supplied with 1 OWS local to the panel + 1 OWS place in CCR for operation & monitoring from CCR. Each OWS shall be LCD TFT type , 21 inch size.
4. The motorized valves shall be with integral actuators. (Wiring Diagram and Datasheet enclosed as Annexure 3 & 4)
5. Signal exchange philosophy various drives and PLC shall be as enclosed.(Annex 2)
6. The control system shall include all primary and secondary Instruments (PG, PS, PT, LS, TE, FT), required for the control of the package along with fittings, accessories and valve manifolds.
7. The solenoid valves shall have limit switches for Open / Close feedback.
8. The junction boxes for termination of Instruments / Actuator LS / Solenoid valve LS and any other local Panel or Remote I/O Panel required are in bidder scope.
9. For cabling scope please refer electrical section.
10. 2x100%UPS for the PLC panel shall be in bidders scope.
11. Time synchronization of PLC with Master Clock system to be carried out. Necessary hardware/software for the same at PLC end to be provided by the Bidder.
12. In case of any contradiction in the requirement specified in this section with that specified in subsequent annexures, requirement spelled out in this section shall prevail.

12. Vendor shall furnish all C&I related engineering documents (viz. Recommended Logic Diagrams, Drive list , I/O list ,Process Graphics, Cable schedule, Termination details etc with KKS no incorporated )

ANNEXURE-1

Form No. PEM-6666-0

| | TITLE: | SPECIFICATION NO. PES-145-36 | |
|---|---|---|---|
| BHEL | **SPECIFICATION FOR PROGRAMMABLE LOGIC CONTROLLER SYSTEM** | VOLUME **II-B** | |
| | | SECTION **D** | |
| | | REV. NO. 02 | DATE: July 19, 2008 |
| | | SHEET 1 OF 9 | |

## 1. SCOPE

This specification covers the Design, Manufacture, Assembly, Inspection and Testing at manufacturer's works, proper packing and delivery to site, erection and commissioning of the PLC Control & Monitoring System comprising PLC Control panel/Remote I/O panel (housing Processors, I/O cards, power supply packs etc.), Operator workstations(OWS), Printers, Annunciation system, UPS, cables and all other equipments and accessories required for completeness of the system as mentioned in different sections of this specification.

## 2. GENERAL

2.1. The PLC shall perform protection logic, interlock and sequential control functions such as binary logic operation, set/reset operation, timers, counters, logic blocks, math functions, input quality checking engineering unit conversion, Boolean functions & PID control (Analog logic function).

2.2. The system shall be redundant in processor, power supply and communication interfaces unless otherwise specified. The system shall have self-diagnostic features. The control of all drives and equipment shall be effected through the keyboard/mouse / panel mounted push button / control switches as per Data sheets-A&B.

2.3. The system shall have facility for connecting to Main Plant's Distributed control system (DCS) using hardware / software interface for two-way transfer of signals.

2.4. The mimic shall be displayed on the OWS screen and may also be provided on the control desk/panel (as per Data sheets).

2.5. In case OWS is provided, HMI functions like Trends, Curves, Bar charts, Historical storage of Data, Logs and reports etc. shall be provided in addition to Plant-schematics. The necessary catalogue / literature elaborating the features of HMI shall be supplied along with the bid.

2.6. It shall be possible to use the same OWS as programming station.

2.7. The PLC system shall be sized to meet process/system requirements as per the approved P&IDs and Control write-up.

2.8. The PLC system shall be designed to ensure that no single device failure should result in failure of any other device.

2.9. Signal multiplication where required shall be done in PLC. Use of relays for multiplication of contacts (for control, monitoring and alarm) is not acceptable. The control/ monitoring components on the control panel/ desk shall be driven through I/O modules.

## 3. TECHNICAL REQUIREMENTS

Details of various PLC system components shall be inclusive of but not limited to the following:

3.1. CODES AND STANDARDS

3.1.1. The equipment covered under this specification shall meet the requirements of latest edition of all applicable codes and standards like ANSI, NEMA, IEEE, IEC, NEC & IS.

3.1.2. PLC shall conform to IEC: 1131

3.1.3. The offered PLC shall comply with safety standards as per Data sheet-A&B.

3.2. CONTROL PANEL

3.2.1. PLC control panel shall be freestanding type with provision for mimic display, push-button stations, control switches, indicating lamps, metering instruments like Indicators, ammeters etc. and facia windows for critical alarms.

3.2.2. The salient features of construction shall be:

Sheet material: Cold rolled sheet steel
Frame thickness: Not less than 3.0mm
Enclosure thickness: Not less than 2.0 mm for load bearing sections (mounted with instruments) and Not less than 1.6 mm for others
Gland plate thickness: 3.0mm
Base channel: ISMC 100 with anti-vibration mounting & foundation bolts.

3.2.3. Each panel shall be identified by a name plate, which shall be of non-rusting metal or three ply lamicold, with engraved lettering.

3.2.4. 25 x 6 mm Copper ground bus to be provided for each panel.

3.2.5. 240V AC single phase, thermostatically controlled space heaters shall be provided. Each free standing panel shall have a door switch operated fluorescent lamp and a 240V AC plug point.

3.2.6. Painting treatment shall be as per IS: 6005. Two coats of lead oxide primer shall be followed by powder coating. Paint shade shall be as specified in the “Data sheet for PLC system”-Data Sheet-A&B.

3.2.7. The annunciation system shall be facia window type, driven by the PLC. Audible alarm, Acknowledge, Reset and lamp test facility shall be provided as per ISA sequence – S18.1, M.

3.3. PROCESSORS

3.3.1. The microprocessors shall be 32 bit, and Hot redundant.

3.3.2. Hot redundancy: PLC shall be provided with two processors (Main processing unit and memories) one for normal operation and one as hot standby. In case of failure of working processor, there shall be an appropriate alarm and simultaneously the hot standby processor shall take over the complete operation automatically. This transfer from main processor to standby processor shall be bump less and shall not cause any disturbance whatsoever. In the event of both processors failing, the system shall revert to fail safe mode. It shall be possible to keep any of the processor as master and other as standby.

3.3.3. An authorized forcing facility shall be provided for changing the status of inputs and outputs, timers and flags to facilitate fault finding and other testing requirements.

3.3.4. The standby processor shall be updated automatically in line with the changes made in the working processor.

3.3.5. In the event of any replacement of the processor, synchronization of the replaced processor shall be automatic upon live insertion.

3.3.6. The cycle time for input scanning, execution of logics, overheads and output scan shall not exceed 120 m sec.

3.3.7. The processor & memory shall be loaded up to 50% at normal conditions and maximum up to 60% under worst loading conditions.

3.3.8. The memories shall be field expandable.

3.4. INPUT / OUTPUT Modules

3.4.1. Input/output card assignments shall be modular i.e. no single card shall be assigned with more than one drive of a particular sub-system. The maximum number of channels per I/O module shall be as follows.

- Analog Input Module: 16
- Analog Output Module: 16
- Binary Input Module: 32
- Binary Output Module: 32
- Analog Input/output combined: 16
- Binary Input/output combined: 32

3.4.2. On line I/O replacement: All I/O cards shall have quick disconnect terminations allowing for card replacement without disconnection of external wiring and without switching off the power supply.

3.4.3. 10% spare capacity shall be ensured in each card channel assignment. Overall minimum 20% spare channels shall be provided.

3.4.4. Output command to MCC/Switchgear shall be through coupling relays, whose mounting location shall be as per “Data sheet A & B for PLC System”. In case coupling relays are located in PLC Panel, the same shall be in PLC vendor’s scope of supply.

3.4.5. Status feedback from MCC shall be in the form of potential free contact.

3.5. DATA BUS/ I/O BUS

3.5.1. The Data bus connecting PLC and HMI work stations shall be TCP/IP on Ethernet.

3.5.2. The Data bus and I/O bus communication medium shall be twisted pair shield copper conductor for indoor locations and those areas not subjected to induced signals. Repeaters/signal amplifiers shall not be used. Copper conductor cable used shall be Category-5 or better. The communication medium shall be Fibre optic cable in the event any portion of communication cable run is in outdoor or where distances are beyond 500 meters.

3.6. OPERATOR WORK STATION (OWS)

3.6.1. The OWS and Keyboard shall be desktop mounted and shall be used for controlling, monitoring and programming function.

3.6.2. Colour CRT(s) with keyboard and mouse shall be as per Data Sheet-A&B. CRT shall have graphic display facility.

3.6.3. The OWS shall be with Windows based operating system having necessary Engineering/Configuring software.

3.7. PRINTER

Printers shall be provided as per Data Sheet-A&B.

3.8. COMMUNICATION WITH PLANT DCS

3.8.1. The PLC system shall be provided with hardwired/serial interface for communication with plant DCS.

3.8.2. Serial communication to / from DCS where provided shall be engineered to ensure that signal communication time from / to DCS shall not exceed 1 seconds for control / feedback.

3.8.3. Serial communication to DCS shall be OPC (Data access 2.0), Ethernet based TCP/IP Protocol. Alternatively the serial communication shall be MODBUS protocol on RS 485 network.

3.8.4. Data transmitted from PLC to DCS shall include all information necessary for the DCS graphic displays to monitor and control the process equipment and PLC. Such data may include pertinent analog and digital status information, interlock, alarms and maintenance conditions. Data transmitted from DCS to the PLC shall include necessary signals to provide operator control interface from DCS for the process/ equipment being controlled by PLC.

3.8.5. Bidder to include 'Light interface units, converters, Ethernet switch, accessories at PLC end for connectivity to other system. The bidder's terminal point shall be Ethernet port in case of copper medium connection to DCS or LIU in case of Fiber optic medium for connectivity with plant DCS. In case distance between PLC & DCS is greater than 1.8 Km, single mode of optical fiber cable with compatible accessories shall be used. For distance less than 1.8 Km multimode optical fiber ports shall be used.

3.9. POWER SUPPLY Scheme

3.9.1. PLC Panel and I/O Cabinets: PLC system shall be provided with 2x100% UPS fed from Two Nos. redundant 415V, 3-ph feeders, as per the scheme PE-SD-999-145-001, sh-08 of 08. Each UPS shall have 30 minutes back up. Input feeder failure shall be monitored in the PLC system. Necessary redundant power pack and transformers shall be provided (in the PLC panel) to derive the power supply for control desk, PLC panel and input / output cabinets etc

3.9.2. Remote I/O panels: Similar power supply arrangement as for PLC panels shall be provided if it is not possible to extend the power cable form UPS of PLC panels.

3.9.3. Each OWS and associated HMI peripherals shall be provided with a feeder from either one of the UPS

## 4. DRAWING/DOCUMENT AND DATA TO BE FURNISHED AFTER AWARD OF THE CONTRACT:

4.1. For Approval:

- PLC system configuration drawing along with functional write-up.
- Input/Output signal list.
- BOM of PLC
- List of PLC controlled devices
- Control panel/control desk GA drawings.
- Control desk/panel component layout drawing.
- Control panel/control desk Foundation detail and cutout drawings
- Power distribution scheme.

- Block logic diagrams.
- Annunciation list.
- PLC control room layout drawing.
- List of soft signal exchange with Plant DCS.
- List of mandatory spares
- Quality plan
- Data Sheet-C
- CRT display
- Power supply scheme for PLC system, HMI & peripherals, Remote I/O etc.

4.2. For Information:

- Cable schedule and cable interconnection drawing( in BHEL approved format)
  - Between Field and PLC
  - Between Field and MCC
  - Between MCC and PLC
- Electronic earthing requirements.
- Panel Heat dissipation data
- Product/component catalogues.
- Operation & Maintenance Manual on CDs.
- Softcopy of Final/As-built drawings on CDs.
- Calculation for Processor, Memory & Data bus loading

The above list is the minimum requirements. Additional documents/calculations required shall be finalized during contract stage.

## 5. DRAWINGS AND DOCUMENTS TO BE SUBMITTED ALONG WITH THE BID

- Proposed PLC system configuration drawing with write-up
- Product catalogues and specifications for PLC as well as HMI application.
- Proposed power supply schemes for PLC system, peripherals, and Remote I/O panels.

## 6. TESTING AND INSPECTION

6.1. The bidder shall adopt suitable quality assurance program to ensure that the equipments offered will meet the specification requirements in full.

6.2. BHEL's standard Quality Plan for PLC is enclosed with the specification. The bidder shall furnish his acceptance to BHEL's QP and submit the signed and stamped copy of QP along with the offer.

6.3. The complete PLC system, including all instrument and devices shall be subjected to standard factory tests (i.e. Type Tests and Routine Tests) as per relevant IS, NEMA, IEEE, IEC.

6.4. Factory Acceptance Test-FAT (Functional Tests) shall be performed prior to shipment and Owner/Purchaser shall be notified 15 days before the schedules dates of the test.

6.5. The certificates for following type tests, as per IEC Standard, shall be submitted: -

- Surge protection test as per IEC-225-4
- Dry heat test as per IEC-68-2-2
- Damp Heat test as per IEC-68-2-3

- Vibration Heat test as per IEC-68-2-6
- Electrostatic discharge test as per IEC-801-2 or equivalent
- Radio frequency Immunity test as per IEC-801-6 or equivalent
- Electromagnetic Immunity test as per IEC-801-3 or equivalent

## 7. SPARES AND CONSUMABLES

7.1. Commissioning Spares and consumables

The bidder shall supply all commissioning spares and consumables 'as required' during Start-up, as part of the main equipment supply.

7.2. Mandatory Spares

The bidder shall offer alongwith main offer, the Mandatory Spares as specified elsewhere in the specification. The Mandatory Spares offered shall be of the same make and type as the main equipment.

7.3. Recommended Spares

The bidder shall furnish a list of Recommended Spares indicating the normal service expectancy period and frequency of replacement; quantities recommended for 3 years operation alongwith unit rate against each item to enable BHEL/BHEL's Customer to place a separate order later, if required.

7.4. Special Tools & Tackles

The bidder shall supply all Special Tools & Tackles 'as required' during Start-up and further maintenance of the system, as part of the main equipment supply.

7.5. Spares, Service support

Bidder shall provide availability of spares and service support for minimum 10 years after guarantee period.

## 8. MARKING AND PACKING

8.1. Marking:

A stainless steel name-plate shall be permanently fixed on each equipment giving its Tag/serial Number and salient technical specification.

8.2. Packing:

All equipment/materials shall be suitably packed and protected for the entire period of dispatch, storage and erection against impact, abrasion, corrosion, incidental damage due to vermin, sunlight, high temperature, rain, moisture, humidity, dust, sea-water spray (where applicable) as well as rough handling and delays in transit and storage in open.

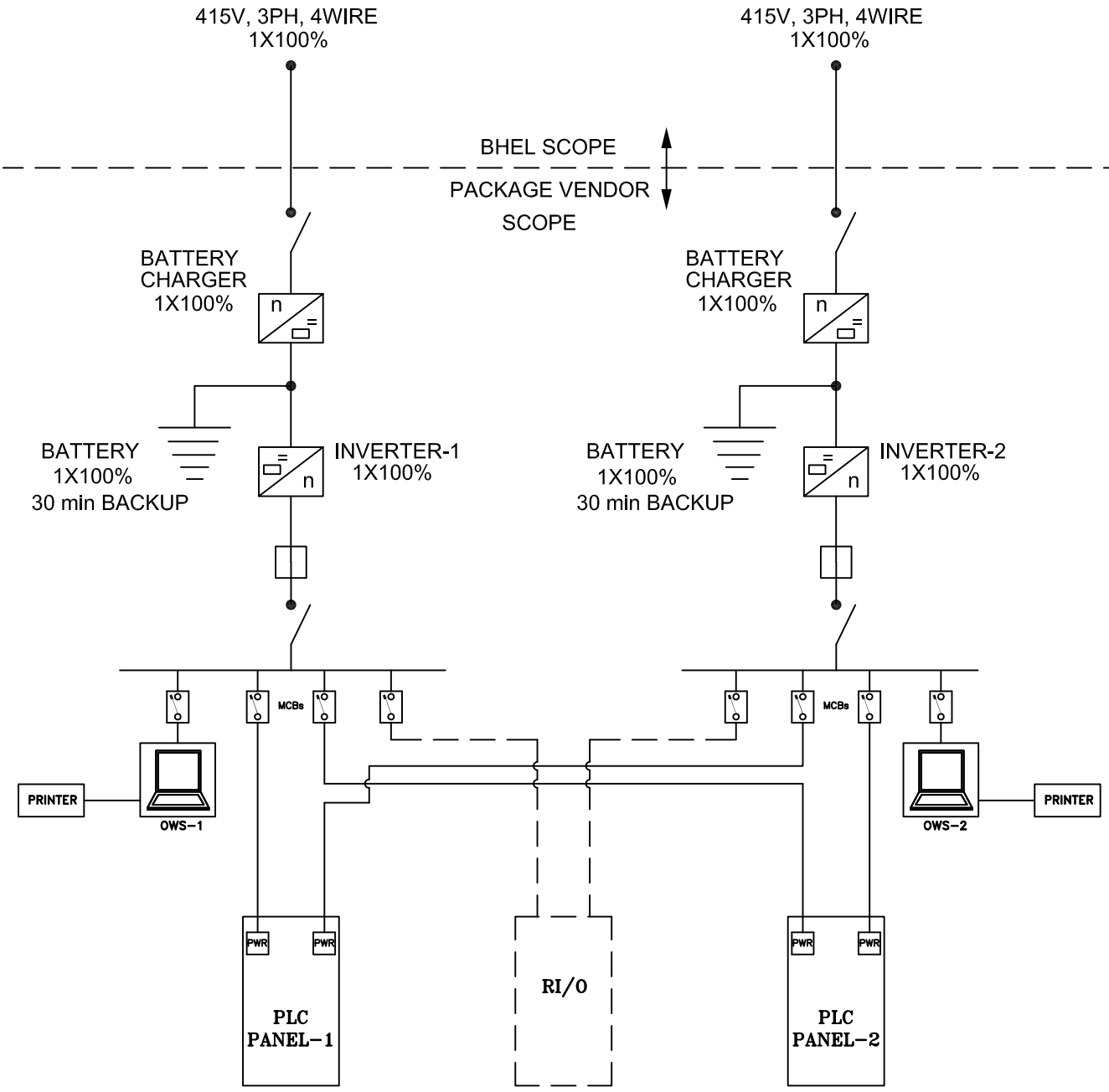
## 9. PERFORMANCE AND GUARANTEE

The PLC system shall be guaranteed to meet the performance requirement as specified and also for trouble-free continuous operation for 12 months from the date of commissioning or 18 months from the date of delivery at site whichever is later unless specified otherwise in Vol-IIB Section - B or Section - C.

## 10. APPLICABLE DATA SHEET FORMS

This document shall be read with the following data sheet forms :

- Data Sheet A & B for PLC system - PE-DC-999-145-I036-1
- Data Sheet C for PLC system - PE-DC-999-145-I036-2




# UPS SCHEME

# TYPICAL POWER SUPPLY ARRANGEMENT
## FOR PLC BASED CONTROL SYSTEM

| | | | | | |
|---|---|---|---|---|---|
| BHARAT HEAVY ELECTRICALS LTD<br>POWER SECTOR<br>PROJECTS ENGINEERING MANAGEMENT<br>NEW DELHI | DEPT CODE | | NAME | SIGN | DATE |
| | I | DRN | GA | | 26.08.07 |
| | | DSGN | SSB | | 26.08.07 |
| | | CHD | AK | | 26.08.07 |
| | | APPD | AK | | 26.08.07 |
| | DRG. NO. PE-SD-999-145-001 | | | | |
| | SHEET 09 OF 09 | | | REV 00 | |

Layer1

FORM NO. PEM-6666-0

| | | |
|---|---|---|
| | **DATA SHEET FOR PLC SYSTEM** | SPECIFICATION NO.: |
| | | VOLUME II B |
| | | SECTION D |
| | | REV. NO. 02 / DATE: 19.07.2008 |
| | | SHEET 1 OF 1 |

Data Sheet No.: **PES-145-36-DS1-0**

## Data Sheet A & B

| | | DATA SHEET-A FOR PLC SYSTEM (TO BE FILLED BY PURCHASER) | DATA SHEET – B (TO BE FILLED BY BIDDER) |
|---|---|---|---|
| **GENERAL** | PROJECT | | |
| | SERVICE | | |
| | QUANTITY | ☐ UNITISED ☐ COMMON | |
| | LOCATION | ☐ INDOOR ☐ OUTDOOR | |
| **PLC EQUIPMENT** | MAKE / MODEL NO. | BIDDER TO INDICATE | |
| | **PROCESSOR** | REDUNDANT WITH HOT STANDBY | |
| | DATA BUS (HMI) | ☐ COPPER WIRE ☐ FIBRE OPTIC | |
| | DATA BUS (I/O - CPU) | ☐ COPPER WIRE ☐ FIBRE OPTIC | |
| | DATA BUS (REMOTE I/O - CPU) | ☐ COPPER WIRE ☐ FIBRE OPTIC | |
| | FIELD CONTACTS INTERROGATION VOLTAGE | ☐ 24 V ☐ 48 V | |
| | LOCATION OF COUPLING RELAYS | ☐ MCC ☐ PLC PANEL | |
| | DESKTOP OWS QUANTITY | ☐ ONE ☐ TWO ☐ _____ | |
| | DESKTOP MONITOR TYPE | ☐ 19" ☐ 21" TFT/CRT MONITOR | |
| | PRINTER (A4) - QUANTITY | INKJET _____<br>LASER B/W _____<br>COLOR INKJET _____<br>COLOR LASER _____ | |
| | PRINTER (A4) - MODEL | INKJET _____<br>LASER B/W _____<br>COLOR INKJET _____<br>COLOR LASER _____ | |
| | PROGRAMMING / CONFIGURATION FACILITY | A) ☐ HAND HELD<br>B) ENGINEERING SOFTWARE<br>☐ ONE OWS<br>☐ ALL OWS<br>☐ _____ | |
| | SAFETY STANDARD | _____ | |
| | COMPUTER FURNITURE | ☐ YES ☐ NO | |
| **PANEL** | QUANTITY | BIDDER TO INDICATE | |
| | CLASS OF PROTECTION | ☐ _____ | |
| | REMOTE I/O PANEL | ☐ YES ☐ NO | |
| | COLOUR | AS PER IS-5 SHADE _____ | |
| | BACK-UP DESK | ☐ YES ☐ NO | |
| | MIMIC | ☐ YES ☐ NO | |
| | CONTROL HARDWARE | ☐ PB ☐ INDICATORS<br>☐ FACIAS _____ Nos. ☐ OTHERS | |
| **COMMUNICATION TO OTHER SYSTEM** | HARDWIRED | ☐ YES ☐ NO | |
| | PURPOSE | ☐ CONTROL ☐ MONITORING | |
| | MEDIUM | ☐ UTP ☐ FIBRE OPTIC ☐ OTHERS | |
| | TIME SYNCRONIZATION SIGNAL FORMAT | ☐ PULSE ☐ RS-485 ☐ IRIG-B | |
| | SOFTLINK | ☐ MODBUS ☐ OPC | |
| | SERIAL LINK | COMMUNICATION PORT TYPE _____ | |
| **POWER SUPPLY INPUT FEEDER** | PLC PANEL | BIDDER TO INDICATE LOAD DATA | |
| | REMOTE I/O PANEL | BIDDER TO INDICATE LOAD DATA | |

FORM NO. PEM-6666-0

| | | |
|---|---|---|
| | **DATA SHEET FOR PLC SYSTEM** | SPECIFICATION NO.: |
| | | VOLUME II B |
| | | SECTION D |
| | | REV. NO. 02 DATE: 19.07.2008 |
| | | SHEET 1 OF 1 |

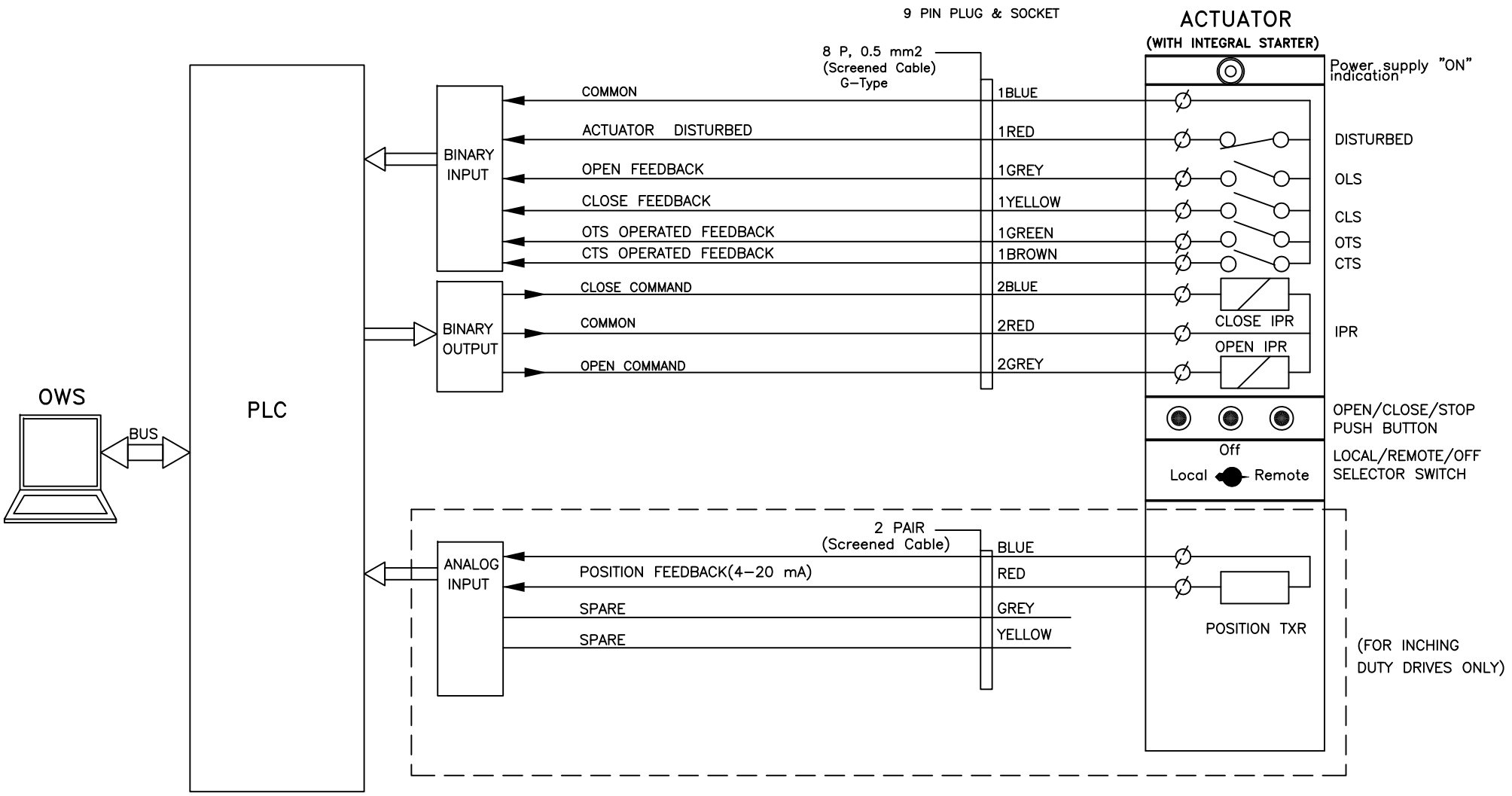
Data Sheet No.: **PES-145-36-DS2-0**

## Data Sheet C

DATA SHEET – C
(TO BE FILLED BY BIDDER AFTER AWARD OF CONTRACT)

| | | |
|---|---|---|
| **GENERAL*** | PROJECT | |
| | SERVICE | |
| | QUANTITY | |
| | LOCATION | |
| **PLC EQUIPMENT** | MAKE / MODEL NO. | |
| | **PROCESSOR** | |
| | DATA BUS (HMI) | |
| | DATA BUS (I/O - CPU) | |
| | DATA BUS (REMOTE I/O - CPU) | |
| | FIELD CONTACTS INTERROGATION VOLTAGE | |
| | LOCATION OF COUPLING RELAYS | |
| | DESKTOP OWS QUANTITY | |
| | DESKTOP MONITOR TYPE | |
| | PRINTER (A4) - QUANTITY | |
| | PRINTER (A4) - MODEL | |
| | PROGRAMMING / CONFIGURATION FACILITY | |
| | SAFETY STANDARD | |
| | COMPUTER FURNITURE | |
| **PANEL** | QUANTITY | |
| | CLASS OF PROTECTION | |
| | REMOTE I/O PANEL | |
| | COLOUR | |
| | BACK-UP DESK | |
| | MIMIC | |
| | CONTROL HARDWARE | |
| **COMMUNICATION TO OTHER SYSTEM** | HARDWIRED | |
| | PURPOSE | |
| | MEDIUM | |
| | TIME SYNCRONIZATION SIGNAL FORMAT | |
| | SOFTLINK | |
| | SERIAL LINK | |
| **POWER SUPPLY INPUT FEEDER** | PLC PANEL | |
| | REMOTE I/O PANEL | |

# PLC INTERFACE FOR BIDIRECTIONAL DRIVE(WITH INTEGRAL STARTER)



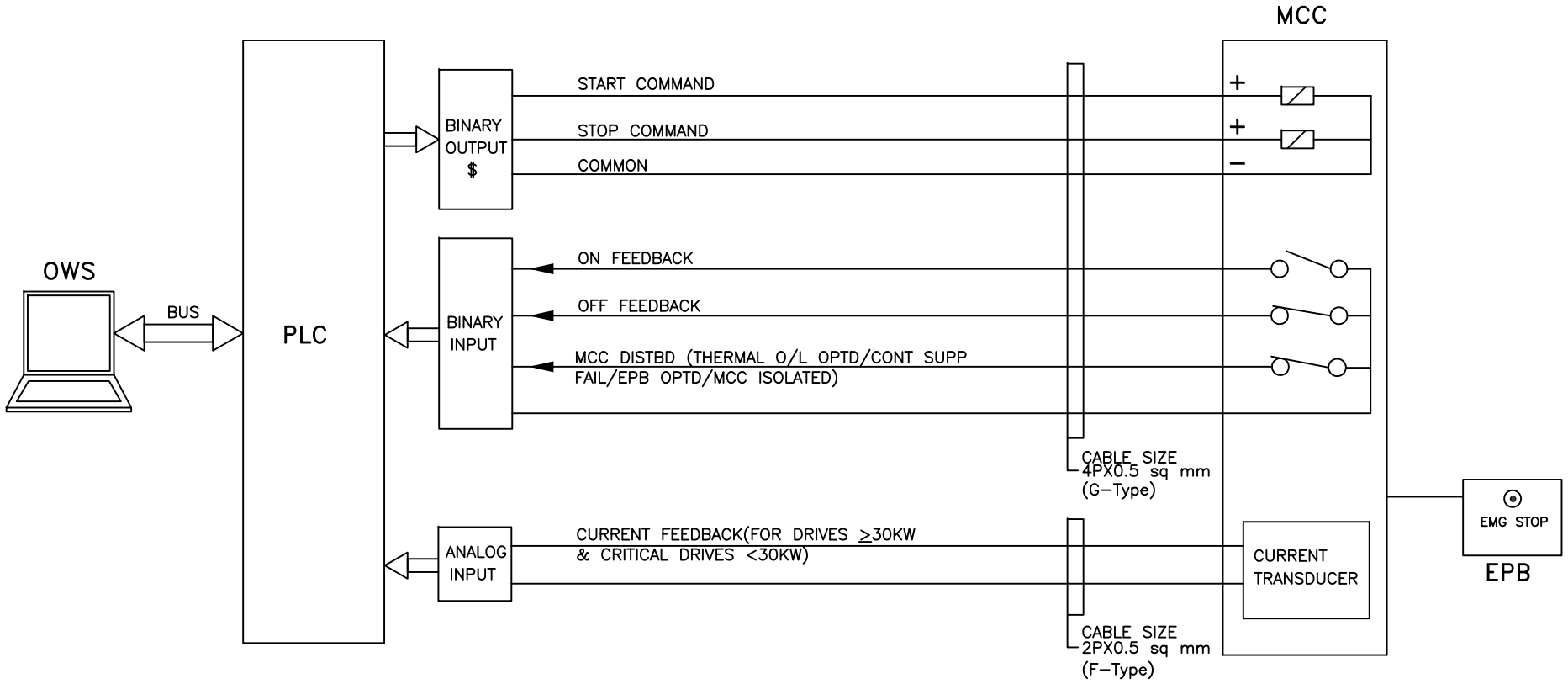

NOTE:

1. DISTURBED= Loss of Power supply (1 Phase/3 Phase), Loss of control supply, Motor thermostate trip, Thermal over load relay trip, Valve jammed, Torque open/close cut off, Local/Off/Remote Sel. switch in local or off mode etc.

## ANNEXURE 2 (SHEET 1 OF 5)

| | | | |
|---|---|---|---|
| BHEL | PROJECT: 2X250MW ALEPP–SYRIA PROPOSAL | DRG.NO. | PE–SD–J20–145–I002 |
| | | | |
| | TITLE PLC INTERFACE FOR BIDIRECTIONAL DRIVE | REV.NO. | |
| | | SHT | 1 OF 5 |

# PLC INTERFACE FOR UNIDIRECTIONAL LT DRIVE

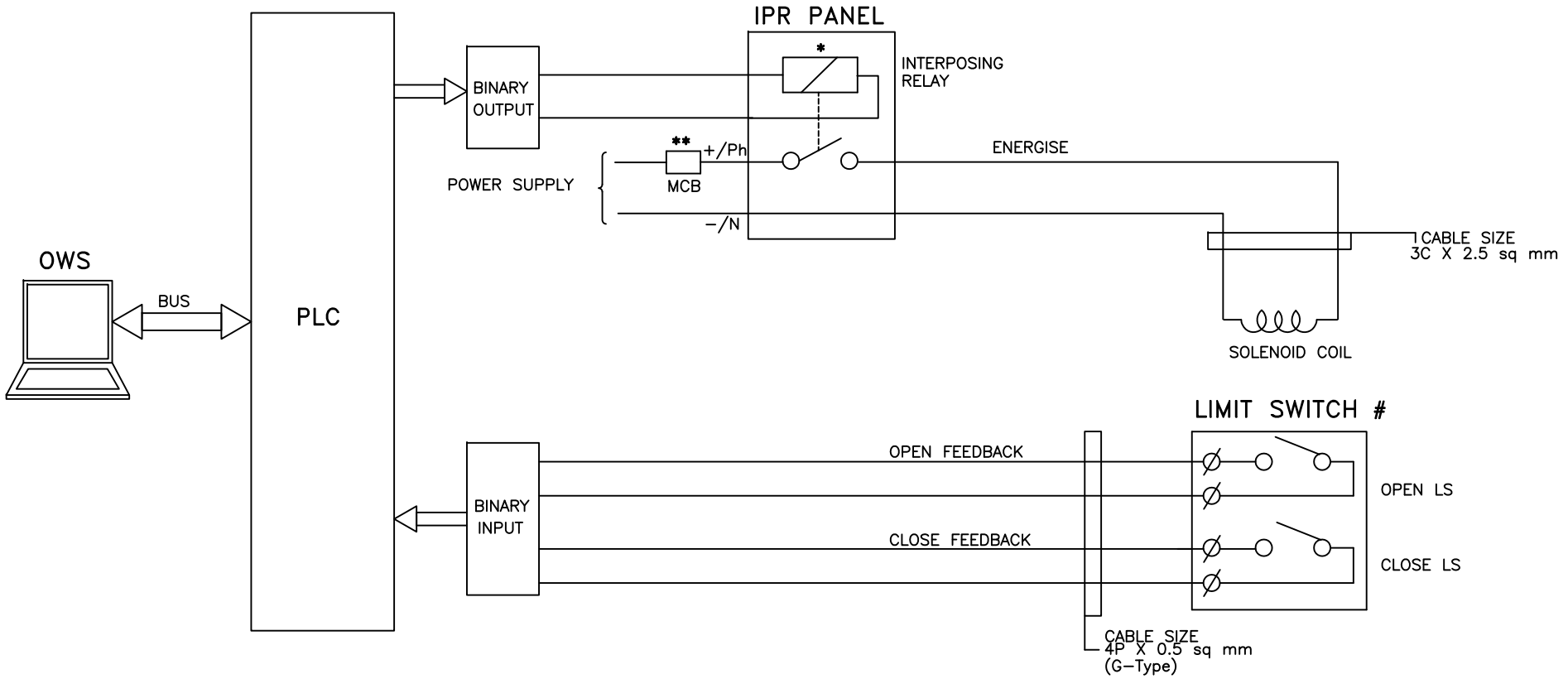



## ANNEXURE 2 (SHEET 2 OF 5)

$ REDUNDANT OUTPUTS

| | | | |
|---|---|---|---|
| BHEL | PROJECT: 2X250MW ALEPP-SYRIA PROPOSAL | DRG.NO. | PE-SD-J20-145-I002 |
| | | | |
| | TITLE PLC INTERFACE FOR UNIDIRECTIONAL LT DRIVE | REV.NO. | |
| | | SHT | 2 OF 5 |

# PLC INTERFACE FOR SOLENOID DRIVE
# (24V DC / 240V AC UPS)




NOTES:

* TWO INDEPENDENT OUTPUTS FROM CONTROL SYSTEM SHALL BE PROVIDED TO PUSH−PULL TYPE VALVES, WITH DUAL COIL SOLENOIDS.

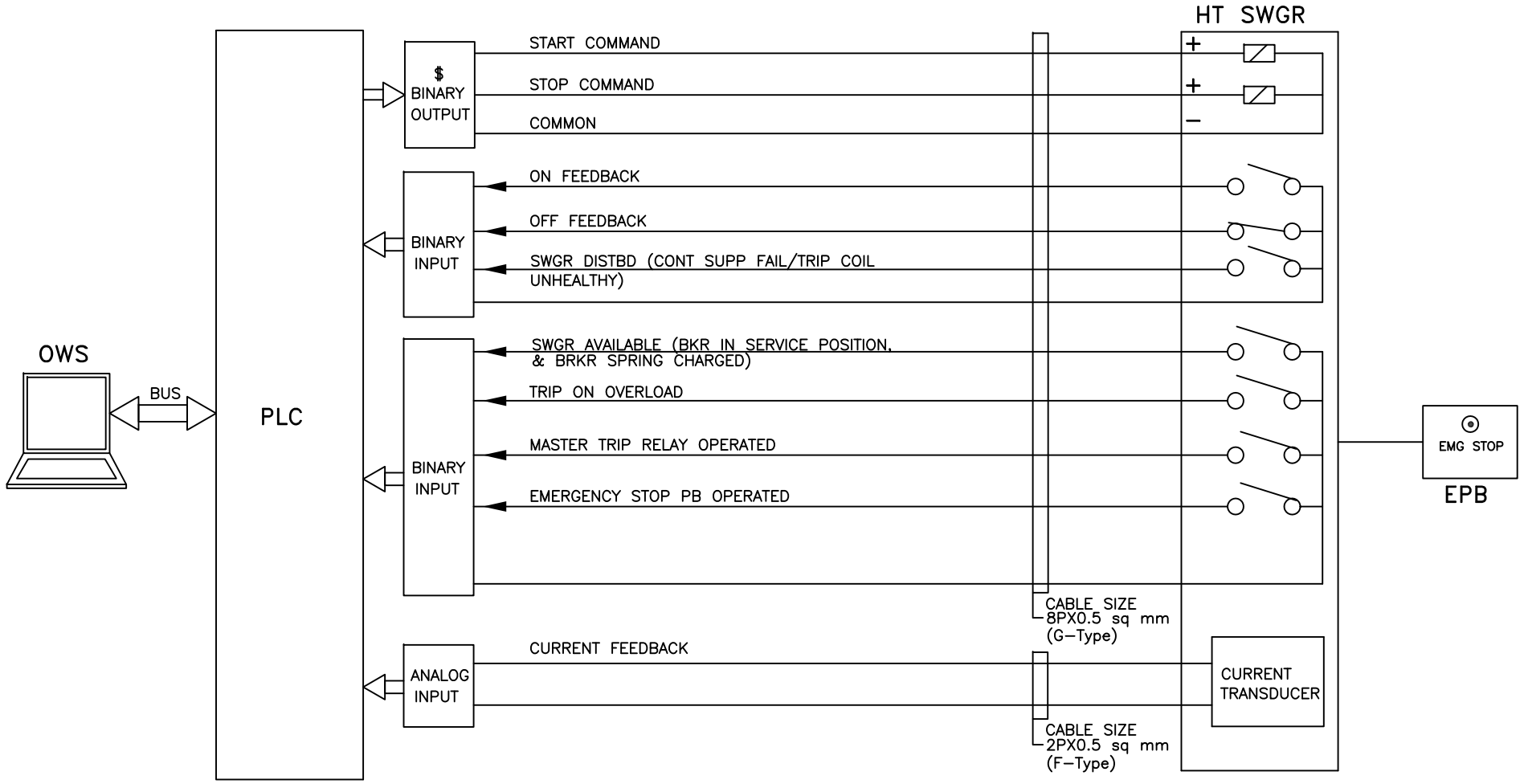
** MCB SHALL BE PROVIDED FOR EACH SOLENOID

\# FOR ON/OFF TYPE, SOLENOID ACTUATED CONTROL VALVE.

## ANNEXURE 2 (SHEET 3 OF 5)

| | | | |
|---|---|---|---|
| BHEL | PROJECT: 2X250MW ALEPP−SYRIA PROPOSAL | DRG.NO. | PE−SD−J20−145−I002 |
| | | | |
| | TITLE PLC INTERFACE FOR SOLENOID DRIVE | REV.NO. | |
| | | SHT | 3 OF 5 |

# PLC INTERFACE FOR UNIDIRECTIONAL HT DRIVE

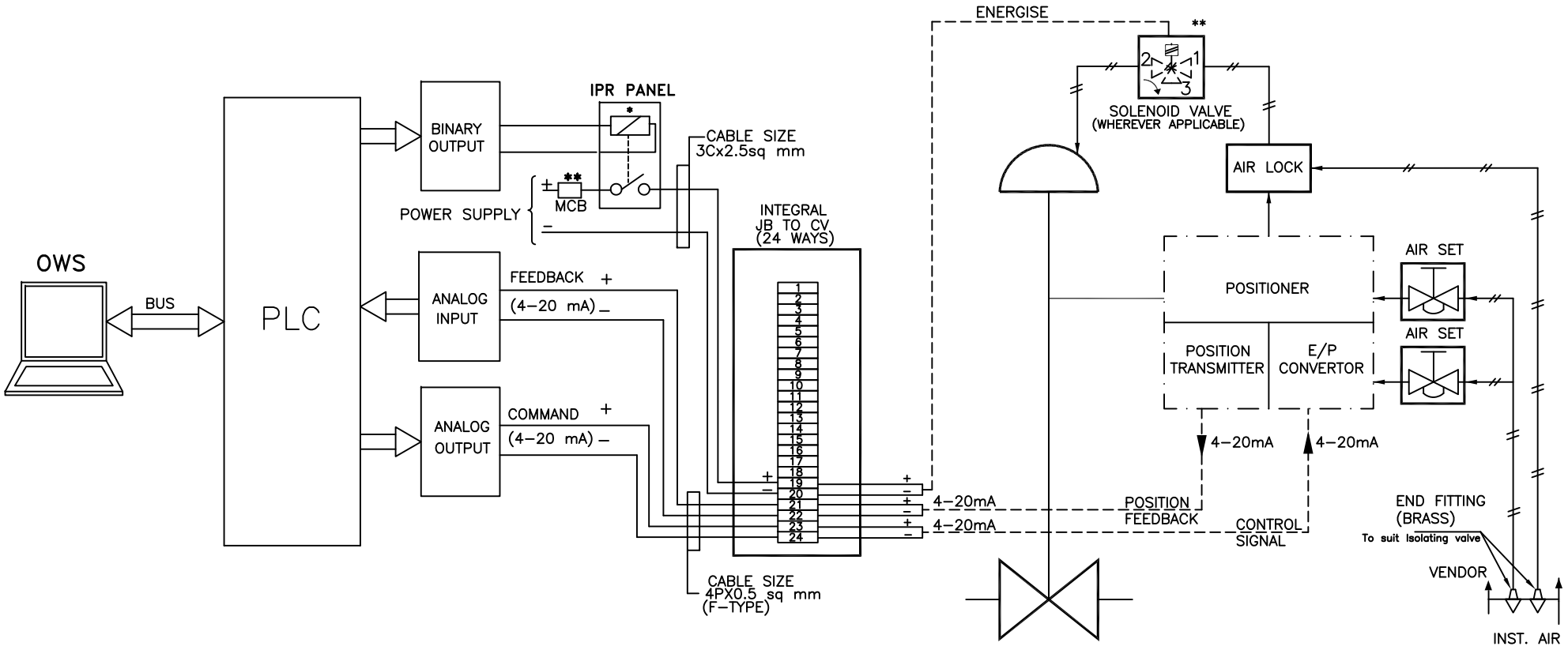



## ANNEXURE 2 (SHEET 4 OF 5)

$ REDUNDANT OUTPUTS

| | | | |
|---|---|---|---|
| BHEL | PROJECT: 2X250MW ALEPP-SYRIA PROPOSAL | DRG.NO. | PE-SD-J20-145-I002 |
| | | | |
| | TITLE PLC INTERFACE FOR UNIDIRECTIONAL HT DRIVE | REV.NO. | |
| | | SHT | 4 OF 5 |

# PLC INTERFACE FOR ANALOG DRIVE




NOTES:

** WHEREVER REQUIRED

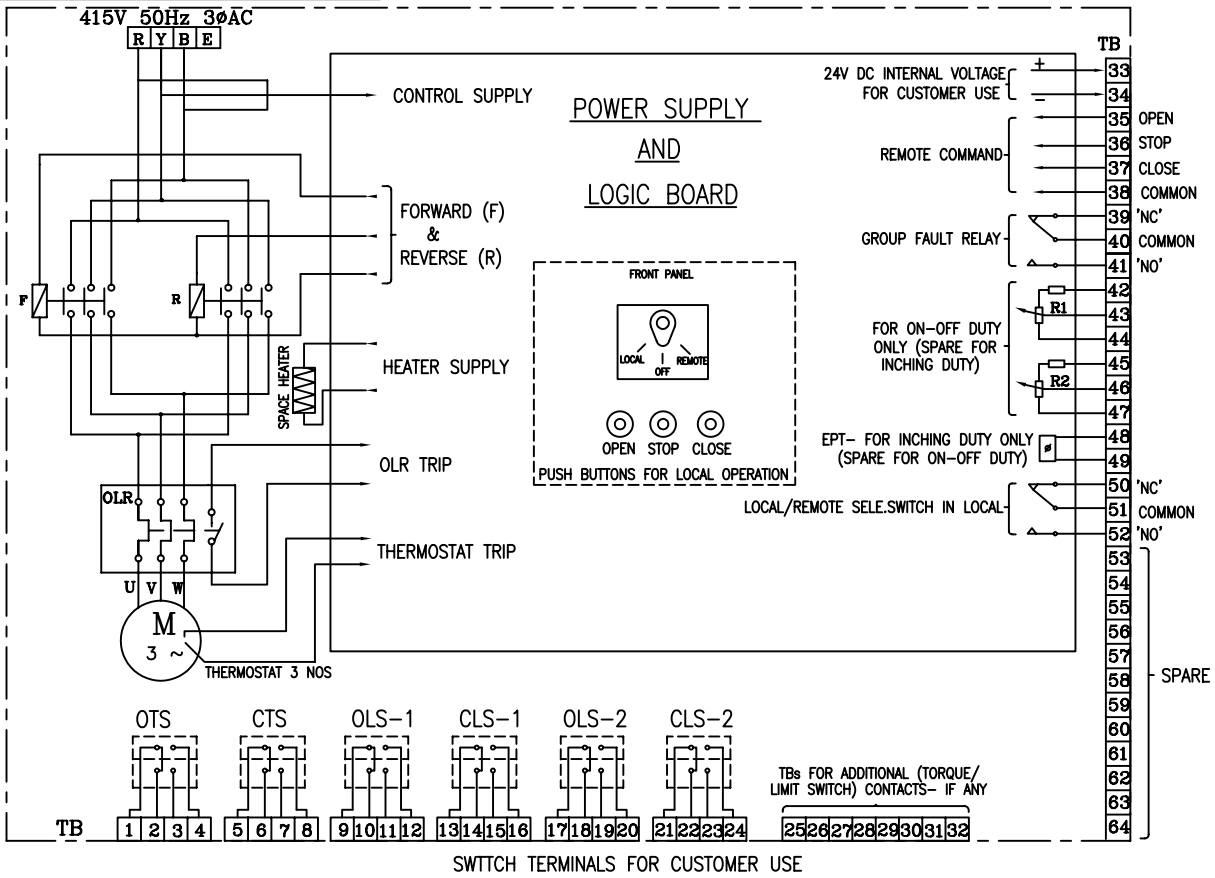
## ANNEXURE 2 (SHEET 5 OF 5)

| | | | |
|---|---|---|---|
| BHEL | PROJECT: 2X250MW ALEPP–SYRIA PROPOSAL | DRG.NO. | PE–SD–J20–145–I002 |
| | | | |
| | TITLE: TYPICAL HOOK–UP DIAGRAM ANALOG DRIVE | REV.NO. | |
| | | SHT | 5 OF 5 |

ANNEXURE-3

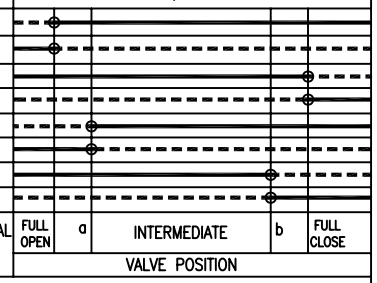
ALL DIMENSIONS ARE IN MILLIMETRES. FOR TOLERANCES OF UNTOLERANCED DIMENSIONS DURING MANUFACTURE REFER RELEVANT QCP / QP.

DRAWING NO. 3-V-MISC-24227




## CONTACT DEVELOPMENT DIAGRAM

| | | |
|---|---|---|
| OTS | 1-2 | OPEN AT OVER TORQUE DURING OPENING TRAVEL |
| | 3-4 | CLOSE AT OVER TORQUE DURING OPENING TRAVEL |
| CTS | 5-6 | OPEN AT OVER TORQUE DURING CLOSING TRAVEL |
| | 7-8 | CLOSE AT OVER TORQUE DURING CLOSING TRAVEL |
| OLS-1 | 9-10 | |
| | 11-12 | |
| CLS-1 | 13-14 | |
| | 15-16 | |
| OLS-2 | 17-18 | |
| | 19-20 | |
| CLS-2 | 21-22 | |
| | 23-24 | |




INDICATES CONTACT CLOSED

INDICATES CONTACT OPEN

CONTACT RATING: 5A AT 250V AC & 0.5A AT 220V DC

## SETTING PROCEDURE OF POSITION LIMIT AND TORQUE SWITCH

| VALVES | OPEN | | CLOSE | |
|---|---|---|---|---|
| | MAIN | BACK UP | MAIN | BACK UP |
| GATE VALVE OF 100 mm AND ABOVE IN 1500 CL AND ABOVE RATINGS | OLS | OTS * | CLS | CTS |
| ALL OTHER GATE & GLOBE VALVES | OLS | OTS * | CTS | # |

# – CLS NOT TO BE CONNECTED IN TRIP CIRCUIT

* – BYPASS OTS FOR INITIAL 5% OF TRAVEL (FOR GATE VALVES ONLY)

NOTE:–

1. ALL TORQUE AND LIMIT SWITCHES (OTS,CTS,OLS1&2, CLS1&2) ARE WITH 2NO+2NC CONTACTS '1NO+1NC' IS TERMINATED IN TBS 1–24, REMAINING CONTACTS ARE FOR INTERNAL USE. ANY SPARE CONTACTS WHICH ARE NOT USED INTERNALLY ARE TO BE TERMINATED IN TBS 25–32
2. CTS – TORQUE SWITCHES FOR CW ROTATION (CLOSE)
3. OTS – TORQUE SWITCHES FOR CCW ROTATION (OPEN)
4. OLS–1, OLS–2 – LIMITSWITCHES FOR POSITION OPEN
5. CLS–1, CLS–2 – LIMITSWITCHES FOR POSITION CLOSE
6. EPT – ELECTRONIC POSITION TRAMSMITTER (POTENTIOMETRIC TYPE, FOR INCHING DUTY)
7. R1–R2–POTENTIOMETER 2 x 100 OHMS (FOR ON–OFF DUTY)
8. FOR COMMANDS & EPT EITHER INTERNALLY GENERATED 24 VDC OR EXTERNAL SUPPLY OF 24VDC CAN BE USED
9. M – MOTOR 3ø 415V 50 Hz AC SUPPLY

| REV | DATE | ALTERED |
|---|---|---|
| | | CHD & APPD |

CAUTION: The information on this document is the property of BHARAT HEAVY ELECTRICALS LTD. It must not be used directly or indirectly in any way detrimental to the interest of the company.

TYPE OF PRODUCT OR NAME OF CUSTOMER/PROJECT: ELECTRICAL VALVE ACTUATORS (AC) WITH INTEGRAL STARTERS (DRAWN FOR INTERMEDIATE POSITION OF VALVES)

BHARAT HEAVY ELECTRICALS LTD.,
UNIT: HIGH PRESSURE BOILER PLANT.
TIRUCHIRAPALLI–620014.
365–121

| | NAME | SIGN | DATE | NO.OF VAR. |
|---|---|---|---|---|
| DRN | N.P.ESWAR | N.P | 07.10.04 | |
| CHD | D.DINAKARAN | D.D | 07.10.04 | |
| APPD | K.ARUNACHALAM | K.A | 07.10.04 | |

DEPT: VL | CODE | SCALE | WEIGHT (KG). | REFERENCE INFORMATIONS | NO. OF ITEMS

TITLE: WIRING DIAGRAM (TERMINAL PLAN) FOR ACTUATOR WITH INTEGRAL STARTER

CARD CODE: U 01

DRAWING NO.: 3–V–MISC–24227

REV: 0

Size A3

ANNEXURE-4

FORM NO. PEM-6666-0

| | | |
|---|---|---|
| | **SPECIFICATION FOR MOTORISED VALVE ACTUATOR** | SPECIFICATION NO.: PE-SS-999-145-I007 |
| | | VOLUME II B |
| | | SECTION D |
| | | REV. NO. 02 DATE: 17.09.07 |
| | | SHEET 1 OF 3 |

## Data Sheet A & B

| | | DATA SHEET-A (TO BE FILLED BY PURCHASER) | DATA SHEET-B (TO BE FILLED-UP BY BIDDER) |
|---|---|---|---|
| **GENERAL*** | * PROJECT | 1X 600 MW KAKATIYA TPS | |
| | OFFER REFERENCE | | |
| | * TAG NO. SERVICE | | |
| | * DUTY | ☐ ON / OFF ☐ INCHING | |
| | * LINE SIZE (inlet/outlet): MATERIAL | | |
| | * VALVE TYPE | ☐ GLOBE ☐ GATE ☐ REG. GLOBE ☐ BUTTERFLY | |
| | * OPENING / CLOSING TIME | | |
| | * WORKING PRESSURE | | |
| | AMBIENT CONDITION | SHALL BE SUITABLE FOR CONTINUOUS OPERATION UNDER AN AMBIENT TEMP. OF -20 to 70 DEG C AND RELATIVE HUMIDITY OF 0-95% | |
| | VALVE SEAT TEST PRESS | BIDDER TO SPECIFY | |
| | REQUIRED VALVE TORQUE | BIDDER TO SPECIFY | |
| | ACTUATOR RATED TORQUE | BIDDER TO SPECIFY | |
| **CONSTRUCTION AND SIZING** | CONSTRUCTION | TOTALLY ENCLOSED, WEATHER PROOF, IP:68 | |
| | MECHANICAL POSITION INDICATOR | TO BE PROVIDED FOR 0-100% TRAVEL | |
| | BEARINGS | DOUBLE SHIELDED, GREASE LUBRICATED ANTI-FRICTION. | |
| | GEAR TRAIN FOR LIMIT SWITCH/TORQUE SWITCH OPERATION | METAL (NOT FIBRE GEARS). SELF-LOCKING TO PREVENT DRIFT UNDER TORQUE SWITCH SPRING PRESSURE WHEN MOTOR IS DE-ENERGIZED. | |
| | SIZING | OPEN/CLOSE AT RATED SPEED AGAINST DESIGNED DIFFERENTIAL PRESSURE AT 85% OF RATED VOLTAGE. FOR ISOLATING SERVICE THREE SUCCESSIVE OPEN-CLOSE OPERATIONS OR 15 MINS. WHICHEVER IS HIGHER. **FOR INCHING(REGULATING) SERVICE 150 STARTS/HR MINIMUM** | |
| **HANDWHEEL** | * REQUIRED | ■ YES ☐ NO | |
| | * ORIENTATION | ☐ TOP MOUNTED ☐ SIDE MOUNTED | |
| | TO DISENGAGE AUTOMATICALLY DURING MOTOR OPERATION. | | |
| **ELECTRIC ACTUATOR** | ACTUATOR MAKE/MODEL | BIDDER TO SPECIFY | |
| | MOTOR MAKE / MODEL / TYPE / RATING (KW) | BIDDER TO SPECIFY | |
| | MOTOR TYPE | SQUIRREL CAGE INDUCTION MOTOR, STARTING CURRENT LIMITED TO SIX TIMES THE RATED CURRENT. | |
| | ACTUATOR APPLICABLE WIRING DIAGRAM | ■ ENCLOSED (BIDDER TO CONFIRM)<br>A: ■ DRG. NO. 3-V-MISC-24227 R00<br>B: ☐ DRG. NO. 3-V-MISC-24550 R00<br>C: ☐ DRG. NO. 3-V-MISC-24283 R00<br>D: ☐ DRG. NO. 4-V-MISC-90271 R11 | |
| | COLOUR SHADE | ☐ BLUE (RAL 5012) ENAMEL ☐ ……. | |
| | SHAFT RPM | BIDDER TO SPECIFY | |
| | OLR SET VALUE | BIDDER TO SPECIFY | |
| | STARTING / FULL LOAD CURRENT | BIDDER TO SPECIFY | |
| | NO. OF REV FOR FULL TRAVEL | BIDDER TO SPECIFY | |
| | @ PWR SUPP TO MTR / STARTER | **415V±10%, 3PH,4WIRE, AC, 50Hz±5%, 10% COMBINED VOLTAGE & FREQUENCY VARIATION** | |
| | @ CONTROL VOLTAGE REQUIREMENT | **240V AC- TO BE DERIVED FROM THE POWER SUPPLY TO THE STARTER** | |
| | @ ENCLOSURE CLASS OF MOTOR | ■ IP 65 ☐ IP 67 ☐ FLAME PROOF<br>☐ IP 55, TOTALLY ENCL, SELF VENTILATED. | |
| | @ INSULATION CLASS | ☐ CLASS-B ■ CLASS-F (TEMPERATURE RISE LIMITED TO CLASS B) | |
| | @ WINDING TEMP PROTECTION | ■ THERMOSTAT (3 Nos.,1 IN EACH PHASE)<br>☐ ---------- | |

| | | |
|---|---|---|
| BHEL | **SPECIFICATION FOR MOTORISED VALVE ACTUATOR** | SPECIFICATION NO.: PE-SS-999-145-I007<br>VOLUME II B<br>SECTION D<br>REV. NO. 02 DATE: 17.09.07<br>SHEET 2 OF 3 |

## Data Sheet A & B

| | | DATA SHEET-A (TO BE FILLED BY PURCHASER) | DATA SHEET-B (TO BE FILLED-UP BY BIDDER) |
|---|---|---|---|
| | SINGLE PHASE / WRONG PHASE SEQUENCE PROTECTION | REQUIRED | |
| **INTEGRAL STARTER** | INTEGRAL STARTER | ■ REQUIRED ☐ NOT REQUIRED | |
| | TYPE OF SWITCHING DEVICE | ☐ CONTACTORS ☐ THYRISTORS | |
| | TYPE | ■ CONVENTIONAL ☐ SMART (NON-INTRUSIVE) | |
| | **IF SMART** | NOT APPLICABLE | |
| | a) SERIAL LINK INTERFACE | ☐ INTEGRAL ☐ FIELD MOUNTED | |
| | b) SERIAL LINK PROTOCOL | ☐ FOUNDATION FIELD-BUS ☐ PROFI-BUS ☐ TCP/IP ☐…… | |
| | c) SERIAL LINK MEDIA | ☐ TWISTED PAIR Cu-CBL ☐ CO-AXIAL Cu-CBL ☐ OFC | |
| | d) HAND HELD PROGRAMMER | ☐ REQUIRED ☐ NOT REQUIRED | |
| | e) MASTER STATION | ☐ REQUIRED ☐ NOT REQUIRED | |
| | f) MASTER STN INTRFACE WITH DCS | ☐ MODBUS ☐ TCP/IP | |
| | g) DETAILS OF SPECIAL CABLE | ☐ ENCLOSED ☐ NOT REQUIRED | |
| | STEP DOWN CONT. TRANSFORMER | ☐ REQUIRED | |
| | OPEN / CLOSE PB | ■ REQUIRED ☐ NOT REQUIRED | |
| | STOP PB | ■ REQUIRED ☐ NOT REQUIRED | |
| | INDICATING LAMPS | ■ REQUIRED ☐ NOT REQUIRED | |
| | LOCAL REMOTE S/S | ■REQUIRED ☐ NOT REQUIRED | |
| | STATUS CONTACTS FOR MONITORING | ■ REQUIRED ☐ NOT REQUIRED | |
| | INTEGRAL STARTER DISTURBED SIGNAL | REQUIRED (O/L RELAY OPERATED, CONT./POWER SUPPLY FAILED, S/S IN LOCAL, TORQUE SWITCH OPTD. MID WAY) | |
| **INTERPOSING RELAY** (Applicable for integral Starter) | INTERPOSING RELAYS | REQUIRED | |
| | INTERPOSING RELAY (QUANTITY) | ■ 2 NOs. ☐ 3 NOs. | |
| | DRIVING VOLTAGE | ■ 20.5 – 24V DC ☐ _____V DC | |
| | DRIVING CURRENT | ■ 125mA MAX ☐ _____mA MAX | |
| | LOAD RESISTANCE | ■ > 192 ohms - <25 k ohms<br>☐ > _____ohms - < _____ohms | |
| **TORQUE SWITCH** (Not Applicable for Smart Actuator) | MFR & MODEL NO. | BIDDER TO SPECIFY | |
| | OPEN / CLOSE | ■1 No. ☐2Nos. / ■1 No. ☐2Nos | |
| | CONTACT TYPE | 2 NO + 2 NC | |
| | RATING | 5A 240V AC AND 0.5A 220V DC | |
| | CALIBRATED KNOBS(OPEN&CLOSE TS) | REQUIRED FOR SETTING DESIRED TORQUE | |
| | ACCURACY | +3% OF SET VALUE | |
| **LIMIT SWITCH** (Not Applicable for Smart Actuator) | MFR & MODEL NO. | BIDDER TO SPECIFY | |
| | OPEN : INT : CLOSE | ☐1 No ■2 Nos. : 2 Nos. (ADJ.) : ☐1 No. ■2Nos. | |
| | CONTACT TYPE | 2 NO + 2 NC | |
| | RATING (AC / DC) | 5A 240V AC AND 0.5A 220V DC | |

FORM NO. PEM-6666-0

| | | |
|---|---|---|
| BHEL | **SPECIFICATION FOR MOTORISED VALVE ACTUATOR** | SPECIFICATION NO.: PE-SS-999-145-I007<br>VOLUME II B<br>SECTION D<br>REV. NO. 02 DATE: 17.09.07<br>SHEET 3 OF 3 |

## Data Sheet A & B

| DATA SHEET-A (TO BE FILLED BY PURCHASER) | DATA SHEET-B (TO BE FILLED-UP BY BIDDER) |
|---|---|

| | | | |
|---|---|---|---|
| **POSITION TRANSMITTER** | POSITION TRANSMITTER (For inching duty) | ■ REQUIRED ☐ NOT REQUIRED | |
| | MFR & MODEL NO. | BIDDER TO SPECIFY | |
| | TYPE | ■ ELECTRONIC (2 WIRE) R/I CONVERTER<br>☐ ELECTRONIC (2 WIRE) CONTACTLESS | |
| | SUPPLY | ■ 24V DC ☐ …… | |
| | OUTPUT | ■ 4-20mA | |
| | ACCURACY | ± 1% FS | |
| **SPACE HEATER** | @SPACE HEATER | REQUIRED | |
| | @ POWER SUPPLY | **240V, AC, SINGLE PHASE** | |
| | @ RATING | **BIDDER TO SPECIFY** | |
| **TERMINAL BOX** | MOTOR TERMINAL BOX | REQUIRED | |
| | ACTUATOR TERMINAL BOX | REQUIRED | |
| | ENCL CLASS MTR T.B. / ACTUATOR T.B. | @■ IP 65 @☐…… ☐ IP65 ☐…… | |
| | @ EARTHING TERMINAL | PROVIDED, **SIZE: DURING DETAILED ENGINEERING.** | |
| | PLUG & SOCKET(9 PIN) (FOR COMMD, LS/TS FEED BACK, PoT) | ☐ REQUIRED ☐ NOT REQUIRED☐<br>☐ 2 NOS. ☐ ---------- | |
| **CABLE GLANDS** | @ POWER CABLE GLAND | SIZE: **LATER-DURING DETAILED ENGINNERING** | |
| | @ SPACE HEATER CABLE GLAND | SIZE: **AS PER REQUIREMENT (MIN. SIZE OF CONDUCTOR-2.5SQ.MM (Cu).** | |
| | OTHER CONTROL CABLE GLANDS-1 | ☐ 1No. for BFV of CW PUMP(Cable size 2Px1.5mm2) | |
| | OTHER CONTROL CABLE GLANDS-2 | QUANTITY & SIZE : Cable glands suitable for 8P x0.5 mm2 cable. | |
| **WEIGHT** | TOTAL WEIGHT (ACTUATOR + ACCESSORIES) | BIDDER TO SPECIFY | _____ Kg. |

**NOTES**:

1. **SCOPE**: DESIGN, MANUFACTURE, INSPECTION, TESTING AND DELIVERY TO SITE OF ELECTRIC ACTUATOR FOR INCHING OR OPEN / CLOSE DUTY.
2. **CODES & STANDARDS**: DESIGN AND MATERIALS USED SHALL COMPLY WITH THE RELEVANT LATEST NATIONAL AND INTERNATION STANDARD. AS A MINIMUM, THE FOLLOWING STANDARDS SHALL BE COMPLIED WITH:
   IS-9334, IS-2147, IS-2148, IS-325, IS-2959, IS-4691 AND IS-4722
3. TEMPERATURE RISE SHALL BE RESTRICTED TO 70 DEG. C FOR AMBIENT TEMPERATURE OF 50 DEG C.
4. CABLE GLANDS OF DOUBLE COMPRESSION TYPE, BRASS MATERIAL SHALL BE PROVIDED.
5. THE TORQUE SWITCHES SHALL BE PROVIDED WITH MECHANICAL LATCHING DEVICE TO PREVENT OPERATION WHEN UNSEATING FROM THE END POSITIONS. THE LATCHING DEVICE SHALL UNLATCH AS SOON AS THE VALVE LEAVES THE END POSITION. IF SUCH PROVISION IS NOT POSSIBLE, THE TORQUE SWITCHES SHALL BE BYPASSED BY END-POSITION LIMIT SWITCHES WHICH OPENS ON VALVE LEAVING END POSITION.THESE LIMIT SWITCHES ARE ADDITIONAL TO THE NUMBER OF LIMIT SWITCHES SPECIFIED ELSEWHERE.
6. THE MOTOR SHALL OPERATE SATISFACTORILY UNDER THE +/- 10% SUPPLY VOLTAGE VARIATION AT RATED FREQUENCY, -5% TO +3% VARIATION IN FREQUENCY AT RATED SUPPLY VOLTAGE, SIMULTANEOUS VARIATION IN VOLTAGE & FREQUENCY THE SUM OF ABSOLUTE PERCENTAGE NOT EXCEEDING 10%.
7. THE MOTOR SHALL BE SUITABLE FOR DIRECT ON LINE STARTING.

.

| | PREPARED BY | CHECKED BY | APPROVED BY | VENDOR COMPANY SEAL |
|---|---|---|---|---|
| NAME | M.A. Mansoori | Pankaj Jain | S.K. Datta | NAME |
| SIGNATURE | | | | SIGNATURE |
| DATE | 17.09.2007 | 27.09.2007 | 28.09.2007 | DATE |

NOTES* = TO BE FILLED BY MPL (LEAD AGENCY). @= TO BE FILLED BY ES

**SCOPE MATRIX FOR DRY COOLING TOWER SYSTEM FOR 2x250 MW SYRIA PROPOSAL**

| | | |
|---|---|---|
| 1.00 | **COMMON / PER UNIT** | PER UNIT |
| 2.00 | **CONTROL SYSTEM** | PLC |
| 3.00 | **PROCESSOR CONFIGURATION FOR PLC SYSTEM** | REDUNDANT WITH HOT STAND BY |
| 4.00 | **LOCATION OF CONTROL SYSTEM** | LOCAL as well as from CCR |
| 5.00 | **CONTROL SYSTEM SCOPE (BIDDER/ BHEL/ CUSTOMER)** | BIDDER |
| 6.00 | **RIO / RPU (Y/N)** | Bidder to specify |
| 7.00 | **## NO. OF OWS / LAPTOP** | Min 2 no of OWS, 1 no for local operation + 1 no OWS or operation from Control Room |
| 8.00 | **SIZE OF OWS/ CRT OR LCD** | 21 inch LCD TFT |
| 9.00 | **NO. OF PRINTER** | 1 no. |
| 10.00 | **PRINTER SIZE AND TYPE** | A4 size, B/W laser |
| 11.00 | **&& POWER SUPPLY AVAILABLE FOR PLC PANEL (3PHASE, 415 V AC/ 1PHASE, 110 V UPS/ 1PHASE, 230 V UPS)** | 3 PHASE, 415 V AC AT SINGLE POINT |
| 12.00 | **REDUNDANT FEEDERS (R) / NON-REDUNDANT (NR) FEEDERS FOR POWER SUPPLY** | R |
| 13.00 | **** UPS BATTERY CONFIGURATION (1X100% / 2X100%)** | 2 X 100 % |
| 14.00 | **BATTERY TYPE (LEAD ACID/ Ni-Cd)** | Ni Cd ( PLANTE TYPE) |
| 15.00 | **BATTERY BACK-UP TIME (in hours)** | 5 |
| 16.00 | **ACTUATOR WITH INTEGRAL STARTER (Y/N)** | Y |
| 17.00 | **PG/ DPG/ PS/ DPS/ PT/ DPT /LT/LS/TE** | Yes |

18.00 **NOTES:**

1. && **THIS IS APPLICABLE FOR PLC CONTROLLED SYSTEMS. ALL POWER SUPPLY REQUIREMENTS FOR INDIVIDUAL SUB-SYSTEMS/ COMPONENTS SHALL BE DERIVED BY THE VENDOR FROM THIS POWER SUPPLY.**

2. ** **THE UPS FOR PLC SHALL BE IN BIDDER'S SCOPE. ITS CONFIGURATION SHALL BE 2X100% CHARGERS / INVERTERS.**

3. ## **FOR PLC BASED CONTROL SYSTEM WHERE OWS IS PROVIDED, THE OWS SHALL HAVE PROGRAMMING & CONFIGURATION FACILITY.**

4. **INSTRUMENT RACK AND JUNCTION BOXES SHALL BE IN BIDDER'S SCOPE OF SUPPLY.**
5. **ALARM FACIA FOR THE PACKAGE SHALL BE UNDER BIDDER'S SCOPE.**

**LEGEND:**

DCS- DISTRIBUTED CONTROL SYSTEM
PLC- PROGRAMMABLE LOGIC CONTROLLER
RPU - REMOTE PROCESSING UNIT

# PEEGT

# ALEPPO STEAM POWER PLANT

# TECHNICAL SCHEDULES & DATASHEET

# CONTROL & INSTRUMENTATION

## TECHNICAL SCHEDULE DATA C&I

DESIGN & PERFORMANCE DATA
SUMMARY SHEET FOR DISTRIBUTED CONTROL SYSTEM

**(I) Instrument Summary**

| Item | Unit | Number |
|---|---|---|
| **(a)** Analogue Measurements Provided | | |
| Temperature | | |
| Pressure | | |
| Differential Pressure | | |
| Level | | |
| Flow | | |
| Conductivity Cation Cond. | | |
| Specific Cond. | | |
| Si | | |
| $O_2$ | | |
| PH | | |
| Sodium | | |
| Other (Specify) | | |
| Local Temperature Indicators | | |
| Local Pressure Indicators | | |
| Local Flow Indicators | | |
| Local level Indicators | | |

## TECHNICAL SCHEDULE DATA C&I

DESIGN & PERFORMANCE DATA
SUMMARY SHEET FOR DISTRIBUTED CONTROL SYSTEM

**(b)** Binary

| Item | Unit | Number |
|---|---|---|
| Temperature Switches | | |
| Pressure Switches | | |
| Level Switches | | |
| Flow Switches | | |

## TECHNICAL SCHEDULE DATA C&I

DESIGN & PERFORMANCE DATA
SUMMARY SHEET FOR DISTRIBUTED CONTROL SYSTEM

**(ii) Valve Summary**

| Item | Unit | Number |
|---|---|---|
| Modulating Valves | | |
| Intermediate Position Valves | | |
| Binary (open/closed) Valves | | |

**(iii) Control Panels Summary**

| Item | Unit | Number |
|---|---|---|
| Control System Panels Located In Relay Room | | |
| Control Panels located Elsewhere | | |
| Application | | |
| Number of Marshalling Cabinets | | |

## TECHNICAL SCHEDULE DATA C&I

DESIGN& PERFORMANCE DATA
SUMMARY SHEET FOR TURBINE CONTROL EQUIPMENT

**(I) Instrument Summary** **ST**

| Item | Unit | Number |
|---|---|---|
| **(a)** Analogue Measurements | | |
| Temperature | | |
| Pressure | | |
| Speed | | |
| Level | | |
| Flow | | |
| Other (specify) | | |
| Local Temperature Indicators | | |
| Local Pressure Indicators | | |
| Local Flow Indicators | | |
| Local Level Indictors | | |

**(b) Binary Measurements**

| Item | Unit | Number |
|---|---|---|
| Temperature Switches | | |
| Pressure Switches | | |
| Level Switches | | |
| Flow Switches | | |

## TECHNICAL SCHEDULE DATA C&I

DESIGN & PERFORMANCE DATA
SUMMARY SHEET FOR TURBINE CONTROL EQUIPMENT

**(ii) Valve Summary**

| Item | Unit | Number |
|---|---|---|
| Modulating Valves | | |
| Intermediate Position Valves | | |
| Binary (open/close) Valves | | |

**(iii) Control Panels Summary**

| Item | Unit | Number |
|---|---|---|
| Control System Panels Located In Relay Room | | |
| Else Where | | |
| Application | | |
| Number of Marshalling Cabinets | | |

## TECHNICAL SCHEDULE DATA C&I

DESIGN & PERFORMANCE DATA
SUMMARY SHEET FOR TURBINE CONTROL EQUIPMENT

**(ii) Value Summary**

| Item | Unit | Number |
|---|---|---|
| Modulating Valves | | |
| Intermediate Position Valves | | |
| Binary (open/close) Valves | | |

**(iii) Control Panels Summary**

| Item | Unit | Number |
|---|---|---|
| Control System Panels Located In Relay Room | | |
| Else Where | | |
| Application | | |
| Number of Marshalling Cabinets | | |

## TECHNICAL SCHEDULE DATA C&I

DESIGN & PERFORMANCE DATA
FLOW MEASURING EQUIPMENT

| Item | Unit | Number |
|---|---|---|
| Type of flow measuring device | | |
| Manufacturer | | |
| Model No. | | |
| Application | | |
| Is complete documentation attached? | | |
| Measuring device material | | |
| Standards to which manufactured and calibrated | | |
| Upstream length of straight pipe required mm | | |
| Downstream length of straight pipe required mm | | |
| Differential pressure at maximum flow kN/m2g | | |
| Accuracy | | |
| Range over which accuracy applies | | |
| Mounting position | | |
| Description of accessory equipment | | |

To be filled in for each application

## TECHNICAL SCHEDULE DATA C&I

DESIGN & PERFORMANCE DATA
LEVEL MEASUREMENT

| Item | Unit | Number |
|---|---|---|
| Type of level measuring device<br><br>Manufacturer<br><br>Model No.<br><br>Application<br><br>Is complete documentation attached?<br><br>Type of connection to tapping point e.g. welded,<br><br>Bolted | | |

To be filled in for each application

## TECHNICAL SCHEDULE DATA C&I

DESIGN & PERFORMANCE DATA
TEMPERATURE MEASUREMENT

| Item | Unit | Number |
|---|---|---|
| Pocket and sensor model nos. | | |
| Manufacturer | | |
| Is complete documentation attached? | | |
| Application | | |
| Pocket Material | | |
| Response time of pocket at maximum flow | sec | |
| Standard to which sensor is manufactured | | |
| Description of temperature compensation Equipment | | |

To be filled in for each application

## TECHNICAL SCHEDULE DATA C&I

DESIGN & PERFORMANCE
PRESSURE MEASUREMENT EQUIPMENT

| Item | Unit | Number |
|---|---|---|
| Model No. of pressure sampling tube | | |
| Manufacturer | | |
| Model No. of Solenoid Valves | | |
| Power and voltage supply requirements | | |
| Is description of measuring point selection equipment included? | | |

To be filled in for each application

## TECHNICAL SCHEDULES C&I

DESIGN & PERFORMANCE DATA
PRESSURE TRANSDUCERS

| Item | Unit | Number |
|---|---|---|
| Model Number | | |
| Manufacturer | | |
| Is complete documentation attached? | | |
| Application | | |
| Input signal range | $kN/m^2g$ | |
| Measuring range | $kN/m^2g$ | |
| Output signal | | |
| Power supply requirements | | |
| Standard to which manufactured | | |
| Any special cabling required? | | |
| Method of mounting | | |
| Accuracy | | |
| Repeatability | | |
| Temperature range for which accuracy and repeatability apply in | $^oC$ | |

To be filled in for each application

## TECHNICAL SCHEDULES C&I

DESIGN & PERFORMANCE DATA
DIFFERENTIAL PRESSURE TRANSDUCERS

| Item | Unit | Number |
|---|---|---|
| Model Number | | |
| Manufacturer | | |
| Is complete documentation attached? | | |
| Application | | |
| Input signal range | $kN/m^2$ g | |
| Measuring range | $kN/m^2$ g | |
| Output signal | | |
| Power supply requirements | | |
| Standard to which manufactured | | |
| Any special cabling required? | | |
| Method of mounting | | |
| Accuracy | | |
| Repeatability | | |
| Temperature range for which accuracy and repeatability apply in | $^oC$ | |

To be filled in for each application

## TECHNICAL SCHEDULES C&I

DESIGN & PERFORMANCE DATA
DIFFERENTIAL PRESSURE TRANSDUCERS

| Item | Unit | Number |
|---|---|---|
| Model Number | | |
| Manufacturer | | |
| Is complete documentation attached? | | |
| Application | | |
| Input signal range | ºC | |
| Measuring range | ºC | |
| Output signal | | |
| Power supply requirements | | |
| Standard to which manufactured | | |
| Any special cabling required? | | |
| Method of mounting | | |
| Accuracy | | |
| Repeatability | | |
| Temperature range for which accuracy and repeatability apply in | ºC | |

To be filled in for each application

## TECHNICAL SCHEDULES C&I

DESIGN & PERFORMANCE DATA
VALVE MANIFOLDS

| Item | Unit | Number |
|---|---|---|
| Model Number of 3 – valve manifold | | |
| Number supplied | | |
| Model Number of 5 – valve manifold | | |
| Number supplied | | |
| Standard to which manufactured | | |
| Material | | |

## TECHNICAL SCHEDULES C&I

DESIGN & PERFORMANCE DATA
ANALYSIS EQUIPMENT

| Item | Unit | Number |
|---|---|---|
| Manufacturer | | |
| Type of measuring electrode | | |
| Application | | |
| Measuring range | | |
| Type of transmitter | | |
| Is special cabling required? | | |
| Is automatic temperature compensation included? | | |
| Output signal of transmitter | | |

*) details depend on sub supplier selected

## TECHNICAL SCHEDULES C&I

DESIGN & PERFORMANCE DATA
CONTROL VALVES

| Item | Unit | Number |
|---|---|---|
| Manufacturer | | |
| Application | | |
| Rated | kg/s | |
| Rated Pressure | MPa | |
| Is full description of valve type, materials and assembly included with tender? | | |
| Method of actuation | | |
| Rated type | kN m | |
| Details of power and voltage supply requirements | | |
| Delivery of period for replacement inserts | | |
| Time required to replace inserts | | |
| Accessories included with valve, e.g. limit switches indication equipment, transducers, other items if applicable. | | |
| Is full description of proposed system | | |
| Included together with details of system components? | | |
| Time for valves to ramp closed from receipt of initiating signal | | |
| Time for valves to ramp closed from receipt of | secs | |
| initiating signal | | |
| Details of voltage and power supplies required | | |

To be filled in for each application

## TECHNICAL SCHEDULES C&I

DESIGN & PERFORMANCE DATA
DISTRIBUTED CONTROL SYSTEM

| Item | Unit | Number |
|---|---|---|
| Manufacturer | | |
| Type | | |
| Year of proven services | yr | |
| Number of units installed (approximately) | | |
| Size of unit | | |
| Mean time between failure of system | hr | |
| Reliability achieved in service (% annual time) | | |
| Number of work station provided (OT/PU/SU) | | |
| Microprocessor redundancy | | |

## TECHNICAL SCHEDULES C&I

DESIGN & PERFORMANCE DATA
DISTRIBUTED CONTROL SYSTEM

| Item | Unit | Number |
|---|---|---|
| Microprocessors | | |
| Model and/or serial number | | |
| Number of words in memory | | |
| Word length | (bits) | |
| Type of memory | | |
| Percentage of free time: | | |
| Average | | |
| Worst case | | |
| Number of spare unused words: | | |
| Memory words per instruction: | | |
| Can input/output operations proceed | | |
| simultaneously with arithmetic operations? | | |
| Type of clock | | |
| Clock rate | | |
| Type of communication (parallel or serial) | | |
| Average scanning rate for: | | |
| Analog inputs | | |
| Binary inputs | | |
| Resolution for Binary signals | | |

## TECHNICAL SCHEDULES C&I

DESIGN & PERFORMANCE DATA
DISTRIBUTED CONTROL SYSTEM

**(ii) Digital Input / Output Cards**

| Item | Unit | Number |
|---|---|---|
| Method of signal isolation | | |
| Number of inputs per card | | |
| Number of outputs per card | | |
| Total number of input & output card provided | | |

**(iii) Analogue Input / Output Cards**

| Item | Unit | Number |
|---|---|---|
| Method of signal isolation | | |
| Number of inputs per card | | |
| Number of outputs per card | | |
| Total number of input cards provided | | |
| Total number of output cards provided | | |
| Voltage used for contract interrogation | | |

**(iv) Drive Cards (where applicable)**

| Item | Unit | Number |
|---|---|---|
| Number of analogue I/O channels per card | | |
| Number of binary I/O channels per card | | |
| Total number of drive cards provided | | |

## TECHNICAL SCHEDULES C&I

DESIGN & PERFORMANCE DATA
DISTRIBUTED CONTROL SYSTEM

**(v) Internal Power Supplies**

| Item | Unit | Number |
|---|---|---|
| Power Supplies | | |
| Manufacturer | | |
| Type | | |
| Number | | |
| Input voltage and number of phases | (V.ph) | |
| Input current | (A) | |
| Output current | (Vdc) | |
| Output watts | | |
| Regulation (for ± 10% input voltage cariation and 0 – 100% rated output variation) | (%) | |
| Power Supply Requirements | | |
| Supply Voltage | (V.D.C.) | |
| Load | kVA | |

## TECHNICAL SCHEDULES C&I

DESIGN & PERFORMANCE DATA

**(vi) VDUs**

| Item | Unit | Number |
|---|---|---|
| Manufacturer | | |
| Number supplied | | |
| Size of screen | | |
| Display area | | |
| Type and size of characters | | |
| Number of characters per line | | |
| Number of lines total | | |
| Number of Colors | | |

**(vii) Archiving**

| Item | Unit | Number |
|---|---|---|
| Memory type | | |
| Manufacturer | | |
| Capacity (MB) | | |
| Number provided | | |

## TECHNICAL SCHEDULES C&I

DESIGN & PERFORMANCE DATA
DISTRIBUTED CONTROL SYSTEM

**(vii) Printers**

| Item | Unit | Number |
|---|---|---|
| Manufacturer | | |
| Number supplied | | |
| Model and / or series number | | |
| Printing speed | (Char./sec) | |
| Character per line | (Char. /line) | |
| Paper width | (Char.mm) | |
| Ribbon colour | | |
| Printing system | | |
| Power supply | (V-Hz) | |
| Power requirements | (VA) | |
| Noise Level | (dB) | |

## TECHNICAL SCHEDULES C&I

DESIGN & PERFORMANCE DATA
MONITORING & OPERATING SYSTEM

### (i) Alarm and Event Recording System

| Item | Unit | Number |
|---|---|---|
| No. of alarms provided | | |
| No. Of events (including alarms) provided | | |
| No. Of alarms displayed on each page | | |
| Resolution time ms | | |
| Storage capacity of historical buffer | | |

### (ii) Logging Function

No. of types of logs provided

### (iii) Scan Rates and Calculations

| Item | Unit | Number |
|---|---|---|
| Scan rates | | |
| System calculations | | |

### (iv) System Hardware

| Item | Unit | Number |
|---|---|---|
| Manufacturer and Model | | |
| CPU type | | |
| Memory type | | |
| Cycle time | | |
| Word length bit | | |
| Maximum memory size | Mbyte | |
| Equipped memory size | Mbyte | |
| Memory increment size | Mbyte | |

## TECHNICAL SCHEDULES C&I

DESIGN & PERFORMANCE DATA
MONITORING AND OPERATING SYSTEM

| Item | Unit | Number |
|---|---|---|
| Type of memory protection | | |
| Capability of direct memory addressing? | Y/N | |
| Hardware memory parity check? | Y/N | |
| Hardware memory mapping? | Y/N | |
| Power fail interrupt and automatic restart? | | |
| Programme real-time clock? | Y/N | |
| No. of basis instructions | | |
| Floating point implementation by hardware of software? | | |
| No. of VDU ports possible | | |
| No. of VDU ports provided | | |
| No. of keyboards possible | | |
| No. of printer ports possible | | |
| No. of printer ports provided | | |

## TECHNICAL SCHEDULES C&I

DESIGN & PERFORMANCE DATA
MONITORING & OPERATING SYSTEM

**(v) Displays**

**(a)** Mimic displays

| Item | Unit | Number |
|---|---|---|
| No. of levels in hierarchy | | |
| No. of displays provided | | |
| No. of analog values per display | | |
| No. of binary values per display | | |
| Maximum number of displays | | |

**(b)** Bar or column displays

| Item | Unit | Number |
|---|---|---|
| No. of displays provided | | |
| No. of analog values per display | | |
| Voltage used for contact interrogation | | |

**(c)** Logic diagram displays

| Item | Unit | Number |
|---|---|---|
| No. of displays | | |

## TECHNICAL SCHEDULES C&I

DESIGN & PERFORMANCE DATA
TURBINE CONTROL EQUIPMENT

| Item | Unit | Number |
|---|---|---|
| Manufacturer | | |
| Type | | |
| Year of proven services yr | | |
| Number of units installed (approximately) and size of unit | | |
| Mean time between failure of system hr | | |
| Availability achieved in service (% annual time) | | |
| Microprocessor redundancy | | |

## TECHNICAL SCHEDULES C&I

DESIGN & PERFORMANCE DATA
TURBINE CONTROL EQUIPMENT

### (i) Microprocessors

| Item | Unit | Number |
|---|---|---|
| Model and / or serial number | | |
| Number of words in memory | | |
| Word length | (bits) | |
| Type of memory | | |
| Percentage of free time: | | |
| Average | | |
| Worst case | | |
| Number of spare unused words: | | |
| Memory words per instruction | | |
| Can input / output operations precede | | |
| Simultaneously with arithmetic operations? | | |
| Type of clock | | |
| Clock rate | | |
| Type of communication (parallel or serial): | | |
| Average scanning rate for: | | |
| Analog inputs min. | | |
| Binary inputs min. | | |
| Resolution for binary signals | | |

## TECHNICAL SCHEDULES C&I

DESIGN & PERFORMANCE DATA
TURBINE CONTROL EQUIPMENT

**(ii) Digital Input /Output Cards**

| Item | Unit | Number |
|---|---|---|
| Method of signal isolation | | |
| **Number of inputs per card** | | |
| **Number of outputs per card** | | |
| **Total number of input cards provided** | | |
| **Interrogation voltage on input cards** | | |
| **Total number of output cards provided** | | |

**(iii) Analogue Input / Output Cards**

| Item | Unit | Number |
|---|---|---|
| Method of signal isolation | | |
| Number of inputs per card | | |
| Number of outputs per card | | |
| Total number of input cards provided | | |
| Total number of output cards provided | | |
| Voltage used for contract interrogation | | |

**(iv) Drive Cards (where applicable)**

| Item | Unit | Number |
|---|---|---|
| Number of analogue I /O channels per card | | |
| Number of binary I / O channels per card | | |
| Total number of drive cards provided | | |

## TECHNICAL SCHEDULES C&I

DESIGN & PERFORMANCE DATA
TURBINE & INSTRUMENTATION

### (v) Internal Power Supplies

| Item | Unit | Number |
|---|---|---|
| Power supplies | | |
| Manufacturer | | |
| Type | | |
| Number | | |
| Input voltage and number of phases | (V.ph) | |
| Input current | (A) | |
| Output current | (Vdc) | |
| Output watts | | |
| Regulation | | |
| (For ±10% input voltage variation and 0 – 100% | | |
| rated output variation) | | |
| Power supply requirements | | |
| Supply voltage | (V.D.C.) | |
| Load | kVA | |

## TECHNICAL SCHEDULES C&I

DESIGN & PERFORMANCE DATA
GENERAL

**(i) Allowable Ambient Temperature Limits**

| Item | Unit | Number |
|---|---|---|
| Maximum and minimum ambient temperature limit | (ºC) | |
| Continuous | (ºC) | |
| Short time (12 hours) | | |

**(ii) List Proprietary Control Packages used for:**

| Item | Unit | Number |
|---|---|---|
| (i) Steam Turbine | | |
| (ii) Boiler | | |
| (iii) Water Treatment | | |
| (iv) Other | | |

## TECHNICAL SCHEDULES C&I

DESIGN & PERFORMANCE DATA
GENERAL

**(iii) Panels**

(a) Panel

| Item | Unit | Number |
|---|---|---|
| Service or name of panel | | |
| Weight | (kg) | |
| Location | | |

(b) Each Local Control Panel

| Item | Unit | Number |
|---|---|---|
| Service or name of panel | | |
| Height / length / width | (mm) | |
| Weight | (kg) | |
| Location | | |
| (c) Each Termination Cabinet | | |
| Service or name of panel | | |
| Height / length / width | (mm) | |
| Weight | (kg) | |
| Location | | |

(c) Each System Cabinet

| Item | Unit | Number |
|---|---|---|
| Service or name of panel | | |
| Height / length / width | (mm) | |
| Weight | (kg) | |
| Location | | |

## TECHNICAL SCHEDULES C&I

DESIGN & PERFORMANCE DATA
GENERAL

(a) Each I / O Cabinet

| Item | Unit | Number |
|---|---|---|
| Service or name of panel | | |
| Height / length / width | (mm) | |
| Weight | (kg) | |
| Location | | |

(b) Each I / O Cabinet

| Item | Unit | Number |
|---|---|---|
| Service or name of panel | | |
| Height / length / width | (mm) | |
| Weight | (kg) | |
| Location | | |

(c) Each Wall Mounted Control Panel

| Item | Unit | Number |
|---|---|---|
| Service or name of panel | | |
| Height / length / width | (mm) | |
| Weight | (kg) | |
| Location | | |

(d) Control Desk

| Item | Unit | Number |
|---|---|---|
| Height / length / width | (mm) | |
| Weight | (kg) | |
| Panel thickness | | |

## TECHNICAL SCHEDULES C&I

MAINTENANCE MANAGEMENT SYSTEM (MMS)

General:

| Item | Unit | Number |
|---|---|---|
| No of user work stations | | |
| Max No of user work stations | | |
| No of Matrix printer | | |
| No of Laser printer | | |

Main computer

| Item | Unit | Number |
|---|---|---|
| Manufacturer and Model | | |
| CPU type | | |
| Memory type | | |
| LCD monitor size | “ | |
| Maximum memory size | MB | |
| Equipped memory size | MB | |
| Storage capacity | MB | |

## TECHNICAL SCHEDULES C&I

MAINTENANCE MANAGEMENT SYSTEM (MMS)

Personal computer

| Item | Unit | Number |
|---|---|---|
| Manufacturer and Model | | |
| CPU type | | |
| Memory type | | |
| LCD monitor size | | |
| Maximum memory size | MB | |
| Equipped memory size | MB | |
| Storage capacity | MB | |
| CD room R/W speed | | |

## TECHNICAL SCHEDULES C&I

CONDITION MONITORING SYSTEM (CMS)
General:

| Item | Unit | Number |
|---|---|---|
| No of user work stations | | |
| Max No of user work stations | | |
| No of Matrix printer | | |
| No of Laser printer | | |
| Type of net work | | |
| No of node | | |
| No. of alarms provided | | |
| Resolution time | ms | |
| Storage capacity of historical buffer | MB | |
| Maximum time period of historical file | Days | |

Main server computer

| Item | Unit | Number |
|---|---|---|
| Manufacturer and Model | | |
| CPU type | | |
| Memory type | | |
| LCD monitor size | | |
| Maximum memory size | MB | |
| Equipped memory size | MB | |
| Storage capacity | MB | |
| CD room R/W speed | | |

## TECHNICAL SCHEDULES C&I

CONDITION MONITORING SYSTEM (CMS)

operation work station:

| Item | Unit | Number |
|---|---|---|
| Manufacturer and Model | | |
| CPU type | | |
| Memory type | | |
| LCD monitor size | | |
| Maximum memory size | MB | |
| Equipped memory size | MB | |
| Storage capacity | MB | |
| CD room R/W speed | | |

# PEEGT

# ALEPPO STEAM POWER PLANT

# SPARE PARTS

# CONTROL & INSTRUMENTATION

| | | |
|---|---|---|
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| **11 INSTRUMENTATION AND CONTROL** | | |
| **(1) Specified Spare Parts** | | |
| 50 Recording paper roll for each recorder In the power plant | 4 sets | |
| 200 signal lamps of each type in the power plant | 2 sets | |
| One electronic card of each type in the power plant<br><br>(If number of cards of the same type are more than 5 then 1 card to be submitted for each 5 similar cards) | 4 sets | |
| One power unit of each type in the power plant | 4 sets | |
| Two (2) auxiliary relays of each type in the power plant, but not less than 20% of each type | 4 sets | |
| One transmitter of each type and range in the power plant<br><br>(If similar transmitters are used then one transmitter to be submitted for each 5 similar transmitter) | 4 sets | |
| One set of spare parts for the same size of control valves and actuators in the power plant | 4 sets | |

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| One impulse line shut-off valve of each type | 15 sets | |
| One indicator and/or recorder for each type of measuring instruments | 4 sets | |
| One operating station | 2 sets | |
| One set of consumed parts enough for two years operation such as ink, pins, diaphragms, joints, gaskets etc. | 5 sets | |
| 3 electrodes of each type for pH and conductivity measurements | 2 sets | |
| One sensor of each type | 4 sets | |
| PLC programming device | 2 sets | |
| Pilot tube for combustion air measurements | 1 set | |
| One thermocouple of each type | 4 sets | |
| One regulator of each type | 3 sets | |
| One pneumatic positioner or feed back of each type for pneumatic control valve | 5 sets | |
| One commutator of each type | 3 sets | |
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| **(2) Spare Parts recommended by Tenderer** | | |
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# SECTION – D

# STANDARD TECHNICAL REQUIREMENTS

# SECTION – D2

# STANDARD TECHNICAL REQUIREMENTS (ELECTRICAL)

# SECTION – 'D'
# STANDARD SPECIFICATION

1.0 GENERAL

This specification covers the design, manufacture, inspection & testing at vendor's works, packing and delivery to site of galvanised mild steel flats, rods & wires to be used for above grade grounding and lightning protection system.

2.0 CODES AND STANDARDS

The material, constructional features and various processes involved in manufacture shall comply with currently applicable Indian standards. All relevant parts of the applicable Indian standards shall be considered.

3.0 DESIGN REQUIREMENTS AND CONSTRUCTIONAL FEATURES

3.1 Straight lengths of hot dip galvanised flats & rods are indicated in Datasheet – A shall be supplied.

3.2 All items listed in the Bill of Quantities Annexure - A (Sec-C of the specification) shall be manufactured as per Datasheet-A.

3.3 The length of galvanised MS flats, rods & wires shall be as indicated in datasheet – A (BOQ).

3.4 All finished materials (after galvanisation) shall be free from sharp edges, corners, burs & unevenness.

4.0 QUALITY/ INSPECTION:

4.1 The following stages of manufacture shall be stage inspected by purchaser or his duly authorised representative.

i) Inspection of raw materials

ii) Inspection of manufacturing processes such as cutting

iii) Inspection of finished products.

4.2 The inspection will be carried out as per BHEL quality plan no. PED-509-00-Q-001/02.

5.0 TESTING:

5.1 The supplier shall perform all tests necessary to ensure that the material and workmanship conform to the relevant standards and comply with the requirements of this specification.

5.2 The tests shall be in accordance with appropriate Indian standards. The extent of the tests to be performed by the supplier shall include but not be limited to the following: -

a) Routine Tests:

(i)Dimension checks

(ii)Tests for galvanizing

b) Acceptance Test:

(i)Dimension checks

(ii)Tests for galvanizing

6.0 PACKING

The material shall be packed to ensure protection against damage during transit, storage for prolonged periods and handling.

Test links with protective boxes & hardware shall be packed together separately to avoid damage.

7.0 DRAWING DATA AND DOCUMENTS REQUIRED (within two weeks of award of contract)

i) Standard Quality Plan
ii) Any other drawings / documents listed in Sec-C.

# SECTION – 'D'

# STANDARD SPECIFICATION FOR

# CABLE TRAY SUPORT SYSTEM (BOLTABLE)

1.0 GENERAL

This specification covers the design, manufacture, inspection & testing at vendor's works, packing and delivery to site of galvanised cable tray support system (boltable).

2.0 CODES AND STANDARDS

The material, constructional features and various processes involved in manufacture shall comply with currently applicable Indian standards. All relevant parts of the applicable Indian standards shall be considered.

3.0 DESIGN REQUIREMENTS AND CONSTRUCTIONAL FEATURES

3.1 All items listed in the Bill of Quantities (Sec-C of the specification) shall be manufactured as per this specification & generally as per drawings enclosed with this specification.

However, minor dimensional differences arising out of manufacturer's fabrication processes may be acceptable after review & approval by BHEL, only if the dimensions are as those for the type tested design of the manufacturer.

3.2 Cable tray supports shall be formed out of sheet steel.

However standard length of SC1/ DC1 channels shall be fabricated out of single piece & it shall not have welded joints in between.

3.4 All welded joints shall be smooth enough to provide a good appearance and shall not cause any injury to working personnel or any damage to the cable laid directly on it. All welding work shall be done by skilled personnel.

4.0 SURFACE TREATMENT

4.1 Galvanizing

4.2 Surface cleaning : In the first step complete surface shall be cleaned with sand paper and / or cotton cloth to remove accumulated dust and dirt.

4.3 Pretreatment : Surface pretreatment shall be done as per IS:6005 before galvanization.

4.4 Surface Finish : Articles shall be hot dip galvanized after fabrication, surface cleaning and pretreatment. The galvanizing shall be uniform, clean, smooth, continuous and free from acid spots. If the galvanizing of the samples is found defective, the entire batch of steel will have to be regalvanized at vendor's cost.

4.5 The amount of zinc deposited shall not be less than 610 grammes per square metre of surface area and in addition, the thickness of the zinc deposit at any spot whatsoever, shall not be less than 75 microns. The purchase reserves the right to measure the thickness of zinc deposit by an Elkometer or any other instrument acceptable to purchaser and reject any component which shows thickness of zinc at any location to be less than 75 microns.

5.0 INSPECTION:

5.1 The following stages of manufacture shall be stage inspected by purchaser or his duly authorised representative.

5.2 Inspection of raw materials including hardware items such as bolts, nuts etc.

5.3 Inspection of manufacturing processes such as shearing, punching, bending, welding, galvanizing, painting etc.

5.4 Inspection of finished products.

5.5 Inspection of packing material and procedure.

5.6 The inspection shall be carried out as per BHEL quality plan no. PED-507-00-Q-005/02

6.0 TESTING:

6.1 The supplier shall perform all tests necessary to ensure that the material and workmanship conform to the relevant standards and comply with the requirements of this specification.

6.2 The tests shall be in accordance with appropriate Indian standards. The extent of the tests to be performed by the supplier shall include but not be limited to the following: -

a) Type Tests:

i)Test for galvanizing

Weight, thickness and uniformity of zinc coating shall be determined in accordance with IS:6745 and IS:2633 for the values indicated in Data Sheet- A.

ii)Following type test shall be performed as per procedure enclosed;

a) Load test for Main support channel with cantilever arm fixed on one side
b) Load test for Main support channel with cantilever arm fixed on both sides
c) Load test for Channel fixed on Beam/Floor
d) Load test for channel supported on wall with Cantilever arm
e) Channel nut slip characteristics (wherever applicable)
f) Weld integrity test

b) Routine Tests:

(i)Dimension checks

c) Acceptance Test:

(i)Dimension checks

(ii)Tests for galvanizing

6.0 PACKING

The material shall be packed to ensure protection against damage during transit, storage for prolonged periods and handling. Packing procedure shall be subject to the purchaser's approval.

7.0 DRAWING DATA AND DOCUMENTS REQUIRED (within two weeks of award of contract)

i) Standard Quality Plan
ii) Any other drawings / documents listed in Sec-C.

# SECTION – 'D'
# STANDARD TECHNICAL SPECIFICATION

1.0 GENERAL

This specification covers the design, manufacture, inspection & testing at vendor's works, packing and delivery to site of cable trays and accessories.

2.0 CODES AND STANDARDS

The material, constructional features and various processes involved in manufacture shall comply with currently applicable Indian standards. All relevant parts of the applicable Indian standards shall be considered.

3.0 DESIGN REQUIREMENTS AND CONSTRUCTIONAL FEATURES

3.1 All items listed in the Bill of Quantities (Sec-C of the specification) shall be manufactured as per Datasheet-A and project drawings enclosed with this specification.

3.2 Cable trays and accessories shall be manufactured as per the drawings enclosed with this specification. Minor fabrication details changes, which do not affect the material/dimensional aspects of the equipment, shall be to BHEL/owner's approval without any commercial implications.

3.3 Cable Trays, Tray Covers and Fittings:

3.3.1 Cable trays shall be of two types, namely ladder type and perforated type as specified in Data Sheet A and drawings enclosed with this specification.

3.3.2 Tray ends shall be connected to other straight trays, horizontal elbows, vertical elbows, tees, cross, reducers etc. by using coupler plates.

3.3.3 The bending radius on inner side of bends shall as specified in Datasheet A / drawings enclosed.

3.3.4 Necessary fasteners shall be provided along with each piece of cable tray as per applicable drawing.

3.3.4 The width of the tray covers (where provided) shall be same as the width of trays. Suitable bolting arrangement shall be supplied for attaching the cover to the cable trays, elbows, reducers, tees etc.

3.3.5 All welded joints shall be smooth enough to provide a good appearance and shall not cause any injury to working personnel or any damage to the cable laid directly on it. All welding work shall be done by skilled personnel.

4.0 QUALITY/ INSPECTION:

4.1 The following stages of manufacture shall be stage inspected by purchaser or his duly authorised representative.

i) Inspection of raw materials including hardware items such as bolts, nuts etc.

ii) Inspection of manufacturing processes such as shearing, punching, bending, welding, galvanizing, painting etc.

iii) Inspection of finished products.

iv) Inspection of packing material and procedure.

4.2 The inspection will be carried out as per BHEL quality plan no. PED-507-00-Q-005/01.

5.0 TESTING:

5.1 The supplier shall perform all tests necessary to ensure that the material and workmanship conform to the relevant standards and comply with the requirements of this specification.

5.2 The tests shall be in accordance with appropriate Indian standards. The extent of the tests to be performed by the supplier shall include but not be limited to the following: -

a) Type Tests:

Load test as per clause 5.3.

b) Routine Tests:

(i)Dimension checks

(ii)Tests for painting and/ or galvanizing, as applicable.

c) Acceptance Test:

(i)Dimension checks

(ii)Tests for galvanizing

5.3 Load Test:

A 2.5 meter straight section of each type of cable tray of width 600mm or 450mm shall be simply supported at the two ends. A uniformly distributed load of 100 kg per meter shall be applied along the length of tray. The maximum deflection at mid span shall not exceed 7 mm.
Load test shall not be conducted on tray width of 300mm and below.

6.0 PACKING

The material shall be packed to ensure protection against damage during transit, storage for prolonged periods and handling. Packing procedure shall be subject to the purchaser's approval.

7.0 DRAWING DATA AND DOCUMENTS REQUIRED (within two weeks of award of contract)

i) Manufacturing Drawings (if required).
ii) SQP/RQP/MQP.
iii) Any other drawings / documents listed in Sec-C.

# TECHNICAL REQUIREMENTS

## 1.00 SCOPE

1.01 GENERAL

a) This specification covers the following activities for cathodic protection system:

i) Carrying out required corrosion survey and collection of data for design and implementation of cathodic protection systems.

ii) Implementation of cathodic protection systems by interpretation of survey data, detailed design, engineering, manufacturing, fabrication, assembly, inspection and testing at manufacturers works, proper packing and delivery at site, unloading and storage at the site, execution of all associated civil works, installation of various equipments, inspection, field testing & commissioning as per the approved commissioning procedure, performance testing at site and handling over to the owner / BHEL.

iii) Periodic monitoring of the system for the specified period.

iv) Providing all the design drawings, design calculations, technical data sheets, “As Built” drawings, manufacture and assembling practices, construction/ installation practices, test procedures followed during manufacturing, erection and commissioning, conducting Performance & Guarantee testing, carrying out monitoring services etc., and submitting Operation & Maintenance manuals for BHEL’s review, approval and records.

b) The “design” shall broadly cover the selection of components, materials, sizes etc. for the equipment of supply in vendor’s scope. Complete responsibility of establishing the correctness of equipment design rests with the vendor.

c) It is not the intent to specify here all the details of design and manufacture. However, the equipment shall conform in all respects to high standards of design, engineering and workmanship, and shall be capable of performing the required duties in a manner acceptable to Engineer / purchaser, who will interpret the meaning of drawings and specifications and shall be entitled to reject any work or material, which in his judgement is not in full accordance herewith.

d) Make of all equipment and components shall be to the approval of purchaser.

Detailed activities in respect of above are listed under clause 4.0 [Scope of Work].

## 1.02 ENGINEERING

a) Specification also covers the aspect of System Design Engineering generally termed as “Engineering”. Engineering shall be the purchaser to the successful bidder shall furnish the responsibility of vendor if indicated in Data Sheet A. Engineering inputs.

b) Engineering, if covered in vendor’s scope, shall include design of complete lighting system for indoor and outdoor areas. The aspect of engineering covers preparation of electrical distribution and control schemes, quantity estimation, luminaire layout drawings, conduit layout drawings, wiring schemes upto luminaires, cable schedules and all associated design work not specifically mentioned in the specification.

c) Complete engineering shall be as per the guidelines of purchaser and shall be subject to the purchaser’s approval.

1.03 The requirements given in enclosed drawings, documents and Data Sheet A form part of this specification and shall be fully complied with. In case any discrepancy arises, the requirements of Data Sheet-A shall prevail.

1.04 In case of any deviation, the bidder shall indicate the same clause-by-clause in the enclosed "Schedule of Deviations". In the absence of duly filled schedules it will be construed that the bid conforms strictly to the specification.

## 2.00 SPECIAL INSTRUCTIONS TO BIDDERS

2.01 Wherever a material or article is specified or described by the name of a particular brand, manufacturer or trade mark, the same shall be understood as establishing the type, function and quality desired. Other manufacturers' products may also be considered provided sufficient information is furnished so as to enable BHEL to determine that the products are equivalent to those named.

2.02 The Bidder is advised to visit the site in order to acquaint himself with all the necessary information such as soil conditions, transportation facilities, data of similar pipelines and underground cables & cable trench/corridor in the adjacent pipe corridor, transmission line/railway line interferences, etc. for proper design and execution of the work. Non-familiarity with the site conditions will not be considered a reason either for extra claims or for not carrying out the work in strict conformity with the drawings and specifications.

2.03 Every item of work and supply shall be subject to Engineer-In-Charge scrutiny, supervision and approval. Any work carried out or supplies effected without such approval shall stand automatically rejected and his claim for compensation for such unauthorized work shall be null and void.

2.04 The Cathodic Protection system also includes certain works related to pipelines such as provision of Insulation Joints.

2.05 The scope of work shall include monitoring services for a specified period after completion of initial operation or commissioning of Impressed Current Cathodic Protection (ICCP) system. During this period, the vendor shall visit the site and carry out testing and measurements of the system parameters in presence of Owner/ BHEL to ascertain the safe and sound operation of the same. Any adjustment in the operating parameters shall be recommended to Owner/ BHEL during the course of such monitoring activity along with technical justification for the same if required. The periodicity of the visits and the period for which monitoring is required shall be once in a month.

2.06 Quantities or rating of the equipment, if mentioned in the specification, are indicative only and are minimum requirements. Bidder shall check the specified BOQ, inclusive of number and weight of anodes, rating of transformer rectifier units, size and types of cables, etc. as per the standards/ codes, practices specified and considering the basic design data / guidelines specified in this section. Any improvement with respect to the rating, number, and size of all equipment to meet the requirements of Technical Specification shall be considered while bidding and the same shall be supplied, erected and commissioned within the quoted price.

## 3.00 SPECIFIC REQUIREMENTS FOR C.P.SYSTEM WORKS

3.01 BHEL/OWNER shall have the right to inspect the following:

- Workshop & production facilities available with contractor or its tie up agency.
- Fabrication/testing of material/equipment to be supplied by contractor or its sub-vendor.

It shall be Bidder's responsibility to arrange access for BHEL/OWNER Personnel for such visits. All costs related with travel, boarding, lodging for BHEL/OWNER personnel for such visits (if any) shall be borne by BHEL/OWNER.

3.02 `A' class Electrical CP System sub-contractor license is essentially required as per regulations laid by electrical inspector of the state for electrical jobs. The CP System subcontractor shall arrange for the same. Any approval from electrical inspector required for the electrical installation shall be in CP System sub-contractor's scope.

**3.03 Material Supplied By Owner**

No material for C.P. System shall be supplied by owner.

**3.04 Material Supplied by CP System sub-contractor:**

The CP System sub-contractor shall procure supply all materials, equipment and consumables required for the work in his scope. Technical specifications of major items are given in section 3.0 for "Job specification for C.P. System", of this document. Supply of all balance materials, consumables not covered in section 3.0 for "Job specification for C.P. System", but required for completion of work as per this specification shall be entirely CP System sub-contractor's responsibility. The rates quoted for the execution of the Contract shall be inclusive of all CP System sub-contractor supplied material and equipment.

**3.05 Temporary cathodic protection:**

The CP System sub-contractor shall provide sacrificial anode type temporary cathodic protection (if specified) for one year. Supply, erection & commissioning all materials, equipment and consumables required for this work in his scope. The rates quoted for the execution of the Contract shall be inclusive of temporary CP System as required.

**3.06 Warranty**

EPC Contractor / CP System sub-contractor needs to provide design guarantee for the system as per codes and standards & the protection criteria mentioned in the section Design basis/Philosophy of this document. CP System sub-contractor needs to replace/ repair or reinstall free of cost any material/equipment supplied or installed by him in case it fails to operate due to defective material or workmanship as per requirements of this specification within 12(Twelve) months from the date of issue of completion certificate and acceptance of the C.P. System by Owner. CP System sub-contractor shall replace at his own cost if any item found defective or missed before handing over the system to owner.

**3.07 Construction Aids, Equipment, Tools and Tackles**

CP System sub-contractor shall be solely responsible for making available for executing the work, all requisite construction Equipment, special Aids, tools, tackles and testing equipment and appliances, all instruments including automatic Programmable current interrupters required for commissioning and interference testing of the system. Such construction equipment shall be in first class operating condition. Any discrepancies pointed out by Owner/BHEL shall be immediately got rectified, repaired or the equipment replaced all together by CP System sub-contractor. Owner/BHEL shall not in any way be responsible for providing any such equipment, machinery tools and tackles etc. The Owner/BHEL reserves the right to re-arrange such deployment depending upon the progress and priority of work in various sections at no extra cost to Owner.

**3.08 Transportation, Packing and Handling**

CP System sub-contractor shall be responsible for transportation of all equipment/materials required for C.P. system work and unload the same at allotted area at site. To protect all the material during period of despatch, storage and erection against corrosion, incidental damage due to vermin, sunlight, rain, high temperature, humid atmosphere, rough handling in transit and storage in open during monsoon including delays in transit. Bidder shall be responsible for any damage to equipment/material due to above reasons.

## 4.00 DESIGN PHILOSOPHY/ BASIS FOR CATHODIC PROTECTION SYSTEM

### 4.01 Codes and Standards

The entire work shall be performed as per the following codes/standards.

- NACE : RP-0169-97, RP-0285-95
- BS : 7361 Part I-1991 ( Formerly CP 1021-1973)
- VDE: 0150, protection against corrosion due to stray currents from DC installations.
- DIN : 30676
- IEC/NEC : Relevant codes
- Indian electricity act and rules framed thereunder.
- Fire insurance regulations.
- Regulations laid by Chief Electrical Inspector of State.
- Regulations laid by Chief Inspector of Explosives.
- Regulation laid by Factory Inspector of State.

Wherever the requirements in this specification are in conflict with any of the above standards, the requirements of this specification shall be binding.

### 4.02 SCHEME FOR ICCP SYSTEM

(a) Impressed current cathodic protection is to be provided for prevention of soil side corrosion of all underground pipelines, underground vessels, mounted storage bullets and bottom plate of the storage tanks under the scope of work. For details, refer BOQ specified in Section-C.

(b) Impressed Current Cathodic Protection System (ICCP) shall typically consist of:

- Required numbers of close distributed long line MMO wire anode prepacked with coke breeze at Anode manufacturer's factory should be considered as anode for impressed current CP System. The make /model of MMO wire anode to be supplied shall be either "MATCOR Make SPL™-FBR-16" or Covalence /Tyco/ Berry Plastics (USA) Make (Anodeflex-3000 or 3020) or equivalent make. The type of Anode and anode bed for the ICCP system shall be in conformance with BS 7361 Part 1.

- 1 No. anode junction box per CP Station.

- 1 No. T/R unit per CP station.

- Single core, 10 sqmm stranded copper conductor, PVC insulated, overall FRLS PVC sheathed armoured cable required for connection between anode and junction box.

- Single core of required cross-section stranded copper conductor, PVC insulated, overall FRLS PVC sheathed armoured cable for connection from T/R unit to junction box and pipeline.

- Two core of required cross-section stranded copper conductor, PVC insulated, overall FRLS PVC sheathed armoured power cable for power connection from power supply source to T/R unit.

- Required thermit weld cartridges complete with mould and all accessories of cathodic measurement bonding cables with pipeline and welding of the same with the pipeline.

- Pure epoxy encapsulation of the anodes and cable connections to pipeline.

- o All civil, structural and electrical materials required for installation of Impressed Current Cathodic Protection System (ICCP) system.
- o All materials required for laying and termination of cables including cable trays, GI conduits, lugs, glands, markers, grounding material, etc.
- o Required numbers of resistance bonding with test stations at power line crossing/ electrical traction/ rail crossing as and where required.
- o Required zinc grounding cells and Kirk cells.
- o Required insulation joints (depending on no. of pedestals and overhead bridges/ trestles installed to support pipeline) for isolating the cathodically protected system from the systems/ equipment/ structure/ facilities that are not cathodically protected.
- o Required numbers of permanent reference cells.
- o Required number of test stations shall be provided for the ICCP system for system monitoring and testing.
- o Complete protection of casing and carrier pipelines (for 30 years) using additional zinc anodes at each encased pipe crossing.
- o Two sets of portable instruments and accessories required to monitor the performance of CP system such as corrosion voltmeters, multimeters, meggar, portable reference cells, electrodes etc.
- o **Outdoor type test stations along the pipe routing at intervals not exceeding 1000 meters and at locations of each of the road/ rail/ drain crossings.**

(c) C.P.System of foreign structure within the plant complex such as RCC pavements, RCC foundations, earthing grids, other U/G piping which are not intended to be protected are excluded from the scope of this work.

(d) Close distributed long line MMO wire anode piggyback connected with anode lead cable, factory pre-packed with coke breeze or tubular MMO anode should be considered as anode for impressed current CP System for all UG Piping.

(e) Close distributed long line MMO wire anode piggyback connected with anode lead cable, factory pre-packed with coke breeze should be considered as anode for impressed current CP System for all and for underground vessels, mounded storage bullets and bottom plate of the storage tanks where design temperature is $65^0$C or more.

(f) For underground vessels, mounded storage bullets and bottom plate of the storage tanks where design temperature is upto 65°C, either Close distributed long line MMO wire anode piggyback connected with anode lead cable and prepacked with coke breeze at Anode manufacturer's factory or conductive polymer anode prepacked with coke breeze at Anode manufacturer's factory should be considered.

(g) All piping & structures which shall be cathodically protected shall be fed from outdoor type, natural air cooled, Transformer-Rectifier unit (T/R Unit) either Classified/explosion proof or non-Classified (IP-55) type depending on the area classification of the outdoor location of the TR Unit. The rating of the TR Unit shall be 75V/75A, 50V/50A or 25V/25A as per load requirement.

(h) Separate T/R Unit should be considered for all different type of structures to be protected such as pipelines, underground vessels, mounded storage bullets and bottom plate of the storage tanks to be located at the OFFSITES & UTILITIES.

(i) T/R Unit shall have one outgoing positive header cable, which may be terminated to CDB, one each positive header cables from the CDB may be terminated to several AJB to be installed along the pipeline route or near the structures to be protected. T/R Unit shall have one out going negative header cable which shall be connected to 1 No. of cathode junction box cum test station (CJB). Each CJB cum test station (CJB) shall be located along the pipeline route or near the structures to be protected for its drainage connection and potential measurement. Minimum two drainage cables and two measurement cables from each pipeline or from each structure to be protected shall be terminated to CJB.

(j) Power supply for the T/R Unit shall be drawn from the nearest switchboard (Customer scope). One or more 125A/63A, 415V, TPN circuit breaker/Switch fuse unit need to be considered at each S/S for the power supply to CP System. CP SYSTEM SUB-CONTRACTOR need to lay one 3-phase, 4-wire power supply cable from this circuit breaker/Switch Fuse unit outlet to one outdoor type PDB near the T/R Unit location for distribution of power to the T/R Unit.

(k) Monitoring of C.P. System performance shall be done by installation of required number of permanent reference cells distributed along the piping route or at each structure to be protected for each TR Unit. The reference cell cables and the measurement cables from each piping/structure shall be routed through the respective cathode junction box (CJB) or test station to a single Monitoring Junction Box (MJB) for each T/R Unit, which shall be located near the T/R Units and have the provision of measurement of structure to soil potential. Also for monitoring of structure to soil potentials at the T/R unit, monitoring cables consisting of reference cell and measurement cables shall be laid between MJB and T/R unit for connection of at least three reference cells to T/R Unit panel.

(l) All Cable laying should be done on existing overhead cable trays/cable trenches wherever possible. Underground Cable laying in paved/unpaved areas should be done as per BHEL/ owner approved recommendation wherever overhead cable trays/cable trenches are not available. Thermit welding shall do connection of drainage cables and measurement cables to the Vessel & piping.

(m) Computerized central monitoring and control of all T/R units and the permanent reference cells shall be done with the help of microprocessor based CP System remote terminal unit RTU/PLC. The central control and monitoring unit shall be located at any one of the Electrical S/S or control room as per the choice of the OWNER. Central control and monitoring unit shall communicate with all the RTU/PLC as master slave system. The communication link between the RTU/PLC and Central monitoring and Control station should be cost effective GSM based wireless technology / RS485 / telephone / fibreoptic / ethernet communication whichever is decided by BHEL/ OWNER as the communication network.

(n) Contractor should design, procure and install the requisite communication system and the cables required for this purpose. Necessary dedicated Telephone lines shall be allotted by OWNER at one centrally located electrical substation for CP System central control and monitoring purpose in case telephone communication is considered between the remote RTU/PLC and central monitoring and control station. Each T/R Unit shall accept set point signals for DC Voltage and DC Current from Remote Monitoring & Controlling Panel and accordingly shall control its output from 0 to 100%.

**4.03 C.P.System shall involve detail engineering, procurement, installation, testing, commissioning considering the following:**

a) **Transformer/Rectifier (T/R) units**: T/R unit shall be of 25V/25A, 50V/50A, 75V/75A capacity depending on the current requirement, oil cooled outdoor plinth mounted and classified/non-classified type depending on the area classification of the location for outdoor installation or air cooled non-classified type for indoor installation. The enclosure of T/R units

shall be as per relevant IEC/NEC codes as per the location of the installations. All T/R units shall be installed under a sun/rain shed if installed outdoor. Approach steps to be provided for all outdoor type oil cooled T/R units coming in low-lying areas.

**b) Anode bed:**

i) **For U/G piping**: Anode Beds to be employed for C.P. System of U/G piping shall be close continuous string anode, MMO wire anode, piggyback connected with anode lead cable, factory pre-packed with coke breeze or tubular MMO anode (as specified). For close continuous string anodes, the length of anode string shall be same as length of U/G pipe for single run of pipe. In case of parallel run of pipes, the no. of continuous anode strings to be considered shall be as per discretion of BHEL/OWNER depending on factors such as diameter of pipes, congestion of the area etc.
However following general guideline shall be considered while deciding the number of anode strings for parallel run of pipelines:

- One string for max. two lines when any one or all the lines are upto 6 inch diameter pipeline.
- One string for max. one line for above 6 inch diameter and upto 30 inch diameter pipeline.
- Two strings for each line for line size above 30 inch diameter and upto 70 inch diameter pipeline.
- When pipeline diameter is more than 70 inch and number of pipeline is one or more, the number of string anode to be considered shall be decided by considering cathode structure current density 30 mA/sq.m and anode current capacity 30mA/m.
- When more than one string is considered for parallel run of pipes, each string shall be preferably laid in different trench with suitable markers for their easy retrieval in future.

Each continuous anode string shall be of 300m (max.) length and shall be fed at both ends from a single T/R Unit using same or different anode junction box. String anode shall be laid laterally along the pipe axis at a distance 2D or 500mm from the pipe whichever is decided by BHEL/OWNER during review of detailed engineering. For mechanical protection of the string at unpaved areas one layer of brick shall be laid along the string after back filling with soil by 150mm. The axis of the brick shall be perpendicular to the axis of the anode string. For future access of each anode string at paved areas, concrete slabs sealed with cement shall be laid along the string after back filling with soil. Care should be taken to ensure that anode string does not touch the structure to be protected or any foreign structure. Continuity test of the string and short circuit test of the string with structure intended to be protected as well as foreign structure shall be carried out before energizing the C.P.System. In case any abnormality is found during this test, CP System sub-contractor needs to do needful to rectify the fault before energizing the system.

ii) **For U/G vessels:** RCC pit shall be provided for the U/G vessel, Anodes employed for C.P. System of U/g vessels shall be mixed metal oxide coated on titanium wire anode, piggyback connected with anode lead cable, factory pre-packed with coke breeze or conductive polymer anode prepacked with coke breeze at Anode manufacturer's factory to be considered as per the temperature criteria mentioned vide section 2.2**,** scheme for ICCP system. The anode strings shall be located within the RCC pit.
Specific installation requirements of String Anode shall be as follows:

- Anode strings shall be installed in the sand cushion surrounding the vessel at a distance of 300mm from the vessel.
- Separation distance between consecutive String anode loop shall be uniform.

- Length of each longer side of the loop string anode shall be same as the length of the vessel + 0.6m.
- Minimum 4 No. of strings should be considered for each vessel

iii) **For Tank Bottom plates:** Anodes employed for C.P. System of tank bottom plates shall be mixed metal oxide coated on titanium wire anode, piggyback connected with anode lead cable, factory pre-packed with coke breeze or conductive polymer anode prepacked with coke breeze at Anode manufacturer's factory to be considered as per the temperature criteria mentioned vide section 2.2. The anode strings shall be laid in the sand cushion or soil under the tank bottom plate extending straight from one end to other end of the tank rim. Following guide lines shall be considered for installation of String Anode for coated tank bottom plates:

- Separation distance of String anode from bottom plate to be protected shall be 1000mm.
- Maximum spacing between consecutive anode strings = 1.5m.

In case 1m space is not available between bottom plate and string anode, suitable shielding arrangement to be provided on string anode so that it does not touch the bottom plate. For such case, Maximum spacing between consecutive anode strings shall depend on available separation distance of String anode from bottom plate and the same shall be decided by BHEL/Owner at the time of detail engineering. In case tank is mounted on RCC pile foundation, one insulating PE film is to be laid on the pile cap before sand filling of the cap to ensure minimum C.P. system current is diverted to the pile cap. Contractor need to lay one layer of insulating P.E. film of thickness 1.2mm on the concrete surface of the RCC cap before sand filling for the tanks mounted on RCC pilling. The Roll size of the P.E. film shall be decided by the contractor. While laying, overlap of 5mm is to be made between consecutive longitudinal P.E. strips. Also, the overlaps need to be sealed using blow lamp or plastic welding method.

iv) **For bullet** : Anodes to be considered shall be close continuous distributed type mixed metal oxide wire anode, piggyback connected with anode lead cable, factory prepacked with coke breeze or conductive polymer anode prepacked with coke breeze at Anode manufacturer's factory to be considered as per the temperature criteria mentioned vide section 2.2. The anode strings shall be laid in the sand cushion of the bullet backfill, in the form of several horizontally laid strings surrounding the bullet. The general specifications of mixed metal oxide coated on titanium wire anode factory prepacked with coke breeze is enclosed in SECTION 3.0. Following guide lines shall be considered for uniform current distribution:

- Separation distance of String anode from bullet to be protected shall be 1.0m, two rows of anode string shall be considered for each bullet, number of strings in each row shall be same as the diameter of the bullet.
- Vertical separation distance between each consecutive anode string shall be 1.0m in each row of anode string.

Free ends of each anode string should be connected to AJB located at each end of the bullet. Thus 2 No. of anode lead cables from each anode string shall be terminated to AJB.

A trained cable jointer need perform the anode lead cable to anode string joints, at factory or at field.

Sand resistivity need to be considered for the Bullet CP System design as 200 ohm- m.

The bullet shall have suitable paint for the soil side corrosion protection.

c) **Junction Boxes**: The enclosure of AJB & CJB shall be classified type as per Area classification and relevant IEC/NEC codes given in enclosed spec. Anode strings should be designed and grouped for each AJB in such a manner that approximately uniform anode

current is discharged through each terminal. While deciding no. of Anode leads for each AJB, at least two nos. of cable entries and cable terminals should be kept spare at each AJB for connection of Anodes as per supplementary design, if required. In case supplementary design is not required in certain areas, the spare cable entries should be closed with a threaded plug.

d) Cables: **Cables for C.P. System shall be as per BHEL standard specifications.**

**e) Power Distribution Board (PDB):** The Power distribution board (PDB) shall be plinth mounted outdoor type if TR Unit is installed out door and shall be installed at classified locations near a single or group of T/R Unit under a sun/rain shed. The enclosure of shall be classified type as per relevant IEC/NEC codes.
The Power distribution board (PDB) shall be composed of one no.3 phase, 4-wire 125A/63A, incoming MCCB and 12/3 nos. 1 phase, 63A outgoing MCB. The incoming switch shall be 4-pole and outgoing switches shall be 2-pole. The MCCB and MCB shall be suitable for motor load application and shall be of BHEL/owner approved make. 4 Nos. of 25x5mm tinned copper bus bar shall be used which should be taped by PVC tape of red, yellow and blue colours for identification of the three phases and black colour for neutral. Wiring inside PDB shall be done using 50mm$^2$, 1-core, copper conductor, PVC insulated, unarmoured cable between TPN switch neutral and neutral bus whereas rest of the wiring shall be done by 25mm$^2$, 1-core, copper conductor, PVC insulated unarmoured cable. All single core cables shall be used red, yellow and blue coloured for phase connections and black coloured for neutral connection. All cables terminations shall be through Tinned copper cable lugs of matching cable size. All cable entries to the PDB panel shall be through Aluminium single compression glands. One gland for required size, 3-phase, 4-core incoming cable connection shall be provided at left side bottom of the panel, 12/3 glands to be provided at right side bottom of the panel for outgoing cable connections for 63A PDB. The outgoing cables shall be 25mm$^2$ (min), 1-phase, 2-core Aluminum conductor cables. Size of the PDB Panel enclosure shall be adequate to accommodate all components easily and shall be made of 2 mm sheet steel. Two nos. hinged front shutters shall be provided. The shutters shall be screwed to the panel enclosure structure at the centre in addition it shall have lockable handles. Painting details of inside and outside surfaces of the PDB panel shall be as follows: After fabrications the entire enclosure shall be sand blasted to a SA2½ surface. An inorganic zinc primer shall then be sprayed to a total thickness of 3 mils. The finish coat shall be of polyamide cured epoxy in three coats to achieve total thickness of 15 mils. The finish paint shade shall be as per choice of BHEL/OWNER specified in Section-C. CP SYSTEM SUB-CONTRACTOR shall prepare the layout/construction drawings and a prototype of PDB showing internal terminal arrangement and wiring arrangements and submit to OWNER/BHEL for approval before procurement/ installation of the same at site.

f) **Cable to cable straight through joint:** As far as possible any straight through joint shall be avoided for any cable run, however for unavoidable situations the straight through joint kit of any standard manufacturer as per OWNER/BHEL approval may be considered for jointing cables.

g) **Thermit Weld Connection**: All cable-to-structure connections shall be made utilizing the exothermic weld process.

h) **Current distribution box (CDB**): A current distribution box shall be employed to feed C.P. current to multiple vessels from a single T/R unit. One no. of CDB shall be connected with single T/R Unit and multiple vessels. The CDB shall be located in the classified area if installed outdoor or in the non- classified area if installed indoor and its enclosure shall be as per Area classification and relevant IEC/NEC codes. The CDB shall have the provision of resistors to control the anode bed current for each tank. The current shall be fed to the anode

bed of each tank from the CDB via local Anode junction box of either 1no. or 2nos. installed for each tank/vessels. Current distribution box shall comprise of one tin-copper bus bar of cross-section 25mm x 5mm of required length. The bus bar is to be connected with 4 nos. of variable coiled stripped resistor of CRESSALL make type ZO or equivalent. Connection to the resistor shall be through welded lugs to the resistor coil having tapping at 25%, 50%, 75% and 100%. The rating of resistor shall be 0-1 ohm, 50 Amp, 2500 watts. Each resistor shall be connected with manganin shunt of rating 50 Amp, 50 MV. The terminals shall be made of 8mm diameter stud/double nut/double spring washer of 8mm-dia stainless steel. Incoming cables will be terminated in the bus bar and each outgoing cable will be connected to the shunt. All outgoing cables shall terminate in the respective anode junction box of each vessel. All incoming and outgoing cables shall be of 95mm$^2$, 1-core, aluminium conductor armoured cable. All cable terminations to the box shall be done using Dowell make lugs suitable for both aluminium and copper conductor. Cable glands should be aluminium, double compression, non-classified type. The terminal board for mounting the accessories shall be phenolic laminated of thickness 10mm. The enclosure shall be painted with polyamide-cured epoxy coating application of 375- micron thickness after surface preparation of SA $2^{1/2}$ and application of inorganic zinc primer. The colour of the final shade shall be yellow. Out of the outlets for positive header cable, if all the outlets are not utilized, the same shall be plugged with threaded MS plug. Vendor shall prepare the layout/construction drawings and a prototype of CDB showing internal terminal arrangement and wiring arrangements and submit to OWNER/BHEL for approval before procurement/ installation of the same at site.

i) **Monitoring Junction Box (MJB)**: MJB shall have provision for measurement of piping to soil potentials for all piping and shall be installed near the T/R Unit under a sun/rain shed. For measurement of piping to soil potentials multi-core cable (25-core x 1.5 mm$^2$, Cu, one-run or 10-core x 1.5 mm$^2$, Cu, two-run) to be laid between CJB and MJB. Multi-core cable (10-core x 1.5 mm2 ,Cu) to be laid also between MJB and T/R Unit for measurement of at least two reference cell potential at the T/R Unit. The enclosure of MJB shall be classified type as per relevant IEC/NEC codes. Monitoring junction boxes (MJB) will be installed near the T/R Unit and shall be required for monitoring potentials of multiple piping. The enclosure for the MJB shall be of IP-55 construction made of 12SWG (2.67) W.T. sheet steel if installed indoor and classified type if installed outdoor. CP System sub-contractor shall prepare the layout/construction drawings and a prototype of MJB showing internal terminal arrangements and wiring arrangements and submit to OWNER/BHEL for approval before procurement/installation of the same.

j) **Permanent Reference cells:** For monitoring the performance of the CP System following number of the Permanent Cu/CuSO4 reference cells shall be considered:
   i) Permanent Cu/CuSO4 reference cells shall be installed at a distance of 300mm from the UG Piping for monitoring of C.P.System. Minimum 10 no. of reference cells to be installed for piping at equidistant locations for each TR Unit.
   ii) Minimum 4 no. of reference cells to be installed for each Vessel
   iii) Minimum 3 no. of reference cells to be installed for each Tank upto 30m diameter and Minimum 5 no. of reference cells to be installed for each Tank above 30m diameter.
   iv) Minimum 16 no. of reference cells to be installed for each bullet at equidistant locations.

**k) Shelter/shed for weather protection of TR Unit, PDB, MJB, CDB, CJB, etc.:** Different groups of TR Unit, PDB, CDB, CJB, MJB, RTU/PLC Panel, local telephone exchange etc. if located outdoor and at different locations of the plant shall be installed under a shelter for its weather protection. The shelter should be covered from top and open at all four sides. Removable steel gray painted 16 SWG sheet metal shall be screwed to angle iron frame as top cover. The angle iron to be considered for the frame shall be of size 2 inch (Min.). The top cover structure shall be screwed to 75 mm diameter vertical supporting pipes grouted at

an interval of 2m. RCC ramp foundation is to be made for grouting of the vertical supporting pipes. The maximum height of the shelter shall be 3m from the grade level. The foundation depth shall be 2m (Min.). RCC pavement 4 inch deep is to be made for the floor of the shelter along with RCC cable trench. The RCC cable trenches should be filled with sand after cable laying to avoid possibility of accumulation of hazardous gas at the bottom of the trench. The detailed design of the shelter/shed need to be prepared by contractor and should be furnished to BHEL/OWNER for approval before execution at site.

**l) Portable half cell:** Portable Cu-$CuSO_4$ reference cells shall be provided for measurement of Pipe/ structure to Soil potential for the pipeline/ structure.

**m) Grounding Cells:** Zinc grounding cell, with minimum 10 m length of cable, shall be provided at each Insulating Joints. Suitable TLP shall be provided at each Grounding cell location.

**n) Solid State type Polarisation cell:** Solid State type Polarization cells shall be installed near HT line crossings and at MOV locations in the mainline. Suitable TLPs are to be provided at these locations.

**o) Surge Arrestors**: Surge arrestors shall be provided at each insulating joints inside the E type TLP Box. Necessary cables are to be provided by the contractor accordingly.

**p) Cable to Pipe Connection:** All cable connections to pipe for Cathode & Permanent Half cell cable shall be through an approved exothermic/pin brazing process. In no case cable shall be connected at the seam of the pipe**.** Repairing of coating including restoration shall be carried out as per approved procedure to the full satisfaction of Engineer-in-Charge.

**4.04 Design basis for C.P.System:**

a) No Insulating joints shall be installed to isolate any incidental structures from C.P.System within Battery limit. Hence the structures intended to be cathodically protected shall be in electrical continuity with many foreign structures within the plant complex such as RCC pavements, RCC foundations, earthing grids, other U/G structures, which are not intended to be protected. The C.P. current requirement, therefore shall be governed by following factors:
   - Surface area and coating quality of structures to be protected.
   - Surface area and surface condition of nearby foreign structures.
   - Relative position of anode between foreign structure and structure intended to be protected.

To take care of such situation C.P. System shall be designed & installed in two stages by providing one preliminary design and another supplementary design as follows:

i) **Preliminary design:** A preliminary design shall be made based on the scheme mentioned in section 2.2 above considering either conductive polymer anode or mixed metal oxide wire anode. The quantities required for T/R units, Power Distribution Boards, anode beds of various configurations, Junction boxes (AJB, CJB, MJB, CDB etc.), Cables of various sizes, Thermit weld connections, and any other materials as required shall be calculated by CP SYSTEM SUB-CONTRACTOR. The locations of T/R units, Distribution Boards, anode beds of various configurations, Junction boxes (AJB, CJB, MJB, CDB etc.), Cables of various sizes, Thermit weld connections, shall be marked by CP SYSTEM SUB-CONTRACTOR in appropriate layout drawings and shall be submitted along with Detail engineering package to OWNER/BHEL for approval. The T/R Units, PDB, CDB and MJB shall be installed at one location under a common sun/rain shed in non-classified area near the Vessel & piping. The power supply for the T/R Unit/PDB shall be drawn from the identified cubical of the electrical

substation nearest to the bullets. The locations for installation of all C.P. system materials/equipment shall be verified at site by OWNER/BHEL to check the practical feasibility of installation as well as its suitability for optimum/ effective performance as envisaged in the design. CP SYSTEM SUB-CONTRACTOR shall start installation work of C.P. System only after site verification and approval of locations by OWNER/BHEL at site. Detailed Engineering works to be performed by CP SYSTEM SUB-CONTRACTOR are mentioned in Section 2.4. After completion of installation work, CP SYSTEM SUB-CONTRACTOR shall carry out testing/ commissioning activities in presence of OWNER/BHEL.

ii) **Supplementary design:** After energising C.P. System as per preliminary design, the unprotected/ under protected and over protected areas shall be identified and a supplementary design is to be made to bring all structures intended to be protected within acceptable potential limits. For identification of under protected/overprotected areas, at first natural Str. To soil potential is to be taken at all test points in presence of OWNER/BHEL. Then the system as per preliminary design shall be energised at different current levels. For each current level, protection potential and protection span of cathode structure nearest to as well as remotest to each anode bed shall be observed until predetermined current limits of Anodes or T/R units are reached or desired protection potential levels are achieved. These observations shall be recorded in a tabular form or graphically plotted and to be submitted to OWNER/BHEL for review. OWNER/BHEL after review/interpretation of the instant commissioning results or within 6 months of the polarization period of the C.P.System, shall decide whether any additional anode bed or additional T/R unit is required to be installed or whether there is requirement for disconnection of some anodes/anode beds or any other remedial measures and the CP System sub-contractor shall update the C.P.System accordingly at no additional cost and within a specified time acceptable to BHEL/OWNER. In case it is decided to install additional anodes then 6A capacity MMO tubular anodes need to be installed at the suitable locations as decided by BHEL.

iii) The following criteria shall be followed to determine the protection levels:
- Maximum allowable vessel to soil potential with respect to Cu/CuSO4 ref. Cell: 2.50V (ON) or –1.10V (Instant OFF)
- Minimum allowable vessel to soil potential with respect to Cu/CuSO4 ref. Cell : 0.850 V (ON) or -100mV polarization shift (Off) or -300mV potential shift from initial native potential to the C.P. potential. Discretion to use any of the criteria shall solely rest with Owner/Owner's Representative.
- Interference Criteria: +100mV positive shift

b) Design life of Anode = 25 years (minimum).

c) Adequate Test station/test points are to be considered including one each at the nearest point as well as remotest point from each anode to ensure adequate potential level of vessels intended to be protected.

d) While deciding number of modular type T/R units, considerations must be given to see no T/R unit is loaded more than 75% of its rated output voltage & current capacity throughout design life while feeding load to a single or group of anode beds.

e) While making preliminary design CP System sub-contractor should make the entire endeavor to ensure the adequacy of the design so that the requirement of supplementary design is bare minimum.

f) For continuous string/wire anode the anode current capacity shall be considered 30mA/m for the design purpose.

g) Identification and mitigation of interference between structures to be protected as well as between the structures to be protected and foreign structures need to be carried out by CP System sub-contractor as per the requirements of the codes mentioned in this document.

h) Suitable measures as per national / international practice will be taken to mitigate any interference current and cross currents from any source.

i) Special protection shall be provided at cased-crossing (Road-crossing/ Rail crossing etc.). Additional sacrificial anodes for casings/ carrier pipes within casings shall be provided by the vendor.

j) Earthing of all T/R Units, PDB, CDB, JUNCTION BOXES, Vessel & piping, Vessels & Bullets need to be done by connecting the same with plant earthing grids, wherever plant earthing grids are not available nearby, a separate earth pit approved by OWNER /BHEL may be considered by CP System sub-contractor.

k) To avoid cable damage in the long run, all cables are to be laid at the cable trays wherever possible; underground cable laying should be considered only when no cable trays are available nearby. All C.P.System cables need to be laid at power cable trays, all multi core-monitoring cables may be laid in either electrical or instrumentation cable trays whichever is available.

l) For road crossing of C.P.System cables, suitable RCC duct or PVC PIPE duct embedded in concrete at proper depth need to be prepared by CP System subcontractor. CP System sub-contractor should get the construction drawing approved by OWNER/BHEL before execution of the work.

m) The type of coating and operating temperature of each Tank should be taken into consideration for all detail-engineering calculations.

n) Wherever specific guidelines are not furnished for cathode structure current density or separation distance of anode from cathode structure and spacing between consecutive anodes, a current density shall be considered for coated piping: 3.0 $mA/m^2$. For Tank bottom plate, Mounded bullets and UG Vessels: 20.0 $mA/m^2$ and for bare cathode/incidental structure 25$mA/m^2$.

o) If operating temperatures of U/g pipeline or mounded vessels exceed 30 deg.C, protective current density shall be corrected @ 0.5mA/m2/deg.C up to a temperature of 60 deg.C.

p) Classified type local AJB/CJB need to be provided near the rim of each vessel for termination anode/cathode/reference cell/measurement cable connections.

**4.05 Detailed Engineering Works To be performed by CP System sub-contractor for C.P.System**

a) Following detailed engineering works are to be performed by CP System sub-contractor based on scheme given and design basis for C.P.System of all structures as per the scope of work mentioned in this document:
- List of materials/equipments to be procured from Indian market/foreign market.
- Item wise list of vendors with their reference lists for supply of materials/ equipment.
- Calculation and Preparation of Bill of Quantities for all C.P. system materials and equipment required.

b) Bill of quantity along with detailed calculations and preparation of specifications, installation work procedures & fabrication/construction drawings for following items:
- C.P.System power distribution board (PDB): Total quantity and connection scheme showing group of T/R units to be connected with each C.P.System PDB and connection details between owner's switch board and each C.P.System PDB.
- T/R unit: Total quantity, Detailed circuit diagrams and their installation drawings.
- AJB/CJB/MJB: Total quantity and connection Scheme showing how group of anodes, anode beds and vessels are to be connected with each AJB/CJB/MJB/CDB. Also fabrication drawing & schematic drawing for internal terminal arrangements and installation drawings for a typical AJB/CJB/MJB/CDB.
- Anodes: Total nos. of Anode strings and anode string to anode lead cable joint details for entire C.P.System and their layout arrangement drawings showing no. of anode strings in each bullet. Construction drawings and work procedures for anode to cable jointing and also for installation of anode strings.

c) Design calculations showing:
- Cables: Total quantity of cables and their layout drawing for each C.P. Station as well as for entire C.P.System for +ve header cables, -ve header cables, anode lead cables, earthing cables, drainage cables, power supply cables and multi-core monitoring cables.
- Cable to Tank/Pipe joint: Total quantity of joints and details of a typical joint.
- T/R unit wise C.P.System layout drawing showing how each T/R unit is connected with group of anode strings/vessels through AJB/CJB/MJB/CDB.
- Test points: All reference cells and anode strings should be marked in a single layout drawing.
- Overall C.P.System layout drawing including all test points, anodes, anode beds, AJB, CJB, MJB, CDB, cable routes on a plot plan. All C.P. System materials/equipment shall be marked properly for easy identification on all appropriate drawings as well as on site.
- Preparation of testing & commissioning procedure for C.P.System.
- Preparation of construction drawings with soft copies before starting of installation/procurement work, Preparation of Soft & hard copies of as built drawings after completion of C.P.System work, shall also be furnished.
- Quantified list of the major construction equipment, tools, tackles etc. including Diesel engine pump set for dewatering at cable/pipe trench the BIDDER proposes to use for execution of the work.
- Details & list of vehicles proposed to be used by the CP SYSTEM SUBCONTRACTOR during the entire construction & commissioning period for transportation of material, equipments, as well as movement of personnel within the plant area.
- Bar chart giving details how BIDDER plans to execute the work within the specified time schedule.
- Quality Assurance Plans/Procedure

d) The CP SYSTEM SUB-CONTRACTOR shall establish document and maintain an effective Quality Assurance system as outlined in recognized codes etc. and Quality Assurance Plans

included in Specifications etc. to ensure that the work is performed in a planned, systematic manner to the best quality standards and properly documented to provide confidence that materials supplied and/or work executed and services performed by him conform to the applicable specifications and all the requirements of contract document and work executed by him shall perform satisfactorily over the entire period of its life. The Quality Assurance Systems Plans/Procedures of the CP SYSTEM SUBCONTRACTOR shall generally cover the following aspects/details, which shall be furnished by BIDDER along with, his detail-engineering package.

- A Quality Assurance Organogram with curriculum vitae of key personnel responsible for the Quality Assurance at site.
- Complete details pertaining to the responsibility authority and accountability of the Quality Assurance Organization of the CP SYSTEM SUB-CONTRACTOR at site.
- Equipments, material, Erection, Installation, Testing and commissioning control plans for quality testing/inspection etc.
- Quality Control of processes such as Thermit welding, anode to cable jointing etc.
- Control Procedures/Plans for calibration and safe up-keep of instruments, gauges and similar testing equipments etc.
- Quality audit & Maintenance/records/procedures etc.
- Other relevant details.

e) Quality Assurance System Plans/Procedures of the CP SYSTEM SUB-CONTRACTOR shall be furnished in the form of a QA manual. BIDDER shall be required to provide explanation pertaining to the details furnished by him in accordance with provisions contained in this clause and any further details, as sought for by OWNER/BHEL. In addition, all the Quality Assurance Programs/Plans as per specifications enclosed with the Contract shall be fully complied with by the CP System sub-contractor.

- Precautionary measures to be taken to prevent fire hazard during Thermit welding and Pin Brazing of vessel for the purpose of cable to vessel joint as well as during installation, operation & maintenance of C.P.System.
- All other information as required in individual job specifications shall be furnished by CP SYSTEM SUB-CONTRACTOR in his detail-engineering package.

**4.06** All erection and commissioning activities are included in vendor's scope. Vendor's technical personnel of suitable qualification and experience and in sufficient numbers shall be deputed to project site for soil resistivity survey and for complete erection and commissioning till the system is successfully commissioned to the satisfaction of owner / BHEL i.e. acceptance of PG testing of the system.

**4.07** Successful bidder shall submit a complete Bill of Materials for the complete system after approval of basic design documentation which shall be to BHEL's approval.

**4.08** Vendor shall select the make of components of cathodic protection system from the list of sub vendors attached with technical specification. However, names of the sub-vendors may be added or deleted from the list without intimation to the vendor and therefore it is mandatory on the part of the vendor to take approval on the make of items during detailed engineering stage. The make of items not listed in the Annexue-IX shall be subject to BHEL/ customer approval without any cost/ delivery implication to BHEL. The list of sub-vendors equipment/components shall be subject to BHEL/ customer approval.

**4.09** Bidders shall submit the list of recommended O&M spares (optional) for trouble free operation for 5 and 10 years for the complete cathodic protection system.

**4.10** Successful bidder shall provide monitoring services for the complete CP system and its equipment for one (1) year from the date of completion of guarantee tests.

4.11 All other materials which may be necessary but not mentioned herein specifically to complete the cathodic protection system in all respects to the best engineering practices shall be in the vendor's scope.

4.12 All materials, consumables, special tools and tackle, testing instruments and machines required for execution of the work are also included in vendor's scope.

4.13 Vendor shall be responsible for conduction of all tests required as per specification. The scope includes making all arrangements (including supply of materials) for all tests, overseeing the performance of tests in presence of Owner/ BHEL's representative. Submission of results for approval and all rectification work, if required.

Vendor shall also be responsible for accurately recording and maintaining records of all tests as per requirement of Owner/ BHEL representative.

4.14 All instruments and consumables required during erection/ pre-commissioning, performance testing and monitoring shall be arranged by the vendor.

4.15 Support pipes/ structures for junction boxes etc. shall be part of scope of supply.

4.16 All other materials necessary but not mentioned herein specifically to complete the cathodic protection system in all respects to the best engineering practices shall be included by the bidders.

4.13 Terminal points :BHEL shall provide 2 nos. (1working + 1 standby) 240 V , single phase, 50 Hz AC power supply uncabled feeder modules at LT panels/ AC distribution boards located in various locations. Bidder to indicate the rating of feeders and power requirement for the same. Cables from the feeder modules / changeover between feeders/ inter-locks/protection devices/ any other supply etc. shall be in bidder's scope only.

5.0 BASIC DESIGN DATA/ GUIDELINES

5.1.0 FOR IMPRESSED CURRENT CATHODIC PROTECTION (ICCP) SYSTEM

(i) The data of pipelines to be protected and the wrapping and coating employed for the protected pipelines are indicated elsewhere in the specification (please refer content sheet).

(ii) The cathodic protection system will be sized in order to guarantee, at each point of same system, the minimum structure-to-soil potential value of (-) 0.95 V versus $Cu/CuSO_4$ half cell reference electrode.

(iii) The maximum negative potential value allowable at the drainage point will be (-) 1.2V (as per BS7361/ 1991 - Section 2, Table 1).

(iv) Overall design Pipeline coating efficiency shall be considered as not more than 70% through out the design pipeline of 30 years for design of ICCP system.

(v) The design current protection density shall not be less than 0.5 mA/Sqm and 20% design current is to be kept as provision for redundancy.

(vi) Design life for the ICCP system shall be minimum 30 years.

(vii) At horizontal crossings the pipeline protection current density applicable for marshy area shall be considered.

(viii) The rating of transformer rectifier shall be considered for an additional requirement of 25 % power compared with the power required under normal operating condition.

5.2.0 Vendor shall submit detailed design calculations for the design of the entire system after award of contract for BHEL approval.

5.3.0 As part of corrosion survey full particulars regarding secondary structure including power cables, communication lines, electrical railway tracks etc. which would adversely influence the system or would be influenced by the system must be collected. The cathodic protection system would incorporate suitable mitigation measures for varying types of soil and moisture content.

5.4.0 Cathodically protected section of the pipe line shall be electrically isolated by use of insulating joints wherever specified.

5.5.0 The carriers in the cased crossings with seals shall be protected by zinc sacrificial anodes. The anodes shall be in the form of ribbon or arc shaped rod and would be welded to the carrier pipe by thermit welding as close to the carrier pipe as practically possible. The length of the ribbon anode would be equal to the length of the carrier pipe inside the casing and anodes will be mounted over the circumference in such a way that it is distributed equally at 120º angle between them.

5.6.0 The external of casings would be coated in the same manner as carrier pipes and also provided with zinc anodes on both sides of the pipe.

5.7.0 As part of cathodic protection monitoring, potential measuring devices would be installed at all test stations. The test station would also provide the flexibility for connecting and disconnecting sacrificial anodes. Some of the test stations having potential measuring terminals shall also have terminal facilities for measuring line currents.

5.8.0 TEST STATIONS

(i) Test stations along the pipeline ROW (Right of Way) and near storage tanks shall be provided for monitoring the performance of cathodic protection system and bonding of pipe lines in common pipe trench or ROW at intervals not exceeding 1000 meters. Test stations shall have, besides pipe-to-soil potential measurement and bonding facilities, four terminal facilities for line current measurement.

(ii) In addition measurement station shall also be provided at following locations:

a) At both sides of major water, road and rail cased crossings.

b) At all insulating joints. The test station shall have terminal facility for connection of grounding cell to pipeline. Besides terminals shall also be provided for pipe-to-soil potential measurement on both shoulders of joint.

c) At crossing of AC/DC electric traction system.

d) At vulnerable location with drastic change in soil resistivity.

e) At HT overhead line crossings and selected locations where HT line passes close to pipe line.

f) In vicinity of DC networks or grounding system where interference problem are suspected.

g) At valve location.

h) At crossing of other foreign pipe lines (bonding facility with resistor shall be provided).

iii) Additional test stations described above, many of which shall fall intermediate between potential test-cum-bond stations, shall have binding facilities. Some of these additional test stations meant for a single pipe or such additional test stations may coincide with those test stations located at 1000 metres interval.

iv) Test stations at location of insulating joints shall be installed independently. Details of terminal facilities and connection schemes for individual type of test station/ current measuring station/ test-cum-bond station shall be as per relevant standards.

v) The location of all the test stations shall be marked with their connection schemes and other relevant information on alignment sheets as a part of detailed engineering. A test station schedule shall also be prepared.

vi) Potential test-cum-bond station provided at regular interval as a means to bond, monitor and control current flow in structures laid in common ROW/trench. These potential test-cum-bond station shall allow detection and mitigation of any interference on foreign structures that may result from operation of this CP system.

5.9.0 REFERENCE ELECTRODES

i) Reference electrodes shall be provided to:

a) Obtain the most reliable indication of the protection and system behaviour.

b) Ascertain the effectiveness of each CP station and control their output.

ii) For separate control, reference electrode including one standby should be placed on all the individual pipelines and below storage tanks.

iii) High purity copper/ copper sulphate reference electrodes shall be used to provide stable potential measurement references.

iv) For each automatically controlled cathodic protection system, monitoring reference electrodes shall be supervised by a duplicate electrode in its close vicinity in an approved location.

v) Such duplicate electrodes shall be provided to guard against reference cell failure possibilities in an unattended automatic system. Facilities shall be provided to reject spurious signal during open or short circuiting of monitoring point.

vi) Suitable provisions shall be provided to insert reference electrodes below storage tanks for periodic monitoring of cathodic protection system performance.

vii) Vendor shall provide 30% spare reference electrode complete with accessories. Number and type of electrodes to be supplied by vendor shall be approved by BHEL.

6.0 SYSTEM DESIGN AND PERFORMANCE CRITERIA

6.01 Standards and Code of Practice

The design, manufacture, shop testing, erection, fabrication at site testing and Initial operation of the cathodic protection system shall conform to the latest revision of following standards and code of practice as specified herein after.

1) BS 7361 Part 1 [Cathodic Protection Code Practice for Land and Marine Application]

2) NACE (USA) Standard RP-0169-02 [Recommended Practice for Control External Corrosion on Underground or submerged metallic piping system].

3) NACE (USA) Standard RP-05-72 [Design, Installation, Operation and Maintenance of Impressed Current Deep Ground Beds].

4) Ferrous Pipeline Corrosion Process Detection & Mitigation

5) Latest international practices, acts and regulations.

The responsibility of establishing conformance to above shall lie with the vendor.

6.02 Performance Criteria for Cathodic Protection

While monitoring effectiveness of cathodic protection, the following criteria shall be applied in principle to achieve a reliable and an easy check of its effectiveness:

i) (-)0.85 V protected structure-to-soil potential (P-S-P) with respect to Copper-Copper Sulphate half cell (reference) electrode in absence of an anaerobic bacteria and (-)0.95 V pipe-to-soil potential with respect to Copper-Copper Sulphate half cell (reference) electrode in presence of an aerobic bacteria (both with the Cathodic Protection System switched 'on').

ii) A minimum negative (cathodic) voltage shift of 300 mV produced by the application of protective current. The voltage shift is measured between the structure surface and a stable reference electrode contacting the electrolyte.

iii) A minimum negative (cathodic) polarization voltage shift of 100 mV measured between the structure surface and stable reference electrode contacting the electrolyte. This polarization voltage shift is to be determined by interrupting the protective current and measuring the polarization decay. When the current is initially interrupted, an immediate voltage shift will occur. The voltage reading after the immediate shift shall be used as the base reading from which to measure polarization decay.

iv) A net protective current flow from the electrolyte into the structure surface as measured by an earth current technique applied to predetermined current discharge (anodic) points of the structure.

7.0 FUNCTIONAL GUARANTEE

7.1 The vendor shall give functional guarantee as elaborated below:

a) The vendor shall guarantee that the performance/ function of the CP system installed shall be strictly in accordance with and conforming to the codes specified and shall perform the specified duties as per the performance criteria specified in Cl 6.02 of this Section.

b) If the vendor fails to prove the functional guarantee of the CP system set forth in the tender documents, the vendor shall investigate the causes and provide free of cost to BHEL, services of vendor's Project Engineer to rectify/ replace the detects within a reasonable period to prove the guarantees. Vendor's liabilities in this respect shall be unlimited.

c) If the vendor fails to prove the guarantee within a reasonable period, BHEL shall have the option to take over the equipment and rectify the same to fulfil the guarantee and/ or to make necessary additions to make up the deficiency at the Vendor's risk and cost. All expenditure incurred by BHEL in this regard shall be to vendor's account.

d) Functional guarantees shall be in respect of the entire cathodic protection system including material supplied and utilized in the CP system.

e) The functional guarantees for Cathodic Protection system after allowing for applicable tolerances as per codes shall be demonstrated by the vendor to BHEL.

f) On successful completion of initial operation, the systems and equipments shall be subjected to functional guarantee test and parameters shall be verified during the test.

g) After successful conductance of the guarantee tests, the monitoring services of the system shall be carried out by the vendor and the system parameters shall be maintained.

8.0 INSPECTION & TESTS

8.1 The vendor shall arrange inspection of the following material before their use at site:

a) All items procured by the vendor whether indigenous or imported.

b) Shop fabricated items at vendor's workshop.

c) Erection work at site (stage wise) including testing of complete Cathodic Protection System.

8.2 The successful vendor shall submit the quality & inspection plans of all equipments during contract stage and the same shall be subject to BHEL/ customer approval without any cost/ delivery implication.

8.3 Owner/ BHEL or their authorized representative reserves the right to visit vendor's, vendor's sub-vendor's shops for the inspection/ quality assurance control & expediting and to be present at the time when the vendor's inspection is being carried out. Such inspection by the Owner / BHEL however in no way relieves the vendor of his responsibilities & obligations.

8.4 The Vendor is responsible for carrying out all tests and checks envisaged in compliance with specifications & to request the Owner / BHEL's inspector to be present when required so as to meet the provisions of the contract. All expenditure in respect of testing of materials shall be borne by the Vendor unless otherwise specified.

8.5 All inspection & tests shall be according to the method indicated in the specifications/ codes/ construction drawings.

8.6 The entire erection of the CP system shall be finally inspected by the Owner/ BHEL to check its conformity with all the drawings & specifications furnished. The vendor shall rectify all the defects and finally hand over the system to the entire satisfaction of Owner/ BHEL.

9.0 SYSTEM TESTING/ COMMISSIONING

Vendor shall furnish the detailed field testing and commissioning procedure for BHEL approval. Field tests as per approved procedures shall be carried out on the equipment/ systems being put into service. Field testing and commissioning shall generally include but not be limited top the following:

9.1 System Testing

a) Vendor shall perform pre-commissioning operations after installation of the system including pre-commissioning checks, calibration and setting of all instruments, control and protective devices. All site tests, reliability and performance tests shall be carried out including supply of all materials and consumables. Before the electrical facilities are placed in operation, vendor shall perform suitable tests to establish to the satisfaction of the Project Engineer in-charge that all equipment, devices wiring and connections have been correctly installed and are in good working conditions.

b) All the test results shall be filled in the proforma to be developed by the vendor and subsequently approved by the Project Engineer-incharge. The proforma shall be jointly signed by the Project Engineer-incharge and vendor.

c) Generally the following tests shall be carried out and recorded on the proforma given in subsequent clauses.

Checking : Visual inspection, comparison with drawings and specifications.

Inspection : Detailed physical inspection and if necessary, by taking stage wise inspection of component parts.

Testing : Simultaneous tests and trial runs of entire equipment to determine its operational fitness.

9.02 Proforma for testing Remarks

a) Transformer Rectifier Unit

- Location/ Station
- Type, Size & Sl. No.
- Rating
- Insulation resistance primary to earth,

  Secondary to earth, primary to secondary
- Polarity check
- Testing of oil (Iif any)

- Check neutral connection
- Equipment Earthing
- Operation of tap changer
- Rectifier continuity & diodes polarity.

b) Cables

- Cable No.
- Voltage grade
- Conductor cross section
- Continuity check
- DC test voltage
- Insulation resistance values

  Between each core & earth and

  Between each core & other

All control cables shall be tested by 500 V megger and all LT power cables shall be tested by a 1000 V megger.

c) Panel

- Location
- Assembly Inspection
- Checking of wiring as per schematics
- Inspection of safety features and their functioning
- Testing anti condensation heaters
- Check circuit numbering
- Insulation resistances of different independent circuits
- Panel to panel connection
- Checking of external cable connections
- Checking of indicating measures and recording circuits
- To carryout simulation test

d) Insulating flanges/joints

- Checking of insulation resistance across the joint before and after charging the line
- by means of insulating-flanges/joint tester.

e) Earthing network

- Location / Station
- Number of electrodes
- Type of electrodes
- Earthing resistance of each electrodes
- Earthing resistance of earthing net work
- Earthing conductor (Type & Size)
- Earthing electrodes shall be inspected before they are installed

f) Anode-Ground Beds

- Location / Station
- Check for its actual & its comparison with drawings
- Resistance of each individual anode
- Current dissipation by each individual anode at different likely voltage
- Total resistance of complete anode bed.
- Mutual interference

9.03 Commissioning Procedure

The installed cathodic protection system shall be commissioned as per following general procedure and the same shall be modified as per the system design parameters.

a) On completion of installation of cathodic protection stations, anode-beds and modification/ integration of corrosion monitoring system as envisaged in this specification, all the elements of the system shall be individually checked, tested and compared against the agreed specifications and procedures. Subsequently the parameters of the anode-beds shall be checked for their veracity. Total anode-bed resistances shall not exceed the calculated design figures.

b) Current dissipating capacity of each anode bed shall be measured and checked.

c) Electrical continuity of the entire pipeline/ storage tanks shall be verified in conformity with design and terminal resistances shall not be allowed to be less than anticipated across the insulating joints.

d) All the insulating joints shall be individually checked for intended electrical isolation.

e) Input resistances of the pipeline at the drainage points shall be checked and recorded.

f) Overall circuit resistance of individual installation shall be measured and recorded.

g) Grounding and polarization cells shall be checked for their expected performance.

h) If any temporary protection facilities are provided, the same shall be disconnected from the system.

i) Bonding between individual pipes in common ROW/ pipe trench shall be ensured.

j) Protection to all lines installed in existing CP Stations shall be switched off and the lines be depolarised for minimum 48 hours.

k) Before the pipelines are put on charge by switching on any of the CP Stations, natural pipe-to-soil potential values shall be measured with respect to $Cu/CuSo_4$ half cell.

l) For each CP system, one of the T/R unit at one CP station end shall be energized to an output regulated manually so as to achieve a maximum structure-to-electrolyte potential of w.r.t. $Cu/CuSo_4$, half cell nearest to drainage points of each line. Observations of spread of protection of each line under this system shall be taken for structure to electrotype potential at each of the installed test station till a value of (–)0.95 volts w.r.t to $CU/CuSo_4$ is reached. Also the pipe line current values across the cross section of the pipeline shall be determined at all the intended test stations influenced by this station. Operating parameters of the T/R unit shall also be recorded.

m) Thereafter the T/R unit at the other CP station end shall be energized after switching off the CP station which was tested. The same procedure as (l) shall be adopted and PSP values recorded. This T/R station shall then be switched off. After ensuring that both T/R units are in order, both shall be switched on simultaneously and PSP values shall be recorded along the entire pipelines at each test station.
Sufficient time must be allowed to elapse between switching on the CP station and recording of pipe to soil potential values.

n) Three complete sets of observation shall be recorded every 24 hours interval of line having stayed on charge after the completion of Sl. No. (m).
It is to be ensured that there is no appreciable difference in the observations and in case of any variations in potentials, the procedure shall be repeated. All the commissioning records shall be recorded in a prescribed proforma and analysed.

o) During the commissioning, maximum protective potential should not be permitted to exceed the design value.

p) Next, the output of the CP station shall be so adjusted that the sites of occurrence of minimum protective potentials are brought down to (-)1.00 V for portion. A full set of observations shall again be taken 72 hours after the first set and the protective systems shall be left in this state or operation.

q) Care shall be exercised that power supplied remains uninterrupted during the period of commissioning, otherwise, in case of an interruption, the test in progress shall be repeated. More sets of observations may be advised to be taken by the Project Engineer in any of the above mentioned steps.

r) After proper polarization (minimum 72 hours), the CP system shall be switched off and the immediate momentary pipe to soil potential measured. This gives the OFF potential which should match with the design value at any point of the pipeline.

s) PSP potentials at all the insulation joints shall be checked before and after energisation of the CP station and shall be recorded.

t) A Pearson survey/ CPL shall finally be run over the entire length of pipeline to detect any holes in the coating which may have developed during backfilling. Coating repairs if any shall be carried out by the vendor. Vendor shall submit a procedure for running this survey for Project Engineer's approval. This step may have to be performed as soon as back filling and compaction is completed.

u) Finished records of testing & commissioning shall be completed with interpretation and submitted for approval.

v) As a result of these tests, if any deficiencies are found in the system, the same shall be rectified by the vendor to the satisfaction of Project Engineer. Such deficiencies shall include mitigation of interaction problems that may be found existing in the course of testing and commissioning. This shall also include a set of SEP observations taken during the peak of first dry season in the area after commissioning the system into regular operation.

w) While commissioning if it is found that the sites of occurrence of minimum protective potentials are below design value for marshy land portion even after 72 hours, the maximum protective drainage point potentials shall be increased depending on Anode Ground Bed current in consultation with Project Engineer. In any case, rectified potential value and the Off Potential of the CP system shall not exceed the design value w.r.t. $Cu/CuSo_4$ cell. The upper limit of pre-set reference SEP value at transformer rectifier unit at which it should operate at permanent half cell failure should then be adjusted according to rectified maximum protective potential value.

x) Vendor shall arrange during commissioning, a cable less potential sensing or any other suitable means proved viable to measure structure-to-electrolyte potentials without requiring physical contact with the monitored structure for the offshore portion only.

## 10.0 DOCUMENTATION

10.01 Technical offer along with bid

Two signed and stamped copies of the following shall be furnished by the bidder as compliance to the specification:

a) Unpriced Price Schedule (As enclosed with the specification) with bidder's signature and company stamp.
b) A copy of the sheet ("Instructions to Bidders for Preparing Technical Offer") and previous sheet (" Contents"), with bidder's signature and company stamp.

10.02 The technical offer shall also include the following as a minimum requirement :

a) Complete technical write-up of system including brief details of major equipments
b) Typical schemes / drawings
c) Catalogues/ leaflets
d) List of orders successfully executed/ under execution
e) Performance feedback for completed orders

10.03 The following minimum design documentation [not essentially limited to these only] shall be furnished by the successful vendor (for review and approval) at contract stage.

1. Corrosion survey report with interpretation.
2. Basic design package and system optimisation studies.
3. Material and equipment specifications, data sheets.
4. Quality plans for all equipment/ items.
5. Field Quality Plan covering site storage, handling, installation and commissioning checks.
6. Detail engineering and final design report.
7. Key diagrams of each discrete systems and complete CP system.
8. Anode installation drawings representing all variations in type, environment, depth, placement, supports etc. including anode.
9. Cable layout schedules and terminals.
10. Foundation, weather protection cover details and support details for T/R sets, anodes, Test Station, distribution boxes and cables of all description.
11. Installation details of T/R sets, test stations distribution boxes etc.
12. Design package on T/R sets essentially incorporating circuit diagrams, fabrications and installation details, parts list, description on operation and maintenance.
13. Design package on anodes essential incorporating composition, fabrication and installation details.
14. Connection schemes for all applicable type of test stations and their schedules.
15. Fabrication and installation details of test stations.
16. Fabrication and installation details of anode and cathode junction boxes, schedules and connection schemes.
17. Interconnection, sectionalisation, isolation schemes for all structures to be protected and those to be isolated but to be checked out for interaction.
18. Power supply arrangement for each T/R set.
19. Safety earthing details.
20. Procedures for testing during installation, commissioning and monitoring of (after installation) complete CP system & each equipment.
21. Design and drawings that may be required for mitigation purposes.
22. Complete CP system layout drawings for each CP station.

23. Cable to pipe joint arrangement using thermite welding.

24. Material test certificate for the materials purchased by the vendor along with copy of manuals.

25. Inspection and test certificates for items fabricated and erected.

26. Performance Test Report.

27. Final check list and completion report.

28. Composite Operation and Maintenance Manual.

29. Monitoring formats.

30. Monitoring schedules.

31. List of E&C Spares.

32. Billing break-up

Note : The list of deliverables shall be finalised during kick-off meeting at contract stage.

## SPECIFICATION FOR C.P. SYSTEM EQUIPMENTAND MATERIALS

| S. No. | Content |
|---|---|
| 1.0 | Specification For Transformer/Rectifier Unit |
| 2.0 | Specification For Mixed Metal Oxide Coated Titanium Tubular Anode |
| 3.0 | Specification For Conductive Polymer Anode |
| 4.0 | Specification For Mixed Metal Oxide Wire Anode |
| 5.0 | Specification For Calcined Petroleum Coke Breeze |
| 6.0 | Specification For Permanent Reference Cell |
| 7.0 | Specification For Cables |
| 8.0 | Specification For Thermit Welding |
| 9.0 | Specification For C.P. System Power Distribution Board (PDB) |
| 10.0 | Specification For Anode, Cathode & Monitoring Junction Boxes |
| 11.0 | Specification For Central monitoring & control system |
| 12.0 | Specification For Soil resistivity test |

1.00 **Specifications and Testing of Transformer Rectifier Units**

The specifications and testing procedure for classified type TR unit (Incase required) need to be prepared by vendor for review/approval by BHEL/OWNER. The specifications and testing procedure for non classified IP-55, weather proof type transformer units are given as follows:

1.01 TRANSFORMER RECTIFIER UNITS(TR UNITS)

The Cathodic Protection Transformer Rectifier unit consists of air-cooled transformer, full wave rectifier, LC circuit for filtering, metering with auto pipe to soil potential control facilities. The TR unit shall also have the facilities for manual control through stepped tapping on the secondary side of the Transformer. The TR unit shall be suitable for outdoor installation having minimum IP-55 degree of protection. Owner will provide un-cabled supply feeder in its LT panel for extending AC power supply to the AC operated transformer rectifier type CP units.

The transformer rectifier units shall be a standard product of a manufacturer regularly engaged in production of cathodic protection power supplies. The units shall be supplied in accordance with the following specifications, standard and data sheets.

1.02 CODES AND STANDARDS

In general the T/R Unit covered by this specification shall unless otherwise specified, be in line with the requirements of any of the latest applicable standard of:

a) Indian Standards Institution(ISI)
b) International Electrotechnical commission(IEC)
c) American Standards Institution(ANSI)
d) British Standards Institution(BS)

which shall include but not to the following:

i) IS: 2026 - Power transformers
ii) IS:2026(Part I)-1977 - General(first revision) with Amendments No.1 to 3)
iii) IS:2026(PartII)-1977- Temperature -rise ( first revision) with Amendments No.1 and 2
iv) IS:2026(Part III)-1981 - Insulation levels and dielectric tests(Second revision) with Amendment No.1.)
v) IS:2026(Part IV-1977 - Terminal markings, tappings and connections(first revision) with Amendment No.1.)
vi) IS:3700 - Essential ratings and characteristics of Semiconductor devices.
vii) IS:3700(Part I)-1972 - General(first revision)&(Reaffirmed IS:4400 (PartI) -1967,1988)
viii) IS:3700(PartII)-1972 - Low Power signal diodes(first & IS:4400(PartII)-1967 revision) (Reaffirmed 1988)
ix) IS:3700(PartIII)-1973 - Rectifier Diodes(First revision)&IS:4400(Part III)-1968 (Reaffirmed 1988)
x) IS:3700(PartIV)-1968 - Low power small signal transistors& IS:4400 (PartIV) 1981(Reaffirmed 1988)
xi) IS:3700(Part V)-1968 - Power transistors(Reaffirmed1988)
xii) IS:3700(PartVI)-1968 – Switching transistors(Reaffirmed 1988)
xiii) IS:3700(PartVII)-1970 - Reverse blocking triode thyristors & IS:4400(Part VII)-1970(Reaffirmed 1988)

Wherever the requirements in this specification are in conflict with any of the above standards, the requirements under this specification shall be binding.

1.03 **TRANSFORMER**

Lighting transformer shall be dry type, natural air cooled and suitable for mounting inside the lighting distribution board. Transformer shall be non-encapsulated type, unless specified otherwise in Data Sheet. Transformer winding insulation shall be class “F” or better. Winding shall be of copper material and maximum winding temperature at full load and under site conditions shall not exceed 120 °C.. Transformer full load efficiency will not be less than 95%.

1.04 **RECTIFYING ELEMENTS**

The power rectification shall be done by Silicon diodes mounted on heat sinks of sufficient size to prevent the diode case temperature from exceeding 100oC at ambient temperature as per data sheet. The peak inverse voltage rating and current ratings of the diodes shall be as per data sheet. The diodes shall be connected in Bridge circuitry for full wave rectification. Each diode in the bridge circuit shall be protected by a HRC fuse.

1.05 **A.C. INPUT**

The transformer rectifier units shall be designed to operate on 240 volts(+/-10%)AC single phase, 50 Hz power supply. Inrush current limiting reactor of suitable rating to be provided at input line of the main transformer to avoid possibility of abnormal tripping of MCB while closing circuit using MCB.

1.06 **D.C. OUTPUT**

The transformer rectifier shall be designed to operate continuously at 110% rated output current and 110% rated output voltage at input supply voltage 240v(+/-10%) without exceeding specified hot spot temperature limit and without damaging any components.

1.07 **DC OUTPUT ADJUSTMENTS**

The DC output control shall be capable of operating in any of the following modes, with the help of a selector switch:

**a) Manual Mode:**

Output voltage control at 2 volt steps from 0-50 V shall be available by means of coarse and fine tap changing switches.

**b) Auto Mode:**

A constant current control will be provided to set the output current to any value up to the rectifier rating. The output current shall not vary more than 1% while the output voltage may vary from zero to 100% depending upon the setting of the voltage control potentiometer. In the constant current mode, the voltage control potentiometer may be used to set the output voltage limit to a desired value.

(i) CONSTANT CURRENT AND VOLTAGE CONTROL (AVCC MODE)

Constant current control feature shall be achieved by automatically adjusting T/R unit output voltage between 0 to 110% rated voltage through close loop control using T/R unit output current as feed back taken from the shunt inside the T/R unit so that T/R unit output current of any value between 0 to 110% rated current does not vary more than +1.0A of set value when there is a change input supply voltage of +10% or change in load resistance over a specified range decided by the ratio of output voltage & current rating of the T/R unit.

(ii) CONSTANT PIPE TO SOIL POTENTIAL CONTROL

Constant Pipe to soil potential (PSP) control feature shall be achieved by automatically adjusting T/R unit output voltage between 0 to 110% rated voltage through close loop control using PSP as feedback taken from external reference cell, to cause change in output current of T/R unit so that PSP as measured by external reference cell always remains constant and does not vary more than +0.04% of the set potential. For feedback PSP reference, 2 nos. Cu/CuSO4 ref. cells to be used one operating and other standby to be selected manually with the help of a selector switch. Continuously adjustable potentiometer to be used for setting T/R unit output current/PSP. Silicon controlled

Rectifiers (SCR's) shall be used in the Primary Circuit of main Transformer for close loop control of the output voltage in automode. The SCR's of the transformer rectifiers will be controlled by commands from electronic circuit cards. These cards shall be the plug-in type Printed Circuit Board(PCB) mounted on the front panel of the rectifier for easy field replacement. The printed circuit board contact pads will be chromium plated to provide easy conduction and to eliminate contact corrosion. Complete printed circuit boards will be sealed with a circuit card sealant to prevent atmospheric corrosion and fungus contamination. Circuit elements in the control cards shall be derated properly and proper heat dissipation arrangements shall be made in the PCB so that they function properly for full load operation of T/R unit at ambient temperature as per data sheet.

1.08 **Reference Cell Selector Circuit and Control**

A circuit shall be used which will accept three (3) reference cell inputs. This circuit will automatically accept the reference with the lowest potential above a pre–selected value higher than the native potential of steel. This limit will minimize the possibility of a rectifier utilising an erroneous reference electrode signal, which could cause over protection to the pipeline. Switches shall be provided to measure the potential of each reference cell used and to allow manual selection of the reference cell to be used.

1.09 **Separate-Drainage Control**

Provision shall exist to individually drain each protected structure and have both auto and manual mode available on each drain.

1.10 **DC OUTPUT RIPPLE**

The single-phase rectifiers shall have an output ripple not exceeding 5%.

1.11 **INPUT OVER LOAD PROTECTION**

**(a)** Protection from over loads on the input will be provided by moulded case magnetic circuit breakers on the input side. These circuit breakers will hold at 100% of rated load. They may trip between 101% and 125% of the rated load and must trip at 125% and above.

**(b)** Circuit breakers will be the manually reset type.The trip point will be unaffected by ambient temperature.

**(c)** Trip handles of individual pole circuit breakers will be mechanically linked to open all lines when an overload occurs. HRC fuse of suitable rating shall be provided as back up to input circuit breaker.

1.12 **OUTPUT OVER LOAD PROTECTION**

(a) Protection from over loads on the output will be provided by an electronic current limiting feature.

(b) Protection from overload on the output will be set by current limit switches marked “Coarse”, “Fine”. The coarse switch shall give limit of 0, 15A, 30A, 45A, 60A, 75A, where as fine switch shall give limit of 0, 3A, 6A, 9A, 12A, 15A.

(c) The limit of the two switches shall be algebraically additive and shall give 25 steps of 3A each.

(d) The maximum current limit can be set by operator at any desired valve in 3 steps and in any circumstances even in case of short circuit the output current should not exceed the maximum set current limit.

(e) In addition to above current limiting feature MCCB of suitable rating to be used at positive and negative terminals to disconnect T/ R unit quickly in case of over loads in the output circuit.

1.13 **VOLTAGE SURGE PROTECTION**

(a) Each silicon-controlled rectifier (SCR) shall be protected from voltage surges by means of R-C circuitry. These devices will be rated such that they will conduct heavily before the peak inverse voltage rating of the SCR's is exceeded.

(b) In addition, lightning arrestors shall be provided in the AC input and DC output circuit of the rectifier.

1.14 **COOLING**

The rectifiers will be natural air-cooled capable of operating simultaneously at rated output in ambient temperature of 45 ºC. The effect of direct sunlight is also to be taken into account.

1.15 **INPUT AND OUTPUT TERMINALS**

(a) DC terminals shall be located convenient to the cable entrance and shall be solder less pressure type terminals of tin plated copper. Output terminals shall be suitable for 50 sqmm cable cross section. Two negative and one positive output terminals shall be provided.

(b) AC terminals shall be insulated to withstand 2000 volts 50Hz to the enclosure shall be shielded to prevent accidental contact and shall be sized to take cable sizes of 25mm$^2$.

1.16 **METERS**

(a) The transformer rectifier units shall be equipped with a separate continuous reading voltmeter and ammeter for DC output and for AC input voltage and current. These meters shall have a full-scale capacity at least 10% above the output rating of the unit.

(b) The transformer rectifier units shall also be supplied with a 0 to $\pm$ 2.5 volt corrosion voltmeter with 10 mega-ohm input impedance. This meter shall be connected to a two-way on and off selector switch to allow structure to electrolyte potential measurements to be taken with respect to either of two reference electrodes. This meter is not intended to control the output of the transformer rectifier.

(c) All meters shall be electronic digital type with LED display arrangement and should be able to indicate the current and voltage ranges as per datasheet unto three decimals. Digit size should be 15mm $*$ 10mm (minimum). Meters shall be rectangular in shape and accurate to within 2% of full scale at 55$^0$C. They shall be temperature compensated to vary no more than 1% per 10% temperature change.

(d) All ammeters and voltmeters shall be provided with separate fuse and toggle switch.

1.17 **ANNUNCIATION**

1.18

Each transformer rectifier shall be supplied with a continuous signal light, which will go out at loss of AC input. This light will be mounted on the top of the transformer rectifier unit. Arrangement shall be provided for giving visual indication of but not limited to the following.

i) Loss of power supply.

ii) Actuation of any protective device.

iii) Failure of auto mode.

iv) Fault on cable on primary and secondary circuit.

v) Under voltage and over voltage on supply side.

## 1.19 ENCLOSURES

a) All transformer rectifier units to be located in non-classified area shall be housed in air cooled enclosure vermin proof and shall be IP 54 as per IEC standards. Minimum cabinet thickness shall be 12 SWG. The enclosure shall be provided with a canopy over the top to protect the T/R unit

b) Accessibility shall be provided by hinged and removable front and sides or by hinged doors and removable chassis. A plexiglas viewing window shall be provided to allow the meters to be read without opening the transformer rectifier unit.

c) The enclosure shall be supplied with an engraved warning label with the words “DANGER”. Transformer rectifier enclosure shall be furnished with gland plate mounted with double compression cable glands for the AC input, DC output and potential measurement cables as per the data sheet.

d) After fabrication the entire enclosure shall be sand blasted to Sa $2^1/_2$ surface. An inorganic zinc primer shall then be sprayed to a total thickness of 3 mils. the finish coat shall be a dark grey shade of polyamide cured epoxy in three coats to achieve total thickness of fifteen (15) mils.

## 1.20 ENCLOSURE EARTHING

All normally dead metallic parts shall be electrically continuous. One earthing terminal suitable for 25 mm square cable connection shall allow their connection to power supply earthing and to earthing pit.
The earth connection points shall be protected against corrosion. It shall not be necessary to scrape the paint away in order to make an effective earth connection. Provision shall also be made adjacent to each gland plate for cable gland earthing connection.

## 1.21 CABLE TERMINATIONS

a) Cable glanding and terminating facilities and terminals shall be suitable for the specified cable type and conductor size. Consideration and provision shall be taken by the manufacturer on the equipment design for the use of cables with aluminium conductors.
b) Cable glands & cable lugs shall be in the scope of supply for CP system installation CP System sub-contractor.
c) Terminal blocks shall be arranged and positioned to afford easy access for carrying out external cable termination, testing, inspection and maintenance. There shall be ample clear space allowed between the terminal block and the gland plate for the spreading and termination of external conductors.

d) All terminal blocks shall be shrouded or provided with transparent covers. Pinch screw type terminals are not acceptable.
e) Three positive and three negative post type D.C. output terminals shall be provided for the T/R Unit. Each post shall be fitted with double nuts and washers.
f) Terminals for different voltages shall be separated by partitions.
g) A terminal box or chamber with undrilled gland plate or entry panel of sufficient dimensions to terminate the specified incoming and outgoing cables shall be provided.
h) Direction of cable entry shall be from below.
i) Termination of single core cables shall be through a non-magnetic metal panel or gland plate and provision made for bonding and earthing any armour and/or concentric ground conductors.
j) Cable terminal arrangements for power and control cables may be integrated provided that a barrier separates the two.
k) Auxiliary wiring shall have copper conductors of the manufacturer's standard sizing (subject to Buyer's approval).
l) Suitable terminals for two nos. ref. cell cables, one no. measurement cables and a selector switch for permanent ref. cell to be provided for T/R unit panel for connection to PSP meter. Wiring shall be crimped using self-insulated compression type terminal blocks which shall be suitably identified. Conductors shall be fitted with sleeve ferrules bearing the same identification as the terminal to which they are connected. Minimum conductor size shall be 1.0mm2 (current density shall not be more than 3A/mm2 for copper conductor).

## 1.22 NAME PLATE

A permanently stamped metal plate with the following information shall be fixed to the outside of the case:

A Manufacturer's name
B Year of manufacture
C AC input voltage and current rating
D AC frequency
E Phase
F Maximum output DC Volts and Amps rating
G Weight in Kg of T/ R unit
H Model number
I Serial number

## 1.23 TESTING OF T/R UNITS

All T/R units shall be tested by CP System sub-contractor and inspected by BHEL/Owner before despatch, testing shall be conducted in accordance with codes and standards enclosed in this document, as per routine tests done by manufacturer and additional tests as mentioned below:

a) Efficiency test of Transformer Rectifier Assembly at 25%, 50%, 75% and 100% rated output current both in Auto and manual mode of operation. Efficiency test of Transformer alone after isolating rectifier at 100% rated output current.
b) No load output voltage test in Manual mode for each voltage setting using coarse and fine tap switches at rated input voltage of 240V AC.
c) Output voltage and current test in Manual mode for each voltage setting using coarse and fine tap switches for the following conditions.
   (i) Input voltage 240V AC, load resistance 1.65ohm for 50A T/R & 1.1 ohm for 75A T/R
   (ii) Input voltage 253 VAC, load resistance 1.65ohm for 50A T/R & 1.1ohm for 75A T/R
   (iii) Input voltage 207 VAC, load resistance 1.65ohm for 50A T/R & 1.1 ohm for 75A T/R.

d) Output voltage test at rated output current setting in Auto mode for the following conditions.
   (i) Input voltage 240VAC, load resistance : 1.65ohm for 50A T/R & 1.1 ohm for 75A T/R
   (ii) Input voltage 253 VAC, load resistance : 1.65ohm for 50A T/R & 1.1 ohm for 75A T/R

(iii) Input voltage 253 VAC, load resistance 0 ohm(short circuit across +ve and -ve terminal of T/R unit). Set back up control 75A & 50A for 75A & 50A T/R unit respectively.

(iv) Input voltage 207VAC, load resistance : 1.65 ohm for 50A T/R & 1.1 ohm for 75A T/R Output current and voltage shall be recorded for each of above conditions (i) to (iv).

e) Heat run test for max. temp rise to be conducted for main transformer, Auto transformer, filter choke, Diodes and SCR's, at 50A output current for 50A T/R Unit & 75A current for 75A T/R unit for 48 to 72 hours continuous operation. Number of T/R units to be considered for Heat run tests and actual duration for which test to be conducted upto 72 hours (max.) shall be decided by BHEL and owner. Thermocouple instrument shall be used for measurement of temperature. The sensors shall be clamped at different locations inside the closed T/R unit cubical and the cable of the sensors shall be connected to temperature indicator through a selector switch outside the T/R unit cubical during heat run test.

f) Insulation resistance test using 500V megger for Auto transformer and Main transformer between primary and secondary, primary and earth, secondary and earth.

g) Dielectric strength test using 2KV for 1 min. duration for Auto transformer, main transformer between Primary and secondary, primary and earth, secondary and earth.

h) Polarity test in Auto and manual mode of operation of T/R unit.

i) Calibration test for all Ammeters and volt meters.

j) Auto mode over load protection test:

k) Set back up control and increase current from zero to max. Possible using main Auto control for T/R Unit having constant current control.
In case of Auto PSP control T/R unit ref. feedback signal to be varied from min. to max. set potential of T/R unit using battery & rheostat in place of ref. half cell signal, current during the test should not exceed more than set current in both cases.

l) Constant Current Test

(i) D.C Current Regulation against variation in AC Input

(ii) Put the unit in constant current mode and set the output current at 75 A by the help of current setting potentiometer and observe the variation in, if any, of output current with variation of AC input voltage at the steps keeping the output load constant: 216V, 240 V, 264 V.

(iii) D.C Current Regulation against variation in Load Voltage

(iv) Keeping the AC input voltage at 240 V constant , set the output D.C current at rated current and observe for any variation of DC current with variation of output load voltage at three different values ensuring that at each output load voltage, taking care voltage limit set value is not exceeded. Repeat the above at 75%, 50% and finally at 50% set output current.

m) Constant voltage test for control circuitry. Supply voltage of T/R unit to be applied 240V 184V and 276V. For each input supply voltage the reference voltage, +ve DC and -ve DC voltages of Auto mode control circuit to be checked whether they are constant.

n) D.C Voltage Regulation against variation in Load Current
Keeping the AC input Voltage at 220 V constant, set the output D.C voltage at 48 V and observe for any variation of D.C Voltage with variation of output load current at three different values ensuring that each output load current, current limit set value is not exceeded. Repeat the above at 24 V and finally at 12 V set output Voltage.

o) Ripple factor test
T/R unit shall be operated at full load both in Auto and Mandual mode. In each case ripple voltage to be checked on a cathode ray oscilloscope (CRO). Peak to Peak ripple wave from shall be limited within 7.05 volt in CRO screen for 50 volt TR unit & 10.575 volt for 75 volt TR unit.

p) Annunciation check:
Annunciations check to be done for power on, manual mode operation and auto mode operation.

q) Auto mode constant PSP operation test:

Connect one battery with variable rheostat in place of reference cell feedback signal and conduct the following test:

(i) Make both T/R unit set potential & feedback signal from battery 1.0V, Switch on T/R unit & note T/R output current. Increase feedback signal from 1.0V to 1.5V and again bring back to 1.0V. Note change in the T/R output current.

(ii) Conduct similar test as item (i) above with decrease of feedback signed from 1.0V to 0.5V and again back to 1.0V. Note change in the T/R output current.

r) Power consumption test for each:

**T/R Unit:**

Forward voltage drop of each diode at T/R unit rated output current:

(i) D1=
(ii) D2=
(iii) D3=
(iv) D4=

Power consumption:

(i) D1=
(ii) D2=
(iii) D3=
(iv) D4=

Voltage drop and power consumption should not be more than specified value mentioned in diode manufacturer's catalogue.

s) Power consumption test for filter choke:
Voltage drop across choke at 75A T/R Unit output current =
Power consumption of choke at 75A T/R unit output current =

## 1.24 DRAWINGS/ DOCUMENTS

a. Fabrication drawings and data sheet of T/ R unit with all dimensions, ratings and weight in final issue, including installation/ foundation arrangement details.
b. Front view and typical section of T/ R unit panel with arrangement of equipment, control, protection and metering.
c. Data sheet of all accessories and circuit element of T/ R unit including ratings.
d. Schematic and wiring diagram of T/ R unit circuitry including Auto/ Manual Mode of control.

e. Fabrication drawings, connection scheme details and data sheet of Distribution Board with all dimensions, rating and weights in final issue including mounting details.

## 2.00 SPECIFICATION FOR MIXED METAL OXIDE COATED TITANIUM TUBULAR ANODE FOR C.P. SYSTEM

2.01 Mixed Metal Oxide Coated Titanium single tubular anodes shall be of BHEL/owner approved standard manufacturer, for use in impressed current Cathodic Protection system. This specification covers the requirements for the design, manufacture and testing of anodes suitable for underground application.

2.02 Anode (preferably LIDA type) and backfill material and construction shall be in accordance with the standards listed in the specification, and shall be in proven use.

2.03 Each anode shall be provided with heat shrunk anode caps matching the anode size. These caps shall be moulded out of radiation cross-linked PE material which shall be heat shrinkable and the material characteristics shall be furnished by the vendor for approval of the BHEL.

2.04 Each anode shall be installed at least 30 meters away from the pipeline and at a depth of 1.0 to 1.2 meter from the level of pipeline. The exact location shall be identifiable by means of suitable marker on the ground to be supplied by vendor. The spacing between two consecutive anodes shall be one (1) meter.

2.05 Each anode shall be installed inside a pipe canister of suitable diameter, length and thickness, so that the backfill is properly consolidated. Two centralizers shall be provided to aid centring of the anode inside the canister. Proper compaction shall be done while pouring backfill material inside the canister. The pipe shall be driven underground after auguring of the hole of required dimensions.

2.06 Anode-bed plot limited upto ROW shall be surveyed for topographic details, its location and orientation shall be reviewed by Project Engineer. A complete drawing showing plots, sub-plots, center line of sub plots, resistivity readings, connection to CP station and to pipeline structure, cable trench layout, etc., shall be submitted along with supporting reasons for anodes bed site selection to Project Engineer on the basis of corrosion survey report prepared by vendor.

2.07 Layout of anodes and installation in anode-bed shall be detailed out in a separate drawing showing anode installation details, anode grouping, anode wiring etc. Type of layout whether vertical installation, horizontal installation in shallow depth to be considered shall be decided in consultation with Project Engineer on the basis of corrosion survey report prepared by vendor.

2.08 Necessary connection of anode lead cable in anodes, packing of anodes in canisters filled with backfill, soldering or canisters shall be supervised at site.

2.09 Each anode shall have lead cables of sufficient length to reach anode junction box without joints in between. Exact length and termination details shall be shown in construction drawings.

2.10 Anode bed sepration from pipeline shall be tested for interaction.

2.11 At landfall points, anode landbeds may be laid, if situation demands, between low and high water line or very near low water line. The configuration shall be horizontal in such cases.

2.12 Sizing of ground bed at each CP station shall be such that its total resistance to remote earth does not exceed 1.0 Ohm inclusive of anode lead cable resistance. Potential gradient around the anode bed shall be within safety requirements and its effective boundary shall be defined and secured.

2.13 The boundary of the anode bed should be clearly marked with the help of permanent boundary of fencing.

2.14 Mixed Metal oxide coated Titanium tube anodes shall be dimensionally stable and will be supplied with anode lead cable connected to it.

2.15 **Cables:**

i) Anode tail cable shall be single core 10 sqmm stranded tinned copper conductor, PVC insulated, FRLS PVC sheathed and armoured type. Anode cable tail shall be long enough to reach the junction box without intervening joint. The cable shall be routed inside a GI pipe conduit. Each cable routing shall be marked clearly with markers supplied by vendor.

ii) The mechanical strength of the anode/ anode cable joint shall be such that weight of the freely suspended anode can be supported.

iii) The connector to be used for anode lead connections shall be zinc alloy. The installed connector shall have minimum pull-out strength of 200kg and a total electrical contact resistance not exceeding 0.0090 ohms as measured across both the copper-to-connector junction and the connector-to-anode junction.

iv) The connection shall be insulated by completely filling the hole with an approved cold applied polyurethane insulating compound at al least 12 inches on both above and below connector.

v) Filling with insulating compound shall be carefully accomplished to ensure a waterproof connection.

2.16 Anode to cable jointing and insulation shall be done by anode manufacturer at his shop.

2.17 Anode lead cable conductor shall be crimped with tubular anode at the center of anode or at the ends and shall be sealed to prevent ingress of water at the joint. Fabrication details of the joint including sealing arrangement and test procedure of the joint shall be furnished by vendor or BHEL's approval before making the joints.

2.18 Manufacturers/ supplier shall furnish detailed dimensioned fabrication drawing of anode as well as details of anode to cable connection and its insulation sealing to OWNER/PMC for approval. Manufacture of anodes shall be commenced after obtaining approval and inspection of a prototype joint by BHEL/owner at anode manufacturer's works. Anode Manufacturer shall furnish following information for BHEL/owner approval before commencement of Anode to cable joint.

- Name of Manufacturer of joint sealing material along with Physical & Chemical Properties.
- Type and make of Heat shrink cap along with its grade and properties.
- Procedure for making the joint

2.19 Following prototype and routine tests are to be conducted by anode manufacturer. Anodes with cables shall be delivered to site only after OWNER/PMC's approval of the test results which are to furnished by anode manufacturer for each anode. Detailed procedure for conducting the following tests shall be furnished by manufacturer for BHEL/owner approval before commencing tests.

(a) Dimensional check (Routine tests): Dimension & weight of all anodes to be checked & recorded. Negative tolerance will not be accepted.

(b) Anode Lead cables (Routine tests): Routine & type test certificates of cable manufacturer to be furnished for anode lead cable as per IEC 502-1983 or relevant IS code. Cable length and identification tag to be verified by measurement.

(c) Anode to Cable joint test (Routine tests): Each anode to cable joint shall be tested for its electrical contact resistance & its value in ohms shall be recorded.

(d) Prototype Test: First anode to cable joint shall be subjected to accelerated aging test & destructive test to determine pull out strength of cable to anode joint as well as effectiveness of the joint insulation.

(e) The vendor shall furnish spectrographic analysis of anodes from each heat.

(f) Inspection and Testing shall be carried out on the anodes and the backfill material to demonstrate that the material is conforming to the physical, chemical and others parameters specified and test certificate shall be submitted to the Owner / BHEL for approval.

(g) The vendor shall submit a certified test report from anode manufacturer showing that the connecting method has passed a 120 day laboratory test without failure at the place of connection when the anode is subjected to its maximum recommended current output continuously while immersed in a 3% weight sodium chloride solution.

(h) All anodes shall be subject to inspection by BHEL or BHEL representatives. Any anode having a surface defect with penetration in excess of 5 mm shall be rejected.

(i) The box shall be split into sections to enable the cable tails to be packed at one end in their separate compartment. All free space shall be tightly packed with soft packing material.

(j) In the event of damage or breakage occurring as a result of inadequate packing, the vendor shall replace the same at no additional cost of BHEL.

## 3.00 SPECIFICATION FOR CONDUCTIVE POLYMER ANODE

3.01 Conductive Polymer anodes shall be for use in impressed current cathodic protection system of tank bottom plates. This specification covers the requirements for the design, manufacture and testing of anodes suitable for application in sand pad under tank bottom plates.

3.02 Conductive Polymer anodes shall be dimensionally stable and shall consist of parallelly installed anode strings connected together. Connection of anode lead cable to the Anode string assembly shall be carried out at site.

3.03 Anode internal header cable and anode lead cable in between each anode string and AJB shall be PVC/XLPE insulated, 7 strands, 10mm$^2$ stranded copper conductor, single core, un-armoured, type.

3.04 Anode to Lead cable jointing and insulation shall be done by using straight through jointing kit which is to be provided by anode manufacturer. Anode to Lead cable jointing and insulation shall be done at manufacturer's work shop or at field by a trained cable jointer.

3.05 Manufacturers/ supplier shall furnish detailed dimensioned fabrication drawing of anode string assembly as well as details of Anode string to Anode Lead Cable connection and its insulation sealing to OWNER/ BHEL for approval. Manufacture of anodes shall be commenced after obtaining approval and inspection of a prototype joint by OWNER/ BHEL at anode manufacturer's works.

3.06 Anode Manufacturer shall furnish following information for OWNER/ PMC approval before commencement of String anode to Anode Lead Cable joint.

- Type and make of Heat shrink cap along with its grade and properties.
- Procedure for making the joint

3.07 Following prototype and routine tests are to be conducted by anode manufacturer. Anodes shall be delivered to site only after OWNER/PMC's approval of the test results which are to furnished by anode manufacturer for each anode. Detailed procedure for conducting the following tests shall be furnished by manufacturer for OWNER/PMC's approval before commencing tests.

i) Dimensional check (Routine tests): Dimension & weight of all string anodes to be checked & recorded. Negative tolerance will not be accepted.

ii) Anode Lead cables (Routine tests): Routine & type test certificates of cable manufacturer to be furnished for anode lead cable as per IEC 502-1983 or relevant IS code. Cable length and identification tag to be verified by measurement.

iii) String anode to Anode Lead Cable joint test (Routine tests): Each anode to cable joint shall be tested for its electrical contact resistance & its value in ohms shall be recorded.

iv) Prototype Test: First String anode to Anode Lead Cable joint shall be subjected to accelerated aging test & destructive test to determine pull out strength of cable to anode joint as well as effectiveness of the joint insulation.

## 4.00 SPECIFICATION FOR MIXED METAL OXIDE WIRE ANODE

4.01 Factory coke backfilled fabric jacketed Mixed Metal Oxide wire anodes shall be a standard product of the manufacturer regularly engaged in the production of such anodes for use in impressed current Cathodic Protection system. The make /model of MMO wire anode to be supplied shall be either "MATCOR Make SPL™-FBR-16" or Covalence/Tyco/ Berry Plastics (USA) Make Make (Anodeflex-3020).

4.02 Mixed Metal oxide anodes shall be dimensionally stable. Each wire anode shall be supplied with anode lead cable piggy back connected to it i.e there will be connection between the Primary anode and the internal header cable at a every 3m (max) distance. The connection shall be multi-step and water proof.

4.03 Anode internal header cable and anode lead cable in between each anode string and AJB shall be KYNAR/HALAR insulated, 7 strands, 10mm2 stranded copper conductor, single core, unarmoured, with a double insulation system. The primary insulation shall be 0.04 inch thick cross-linked polyvinylidene floride (PVDF) 1100 Volt grade. The secondary insulation shall be 0.065 inch thick high molecular weight polyethelene (HMWPE) sheathing jacket over the primary insulation.
Jointing of anode lead cable with internal anode header cable and its insulation shall be done by using standard jointing kit which is to be provided by anode manufacturer. However, preference will be given for direct termination of the anode header cable to AJB without any joint in between with internal anode header cable and anode lead cable. Wire Anode to anode header cable jointing incase unavoidable, shall be done at factory or site by a trained cable jointer.

4.04 Manufacturers/ supplier shall furnish detailed dimensioned fabrication drawing of anode string assembly as well as details of Anode string to Anode Lead Cable connection and its insulation sealing to OWNER/ BHEL for approval. Manufacture of anodes shall be commenced after obtaining approval and inspection of a prototype joint by OWNER/ BHEL at anode manufacturer's works.

4.05 Anode Manufacturer shall furnish following information for OWNER/ PMC approval before commencement of String anode to Anode Lead Cable joint.

- Type and make of Heat shrink cap along with its grade and properties.
- Procedure for making the joint

4.06 Following prototype and routine tests are to be conducted by anode manufacturer. Anodes shall be delivered to site only after OWNER/PMC's approval of the test results which are to furnished by anode manufacturer for each anode. Detailed procedure for conducting the following tests shall be furnished by manufacturer for OWNER/PMC's approval before commencing tests.

v) Dimensional check (Routine tests): Dimension & weight of all string anodes to be checked & recorded. Negative tolerance will not be accepted.

vi) Anode Lead cables (Routine tests): Routine & type test certificates of cable manufacturer to be furnished for anode lead cable as per IEC 502-1983 or relevant IS code. Cable length and identification tag to be verified by measurement.

vii) String anode to Anode Lead Cable joint test (Routine tests): Each anode to cable joint shall be tested for its electrical contact resistance & its value in ohms shall be recorded.

viii) Prototype Test: First String anode to Anode Lead Cable joint shall be subjected to accelerated aging test & destructive test to determine pull out strength of cable to anode joint as well as effectiveness of the joint insulation.

## 5.00 SPECIFICATION FOR CALCINED PETROLEUM COKE BREEZE

5.01 Calcined Petroleum Coke Breeze shall conform to the following specifications as per **IS:8502-1977, Grade A,** :

| | | |
|---|---|---|
| **A** | **Chemical Composition:** | |
| | Moisture (on Dry Basis) | 0.1 (% by mass) |
| | Fixed Carbon | 99.0 (% by mass) |
| **B** | **Bulk density** | 800 Kg/m3 to 1200 Kg/m3 |
| **C** | **Real density** | 2.03 gm/cc |
| **D** | **Particle Size** | 1.00mm(max.), Dust free |
| **E** | **Resistivity** | 0.1 ohm cm. at 150 PSI. |

5.02 **Test Certificates**

Test Certificate shall be furnished for the following:

a) Make of coke breeze
b) Batch no.
c) Chemical composition
d) Bulk density and Real density
e) Particle size analysis
f) Resistivity( ohm-Cm.) at 150 psi compaction

Any delivery effected without prior approval of test certificate by BHEL/owner will be at suppliers risk & cost.

5.03 Above mentioned specification for coke breeze shall be considered for MMO tubular anodes incase required for supplementary design, the coke breeze to be considered for MMO wire anode may be of make as per the anode manufacturer's choice meeting the requirements of the specifications mentioned above.

## 6.00 SPECIFICATIONS FOR PERMANENT REFERENCE HALF CELL

6.01 This specification covers technical requirements for reference electrodes to measure structure-to-electrolyte (P-S-P) potential in cathodic protection system. Reference electrodes are to be used for measuring structure/ electrolyte potentials, or as sensing electrodes for control systems.

6.02 A copper/ copper sulphate reference electrode is to be used for making contact with soil and fresh water while a silver/ silver chloride reference electrode is preferable for immersion in saline waters. Zinc electrodes can be used in clean sea water. Electrodes to be used as sensing electrodes shall be so designed as to be stable over a long period (minimum 10 years).

6.03 In reference electrodes having a metal electrode in contact with a concentrated salt solution (e.g. copper sulphate or potassium chloride), concentration is maintained by excess solid salt being present. Contact with the electrolyte (i.e. soil or water) is made via a porous plug of ceramic construction acting as salt bridge between the electrolyte and the concentrated salt solution. These electrodes will remain suitable for use until the salt is exhausted by diffusion through porous plug. When not in use, these should be stored in a saturated solution of the relevant salt.

6.04 Testing of reference electrodes as per standards shall be witnessed by BHEL before despatch.

6.05 Minimum three (3) nos. permanent reference electrodes will be required at each drain point one at either side of pipe for each transformer rectifier unit. This reference electrode shall have a stability of plus/minus 5 millivolts at a maximum load of 3.0 micro amps and have a design life of 25 years.

6.06 Each reference shall be supplied in cotton bag of chemical backfill having overall size 8" dia x 16" long and complete with 25 M (minimum) cable as per specification. However, CP System sub-contractor to measure the actual length of measurement cable required at site during detailed engineering stage and cut the required length from cable drum so as to avoid cable-to-cable joint.

6.07 **COPPER/ COPPER SULPHATE REFERENCE ELECTRODE**

(a) A form of copper/ copper sulphate reference electrode that is suitable for measurements under most conditions, including probing, shall be supplied by the bidder. The dimensions may be made to suit the method of use, but the surface area of copper electrode In contact with the copper sulphate solution should be large enough to prevent polarization during test. The metallic electrode should be of high conductivity copper of at least the purity specified for grade C101 in BS 2874.

(b) The copper should be cleaned to remove all traces of oxide and grease and immersed in saturated copper sulphate solution. Saturation shall be maintained by providing excess solid copper sulphate. The copper sulphate solution shall be made with fine crystals of copper sulphate to at least analytical reagent (AR) grade or British Pharmacopoeia (BP) quality with distilled or de-ionized water which shall be boiled in a clean glass or enamelled container before use. Electrical contact with the soil is made only through the porous element, which is kept moist by seepage of copper sulphate solution. Electrodes shall be immersed in saturated copper sulphate solution for long duration storage.

## 6.08 SILVER/ SILVER CHLORIDE REFERENCE ELECTRODES

(a) A silver/ silver chloride electrode is formed from silver, the surface of which has been coated with silver chloride by thermal or electrolyte methods. The silver/ silver chloride element shall be used directly in sea water or saline estuarine waters. In other applications (e.g. steel in concrete) a silver/ silver chloride/ potassium chloride electrode may be used.

(b) Electrodes for use in sea water shall be encased in perforated containers for mechanical protection and to allow free access of sea water to the electrode. They should be immersed in fresh sea water for several hours before use. Cable end shall be insulated to prevent short-circuiting of electrode.

**7.00 SPECIFICATION FOR CABLES**

7.01 This specification covers requirements for type, rating, manufacture and testing of the cables to be used for impressed current type cathodic protection system.

7.02 **CODES AND STANDARDS**

In general the cables covered by this specification shall unless otherwise specified be in the line with the requirements of any of the latest applicable standard of:

a) IS: 7098(Part I) -1988
b) IS: 1554
c) IS: 3961(Part IV)-1968
d) IS: 3961(Part II)-1967

Wherever the requirements in this specification are in conflict with any of the above standard, the requirements under this specification shall be binding.

7.03 **ANODE LEAD CABLE**

Anode internal header cable and anode lead cable in between each anode string and AJB shall be PVC/ XLPE insulated, 7 strands, 10mm$^2$ stranded copper conductors, single core, unarmoured.

7.04 **+VE, -VE HEADER CABLE**

+ve header and -ve header cables shall be of cross section as required, stranded copper conductor, single core, aluminum wire armoured, PVC insulated and PVC sheathed 1100V grade cable.

7.05 **DRAINAGE CABLE**

Drainage cables shall be 50mm$^2$, stranded aluminium conductor, single core, aluminum wire armoured, PVC insulated and sheathed 1100V grade cable.

7.06 **POWER SUPPLY CABLE(Between PDB & T/R Unit)**

Power supply cable between Power source or C.P.System DB and T/R unit shall be 25mm$^2$, stranded aluminum/copper conductor, 3-core, Aluminum wire armoured, PVC insulated and sheathed 1100V grade cable.

7.07 **POWER SUPPLY CABLE (between Power Source & PDB).**

Power supply cable between Power source & C.P.System PDB shall be 50mm$^2$, stranded Aluminum conductor, 4-core, Aluminum wire armoured, PVC insulated & sheathed 1100 V grade cable.

7.08 **EARTHING CABLE**

Earthing cable shall be 35mm2, stranded Aluminum conductor, 1-core, unarmoured, PVC insulated and sheathed 1100V grade cable.

7.09 **MEASUREMENT CABLE AND PERMANENT REFERENCE CELL CABLE BETWEEN TANK/VESSEL/BULLET AND CJB CUM TEST STATION**

The measurement cable and permanent reference cell cable shall be 4mm2, stranded copper conductor, single core, PVC insulated and sheathed, 1100V grade aluminum wire armoured and screened cable.

7.10 **MEASUREMENT CABLE AND PERMANENT REFERENCE CELL CABLE BETWEEN CJB CUM TEST STATION AND MJB**

The measurement cable and permanent reference cell cable shall be 2.5mm2, solid copper conductor, 10 core, PVC insulated and sheathed, 1100V grade aluminum wire armoured and screened cable.

7.11 **MEASUREMENT CABLE AND PERMANENT REFERENCE CELL CABLE BETWEEN MJB AND TR UNIT**

The measurement cable and permanent reference cell cable shall be 2.5mm2, solid copper conductor, 10 core, PVC insulated and sheathed, 1100V grade aluminum wire armoured and screened cable.

7.12 **REFERENCE CELL / MEASUREMENT CABLE BETWEEN MJB & RTU/PLC**

Instrumentation cable, 2.5mm2, 20-core, stranded copper conductor, PE/PVC insulated and PVC sheathed, screened and armoured cable, PE/PVC insulation of each core shall be Numbered or colour coded for easy identification of each core.

7.13 **REFERENCE CELL / MEASUREMENT CABLE BETWEEN TRU & RTU/PLC**

Instrumentation cable, 2.5mm2, 24-core, stranded copper conductor, PE/PVC insulated and PVC sheathed, screened and armoured cable, PE/PVC insulation of each core shall be Numbered or colour coded for easy identification of each core.

7.14 **TELEPHONE CABLE BETWEEN RTU/ CENTRAL MONITORING PC TO LOCAL TELEPHONE EXCHANGE, LOCAL TELEPHONE EXCHANGE TO MAIN TELEPHONE EXCHANGE.**

Telephone cable, 0.5mm2, 5-Pair, each pair twisted and Laid, Numbered or colour coded, solid copper conductor, PE insulated and sheathed, Jelly filled provided with polyester tape over it, screened with Poly Aluminium tape of 0.3mm and armoured with one layer of GI wire cable. In case other than telephone communication is considered, contractors need to design, supply and install the same after taking BHEL/OWNER's approval for the same.

7.15 **POWER SUPPLY CABLE BETWEEN PDB TO LOCAL TELEPHONE EXCHANGE & PDB TO RTU/PLC FOR CENTRAL MONITORING**

Power supply cable between PDB to local TELEPHONE EXCHANGE & PDB to RTU for central monitoring shall be 16mm2, stranded Aluminum conductor, 3-core, aluminium wire armoured, PVC insulated and sheathed 1100V grade cable.

7.16 **CABLE DRUMS**

All cables to be supplied in wooden drums. Cable lengths in each cable drum shall be 500m (min.) where ever cable lengths are more than 500m.

7.17 **INSPECTION**

All cables along with manufacturer's test certificate as per IS standards shall be inspected by OWNER/BHEL at the vendor's shop before despatch. Minimum 15 days advance notice to be furnished by vendor for this purpose. In case of any doubt OWNER/BHEL may insist vendor to conduct the tests as per IS standards in presence of OWNER/BHEL at some third party reputed laboratory approved by OWNER/BHEL at no extra cost.

7.18 **CABLE IDENTIFICATION**

(a) For easy identification of cable, the oversheath of the cable should have yellow colour and "C.P. SYSTEM CABLES" should be printed using black colour at one meter interval throughout the length of the cable.

(b) All cables will be identified and labelled at terminal blocks of test station and transformer rectifier.

To this purpose, coloured heat shrinkable sleeves will be supplied for use as per following colour code key:

Structure to protect : Green

| | | |
|---|---|---|
| Structure to T/R U connection | : | Green |
| Groundbed to T/R U | : | Red |
| Casting Pipe | : | Blue |
| Plant side shorting connection | : | Green/Brown |
| Monitoring connection | : | Black |
| Reference cell | : | White |
| Half cell | : | Yellow |
| Structure | : | Yellow/Green |

## 8.0 SPECIFICATION FOR THERMID WELDING

8.01 Thermit welding shall be used for cable attachment to steel or iron with metallurgically limited usage. This process enables copper to be welded to steel or iron without the use of welding equipment. The temperature of the reaction is such that the surface layer of base metal undergoes a metallurgical change by both heat treatment and partial alloying with the copper content of the thermit charge. Because of the intense reaction, extreme care shall be taken in preparation and firing together with the correct choice of attached cable size, change and mould.

8.02 Both horizontal and vertical connections can be achieved in the following manner:

a. Clean off a 50X50mm area to clean, bright dry metal

b. Cut back 50mm of insulation from the cable; keep clean, dry and grease free.

c. Insert cable into slot in bottom of mould and place squarely on the cleaned area.

d. Break open the charge cartridge and upend the power into centre mould after placing metal retainer disc in bottom. Ensure that the fine starter powder which sometimes gets left behind in the container, is shaken onto the top.

e. Hold mould firmly onto pipe, shut the lid, and spark off with a flint gun.

f. Allow to cool for thirty seconds and remove mould.

g. Tap off slag and test adhesion when cool by a sharp sideways rap with a 2 lb hammer.

h. Carefully mould over the top using material compatible with the pipeline coating.

i. The thermit welded joints shall then be appropriately encapsulated by epoxy encapsulation as stated elsewhere.

8.03 The same parameters shall apply for the brazing method and type of charge necessary for welding to advice on the bond size and type of charge necessary for welding to be approved at site (by the inspecting authority/ BHEL).

8.04 Each thermit weld connection will basically require the following equipment :

a. Thermit weld mold.
b. Thermit weld metal.
c. Thermit weld cap
d. Steel disc.
e. Copper sleeve
f. Flint ignitor.
g. Mould packing.
h. Epoxy encapsulation kit.

## 9.00 SPECIFICATION FOR POWER DITRIBUTION BOARD

9.01 The Power distribution board (PDB) shall be plinth mounted outdoor type if TR Unit is installed out door and shall be installed at classified locations near a single or group of T/R Unit under a sun/rain shed. The enclosure of shall be classified type as per relevant IEC/NEC codes.

9.02 The Power distribution board (PDB) shall be composed of one no.3 phase, 4-wire 125A/63A, incoming MCCB and required nos. of 1 phase, 63A outgoing MCB. The incoming switch shall be 4-pole and outgoing switches shall be 2-pole. The MCCB and MCB shall be suitable for motor load application and shall be of BHEL/OWNER approved make.

9.03 4 Nos. of 25x5mm tinned copper busbar shall be used which should be taped by PVC tape of red, yellow and blue colours for identification of the three phases and black colour for neutral. Wiring inside PDB shall be done using 50mm2, 1-core, copper conductor, PVC insulated, unarmoured cable between TPN switch neutral and neutral bus whereas rest of the wiring shall be done by 25mm2, 1-core, copper conductor, PVC insulated unarmoured cable. All single core cables shall be used red, yellow and blue coloured for phase connections and black coloured for neutral connection.

9.04 All cables terminations shall be through Tinned copper cable lugs of matching cable size. All cable entries to the PDB panel shall be through Aluminium single compression glands. One gland for 3-phase, 4-core incoming cable connection shall be provided at left side bottom of the panel, required nos. of glands to be provided at right side bottom of the panel for outgoing cable connections for 63A PDB.

9.05 Size of the PDB Panel enclosure shall be adequate to accommodate all components easily and shall be made of 2 mm sheet steel. Two nos. hinged front shutters shall be provided. The shutters shall be screwed to the panel enclosure structure at the centre in addition it shall have lockable handles. Painting details of inside and outside surfaces of the PDB panel shall be as follows: After fabrications the entire enclosure shall be sand blasted to a SA2½ surface. An inorganic zinc primer shall then be sprayed to a total thickness of 3 mils. The finish coat shall be of polyamide cured epoxy in three coats to achieve total thickness of 15 mils. The finish coat shall be as per choice of OWNER/BHEL. CP SYSTEM SUB-CONTRACTOR shall prepare the layout/construction drawings and a prototype of PDB showing internal terminal arrangement and wiring arrangements and submit to OWNER/BHEL for approval before procurement/ installation of the same at site.

## 10.00 SPECIFICATION FOR ANODE, CATHODE & MONITORING JUNCTION BOXES

10.01 An anode lead junction box (AJB) will be provided to feed T/R Unit output current to anode strings. All anode cable tails from individual anodes shall be terminated into 'Anode Junction Box' and further connected to the anode bus. Anode cable coming from CP unit shall be connected to Anode bus. Anode junction box shall essentially contain anode bus, ammeter shunts of suitable rating and control resistance. All the cable tail from the individual anodes shall be connected to anode bus through current measuring shunts and variable resistance for control of anode current from each anode. At least 30% spare anode terminals complete with current measurement and control facilities and cable termination arrangement shall be provided. Depending on the size and configuration of anode- ground beds one or more anode -junction boxes shall be provided with the ground bed.

10.02 All the cable / lead wire entry to Anode Junction box shall be through double compression type water and weather proof type cable glands.

10.03 Anode junction Box shall be erected on a structure/ wall. A chain link fencing having door & locking arrangement shall be provided around the Anode junction box. Contractor shall furnish required engineering / construction drawing of the chain link fencing, Anode junction box for approval of BHEL/owner. The rate of the anode junction box should be inclusive of the foundation and chain link fencing pertaining to the anode junction box for which no separate payment shall be made. Flame proof anode junction boxes are to be used in hazardous areas inside pumping / boosting / terminal / T point / Intermediate stations whereas non-flame proof junction boxes shall be used in the remaining sites. Flameproof junction boxes shall not require any chain link fencing.

10.04 Where output of the CP power supply unit is connected to multiple pipelines/ structures a cathode junction box shall be supplied for connection of the negative drainage cable to the pipelines. The Junction box shall have a bus bar with an incoming circuit for connecting to the negative of CP power source and separate outgoing circuits for collection of negative drainage current from each of the pipelines. Terminals shall be of anti loosening type and shall be clearly identified.

10.05 Cathode junction Box for Cathodic protection shall be erected near transformer rectifier unit indoors. It shall have minimum one input (from TR unit) & minimum three outputs (for connecting to multiple structures). Each output circuit shall have variable resistor to control the required current manually.

10.06 Cathode junction box cum test station (CJB) will be required for bonding multiple structures at drain point as well as for measurement of potential for each structure. One CJB shall be provided for each structure. Drainage cable, reference cell cables and measurement cables from structure shall terminate in its respective cathode junction box cum test station. All the above-mentioned reference cell cables and measurement cables from each CJB shall be terminated into a single Monitoring junction box (MJB). Each CJB shall be connected to the negative terminal of the T/R unit through loop in loop out arrangement for return of drainage current from multiple structures to the T/R unit.

10.07 The enclosure of CJB shall be structure/wall mounted type. Shutter should be provided with closed cell neoprene sealing gaskets. The terminal board shall be of 10mm WT Phenolic laminated sheet on which all terminals and shunts are to be mounted. The terminals shall be made of cadmium plated steel or stainless steel stud nut and washers of M-10 size for termination of anode and cathode lead cables and M-4 size for termination of reference cell and measurement cables. All cable entries shall be through Aluminium double comprehension

glands. The external bolt, nuts and clamps to be used for mounting the junction box with back plate/structures shall be MS electro-galvanised or Cadmium plated.

10.08 Monitoring junction boxes (MJB) will be installed near the T/R Unit and shall be required for monitoring potentials of multiple structures. The enclosure for the MJB shall be of IP-55 construction made of 12SWG (2.67) W.T. sheet steel if installed indoor and classified type if installed outdoor. The enclosure shall be structure/wall mounted type having removable hinged front shutter with one handle and flush type locking arrangement. Shutter should be provided with closed cell neoprene sealing gaskets. The terminal board shall be of 8mm thick Phenolic laminated sheet on which all terminals shall be made of stainless steel stud, nut and double spring washers of M-4 size for reference cell/measurement cables. The terminal arrangement shall be such that bottom row is utilised for termination of measurement cables from each structure and upper rows one each is allotted for the reference cell cable termination from each structure, hence total number of rows shall be one more than the total number of structures. All cable entries shall be through Aluminum double compression glands. The external bolt, nuts and clamps to be used for mounting the junction box with back plate/structures shall be MS electro-galvanised or Cadmium, plated. Shutter should be provided with closed cell neoprene sealing gaskets.

10.09 The weather proof Junction Boxes shall be fabricated from cold rolled steel of minimum thickness 3.0 mm, suitable painted. They shall be suitable for use in a highly corrosive environment. Suitable canopy shall be provided for protection against rain.

10.10 For classified areas, Junction box enclosure shall be of type "Exd" protection Zone 2/Group IIA/IIB application, Temp. Class: T-6, as per IS 5571,5572,2148 & 8289 and relevant IEC/NEC standards. The cable glands shall be FLP double compression type made of Aluminium. Enclosure need to be certified by CMRI. The shutter of the junction box shall be screwed to the body of junction box by using MS electro galvanised/Cadmium plated nut, bolt and washers. The enclosure of the junction box shall be made of cast aluminium. One earthing terminal shall be provided for earthing the junction box.

10.11 It is essential that all cables should fit tight at cable glands. For this purpose vendor need to make openings for glands at junction box or cast/procure cable glands as per cable samples to be procured for C.P.System.

## 11.00 CENTRAL MONITORING & CONTROL SYSTEM

11.01 Computerized central monitoring and Control is required for the CP System. For this purpose, the T/R unit & permanent reference cells should be connected to Remote Terminal Unit (RTU) consisting of microprocessor based CPS controller with alphanumeric LCD display, memory, real time clock, keypad, battery backup and communication ports or equivalent PLC-SCADA system.

11.02 **Central monitoring & control system for UG Piping:** RTU/PLC system to be considered for central monitoring & control system for UG piping shall be capable to process minimum 12 analogue input signals (one each for TR Unit output current & voltage and rest for piping to soil potential measurements), 5 digital input signals, 4 analogue output signals and 4 digital output signals for monitoring performance of each TR Unit which shall be considered for plant piping protection.

11.03 **Central monitoring & control system for mounded bullet:** RTU/PLC system to be considered for central monitoring & control system for each mounded storage bullet shall be capable to process minimum 18 analogue input signals (one each for TR Unit output current & voltage and rest for bullet to soil potential measurements), 5 digital input signals, 4 analogue output signals and 4 digital output signals for monitoring performance of each TR Unit which shall be considered for mounded bullet protection.

11.04 **Central monitoring & control system for tank:** RTU/PLC system to be considered for central monitoring & control system for each tank shall be capable to process minimum 7 analogue input signals (one each for TR Unit output current & voltage and rest for tank to soil potential measurements), 5 digital input signals, 4 analogue output signals and 4 digital output signals for monitoring performance of each TR Unit which shall be considered for tank protection.

11.05 **Central monitoring & control system for UG Vessel:** RTU/PLC system to be considered for central monitoring & control system for each UG Vessel shall be capable to process minimum 6 analogue input signals (one each for TR Unit output current & voltage and rest for UG Vessel to soil potential measurements) , 5 digital input signals, 4 analogue output signals and 4 digital output signals for monitoring performance of each TR Unit which shall be considered for UG Vessel protection.

11.06 **Central monitoring & control system for multiple number of UG Vessel/Tank/Bullet/ UG piping:** RTU/PLC system shall be capable to process suitable number of analogue input signals in line with requirements given above for each unit , 5 digital input signals, 4 analogue output signals and 4 digital output signals for monitoring performance of each TR Unit when it shall be considered for multiple number of UG Vessel /Tank/Bullet/ UG piping protection.

11.07 In addition to this some digital and analog (input / output) signal should also be kept as spare capacity.

11.08 Single or multiple RTU/PLC system may be provided for monitoring and control of all TR unit output and monitoring of potential for Piping/Tank/Bullet/Vessel.

11.09 Thus considering few spares minimum analogue inputs, digital inputs, digital outputs and analogue outputs to be processed by each RTU/PLC system is to be designed by vendor for review / approval by BHEL/OWNER. The system should also have inbuilt mechanisms to reduce / nullify induced AC interference voltages.

11.10 The RTU/PLC Unit shall also be provided with 1 No. digital output for switching operation for TR Unit. This output shall be used to turn the rectifier OFF and ON for depolarized and instant "OFF" readings. The rectifier shall have in-built facility to accept these signals and interrupt its output

supply. The digital input/ output channels shall be optically isolated. The RTU/PLC should include a GPS based time synchronization unit for measurement of true OFF potential readings.

11.11 Further, RTU/PLC shall be provided with 1 analogue output that can be used for controlling the various modes of the TR unit for remote control.

11.12 The RTU/PLC should be capable of generating alarms when the parameter limits are violated and it should communicate the alarm data in real time and should not wait for the monitoring software query.

11.13 All CP System parameters shall be monitored and controlled from central control room using suitable soft ware. The communication link between the RTU/PLC and Central monitoring and Control station should be cost effective GSM based wireless technology RS485 / telephone / fibreoptic / ethernet communication whichever is decided by BHEL/ OWNER as the communication network. CP System sub-contractor should design, procure and install the requisite communication system and the cables required for this purpose.

11.14 Central monitoring and Control station computer to be provided by the CP System subcontractor shall consist of standalone computer suitable for CP monitoring application with following minimum specifications:

- Intel Core 2 .Duo processor
- Genuine Windows Vista/XP operating system with License
- 2GB DDR2 NECC Dual Channel SDRAM at 667 MHz
- 320 GB SATA II HDD AT 7200 rpm
- 24in Flat Panel LCD Colour Monitor
- CD Rom
- Intel Integrated 10/ 100 Ethernet Network Card
- 1 Serial, 1 Parallel, 6 USB Port
- MS SQL Server 2000
- A3 Laser jet printer (HP make)
- Inbuilt UPS system which can operate up to 30 minutes on full load in case of power failure
- Other standard accessories

11.15 CP System sub-contractor shall also provide necessary Software for Remote Monitoring & Control as well as for printing of CP reports. The software should be compatible to Windows format and MS SQL Server or Oracle database (10g) with proper License should be used.

11.16 **REMOTE MONITORING & CONTROLLING CENTRAL CONTROL SYSTEM:**

(a) The software and hardware for the proposed SCADA system shall have a proven track record of minimum three years of successful operation in the field of CP monitoring and shall be procured from BHEL/ OWNER approved supplier.

(b) The Remote Monitoring & Control Panel (RMCP) shall have a Data Acquisition and Control Hardware operating in Real Time on PC having minimum specification mentioned in item 11.14. A Front End Processor (FEP) is also required that will be responsible for managing the entire communication traffic between the RMCP and RTU/PLC. The unit shall maintain the data flow even in the event that the RMCP computer is not operative.

(c) The T/R Unit Output DC Voltage, DC Current, Reference Electrode Voltages, Alarms are to be extended to RMCP Panel through RTU/PLC units by any of the cost effective communication network such as GSM based wireless technology / RS485 / telephone / fibreoptic / ethernet communication whichever is decided by BHEL/ OWNER as the

communication network. for data downloading and remote monitoring & control from master control room.

(d) Each T/R Unit shall accept set point signals for DC Voltage and DC Current from Remote Monitoring & Controlling Panel and accordingly shall control its output from 0 to 100%.

11.17 **REMOTE MONITORING SYSTEM - SOFTWARE:**

(a) The Remote Monitoring and Control System shall monitor and control all process parameters of Cathodic protection system.

(b) The Monitoring software shall be user friendly, Windows Vista / XP compatible, and should allow easy data transfer to other windows based applications or custom applications having ODBC compliant database. The Software shall have built-in graphic package to display graphical representation of the process on-screen with embedded buttons for switching ON/ OFF TR units.

(c) Data security should be ensured through three different types of Access Levels namely Expert, Supervisory and Operator. It should have provisions to accommodate future need of addition of new TRs or storage Vessel & piping as may be required from time to time.

(d) The software shall be compatible for interfacing of the available CP System monitoring data on LAN at 10 No. nodes for management information system for access and reporting for the management.

(e) The monitoring software should be capable of generating Email, SMS based notification & visual alarm, as and when signals go outside programmed set points and during RTU/PLC failure and TR Unit input power failure. It should generate customized reports as decided by BHEL/ OWNER. The software shall allow configuration of mobile numbers of the OWNERS employees who are responsible for maintenance and in the event of any malfunctioning of the CP system, the software shall send an SMS to the concerned person to enable him to take the corrective action to ensure that system is restored to normal at the earliest.

11.18 The software should generate reports, which can be viewed as well as printed as listed below:

i) A monthly report showing readings from every system. The reports shall highlight readings outside limits and systems, which did not call.

ii) A single page report yearly report for each remote monitoring. This shall be used to show the monthly readings for each site.

iii) At any time, an exception report shall be available. This report shall show the Remote Monitoring system, which called because of abnormal conditions, and the systems that should have called but did not.

iv) A report shall be generated at 1 second logging interval by normal report generator so special marks for proper interruption cycle operation.

v) Alarm Reports: This particular report shall give all information about the alarms, which occurred in any abnormal conditions.

vi) Report information shall be compatible with standard spread sheet programs.

vii) All above reports of different type should be available in graphical presentation, on screen and printer.

viii) Scaling and calibration of analogue channel can be done by use of SCANET Editor Software.

11.19 **DATA BASE SECURITY:**

Database shall be in the form of SQL Server. The version of SQL shall be SQL 2000. Following security features shall be provided in the server software:

(i) Roles

- Fixed Server Roles
- Fixed Database Roles
- User-Defined Roles

- Application Roles

(ii) Granting and Denying Permissions to Users and Roles
(iii) Ownership Chains
(iv) Cross-database ownership chaining
(v) Use of Security Identifiers
(vi) Object Level Security Implementation
(vii) Several levels of auditing of both events and states
(viii) Support for SSL implementation
(ix) Remote Administration - Secured Terminal Services

11.20 Over and above the above features, the software supplied by the vendor shall have following essential futures to access the database.

- Group Creation
- User Creation
- User Group Allocation
- Password Aging Period
- Maximum Failure Attempts
- Failure Notifications
- Enable - Disable Account Status
- Template Based security setttings
- e-Signature
- Audit Trail
- Access Level Based on the operation
- Access Security Based on Object / User
- Roles and Reasons
- Audit Trail Query Builder
- Password Masking
- Automatic Application Lock out

12.00 Site Survey

12.01 Resistivity Measurement & Calculations:

(a) Wenner's 4 pin method shall be used to carry out soil resistivity measurement.

(b) Care should be taken that measurements are not influenced by presence of overhead lines over earth currents in the area. Soil resistivity measurements shall be made at least 15M away from underground metallic structures if any along ROW or anode ground bed locations.

(c) The depth of insertion of each pin while measuring resistivity shall be 1/ 20th of the pin spacing.

(d) Soil resistivity shall be computed by the following relation :

$$P = 2\pi AR$$

Where

P - Average Resistivity of soil depth of 'a' metres in ohm-metron.
A - Spacing between two consecutive pins in metres.
R -Resistance in ohms displayed by Megger.

12.02 Soil Resistivity Measurement along ROW/ Piping Corridor

(a) Generally the observations shall be made enclosing the soils immediately surroundings the pipeline route between the central electrodes where right of way has been cleared.

(b) At places where right of way has not yet been cleared, measurements shall be made right over the defined locations to account for cutting filling also. All measurements shall be taken at right angles to ROW unless otherwise asked for by Project Engineer at site.

(c) Each spot shall be investigated so as to obtain average soil resistivity up to the following depths : 0.5, 1.5, 3.0 & 6.0 Metres

(d) All the river creek beds and other major water crossing/ marshy lands, swamps should be so chosen for resistivity observations so as to obtain resistivity of the soil at river/ creek beds or marsh lands.

12.03 Soil Resistivity Measurement on Anode Ground Bed

(a) After completion of soil resistivity survey along ROW and preparation of soil resistivity plot (resistivity contour), based on the resistivity values, two (2) anode grounded plots shall be selected in consultation with and as directed by the Project Engineer for each proposed CP station.

(b) After marking of the various anode ground bed plots, each plot shall be subdivided into three subplots, each of which shall then be investigated for resistivity measurement at the following pin spacings: 1, 2, 3, 4, 5, 6 & 10 metre.

Thus each anode ground subplot shall have a set of seven observations at an average with a view to determine the nature of soil level and soil stratification and also possible water table depth.

12.04 Soil Resistivity Survey Instrument :

Nomenclature : Battery Powered soild state 500 volts 5 terminal earth megger.

Range : 0-01, 0-1, 0-10, 0-100 ohms.

Accuracy : With +/- 1% of maximum valve of selected range.

Sensitivity : Two position switch for low and high balance sensitivity shall be prepared.

Instrument should incorporate design features for max. A.C. & D.C. ground current rejections.

Temp. Range : 0-60$^0$C fully temperature stabilised.

Circuity :Solid state suitable for rough and rugged use.
Suitable for 2, 3 & 4 pin application

12.05 CALIBRATION OF SOIL RESISTIVITY METER

Soil resistivity meter should be calibrated at a reputed laboratory before use. The calibration certificate must be furnished to ENGINEER-IN-CHARGE for approval of the meter before use of the same for soil resistivity test at site.

12.06 REPORT PREPARATION

All soil resistivity readings shall be typed and presented in a tabular form giving coordinates and other location reference of each test locations & depth of each reading. The soil resistivity is to be expressed in ohm-cm. Six copies each of soil resistivity report to be furnished to OWNER/BHEL for record.

# TECHNICAL SPECIFICATION FOR

# LIGHTING SYSTEM (SUPPLY)

# SPECIFICATION NO. PE-SS-999-558-E001

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1.0 SCOPE

1.1 GENERAL

a) This specification covers the design, manufacture, assembly, testing and inspection at vendor's / sub-vendor's works, packing and despatch to site of lighting system and low voltage power services equipment.

b) The "design" shall broadly cover the selection of components, materials, sizes etc. for the equipment of supply in vendor's scope. Complete responsibility of establishing the correctness of equipment design rests with the vendor.

c) It is not the intent to specify here all the details of design and manufacture. However, the equipment shall conform in all respects to high standards of design, engineering and workmanship, and shall be capable of performing the required duties in a manner acceptable to Engineer / purchaser, who will interpret the meaning of drawings and specifications and shall be entitled to reject any work or material, which in his judgement is not in full accordance herewith.

d) Make of all equipment and components shall be to the approval of purchaser.

1.2 ENGINEERING

a) Specification also covers the aspect of System Design Engineering generally termed as "Engineering". Engineering shall be the responsibility of vendor if indicated in Data Sheet A. Engineering inputs shall be furnished by the purchaser to the successful bidder.

b) Engineering, if covered in vendor's scope, shall include design of complete lighting system for indoor and outdoor areas. The aspect of engineering covers preparation of electrical distribution and control schemes, quantity estimation, luminaire layout drawings, conduit layout drawings, wiring schemes upto luminaires, cable schedules and all associated design work not specifically mentioned in the specification.

c) Complete engineering shall be as per the guidelines of purchaser and shall be subject to the purchaser's approval.

1.3 Although erection and commissioning is not included in vendor's scope, the vendor shall still not be absolved of his responsibility of establishing the correctness of engineering and equipment at site.

1.4 The requirements given in enclosed drawings, documents and Data Sheet A form part of this specification and shall be fully complied with. In case any discrepancy arises, the requirements of Data Sheet A shall prevail.

1.5 In case of any deviation, the bidder shall indicate the same clause-by-clause in the enclosed "Schedule of Deviations". In the absence of duly filled schedules it will be construed that the bid conforms strictly to the specification.

2.0 CODES & STANDARDS

2.1 Unless specified otherwise, the latest revisions of standards, codes and other applicable statutory rules and regulations specified in Annexure-I are applicable and shall be referred to.

3.0 LIGHTING SYSTEM DESCRIPTION (CONCEPTUAL VIEW)

3.1 All areas of plant (indoor and outdoor) shall be provided with suitable lighting arrangement to meet the functional requirements by use of various types of luminaires so as to achieve the desired quality and level of illumination.

3.2 Lighting system shall also cover the low voltage power services such as power receptacles and single phase feeders.

3.3 Lighting system shall be fed through various power sources such as AC Normal, AC Emergency and DC Normal and DC Emergency supply to achieve the desired reliability.

3.4 Power tapped from various sources shall be distributed through lighting distribution boards and lighting panels upto the various luminaires and power outlet sockets / feeders.

4.0 SYSTEM DESIGN ENGINEERING

Engineering shall be done by the vendor only during the contract engineering stage if the same is covered in his scope. During tender stage, bidder shall make his quotation on the basis of BOQ furnished by the purchaser with the tender document.

4.1 ENGINEERING INPUTS : Complete engineering shall be done by the vendor on the basis of documents listed below. The engineering inputs shall be furnished by purchaser.

4.1.1 Indoor Areas

a) Room dimensions (details as covered in various layout drawings)

b) Lighting System Design Data (LSDD) covering typical values for various types of indoor areas, indicating :

i. Required average illumination level

ii. Reflection factors for walls, ceiling and floor

iii. Maintenance factor

iv. Type of luminaire

v. Mounting height of luminaire

vi. Height of working plane

c) AC Emergency lighting requirements

d) DC lighting requirements

e) Requirement of sockets

f) Requirement of exhaust fans and fan points

4.1.2 Outdoor Areas

a) Area geometry (details as covered in various layout drawings)

b) Lighting System Design Data (LSDD) covering typical values for various types of outdoor areas, indicating :

i. Average illumination level

ii. Type of luminaire

iii. Preferred pole heights / mounting height

iv. AC Emergency lighting requirement

v. DC lighting requirements

c) Requirement of sockets

4.1.3 Other inputs

a) Suggestive location of LDBs

b) Suggestive power distribution scheme (SLDs)

c) Control schemes

d) Single phase feeder details

e) No. of sockets / criteria for computation of no. of sockets / location of sockets etc.

4.2 DESIGN CRITERIA :

4.2.1 General Requirements of Design

4.2.1.1 Lighting system shall be provided to ensure adequate visual performance, safety and amenity and shall be free from excessive glare and flicker from discharge lamps. Particular attention hall be paid to ensure that level of illumination is satisfactory in all respects including viewing of all instruments, alarms, annunciations and indicating lamps.

4.2.1.2 Complete system design shall be done on the basis of inputs provided by the purchaser and in line with the laid down criteria.

4.2.1.3 Requirements of sockets shall be as per the criteria / number of sockets given by the purchaser during detailed engineering stage.

4.2.2 Sources of Power Supply

4.2.2.1 The lighting system shall be provided with the power from the following sources :

a) AC - normal
b) AC - emergency
c) DC - normal
d) DC - emergency

4.2.2.2 AC emergency supply is made available from purchaser's AC emergency Board. This board in turn has two incomers; one from the normal supply source i.e. station supply and other from emergency source i.e. diesel generator supply which is available upon failure of normal supply.

4.2.2.3 Arrangement and distribution of power shall depend upon the functional requirements of areas and therefore supply from all types of power sources shall not be made available to all areas.

4.2.2.4 Power from the purchaser's supply sources shall be brought upto the Lighting Distribution Boards (LDBs) of various types. Each LDB shall in turn feed power to various Lighting Panels (LPs).

4.2.2.5 Power to the AC normal luminaires shall be available through AC normal LDB & LP. Power to the AC emergency luminaires shall be available through AC emergency LDB & AC emergency LP. Power to DC normal luminaires shall be available through DC normal LP, which in turn shall be fed directly from DCDB / Sub-DCDB. However power to the DC emergency luminaires shall be available through DC emergency LDB & LP.

4.2.2.6 Complete power distribution system shall be designed keeping following criteria in view :

a) Simplicity
b) Controlled voltage drop
c) Cost effectiveness

4.2.2.7 Area Classification

The detailed requirements of luminaires depending upon type of power supply source for each area shall be as per the details to be furnished by purchaser during contract engineering. Area classification on the basis of type of luminaires to be provided shall be as under :

a) Area A : AC normal, AC emergency, DC normal and DC emergency luminaires.

b) Area B : AC normal, AC emergency and DC emergency luminaires.

c) Area C : AC Normal and AC emergency luminaires

d) Area D : AC Normal luminaires.

e) Area E : AC Normal luminaires and portable emergency lighting.

4.2.3 Lighting Philosophy

4.2.3.1 In the normal course, for areas A, B and C, all the AC luminaires shall remain switched on through two different sources of supply i.e. AC normal and AC emergency. DC normal luminaires shall also remain switched on for areas A.

4.2.3.2 In case of failure of AC normal supply the following shall apply :

a) Areas A shall remain lit through DC normal luminaires.

b) Areas A & B shall automatically get illuminated from DC emergency luminaires. This supply shall be available till AC emergency power is restored and stabilised.

c) Areas C shall remain temporarily dark till the AC emergency supply is restored from diesel generator set.

d) Areas D shall remain dark till the AC normal supply is restored.

4.2.3.3 As soon as the AC emergency supply is restored, the AC emergency luminaires shall come into operation. DC emergency luminaires shall have time delayed switching off after a specified duration to ensure that the AC emergency supply is stabilised.

4.2.3.4 When the AC normal supply is restored, the following shall apply :

a) DC emergency luminaires shall be switched off immediately, if they are switched on.

b) AC emergency luminaires shall switch off momentarily when AC emergency board incoming supply is changed over from diesel generator to the AC normal supply.

4.2.3.5 Street Lighting / Flood Lighting

Street lights / flood lights will be fed from Street Lighting Panel (SLP). The number of street lights / flood lights shall be grouped in such a way that they will be fed from the nearest SLP available. Street lights shall have provision of automatic switching ON and OFF in any one of the following modes and as per the purchaser's scheme:

a) Manual

b) Automatic through 00 - 24 hrs time switch

c) Automatic through combination of 00 - 24 hrs time switch and a remote sensing device for monitoring external illumination level.

Each SLP shall be provided with a time switch and a remote light sensing device.

4.2.4 Number of Luminaires

4.2.4.1 All calculations shall be done as per the input data covered under "Engineering Inputs".

4.2.4.2 Total AC luminaires

Indoor Areas : Total number of AC luminaires shall be calculated by the Lumen Method for average light intensity.

Outdoor Areas : Total number of AC luminaires for outdoor areas shall be calculated on the basis of point to point method by an established computer program. Optimisation criteria shall form part of street lighting calculations.

4.2.4.3 AC Normal & AC Emergency Luminaires

Area A, B & C : A specified percentage of total AC luminaires shall be considered as AC emergency luminaires. The percentage shall be as specified in Data Sheet A. The remaining luminaires shall be AC normal luminaires.

Area D : All the luminaires shall be considered as AC normal luminaires.

4.2.4.4 DC Normal & DC Emergency Luminaires

Where specified, DC normal luminaires shall be provided for areas A. The vendor shall consider the quantities of DC emergency luminaires as suggested by purchaser for Area A & B types. Unless otherwise indicated, DC luminaires are for the functional purpose only and no design calculations are to be done. Vendor shall ensure that adequate number of DC emergency lights are provided for essential operations of the plant and shall suggest the changes in purchaser's DC lighting stipulations, if required.

4.2.4.5 Independent DC Luminaires

In areas comparatively remote from power house building, emergency illumination, where required will be provided by rechargeable emergency units. Such units will be installed at suitable location without plug and socket and will be permanently connected to normal AC supply. These emergency units will automatically light-up upon failure of normal AC supply.

4.2.5 Layout Considerations

4.2.5.1 General Layout Considerations

a) Layout of equipment such as LDBs and LPs shall be on the basis of following criteria :

   i. Ease of operation

   ii. Maintainability

   iii. Aesthetics

b) Luminaires shall be located to meet the functional requirements of the area. Aesthetics shall form part of layout considerations.

c) Due considerations shall be given to the mounting arrangement depending upon location and type of area.

d) While preparing lighting system layout drawings for air conditioned control rooms/areas having false ceilings, the vendor shall be required to coordinate with the Air Conditioning / Ventilation Duct layout and false ceiling layout drawings to avoid fouling / interference.

4.2.5.2 Conduit System

a) Unless indicated otherwise, conduits shall originate from respective lighting panels and shall continue upto the luminaires for all indoor areas.

b) Conduits shall run in straight runs, parallel to building columns, walls etc. as far as practicable.

c) Unnecessary bends and crossings shall be avoided.

d) In the corrosive environment, conduit installations shall be made with corrosion proof conduits. Such requirements shall be clearly indicated while preparing BOQ.

4.2.5.3 Wiring

a) Each circuit starting from LP shall be taken in a separate conduit.

b) Receptacle wiring conduits shall be distinct from lighting conduits.

c) All wiring shall be of PVC insulated copper conductors. The following conductor sizes shall be applicable :

i. Luminaires 2.5 sq.mm.

ii. 5A plug and socket 2.5 sq.mm.

iii. 5A-15A plug and socket 4.0 sq.mm.

d) Wiring shall be designed for the uniformly distributed spread of luminaires on each phase i.e. R, Y & B. Distribution of luminaires on these phases shall be such that there is generally uniform light intensity in the event of failure of one or two phases.

e) Luminaires located in the offices, stores, laboratories, toilets etc. shall be individually or group controlled.

4.2.5.4 Cabling

a) Cables shall be considered wherever it is not desirable to run the insulated wires due to long runs or for any other valid reason.

b) Cable Schedule shall be prepared for all cable connections.

4.3 ENGINEERING OUTPUTS :

Vendor shall prepare and submit following documents and drawings for purchaser's approval :

a) Lighting calculations for indoor areas covering details such as room dimensions (length, width, height), illumination level, reflection factors (walls, ceiling, floor), maintenance factor, type of luminaire, mounting height of luminaire, room index, coefficient of utilisation, no. of luminaires (AC Normal & AC Emergency), lumen output of each luminaire, reference drawings and remarks.

b) Lighting calculations for outdoor areas covering average illumination level, type of luminaire, chart for illumination level at various points in the area; location (coordinates), number and height of poles; type, number (normal + emergency) and orientation of luminaires etc. Calculated values of average and minimum illumination level as obtained through computer package shall also be furnished. Dot density plots for lux level shall be furnished if available in the computer package.

c) Single line diagrams of power distribution upto Lighting Panels. Separate drawing for complete lighting distribution shall also be prepared by vendor.

d) Control schemes for DC and street lighting.

e) Loads on each phase of LP and LDB with consideration of diversity factor for sockets.

f) Layout drawings for each indoor area indicating location of luminaires, sockets, fan points, exhaust fans, LDBs and LPs. Details of type of luminaires, source of power supply (AC Normal, AC Emergency, DC Normal and DC Emergency). Bill of Material shall also be covered which shall include unit wise requirements of luminaires and other items.

g) Layout drawings for each outdoor area indicating location of poles / towers, orientation of luminaires, sockets and LPs. Details of pole height / mounting height, type of luminaires, source of power supply (AC Normal, AC Emergency, DC Normal and DC Emergency). Bill of Material shall also be covered for various types of luminaires.

h) Conduit layout drawings with wiring and load distribution details as superimposed on the area layout drawings indicated above. Drawings shall include Bill of Material for conduits, wires etc.

i) Wiring and load distribution details for outdoor areas.

j) Master Bill of Material (to be submitted at regular intervals).

## 5.0 LUMINAIRES, ACCESSORIES AND LAMPS

### 5.1 GENERAL REQUIREMENTS OF LUMINAIRES

5.1.1 All luminaires and accessories shall be designed for continuous operation and shall be suitable for the system design data given in Data Sheet A.

5.1.2 Luminaires shall be complete with accessories mounted inside the luminaire assembly. Lamps shall be supplied separately as per BOQ.

5.1.3 All luminaires and accessories shall be suitable for operation in the atmospheric conditions prevailing at site.

5.1.4 Power factor for fluorescent lamp luminaires shall be 0.9 or more and that for HPMV / HPSV luminaires shall be 0.85 or more. Power factor correction capacitors shall be provided for this purpose.

5.1.5 Luminaires shall be designed for minimum glare. No bright spots should appear from the lamp or from the reflectors.

5.1.6 All accessories shall be wired upto a terminal block or a separate weather proof metallic terminal box suitable for 2.5 sq. mm. copper wire termination.

5.1.7 All internal wiring shall be of PVC or silicon rubber insulation, capable of withstanding the maximum temperature to which it will be subjected under specified service conditions without deterioration.

5.1.8 All luminaires and accessories including the breathing holes shall be vermin proof.

5.1.9 Surface Treatment:

a) All surfaces after manufacture shall be thoroughly cleaned and degreased. Pre-treatment of surfaces shall be as per the applicable standard. Pretreated surfaces shall be free from rust, sharp edges, scales and burrs.

b) Finish of surfaces shall be non-porous, smooth and unfaded.

5.1.10 All metal parts of the luminaires shall be bonded and connected to the earthing terminal. Earthing terminal shall be suitable for connecting 16 SWG GI wire.

5.1.11 Flood lights shall be provided with base frame / base plate for mounting on structural steel members / wall.

5.1.12 All weather proof luminaires shall have the control gear housed in a weather proof enclosure with necessary gaskets, mounting bracket, locking screws etc.

5.2 LUMINAIRE TYPES

General requirements depending upon type of luminaire are listed below. Specific requirements of each luminaire are indicated in “Luminaire Details” enclosed as Annexure-II.

5.2.1 Channel Mounted Luminaires (Fluorescent Luminaires)

5.2.1.1 Channel mounting luminaires, except the special purpose luminaires, shall have CRCA sheet steel base plate / rail / channel / box / side panels / housing as per “Luminaire Details”. Sheet shall be completely stove enameled unless mentioned vitreous enameled in “Luminaire Details”. Colour of enamel shall be grey on all non-reflecting surfaces and white on reflecting surfaces.

5.2.1.2 Twin fluorescent luminaires shall be wired in lead-lag circuit to minimise stroboscopic effect.

5.2.1.3 Luminaires suitable for surface mounting shall also be suitable for pendant mounting. Knockouts of 20mm ET conduit fixation shall be provided for this purpose.

5.2.1.4 Decorative Fluorescent Luminaires

a) Decorative luminaires shall be provided with one of the following as per "Luminaire Details" :

i. Perspex acrylic diffuser.

ii. High purity, anodised aluminium, mirror optic reflectors with anodised aluminium matt finish transverse fins to control glare.

iii. Opal polystyrene louvers and sheet steel side panels.

iv. Vertical metallic louvers finished in stove enamelled white and with sheet steel side panels.

b) End plates of decorative luminaires shall be of high impact polystyrene or sheet metal finished in black colour.

c) Diffusers and louvers for the fluorescent lamps shall be made of high impact polystyrene sheet and shall have no yellowing property over a prolonged period of use.

d) Recessed type decorative luminaires shall be suitable for mounting with gypsum boards / luxalon / plaster of paris false ceiling of standard size as per Data Sheet A and "Luminaire Details".

5.2.1.5 Industrial Fluorescent Luminaires (General Purpose)

a) Industrial luminaires shall be provided with vitreous enameling, if specified in "Luminaire Details".

b) Additional reflectors, wherever provided, shall be easily removable type.

5.2.1.6 Industrial Fluorescent Luminaires (Special Purpose)

a) Luminaires for chemical vapour (acidic / alkaline) laden environment shall be of cast aluminium controlgear box and end boxes. Controlgear housing shall have detachable, one piece neoprene gasket cover to make it weather proof. Design shall be suitable for chemically charged environment.

b) Luminaires for corrosive and dust laden environment shall be made of tray type sheet steel housing and transparent acrylic visor supported by a galvanised sheet steel frame, fitted to the housing with gasket all around. Cable entry shall be from the side of luminaire. Luminaire shall be totally dust and vapour proof.

c) Luminaires for highly corrosive environment shall have fiberglass reinforced polyester controlgear housing, CRCA sheet steel controlgear tray with a stove enamelled white reflector. A clear acrylic cover of dish shape, secured to canopy by stainless steel toggle and neoprene gasket lining, shall be provided at the bottom.

d) Luminaires for drip proof environment such as street lighting fluorescent luminaire shall have sheet aluminium canopy, a detachable reflector-cum-controlgear housing, clear ribbed acrylic cover held in aluminium frame. Luminaire shall have the degree of protection IP : 54 unless mentioned otherwise in Data Sheet A. Luminaire shall be suitable for side entry mounting with the pole bracket arm.

5.2.2 Bay Type Luminaires

5.2.2.1 Luminaires shall be designed for following indoor applications:

a) High bay above 8 metres

b) Medium bay 6 - 8 metres

c) Low bay below 6 metres

5.2.2.2 Luminaires shall have top mounted, cast aluminium controlgear housing. Housing shall have cooling fins and canopy for easy access to the components. Canopy shall be hinged at one end and wing screw bolted at the other end.

5.2.2.3 Controlgear shall be connected to the detachable lamp housing at the bottom such that heat dissipation is proper and distributed.

5.2.2.4 Lamp housing-cum-reflector shall be made from spun aluminium, electrochemically brightened and anodised.

5.2.2.5 Lamp housing for the dust laden environment shall be totally enclosed type. A clear toughened glass cover shall be attached to the lamp housing with an aluminium frame and neoprene gasket. Luminaire shall be provided with a safety chain for toughened glass.

5.2.2.6 Mounting arrangement shall consist of MS brackets with an anti-vibration eye-bolt.

5.2.2.7 Side mounted controlgear box shall be provided for low bay luminaires, if mentioned in “Luminaire Details”.

5.2.3 Well Glass Luminaires

5.2.3.1 Well glass luminaires shall be suitable for dust and vapour laden environment.

5.2.3.2 Luminaires shall be provided with a die-cast aluminium canopy and heat resistant well glass, fitted with a ring type gasket.

5.2.3.3 All well glass luminaires shall be provided with vitreous enamelled reflector.

5.2.3.4 Zinc plated MS wire guard shall be provided for protection of well glass.

5.2.3.5 Separate side mounted and top connected controlgear box shall be provided for use with HPMV & HPSV lamps. Separate, non-integral controlgear box is also acceptable.

5.2.3.6 Integral controlgear box, where applicable, shall be of die cast aluminium material with one piece neoprene gasket between the box and its cover to make it dust and vapour proof.

5.2.3.7 Luminaires shall be conduit mounted type for incandescent lamps and surface mounting type for HPMV & HPSV lamps.

5.2.3.8 Flame Proof Well Glass Luminaires

a) Housing material shall be cast aluminium alloy LM6. Housing outer surface shall be provided with cooling fins.

b) Flame proof luminaires shall be provided with heavy toughened well glass cemented in a retaining ring.

c) Zinc-coated / chrome-plated MS chain connected to the main body and glass retaining ring shall be provided.

d) A detachable terminal box at the top shall be provided.

e) Neoprene gaskets, where needed, shall be provided for weather proof construction and indoor and outdoor application.

g) Two cable entries of 20mm ET conduit shall be provided with one flame proof plug.

h) Mounting shall be through eye-bolt or MS galvanised strap as per Data Sheet A.

i) Luminaires shall be suitable for the hazardous areas as classified in Data Sheet A. Design of flame proof luminaire shall be supported by the type test report for flame proofness from a government or government approved independent laboratory.

5.2.4 Street Lighting Luminaires (Other than Fluorescent Luminaire)

5.2.4.1 These luminaires shall be suitable for street lighting and general purpose outdoor area lighting.

5.2.4.2 Luminaire housing shall be one piece cast aluminium alloy to accommodate lamp housing and controlgear in two different compartments for lamp wattage upto 125 Watts. For lamp wattage above 125 Watts, controlgear housing shall be of cast aluminium alloy whereas lamp housing shall be of deep drawn aluminium.

5.2.4.3 Inside finish of the lamp housing shall be stove enamelled white. Optical control shall be provided with two high purity, electro brightened and anodised side reflectors.

5.2.4.4 Clear acrylic bowl fitted with a rubber gasket and easily removable type shall be secured to the lamp housing.

5.2.4.5 Provision shall be made for adjustment of lamp location for proper focussing.

5.2.4.6 Luminaires shall be suitable for mounting with pole bracket arm.

5.2.5 Flood Lighting Luminaires

5.2.5.1 Flood light lamp housing and reflector shall be separate from controlgear box. Requirements of controlgear box are specified elsewhere.

5.2.5.2 Lamp reflectors shall be of high purity spun aluminium attached to the cast aluminium lamp holder housing at the rear. Lamp holder housing shall be provided with cooling fins.

5.2.5.3 Reflector shall be closed from the front by heat resistant toughened glass and synthetic “S” type weather proof gasket.

5.2.5.4 Luminaire shall be provided with special lamp centering and focussing device ensuring good beam control.

5.2.5.5 MS mounting bracket shall allow fixation of the flood light in any position in a horizontal plane and the flood light can be locked in at any set angle in the vertical plane. Cast iron base and / or two protector scales shall also be provided where specified in “Luminaire Details”

5.2.5.6 Design shall permit replacement of lamp from the rear without disturbing the previously set aiming angles. Special guide pins shall also be provided for protecting the lamps from damage while replacing.

5.2.5.7 Halogen Flood Lighting Luminaire

a) Luminaires shall be compact in design with aluminium alloy housing and three piece highly polished and anodised reflector assembly.

b) Toughened glass panel in the front shall be provided with silicon gaskets.

c) Lamp replacement from the front is also acceptable.

5.2.6 Post Top Lanterns

5.2.6.1 Luminaire shall comprise of a spun aluminium canopy, opal acrylic diffuser and a cast aluminium spigot.

5.2.6.2 Controlgear shall be integral type and shall be housed in the spigot.

5.2.6.3 Luminaire shall be supplied without mounting pole.

5.2.7 Bulk Head Luminaires

5.2.7.1 Bulk Head (Flame Proof)

a) Bulk head luminaires shall be used for the locations where explosion or fire hazard exists.

b) Luminaire shall be made of cast iron housing with integral terminal box.

c) Front of the luminaire shall be covered with flat toughened glass cemented into a retaining ring.

d) Lamp replacement shall be from the front.

e) Controlgear box for HPMV lamps shall be integral to the housing.

f) MS fixing straps shall be provided for mounting.

g) Luminaire shall be stove enameled grey outside and white inside.

h) Terminal box shall be provided with 20 mm ET conduit entry.

i) Complete luminaire shall be suitable for the hazardous area as classified in Data Sheet A. Type test certificate for flame proofness test from government or government approved independent laboratory shall be submitted.

5.2.7.2 Bulk Head (Weather Proof)

a) Luminaire shall be suitable for indoor / outdoor applications having weather proof features.

b) The luminaire shall comprise of die cast aluminium alloy body of dish shape.

c) Luminaire shall have a heat resistant prismatic cover held in a weather proof gasket.

d) Luminaire shall be stove enamelled grey outside and white inside.

e) Glass cover shall have a galvanised wire protection.

f) Luminaire shall be provided with locking arrangement with Allen key to prevent pilferage.

g) Luminaire shall be suitable for use with incandescent lamp upto 100W.

h) Provision for 20 mm ET conduit entry shall be provided at the bottom.

5.2.8 Emergency Lighting Luminaires

5.2.8.1 The luminaire shall be automatic, 40W incandescent bulb unit having in-built battery.

5.2.8.2 Battery shall have integral charging unit. Battery rating shall be 4 hours i.e. during AC supply failure emergency lighting shall operate for 4 hours without recharging.

5.2.8.3 Charger shall be suitable for operation as per system design data.

5.2.8.4 Battery shall be maintenance free sealed lead-acid type unless mentioned otherwise in Data Sheet A as Ni-Cd battery.

5.2.8.5 The battery enclosure shall be suitably painted and ventilated for the performance with sealed lead acid battery, as applicable.

5.3 CONTROLGEAR BOX (NON-INTEGRAL TYPE)

5.3.1 Non-integral controlgear boxes shall be of 1.6 mm thick CRCA sheet steel construction unless specified otherwise in Data Sheet A.

5.3.2 Boxes shall have weatherproof construction and shall be provided with one piece neoprene gasket. Unless mentioned otherwise in Data Sheet A, degree of protection shall be IP:55.

5.3.3 Boxes shall be provided with HRC fuse mounted on a removable tray. Boxes shall be provided with all necessary components having a neat layout arrangement such that it is possible to test, inspect or replace any component without difficulty.

5.3.4 Boxes shall be suitable for mounting on structures, walls and columns.

5.3.5 Unless mentioned otherwise in Data Sheet A, boxes shall be galvanised.

5.3.6 Suitable number of terminals shall be provided for looping-in and looping-out of cable connections and also connections to the luminaire(s).

5.3.7 Cable / conduit knock-outs shall be for each loop-in and loop-out connection and also connection to the luminaire(s).

5.4 REFLECTORS

5.4.1 Reflectors shall be made of sheet steel or aluminium as applicable.

5.4.2 The aluminium reflectors shall be made of high purity aluminium sheet. Sheet will be polished, electrochemically brightened and anodised.

5.4.3 Wherever reflectors are separate from housing, they shall be securely attached to the luminaire by means of easily accessible fastening devices such that they are readily removable from the housing for maintenance.

5.5 LAMP HOLDERS

5.5.1 Holders shall be resistant to wear and shall be smooth in operation.

5.5.2 Contacts shall be of durable quality.

5.5.3 Holders shall hold the lamp under condition of shock and vibration.

5.5.4 Lamp holders for fluorescent lamp shall be spring loaded, bi-pin, rotor type with low contact resistance.

5.5.5 Live parts of the holder shall not be exposed when the lamp is inserted or removed in case of fluorescent luminaires.

5.5.6 Lamp holders for HPMV & HPSV lamps shall be of porcelain material.

5.5.7 Holders shall be screw type for HPSV & HPMV lamps. Holders for incandescent lamps shall be screw type, unless mentioned otherwise in Data sheet A.

5.5.8 Lamp holders for incandescent lamps shall be of brass or porcelain.

5.6 STARTER HOLDERS

5.6.1 Starter holders shall be designed and manufactured as per the applicable standard.

5.7 BALLASTS

5.7.1 Fluorescent fixtures, installed in other than control room areas shall have electronic ballasts. For control room, the ballast shall be copper wound, inductive, heavy duty type, filled with thermosetting insulating moisture repellent polyster and designed for long service life and low power loss.

5.7.2 Ballasts shall be totally enclosed type.

5.7.3 Ballasts shall be easily removable type.

5.7.4 Core shall be made of low loss, electrical grading stampings.

5.7.5 Coils shall be annealed copper wire wound, inductive, heavy duty type.

5.7.6 The core and coil assembly shall be impregnated with suitable insulating material of high thermal stability and integrally encapsulated in thermosetting polyester compound. The compound shall be insulating and moisture resistant filled under pressure or vacuum.

5.7.7 End connections shall be made available in a terminal block, rigidly fixed to the ballast enclosure.

5.7.8 Ballasts shall be free from humming.

5.7.9 Ballast shall be provided separately for each lamp in a multi-lamp luminaire.

5.7.10 Tappings shall be provided to set the voltage within range for HPMV & HPSV luminaires.

5.8 STARTERS

5.8.1 Starters shall be made of aluminium material. Plastic or any other material if used shall be subject to purchaser's approval.

5.8.2 Starters shall have bi-metal electrodes.

5.8.3 Starter shall be replaceable without the use of any tool and without disturbing any accessory or lamp.

5.8.4 Starters shall have high mechanical strength.

5.8.5 Starters shall be provided with radio interference suppressing capacitors.

5.8.6 Starters shall have brass contacts.

5.9 CAPACITORS

5.9.1 Capacitors shall have constant value of capacitance, suitable for operation at supply voltage.

5.9.2 Capacitors shall be hermetically sealed, preferably in a metal enclosure to prevent seepage of impregnant and ingress of moisture.

5.10 LAMPS

5.10.1 Lamps shall be suitable for use in any position.

5.10.2 Lamps shall be capable of withstanding small vibrations without breakage to filaments / electrodes and lead-in wire.

5.10.3 Type of Lamps

a) Fluorescent Lamp

i. They shall be of the “cool daylight” type, unless mentioned otherwise in Data Sheet A.

ii. Anode rings shall be provided to prevent blackening of the ends.

iii. Lamp caps shall be two pin type at each end.

b) Incandescent (GLS) Lamps

i. Incandescent lamps shall be “clear” type.

ii. Lamp caps shall be screw type , unless mentioned otherwise in Data sheet A.

c) Mercury Vapour Lamps

i. Lamps shall have outer envelope with colour corrected fluorescent powder, unless mentioned otherwise in Data Sheet A.

ii. Lamp caps shall be screw type.

d) Sodium Vapour Lamps

i. Lamps shall be ovoid shaped with diffusing powder coating.

ii. Lamps shall be provided with external igniters and rapid restart facility.

iii. Lamp caps shall be screw type.

e) Halogen Lamps

i. Lamps shall be double ended linear type.

ii. Lamps shall be of immediate start type.

iii. Design of lamps shall ensure high performance and high efficiency.

## 6.0 DESIGN REQUIREMENTS (MAIN EQUIPMENT EXCEPT LUMINAIRES AND LAMPS)

### 6.1 LIGHTING DISTRIBUTION BOARD (LDB)

#### 6.1.1 General Requirements of LDBs

6.1.1.1 LDBs shall be totally enclosed, modular in construction, indoor type and suitable for electrical system data as specified in Data Sheet A. The LDB shall be free standing type suitable for installation on cable trenches / floor.

6.1.1.2 LDBs shall be constructed from CRCA sheet and structural sections. Sheet thickness for load bearing members shall be 2.0 mm and that for non-load bearing members shall be 1.6 mm,

unless specified otherwise in Data Sheet A. The design and construction of LDBs shall ensure adequate rigidity.

6.1.1.3 Vertical cable chambers / alleys of adequate width but not less than 250 mm shall be provided for incoming / outgoing cables of each panel.

6.1.1.4 LDBs shall have only one operational front. Door shall be provided at the front of each module to give full access to all the components.

6.1.1.5 LDBs shall consist of dust and vermin proof cubicles without the use of louvers (except the transformer compartment, where applicable).

6.1.1.6 Good quality synthetic rubber / neoprene gaskets shall be put around the door, cover edges and cutout edges for pushbutton, lamps etc. for protection against dust. The door when closed, shall compress the gasket uniformly.

6.1.1.7 Cutout edges for instruments, relays etc. shall have sufficient overlap surface to minimize the dust entry. The arrangement for the front mounting of switch handles shall render the LDB reasonably dust free such that the normal operations are not affected.

6.1.1.8 Degree of protection for completed LDBs (Distribution Board) shall be IP:52 unless mentioned otherwise in Data Sheet A.

6.1.1.9 The LDBs shall be designed to prevent contact with live parts both within the modules and in the cable alley.

6.1.1.10 The ratings of all components shown in the enclosed drawings are indicative only. The bidder shall be responsible to check and coordinate the MCB characteristic with back up fuses etc. provided. Any change in size / ratings of components required for final arrangement may be complied with and provided by the vendor at no extra cost.

6.1.1.11 All equipment shall be constructed of non-hygroscopic and non-inflammable materials.

6.1.1.12 All components mounted in the LDBs shall be accessible and shall not impede access to wiring or terminals. All faults except busbar fault which may occur within any individual unit shall be confined within that unit only and shall not cause shutdown of any section of the board other than the affected unit itself. Maintenance and inspection shall be possible in any individual unit without affecting other units.

6.1.1.13 Incoming unit shall comprise of either switch-fuse / composite fuse-switch unit or MCCB as per scheme / Data Sheet A. Outgoing units shall be a switch-fuse / composite fuse-switch unit / MCB.

6.1.1.14 The rated continuous current of the equipment and components shall be as given in the schemes. These ratings shall be obtained with the components mounted in their housing as in service without exceeding the permissible temperature rise.

6.1.1.15 Interlock between compartment door and modules shall be provided such that the door cannot be opened without switching off the power supply to the module.

6.1.1.16 Defeat interlock shall be provided for the units comprising of switch or moulded case circuit breaker as a means of isolation device, such that it is possible to open the door with device ON. It shall not be possible to close the door till the interlock has been reinstated.

6.1.1.17 Each LDB shall be fitted with base frame made of angle or channel.

6.1.1.18 All fixing nuts and bolts together with grounding bolts shall be provided.

6.1.1.19 Lifting lugs shall be provided for each shipping section of LDB. Removal of such lugs or hooks shall leave no opening in the LDB.

6.1.2 LDBs with transformers (Additional Features)

6.1.2.1 The lighting distribution board shall be arranged in two adjacent but separate compartments, one compartment for the lighting transformer and the other for the incoming & outgoing feeders etc.

6.1.2.2 The transformer shall be mounted on the base channel and it shall be possible to easily remove the transformer from the cubicle after opening the door. Necessary portable ramp made of mild steel shall be supplied along with each LDB.

6.1.2.3 Independent gasket hinged door with operating handle shall be provided for access to transformer & its taps. Operating handle shall have built-in key locking arrangement.

6.1.2.4 Suitable ventilation arrangement for the transformer compartment to dissipate the heat of the transformer shall be provided. The arrangement shall be in the form of louvers and the same shall be provided with galvanised wire mesh with dust catchers on the inside.

6.1.2.5 The degree of protection for transformer compartment shall be IP:42 unless mentioned otherwise in Data Sheet A.

6.1.2.6 Connections between transformer secondary terminals and the busbars shall be made by using PVC insulated flexible copper cables or busbars.

6.1.2.7 Warning plate shall be provided on transformer enclosure. The inscription of warning plate shall be as given below :

- DO NOT OPEN DOORS WHEN ENERGISED
- KEEP TAPS AT SAME POSITION FOR ALL PHASES

6.1.2.8 Transformer enclosure shall be provided with a danger plate.

6.1.3 Lighting Transformer

6.1.3.1 Lighting transformer, where specified, shall form an integral part of lighting distribution board.

6.1.3.2 Lighting transformer shall be dry type, natural air cooled and suitable for mounting inside the lighting distribution board. Transformer shall be non-encapsulated type, unless specified otherwise in Data Sheet A.

6.1.3.3 Rating of transformer shall be 50 kVA or 100 kVA as per type of LDB.

6.1.3.4 Voltage rating shall be as given in Data Sheet A.

6.1.3.5 Percentage impedance shall be 3% for 50 kVA and 4% for 100 kVA transformers, unless specified otherwise in Data Sheet A.

6.1.3.6 Off circuit tap changers / links shall be provided for +5% in steps of 2.5%.

6.1.3.7 Transformer winding insulation shall be class “F” or better.

6.1.3.8 Transformer shall be of vector group Dyn1.

6.1.3.9 Winding shall be of copper material and maximum winding temperature at full load and under site conditions shall not exceed 120 oC.

6.1.3.10 Transformer shall be suitable for cable connections on the primary side and flexible cable or busbar connection on the secondary side.

6.1.3.11 The secondary neutral of the transformer shall be brought out for getting a grounded 4 wire supply system.

6.1.3.12 The transformer neutral shall be brought outside the LDB for earthing. The neutral bus bar shall be insulated from the LDB enclosure.

6.1.3.13 Transformers shall be provided with the rollers, pulling holes, lifting lugs, jacking positions etc.

6.1.4 Busbars, Connections and Joints

6.1.4.1 Busbars shall be made of aluminium grade E 91E or high conductivity copper (ETC). Busbar material shall generally be aluminium unless mentioned otherwise in Data Sheet A.

6.1.4.2 Busbars shall be supported on non-hygroscopic and non-inflammable insulators of material such as glass reinforced moulded plastic material, epoxy cast resin etc. Separate supports shall be provided for each phase of the busbars. Insulation level of neutral busbar shall be same as that of phase busbars.

6.1.4.3 Busbars shall be contained in a separate vermin-proof compartment within the LDB and shall have bolted sheet steel covers for providing suitable access.

6.1.4.4 Busbar clearances in the air shall be as per applicable standard for 500V, 3 phase system.

6.1.4.5 Temperature for busbars, droppers and connections shall not exceed 90oC for an ambient of 50oC while carrying maximum continuous current.

6.1.4.6 The busbar, busbar connections and supports shall have sufficient strength to withstand thermal and electromechanical stresses produced by the specified short circuit level of the system.

6.1.4.7 Busbars (including neutral busbar) shall be capable of carrying the short-time current specified in Data Sheet A. The duration of short-time current shall be 1 sec unless mentioned otherwise

in Data Sheet A. For the specified current and duration, there shall be no damage to the equipment.

6.1.4.8 The neutral bus shall be rated same as phase bus.

6.1.4.9 Main busbars and connections shall be prominently marked and displaced for standard sequence counting from rear to front, top to bottom, or left to right as viewed from the switching device operating mechanism side.

6.1.4.10 Busbars and connections shall be provided with colour coded PVC sleeves. All live parts shall be properly shrouded with insulating material.

6.1.4.11 Earth busbar shall be provided separately. Material of earth busbar shall be GI unless mentioned otherwise in Data Sheet A.

6.1.4.12 Busbar Joints

a) Busbar and tap off joints shall be bolted type.

b) Busbars shall be thoroughly cleaned before jointing. Suitable contact grease shall be applied to remove oxide film just before jointing.

c) For copper busbars, the connecting portion shall be tinned or silver plated.

6.1.5 Wiring and Terminals

6.1.5.1 All internal wiring for connections to remote equipment shall be brought to terminal boards. Spare contacts of devices shall also be wired upto terminal board as per schemes. Wires shall not be jointed or teed-off except at terminal points.

6.1.5.2 Wiring shall be made by 1000 volt grade three / seven strand PVC insulated copper wire having a cross-sectional area of not less that 1.5 sq.mm. All connections from CT leads upto instruments, terminals shall be made by copper wires of minimum 2.5 sq.mm. size.

6.1.5.3 All wiring shall be made with the Colour Codes specified below :

a) 3 phase AC Connections

| | |
|---|---|
| Phase 1 (R) | Red |
| Phase 2 (Y) | Yellow |
| Phase 3 (B) | Blue |
| Neutral | Black |

b) 1 phase AC Connections

| | |
|---|---|
| Phase | Red / Yellow / Blue (as per associated circuit) |
| Neutral | Black |

c) DC Connections

| | |
|---|---|
| Positive | White |
| Negative | Grey |

d) Earth Connection Green

6.1.5.4 Where wiring passes from one compartment to another, the aperture shall be 'Bushed' to prevent damage to wires against sheet metal edges. Bushes may comprise of good quality rubber / PVC grommets.

6.1.5.5 Every wire end shall be fitted with numbered ferrules of white or yellow colour having glossy finish with identification number engraved in black. Ferrules shall be made of moisture and oil resisting insulating material. Ferrules shall be of interlocked type or tight fitting type. Ferrules shall be so fitted that they will not get detached, when the wire is removed from the terminal.

6.1.5.6 System of marking of wiring shall be as per applicable standard.

6.1.5.7 All wires used internally shall have crimped on tinned copper lugs for terminations.

6.1.5.8 Terminal boards shall be stud type with insulating barriers of adequate height.

6.1.5.9 Terminal boards shall have separate terminals for incoming and outgoing wires with not more than two wires connected to any one terminal.

6.1.5.10 Terminal boards shall be mounted vertically or in the horizontal rows and properly spaced to have clean wiring arrangement, adequate access for putting ferrules, making terminations etc. It shall be possible to read the ferrule numbers when the wiring is complete. Where terminals may be live when the equipment is isolated from the main supply, these shall be clearly marked near the terminal boards.

6.1.6 Controls

The controls shall be provided as per purchaser's requirements covered in the specification and control schemes.

6.1.7 Switch Fuse Units

Refer clause 7.0 (COMPONENTS OF MAIN EQUIPMENT)

6.1.8 Cable Terminations

6.1.8.1 All cables, either incoming or outgoing to the LDB, shall be terminated in a cable chamber. For each panel, there shall be a cable chamber on the side. The door of cable chamber should open or be locked with the help of a tool. Unless stated otherwise in Data Sheet A, all cables shall enter from the bottom.

6.1.8.2 Removable undrilled gland plates of sheet steel shall be provided in the cable chamber for entry of cables. Minimum thickness of gland plate shall be 3mm. The gland plate shall be of adequate size for connecting requisite number of cable glands for power and control cables.

6.1.8.3 Heavy duty bolt-on termination tinned copper lugs of compression type shall be used in for power cable termination.

6.1.8.4 For supporting and clamping of cable cores at regular interval in cable alleys, suitable slotted angle upto the respective terminal blocks shall be provided.

6.1.8.5 The supply of tinned copper cable lugs for power cables forms part the supply of equipment.

6.1.9 Earthing

6.1.9.1 An earth busbar of adequate size of galvanised MS shall be provided at the bottom for the entire length of the LDB.

6.1.9.2 Every metal part other than those forming parts of an electrical circuit shall be connected to the earth bus by means of high conductivity copper wire of size not less than 2.5 sq. mm. cross-sectional area.

6.1.9.3 Doors shall have a flexible copper wire for earth connection to fixed unit.

6.1.9.4 Each LDB shall be fitted with two earthing studs located in accessible position on sides for connection of internal earth busbar to the external earthing connection.

6.1.9.5 Earth busbar shall be brought outside LDB for making external connections.

6.1.10 Types of LDBs

The LDBs shall be of following type :

a) LDB-H (n) - AC LDB with 100 kVA transformer

b) LDB-F (n) - AC LDB with 50 kVA transformer

c) LDB-N (n) - AC LDB with no transformer

d) LDB-D (n) - DC LDB

NOTE : (n) indicates number of outgoing feeders.

6.1.10.1 AC LDBs (LDB-H, LDB-F, LDB-N)

Each LDB shall comprise of the following and comply with the enclosed single line diagrams :

a) One lighting transformer (LDB-H & LDB-F).

b) One incomer of TP / TPN switch-fuse unit or MCCB / MCCB with neutral link as per Data Sheet A. It shall be provided on the primary side of transformer for LDB type LDB-H & LDB-F.

c) Set of busbars with 3 phase and neutral.

d) TPN switchfuse units for each outgoing circuit.

e) Three indicating lamps with fuses for indicating bus supply ON.

f) CT operated ammeter with selector switch.

g) VT operated voltmeter with selector switch.

h) Power & control terminals, earth-stud, earth busbar, designation labels, internal wiring, power cable lugs, glands etc. shall be provided to complete the LDB in all respects.

6.1.10.2 DC LDBs (LDB-D)

Each LDB shall comprise of the following and comply with the enclosed single line diagrams :

a) One incomer of two pole switch-fuse unit.

b) Two pole DC contactor on the incoming circuit for changeover to DC in case of AC normal supply failure.

c) One under voltage relay of suitable range, if specified in Data Sheet A.

d) One ON delay timer.

e) One test push button.

f) Set of busbars for positive and negative.

g) Two pole switch-fuse units / MCB for outgoing feeders.

h) Two indicating lamps with fuses for indicating bus supply ON.

i) Power & control terminals, earth-stud, earth busbar, designation labels, internal wiring, power cable lugs, glands etc. shall be provided to complete the LDB in all respects.

6.2 LIGHTING PANELS (LPs)

6.2.1 General Requirements of Lighting Panels

6.2.1.1 LPs shall be totally enclosed, suitable for electrical system data as specified in Data Sheet A. The LP shall be suitable for mounting on wall / column / structure.

6.2.1.2 Panels shall be suitable for indoor / outdoor application as per Data Sheet A and BOQ. Outdoor panels shall have a sloping canopy.

6.2.1.3 LPs shall be constructed from CRCA sheet. Sheet thickness shall be 2.0 mm, unless mentioned otherwise in Data Sheet A. The construction of LPs shall ensure adequate rigidity.

6.2.1.4 All components of the LP shall be fully mounted inside the panel. LPs shall have only one operational front. Door shall be provided to give full access to all the components. Door shall have padlocking arrangement.

6.2.1.5 LPs shall consist of dust and vermin proof cubicles without the use of louvers.

6.2.1.6 Good quality synthetic rubber / neoprene gaskets shall be put around the door. The door when closed, shall compress the gasket uniformly.

6.2.1.7 Unless mentioned otherwise in Data Sheet A, degree of protection for completed LPs shall be IP:52 for indoor LPs and IP:55 for outdoor LPs.

6.2.1.8 The LPs shall be designed to prevent contact with live parts when the front door is open.

6.2.1.9 All busbars (phase, neutral, positive, negative as applicable) within a panel shall be of the same size.

6.2.1.10 All control wiring inside the panels shall be carried out with 1100 V grade, PVC insulated flexible copper wire of 2.5 sq. mm size.

6.2.1.11 The rated continuous current of the equipment and components shall be as given in the single line diagrams. These ratings shall be obtained with the components mounted in their housing as in service without exceeding the permissible temperature rise.

6.2.1.12 Each LP shall be fitted with M.S. mounting brackets.

6.2.1.13 Panel shall be suitable for top / bottom cable / conduit entries. However, outdoor LPs shall have bottom cable / conduit entry. Removable undrilled gland plate of sheet steel shall be provided for entry of cables. Minimum thickness of gland plate shall be 3 mm. The gland plate shall be of adequate size having knock-outs for requisite number cable connections. Gland plate shall be provided with gasket.

6.2.1.14 The lighting panel shall be complete with copper busbars, and shall incorporate switch fuse or MCB on the incoming side, single pole miniature circuit breakers (MCBs) for AC outgoing circuits and double pole MCBs for DC outgoing circuits. Number of outgoing circuits shall be as per BOQ.

6.2.1.15 Each lighting panel shall be fitted with two GI earth studs located in accessible position on the outside of the panel on opposite sides.

6.2.1.16 All metal parts of the panel except current carrying parts shall be bonded together electrically to the earthing stud.

6.2.1.17 Each panel shall be fitted with phase barriers of fireproof insulating material in such a manner that it is not readily possible for personnel to touch the phase busbars. Insulating sheet shall be fitted around the MCBs such that only the surface and toggle of the MCBs are available on the front.

6.2.1.18 The supply of cable lugs for power and control cable connections forms part the supply of equipment.

6.2.1.19 Each panel shall be provided with a circuit directory plate with inscriptions neatly typed and laminated, fitted on the inside of door.

6.2.2 Type of Lighting Panels

a) LP-A (n) - AC Lighting Panel

b) LP-D (n) - DC Lighting Panel

c) LP-F (n) - Fancy Lighting Panel (Decorative)

d) LP-S (n) - Street Lighting Panel

NOTE : (n) indicates number of outgoing circuits.

6.2.3 AC Lighting Panel (LP-A)

6.2.3.1 LPs shall be provided with TPN switch as incomer.

6.2.3.2 Requisite number of single pole MCBs shall be provided for outgoing circuits.

6.2.3.3 Separate neutral shall be available at terminal block for each outgoing circuit.

6.2.3.4 Construction of AC Normal and AC Emergency panels shall be same.

6.2.4 DC Lighting Panels (LP-D)

6.2.4.1 LPs shall be provided with double pole switch as incomer.

6.2.4.2 Requisite number of double pole MCBs shall be provided for outgoing circuits.

6.2.5 Decorative Type Lighting Panels (LP-F)

6.2.5.1 Decorative lighting panels shall be designed for use in areas like administrative building, service building, canteen, residential premises etc.

6.2.5.2 Thickness of sheet steel shall be as per manufacturer's practice.

6.2.5.3 LPs shall be of tone colour with elegant finish.

6.2.5.4 LPs shall be provided with TPN switch as incomer and requisite number of MCBs shall be provided for outgoing circuits.

6.2.5.5 LPs shall be suitable for either surface or flush mounting as per Data Sheet A and BOQ. Flush mounted panels shall have the collared door suitable for matching with the wall.

6.2.5.6 Lighting Panels may be provided with transparent acrylic cover for operation of MCBs, if asked for in Data Sheet A.

6.2.5.7 LPs shall be provided with knockouts on the top, bottom and sides.

6.2.6 Street Lighting Panel (LP-S)

6.2.6.1 Street Lighting Panels shall be provided for feeding power supply to luminaires of street light poles, flood lighting poles, lighting masts etc.

6.2.6.2 Each Street Lighting Panel shall comprise of the following :

a) One TPN door interlocked switch-fuse unit. Interlock defeat feature shall also be provided.

b) Three pole AC Contactor

c) 00 - 24 hrs timer and a photo-electric switch for automatic switching of contactor

d) Three phase & neutral busbars

e) Single pole or three pole MCBs for each outgoing circuit as per Data Sheet A

f) Two lamps for bus supply ON & OFF indications

g) Complete wiring arrangement as per control scheme.

h) Auto-Manual selector switch

i) ON push button

j) OFF push button

k) Photo switch

6.2.6.3 Switching ON and switching OFF shall be through both 00 - 24 hrs timer and light sensor in automatic mode.

6.2.6.4 One number light sensor in weather proof enclosure having IP:55 degree of protection shall be supplied loose along with each SLP.

6.2.6.5 Internal power wiring shall be done with PVC insulated Cu wire of suitable size. All control wiring inside the panel shall be carried out with 1100 V grade, PVC insulated flexible copper wires.

6.3 LIGHTING POLES

6.3.1 Lighting poles as required for street lighting and flood lighting shall be of swaged/stepped tubular steel of swan neck construction as per applicable standard. As an alternative RCC tubular pole construction as per applicable standard can also be quoted.

6.3.2 Unless mentioned otherwise in Data Sheet A, lighting poles shall be painted type provided with following surface treatment:

a) The poles shall be coated with black bituminous paint, conforming to applicable standard, throughout on the inside surface and on the outside surface up to the level which is embedded in ground.

b) Exposed outside surface shall be painted with two coats of red lead oxide primer and followed by two coats of aluminium paint.

6.3.3 Where galvanization of poles is specified;

a) All inside and outside surfaces of the pole and base plate shall be hot dip galvanised as per manufacturer's practice.

b) Base plate shall be galvanised after welding to the pole base.

c) Manufacturer's procedure for galvanisation shall be submitted for purchaser's approval during detailed engineering stage.

6.3.4 Each street lighting pole shall be supplied with necessary pipe-reducer / fixing-bracket for fixing the luminaire. The details of bracket arm are indicated in enclosed drawing.

6.3.5 Each street lighting pole shall be suitably provided with weather proof, galvanised steel junction box and two numbers fixing brackets suiting the diameter of the pole. The requirements of junction box are stipulated elsewhere. The fixing brackets shall be supplied loose.

6.3.6 Street lighting pole shall be provided with wiring hole. The location shall be coordinated with mounting position of street lighting pole JB. The diameter of hole shall be 20 mm. The hole shall be provided with a rubber / PVC grommet.

6.3.7 Flood lighting pole shall be provided with painted MS plate and shall be suitable for the number of flood lighting luminaires and controlgear boxes as per enclosed drawings.

6.3.8 Provision for earthing shall be provided for flood / street lighting poles at a height 1 metre above the ground.

6.3.9 Types of Lighting Poles

Exact type and designation of lighting pole is as given in Data Sheet A. Basic types are as follows :

a) PS1 - Street Lighting Pole for one luminaire with 1200mm bracket arm.

b) PS2 - Street Lighting Pole for one luminaire with 1800mm bracket arm.

c) PS3 - Street Lighting Pole for one luminaire with 2500mm bracket arm.

d) PS4 - Street Lighting Pole for two luminaires with 1800mm bracket arm each.

e) PS5 - Street Lighting Pole for two luminaires with 2500mm bracket arm each.

f) PS6 - Street Lighting Pole for four luminaires with 1800mm bracket arm each.
g) PS7 - Street Lighting Pole for four luminaires with 2500mm bracket arm each.

h) PF1 - Flood Lighting Pole for one luminaire.

i) PF2 - Flood Lighting Pole for two luminaires.

j) PF3 - Flood Lighting Pole for three luminaires.

k) PF4 - Flood Lighting Pole for four luminaires.

6.4 LIGHTING MASTS

6.4.1 The lighting mast (tower) shall be of steel sections having lattice structure construction with ladder, cage and top platform.

6.4.2 Lighting mast design shall be suitable for following :

a) Height of the lighting mast as per type.

b) Maximum number of luminaires as per Data Sheet A.

c) Additional load of 500 kg towards the weight of maintenance crew.

6.4.3 Permissible design parameters should be according to relevant standard. The deflection under the maximum wind pressure of 150 kg/sq.m shall not exceed 1 in 360.

6.4.4 All steel sections, members and hardware used shall be hot dip galvanised as per applicable standard.

6.4.5 The mast shall be provided with a platform at the top, a steel cage ladder connecting to the ground and a midway landing. Height of the platform provided on the top of the mast shall be 2.0 metre and mid-way landing platform height shall be minimum 1.0 metre.

6.4.6 The span of rung shall not be less than 300mm and spacing between two adjacent rungs shall not be more than 300mm. Diameter of cage for ladder shall not be less than 1000 mm. Ladder shall be supported to give adequate rigidity.

6.4.7 Necessary mounting facilities for mounting of luminaires and controlgear boxes shall be provided at top platform. This shall include provision of holes in the fixing bracket for movable fixing plate. Adequate number of movable plates affixed to the bracket shall also be provided. Size of movable plates and the position of holes shall match with the luminaire fixing arrangement.

6.4.8 Mast shall be provided with 600mm long air termination for the lightning protection. Suitable arrangement for connection of down comer (not in the scope of vendor) shall be provided. Provision of earth connection of GI strip shall also be kept at an height of one metre from the ground.

6.4.9 Provision shall be made for supporting cables, down conductors etc. at regular intervals on lighting tower. Hot dip galvanised brackets of required size shall be provided for the same.

6.4.10 Height of lighting tower shall be the height of tower above the ground and upto the top of the top platform. Other members such as foundation members and lightning arrester shall not be considered for defining the height of tower.

6.4.11 Types of Lighting Masts

a) LM25 - Lighting Mast with 25 m height

b) LM28 - Lighting Mast with 28 m height

c) LM30 - Lighting Mast with 30 m height

d) LM32 - Lighting Mast with 32 m height

c) LM35 - Lighting Mast with 35 m height

6.5 JUNCTION BOXES

6.5.1 Junction boxes with terminals shall be supplied for branching and terminating lighting wires/cables whenever required, as specified.

6.5.2 Construction Features

The junction boxes shall be fabricated out of MS sheet of thickness not less than 2.0mm and shall be of rectangular shape. The cover shall be hinged or bolted with captive nuts and bolts and shall be provided with neoprene gasket lining all over.

The junction boxes shall be provided with suitable knock outs/ gland plates for conduit/ cable connection. The conduit connection shall be properly sealed. The junction boxes meant for cable connection shall be complete with removable gland plates, glands and cable lugs, as required. The junction boxes shall be provided with two earthing terminals suitable for GI earthing wires.

The junction boxes shall be weather proof type conforming to IP-55 of IS:2147. Junction boxes for street light poles and lighting/lightning masts shall be provided with hinged doors and allen keys with bolts as locking arrangement.

The boxes and cover shall be hot dip galvanised. Junction boxes for corrosive areas like DM Plant, water treatment plant etc. shall have additional epoxy/acrylic coating of thickness not less than 50microns on outer surface.

The junction boxes shall be suitable for mounting on wall, columns, lighting poles, mast structures etc. The brackets, bolts, nuts, screws and any other erection accessories required for erection shall be included in the erection price. Circuit number, number of street lighting panel and pole/mast at site by the contractor after their installation.

6.5.3 Terminals

Multiway terminal blocks of approved type and make complete with galvanised screws, nuts, washers and marking strips shall be furnished for terminating the lighting wires.

All the terminals blocks shall be of 650V grade one piece construction with insulating barriers. These terminals shall be made of copper alloy and shall be stud type. Each terminal provided on junction box shall be suitable for terminating two numbers of aluminium conductors of the size as specified without any damage to the conductors or looseness.

6.5.4 The junction boxes shall be of following types:

Type of junction boxes:

| Type | Description |
|---|---|
| JB-F | Provided with four (4) way stud type terminals for terminating upto 2Nos. 10 mm2 stranded aluminium conductors on each terminal, suitable for outdoor installations. |
| JB-FE | Same as above but with an additional epoxy coating of 50micron thickness. |
| JB-S | Provided with four (4) way stud type terminals, each terminal suitable for terminating upto two nos. of 16mm2 stranded aluminium conductors & with one no.6A HRC fuse and link. |
| JB-M | Provided with four (4) way stud type terminals, each terminal suitable for terminating upto two nos. of incoming 35mm2 stranded aluminium conductors, with three nos. 25A HRC fuses, one link, and one number 32A TPN switch, and four way stud type terminals each suitable for terminating 16sq.mm. Al conductor outgoing cable. |
| JB-M1 | 6way stud type terminal block for three phases and three neutrals of adequate size to receive 4C-16mm2 incomer cables and three nos. 2Cx2.5mm$^2$ Cu conductor outgoing cables. |
| JB-SW1 | Provided with four (4) way stud type terminals each terminal suitable for terminating to 10mm2 stranded aluminium conductor. |
| JB-SW2 | Similar to the JB-SW1 but provided with ten (10) way terminals. |
| JB-SW3 | Similar to JB-SW1 but provided with eighteen (18) way terminals. |

6.6 FUSE BOXES

6.6.1 Boxes shall be suitable for accommodating fuses, neutral links and termination of cables on each side.

6.6.2 Boxes shall be of rectangular shape and fabricated out of sheet steel, hot dip galvanised and of weather proof construction.

6.6.3 Sheet steel thickness shall be 1.6 mm, unless mentioned otherwise in Data Sheet A.

6.6.4 Unless specified otherwise in Data Sheet A, degree of protection of fuse boxes shall be IP:55.

6.6.5 Galvanisation shall be done corresponding to the sheet thickness and as per the applicable standard.

6.6.6 Boxes shall be provided with a hinged lockable door with neoprene gasket lining all over. Lock shall be operable with an allen key.

6.6.7 Terminals shall be stud type suitable for ring type lugs. The size of cable shall be intimated during detailed engineering.

6.6.8 Boxes shall be provided with suitable knock outs for conduit / cable connections.

6.6.9 Two earthing terminals suitable for GI earthing wire shall be provided for each box.

6.6.10 Boxes shall be suitable for mounting on walls, structural members etc. Suitable welded fixing brackets shall be provided for this purpose.

6.6.11 Fuse boxes shall be provided with a danger plate for the rated line to line voltage.

6.6.12 Types of Fuse Boxes

a) FB - 1 Fuse Box with 1 fuse and 1 link

b) FB - 2 Fuse Box with 2 fuses and 2 links

c) FB - 3 Fuse Box with 3 fuses and 3 links

d) FB - 4 Fuse Box with 3 fuses and 1 link

6.7 RECEPTACLES

6.7.1 Receptacle unit shall consist of socket outlet with associated switch and plug. The socket outlet and switch shall be flush mounted on a box which shall be suitable for mounting on wall or steel structures.

6.7.2 Receptacle boxes shall be fabricated from CRCA sheets or made of heavy duty cast aluminium alloy as per Data Sheet A. Thickness of sheet steel shall be 1.6 mm, unless mentioned otherwise in Data Sheet A.

6.7.3 Steel boxes shall be hot dip galvanised as per the requirements of applicable standard corresponding to the sheet thickness.

6.7.4 The boxes shall have conduit knock-outs and shall be suitable for cable entry of the size to be specified by purchaser during detailed engineering.

6.7.5 The boxes shall be provided with neoprene rubber gaskets to make them moisture and dust proof.

6.7.6 Suitable loop-in and loop-out terminals shall be provided inside the box. Terminals for incoming and outgoing shall be suitable for the size of conductor of cables.

6.7.7 The receptacle units shall be of the following types:

i) Type RA: It shall have the following:

a) 20A, 250V, 1-phase, 2 pole, 3-pin (third pin scrapping earth) porcelain, metal clad socket with a metallic cover tied to it, similar to `Crompton Greaves' type AS20 or equivalent.

b) Rotary, heavy duty 20A switch conforming to applicable standard.

c) Shrouded, die-cast aluminium plug similar to `Crompton Greaves' type AS20 or equivalent. Combined interlocked weather proof industrial unit.

d) Mechanical interlock shall be provided as follows :

i) Switch can be put ON only when plug is fully engaged.

ii) Plug can be withdrawn only when switch is in OFF position.

iii) Cover can be opened only when switch is in OFF position.

e) The arrangement should ensure that water does not enter tyhe plug when socket is ON.

f) Loop-in loop-out terminals shall be provided inside the box suitable for 10 mm2 Al conductor.

ii) Type RB: It shall have the following:

a) Combination of 5A & 15A, 240V, 1-phase, 2 pole, 3-pin, third pin grounded socket with integral piano key type 15A switch, flush mounted on decorative backelite (6 mm thick)/ perspex (3 mm thick) sheet as cover of the boxes.

b) Loop-in loop-out terminals similar to type RA shall be provided. These will be located in office areas.

iii) Type RC: It shall have the following:

a) 63A, 415V, 3-phase-neutral earth, metal clad socket with cover, similar to `Crompton Greaves' type CS63.

b) Rotary, heavy duty 63A switch conforming to applicable standard.

c) Shrouded, die-cast aluminium plug similar to `Crompton Greaves' type CP63

d) It shall be combined, interlocked weather proof industrial unit.

e) Mechanical interlock shall be same as that are applicable for RA type receptacles

f) The receptacle boxes shall be suitable for entry and exit of 3.5CX70 mm2 Al conductor PVC cable and loop-in loop-out terminals for the same shall be provided such that not more than one core is terminated at one terminal. Removable, undrilled cable gland plate shall be provided. Tinned copper lugs and double compression cable glands shall also be supplied by the bidder.

6.8 CEILING FAN & REGULATORS

6.8.1 The bidder shall supply the following ceiling fans complete with suspension rod, canopy and accessories and regulators:

i) 1200 mm sweep

ii) 1400 mm sweep

6.8.2 The fan motor shall be totally enclosed. The motor winding shall be of copper wire provided with double or reinforced class-E insulation.

6.8.3 The fan shall have three (3) well balanced blades. Precaution shall be taken in the manufacture of fan as well as regulators to ensure reasonable degree of silence at all speeds.

6.8.4 The regulator shall be conventional/electronic type with stepped/smooth (stepless) control of approved make.

6.8.5 The ceiling fans shall generally conform to relevant IS.

6.9 LIGHTING CONTROL SWITCH-BOXES

6.9.1 The switch-boxes shall be of bent steel construction, fabricated of 1.6 mm thick MS steel, with 6 mm thick decorative bakelite or 3 mm thick perspex sheet cover. The boxes shall be hot-dip galvanised.

6.9.2 The switch-boxes shall be suitable for surface mounting as well as flush mounting in brick walls. They shall be flush mounted in the walls in the office areas where false ceiling is provided.

6.9.3 Switch-boxes shall have conduit knock-out on two sides. Adequate provision shall be made for ventilation of these boxes. Conduit knock-out sizes shall be as per conduit layout drgs.

6.9.4 Switches shall be of piano-key type having quick-make, quick-break mechanism, provided with position marking, suitable for mounting on insulating plate. The switches shall be suitable for 1-phase, 240V, 50 Hz supply. They shall conform to relevant standards. The switches shall be supplied loose and shall be fixed at site according to requirement.

6.9.5 All components housed in the switch-boxes shall be wired to an outgoing junction box by 1.5 mm2 Cu wire. The junction box shall have adequate nos. of terminals.

6.9.6 The size of switch-boxes shall be adequately chosen to accommodate the no. of switches and fan regulator boxes specified below. Fan regulators shall be supplied separately.

i) Type SWB1 - Switch board with 1 no. 5A switch & JB type SW1.

ii) Type SWB2 - 3 nos. 5A switches and 1 no. fan regulator with JB type SW2.

iii) Type SWB3 - 7 nos. 5A switches and 3 nos. fan regulator with JB type SW3.

7.0 COMPONENTS OF MAIN EQUIPMENT (OTHER THAN LUMINAIRES)

7.1 MOULDED CASE CIRCUIT BREAKERS

7.1.1 Moulded case circuit breakers (MCCBs) shall be provided when called for in Data Sheet A for use in lieu of switch fuse for LDB incomer. MCCB shall meet the requirements stipulated in Data Sheet A.

7.1.2 MCCBs in AC circuits shall be of triple pole construction arranged for simultaneous three pole manual closing and opening and for automatic tripping at short circuit and overload. Neutral link shall be provided for LDBs without transformers.

7.1.3 Operating mechanism shall be quick make, quick break and trip free type.

7.1.4 The ON, OFF & TRIP positions of the MCCB shall be clearly indicated so as to be visible to the operator when mounted as in service. Operating handle shall be provided on front of the LDB.

7.1.5 MCCBs shall be capable of withstanding the thermal stresses caused by overloads and short circuits. The maximum tripping time under short circuit shall not exceed 20 milli seconds.

7.1.6 MCCB terminals shall be shrouded and designed to receive cable lugs for cable sizes relevant to circuit ratings.

7.1.7 Under voltage release and other releases shall be provided as specified in Data Sheet A / BOM / schemes.

7.2 SWITCH-FUSE UNITS

7.2.1 These units shall preferably comprise of switches having integral fuses, called composite units. Alternatively, combination units of separate switch and fuse may also be acceptable.

7.2.2 These units shall be provided for general purpose i.e. incoming or outgoing units.

7.2.3 The units shall be of the air break air insulated type and designed to ensure safety to operating personnel.

7.2.4 Composite units shall have integral fuses i.e. fuse carrier with fuse link (fuse link forming the moving contact). The design shall ensure that the moving contact is not live when switch is open i.e. in OFF position, so as to facilitate removal of fuse.

7.2.5 The switch shall be capable making and carrying the system prospective fault current, but limited in magnitude and duration by the cut off characteristics of the largest HRC fuse link that may be fitted to that unit.

7.2.6 The fixed contact shall be so shrouded that maintenance of the unit can be carried out in safety with the busbars live.

7.2.7 Where one isolating switch is used as the incoming device, the incoming side fixed contacts shall be shrouded to ensure that maintenance can be carried out with the remote fuse and switch closed.

7.2.8 Composite switch-fuse or the combination of switch and fuse shall meet the requirements of its components as follows:

7.2.9 Isolating Switch

a) Switches shall be air-break, quick make, quick break heavy duty type conforming to applicable standard.

b) All switches shall have visible ON / OFF position indication and shall be padlockable in any (ON / OFF) position.

c) Switches shall be door interlocked such that it shall not be possible to gain access to inside the unit unless the isolating switch is in OFF position.

d) The switches shall be suitable for independent manual operation.

e) The switch contacts shall be of silver alloy or silver plated copper and springs of non-corrosive material.

f) Inter-phase barriers shall be provided to prevent possibilities of phase to phase fault in the switch. The switch shall also be shrouded from all sides to prevent access to live parts on the switch after opening the unit door. The barriers and shrouding shall extend upto the height of switch to fully enclose both side terminals of the device. The arrangement shall permit easy maintenance.

7.2.10 High Rupturing Capacity (HRC) Fuses

a) The fuse serving as the short-circuit protective device in isolating fuse-switch units shall be of HRC cartridge, current limiting and plug-in non-deteriorating type.

b) The fuse carriers shall be easily withdrawable for replacement of fuse. Insulated fuse pullers shall be provided where fuses are not mounted in insulating carriers to remove and replace fuses in live conditions.

c) Fuses shall preferably be fitted with a device to indicate operation (i.e. when the fuse has blown).

d) Live terminals of fuse bases shall be shrouded to prevent contact with personnel where fuse links are not mounted in carriers and are directly plugged into the fuse base. Inter-phase barriers extending throughout the length of the fuse base shall be provided to prevent inter-phase short circuit. They shall be shrouded from all sides to prevent accidental contact.

e) Fuse carriers and bases shall be of good quality moulded insulating material. Porcelain fuse bases and carriers will not be accepted.

f) The rating and characteristics of fuse links shall be chosen appropriately for short circuit protection of circuits down stream.

7.3 INDICATING METERS

7.3.1 Meters shall be panel mounted, flush type and suitable for rear terminal connection.

7.3.2 Meters and instruments shall be enclosed in dust proof, moisture resistant black finished cases and shall be suitable for tropical use. Instruments shall be suitable for operation from the secondary windings of CTs and VTs.

7.3.3 All instruments shall be calibrated to enable direct reading of primary quantities. Instruments shall be adjusted and calibrated at manufacturer's works and shall have means of calibration, checking and zero adjustment at site.

7.3.4 Instruments pointer shall have $90^0$ movement. All the divisions and the quantity to be measured shall be clearly marked. Instruments shall conform to applicable standard and shall have accuracy class 1.5 or better having black numerals and lettering on white anti-parallax dial with knife edge pointer. Indicating instruments shall be of moving iron type for AC and moving coil type for DC circuits.

7.3.5 Ammeter, voltmeter etc. shall be of 96mm x 96mm (minimum) size.

7.3.6 Instruments having metallic cases shall be fitted with earthing terminals.

7.4 CONTACTORS

7.4.1 Contactors shall be of the air break type fitted with arc shields.

7.4.2 The operating coil shall be suitable for satisfactory operation in the range of 85% - 110% of nominal voltage specified under the Data Sheet A. The coil shall be tropicalized having insulation not less than class 'E'.

7.4.3 Electrically independent auxiliary contacts not less than 2NO + 2NC for interlocking and indication shall be fitted to individual power contactor.

7.4.4 All springs shall be made out of a corrosion proof material.

7.5 RELAYS

7.5.1 Relays shall be provided on the various circuits as per schemes. Relays shall be flush mounted on front of the board. Relay case shall be painted with dull black or egg shell black enamel and with back connected terminals. Metal cases and frames of relay shall be earthed.

7.5.2 All relays shall be of withdrawable type with built-in testing facilities, with provision for inspection, maintenance and replacement. Where built-in test facility is not provided for a particular relay, separate suitable test block shall be provided on the board for this purpose.

7.5.3 Relay performance shall not alter due to mechanical shock or vibration or external magnetic field which may be present at the place of mounting.

7.5.4 Each relay shall not have less than two independent pairs of contacts.

7.6 CURRENT TRANSFORMERS

7.6.1 CTs shall be air insulated having insulation class E or better, cast resin type and shall be capable to withstand the thermal and mechanical stresses resulting from maximum short circuit.

7.6.2 The short time current duration for CTs shall be one second.

7.6.3 CT primary current shall not be less than the full load thermal rating of the associated circuit. CT secondary shall have 5Amp rating unless specified otherwise in Data Sheet A. Polarity shall be marked in a suitable manner. The ratings shall be adequate to cater for the burden of connected instruments.

7.6.4 Measuring CTs shall have accuracy class 1.0 and instrument security factor less than 5.

7.6.5 CTs shall be of bar primary / wound primary / ring type capable of carrying the rated primary current.

7.7 VOLTAGE TRANSFORMER

7.7.1 Voltage transformers (VT) shall be dry, cast resin type comprising of single phase or three phase units. They shall have their primary windings protected by current limiting fuses with interrupting capacity corresponding to that of the lighting board / panel.

7.7.2 VT secondary windings shall be earthed in LDB / LP through link, which can be removed for insulation testing.

7.7.3 Three phase voltage transformers shall have 110 V secondary voltage unless mentioned otherwise in Data Sheet A. Single phase VTs shall have voltage rating of :

(Nominal System Voltage / $\sqrt{3}$) V / (110 / $\sqrt{3}$ ) V

So that secondary voltage shall be 110 volts phase to phase when the secondary winding is star connected. The accuracy class of VTs shall be 1.0. VTs shall have an output rating adequate to cater to the burden connected to them.

7.8 MINIATURE CIRCUIT BREAKERS

7.8.1 The use of miniature circuit breakers (MCBs) combining thermal overload and magnetic short circuit protection shall be application for the outgoing circuits of Lighting Panels.

7.8.2 MCBs shall have suitable rating but not less than 20A, 9kA.

7.8.3 MCBs shall be suitable for housing in the lighting panel and for connection of copper link bus bar at the incoming and copper lugs at the outgoing ends.

7.8.4 The terminals of MCB and ON / OFF positions shall be clearly and indelibly marked.

7.9 SELECTOR SWITCHES

7.9.1 The rating and other features of the switches shall be suitable for the application. The number of positions and the number of contacts required for each switch shall be as indicated in the schemes enclosed.

7.9.2 Selector switches shall be stay put type, provided with properly designated escutcheon plates clearly marked to show operating position.

7.9.3 Terminals carrying potential above 120 Volts shall be shrouded to prevent accidental contact with personnel.

7.9.4 Ammeter selector switches shall have make before break contacts.

7.9.5 The switches shall be suitable for semi-flush mounting with the front plate and operating handle projecting out. All connection to the switches shall be from the back.

7.9.6 The arrangement for front mounting of these devices shall be such as to make them reasonably dust free so as not to interfere with normal operation.

7.10 INDICATION LAMPS

7.10.1 Indication lamps shall be complete with lens covers and holders.

7.10.2 Each lamp shall be fitted with a durable resistance integrally wired in series with the lamp. Alternatively, lamps with built in transformers are acceptable.

7.10.3 The lamp cover (lens) shall be translucent of appropriate colour.

7.10.4 Bulbs and covers shall be interchangeable, easily replaceable from the front without the need for any special means.

7.10.5 Terminals having potential above 120V shall be shrouded to prevent contact with personnel.

7.11 PUSH BUTTONS

7.11.1 Push button shall be heavy duty, flush mounted suitable for the application.

7.11.2 Push button shall be provided with integral escutcheon plates marked with its function identified as per schemes.

7.11.3 Colour shall be appropriate to the function.

7.11.4 Minimum number of contacts shall be 1 NO + 1 NC or as per the requirements of control scheme.

7.12 TERMINALS

7.12.1 Terminals shall be stud type of copper material.

7.12.2 Terminals shall be provided with transparent cover(s).

7.12.3 Separate terminals shall be available for each termination of loop-in and loop-out power connections.

7.12.4 Terminals shall be suitable for ring type copper cable lugs of size depending upon the circuit rating.

7.13 CABLE GLANDS

7.13.1 Whether specifically mentioned or not, cable glands of suitable sizes shall be supplied along with each equipment for power and control cables.

7.13.2 Cable glands shall be single compression type of brass material.

7.13.3 Cable glands shall be nickel plated, unless specified otherwise in Data Sheet A.

7.13.4 Rubber components used in the gland shall be of neoprene.

7.13.5 Name / trade name of manufacturer, type no. and applicable range of outer diameter of cable shall be engraved / indelibly printed on the cable gland.

7.14 CABLE LUGS

7.14.1 All equipment shall be supplied with the power and control cable lugs of suitable size, whether specifically mentioned or not.

7.14.2 Cable lugs shall be of tinned copper.

7.14.3 Name / trade name and size of lug shall be engraved/ indelibly printed on each cable lug.

7.15 TIMERS

7.15.1 Time Switch

a) Time switch shall be suitable for automatic switching ON and OFF of street lighting / flood lighting circuits.

b) Time switch have 00 - 24 hrs clock base.

c) Time switch shall indicate actual time and shall permit accurate time setting.

d) Time switch shall be rugged, independent of normal fluctuations of voltage / frequency and free from maintenance.

e) Contact rating, clock accuracy, rated voltage rating and frequency rating of timer shall be suitable to its application.

f) Time switch shall be provided with Ni-Cd battery.

g) Time switch shall be suitable for mounting inside the panel.

7.15.2 On Delay Timer

a) On delay timer shall be required for continuation of DC supply for a limited duration when the AC Emergency supply has been restored and DG set is under stabilisation.

b) Timer shall be fully static and suitable for operation on normal frequency and system voltage.

c) Timer shall have high setting accuracy, high repeat accuracy, low reset time and low power consumption.

d) Timer shall have the time setting range of 24 - 240 seconds, unless mentioned otherwise in Data Sheet A.

e) Timer shall be suitable for mounting inside the panel.

8.0 LABELING

8.1 Labels to identify all the Main assemblies, Sub-assemblies and components of the LDBs and LPs shall be provided.

8.2 Name and rating plate / marking shall be provided as required by relevant standard applicable to each component / assembly to be identified.

8.3 Labels shall be of two colour, three layer plastic material with matt or semi matt finish or of the anodised aluminium sheet.

8.4 All labels other than “Danger” or “Warning” labels shall have black lettering on a white background. Danger labels shall be as per applicable standard and shall not be affixed on to removable parts.

8.5 All labels shall be securely fixed on to the equipment by means of self tapping screws or other approved means.

8.6 Stick-on type labels of good quality and permanent mounting shall be acceptable for internally mounted components only.

8.7 A list of all such items to be labeled and text and type of labels to be provided is given below :

a) BOARD DESIGNATION (MAIN EQUIPMENT LABEL)

i. Inscription : Designation & LDB number for LDBs.
Designation and LP number for LPs.

ii. Location : Top centre in the front of the LDB.
Top centre in the front of the LP.

iii. Material : 3 Layer plastic material, fixation by self tapping, non-rusting screws, black inscription on white back ground.

b) OUTGOING - FEEDER DESIGNATION

i. Inscription : Module number, LP number / purpose.

ii. Material : Black engraving on white anodised aluminium plate of thickness 1.6 mm or more. Plate to be secured with screws.

c) COMPONENT DESIGNATION

i. Inscription : Letter symbol / Legend as assigned in schemes.

ii. Location : Near or on the component

iii. Material : Stick-on type

8.8 CIRCUIT DIAGRAM / DIRECTORY PLATE

8.8.1 A diagram is to be prepared for fixing to the inside cover of every lighting panel giving details of the points controlled by each circuit.

8.8.2 The circuit list shall be typed or printed stating the location of the equipment served, rating of the protective unit and the circuit loadings.

8.8.3 The list shall be mounted on the inside of the cover door and shall be protected by an acrylic sheet cover to be easily removable to permit circuit modifications.

9.0 SURFACE TREATMENT

9.1 All metal parts and the surfaces (exterior & interior) of equipment, unless stated otherwise in case of reflectors, shall be degreased by dipping in hot alkaline solution and rubbed with wire brush to remove oil & scale from them & then rinsed in water.

Alternatively, they may be shot / sand blasted.

9.2 Parts shall be pickled by dipping in hydrochloric acid tank to remove the rust from the surfaces formed during storage of sheets & then rinsed to remove traces of the acid. The cleaning and pretreatment of all metal parts shall be as per applicable standard.

9.3 The surfaces to be painted shall then be prepared by phosphatizing to protect them from further rusting & to create a good bond with the paint. The pretreatment shall conform to the applicable standard.

9.4 All parts shall then be subjected to a coat of red oxide primer paint.

9.5 All inside and outside surfaces of panel shall be spray painted with synthetic enamel of the shade as per Data Sheet A.

9.6 Paint thickness shall be minimum 80 microns unless specified otherwise in Data Sheet A.

9.7 Electrostatic or powder painting shall be acceptable subject to purchaser's approval.

9.8 Wherever possible, finished parts shall be coated with peelable compound by spraying method to protect the finished product from scratches, grease, dirty and oily spots during handling and transportation.

10.0 PACKING

10.1 Packing procedure shall conform to the General Technical Conditions (Volume IIC).

10.2 Specification for the sea worthy packing, if enclosed, for the export jobs shall form part of the specification.

11.0 GUARANTEED PERFORMANCE REQUIREMENTS

11.1 The vendor shall guarantee satisfactory performance of the equipment supplied under all conditions and requirement as laid down by this specification.

11.2 For the general requirements of performance guarantees refer to other parts of the specification.

12.0 INSPECTION & TESTING

12.1 Inspection and testing of Lighting equipment shall be performed as per BHEL standard Quality Plans. Bidder shall sign and stamp the Quality Plans for conforming compliance. The equipment which are not covered in the Quality Plan shall be tested as per the QP to be submitted by bidder. Purchaser's comments shall be incorporated and final QPs shall be submitted for purchaser's approval during contract engineering stage. Modifications in the QP shall be incorporated without any cost implication to the purchaser.

12.2 All the components and completely assembled equipment shall be tested as per the latest edition of standards indicated in Annexure-I.

12.3 All the specified type and routine tests shall be carried out to verify the rating and performance of the equipment. Where valid type test certificates in evidence of equipment performance claimed are available & approved by purchaser, the requirements for conducting type tests may be waived. The general arrangement of object under test shall be to purchaser's approval.

12.4 Functional testing shall be carried out for Lighting Distrbution Boards.

12.5 All manufacturing processes viz. machining, sheet forming, electroplating, wire routing, cleating & crimping, assembly, surface preparation shall conform to good manufacturing practices.

12.6 Inspection for dimensional & visual checks especially of the following, with respect to contract drawings, documents & standards shall be conducted:

a) General sturdiness & rigidity of equipment.

b) Surface finishing.

c) Gasketting.

d) Inter-changeability.

e) Constructional features viz. location, accessibility & marking of components, segregation, accessibility to live parts (shrouding) etc.

f) Completeness of scope.

12.7 Safety interlocking verification shall be done.

12.8 Each lighting transformer shall be routine tested and one transformer of each rating shall be type tested in accordance with relevant standard in case type test certificates of similar transformers are not available / not acceptable to the purchaser.

12.9 Equipment shall be liable for rejection if tolerances on the values of dimensions, power consumption, impedances, temperature rise etc. exceed the specified values by purchaser and / or standards.

13.0 QUANTITY VARIATION

13.1 Quantities of various items are indicated in BOQ as part of Section C, Volume IIB for the purpose of bidding.

13.2 Purchaser reserves the right to delete / add any of the equipment from the vendor's scope of supply. Unit prices quoted shall be considered for this purpose.

13.3 Unless stated otherwise in Data Sheet A, the unit rates quoted by the bidder for various equipment shall be firm for a variation of quantities limited to as follows :

a) +30% of the total order value till the finalisation of engineering details and Master BOQ.

b) +10% of total order value till the completion of works at site.

14.0 SPARES

14.1 A list of commissioning spares and O&M spares' quantities for a duration specified in Data Sheet A shall be filled up in the applicable schedule / format and submitted by bidder along with offer.

14.2 The bidder shall indicate any additional start-up and O&M spares and their recommended quantities, which may be required as per vendor's usual practice. However, the acceptance of the same shall not be binding on purchaser.

15.0 TOOLS AND TACKLE

15.1 Tools & tackle which are essential to facilitate assembly, adjustments, erection, maintenance & dismantling of equipment shall be provided as part of equipment supplied.

15.2 The above tools shall be supplied along with the initial consignment of equipment so as to be available prior to erection but may not be used for erection purposes.

15.3 Vendor shall also submit a list of recommended tools and tackle. Acceptance of these tools and tackle shall not be a binding on the purchaser.

15.4 Schedule of tools & tackle shall be filled up by bidder.

16.0 DOCUMENTATION

16.1 Purchaser's documents as part of tender

Purchaser's single line diagrams, schematic drawings, documents etc. being enclosed in the specification are listed in Data Sheet A.

Specification of sea-worthy packing forms part of the specification for export jobs.

16.2 Documents to be submitted by the Bidder along with the bid.

a) Complete technical literature on luminaires, accessories and lamps.

b) Quality Plans enclosed with the tender with bidder's seal and signature of acceptance on each sheet.

c) Quality Plan for additional items.

d) Catalogues / technical leaflets of all major components.

e) Deviations from the technical specification, if any, brought out in the enclosed "Schedule of Deviations" (Volume III).

f) Unpriced Price Schedules enclosed in Vol.III.

g) Schedule of quantities of commissioning spares.

h) Schedule of quantities of O&M spares.

16.3 Documents to be submitted by the vendor immediately after award of contract (Along with Data Sheet B).

a) General arrangement drawings for all types of LDBs with following details :

i. Dimensions of each panel and overall dimensions.

ii. Arrangement of panels / modules.
iii. Floor mounting details and cutout details.

iv. Single Line Diagram.

v. Rating of components.

vi. Bill of quantities.

b) General arrangement drawing of Lighting Transformer.

c) Bar chart of activities of manufacture, testing, inspection and despatch.

16.4 Documents to be submitted during detailed engineering of contract

16.4.1 Engineering documents (refer clause 4.3) to be generated by the vendor, if applicable.

a) Lighting calculations for indoor areas.

b) Lighting calculations for outdoor areas.

c) SLD of power distribution upto LPs.

d) Control schemes for DC and street lighting

e) Power load on each LP & LDB

f) Layout drawings for indoor areas

g) Layout drawings for outdoor areas.

h) Conduit layout drawings.

i) Wiring and load distribution details for outdoor areas.

j) Master Bill of Material.

16.4.2 Other documents :

a) Final Quality Plans

b) Polar curves, zonal flux diagram and CoU charts of luminaires.

c) Complete design calculations for arriving at number of luminaires.

d) Fixing / mounting details of luminaires and other items.

e) General arrangement drawings of following :

i. Luminaires

ii. Controlgear boxes
iii. LPs

iv. Lighting Poles

v. Lighting Masts
vi. Street Lighting Pole JBs

vii. Fuse Boxes

viii. Receptacles

ix. 24 V Supply module

f) Field Quality Plan as per General Technical Conditions.

g) Rating and diagram plate drawing for lighting transformer.

h) Structural design calculations for lighting tower.

i) Foundation design calculations for lighting tower.

j) Control Scheme for fluorescent, HPMV and HPSV luminaires.

k) Schematic drawings for LDBs / LPs.

l) Type test certificates.

m) Catalogues / leaflets

16.4.3 Operation and maintenance (O&M) manual :

16.4.3.1 The document shall comprise of installation, operating and maintenance instructions for various items / components. The O&M manual shall include the following :

a) Write ups / instructions / procedures for

i. Storage at site.

ii. Unpacking.

iii. Handling at site.

iv. Erection.

v. Pre-commissioning / commissioning tests.

vi. Operating procedures.

vii. Maintenance procedures.

viii. Precautions to be taken during operation and maintenance work.
ix. Trouble shooting charts covering problems, cause and solution.

b) Approved Technical Data Sheets.

c) Characteristic curves of HRC fuses, MCCBs, MCBs etc.

d) Technical leaflet of various items / components.

e) Copies of the type, acceptance and routine test certificates in bound volume.

f) Details of all components liable to be replaced during the life of the equipment.

g) List of maintenance tools required.

h) List of testing equipment required.

16.4.3.2 Draft O & M manual shall be submitted for approval

16.4.3.3 Final O&M shall be submitted in bound volume.

16.5 AS BUILT DRAWINGS

16.5.1 In case Engineering is the scope of vendor, the preparation of As Built Drawings shall be the scope of vendor.

16.5.2 The As Built Drawings shall be prepared on the basis of marked up copies received from the erection contractor.

16.5.3 Entire work of As Built Drawings shall be to the satisfaction of purchaser. Requisite number of prints and RTFs shall be submitted by vendor.

16.6 Number of copies of documents to be submitted by vendor shall be as per section-C of specification.

## ANNEXURE-I

LIST OF APPLICABLE STANDARDS

**ILLUMINATION**

| | | |
|---|---|---|
| 1. | Code of practice for interior illumination | [ ] IS 3646 |
| 2. | Code of practice for industrial lighting | [ ] IS 6665 |
| 3. | Code of practice for design of electrical street lighting installations | [ ] IS 1944 |

**LUMINAIRES**

| | | |
|---|---|---|
| 4. | General and safety requirement for electric lighting fittings | [ ] IS 1944 |
| 5. | Luminaires | [ ] IS 10322 |
| 6. | Industrial lighting fittings with metal reflector | [ ] IS 1777 |
| 7. | Industrial lighting fittings with plastic reflectors | [ ] IS 3287 |
| 8. | Decorative lighting outfits | [ ] IS 5077 |
| 9 | Water proof electric lighting fittings | [ ] IS 3528 |
| 10. | Water tight electric lighting fittings | [ ] IS 3553 |
| 11. | Dust proof electric lighting fittings | [ ] IS 4012 |
| 12. | Dust tight electric lighting fittings | [ ] IS 4013 |
| 13. | Flame proof electric lighting fittings well glass & bulk head types | [ ] IS 2206 |
| 14. | Electric lighting fittings for division 2 areas | [ ] IS 8224 |

**LAMPS**

| | | |
|---|---|---|
| 15. | Electric lamps, tungsten filament general service | [ ] IS 418 |
| 16. | Tubular fluorescent lamps for general lighting service | [ ] IS 2418 |

| | | |
|---|---|---|
| 17. | High pressure mercury vapour lamps | [ ] IS 9900 |
| 18. | High pressure sodium vapour lamps | [ ] IS 9974 |

**LUMINAIRE COMPONENTS**

| | | |
|---|---|---|
| 19. | Ballast for fluorescent lamps for switch start circuits | [ ] IS 1534 |
| 20 | Ballast for high pressure mercury vapour lamps | [ ] IS 6616 |
| 21. | Capacitors for electric discharge lamps (fluorescent and MV) | [ ] IS 1569 |
| 22. | Bi-pin lamp holders for tubular fluorescent lamps | [ ] IS 3223 |
| 23. | Methods of measurement of lamp cap temp. rise | [ ] IS 8913 |
| 24. | Starters for fluorescent lamps | [ ] IS 2215 |
| 25. | Holders for starters for tubular fluorescent lamps | [ ] IS 3324 |
| 26. | Cast acrylic sheets for use in luminaires | [ ] IS 7569 |

**ASSEMBLED EQUIPMENT AND COMPONENTS**

| | | |
|---|---|---|
| 27. | General requirements for swgr. and control gear for voltage not exceeding 1000 V AC or 1200 V DC | [ ] IS 4237 |
| 28. | Code of practice for selection, installation & maintenance of switchgear & control gear | [ ] IS 10118 |
| 29. | Flame proof enclosures for electrical apparatus | [ ] IS 2148 |
| 30. | Classification of hazardous areas for electrical installations | [ ] IS 5572 |
| 31. | Degree of protection provided by enclosures for LV switchgear & control gear | [ ] IS 2147 |
| 32. | Dry type transformers | [ ] IS 11171 |

| | | |
|---|---|---|
| 33. | Air break switches, disconnector etc. and fuse combinations units | [ ] IS 4064 |
| 34. | Miniature air break circuit breaker for voltages not exceeding 1000 V | [ ] IS 8828 |
| 35. | Low voltage Fuses | [ ] IS 9224 |
| 36. | Contactors for voltags not exceeding 1000 V AC or 1200V DC | [ ] IS 2959 |
| 37. | Indicator lamps (visual) | [ ] IS 1901 |

**POLES, SOCKETS AND OTHER MISCELLANEOUS**

| | | |
|---|---|---|
| 38. | Tubular steel poles for over head power lines | [ ] IS 2713 |
| 39. | Three pin plugs and sockets | [ ] IS 1293 |
| 40. | Switch socket outlets (non-interlocking) | [ ] IS 4615 |
| 41. | Interlocking switch socket outlet | [ ] IS 4160 |
| 42. | Structural steel (Standard quality) | [ ] IS 226 |
| 43. | Danger notice plates | [ ] IS 2551 |
| 44. | Boxes for enclosure of electric accessories steel & cast iron boxes | [ ] IS 5133 |
| 45. | Code of practice for general construction in steel | [ ] IS 800 |
| 46. | Wrought aluminium and aluminium alloy bars, rods, tubes and sections for electrical purposes | [ ] IS 5082 |
| 47. | Code of practice for phosphating of iron and steel | [ ] IS 6005 |
| 48. | Colour for ready mixed paints & enamels | [ ] IS 5 |
| 49. | Recommended practice for hot dip galvanising of iron & steel | [ ] IS 2629 |
| 50. | Method of testing uniformity of coating on zinc coated articles | [ ] IS 2603 |

**ANNEXURE-II**

## LUMINAIRE DETAILS

### LUMINAIRE CODING SCHEME

1.0 Code Structure

A A NN (no. x W) — Number of lamps x Wattage of each lamp
NN — Classified Serial Number (Numeric)
A — Luminaire type (Alpha)
A — Lamp type (Alpha)

2.0 Lamp types

a) F - Fluorescent
b) M - Mercury Vapour
c) S - Sodium Vapour
d) T - Tungsten
e) H - Halogen

3.0 Luminaire types

a) C - Channel Mounted (Fluorescent)
b) B - Bay Mounted
c) W - Well Glass
d) S - Street Lighting
e) F - Flood Lighting
f) H - Bulk Head
g) P - Post Top Lantern
h) E - Emergency Lighting
i) X - Others

4.0 Serial Numbers

a) 01 - 20 General Purpose ( Industrial)
b) 21 - 40 Decorative
c) 41 - 50 Vapour Proof
d) 51 - 60 Dust Proof
e) 61 - 70 Drip Proof
f) 81 - 90 Corrosion Proof
g) 91 - 99 Flame Proof

NOTES :

1. Flood lighting luminaires to have non-integral control gearbox.

2. All other luminaires shall have integral control gearbox, unless specifically mentioned otherwise in enclosed sheets.

3. For more details of each luminaire, refer specification.

1.0 **Fluorescent Lamp Luminaires**

1.1 FC01 1 x 40 Fluorescent, industrial box type base without any cover.

1.2 FC02 2 x 40 Fluorescent, industrial box type base without any cover.

1.3 FC03 1 x 40 Fluorescent, industrial box type base and stove enamelled side reflectors.

1.4 FC04 2 x 40 Fluorescent, industrial box type base and stove enamelled side reflectors.

1.5 FC05 1 x 40 Fluorescent, industrial box type base and vitreous enamelled side reflectors.

1.6 FC06 2 x 40 Fluorescent, industrial box type base and vitreous enamelled side reflectors.

1.7 FC21 1 x 40 Fluorescent, decorative with 3 side perspex acrylic diffuser.

1.8 FC22 2 x 40 Fluorescent, decorative with 3 side perspex acrylic diffuser.

1.9 FC23 1 x 40 Fluorescent, decorative, recessed type with perspex acrylic diffuser.

1.10 FC24 2 x 40 Fluorescent, decorative, recessed type with perspex acrylic diffuser.

1.11 FC25 1 x 40 Fluorescent, decorative, recessed type with mirror optic reflector.

1.12 FC26 2 x 40 Fluorescent, decorative, recessed type with mirror optic reflector.

1.13 FC27 2 x 40 Fluorescent, decorative with opal polystyrene louvers.

1.14 FC28 2 x 40 Fluorescent, decorative, recessed type with opal polystyrene louvers.

1.15 FC29 2 x 40 Fluorescent, decorative with vertical metallic louvers.

1.16 FC30 4 x 20 Fluorescent, decorative, recessed type, 600 x 600 size with perspex acrylic diffuser.

1.17 FC31 4 x 20 Fluorescent, decorative, recessed type, 600 x 600 size with opal polystyrene louvers.

1.18 FC32 2 x 20 Fluorescent, decorative, surface mounted with mirror optic reflector.

1.19 FC41 2 x 40 Fluorescent, vapour proof with end boxes and controlgear box of cast Al.

1.20 FC51 2 x 40 Fluorescent, dust proof, totally enclosed type with sheet steel housing.

1.21 FC61 1 x 40 Fluorescent, street light with sheet aluminium canopy and ribbed acrylic cover.

1.22 FC62 2 x 40 Fluorescent, street light with sheet aluminium canopy and ribbed acrylic cover.

1.23 FC81 2 x 40 Fluorescent, corrosion proof, totally enclosed type with sheet aluminium housing.

2.0 **High Pressure Mercury Vapour (HPMV) Lamp Luminaire**

| | | | |
|---|---|---|---|
| 2.1 | MB01 | 1 x 250 | Mercury, high bay, industrial type. |
| 2.2 | MB02 | 1 x 400 | Mercury, high bay, industrial type. |
| 2.3 | MB03 | 1 x 1000 | Mercury, high bay, industrial type. |
| 2.4 | MB04 | 1 x 250 | Mercury, high bay, totally enclosed industrial type. |
| 2.5 | MB05 | 1 x 400 | Mercury, high bay, totally enclosed industrial type. |
| 2.6 | MB06 | 1 x 250 | Mercury, high bay with non-integral controlgear box. |
| 2.7 | MB07 | 1 x 400 | Mercury, high bay with non-integral controlgear box. |
| 2.8 | MB11 | 1 x 250 | Mercury, medium bay, industrial type. |
| 2.9 | MB12 | 1 x 400 | Mercury, medium bay, industrial type. |
| 2.10 | MB13 | 1 x 250 | Mercury, medium bay, totally enclosed industrial type. |
| 2.11 | MB14 | 1 x 400 | Mercury, medium bay, totally enclosed industrial type. |
| 2.12 | MB17 | 1 x 80 | Mercury, low bay, industrial type. |
| 2.13 | MB18 | 1 x 125 | Mercury, low bay, industrial type. |
| 2.14 | MB19 | 1 x 80 | Mercury, low bay, totally enclosed industrial type. |
| 2.15 | MB20 | 1 x 125 | Mercury, low bay, totally enclosed industrial type. |
| 2.16 | MW41 | 1 x 80 | Mercury, well glass, vapour proof with vitreous enamelled reflector. |
| 2.17 | MW42 | 1 x 125 | Mercury, well glass, vapour proof with vitreous enamelled reflector. |
| 2.18 | MW51 | 1 x 80 | Mercury, well glass, dust proof with vitreous enamelled reflector. |
| 2.19 | MW52 | 1 x 125 | Mercury, well glass, dust proof with vitreous enamelled reflector. |
| 2.20 | MW91 | 1 x 80 | Mercury, well glass, flame proof with vitreous enamelled reflector and cast aluminium housing. |
| 2.21 | MW92 | 1 x 125 | Mercury, well glass, flame proof with vitreous enamelled reflector and cast aluminium housing. |
| 2.22 | MW93 | 1 x 80 | Mercury, well glass, flame proof with vitreous enamelled reflector and cast iron housing. |
| 2.23 | MW94 | 1 x 125 | Mercury, well glass, flame proof with vitreous enamelled reflector and cast iron housing. |
| 2.24 | MW95 | 1 x 80 | Mercury, well glass, flame proof increased safety luminaire |

| | | | |
|---|---|---|---|
| | | | with vitreous enamelled reflector and cast iron housing for Div.-2 areas. |
| 2.25 | MW96 | 1 x 125 | Mercury, well glass, flame proof increased safety luminaire with vitreous enamelled reflector and cast iron housing for Div. 2 areas. |
| 2.25a | MW98 | 1 x 125 | Mercury, well glass, flame proof increased safety luminaire with vitreous enamelled reflector and cast iron housing for Div. 2, Group-IIC areas. |
| 2.26 | MS61 | 1 x 125 | Mercury, street light with one piece cast aluminium body. |
| 2.27 | MS62 | 1 x 250 | Mercury, street light with two piece cast aluminium body. |
| 2.28 | MS63 | 1 x 400 | Mercury, street light with two piece cast aluminium body. |
| 2.29 | MF61 | 1 x 250 | Mercury, flood light, general purpose. |
| 2.30 | MF62 | 1 x 400 | Mercury, flood light, heavy duty type. |
| 2.31 | MF63 | 2 x 400 | Mercury, flood light, heavy duty type. |
| 2.32 | MP21 | 1 x 80 | Mercury, post top lantern |
| 2.33 | MP22 | 1 x 125 | Mercury, post top lantern |

3.0 **High Pressure Sodium Vapour (HPSV) Lamp Luminaire**

| | | | |
|---|---|---|---|
| 3.1 | SB01 | 1 x 150 | Sodium, high bay, industrial type. |
| 3.2 | SB02 | 1 x 250 | Sodium, high bay, industrial type. |
| 3.3 | SB03 | 1 x 400 | Sodium, high bay, industrial type. |
| 3.4 | SB04 | 1 x 150 | Sodium, high bay, totally enclosed industrial type. |
| 3.5 | SB05 | 1 x 250 | Sodium, high bay, totally enclosed industrial type. |
| 3.6 | SB06 | 1 x 400 | Sodium, high bay, totally enclosed industrial type. |
| 3.7 | SB07 | 1 x 150 | Sodium, high bay with non-integral controlgear box. |
| 3.8 | SB08 | 1 x 250 | Sodium, high bay with non-integral controlgear box. |
| 3.9 | SB09 | 1 x 400 | Sodium, high bay with non-integral controlgear box. |
| 3.10 | SB11 | 1 x 150 | Sodium, medium bay, industrial type. |
| 3.11 | SB12 | 1 x 250 | Sodium, medium bay, industrial type. |
| 3.12 | SB13 | 1 x 150 | Sodium, medium bay, totally enclosed industrial type. |
| 3.13 | SB14 | 1 x 250 | Sodium, medium bay, totally enclosed industrial type. |

| | | | |
|---|---|---|---|
| 3.14 | SB17 | 1 x 70 | Sodium, low bay, industrial type. |
| 3.15 | SB18 | 1 x 150 | Sodium, low bay, industrial type. |
| 3.16 | SB19 | 1 x 70 | Sodium, low bay, totally enclosed industrial type. |
| 3.17 | SB20 | 1 x 150 | Sodium, low bay, totally enclosed industrial type. |
| 3.18 | SW41 | 1 x 70 | Sodium, well glass, vapour proof with vitreous enamelled reflector. |
| 3.19 | SW42 | 1 x 150 | Sodium, well glass, vapour proof with vitreous enamelled reflector. |
| 3.20 | SW51 | 1 x 70 | Sodium, well glass, dust proof with vitreous enamelled reflector. |
| 3.21 | SW52 | 1 x 150 | Sodium, well glass, dust proof with vitreous enamelled reflector. |
| 3.22 | SW91 | 1 x 70 | Sodium, well glass, flame proof with vitreous enamelled reflector and cast aluminium housing. |
| 3.23 | SW92 | 1 x 150 | Sodium, well glass, flame proof with vitreous enamelled reflector and cast aluminium housing. |
| 3.24 | SW93 | 1 x 70 | Sodium, well glass, flame proof with vitreous enamelled reflector and cast iron housing. |
| 3.25 | SW94 | 1 x 150 | Sodium, well glass, flame proof with vitreous enamelled reflector and cast iron housing. |
| 3.26 | SW95 | 1 x 70 | Sodium, well glass, flame proof increased safety luminaire with vitreous enamelled reflector and cast iron housing for Div. 2 areas. |
| 3.27 | SW96 | 1 x 150 | Sodium, well glass, flame proof increased safety luminaire with vitreous enamelled reflector and cast iron housing for Div. 2 areas. |
| 3.28 | SS61 | 1 x 70 | Sodium, street light with one piece cast aluminium body. |
| 3.29 | SS62 | 1 x 150 | Sodium, street light with one piece cast aluminium body. |
| 3.30 | SS63 | 1 x 250 | Sodium, street light with two piece cast aluminium body. |
| 3.31 | SS64 | 1 x 400 | Sodium, street light with two piece cast aluminium body. |
| 3.32 | SF61 | 1 x 250 | Sodium, flood light, general purpose. |
| 3.33 | SF62 | 1 x 400 | Sodium, flood light, general purpose. |
| 3.34 | SF63 | 1 x 250 | Sodium, flood light, heavy duty type. |
| 3.35 | SF64 | 1 x 400 | Sodium, flood light, heavy duty type. |
| 3.36 | SF65 | 2 x 250 | Sodium, flood light, heavy duty type. |

| | | | |
|---|---|---|---|
| 3.37 | SF66 | 2 x 400 | Sodium, flood light, heavy duty type. |
| 3.38 | SP21 | 1 x 70 | Sodium, post top lantern. |

4.0 **Tungsten Lamp Luminaires**

| | | | |
|---|---|---|---|
| 4.1 | TW41 | 1 x 100 | Tungsten, well glass, vapour proof with vitreous enamelled reflector. |
| 4.2 | TW42 | 1 x 200 | Tungsten, well glass, vapour proof with vitreous enamelled reflector. |
| 4.3 | TW51 | 1 x 100 | Tungsten, well glass, dust proof with vitreous enamelled reflector. |
| 4.4 | TW52 | 1 x 200 | Tungsten, well glass, dust proof with vitreous enamelled reflector. |
| 4.5 | TW91 | 1 x 100 | Tungsten, well glass, flame proof with vitreous enamelled reflector. |
| 4.6 | TW92 | 1 x 200 | Tungsten, well glass, flame proof with vitreous enamelled reflector. |
| 4.7 | TW95 | 1 x 100 | Tungsten, well glass, increased safety (Div. 2) with vitreous enamelled reflector. |
| 4.8 | TW96 | 1 x 200 | Tungsten, well glass, increased safety (Div. 2) with vitreous enamelled reflector. |
| 4.9 | TB21 | 1 x 60 | Tungsten, bulk head, weather proof. |
| 4.10 | TB22 | 1 x 100 | Tungsten, bulk head, weather proof. |
| 4.11 | TB91 | 1 x 100 | Tungsten, bulk head, flame proof. |
| 4.12 | TB92 | 1 x 200 | Tungsten, bulk head, flame proof. |
| 4.13 | TP21 | 1 x 200 | Tungsten, post top lantern. |
| 4.14 | TE02 | 1 x 20 | Tungsten, portable emergency unit with rechargeable battery. |
| 4.15 | TE02 | 1 x 40 | Tungsten, portable emergency unit with rechargeable battery. |
| 4.16 | TX01 | 1 x 60 | Dispersive vitreous enamelled reflector. |
| 4.17 | TX02 | 1 x 100 | Dispersive vitreous enamelled reflector. |
| 4.18 | TX03 | 1 x 75 | Decorative recessed mounting luminaire suitable for comptalux lamp. |
| 4.19 | TX04 | 1 x 100 | Decorative recessed mounting luminaire suitable for comptalux lamp. |
| 4.20 | TX05 | 2 x 100 | Double obstruction aviation light of cast Al. alloy with red glass. |

5.0 **Halogen**

| | | | |
|---|---|---|---|
| 5.1 | HF61 | 1 x 300 | Halogen, flood light, drip proof. |
| 5.2 | HF62 | 1 x 500 | Halogen, flood light, drip proof. |
| 5.3 | HF63 | 1 x 750 | Halogen, flood light, drip proof. |
| 5.4 | HF64 | 1 x 1000 | Halogen, flood light, drip proof. |

# TECHNICAL SPECIFICATION FOR

# LIGHTING SYSTEM (CONDUIT)

# SPECIFICATION NO. PE-SS-999-558-E002

## CONTENTS

| CLAUSE No. | DESCRIPTION |
|---|---|
| 1.0 | GENERAL |
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| 4.0 | INSPECTION |
| 5.0 | TESTING |
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| 7.0 | DRAWING, DATA AND DOCUMENTS REQUIRED |
| 8.0 | TECHNICAL DETAILS OF CONDUITS |

1.0 GENERAL

1.1 This specification covers the manufacture, inspection & testing at vendor's works and delivery to site of conduits, pipes and their fittings for electrical installation.

2.0 CODES AND STANDARDS

2.1 The material, constructional features and various processes involved in manufacture shall comply with currently applicable Indian Standards.

2.2 The following Indian Standards shall be applicable, in general. However if Data Sheet A specifies conformance to other international standards, the equivalent IEC/BS/other standards shall be considered.

a) IS:9537 (All Parts) Conduits for electrical installation.

b) IS:3480 Flexible steel conduits for electrical wiring.

c) IS:6946 Flexible non-metallic conduits for electrical installation.

d) IS:1239 Mild steel tubes, tubulars and other wrought steel fittings (for size above 63mm dia of rigid conduits).

e) IS:2667 Fittings for rigid steel conduits for electrical wiring.

f) IS:3837 Accessories for rigid steel conduits for electrical wiring.

g) IS:3419 Fittings for rigid non-metallic conduits.

h) IS:6005 Code of practice for phostating iron & steel.

i) IS:2629 Recommended practice for hot dip galvanizing on iron and steel.

j) IS:4759 Specification for hot dip zinc coatings on structural steel and allied products.

k) IS:6745 Methods for determination of mass of zinc coating on zinc coated iron and steel articles.

3.0 DESIGN REQUIREMENTS AND CONSTRUCTIONAL FEATURES

The conduit and conduit accessories shall include conduit plugs & caps, gaskets and box cover etc in addition to any specific requirement given in Data Sheet A. The diameter of conduits and accessories shall be uniform throughout the length.

3.1 Rigid Conduits and Fittings

3.1.1 Rigid conduits shall generally conform to the requirements of IS:9537 (Part I & Part II). However conduits above 63mm diameter shall conform to the requirements of IS:1239. Unless specified otherwise in Data Sheet A, all conduits and pipes shall be of medium duty.

3.1.2 The rigid conduits shall be hot dip galvanized inside and outside. Weight of zinc shall be as per IS:4759. Conduits shall be thoroughly cleaned and pretreated, conforming to IS:6005.

3.1.3 Conduits shall be supplied in approximate length as specified below

a) Rigid Conduits 3 - 4 metres
b) Flexible Conduits 10 - 30 metres

3.1.4 Each end of conduit length shall be threaded. The ends of conduits shall be sealed with protective caps to prevent damage to threaded portions and entrance of moisture and foreign material.

3.1.5 The inside surface of all conduits shall be smooth and suitable for pulling insulated cables and wires without damage.

3.1.6 Conduit fittings shall be made out of tube or cast to the shape as to match with corresponding conduit sizes and meet their purpose without any special adjustment.

3.1.7 All fittings shall be screwed type and hot dip galvanized inside and outside.

3.2 Flexible Metallic Conduits and Fittings

3.2.1 Flexible metallic conduits shall generally conform to the requirements of IS:3480.

3.2.2 Flexible conduits shall be made of strip steel, which shall be of cold rolled mild steel. The strip shall be of uniform width and thickness throughout.

3.2.3 The strip shall be electro galvanized to a minimum thickness of 25 microns as specified in IS:3480. The surface of the strip shall be thoroughly cleaned before application of protective coating. Pretreatment, before galvanization, shall conform to IS:6005.

3.2.4 The strip for making flexible conduit shall be wound tightly and so overlapped in subsequent helicals that no openings are seen in normal position.

3.2.5 Flexible conduits shall be lead coated for application in high temperature zones, if specifically mentioned in Data Sheet A.

3.2.6 The conduit shall have uniform diameter throughout its length. The internal surface of all conduits shall be smooth and suitable for pulling insulated cables and wires without damage.

3.3 PVC Conduits

3.3.1 PVC conduits shall generally conform to the requirements of IS:9537(Part I & Part III).

4.0 INSPECTION

4.1 The following stages of manufacture shall be stage inspected by Purchaser or his duly authorized representative.

4.1.1 Inspection of manufacturing processes such as shearing, punching, bending, welding, galvanizing etc.

4.1.2 Inspection of packing material and procedure.

4.1.3 Inspection of finished product.

4.2 The inspection will be carried out as per agreed quality plan.

5.0 TESTING

5.1 Rigid Conduits

a) Acceptance Tests: As per IS: 9537 Part 1 & 2 upto 63mm OD and IS:1239 above 63mm OD.

i) Dimension checks
ii) Bending test (below 32mm OD)
iii) Compression test

b) Special Tests (as acceptance test) as applicable to galvanizing.

5.2 Flexible Steel Conduits

a) Acceptance Tests: As per IS: 3480.

i) Dimension checks
ii) Linear breaking test
iii) Test for flexibility
iv) Bend fracture test
v) Crushing test

b) Special Tests (as acceptance test) as applicable to galvanizing.

5.3 PVC Conduits

a) Type Tests: As per IS: 9537 (Part 1 & 3).

i) Dimension checks
ii) Bending test
iii) Compression test
iv) Impact test
v) Collapse test
vi) Resistance test
vii) Resistance to burning
viii) Electrical Characteristics

b) Acceptance tests: As per IS: 9537 (Part 1 & 3).

i) Dimension checks
ii) Bending test
iii) Compression test
iv) Collapse test
v) Resistance to burning
vi) Electrical characteristics

5.4 Sampling for the tests shall be done as per applicable standards mentioned above.

5.5 The testing shall be carried out as per agreed quality plan.

## 6.0 PACKING

6.1 The material shall be packed as per manufacturer's standard. Packing procedure shall be to the purchaser's approval.

## 7.0 DRAWING, DATA AND DOCUMENTS REQUIRED

7.1 The following information shall be furnished within two weeks of award of contract, for purchaser's approval.

a) Data Sheet-B

b) Final quality plan

## 8.0 TECHNICAL DETAILS OF CONDUITS

Refer Annexure-1 as "TECHNICAL DETAILS OF CONDUITS ".

## ANNEXURE-1
## TECHNICAL DETAILS OF CONDUITS

1.0 APPLICABLE STANDARDS : IS

2.0 RIGID STEEL CONDUITS & STEEL PIPES

a) Material : Cold rolled mild steel to IS:226

b) Applicable standard

i) Upto 63mm OD : IS:9537 Part I & II

ii) Above 63mm OD : IS:1239

c) Surface treatment : Hot dip galvanizing inside & outside as per IS:2629

d) Min. Weight of zinc coating ($gm/m^2$) : 340 upto 32 mm dia
460 above 32 mm & upto 50 mm dia

e) Duty : Heavy duty type

f) Fittings : Screw type as per IS:2667

2.1 Sheet thickness (minimum) : 1.6 mm upto 32 mm dia
2.0mm above 32 mm & upto 50 mm dia

2.2 Min. Thickness of zinc coating (microns) [By Elcometer] : 48 upto 32 mm dia
65 above 32 mm & upto 50 mm dia

2.3 Standard length approximate : 3 - 5 meters

3.0 FLEXIBLE CONDUITS:

a) Material : Strip steel cold rolled and annealed

b) Standard applicable : IS: 3480

c) Surface treatment : Electro galvanized as per IS: 3480

d) Whether lead coated : YES

e) Minimum thickness : 25 microns of zinc coating

4.0 PVC CONDUITS

a) Material : PVC

b) Applicable standard : IS: 9537 (Part I & III)

5.0 SALIENT PARAMETERS OF CONDUIT ACCESSORIES

5.1 LOCKNUTS

| Size of Conduit | Thickness | Width Across Flat (mm) |
|---|---|---|
| 20 mm | 5 mm | 27 |
| 25 mm | 5mm | 33 |
| 32 mm | 5 mm | 41 |
| 40 mm | 5 mm | 50 |

5.2 SADDLES

| Size of Conduit | A(mm) | B(mm) | C(mm) | D(mm) | E(mm) | F(mm) | G(mm) |
|---|---|---|---|---|---|---|---|
| 20mm | 53 | 20 | - | 22 | 4 | 15.5 | 40 |
| 25mm | 60 | 25 | - | 22 | 4 | 18 | 46 |
| 32mm | 68 | 32 | - | 18 | 5 | 17.5 | 55 |
| 40mm | 65 | 40 | - | 18 | 5 | 20 | 67 |

5.3 COUPLER (ELECTRO GALVANISED)

| Nominal Size of Coupler | L(min).(mm) |
|---|---|
| 20 mm | 35 |
| 25mm | 43 |
| 32mm | 43 |
| 40mm | 43 |

5.3 CIRCULAR BOXES (Refer IS)

DIMENSIONS OF SMALL CIRCULAR BOXES

| Size of Conduit | B(mm) | C(mm) | D(mm) | E(mm) | F(mm) | G(mm) | H(mm) | I(Cixmm) |
|---|---|---|---|---|---|---|---|---|
| 20mm | 25 | - | 18 | 16.5 | 25 | 60 | 50 | 3mm |
| 25mm | 30 | - | 19 | 18 | 28 | 60 | 50 | 3mm |
| 32mm | 38 | - | 14 | 13 | 35 | 75 | 60 | 2.5 |
| 40mm | 45 | - | 19 | 18 | 44 | 75 | 64 | 2.5 |

5.4 NORMAL BEND

| Size of Conduit | Straight Length (mm) | Radius (mm) |
|---|---|---|
| 20mm | 30 | 60 |
| 25mm | 50 | 69.5 |
| 32mm | 60 | 90 |
| 40mm | 60 | 130 |

5.5 INSPECTION BENDS

The main criteria is for the threaded portion which has to be taken same as that of a normal bend.

| Conduit Size | Threaded Portion (mm) |
|---|---|
| 20mm | 15.0 |
| 25mm | 19.0 |
| 32mm | 19.0 |
| 40mm | 19.0 |

# TECHNICAL SPECIFICATION FOR

# LIGHTING SYSTEM (INSTALLATION)

# SPECIFICATION NO. PE-SS-999-558-E003

## CONTENTS

| CLAUSE No. | DESCRIPTION |
|---|---|
| 1.0 | SCOPE OF WORK |
| 2.0 | CODES & STANDARDS |
| 3.0 | GUIDELINES FOR LIGHTING SYSTEM ERECTION WORK |
| 4.0 | TESTING & INSPECTION AT CONTRACTOR'S WORKS |
| 5.0 | DRAWINGS/ DOCUMENTS |
| 6.0 | PRICES |

1.0 SCOPE OF WORK

The scope of installation work of the complete lighting and low voltage power services equipment shall be as follows:

1.1 Receipt at site, unloading, handling, unpacking, storing and preservation of all lighting equipment specified under technical specification (Supply) of Section-D and all other materials required for completion of this package

1.2 Erection, testing and commissioning of complete lighting and low voltage power services for the power station.

1.3 The contractor's scope shall also be deemed to include all such other equipment/materials and services required for the completeness of the job, but not listed above, as applicable and shall be quoted for accordingly.

1.4 Supply & erection of consumable like conduit accessories & fittings, conduit boxes, saddles, clamps, flexible conduit, junction boxes, fixing hardwares, anchors, wedges, nuts & bolts, concrete inserts, materials required for mounting the fixtures, consumable and other incidental materials required to complete the installation testing & commissioning of complete lighting system for successful operation, & to the satisfaction of purchaser/ customer. Supply scope of these items shall form part of the installation rates quoted for the item.

Minor civil works Plumbing/Grouting/Foundation required to complete the lighting installation are covered under the scope of this contract and form part of the item installation cost and are not payable separately.

1.5 Power cables from lighting distribution boards LDBs to lighting panels (LPs), LDBs to street lighting panel, street lighting panels to poles and control cables from LDBs to remote street lighting control panel will be supplied by purchaser as free issue item to contractor, Laying & termination of these cables are to be done by the bidder.

1.6 Supply & Erection of supporting structural steel i.e. angles, channels etc. are to be quoted on tonnage basis. During contract stage contractors has to furnish total requirement for structural steel.

1.7 All tools & tackles, ladders, testing equipment etc. required for erection, testing & commissioning of complete lighting system are to be arranged by the contractors.

1.8 The entire work shall be carried out in accordance with specified installation instruction, manufacturer's recommendations, purchaser's approved drawings and/or as directed by the purchaser. Manufacturer' drawings and instructions shall be correctly followed in handling setting, testing and commissioning of all equipment and care shall be taken in handling to avoid distortion to structures, marring of finished surface, damage to delicate instruments etc. The equipment shall be installed in a neat work-manship like manner.

1.9 The erection work shall conform to latest applicable Indian standards, codes and practices, Electricity rules, fire insurance regulations and safety regulations of the locality where the equipment will be installed. All apparatus, wiring and connections shall be designed so as to minimise risk of fire or any damage which will be caused in the event of fire. Contractor to furnish the installation drawings of all equipment for purchaser's approval.

2.0 CODES AND STANDARDS

The design, Manufacture and performance of equipment shall comply with all currently applicable regulations and safety codes in the locality where the equipment will be installed. Nothing in this specification shall be constructed to relieve the bidder of these responsibilities.

2.1 Unless otherwise specified, equipment offered shall conform to latest applicable Indian and IEC standards. Equipment complying with any other authoritative standards such as British, U.S.A, VDE etc. may also be considered provided these standards ensure performance equivalent to or superior to Indian Standards. In such cases the Bidder shall clearly indicate the standard adopted and furnish a copy of the latest English version of the standard along with the tender. Should there be any dispute of design standard, the most stringent one shall be followed. The relevant Indian Standards are:

Lighting Wires

| | |
|---|---|
| IS: 694 | PVC insulated cables for working voltages upto and including 1100V. |
| IS: 3961 | Recommended current ratings for PVC insulation light out put cables. |
| IS: 5331 | PVC insulation and sheath of electric cables |
| IS: 8130 | Conductors for insulated electric cables and flexible cards. |
| IS: 10810 | Methods of tests for cables. |

Conduits & Accessories and Junction Boxes

| | |
|---|---|
| IS: 1653 | Rigid steel conduits for electrical wiring. |
| IS: 3480 | Flexible steel conduit for electrical wiring. |
| IS: 2667 | Fittings for rigid steel conduits for electrical wiring. |
| IS: 3837 | Accessories for rigid steel conduits for electrical wiring. |
| IS: 4649 | Adaptors for flexible steel conduits. |
| IS: 5077 | Decorative Lighting outfits. |
| IS: 5133 | Steel and Cast Iron Boxes. (Part-I) |
| IS: 5133 | Boxes made of Insulating materials (part-II) |
| IS: 2629 | hot dip galvanising of iron & Steel. |
| IS: 9537 | Specification for conduits for Electricals installation. (part-I & II) |

Electrical Installation Practices & Miscellaneous

| | |
|---|---|
| IS: 5 | Colour for ready mixed paints 2 enamels. |
| IS: 1293 | 3 Pin, Plug & Socket Outlets. |
| IS: 226 | Structural steel (standard quality). |
| IS: 2509 | Rigid non metallic conduits for electric wire. |
| IS: 371 | Ceiling roses |
| IS: 3854 | Switches for domestic and similar purposes. |
| IS : 5216 | Guide for safety procedures and practices in electrical work. |
| IS: 1913 | General and safety requirements for electric lighting fittings. |
| IS: 3419 | Fittings for rigid non metallic conduit. |
| IS: 732 | Code of practice for Electrical Wiring installation (System Voltage not exceeding 650V). |
| IS: 3646 | Code of practice for interior illumination part I, II & III. |
| IS: 1944 | Code of practice for lighting of public thorough forces. |
| IS: 3106 | Code of practice for selection of installation and maintenance of fuses. (Voltage not exceeding 650V). |
| IS: 4615 | Switch socket out let (Non-locking). |
| IS: 5571 | Guide for selection of electrical equipment for hazardous areas. |
| IS: 5572 | Classification of hazardous areas electrical installation. |
| IS: 800 | Code of practice for use of structural steel in general building construction. |
| IS: 2633 | Method of testing uniformity of coating in zinc plated articles. |
| IS: 6005 | Code of practice for phosphating of form & steel. |
| IS: 3043 | Code of practice for earthing. |

INDIAN ELECTRICITY ACT AND RULES

| | |
|---|---|
| IS: 6665 | Code of practice for industrial lighting. |
| IS: 458 | Specification for concrete pipes. |

Fire Insurance Regulations

Rule no. 35, 48, 49, 50, 61 & 64 of Indian Electricity Rule with amendment-3 rules 1986 Regulations laid down by the chief Electrical Inspector of the State.

3.0 GUIDELINES FOR LIGHTING SYSTEM ERECTION WORK.

3.1 The contractor shall work in co-ordination with civil, air-conditioning, ventilation & switchgear vendors. Where holes or openings in walls and floors are required for routing the conduits, the contractor shall provide the same. Cut-outs in false ceiling shall be provided by false ceiling contractor.

3.2 The contractor shall be responsible if any parts of lighting fixtures, LDBs, LPs are lost or damaged and lamps are broken during installation. All damage and thefts shall be made good by the contractor till the installation is handed over to the customer.

3.3 The contractor shall note that for any change in the location of lighting panels, lighting fixtures, switch boxes/receptacles, no extra charges will be paid so long as the modifications are indicated to the contractor before commencement of the work on that particular equipment or circuit.

3.4 The contractor shall have a separate cleaning gang to clean all equipment under erection as well as the work area and the project site at regular intervals to the satisfaction of Engineer-in-charge. In case this is not done, the purchaser will have the right to carry out the cleaning operation and any expenditure incurred in this regard will be to the contractor account.

3.5 Except as specifically approved by the Engineer-in-Charge, installation of exposed conduits, mounting of lighting fixtures, etc. shall be taken up only after other services such as piping, air ducting, cable tray/bus duct hangers, structural bracing's etc. in a particular area have been installed

3.6 After installation of lighting fixtures/receptacles, panel number and circuit number shall be painted on them at a suitable place

3.7 Lighting Fixtures and Accessories.

3.7.1 Lighting fixtures of appropriate type as per the lighting layout drawings shall be installed by the contractor. The type of mounting. arrangement of fixtures shall be selected from the typical arrangements shown in enclosed fixture mounting details drawings in section-E. The type of mounting will generally be indicated on the layout drawings. The exact mounting will, however, be decided at site depending upon the actual space/other facilities available at site.

3.7.2 The contractor shall submit for purchaser's approval the drawings showing the detailed mounting arrangements of various types of fixtures prior to installation.

3.7.3 Wooden plugs in walls and ceilings for fixing of lighting fixtures and accessories are not acceptable. A suitable fool-proof method (preferably using nylon rawl plug) of fixing these shall be offered and this be subject to the purchaser approval.

3.7.4 The bracket for mounting the lighting fixtures on boiler platforms shall be fabricated at site using 40 mm GI conduit with a reducing socket to suit the fixture and clamped to the hand rails. However, the clamping of these conduits at points of large vibrations should be avoided. The fixing shall be strong enough to withstand vibrations and wind velocity. If a roof (or other platform over the platform is available, the fixture will be pendant mounted (supported to the structural members of the platform above).

3.7.5 Flood lights shall be mounted on steel base facing the tentative direction shown on drawings. Bolts shall be tightened with spring washers. Terminals connection to the flood lights shall be through flexible conduits.

3.7.6 In the rooms where false ceilings are provided, the lighting fixtures shall be supported separately by false ceiling grid of roof over false ceiling if it is of steel structural or form ceiling and not by the false ceiling board. The arrangement shall be to the approval of purchaser. The erection rate of lighting fixtures shall include the supply of steel brackets, supporting, anchoring material, hardware and also steel brackets/hangers for bridging the gap above false ceilings, etc., required for installation of lighting fixtures as shown in the approved fixture mounting arrangement drawings.

3.7.7 A four (4) way terminal junction box type F shall be provided near each lighting fixture, for loop-in, loop-out and off connection of lighting wires or as required.

3.7.8 To distinguish emergency AC fixtures form normal AC fixtures, red painted circular mark of 1 cm dia. shall be provided on emergency fixtures.

3.7.9 The self contained emergency lighting fixtures shall be installed in required areas. Mounting brackets are to be provided by the contractor.

3.8 Lighting distribution board and Lighting Panels.

3.8.1 Lighting DB's consisting of lighting transformer etc, shall be mounted on floor and LP's shall be mounted on the walls/columns/steel structures at the locations indicated in the drawings.

3.8.2 Suitable Space provision for LDB mounting on floor would be made by the purchaser. The contractor will supply necessary foundation bolts and do the grouting to fix up the LDBs.

3.8.3 LPs shall be installed by fastening to studs of not less than 12 mm dia. which will be suitably grouted/welded to the wall/column by the contractor. All the required accessories including studs for the erection of the panel shall be supplied by the contractor. If Mounting channels are required for, LPs the same will be provided by contractor.

3.8.4 Unless specifically noted otherwise on the drawings the height of the centre line of lighting panels from the floor shall be 1200 mm.

3.9 Lighting control Switch Boxes & Receptacle Boxes.

3.9.1 The locations of switch/receptacle boxes will be approximately as shown in the drawings. The exact location shall be finalised by the contractor in consultation with the engineer-in-Chief.

3.9.2 All switch/receptacle boxes in offices and control room shall be flush mounted in the wall. In other areas they shall be mounted on wall or column.

3.9.3 Unless Otherwise noted on the drawings the mounting height of switch/receptacle boxes shall be as follows.

i. Lighting Control switch boxes - 1500 mm.
ii. Receptacle boxes 500 mm for indoor and 900 mm for outdoor locations.

3.10 Conduits and Accessories

3.10.1 All lighting wires shall be run inside the conduit. Size of conduit shall be selected as per the table given below.

| Size of Wire | Max. number of wires in | |
|---|---|---|
| | 20mm conduit | 25mm conduit |
| 1.5 sq. mm. | 4 | |
| 2.5 sq. mm. | 4 | 6 |

3.10.2 Conduit shall run along wall, floor, ceiling, on steel structures, embedded in wall, floor, for ceiling, in accordance with relevant layout drawings. The contractor shall closely co-ordinate his work with the civil contractor. Exposed conduits shall be run in straight lines parallel to building columns, beams and walls. Unnecessary bends and crossings shall be avoided to present a neat appearance. In the office area as specified conduits shall be embedded along the entire run. It is the responsibility of the lighting contractor to co-ordinate with the civil contractor of these buildings. Conduits supports shall be provided at an interval of 750 mm for horizontal runs and 1000 mm vertical runs

3.10.3 Conduit shall be clamped on to approved type spacer plates or brackets by saddles or U-bolts. The spacer plates or brackets in turn, shall be securely fixed to the building steel by welding and to concrete or brick work by grouting or by nylon rawl plugs.

3.10.4 Embedded conduits shall be securely fixed in position to preclude any movement. In fixing embedded conduit, if welding or brazing is used, extreme care should be taken to avoid any injury to the inner surface of the conduit.

3.10.5 Spacing of embedded conduits shall be such as to permit flow of concrete between them and in no case shall be less then 40mm.

3.10.6 Where conduits are along cable trays provided by purchaser, they shall be clamped to supporting steel at an interval of 600 mm.

3.10.7 For direct embedding in soil, the conduits shall be coated with an asphaltbase compound. Concrete pier or anchor shall be provided where necessary to support the conduit rigidly and to hold it in place.

3.10.8 Conduits shall be installed in such a way as to ensure against trouble from trapped condensation.

3.10.9 The contractor shall made available at site, dies for threading various conduits. Running threads shall be avoided as far as practicable. Where it is unavoidable, check nut shall be used. All field thread ends shall be reamed after threading and anti-corrosive paint applied.

3.10.10 Conduits shall be kept, wherever possible, at least 300 mm away from hot pipes, heating devices etc.

3.10.11 Slip joints shall be provided when conduits cross structural expansion joints or where long run of exposed conduits are installed, so that temperature change will cause no distortion due to expansion or contraction of conduit run

3.10.12 For long conduit runs junction/pull boxes shall be provided at suitable intervals (not exceeding 10 m) to facilitate wiring.

3.10.13 Conduits shall be securely terminated at LPs/junction boxes or lighting fixtures by proper fastening with a lock put on inside and outside. The number of conduits terminating at LP's shall not exceed the permissible number considering the glanding area of lighting panel. Conduit termination's shall be made water & vermin proof.

3.10.14 Conduits lengths shall be jointed by acrewed couplers. Conduit shall be cleanly cut. The cut ends shall be within three (3) degrees of square with the conduit axis. Cut ends shall be reamed and all burrs and sharp edges removed.

3.10.15 Conduits lengths shall be jointed connection and shall be made thoroughly water-tight and rust-proof by application of a thread compound which will not insulate the joints. White lead will be uses for embedded conduit and red lead for exposed conduit.

3.10.16 Water treatment plant chlorination plant lighting installations shall be made with epoxy coated steel conduits and accessories.

3.10.17 Field bends shall have a minimum radius of four (4) times the conduit diameter. All bends shall be free of kinks, indentations or flattened surfaces. Heat shall not be applied in making any conduct bend. Separate bends may be sued for this purpose.

3.10.18 The entire metallic conduit system, whether embedded or exposed, shall be electrically continuous and thoroughly grounded where slip joints used, suitable bending shall be provided around the joint to ensure a continuous ground circuit.

3.10.19 Conduits and fittings shall be properly protected during construction period against mechanical injury. Conduit ends shall be plugged or capped to prevent entry of foreign material.

3.10.20 After installation, the conduits shall be thoroughly cleaned by compressed air before pulling in the wire.

3.10.21 Lighting fixtures shall not be suspended directly from the junction box in the main conduit run.

3.11 Lighting wires

3.11.1 Lighting wires from lighting panels to junction boxes and junction boxes to lighting fixtures, switch boxes and receptacle boxes shall run in conduits (Rigid/flexible).

3.11.2 All wires in a conduit shall be drawn simultaneously. No subsequent drawing is permissible.

3.11.3 Wires shall not be pulled through more than two equivalent 90 deg. bends in a single conduit run. Wherever required, suitable conduit junction boxes/pull boxes shall be provide. All types of wiring, concealed or unconcealed shall be capable of easy inspection.

3.11.4 Receptacles and lighting circuits shall be fed from different circuits. The switch controlling these circuits shall be on the live side (phase wire) of the circuits.

3.11.5 A.C. normal, A.C. emergency and D.C. emergency system wiring shall run throughout in separate conduits.

3.11.6 Wiring shall be spliced only at junction boxes. Maximum two wires shall be connected at each terminal.

3.11.7 In vertical run of wires in conduit the wires shall be suitably supported by means of wooden/hard rubber plugs at each pull/junction box.

3.11.8 All lighting wires shall be crimped using suitable type of solderless, crimping, tinned fork type copper lugs. Cost of the lugs shall be included in the erection price of wire.

3.12 Junction Boxes

3.12.1 Junction boxes having volume upto 1600 cubic centimetre may be installed without any support other than that resulting from connecting conduits where two or more rigid metallic conduits enter and accurately position the box. Boxes shall be installed so that they are levelled, properly aligned and present a pleasing appearance. Boxes with volumes greater that 1600 cubic cm. or for other reasons not rigidly held, shall be adequately supported. The contractor shall perform all drilling, cutting, welding, shimming and bolting required for attachment to supports.

3.12.2 Necessary holes for conduit/cable entry shall be done during installation depending on the requirement. The holes shall be drilled/punched neatly and shall be dust/vermin proof after installation of the conduit.

3.12.3 All welds, bolts holes, conduit entry holes etc,. made during installation as mentioned above shall be wire brushed and touched up with metal primer (lead oxide and zinc chromate in synthetic medium

3.13 Street Lighting/Flood Lighting Poles

3.13.1. The lighting poles and lighting Tower shall be erected by the contractor at locations shown in the street lighting layout to be prepared by contractor and shall be got approved from the purchaser. The erection work shall include making of foundations (with supply of all materials). Installation of necessary wiring/ cabling, junction/ switch box and mounting of assembled fittings The cable from junction box at the bottom of pole upto the lighting fixture shall be supplied by the contractor. All the above erection work shall be done by contractor for lighting masks including making of foundations. 50mm GI pipe shall be provided for cable protection from trench to junction box by the contractor for loop-in-loop-out cables.

3.13.2 The lighting poles shall be painted with two coats of aluminium paint after completion of installation or as specified by purchaser.

3.13.3 The flood light fixtures shall be mounted on galvanised M.S. base making use of shop drilled holes or by suitable clamps. No cutting or drilling of galvanised structure is permitted.

3.13.4 Each lighting poles and lighting/lightning mast junction box shall be earthed by 25X3 mm GS flat bonded to one (1) 20 mm dia MS earth electrode of 3 meter length driven vertically in the ground. The flat and electrode shall be supplied by the bidder and price of these shall be included in the erection price of individual pole/mast. 14 SWG GI wire shall be taken from fixture to JB.

The bidder shall submit the foundation drgs of poles/masts for purchaser's approval.

3.14 Earthing of Lighting system

3.14.1 All junction boxes, receptacles, switch boxes, lighting fixtures, conduit etc. shall be earthed in compliance with the provision of I.E. rules and applicable Indian Standard amended upto date.

3.14.2 A continuous earth conductor of 14 SWG G.I. wire shall be run all along each conduit run and bonded at every 600 mm by not less than two turns of the same size of wires. This conductor shall be connected to the earth bus of lighting panel from which the conduits originate. All junction boxes, receptacles, lighting fixtures etc. shall be connected to this 14 SWG GI earth conductor. All lighting panels and LDBs shall be earthed by GI flats to the purchasers earthing bus. The supply of GI flat and erection shall be in contractor's scope and rates of the same shall be included in the erection rates of the respective LDB/LP.

3.15 Ceiling Fans and Regulators (If Appilicable)

3.15.1 The contractor shall install the ceiling fans and regulators at the locations shown in the relevant drawings. The exact location will however, be decided at site in consultation with engineer-in-charge.

3.15.2 The fan regulators shall be flush mounted on the lighting control switch boxes provided in that area.

3.15.3 Hook alongwith rubber bush shall be supplied and grouted by contractor in ceiling for mounting the fan. All necessary material and hard wares for installation shall be supplied by contractor.

3.16 Foundation & Civil Works

3.16.1 Equipment foundations, for street lighting Poles/Flood Lighting Poles,lighting mast, street lighting panel and other panels mounting foundation and other civil work including supply of cement, steel and other materials as per relevant drawings and specification clauses shall be provided by the contractor. Cost of foundation works , including supply of necessary material is to be quoted as part of E & C rates for these items.

3.16.2 All foundation drawings shall be subject to the purchaser's approval. However, it shall be the responsibility of the contractor to check these foundations before commencement of erection to ensure their suitability.

3.16.3 Al final adjustment of foundation levels, chipping and dressing of foundation surfaces, setting and grouting of anchor bolts, sills, inserts and fastening devices shall be carried out by the contractor including minor modification of civil work as may be required for erection.

3.16.4 Any cutting of masonry/concrete work, which is necessary, shall be done by the contractor at his own cost and shall be made good to match the original work. The contractor shall obtain approval of the purchaser before proceeding with any cutting of masonry/concrete work.

3.16.5 The contractor shall perform all excavation and backfilling as required for ground connections and casting foundations.

3.16.6 Excavation shall be performed upto the required depth. Such measures shall be taken as may be necessary for protection of the wall.

3.16.7 The contractor shall make use of his own arrangements for pumping out any water that may be accumulated in the excavation.

3.16.8 All excavation shall be backfilled to the original level with good consolidation.

3.17 Cabling work:

3.17.1 The owner will supply necessary cables required for the system as per the specification & the bidder shall have to lay & terminate the same. This shall include all clamping, fixing, drilling, cutting, glanding, luging, connecting to terminal blocks, grounding etc. as required to complete the job. Cost of all consumable materials required for cable laying & cable termination shall be included in the erection rate to be quoted by the bidder.

3.17.2 Bidder shall supply all necessary glands & lugs required for cable termination carried out by him. Size of glands & lugs shall be as per the size of the cables selected during detailed engg.

3.17.3 Cable glands shall be double compression type & made of tin plated heavy duty brass casting and machine finished. Glands shall be of robust construction capable of clamping cable & cable armour firmly without injury to the cable. Thickness of tin coating shall not be less than 10 microns. All washers and hardwares shall be made of brass & tinned. Rubber components used in the glands shall be made of neoprene of tested quality.

3.17.4 Cable lugs shall be tinned copper, solderless crimping type, conforming to IS:8309 suitable for Al or Cu conductors. Crimping of terminals shall be done by using corrosion inhibitory compound.

3.17.5 All cable entry points shall be sealed & made vermin & dust proof. Unused opening shall be effectively closed.

3.17.6 Cables shall be laid in owner's trays wherever available. In areas, where owners trays are not available, cable shall be clamped to the structures or laid in conduit or buried depending on the area.

3.17.7 Each cable shall be tagged with the cable no. as per cable schedule. The tag shall be of rectangular shape & attached to the cable by not less than two turns of 20 SWG GI wire. Cable tag shall be provided at each end of the cable before entering the equipment enclosure, on both sides of wall or floor crossing and every 30 meter of cable runs.

3.17.8 Minimum bending radius for the cables shall not be less than 12D, where D is the overall dia of the cable.

3.18 Steel Fabrication

3.18.1 The steel structures supplied and fabricated by the contractor shall be made from standard quality steel sections/flats/plates. The steel fabricated structures shall be free from defects, cleaned of rust, grease, oil etc,. and sharp edges shall be removed.

3.18.2 The welds shall be wire brushed or cleaned otherwise. The holes shall be touched up with metal primer.

3.18.3 All steel fabrications shall be painted with two coats of metal primer (lead oxide and zinc chromate in synthetic medium) followed by two coats of aluminium paint. The welds to galvanised steel shall be touched up with galvanised weld rod applied in accordance with manufacturer's instruction.

3.19 Cutting & wastage allowances:

3.19.1 Contractor shall carefully plan cutting schedule of each cable drum, conduit, lighting wires, GI wires such that wastage's are minimised and any resultant short length can be used where appropriate route length are available. The following wastage's allowances are permissible for various materials.

3.19.2 Power cables, and control cables, Cutting & wastage's allowance shall be computed on the length actually measured, used & accepted. Break up of above 3% wastage allowances are given below :

a) 1% unaccountable wastage.
b) 2% accountable wastage.

Note: Usable length to be returned to purchaser. Minimum wastage length is to be decided in consultant with site engineers.

3.19.3 The contractor shall take-back the unused installation materials which has not been entered in the measurement records by the purchaser after completion of job.

3.20 Quantity measurement:

3.20.1 For all payment purpose, measurement shall be made on physical measurements. Physical measurements shall be made by the contractor in the presence of the site engineer/purchaser.

3.20.2 The measurement of cable laying shall be made on the basis of length actually laid from lug to lug including that of loops provided.

3.20.3 In the measurement of conduits, the accessories will not be include GI wire / GI strip.

3.20.4 The E & C cost of of lighting wires and earthing wires shall be included in the E & C cost of conduits. No separate cost of erection of lighting wires and earthing wires shall be paid.

3.20.5 The accountable wastage to be returned to purchaser's store in good condition and as directed by site engineer.

3.20.6 Any wastage granted by the vendor in excess of the allowable percentage shall be charged at the panel rates decided by the site engineer whose decision shall be final and binding on the vendor.

3.21 Contractor to make a protocol in consultation with site engineer and customer's representative for erection, testing & commissioning of all lighting equipment.

4.0 TESTING & INSPECTION AT CONTRACTOR'S WORKS

4.1 Standard quality plan (QP) for lighting equipment is enclosed. Bidder to confirm compliance to this QP by signing every page of it.

4.2 All accessories shall be subject to routine and type tests in accordance with requirement of appropriate IS in the presence of purchaser's representative.

4.3 Samples selected by the purchaser of all galvanising material shall be subjected to galvanising tests. All fittings, fabrications, hardwares etc. as specified shall be inspected & tested in accordance with IS recommendation. Type test certificates from National Test House or from reputed agency shall be considered.

4.4 Field quality plan for quality checks to be observed at site during erection, testing & commissioning shall also be furnished by contractor alongwith offers as per standard format.

4.5 Testing and commissioning

4.5.1 On completion of erection work, the contractor shall request the site engineer for inspection and test.

4.5.2 The site engineer shall arrange for joint inspection of the installation by purchaser's and customers representative for completeness and correctness of the work. Any defect pointed out during such inspection shall be promptly rectified by the contractor.

4.5.3 The installation shall be then tested and commissioned in presence of the site Engineer & customer's representative

4.5.4 The contractor shall provide all men, material and equipment required to carry out the tests.

4.5.5 All rectification's, repairs or adjustment work found necessary during inspection, testing and commissioning shall be carried out by the contractor without nay extra cost. The handing over of the lighting installation shall be effected only after the receipt of written instruction from the site engineers/ customer.

4.5.6 The testing shall be done in accordance with the applicable Indian standards and codes of practice. The following tests shall be specifically carried out for all lighting installation.

i. Insulation resistance
ii. Testing of earth continuity path
iii Polarity test of single phase switches.

4.5.7 The lighting circuits shall be tested in the following manner.

i. All switches ON and consuming devices in circuit, both poles connected together, to obtain resistance to earth.

ii. Insulation resistance between poles with lamps and other consuming devices removed and switches ON

5.0 DRAWINGS/ DOCUMENTS

REFER VARIOUS CLAUSES OF ELSEWHERE

6.0 PRICES

6.1 The contractor shall quote his prices for supply, erection, testing & commissioning of complete lighting system as per format attached with the specification.

6.2 Unit price quoted for erection, testing & commissioning of items listed under B O M shall be deemed to have been included the prices for erection material as described in clause 1.4 of this specification and other relevant clauses of this specification for various lighting equipment.

6.3 The unit rates of supply & installation ( E & C ) for all equipment and service quoted by the bidder shall be firm for a variation of quantities limited to

a. ±30% of total order value till finalisation of engineering details & BOQ.

b. +10% of the total order value in addition to (a) above, till the completion of job.

6.4 Purchaser reserves the right to right to delete/add any equipment or services from the bidders scope, and for price adjustment in such cases, unit prices quoted by the bidder will be considered.

6.5 The bidder shall furnish unpriced price schedule of all equipment and services inclusive of E & C and recommended spares alongwith the technical bid.

| | TITLE | SPECIFICATION NO. PE-TS-J20-165-001 |
|---|---|---|
| BHEL | **LV MOTORS**<br>**DATA SHEET-A** | VOLUME II B<br>SECTION D<br>REV NO.<br>SHEET 1 OF 1 |

| | | | | |
|---|---|---|---|---|
| 1.0 | Design ambient temperature | | : | 45 $^{o}$C |
| 2.0 | Maximum acceptable kW rating of LV motor | | : | 200KW |
| 3.0 | Installation (Indoors/ Outdoors) | | : | As required |
| 4.0 | Details of supply system | | | |
| | a) | Rated voltage (with variation) | : | 380V ± 10% |
| | b) | Rated frequency (with variation) | : | 50 Hz ± 5% |
| | c) | Combined voltage & freq. variation | : | 10% (sum of absolute values) |
| | d) | System fault level at rated voltage | : | 50 kA for 1 sec |
| | e) | Short time rating for terminal boxes | | |
| | | o 160 kW and above (Breaker controlled) | : | 50 KA for 0.20 sec. |
| | | o Below 160 kW (Contactor controlled) | : | 50 KA protected by MCCB |
| | f) | LV System grounding | : | Solidly |
| 5.0 | Class of insulation | | : | Class ‘F’, with temp rise limited to class B. |
| 6.0 | Minimum voltage for starting (As percentage of rated voltage) | | : | 80% of rated voltage |
| 7.0 | Power cables data | | : | Shall be given during Detailed engg |
| 8.0 | Earth Conductor Size & Material | | : | Shall be given during Detailed engg |
| 9.0 | Space heater supply | | : | 220 V, 1¢ , 50 Hz |
| 10.0 | Rating up to which Single phase motor | | : | Acceptable below 0.20 kW |
| 11.0 | Locked rotor current | | | |
| | a) | Limit as percentage of FLC | : | 600% |
| | b) | Permissible tolerance, if any | : | ±20% |
| 12.0 | Additional tests | | : | As per QP |
| 13.0 | Flame-proof motor | | | |
| | a) | Enclosure suitable (As per IS:2148) | : | As per requirement |
| | b) | Classification of Hazardous area (As per IS: 5572 part-I) | : | As per requirement |
| 14.0 | Makes | | : | ABB/ Bharat Bijlee/ CGL/ KEC/ NGEF/ Siemens/ MARATHON |
| 15.0 | Paint shade | | : | 631 IS-5, |

| | TITLE | SPECIFICATION NO. |
|---|---|---|
| | **MOTOR** | **VOLUME II B** |
| | | **SECTION D** |
| | **DATA SHEET - C** | **REV NO. 00 DATE 29/08/2005** |
| | | **SHEET 1 OF 2** |

| S. No. | Description | Data to be filled by successful bidder |
|---|---|---|
| **A.** | **General** | |
| 1 | Manufacturer & country of origin | |
| 2 | Motor type | |
| 3 | Type of starting | |
| 4 | Name of the equipment driven by motor & Quantity | |
| 5 | Maximum Power requirement of driven equipment | |
| 6 | Rated speed of Driven Equipment | |
| 7 | Design ambient temperature | |
| **B.** | **Design and Performance Data** | |
| 1 | Frame size & type designation | |
| 2 | Type of duty | |
| 3 | Rated Voltage | |
| 4 | Permissible variation for | |
| 5 | a Voltage | |
| 6 | b Frequency | |
| 7 | c) Combined voltage & frequency | |
| 8 | Rated output at design ambient temp (by resistance method) | |
| 9 | Synchronous speed & Rated slip | |
| 10 | Minimum permissible starting voltage | |
| 11 | Starting time in sec with mechanism coupled | |
| 12 | a) At rated voltage | |
| 13 | b) At min starting voltage | |
| 14 | Locked rotor current as percentage of FLC (including IS tolerance) | |
| 15 | Torque | |
| | a) Starting | |
| | b) Maximum | |
| 16 | Permissible temp rise at rated output over ambient temp & method | |
| 17 | Noise level at 1.0 m (dB | |
| 18 | Amplitude of vibration | |
| 19 | Efficiency & P.F. at rated voltage & frequency | |
| | a) At 100% load | |
| | c) At 75% load | |

| S. No. | Description | Data to be filled by successful bidder |
|---|---|---|
| | c) At starting | |
| **C.** | **Constructional Features** | |
| 1 | Method of connection of motor driven equipment | |
| 2 | Applicable Standard | |
| 3 | DOP of Enclosure | |
| 4 | Method of cooling | |
| 5 | Class of insulation | |
| 6 | Main terminal box | |
| | a) Type | |
| | b) Power Cable details (Conductor, size, armour/unarmour) | |
| | c) Cable Gland & lugs details (Size, type & material) | |
| | d) Permissible Fault level ( kArms & duration in sec) | |
| 7 | Space heater details (Voltage & watts) | |
| 8 | Flame proof motor details (if applicable) | |
| | a) Enclosure | |
| | b) suitability for hazardous area | |
| | i Zone | O / I / II |
| | ii Group | IIA / IIB / IIC |
| 9 | No. of Stator winding | |
| 10 | Winding connection | |
| 11 | Kind of rotor winding | |
| 12 | Kind of bearings | |
| 13 | Direction of rotation when viewed from NDE | |
| 14 | Paint Shade & type | |
| 15 | Net weight of motor | |
| 16 | Outline mounting drawing No (To be enclosed as annexure) | |
| D. | **Characteristic curves/ drawings**<br>(To be enclosed for motors of rating ≥ 55KW) | |
| | a) Torque speed characteristic | |
| | b) Thermal withstand characteristic | |
| | c) Current vs time | |
| | d) Speed vs time | |

# GENERAL TECHNICAL REQUIREMENTS

# FOR

# LV MOTORS

**SPECIFICATION NO.: PE-SS-999-506-E101 Rev 00**

## 1.0 INTENT OF SPECIFIATION

The specification covers the design, materials, constructional features, manufacture, inspection and testing at manufacturer's work, and packing of Low voltage (LV) squirrel cage induction motors along with all accessories for driving auxiliaries in thermal power station.

Motors having a voltage rating of below 1000V are referred to as low voltage (LV) motors.

## 2.0 CODES AND STANDARDS

Motors shall fully comply with latest edition, including all amendments and revision, of following codes and standards:

| | |
|---|---|
| IS:325 | Three phase Induction motors |
| IS : 900 | Code of practice for installation and maintenance of induction motors |
| IS: 996 | Single phase small AC and universal motors |
| IS: 4722 | Rotating Electrical machines |
| IS: 4691 | Degree of Protection provided by enclosures for rotating electrical machines |
| IS: 4728 | Terminal marking and direction of rotation rotating electrical machines |
| IS: 1231 | Dimensions of three phase foot mounted induction motors |
| IS: 8789 | Values of performance characteristics for three phase induction motors |
| IS: 13555 | Guide for selection and application of 3-phase A.C. induction motors for different types of driven equipment |
| IS: 2148 | Flame proof enclosures for electrical appliance |
| IS: 5571 | Guide for selection of electrical equipment for hazardous areas |
| IS: 12824 | Type of duty and classes of rating assigned |
| IS: 12802 | Temperature rise measurement for rotating electrical machnines |
| IS: 12065 | Permissible limits of noise level for rotating electrical machines |
| IS: 12075 | Mechanical vibration of rotating electrical machines |

In case of imported motors, motors as per IEC-34 shall also be acceptable.

## 3.0 DESIGN REQUIREMENTS

3.1 Motors and accessories shall be designed to operate satisfactorily under conditions specified in data sheet-A and Project Information, including voltage & frequency variation of supply system as defined in Data sheet-A

3.2 Motors shall be continuously rated at the design ambient temperature specified in Data Sheet-A and other site conditions specified under Project Information
Motor ratings shall have at least a 15% margin over the continuous maximum demand of the driven equipment, under entire operating range including voltage & frequency variation specified above.

### 3.3 Starting Requirements

3.3.1 Motor characteristics such as speed, starting torque, break away torque and starting time shall be properly co-ordinated with the requirements of driven equipment. The accelerating torque at any speed with the minimum starting voltage shall be at least 10% higher than that of the driven equipment.

3.3.2 Motors shall be capable of starting and accelerating the load with direct on line starting without exceeding acceptable winding temperature.

The limiting value of voltage at rated frequency under which a motor will successfully start and accelerate to rated speed with load shall be taken to be a constant value as per Data Sheet - A during the starting period of motors.

3.3.3 The following frequency of starts shall apply

i) Two starts in succession with the motor being initially at a temperature not exceeding the rated load temperature.

ii) Three equally spread starts in an hour the motor being initially at a temperature not exceeding the rated load operating temperature. (not to be repeated in the second successive hour)

iii) Motors for coal conveyor and coal crusher application shall be suitable for three consecutive hot starts followed by one hour interval with maximum twenty starts per day and shall be suitable for mimimum 20,000 starts during the life time of the motor

3.4 **Running Requirements**

3.4.1 Motors shall run satisfactorily at a supply voltage of 75% of rated voltage for 5 minutes with full load without injurious heating to the motor.

3.4.2 Motor shall not stall due to voltage dip in the system causing momentary drop in voltage upto 70% of the rated voltage for duration of 2 secs.

3.5 **Stress During bus Transfer**

3.5.1 Motors shall withstand the voltage, heavy inrush transient current, mechanical and torque stress developed due to the application of 150% of the rated voltage for at least 1 sec. caused due to vector difference between the motor residual voltage and the incoming supply voltage during occasional auto bus transfer.

3.5.2 Motor and driven equipment shafts shall be adequately sized to satisfactorily withstand transient torque under above condition.

3.6 Maximum noise level measured at distance of 1.0 metres from the outline of motor shall not exceed the values specified in IS 12065.

3.7 The max. vibration velocity or double amplitude of motors vibration as measured at motor bearings shall be within the limits specified in IS: 12075.

4.0 **CONSTRUCTIONAL FEATURES**

4.1 Indoor motors shall conform to degree of protection IP: 54 as per IS: 4691. Outdoor or semi-indoor motors shall conform to degree of protection IP: 55 as per IS: 4691and shall be of weather-proof construction. Outdoor motors shall be installed under a suitable canopy

4.2 Motors upto 160KW shall have Totally Enclosed Fan Cooled (TEFC) enclosures, the method of cooling conforming to IC-0141 or IC-0151 of IS: 6362.

Motors rated above 160 KW shall be Closed Air Circuit Air (CACA) cooled

4.3 Motors shall be designed with cooling fans suitable for both directions of rotation.

4.4. Motors shall not be provided with any electric or pneumatic operated external fan for cooling the motors.

4.5 Frames shall be designed to avoid collection of moisture and all enclosures shall be provided with facility for drainage at the lowest point.

4.6 In case Class 'F' insulation is provided for LV motors, temperature rise shall be limited to the limits applicable to Class 'B' insulation.
In case of continuous operation at extreme voltage limits the temperature limits specified in table-1 of IS:325 shall not exceed by more than 10°C.

4.7 **Terminals and Terminal Boxes**

4.7.1 Terminals, terminal leads, terminal boxes, windings tails and associated equipment shall be suitable for connection to a supply system having a short circuit level, specified in the Data Sheet-A.

Unless otherwise stated in Data Sheet-A, motors of rating 110 kW and above will be controlled by circuit breaker and below 110 kW by switch fuse-contactor. The terminal box of motors shall be designed for the fault current mentioned in data sheet "A".

4.7.2 unless otherwise specified or approved, phase terminal boxes of horizontal motors shall be positioned on the left hand side of the motor when viewed from the non-driving end.

4.7.3 Connections shall be such that when the supply leads R, Y & B are connected to motor terminals A B & C or U, V & W respectively, motor shall rotate in an anticlockwise direction when viewed from the non-driving end. Where such motors require clockwise rotation, the supply leads R, Y, B will be connected to motor terminals A, C, B or U W & V respectively.

4.7.4 Permanently attached diagram and instruction plate made preferably of stainless steel shall be mounted inside terminal box cover giving the connection diagram for the desired direction of rotation and reverse rotation.

4.7.5 Motor terminals and terminal leads shall be fully insulated with no bar live parts. Adequate space shall be available inside the terminal box so that no difficulty is encountered for terminating the cable specified in Data Sheet-A.

4.7.6 Degree of protection for terminal boxes shall be IP 55 as per IS 4691.

4.7.7 Separate terminal boxes shall be provided for space heaters.. If this is not possible in case of LV motors, the space heater terminals shall be adequately segregated from the main terminals in the main terminal box. Detachable gland plates with double compression brass glands shall be provided in terminal boxes.

4.7.8. Phase terminal boxes shall be suitable for 360 degree of rotation in steps of 90 degree for LV motors.

4.7.9 Cable glands and cable lugs as per cable sizes specified in Data Sheet-A shall be included. Cable lugs shall be of tinned Copper, crimping type.

4.8 Two separate earthing terminals suitable for connecting G.I. or MS strip grounding conductor of size given in Data Sheet-A shall be provided on opposite sides of motor frame. Each terminal box shall have a grounding terminal.

4.9 **General**

4.9.1 Motors provided for similar drives shall be interchangeable.

4.9.2 Suitable foundation bolts are to be supplied alongwith the motors.

4.9.3 Motors shall be provided with eye bolts, or other means to facilitate safe lifting if the weight is 20Kgs. and above.

4.9.4 Necessary fitments and accessories shall be provided on motors in accordance with the latest Indian Electricity rules 1956.

4.9.5 All motors rated above 30 kW shall be provided with space heaters to maintain the motor internal air temperature above the dew point. Unless otherwise specified, space heaters shall be suitable for a supply of 240V AC, single phase, 50 Hz.

4.9.6 Name plate with all particulars as per IS: 325 shall be provided

4.9.7 Unless otherwise specified, the colour of finish shall be grey to Shade No. 631 and 632 as per IS:5 for motors installed indoor and outdoor respectively. The paint shall be epoxy based and shall be suitable for withstanding specified site conditions.

## 5.0 INSPECTION AND TESTING

5.1 All materials, components and equipments covered under this specification shall be procured, manufactured, as per the BHEL standard quality plan No. PED-506-00-Q-006/0 and PED-506-00-Q-007/2 enclosed with this specification and which shall be complied.

5.2 LV motors of type-tested design shall be provided. Valid type test reports not more than 5 year shall be furnished. In the absence of these, type tests shall have to be conducted by manufacturer without any commercial implication to purchaser.

5.3 All motors shall be subjected to routine tests as per IS: 325 and as per BHEL standard quality plan.

5.4 Motors shall also be subjected to additional tests, if any, as mentioned in Data Sheet A.

## 6.0 DRAWINGS TO BE SUBMITTED AFTER AWARD OF CONTRACT

a) OGA drawing showing the position of terminal boxes, earthing connections etc.
b) Arrangement drawing of terminal boxes.
c) Characteristic curves:
(*To be given for motor above 55 kW unless otherwise specified in Data Sheet*).

i) Current vs. time at rated voltage and minimum starting voltage.
ii) Speed vs. time at rated voltage and minimum starting voltage.
iii) Torque vs. speed at rated voltage and minimum voltage.
For the motors with solid coupling the above curves i), ii), iii) to be furnished for the motors coupled with driven equipment. In case motor is coupled with mechanical equipment by fluid coupling, the above curves shall be furnished with and without coupling.
iv) Thermal withstand curve under hot and cold conditions at rated voltage and max. permissible voltage.

# SECTION – 'D'
# STANDARD TECHNICAL SPECIFICATION

1.0 GENERAL

This specification covers the design, manufacture, inspection & testing at vendor's works, packing and delivery to site of cable trefoil clamps.

2.0 CODES AND STANDARDS

The material, constructional features and various processes involved in manufacture shall comply with currently applicable Indian standards. All relevant parts of the applicable Indian standards shall be considered.

3.0 DESIGN REQUIREMENTS AND CONSTRUCTIONAL FEATURES

3.1 All items listed in Bill of Quantities (Sec-c of the specification) shall be manufactured as per Datasheet –A.

3.2 Cable trefoil clamps shall be any one of the following type

a) Type – I : Cable trefoil clamps made of Aluminium Alloy

b) Type – II: Cable trefoil clamps made of Nylon – 6 material

3.3 The cable trefoil clamp shall be designed to operate satisfactorily and meet all the requirements specified in Datasheet – A.

3.4 The cable trefoil clamps shall be designed & manufactured in accordance with the best engineering practices and shall be such as has been proved to be suitable for intended purpose.

3.5 The Nylon – 6 cable trefoil clamps shall meet the following requirements

a) High mechanical strength

b) Resistance to chemicals

c) Non hygroscopic

d) Fire retardant

e) Bolts, nuts & washers used shall be hot dip galvanised for both type of trefoil clamps.

4.0 QUALITY/ INSPECTION:

4.1 The following stages of manufacture shall be stage inspected by purchaser or his duly authorised representative.

i) Inspection of raw materials

ii) Inspection of manufacturing processes

iii) Inspection of finished products.

iv) Inspection of packing material and procedure.

4.2 The inspection will be carried out as per BHEL approved quality plan furnished by vendor.

5.0 TESTING:

5.1 The supplier shall perform all tests necessary to ensure that the material and workmanship conform to the relevant standards and comply with the requirements of this specification.

5.2 The tests shall be in accordance with appropriate Indian standards. The extent of the tests to be performed by the supplier shall include but not be limited to the following: -

a) Routine Tests:

(i)Dimension checks

b) Acceptance Test:

i) Dimension checks

6.0 PACKING

The material shall be packed to ensure protection against damage during transit, storage for prolonged periods and handling. Packing procedure shall be subject to the purchaser's approval.

7.0 DRAWING DATA AND DOCUMENTS REQUIRED (within two weeks of award of contract)

i)Manufacturing Quality Plan with bidder's signatures and seal affixed.
ii)GA drg. of clamp.

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **QUALITY PLAN** | | CUSTOMER : | | | PROJECT<br>TITLE | | | SPECIFICATION :<br>NUMBER : | | | |
| | | | BIDDER/ VENDOR : | | | QUALITY PLAN<br>NUMBER PED-506-00-Q-007/2 | | | SPECIFICATION :<br>TITLE | | | |
| | SHEET 1 OF 9 | | SYSTEM | | | ITEM: AC ELECT. MOTORS 75KW & ABOVE (LV & MV) | | | SECTION | | | VOLUME III |
| SL. NO. | COMPONENT/OPERATION | CHARACTERISTIC CHECK | CAT. | TYPE/ METHOD OF CHECK | EXTENT OF CHECK | REFERENCE DOCUMENT | ACCEPTANCE NORM | FORMAT OF RECORD | AGENCY<br>**P** | **W** | **V** | REMARKS |
| **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | | | **11** |
| 1.0 | RAW MATERIAL & BROUGHT CONTROL | | | | | | | | | | | |
| 1.1 | SHEET STEEL, PLATES, SECTION, EYEBOLTS | 1.SURFACE CONDITION | MA | VISUAL | 100% | - | FREE FROM BLINKS, CRACKS, WAVINESS ETC | LOG BOOK | 3 | - | - | |
| | | 2.DIMENSIONS | MA | MEASUREMENT | SAMPLE | MANFR'S DRG./SPEC | MANFR'S DRG./SPEC | -DO- | 3 | - | - | |
| | | 3.PROOF LOAD TEST (EYE BOLT) | MA | MECH. TEST | -DO- | -DO- | -DO- | INSPEC. REPORT | 3 | - | - | |
| 1.2 | HARDWARES | 1.SURFACE CONDITION | MA | VISUAL | 100% | | FREE FROM CRACKS, UN-EVENNESS ETC. | -DO- | 3 | - | - | |
| | | 2.PROPERTY CLASS | MA | VISUAL | SAMPLES | MANFR'S DRG./SPEC BOOK | RELEVENT IS/SPEC. | SUPPLIERS TC & LOG | 3 | - | 2 | PROPERTY CLASS MARKING SHALL BE CHECKED BY THE VENDOR |
| 1.3 | CASTING | 1.SURFACE CONDITION | MA | VISUAL | 100% | | FREE FROM CRACKS, BLOW HOLES ETC. | LOG BOOK | 3 | - | - | |
| | | 2.CHEM. & PHY. PROP. | MA | CHEM & MECH TEST | 1/HEAT NO. | MANFR'S DRG./SPEC | RELEVENT IS/ | SUPPLIER'S TC | 3 | - | 2 | HEAT NO. SHALL BE VERIFIED |
| | | 3.DIMENSIONS | MA | MEASUREMENT | 100% | MANUFR'S DRG. | MANUFR'S DRG. | LOG BOOK | 3 | - | - | |
| 1.4 | PAINT & VARNISH | 1.MAKE, SHADE, SHELF LIFE & TYPE | MA | VISUAL | 100% CONTINUOUS | MANFR'S DRG./SPEC | MANFR'S DRG./SPEC | LOG BOOK | 3 | - | - | |

| **BHEL** | **PARTICULARS** | **BIDDER/VENDOR** | |
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| | **NAME** | | |
| | **SIGNATURE** | | |
| | **DATE** | | BIDDER'S/VENDORS COMPANY SEAL |

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| | | **QUALITY PLAN** | CUSTOMER : | | | PROJECT<br>TITLE | | | SPECIFICATION :<br>NUMBER : | | | |
| | | | BIDDER/ :<br>VENDOR | | | QUALITY PLAN<br>NUMBER PED-506-00-Q-007/2 | | | SPECIFICATION :<br>TITLE | | | |
| | | SHEET 2 OF 9 | SYSTEM | | | ITEM: AC ELECT. MOTORS 75KW & ABOVE (LV & MV) | | | SECTION | | | VOLUME III |
| SL. NO. | COMPONENT/OPERATION | CHARACTERISTIC CHECK | CAT. | TYPE/ METHOD OF CHECK | EXTENT OF CHECK | REFERENCE DOCUMENT | ACCEPTANCE NORM | FORMAT OF RECORD | AGENCY | | | REMARKS |
| | | | | | | | | | **P** | **W** | **V** | |
| **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | | | **11** |
| 1.5 | SHAFT<br>(FORGED OR ROLLED) | 1. SURFACE COND. | MA | VISUAL | 100% | - | FREE FROM VISUAL DEFECTS | -DO- | 3 | - | - | VENDOR'S APPROVAL IDENTIFICATION SHALL BE MAINTAINED |
| | | 2. CHEM. & PHYSICAL PROPERTIES | MA | CHEM. & PHYSICAL TESTS | 1/HEAT NO. OR HEAT TREATMENT BATCH NO | MFG. DRG. SPEC. | RELEVANT IS | SUPPLIER'S TC | 3 | - | 2 | |
| | | 3. DIMENSIONS | MA | MEASUREMENT | 100% | -DO- | MANUFR'S DRG. | LOG BOOK | 3 | - | - | |
| | | 4.INTERNAL FLOWS | CR | UT | -DO- | ASTM-A388 | MANUFR'S SPEC.<br>BHEL SPEC. | -DO- | 3 | 2 | 1 | FOR DIA OF 55 MM & ABOVE |
| 1.6 | SPACE HEATERS, CONNEC-TORS, TERMINAL BLOCKS, CABLES, CABLE LUGS, CARBON BRUSH TEMP. DETECTORS, RTD, BTD'S | 1. MAKE & RATING | MA | VISUAL | -DO- | MANUFR'S DRG. SPEC. | MANUFR'S DRG. SPEC. | -DO- | 3 | - | - | |
| | | 2. PHYSICAL COND. | MA | -DO- | -DO- | - | NO BREAKAGE ON OTHER PHY. DESIGN | -DO- | 3 | - | - | |
| | | 3.DIMENSIONS (WHEREVER APPLICABLE) | MA | MEASUREMENT | SAMPLE | MANUFR'S DRG./ SPEC. | MANUFR'S DRG. / SPEC. | -DO- | 3 | - | - | |
| | | 4.PERFORMANCE/ CALIBRATION | MA | TEST | 100% | -DO- | -DO- | INSP. REPORT | 3 | - | - | |

| **BHEL** | **PARTICULARS** | **BIDDER/VENDOR** | |
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| | **NAME** | | |
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| | **QUALITY PLAN** | | CUSTOMER : | | | PROJECT TITLE | | | SPECIFICATION : NUMBER : | | | |
| | | | BIDDER/ VENDOR : | | | QUALITY PLAN NUMBER PED-506-00-Q-007/2 | | | SPECIFICATION : TITLE | | | |
| | SHEET 3 OF 9 | | SYSTEM | | | ITEM: AC ELECT. MOTORS 75KW & ABOVE (LV & MV) | | | SECTION | | | VOLUME III |
| SL. NO. | COMPONENT/OPERATION | CHARACTERISTIC CHECK | CAT. | TYPE/ METHOD OF CHECK | EXTENT OF CHECK | REFERENCE DOCUMENT | ACCEPTANCE NORM | FORMAT OF RECORD | AGENCY P | W | V | REMARKS |
| **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | | | **11** |
| 1.7 | OTHER INSULATING MATERIALS LIKE SLEEVES, BINDINGS CORDS, PAPERS, PRESS BOARDS ETC. | 1. SURFACE COND. | MA | VISUAL | 100% | - | NO VISUAL DEFECTS | INSPT. REPORT | 3 | - | - | |
| | | 2. OTHER CHARACTERISTICS | MA | TEST | SAMPLE | MANUF'S SPEC. | MANUF'S SPEC. | LOG BOOK AND OR SUPPLIER'S TC | 3 | - | 2 | |
| 1.8 | SHEET STAMPING (PUNCHED) | 1. SURFACE COND. | MA | VISUAL | 100% | - | NO VISUAL DEFECTS (FREE FROM BURS) | LOG BOOK | 3 | - | - | |
| | | 2.DIMENSIONS INCLUDING BURS HEIGHT | MA | MEASUREMENT | SAMPLE | MANUFR'S DRG. . | MANUFR'S DRG. | -DO- | 3 | - | 2 | FOR MV MOTOR INSULA-TION/VARNISH THICKNESS SHALL BE MORE THAN THE BURS HEIGHT |
| | | 3. ACCEPTANCE TESTS | MA | ELECT. & MECH TESTS | -DO- | MANUF'S SPEC./ RELEVANT IS | RELEVANT IS | SUPPLIER'S TC | 3 | - | 2 | |
| 1.9 | CONDUCTORS | 1. SURFACE FINISH | MA | VISUAL | 100% | - | FREE FROM VISUAL DEFECTS | LOG BOOK | 3 | - | - | |
| | | 2.ELECT. PROP, & MECH. PROP | MA | ELECT. & MECH.TEST | SAMPLES | RELEVANT IS/ BS OR OTHER STANDARDS | RELEVANT IS/ BS OR OTHER STANDARDS | SUPPLIERS TC & VENDOR'S INSPN. REPORTS | 3/2 | - | 2 | |

| **BHEL** | **PARTICULARS** | **BIDDER/VENDOR** | |
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| | **NAME** | | |
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| | **QUALITY PLAN** | | CUSTOMER : | | | PROJECT TITLE | | | SPECIFICATION : NUMBER : | | | |
| | | | BIDDER/ VENDOR : | | | QUALITY PLAN NUMBER PED-506-00-Q-007/2 | | | SPECIFICATION : TITLE | | | |
| | SHEET 4 OF 9 | | SYSTEM | | | ITEM: AC ELECT. MOTORS 75KW & ABOVE (LV & MV) | | | SECTION | | | VOLUME III |
| SL. NO. | COMPONENT/OPERATION | CHARACTERISTIC CHECK | CAT. | TYPE/ METHOD OF CHECK | EXTENT OF CHECK | REFERENCE DOCUMENT | ACCEPTANCE NORM | FORMAT OF RECORD | AGENCY P | W | V | REMARKS |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | | | 11 |
| | | 3.DIMENSIONS | MA | MEASUREMENT | -DO- | -DO- | -DO- | Log Book | 3 | - | - | |
| 1.10 | BEARINGS | 1.MAKE & TYPE | MA | VISUAL | 100% | MANFR'S DRG. | MANFR'S DRG. | -DO- | 3 | - | - | |
| | | 2.DIMENSIONS | MA | MEASUREMENT | SAMPLE | BHEL DATA SHEET | BHEL DATA SHEET BEARING MANUF'S CATALOGUES | -DO- | 3 | - | - | |
| | | 3.SURFACE FINISH | MA | VISUAL | 100% | - | FREE FROM VISUAL DEFECTS | -DO- | 3 | - | - | |
| 1.11 | SLIP RING | 1.SURFACE COND. | MA | VISUAL | 100% | - | -DO- | -DO- | 3 | - | - | |
| | | 2.DIMENSIONS | MA | MEASUREMENT | SAMPLE | MANUF'S DRG | MANUF'S DRG | -DO- | 3 | - | - | |
| | | 3.TEMP.WITH-STAND CAPACITY | MA | ELECT.TEST | -DO- | MANUF'S SPEC. | MANUF'S SPEC. | -DO- | 3 | - | - | |
| | | 4.HV/IR | MA | -DO- | 100% | -DO- | -DO- | -DO- | 3 | - | - | |
| 1.12 | OIL SEALS & GASKETS | 1.MATERIAL OF GASKET | MA | VISUAL | 100% | MANUF'S DRG/SPECS | MANUF'S DRG./ SPECS. | -DO- | 3 | - | - | |
| | | 2.SURFACE COND. | MA | VISUAL | 100% | - | FREE FROM VISUAL DEFECTS | -DO- | 3 | - | - | |
| | | 3.DIMENSIONS | MA | MEASUREMENT | SAMPLE | MANUF'S DRG | MANUF'S DRG | -DO- | 3 | - | - | |

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| **BHEL** | **PARTICULARS** | **BIDDER/VENDOR** | |
| | **NAME** | | |
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| | **QUALITY PLAN** | | CUSTOMER : | | | PROJECT TITLE | | | SPECIFICATION : NUMBER : | | | |
| | | | BIDDER/ VENDOR : | | | QUALITY PLAN NUMBER PED-506-00-Q-007/2 | | | SPECIFICATION : TITLE | | | |
| | SHEET 5 OF 9 | | SYSTEM | | | ITEM: AC ELECT. MOTORS 75KW & ABOVE (LV & MV) | | | SECTION | | | VOLUME III |
| SL. NO. | COMPONENT/OPERATION | CHARACTERISTIC CHECK | CAT. | TYPE/ METHOD OF CHECK | EXTENT OF CHECK | REFERENCE DOCUMENT | ACCEPTANCE NORM | FORMAT OF RECORD | AGENCY P | W | V | REMARKS |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | | | 11 |
| 2.0 | IN PROCESS | | | | | | | | | | | |
| 2.1 | STATOR FRAME WELDING (IN CASE OF FABRICATED STATOR ) | 1.WORKMANSHIP & CLEANNESS | MA | VISUAL | 100% | -DO- | GOOD FINISH | LOG BOOK | 3 | - | - | |
| | | 2.DIMENSIONS | MA | MEASUREMENT | -DO- | MANUF'S DRG | MANUF'S DRG | -DO- | 3 | - | - | |
| 2.2 | MACHINING | 1.FINISH | MA | VISUAL | 100% | -DO- | GOOD FINISH | LOG BOOK | 3 | - | - | |
| | | 2.DIMENSIONS | MA | MEASUREMENT | -DO- | MANUF'S DRG | MANUF'S DRG | -DO- | 3 | - | - | |
| | | 3.SHAFT SURFACE FLOWS | MA | PT | -DO- | RELEVENT SPEC./ ASTM-E165 | MANUFR'S SPEC./ BHEL SPEC./ | -DO- | 3 | - | 1 | |
| 2.3 | PAINTING | 1.SURFACE PREPARATION | MA | VISUAL | 100% | MANFR'S SPEC/BHEL SPEC./ RELEVANT STAND | BHEL SPEC. SAME AS COL.7 | LOG BOOK | 3 | - | - | |
| | | 2.PAINT THICKNESS (BOTH PRIMER & FINISH COAT) | MA | MEASUREMENT BY ELCOMETER | SAMPLE | -DO- | -DO- | -DO- | 3 | - | 2 | |
| | | 3.SHADE | MA | VISUAL | -DO- | -DO- | -DO- | Log Book | 3 | - | - | |
| | | 4.ADHESION | MA | CROSS CUTTING & TAPE TEST | -DO- | -DO- | -DO- | Log Book | 3 | - | - | |

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| **BHEL** | **PARTICULARS** | **BIDDER/VENDOR** | |
| | **NAME** | | |
| | **SIGNATURE** | | |
| | **DATE** | | BIDDER'S/VENDORS COMPANY SEAL |

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| | **QUALITY PLAN** | | CUSTOMER : | | | PROJECT TITLE | | | SPECIFICATION : NUMBER : | | | |
| | | | BIDDER/ VENDOR : | | | QUALITY PLAN NUMBER PED-506-00-Q-007/2 | | | SPECIFICATION : TITLE | | | |
| | SHEET 6 OF 9 | | SYSTEM | | | ITEM: AC ELECT. MOTORS 75KW & ABOVE (LV & MV) | | | SECTION | | | VOLUME III |
| SL. NO. | COMPONENT/OPERATION | CHARACTERISTIC CHECK | CAT. | TYPE/ METHOD OF CHECK | EXTENT OF CHECK | REFERENCE DOCUMENT | ACCEPTANCE NORM | FORMAT OF RECORD | AGENCY P | AGENCY W | AGENCY V | REMARKS |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | | | 11 |
| 2.4 | SHEET STACKING | 1.COMPLETENESS | MA | MEASUREMENT | SAMPLE | MANUFR'S SPEC. | MANUFR'S SPEC. | Log Book | 3 | - | - | |
| | | 2.COMPRESSION & TIGHTENING | MA | MEASUREMENT | 100% | -DO- | -DO- | Log Book | 3 | - | - | |
| | | 3.CORE LOSS & HOTOPOT | MA | ELECT.TEST | -DO- | -DO- | -DO- | Log Book | 3 | - | 2 | (FOR MOTORS OF 2MW AND ABOVE) |
| 2.5 | WINDING | 1.COMPLETENESS | CR | VISUAL | 100% | MANUFR'S SPEC./BHEL SPEC. | MANUFR'S SPEC./BHEL SPEC. | Log Book | 3 | - | - | |
| | | 2.CLEANLINESS | CR | -DO- | -DO- | -DO- | -DO- | Log Book | 3 | - | - | |
| | | 3.IR-HV-IR | CR | ELECT. TEST | -DO- | -DO- | -DO- | Log Book | 3 | - | - | |
| | | 4.RESISTANCE | CR | -DO- | -DO- | -DO- | -DO- | Log Book | 3 | - | 2 | |
| | | 5.INTERTURN INSULATION | CR | -DO- | -DO- | -DO- | -DO- | Log Book | 3 | 2 | - | |
| | | 6.SURGE WITH STAND AND TAN. DELTA TEST | CR | -DO- | -DO- | -DO- | -DO- | Log Book | 3 | 2 | 1 | FOR MV MOTOR |
| 2.6 | IMPREGNATION | 1.VISCOSCITY | MA | PHY. TEST | AT STARTING | -DO- | -DO- | Log Book | 3 | - | - | |
| | | 2.TEMP. PRESSURE VACCUM | MA | PROCESS CHECK | CONTINUOUS | -DO- | -DO- | Log Book | 3 | - | - | |
| | | 3.NO. OF DIPS | MA | -DO- | -DO- | -DO- | -DO- | Log Book | 3 | - | 2 | THREE DIPS TO BE GIVEN |

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| **BHEL** | **PARTICULARS** | **BIDDER/VENDOR** | |
| | **NAME** | | |
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| | **QUALITY PLAN** | | CUSTOMER : | | | PROJECT<br>TITLE | | | SPECIFICATION :<br>NUMBER : | | | |
| | | | BIDDER/ VENDOR : | | | QUALITY PLAN<br>NUMBER PED-506-00-Q-007/2 | | | SPECIFICATION :<br>TITLE | | | |
| | SHEET 7 OF 9 | | SYSTEM | | | ITEM: AC ELECT. MOTORS 75KW & ABOVE (LV & MV) | | | SECTION | | | VOLUME III |
| SL. NO. | COMPONENT/OPERATION | CHARACTERISTIC CHECK | CAT. | TYPE/ METHOD OF CHECK | EXTENT OF CHECK | REFERENCE DOCUMENT | ACCEPTANCE NORM | FORMAT OF RECORD | AGENCY | | | REMARKS |
| | | | | | | | | | **P** | **W** | **V** | |
| **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | | | **11** |
| | | 4.DURATION | MA | -DO- | -DO- | -DO- | -DO- | Log Book | 3 | - | 2 | |
| 2.7 | COMPLETE STATOR ASSEMBLY | 1.COMPACTNESS & CLEANLINESS | MA | VISUAL | 100% | -DO- | -DO- | Log Book | 3 | - | - | |
| 2.8 | BRAZING/COMPRESSION JOINT | 1.COMPLETENESS | CR | -DO- | -DO- | -DO- | -DO- | Log Book | 3 | - | - | |
| | | 2.SOUNDNESS | CR | MALLET TEST & MV TEST | -DO- | -DO- | -DO- | Log Book | 3 | - | - | |
| | | 3.HV | MA | ELECT. TEST | -DO- | -DO- | -DO- | Log Book | 3 | - | - | |
| 2.9 | COMPLETE ROTOR ASSEMBLY | 1.RESIDUAL UNBALANCE | CR | DYN. BALANCE | -DO- | MFG SPEC./ ISO 1940 | MFG. DWG. | Log Book | 3 | 2 | 1 | VERIFICATION FOR MV MOTOR ONLY |
| | | 2.SOUNDNESS OF DIE CASTING | CR | ELECT. (GROWLER TEST) | -DO- | MFG. SPEC. | MFG. SPEC. | Log Book | 3 | 2 | - | |
| 2.10 | ASSEMBLY | 1.ALIGNMENT | MA | MEAS. | -DO- | -DO- | -DO- | Log Book | 3 | - | - | |
| | | 2.WORKMANSHIP | MA | VISUAL | -DO- | -DO- | -DO- | Log Book | 3 | - | - | |
| | | 3.AXIAL PLAY | MA | MEAS. | -DO- | -DO- | -DO- | Log Book | 3 | - | 2 | |
| | | 4.DIMENSIONS | MA | -DO- | -DO- | MFG.DRG./ MFG SPEC. | MFG. DRG/ RELEVANT IS | Log Book | 3 | - | - | |
| | | 5.CORRECTNESS, COMPLETENESS TERMINATIONS/ MARKING/ COLOUR CODE | MA | VISUAL | 100% | MFG SPEC. RELEVANT IS | MFG SPEC. RELEVANT IS | Log Book | 3 | - | - | |

| **BHEL** | **PARTICULARS** | **BIDDER/VENDOR** | |
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| | **NAME** | | |
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| | **QUALITY PLAN** | | CUSTOMER : | | | PROJECT TITLE | | | SPECIFICATION : NUMBER : | | | |
| | | | BIDDER/ VENDOR : | | | QUALITY PLAN NUMBER PED-506-00-Q-007/2 | | | SPECIFICATION : TITLE | | | |
| | SHEET 8 OF 9 | | SYSTEM | | | ITEM: AC ELECT. MOTORS 75KW & ABOVE (LV & MV) | | | SECTION | | | VOLUME III |
| SL. NO. | COMPONENT/OPERATION | CHARACTERISTIC CHECK | CAT. | TYPE/ METHOD OF CHECK | EXTENT OF CHECK | REFERENCE DOCUMENT | ACCEPTANCE NORM | FORMAT OF RECORD | AGENCY P | AGENCY W | AGENCY V | REMARKS |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | | | 11 |
| 3.0 | TESTS | 1.TYPE TESTS INCLUDING SPECIAL TESTS AS PER BHEL SPEC. | MA | ELECT.TEST | 1/TYPE/SIZE | IS-325/ BHEL SPEC./ DATA SHEET | IS-325/ BHEL SPEC./ DATA SHEET | TEST REPORT | 3 | 1 | 1,2 | NOTE - 1 |
| | | 2.ROUTINE TESTS INCLUDING SPECIAL TEST AS PER BHEL SPEC. | MA | -DO- | 100% | -DO- | -DO- | -DO- | 3 | 1,2 | 1,2 | NOTE - 2 |
| | | 3.VIBRATION | MA | -DO- | 100% | IS-12075 | IS-12075 | -DO- | 3 | 1,2 | - | |
| | | 4.OVERALL DIMENSIONS AND ORIENTATION | MA | MEASUREMENT & VISUAL | 100% | APPROVED DRG/DATA SHEET | APPROVED DRG/DATA SHEET & RELEVANT IS | INSPC. REPORT | 3 | 2,1 | - | |
| | | 5.DEGREE OF PROTECTION | MA | ELECT. & MECH. TEST | 1/TYPE/ SIZE | RELEVANT IS | BHEL SPEC. AND DATA SHEET | TC | 3 | - | 2,1 | TC FROM AN INDEPENDENT LABORATORY NOTE-3 |
| | | 6.NAMEPLATE DETAILS | MA | VISUAL | 100% | IS-325 & DATA SHEET | IS-325 & DATA SHEET | INSPC. REPORT | 3 | 2,1 | - | |
| | | 7.EXPLOSION FLAME PROOF NESS (IF SPECIFIED) | MA | EXPLOSION FLAME PROOF TEST | 1/TYPE | IS-3682 IS-8239 IS-8240 | IS-3682 IS-8239 IS-8240 | TC | 3 | - | 2,1 | NOTE-3 |
| | | 8.PAINT SHADE, THICKNESS & FINISH | MA | VISUAL & MEASUREMENT BY ELKOMETER | SAMPLE | BHEL SPEC. & DATA SHEET | BHEL SPEC. & DATA SHEET | TC | 3 | 2,1 | - | SAMPLING PLAN TO BE DECIDED BY INSPECTION AGENCY |

| **BHEL** | **PARTICULARS** | **BIDDER/VENDOR** | |
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| | **QUALITY PLAN** | | CUSTOMER : | | | PROJECT TITLE | | | SPECIFICATION : NUMBER : | | | |
| | | | BIDDER/ VENDOR : | | | QUALITY PLAN NUMBER PED-506-00-Q-007/2 | | | SPECIFICATION : TITLE | | | |
| | SHEET 9 OF 9 | | SYSTEM | | | ITEM: AC ELECT. MOTORS 75KW & ABOVE (LV & MV) | | | SECTION | | | VOLUME III |
| SL. NO. | COMPONENT/OPERATION | CHARACTERISTIC CHECK | CAT. | TYPE/ METHOD OF CHECK | EXTENT OF CHECK | REFERENCE DOCUMENT | ACCEPTANCE NORM | FORMAT OF RECORD | AGENCY P | W | V | REMARKS |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | | | 11 |

NOTES:

1 DEPENDING UPON THE SIZE AND CRITICALLY, WITNESSING BY BHEL SHALL BE DECIDED.

2 ROUTINE TESTS ON 100% MOTORS SHALL BE DONE BY THE VENDOR. HOWEVER, BHEL SHALL WITNESS ROUTINE TESTS ON RANDOM SAMPLES. THE SAMPLING PLAN SHALL BE MUTUALLY AGREED UPON.

3 IN CASE TEST CERTIFICATES FOR THESE TESTS ON SIMILAR TYPE, SIZE AND DESIGN OF MOTOR FROM INDEPENDENT LABORATORY ARE AVAILABLE, THESE TEST MAY NOT BE REPEATED.

4 WHEREVER CUSTOMER IS INVOLVED IN INSPECTION WITH THE CUSTOMERS, AGENCY (1) SHALL MEAN BHEL AND CUSTOMERS BOTH TOGETHER.

| **BHEL** | **PARTICULARS** | **BIDDER/VENDOR** | |
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| | **QUALITY PLAN** | | CUSTOMER : | | | PROJECT<br>TITLE | | | SPECIFICATION :<br>NUMBER : | | | |
| | | | BIDDER/ VENDOR : | | | QUALITY PLAN<br>NUMBER PED-506-00-Q-006/0 | | | SPECIFICATION<br>TITLE | | | |
| | SHEET 1 OF 2 | | SYSTEM | | | ITEM AC ELECT. MOTORS BELOW 75KW (LV) | | | SECTION | | | VOLUME III |
| SL. NO. | COMPONENT/OPERATION | CHARACTERISTICS CHECK | CAT. | TYPE/ METHOD OF CHECK | EXTENT OF CHECK | REFERENCE DOCUMENT | ACCEPTANCE NORM | FORMAT OF RECORD | AGENCY P | AGENCY W | AGENCY V | REMARKS |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | | | 11 |
| 1.O | PAINTING | 1.SHADE | MA | VISUAL | SAMPLE | MANUFR'S SPEC/BHEL SPEC./RELEVANT STANDARD | BHEL SPEC. SAME AS COL.7 | LOG BOOK | 3 | - | - | |
| 2.0 | ASSEMBLY | 1.WORKMANSHIP | MA | VISUAL | 100% | MANUF'S SPEC | MANUF'S SPEC | -DO- | 3 | - | - | |
| | | 2.DIMENSIONS | MA | -DO- | -DO- | MFG. DRG./ MFG. SPEC. | MFG. DRG./ MFG. SPEC. | -DO- | 3 | - | - | |
| | | 3.CORRECTNESS COMPLETENESS TERMINATIONS/ MARKING/COLOUR CODE | MA | VISUAL | 100% | MFG.SPEC./ RELEVANT IS | MFG.SPEC. RELEVANT IS | -DO- | 3 | - | - | |
| 3.0 | TESTS | 1.ROUTINE TEST INCLUDING SPECIAL TEST AS PER BHEL SPEC. | MA | -DO- | 100% | IS-325/ BHEL SPEC./ DATA SHEET | SAME AS COL.7 | TEST REPORT | 3 | 2,1 | 2,1 | NOTE -1 |
| | | 2.OVERALL DIMENSIONS & ORIENTATION | MA | MEASUREMENT & VISUAL | 100% | APPROVED DRG/DATA SHEET | APPROVED DRG/DATA SHEET & RELEVANT IS | INSPN. REPORT | 2 | 1 | - | |

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| **BHEL** | **PARTICULARS** | **BIDDER/VENDOR** | |
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| | **QUALITY PLAN** | | CUSTOMER : | | | PROJECT TITLE | | | SPECIFICATION : NUMBER : | | | |
| | | | BIDDER/ VENDOR : | | | QUALITY PLAN NUMBER PED-506-00-Q-006/0 | | | SPECIFICATION : TITLE : | | | |
| | SHEET 2 OF 2 | | SYSTEM | | | ITEM AC ELECT. MOTORS BELOW 75KW (LV) | | | SECTION | | | VOLUME III |
| SL. NO. | COMPONENT/OPERATION | CHARACTERISTICS CHECK | CAT. | TYPE/ METHOD OF CHECK | EXTENT OF CHECK | REFERENCE DOCUMENT | ACCEPTANCE NORM | FORMAT OF RECORD | AGENCY P | AGENCY W | AGENCY V | REMARKS |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | | | 11 |
| | | 3.NAMEPLATE DETAILS | MA | VISUAL | 100% | IS-325 & DATA SHEET | IS-325 & DATA SHEET | INSPN. REPORT | 3 | 1 | - | |

NOTES:

1 ROUTINE TESTS ON 100% MOTORS SHALL BE DONE BY THE VENDOR. HOWEVER, BHEL SHALL WITNESS ROUTINE TESTS ON RANDOM SAMPLES. THE SAMPLING PLAN SHALL BE MUTUALLY AGREED UPON

2 WHERE EVER CUSTOMER IS INVOLVED IN INSPECTION, (1) SHALL MEAN BHEL AND CUSTOMERS BOTH TOGETHER.

3 FOR EXHAUST/VENTILATION FAN MOTORS OF RATING UPTO 1.5KW , ONLY ROUTINE TEST CERTIFICATES SHALL BE FURNISHED FOR SCRUTINY.

| **BHEL** | **PARTICULARS** | **BIDDER/VENDOR** | |
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| | **SIGNATURE** | | |
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FOREM NO. PEM-6041-0

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| | **QUALITY PLAN** | | CUSTOMER : | | | PROJECT TITLE | | | SPECIFICATION NUMBER | | | |
| | | | BIDDER/ VENDOR : | | | QUALITY PLAN NUMBER PED-506-00-Q-002/01 | | | SPECIFICATION TITLE | | | |
| | SHEET 1 OF 3 | | SYSTEM | | | ITEM :BOUGHT OUT ITEMS | | | SECTION | | | VOLUME III |
| SL. NO. | COMPONENT/OPERATION | CHARACTERISTIC CHECK | CAT. | TYPE/ METHOD OF CHECK | EXTENT OF CHECK | REFERENCE DOCUMENT | ACCEPTANCE NORM | FORMAT OF RECORD | AGENCY P | AGENCY W | AGENCY V | REMARKS |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | | | 11 |
| 1.0 | MATERIAL | | | | | | | | | | | |
| 1.1 | SECTIONS, HARDWARES, FLATS, ANGLES & CHANNEL | 1. DIMENSIONS | MA | MEASUREMENT | SAMPLE | BHEL TECH. SPEC./ DRG. /DATA SHEETS/ RELEVANT. IS | BHEL TECH. SPEC./ DRG. /DATA SHEETS/ RELEVANT. IS | TEST CERT. & INSPN. REPORT | 3/2 | - | 2 | NO VISUAL DEFECT |
| | | 2. SURFACE CONDITION | MA | VISUAL | 100% | -DO- | NO VISUAL DEFECTS | -DO- | 3/2 | - | 2 | TC FOR PLATING QUALITY TO BE PROVIDED |
| | | 3. SURFACE PROTECTION (HARDWARES) | MA | VISUAL | SAMPLE | -DO- | BHEL SPEC. | -DO- | 3/2 | - | 2 | |
| 1.2 | SWITCHGEAR COMPONENTS A) SWITCH, SFU'S. INSTRUMENT, TRANSF, FUSES, CONTACTORS AIR CIRCUIT BREAKERS, ISOLATORS. BIMETAL THERMAL RELAYS, MCB.S & MCCB.S | 1. TYPE TESTS | MA | ELECTRICAL | EACH TYPE | BHEL SPEC./ RELEVENT IS | BHEL SPEC./ RELEVENT IS | TEST CERTIFICATE | 3/2 | - | 2,1 | |
| | | 2. ROUTINE TESTS (FOR METERS CT'S & PT'S) | MA | ELECTRICAL | 100% | -DO- | -DO- | ROUTINE TEST CERTIFICATE | 3/2 | - | 2 | IF THESE ARE TAKEN FROM BHEL APPROVED SOURCE THEN TC NOT REQUIRED |
| | | 3. PHYSICAL CONDITION | MA | VISUAL | 100% | NO BREAKAGES/ DAMAGES | NO. BREAKAGES/ DAMAGES | INSPN. REPORT | 2 | - | - | |
| | | 4. MAKE TYPE RATING ETC. | MA | VISUAL | 100% | BHEL SPEC./ APPD. DRGS | BHEL SPEC./ APPD. DRGS | -DO- | 2 | - | - | TO BE PROCURED FROM APPROVED MAKE |
| | | 5. FUNCTIONAL TEST | MA | ELECTRICAL | 100% | RELEVENT IS | RELEVENT IS | -DO- | 2 | - | - | |

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| BHEL | QUALITY PLAN | | CUSTOMER | | | PROJECT TITLE | | | SPECIFICATION NUMBER | | | |
| | | | BIDDER/ VENDOR | | | QUALITY PLAN NUMBER PED-506-00-Q-002/01 | | | SPECIFICATION TITLE | | | |
| | SHEET 2 OF 3 | | SYSTEM | | | ITEM :BOUGHT OUT ITEMS | | | SECTION | | | VOLUME III |

| SL. NO. | COMPONENT/OPERATION | CHARACTERISTIC CHECK | CAT. | TYPE/ METHOD OF CHECK | EXTENT OF CHECK | REFERENCE DOCUMENT | ACCEPTANCE NORM | FORMAT OF RECORD | AGENCY P | AGENCY W | AGENCY V | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | | | 11 |
| | B) INSTRUMENTS, GAUGES, CONNECTORS, LUGS, GLANDS SPACE HEATER,THERMOSTAT, | 1. PHYSICAL CONDITION | MA | VISUAL | 100% | NO BREAKAGES/ DAMAGES | NO BREAKAGES/ DAMAGES | INSPECTIONN REPORT | 2 | - | - | |
| | TERMINAL BLOCKS, LAMPS, PUSHBUTTONS, SMALL , SWITCHES, NAMEPLATES, | 2. MAKE, TYPE, RATING ETC | MA | VISUAL | 100% | BHEL SPEC./ APPD. DRGS. | BHEL SPEC./ APPD. DRGS. | -DO- | 2 | - | - | TO BE PROCURED FROM APPROVED MAKE |
| | FERRULES, LABELS, STICKERS, PVC SLEEVES/ CHANNELS | 3. FUNCTIONAL | MA | ELECTRICAL | 100% | RELEVANT IS | RELEVANT IS | -DO- | 2 | - | - | |
| | C) RELAYS & TIMERS | 1. PHYSICAL CONDITION | MA | VISUAL | 100% | NO BREAKAGES/ DAMAGES | NO BREAKAGES/ DAMAGES | INSPECTION REPORT | 2 | - | - | |
| | | 2. MAKE, TYPE, RATING ETC | MA | VISUAL | 100% | BHEL SPEC./ APPD. DRGS. | BHEL SPEC./ APPD. DRGS. | -DO- | 2 | - | - | TO BE PROCURED FROM APPROVED MAKE |
| | | 3. FUNCTIONAL TEST | MA | ELECTRICAL | 100% | RELEVANT IS | RELEVANT IS | -DO- | 2 | - | - | |
| | D) PCB ASSEMBLY | REFER TO QP NO…….PED-557-00-Q-002 | | | | | | | | | | |
| 1.3 | INSULATING MATERIALS (FRP,SMC,DMC,ETC.) | 1. ELECTRICAL | CR | ELECT. TEST | SAMPLE | BHEL SPEC./ RELEVANT IS MANUFS. STD. | BHEL SPEC./ RELEVANT IS MANUFS. STD. | TEST CERTIFICATE | 2 | - | 1 | |
| | | 2. MECH. PROPS. | MA | MECH. TEST | SAMPLE | -DO- | -DO- | -DO- | 2 | - | 1 | |
| | | 3. TRACKING INDEX | MA | ELECT. TEST | SAMPLE | -DO- | -DO- | -DO- | 3/2 | - | 1 | |
| 1.4 | WIRES/CABLES | 1. SURFACE FINISH | MA | VISUAL | 100% | NO VISUAL DEFECT | NO VISUAL DEFECT | LOG BOOK/ INSP. REPORT | 2 | - | - | |
| | | 2. DIMENSIONS | MA | MEASUREMENT | SAMPLE | BHEL SPECN. | BHEL SPECN. | -DO- | 2 | - | - | |
| | | 3. HV TEST AT 80% OF ORIGINAL | CR HV | ELECT. TEST | 100% | IS:694 | IS:694 | -DO- | 2 | - | - | |

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| | QUALITY PLAN | CUSTOMER | | | PROJECT<br>TITLE | | | SPECIFICATION<br>NUMBER | | | | |
| | | BIDDER/<br>VENDOR | | | QUALITY PLAN<br>NUMBER PED-506-00-Q-002/01 | | | SPECIFICATION<br>TITLE | | | | |
| | SHEET 3 OF 3 | SYSTEM | | | ITEM :BOUGHT OUT ITEMS | | | SECTION | | | VOLUME III | |
| SL. NO. | COMPONENT/OPERATION | CHARACTERISTIC CHECK | CAT. | TYPE/ METHOD OF CHECK | EXTENT OF CHECK | REFERENCE DOCUMENT | ACCEPTANCE NORM | FORMAT OF RECORD | AGENCY P | AGENCY W | AGENCY V | REMARKS |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | | | 11 |
| 1.5 | BUSBARS | 1. DIMENSION | MA | MEASUREMENT | SAMPLE | BHEL SPEC./ APPD. DRGS. | BHEL SPEC./ APPD. DRGS. | LOG BOOK/ INSP. REPORT | 2 | - | - | |
| | | 2. SURFACE FINISH | MA | VISUAL | 100% | -DO- | -DO- | -DO- | 2 | - | - | |
| | | 3. MATERIAL GRADE | MA | VERIF. OF TC | 1/LOT | -DO- | -DO- | TEST. CERT. | 2 | - | 1 | |
| | | 4. CONDUCTIVITY | CR | ELECT. TEST | -DO- | -DO- | -DO- | -DO- | 2 | - | 1 | |
| 1.6 | SHEET STEEL | 1. THICKNESS | MA | MEASUREMENT | SAMPLE | -DO- | -DO- | -DO- | 2 | - | - | |
| | | 2. WAVINESS | MA | MEASUREMENT | 100% | -DO- | -DO- | -DO- | 2 | - | - | |
| | | 3. DUCTILITY | CR | BEND TEST | SAMPLES | -DO- | -DO- | TEST. CERT./ INSP. REPORT | 2 | - | - | |
| 1.7 | TRANSFORMER & REACTORS | 1. ROUTINE TESTS | MA | ELECT. TEST | 100% | RELEVANT STD. & BHEL SPEC. | RELEVANT STD. & BHEL SPEC. | TEST CERT. | 3 | - | 1,2 | |
| | | 2. TEMP. RISE TEST | MA | ELECT. TEST | 1/RATING | -DO- | -DO- | -DO- | 3 | - | 1,2 | |
| 1.8 | PAINTS | SHELF LIFE | MA | VISUAL | 100% | ....AS PER PAINTS MANUF'S. SPEC..... | | INSPN REPORT | 2 | - | - | |
| 1.9 | GASKETS (SYN. RUBBER ONLY) | 1. DIMENSION | MA | MEASUREMENT | SAMPLE | MANUFACTURER'S DRGS. | MANUFACTURER'S DRGS. | INSPN REPORT | 2 | - | - | |
| | | 2. SHORE HARDNESS | MA | TEST | -DO- | MANUFACTURER'S STD. | MANUFACTURER'S STD. | INSPN REPORT | 2 | - | - | |
| | | 3. AGEING | MA | TEST | -DO- | IS-3400/ BS-2752 | IS-3400/ BS-2752 | INSPN REPORT | 2 | - | - | |

| BHEL | PARTICULAR | BIDDER / VENDOR | |
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| | **QUALITY PLAN** | | CUSTOMER : | | | PROJECT<br>TITLE | | | SPECIFICATION :<br>NUMBER : | | | |
| | | | BIDDER/ :<br>VENDOR | | | QUALITY PLAN<br>NUMBER PED-507-00-Q-005/02 | | | SPECIFICATION :<br>TITLE | | | |
| | SHEET 1 OF 2 | | SYSTEM | | | ITEM : CABLE TRAYS & ACCESSORIES | | | SECTION | | | VOLUME III |
| SL. NO. | COMPONENT/OPERATION | CHARACTERISTIC CHECK | CAT. | TYPE/ METHOD OF CHECK | EXTENT OF CHECK | REFERENCE DOCUMENT | ACCEPTANCE NORM | FORMAT OF RECORD | AGENCY | | | REMARKS |
| | | | | | | | | | **P** | **W** | **V** | |
| **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | | | **11** |
| 1.0 | RAW MATERIAL | | | | | | | | | | | |
| 1.1 | ROLLED SHEET | 1.SURFACE FINISH | MA | VISUAL | 100% | IS-1079/ TECH. SPEC. | IS-1079/ TECH. SPEC. | QC RECORD | 2 | - | - | |
| | | 2.DIMENSIONS | MA | MEASUREMENT | 100% | -DO-/IS-1730 | -DO-/IS-1730 | -DO- | 2 | - | - | |
| | | 3.CHEM.& PHY. PROPERTY | MA | VERIFICATION OF TC | 100% | IS1079/TECH SPEC | IS1079/TECH SPEC | MILL TC | 3/2 | - | - | |
| 1.2 | ZINC | CHEM.COMP. | | CHEM TEST | EACH HEAT | IS-209 | IS-209 | TC | 3/2 | - | 1/2 | |
| 2.0 | IN-PROCESS | | | | | | | | | | | |
| 2.1 | FABRICATION | 1.DIMENSIONS & DISTORTION | MA | MEASUREMENT | 100% | APPD.DRG. | APPD.DRG. | QC RECORD | 2 | - | - | |
| | | 2.SURFACE FINISH | MA | VISUAL | 100% | | FREE FROM BURRS | -DO- | 2 | - | - | |
| | | 3.WELDING QUALITY | MA | VISUAL | 100% | PLANT STANDARD | FREE FROM DEFECTS & SLAG | -DO- | 2 | - | - | |
| | | 4.RIGIDITY (CABLE TRAYs) | MA | DEFLECTION TEST | 2 OF EACH SIZE | TECH. SPEC. | TECH. SPEC. | -DO- | 2 | - | - | |
| 2.2 | SURFACE PREPARATION | 1.CLEANING PICKLING & RINSING, BATH STRENGTH/ PURITY & TEMPERATURE | MA | CHEM. & MEASUREMENT | PERIODIC IN EACH SHIFT | IS:2629 | IS:2629 | QC RECORD | 2 | - | - | |
| | | 2. SURFACE QUALITY | MA | VISUAL | 100% | -DO- | -DO- | -DO- | 2 | - | - | |

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| **1. BHEL, 2. CONTACTOR, 3. SUPPLIER** | **PARTICULARS** | **BIDDER/VENDOR** | |
| **INDICATE 'P' PERFORM 'W' WITNESS & 'V' VERIFICATION** | **NAME** | | |
| | **SIGNATURE** | | |
| | **DATE** | | BIDDER'S/VENDORS COMPANY SEAL |

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| | | **QUALITY PLAN** | CUSTOMER : | | | PROJECT<br>TITLE | | | SPECIFICATION :<br>NUMBER : | | | |
| | | | BIDDER/ VENDOR : | | | QUALITY PLAN<br>NUMBER PED-507-00-Q-005/02 | | | SPECIFICATION :<br>TITLE | | | |
| | | SHEET 2 OF 2 | SYSTEM | | | ITEM : CABLE TRAYS & ACCESSORIES | | | SECTION | | | VOLUME III |
| SL. NO. | COMPONENT/OPERATION | CHARACTERISTIC CHECK | CAT. | TYPE/ METHOD OF CHECK | EXTENT OF CHECK | REFERENCE DOCUMENT | ACCEPTANCE NORM | FORMAT OF RECORD | AGENCY | | | REMARKS |
| | | | | | | | | | **P** | **W** | **V** | |
| **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | | | **11** |
| 2.3 | GALVANISING | 1.TEMPERATURE OF ZINC BATH | MA | TEMPERATURE INDICATOR | CONTINUOUS | IS-2629 | IS-2629 | -DO- | 2 | - | - | |
| | | 2.DURATION OF DIP | MA | VISUAL | -DO- | MANUFS.PRACT | MANUFS.PRACT | | 2 | - | - | |
| | | 3.SURFACE QUALITY | MA | VISUAL | 100% | -DO- | FREE FROM BURRS ROUGHNESS, SLAG FLUX. STAIN. ETC. | -DO- | 2 | - | - | |
| | | 4.GROSS QUANTITY & AGITATION | MA | TEST | PERIODIC | RELEVENT:IS | RELEVANT:IS | -DO- | 2 | - | - | |
| 3.0 | FINISHED ITEMS | | | | | | | | | | | |
| 3.1 | (CABLE TRAY, ACCESSO-RIES & HARDWARES) | 1.DIMENSIONS DISTORTION | MA | MEASUREMENT | IS-2500 (1) LEVEL IV | APPD. DRG | APPD. DRG | INSP.REPORT | 2 | 1 | - | BOLT AND NUTS SHALL BE OF REPUTED & APPROVED MAKE |
| | | 2,SURFACE FINISH | MA | VISUAL | -DO- | | FREE FROM BURRS, SLAG, ROUGHNESS, FLUX. STAIN. ETC. | -DO- | 2 | 1 | - | |
| | | 3.RIGIDITY (FOR TRAYS) | MA | DEFLECTION TEST | 1 OF EACH TYPE OF 600MM OR 450MM | TECH. SPEC. | TECH. SPEC. | -DO- | 2 | 1 | - | |
| | | 4.WEIGHT OF ZINC COATING | MA | CHEM. TEST | IS-4759 | IS-6745 | TECH. SPEC. | -DO- | 2 | 1 | - | |
| | | 5.UNIFORMITY OF ZINC COATING | MA | -DO- | -DO- | IS-2633 | IS-2633 | -DO- | 2 | 1 | - | |
| | | 6.THICKNESS OF ZINC COATING | MA | ELCOMETER | -DO- | TECH. SPEC. | TECH. SPEC. | -DO- | 2 | 1 | - | |
| | | 7.ADHESION | MA | MECH.TEST | IS-4759 | IS-2629 | IS-2629 | -DO- | 2 | 1 | - | |

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| **1. BHEL, 2. CONTACTOR, 3. SUPPLIER** | **PARTICULARS** | **BIDDER/VENDOR** |
| **INDICATE 'P' PERFORM 'W' WITNESS & 'V' VERIFICATION** | **NAME** | |
| | **SIGNATURE** | |
| | **DATE** | BIDDER'S/VENDORS COMPANY SEAL |

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| | **QUALITY PLAN** | | CUSTOMER : | | | PROJECT<br>TITLE | | | SPECIFICATION :<br>NUMBER : | | | |
| | | | BIDDER/ :<br>VENDOR | | | QUALITY PLAN<br>NUMBER PED-558-00-Q-001/01 | | | SPECIFICATION :<br>TITLE | | | |
| | SHEET 1 OF 3 | | SYSTEM | | | ITEM :ILLUMINATION | | | SECTION | | | VOLUME III |
| SL. NO. | COMPONENT/OPERATION | CHARACTERISTIC CHECK | CAT. | TYPE/ METHOD OF CHECK | EXTENT OF CHECK | REFERENCE DOCUMENT | ACCEPTANCE NORM | FORMAT OF RECORD | AGENCY | | | REMARKS |
| | | | | | | | | | **P** | **W** | **V** | |
| **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | | | **11** |
| 1.0 | CABLES & WIRES | 1.SURFACE DEFECTS | MA | VISUAL | SAMPLE | BHEL SPEC.<br>IS:694<br>IS:1554 | BHEL SPEC.<br>IS:694<br>IS:1554 | INSPN. REPORT & TEST REPORT FROM MANUFACTURER | 3/2 | 2 | 1 | TO BE PROCURED FROM APPROVED SOURCE |
| | | 2.DIMENSIONS | MA | MEASUREMENT | SAMPLE | -DO- | -DO- | -DO- | 3/2 | 2 | 1 | |
| | | 3.TYPE TESTS | CR | ELEC.TESTS | ONE/TYPE & SIZE | BHEL SPEC.<br>IS:694<br>IS:1554 | BHEL SPEC.<br>IS:694<br>IS:1554 | TEST CERT. | 3 | 2 | 1 | |
| | | 4.ACCEPTANCE TESTS | MA | -DO- | SAMPLING | -DO- | -DO- | -DO- | 3 | 2 | 1 | |
| | | 5.ROUTINE TESTS | MA | -DO- | 100% | -DO- | -DO- | -DO- | 3 | - | 2,1 | |
| | | 6.FRLS PROPS. | CR | FRLS TESTS | SAMPLES | BHEL SPEC | BHEL SPEC | -DO- | 3 | 2 | 1 | |
| 2.0 | JUNCTION BOXES, LIGHTING PANELS AND DISTRIBUTION BOARDS | | | | | | | | | | | |
| 2.1 | JUNCTION BOXES | 1.DIMENSIONS | MA | MEASUREMENT | 100% | BHEL DRG. | BHEL DRG. | INSP. REPORT | 3 | - | 2 | COMPONENTS TO BE OF APPROVED MAKE |
| | | 2.PAINT SHADE/ THICKNESS | MA | VISUAL/MEAS. | SAMPLE | BHEL SPEC/DRG | BHEL SPEC/DRG | -DO- | 3 | - | 2 | |
| | | 3.HV/IR/HV | MA | ELECT.TESTS | 100% | 2KV AC FOR 1 MINUTE | 2KV AC FOR 1 MINUTE | -DO- | 3 | - | 2 | |

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| **BHEL** | **PARTICULARS** | **BIDDER/VENDOR** | |
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| | | **QUALITY PLAN** | CUSTOMER : | | | PROJECT<br>TITLE | | | SPECIFICATION :<br>NUMBER : | | | |
| | | | BIDDER/ :<br>VENDOR | | | QUALITY PLAN<br>NUMBER PED-558-00-Q-001/01 | | | SPECIFICATION :<br>TITLE | | | |
| | | SHEET 2 OF 3 | SYSTEM | | | ITEM :ILLUMINATION | | | SECTION | | | VOLUME III |
| SL. NO. | COMPONENT/OPERATION | CHARACTERISTIC CHECK | CAT. | TYPE/ METHOD OF CHECK | EXTENT OF CHECK | REFERENCE DOCUMENT | ACCEPTANCE NORM | FORMAT OF RECORD | AGENCY | | | REMARKS |
| | | | | | | | | | **P** | **W** | **V** | |
| **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | | | **11** |
| | | 4.DEGREE OF PROTECTION | MA | TEST | 1/SIZE | IS:2147 | IS:2147 | TEST CERT. | - | - | 2,1 | |
| | | 5.SPECIAL TESTS IF ANY,EXPLOSION PROOF ETC. | MA | TEST | 1/SIZE | IS:2148 | IS:2148 | TEST CERT. | - | - | 2,1 | |
| 2.2 | LIGHTING PANELS AND LIGHTING DISTRIBUTION BOARDS | 1.DIMENSIONS | MA | MEASUREMENT | SAMPLE | BHEL DRG. | BHEL DRG. | INSPT. REPORT | 3 | 2,1 | - | COMPONENTS TO BE OF APPROVED MAKE |
| | | 2.PAINT SHADE/ THICKNESS | MA | VISUAL/ MEASUREMENT | -DO- | BHEL SPEC/DRG | BHEL SPEC/DRG | INSPT. REPORT | 3 | 2,1 | - | |
| | | 3.DEGREE OF PROTECTION (INCLUDING EXPLOSION PROOF IF ANY) | MA | TESTS | 1/SIZE | BHEL SPEC/ RELEVANT IS | BHEL SPEC/ RELEVANT IS | TEST CERT | - | - | 2,1 | |
| | | 4.PERFORMANCE TESTS | MA | ELECT. | 100% | BHEL SPEC. | BHEL SPEC. | INSPT. REPORT | 3 | 2,1 | - | BHEL SHALL WITNESS ON RANDOM ONE SAMPLE, THOUGH EACH ITEM SHALL BE CHECKED BY THE MANUFACTURER |
| | | 5.HV/IR/HV | MA | ELECT | 100% | 2.5KV AC FOR 1 MINUTE | 2.5KV AC FOR 1 MINUTE | INSPT. REPORT | 3 | 2,1 | - | -DO- |
| | | 6.TEMP.RISE TEST (FOR COM-PLETE ASSEMBLED LDB) | MA | ELECT | 1/RATING | BHEL SPEC. | BHEL SPEC. | -DO- | 3 | 2 | 1 | |
| 3.0 | TUNGSTEN FILAMENT LAMPS, TUBULAR FLUORESCENT LAMPS, HP MERCURY VAPOUR LAMPS, SODIUM VAPOUR LAMPS, BALLASTS, LUMINAIRES | 1. ACCEPTANCE TESTS | MA | TESTS | SAMPLE | BHEL SPEC/ RELEVANT IS | BHEL SPEC/ RELEVANT IS | TEST CERT | 3/2 | - | 1 | |

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| **BHEL** | **PARTICULARS** | **BIDDER/VENDOR** | |
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| | **QUALITY PLAN** | | CUSTOMER : | | | PROJECT<br>TITLE | | | SPECIFICATION :<br>NUMBER : | | | |
| | | | BIDDER/ VENDOR : | | | QUALITY PLAN<br>NUMBER PED-558-00-Q-001/01 | | | SPECIFICATION :<br>TITLE | | | |
| | SHEET 3 OF 3 | | SYSTEM | | | ITEM :ILLUMINATION | | | SECTION | | | VOLUME III |
| SL. NO. | COMPONENT/OPERATION | CHARACTERISTIC CHECK | CAT. | TYPE/ METHOD OF CHECK | EXTENT OF CHECK | REFERENCE DOCUMENT | ACCEPTANCE NORM | FORMAT OF RECORD | AGENCY | | | REMARKS |
| | | | | | | | | | **P** | **W** | **V** | |
| **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | | | **11** |
| 4.0 | CONDUITS | 1.MATERIAL | MA | VISUAL,MECH, & CHEMICAL | AS PER SPEC./ IS 9537 | IS:9537 | IS:9537 | INSPT. REPORT | 3 | 2 | 1 | |
| | | 2.DIMENSIONS | MA | MEASUREMENT | AS PER SPEC./ IS 9537 | IS:9537 | IS:9537 | INSPT. REPORT | 3 | 2 | 1 | |
| | | 3.OTHER TESTS | MA | TEST | AS PER SPEC./ IS 9537 | AS PER SPEC./ IS 9537 | IS:9537 | INSPT. REPORT | 3 | 2 | 1 | |
| 5.0 | ELECTRIC POLES | | | | | | | | | | | |
| 5.1 | MATERIAL | 1.CHEMICAL COMP. | MA | CHEM. ANALYSIS | SAMPLE | IS-2713 IS:228 & IS:1894 | IS-2713 IS:228 & IS:1894 | -DO- | 3/2 | - | 2,1 | |
| | | 2.PHYSICAL PROP. | MA | PHY.TESTS | -DO- | -DO- | -DO- | -DO- | 3/2 | - | 2,1 | |
| 5.2 | FINAL INSPECTION | 1.WORKMANSHIP AND FINISH | MA | VISUAL & MEAS | SAMPLES | BHEL DRG./ IS:2713 | BHEL DRG./ IS:2713 | -DO- | 3/2 | 2,1 | - | |
| | | 2.DIMENSIONS | MA | -DO- | -DO- | -DO- | -DO- | -DO- | 3/2 | 2,1 | - | |
| | | 3.WEIGHT | MA | -DO- | -DO- | -DO- | -DO- | -DO- | 3/2 | 2,1 | - | |
| | | 4.TESTS AS PER IS-2713 | MA | -DO- | -DO- | IS-2713 | IS-2713 | -DO- | 3/2 | 2,1 | - | |
| | | NOTE:<br>IN CASE TYPE TEST CERTIFICATE FOR DEGREE OF PROTECTION/EXPLOSION PROOFNESS FROM INDEPENDENT LAB. IS NOT AVAILABLE, THE ITEM SHALL BE TESTED AT AN INDEPENDENT LAB. | | | | | | | | | | |

| **BHEL** | **PARTICULAR** | **BIDDER / VENDOR** | |
|---|---|---|---|
| | **NAME** | | |
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| | **QUALITY PLAN** | CUSTOMER | | PROJECT<br>TITLE | | | SPECIFICATION<br>NUMBER | | | | | |
| | | BIDDER/<br>VENDOR | | QUALITY PLAN<br>NUMBER PED-506-00-Q-005/01 | | | SPECIFICATION<br>TITLE | | | | | |
| | SHEET 1 OF 6 | SYSTEM | | ITEM :LCC'S / M. BOXES/ JN. BOXES | | | SECTION VOLUME III | | | | | |
| **SL. NO.** | **NENT/OPERATION** | **CHARACTERISTIC CHECK** | **CAT.** | **TYPE/ METHOD OF CHECK** | **EXTENT OF CHECK** | **REFERENCE DOCUMENT** | **ACCEPTANCE NORM** | **FORMAT OF RECORD** | **GENCY** | | | **REMARKS** |
| | | | | | | | | | **P** | **W** | **V** | |
| **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | | | **11** |
| 1.0 | RAW MATERIAL & BOUGHT OUT CONTROL | | | | | | | | | | | |
| 1.1 | SHEET STEEL/CHANNELS | 1. DUCTILITY | CR | BEND TEST | SAMPLE | IS-1079/IS-513/ IS-226 | IS-1079/IS-513/ IS-226 | LOG BOOK | 3/2 | - | 2 | FOR SHEET STEEL |
| | | 2. SURFACE FINISH DEFECTS | MA | VISUAL | 100% | FACTORY STD | NO RUSTING | -DO- | 3/2 | - | - | |
| | | 3. THICKNESS | MA | MEASUREMENT | 100% | BHEL SPEC./ IS-1730 | BHEL SPEC./ IS-1730 | -DO- | 3/2 | - | 2 | |
| 1.2 | WIRES | 1. SURFACE DEFECTS. | MA | VISUAL | 100% | BHEL SPEC./ IS-1554/IS-694/ RELEVANT. IS | BHEL SPEC./ IS-1554/IS-694/ RELEVANT. IS | -DO- | 3/2 | - | - | ONLY APPROVED MAKES TO BE USED |
| | | 2. IR, HV, IR | MA | ELECTRICAL | SAMPLE | -DO- | -DO- | -DO- | 3/2 | - | - | |
| | | 3. TYPE / ROUTINE TESTS | MA | VERIFICATION OF TYPE / ROUTINE TEST CERTI-FICATE | 100% | -DO- | -DO- | MFR'S TEST CERT. | 3 | - | 1,2 | |
| 1.3 | ZINC INGOT FOR GALVANISING | CHEM. COMP. | MA | CHEM. TEST | EACH | IS-209 | IS-209 | TEST CERT | 3/2 | - | 1,2 | |

| **BHEL** | **PARTICULARS** | **BIDDER/VENDOR** | |
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| | QUALITY PLAN | | CUSTOMER | | | PROJECT TITLE | | | SPECIFICATION NUMBER | | | |
| | | | BIDDER/ VENDOR | | | QUALITY PLAN NUMBER PED-506-00-Q-005/01 | | | SPECIFICATION TITLE | | | |
| | SHEET 2 OF 6 | | SYSTEM | | | ITEM :LCC'S / M. BOXES/ JN. BOXES | | | SECTION | | | VOLUME III |
| SL. NO. | COMPONENT/OPERATION | CHARACTERISTIC CHECK | CAT. | TYPE/ METHOD OF CHECK | EXTENT OF CHECK | REFERENCE DOCUMENT | ACCEPTANCE NORM | FORMAT OF RECORD | AGENCY P | AGENCY W | AGENCY V | REMARKS |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | | | 11 |
| 1.3 | ELECTRICAL COMPONENTS LIKE FUSE, SWITCHES, INDICATING LAMPS, PUSH BUTTON, TERMINALS, GASKETS CABLE GLANDS AND LUGS | 1. MAKE TYPE RATING | MA | VISUAL | SAMPLE | BHEL SPEC. & BOM | BHEL SPEC. & BOM | LOG BOOK | 3/2 | - | - | |
| | | 2.OPERATION/ FUNCTIONAL CHECK | CR | ELECTRICAL TEST | SAMPLE | RELEVANT IS AND CATALOGUE | RELEVANT IS AND CATALOGUE | -DO- | 3/2 | 2,1 | 2 | |
| | | 3. IR, HV, IR | MA | ELECTRICAL | 100% | -DO- | -DO- | -DO- | 3/2 | 2,1 | 2 | |
| 2.0 | IN-PROCESS CONTROL | | | | | | | | | | | |
| 2.1 | NIBBLING/PUNCHING | 1. CUTOUT SIZES | MA | MEASUREMENT | 100% | APPD. DRGS | APPD. DRGS | LOG BOOK | 3/2 | - | 2,1 | STANDARD CUT OUTS TO BE DONE WITH DIES & PUNCHES ONLY |
| | | 2.DEBURRING | MI | VISUAL | 100% | -DO- | -DO- | -DO- | 3/2 | - | - | |
| 2.2 | PANEL FABRICATION | 1. DIMENSIONS | MA | MEASUREMENT | 100% | APPR. DRGS | APPR. DRGS | LOG BOOK | 3/2 | 2 | - | |
| | | 2. ALIGNMENT | MA | MEASUREMENT | 100% | MFR'S STD | MFR'S STD | LOG BOOK | 3/2 | 2 | - | |
| | | 3. WELDING QUALITY | MI | VISUAL | 100% | -DO- | -DO- | -DO- | 3/2 | 2 | - | |

| | PARTICULARS | BIDDER/VENDOR | |
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| BHEL | NAME | | |
| | SIGNATURE | | |
| | DATE | | BIDDER'S/VENDOR'S COMPANY SEAL |

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| | QUALITY PLAN | CUSTOMER | | PROJECT TITLE | | | SPECIFICATION NUMBER | | | | | |
| | | BIDDER/ VENDOR | | QUALITY PLAN NUMBER PED-506-00-Q-005/01 | | | SPECIFICATION TITLE | | | | | |
| | SHEET 3 OF 6 | SYSTEM | | ITEM :LCC'S / M. BOXES/ JN. BOXES | | | SECTION | | | VOLUME III | | |
| SL. NO. | COMPONENT/OPERATION | CHARACTERISTICS CHECK | CAT. | TYPE/ METHOD OF CHECK | EXTENT OF CHECK | REFERENCE DOCUMENT | ACCEPTANCE NORM | FORMAT OF RECORD | GENCY P | GENCY W | GENCY V | REMARKS |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | | | 11 |
| 2.3 | SURFACE PREPARATION AND PRE-TREATMENT (7 OR 8 TANK PROCESS) | 1. PROCESS PARAMETERS LIKE BATH TEMP, CONCENTRATION, DIPPING/ REMOVAL TIME | MA | PROCESS CHECK | PERIODIC | BHEL SPEC., MFR. SPEC., IS-6005 | BHEL SPEC., MFR. SPEC., IS-6005 | LOG BOOK | 3/2 | - | - | IF SAND/SHOT BLASTING, ACID PICKLINGS IS NOT REQUIRED. |
| | | 2. SURFACE QUALITY AFTER EVERY DIP | MA | VISUAL | 100% | -DO- | -DO- | -DO- | 3/2 | - | - | |
| 2.4 | PRIMER APPLICATION & PAINTING | 1. SURFACE FINISH & COVERAGE | MA | VISUAL | 100% | MFR. SPEC., IS-6005 | MFR. SPEC., IS-6005 | LOG BOOK | 3/2 | - | - | |
| | | 2. FILM THICKNESS | MA | MEASUREMENT | 100% | -DO- | -DO- | -DO- | 3/2 | - | 2 | |
| | | 3. SHADE | MA | VISUAL | 100% | -DO- | -DO- | -DO- | 3/2 | - | 2 | |
| | | 4. ADHESION | MA | SCRATCH TEST / CROSS OUT TAPE | TEMPLATE | -DO- | -DO- | -DO- | 3/2 | - | 2 | |

| | PARTICULARS | BIDDER/VENDOR | |
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| BHEL | NAME | | |
| | SIGNATURE | | |
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| | QUALITY PLAN | | CUSTOMER | | | PROJECT<br>TITLE | | | SPECIFICATION<br>NUMBER | | | |
| | | | BIDDER/<br>VENDOR | | | QUALITY PLAN<br>NUMBER PED-506-00-Q-005/01 | | | SPECIFICATION :<br>TITLE | | | |
| | SHEET 4 OF 6 | | SYSTEM | | | ITEM :LCC'S / M. BOXES/ JN. BOXES | | | SECTION | | | VOLUME III |
| SL. NO. | NENT/OPERATION | CHARACTERISTICS CHECK | CAT. | TYPE/ METHOD OF CHECK | EXTENT OF CHECK | REFERENCE DOCUMENT | ACCEPTANCE NORM | FORMAT OF RECORD | GENCY P | W | V | REMARKS |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | | | 11 |
| 2.5 | WIRING, GASKET, NAME PLATE, COMPONENT MOUNTING ETC. | 1. WIRING LAYOUT | MA | VISUAL | 100% | APPD . DRGS & SPEC. | APPD . DRGS & SPEC. | LOG BOOK | 3/2 | - | - | PVC CHANNELS TO BE USED |
| | | 2. WORKMANSHIP AND FINISH CORRECTNESS COMPLETENESS | MA | VISUAL | 100% | -DO- | -DO- | -DO- | 3/2 | - | - | |
| 2.6 | GALVANISATION PROCESS | 1. TEMP OF ZINC BATH | MA | TEMP. INDICATOR | CONTIN-UOUS | IS-2629 | IS-2629 | QC RECORD | 2 | - | - | |
| | | 2. DURATION OF DIP | MA | VISUAL | -DO- | MANUFACTURER PRACTICE. | MANUFACTURER PRACTICE. | -DO- | 2 | - | - | |
| | | 3. SURFACE QUALITY | MA | VISUAL | 100% | -DO- | FREE FROM ROUGHNESS, FLUX, STAIN ETC. | -DO- | 2 | - | - | |
| | | 4. GROSS QUANTITY & AGITATION | MA | TESTS | PERIODIC | RELEVANT. IS | RELEVANT. IS | -DO- | 2 | - | - | |
| 3 | FINAL INSPECTION | | | | | | | | | | | |
| 3.1 | COMPLETE JUNCTION BOX/ LCC'S MARSHALLING BOXES | 1. WORKMANSHIP & FINISH, PAINT SHADE/GALV. THICKNESS & ADHESION | MA | VISUAL | 100% | BHEL SPEC. APPD. DRG RELEVANT. IS | BHEL SPEC. APPD. DRG RELEVANT. IS | INSPN REPORT | 3/2 | 2,1 | - | |

| | PARTICULARS | BIDDER/VENDOR | |
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| BHEL | NAME | | |
| | SIGNATURE | | |
| | DATE | | BIDDER'S/VENDOR'S COMPANY SEAL |

FORM NO. PEM-6041-0

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| | QUALITY PLAN | | CUSTOMER | | | PROJECT TITLE | | | SPECIFICATION NUMBER : | | | |
| | | | BIDDER/ VENDOR | | | QUALITY PLAN NUMBER PED-506-00-Q-005/01 | | | SPECIFICATION TITLE | | | |
| | SHEET 5 OF 6 | | SYSTEM | | | ITEM :LCC'S / M. BOXES/ JN. BOXES | | | SECTION | | | VOLUME III |
| SL. NO. | COMPONENT/OPERATION | CHARACTERISTICS CHECK | CAT. | TYPE/ METHOD OF CHECK | EXTENT OF CHECK | REFERENCE DOCUMENT | ACCEPTANCE NORM | FORMAT OF RECORD | AGENCY P | AGENCY W | AGENCY V | REMARKS |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | | | 11 |
| | | 2. UNIFORMITY OF ZINC COATING | MA | CHEM. TEST | IS-5358 | IS-2633 | IS-2633 | INSPN REPORT | 2 | 1 | - | |
| | | 3. THICKNESS OF ZINC COATING | MA | ELCOMETER | -DO- | BHEL SPEC. | BHEL SPEC. | -DO- | 2 | 1 | - | |
| | | 4. WIRING LAYOUT | MA | VISUAL | 100% | -DO- | -DO- | -DO- | 3/2 | 2,1 | - | |
| | | 5. COMPONENT LAYOUT & FIXING, ACCESSI-BILITY AND SAFETY | MA | VISUAL | 100% | -DO- | -DO- | -DO- | 3/2 | 2,1 | - | |
| | | 6. COMPONENT IDENTIFICATION (MARKING/ NAME PLATES) | MA | VISUAL | 100% | APPD. DRG. | APPD. DRG. | -DO- | 3/2 | 2,1 | - | |
| | | 7. PROPER WIRE TERMINATION | MA | PULLING | SAMPLE | -DO- | NO LOOSE CONNECTIONS. ALL TERMINATION TO BE LUGGED | -DO- | 3/2 | 2,1 | - | |
| | | 8. DOOR LOCK FUNCTIONING | MA | OPERATON | 100% | APPD. DRG | NO MISMATCH | -DO- | 3/2 | 2,1 | - | |

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| | PARTICULARS | BIDDER/VENDOR | |
| BHEL | NAME | | |
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| | DATE | | BIDDER'S/VENDOR'S COMPANY SEAL |

FORM NO. PEM-6041-0

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| | QUALITY PLAN | | CUSTOMER | | | PROJECT<br>TITLE | | | SPECIFICATION<br>NUMBER | | | |
| | | | BIDDER/<br>VENDOR | | | QUALITY PLAN<br>NUMBER PED-506-00-Q-005/01 | | | SPECIFICATION<br>TITLE | | | |
| | SHEET 6 OF 6 | | SYSTEM | | | ITEM :LCC'S / M. BOXES/ JN. BOXES | | | SECTION | | | VOLUME III |
| SL. NO | COMPONENT/OPERATION | CHARACTERISTICS CHECK | CAT. | TYPE/ METHOD OF CHECK | EXTENT OF CHECK | REFERENCE DOCUMENT | ACCEPTANCE NORM | FORMAT OF RECORD | AGENCY P | AGENCY W | AGENCY V | REMARKS |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | | | 11 |
| | | 9.OVERALL DIMENSIONS | MA | MEASUREMENT | 100% | APPD. DRG. | APPD. DRG. | INSPN. REPORT | 3/2 | 2,1 | - | |
| | | 10. CONTINUITY | CR | ELECTRICAL | 100% | APPD. DRG., BHEL SPEC., & RELEVANT IS | APPD. DRG., BHEL SPEC., & RELEVANT IS | -DO- | 3/2 | 2,1 | - | |
| | | 11. IR-HV-IR | CR | ELECTRICAL | 100% | -DO- | -DO- | -DO- | 3/2 | 2,1 | - | IR-HV-IR TEST TO BE DONE |
| | | 12.OPERATION INTERLOCKS ETC | CR | ELECTRICAL OPERATION AND FUNCTION IN ENERGISED CONDITION | 100% | -DO- | -DO- | -DO- | 3/2 | 2,1 | - | BEFORE OPERATIONAL TESTS |
| | | 13. TEMP RISE (IF APPLICABLE) | CR | ELECTRICAL | ONE/ TYPE/ SIZE | BHEL SPEC. RELEVANT IS | BHEL SPEC. RELEVANT IS | -DO- | 3/2 | 2,1 | - | |
| | | 14. DEGREE OF PROTECTION & FLAME/ EXPLOSION PROOF | CR | WATER AND DUST TESTS, FLAME/ EXPLOSION TESTS | ONE/ TYPE | -DO- | -DO- | -DO- | 3/2 | 2 | - | FLAME/EXPLOSION PROOF TEST, IF SPECIFIED IN BHEL SPEC. |
| | | NOTE:<br>IF TC'S FOR DEGREE OF PROTECTION/EXPLOSION PROOFNESS IS AVAILABLE FROM AN INDEPENDENT LABORATORY FOR IDENTICAL DESIGN (SIZE SHALL BE SMALLER THAN THAT INDICATED IN THE TC) THESE TESTS NEED NOT BE REPEATED. | | | | | | | | | | |

| | PARTICULARS | BIDDER/VENDOR | |
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| | **QUALITY PLAN** | | CUSTOMER : | | | PROJECT<br>TITLE | | | SPECIFICATION :<br>NUMBER : | | | |
| | | | BIDDER/ :<br>VENDOR | | | QUALITY PLAN<br>NUMBER PED-507-00-Q-006/01 | | | SPECIFICATION<br>TITLE | | | |
| | SHEET 1 OF 1 | | SYSTEM | | | ITEM RIGID STEEL CONDUITS & PIPES | | | SECTION | | | VOLUME III |
| SL. NO. | COMPONENT/OPERATION | CHARACTERISTICS CHECK | CAT. | TYPE/ METHOD OF CHECK | EXTENT OF CHECK | REFERENCE DOCUMENT | ACCEPTANCE NORM | FORMAT OF RECORD | AGENCY | | | REMARKS |
| | | | | | | | | | **P** | **W** | **V** | |
| **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | | | **11** |
| | FINISHED PRODUCT | | | | | | | | | | | |
| | | 1. DIMENSIONAL CONFORMITY | MA | MEASUREMENT | 5 SAMPLES PER SIZE PER LOT | AS PER IS-9537 PT I & II AND OTHER IS | AS PER IS-9537 PT I & II AND OTHER IS | IR | 2 | 1 | - | |
| | | 2.FINISH | MI | VISUAL | -DO- | -DO- | -DO- | -DO- | 2 | 1 | - | |
| | | 3. SCREW THREAD | MI | MEASUREMENT | -DO- | -DO- | -DO- | -DO- | 2 | 1 | - | |
| | | 4. BEND TEST | MA | MECH. | 1 SAMPLE OF EACH SIZE | -DO- | -DO- | -DO- | 2 | 1 | - | |
| | | 5. COMPRESSION TEST | MA | MECH. TEST | -DO- | -DO- | -DO- | -DO- | 2 | 1 | - | |
| | | 6. WT. OF ZINC COATING | MA | MEASUREMENT | ONE SAMPLE | IS-6745 | IS-4736 | -DO- | 3 | 2,1 | - | |
| | | 7.UNIFORMITY OF ZINC | MA | CHEMICAL | -DO- | IS-2633 | IS-2633 | -DO- | 3 | 2,1 | - | |
| | | 8. ADHESION TEST | MA | PIVOT/HAMMER TEST | -DO- | IS2629 | IS-2629 | -DO- | 3 | 2,1 | - | |

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| **BHEL** | **PARTICULARS** | **BIDDER/VENDOR** | |
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| | **DATE** | | BIDDER'S/VENDORS COMPANY SEAL |

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| | **QUALITY PLAN** | | CUSTOMER : | | | PROJECT<br>TITLE | | | SPECIFICATION :<br>NUMBER : | | | |
| | | | BIDDER/ :<br>VENDOR | | | QUALITY PLAN<br>NUMBER PED-507-00-Q-013/00 | | | SPECIFICATION :<br>TITLE | | | |
| | SHEET 1 OF2 | | SYSTEM | | | ITEM : CABLE TRAY SUPPORT MATERIAL & ACCESSORIES (BOLTABLE) | | | SECTION | | | VOLUME III |
| SL. NO. | COMPONENT/OPERATION | CHARACTERISTIC CHECK | CAT. | TYPE/ METHOD OF CHECK | EXTENT OF CHECK | REFERENCE DOCUMENT | ACCEPTANCE NORM | FORMAT OF RECORD | AGENCY | | | REMARKS |
| | | | | | | | | | P | W | V | |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | | | 11 |
| **1.0** | **RAW MATERIAL** | | | | | | | | | | | |
| **1.1** | ROLLED SHEET | 1.CHEM.& PHY. PROPERTIES | MA | VERIFICATION OF TC'S | 100% | IS1079 (for hot rolled) IS-513 (for cold rolled | IS1079 (for hot rolled) IS-513 (for cold rolled) | MILL TC | 3/2 | - | - | AS PER CONTRACT & AS APPLICABLE IN TECH. SPECIFICATION |
| | | 2.DIMENSIONS | MA | MEASUREMENT | 100% | IS-1730/ SPECIFICATION | IS-1730/ SPECIFICATION | QC RECORD | 3/'2 | - | - | |
| | | 3.SURFACE FINISH | MA | VISUAL | 100% | IS1079 (for hot rolled) IS-513 (for cold rolled | IS1079 (for hot rolled) IS-513 (for cold rolled) | QC RECORD | 3/'2 | - | - | |
| **1.2** | ZINC | CHEM.COMP. | MA | CHEM TEST | EACH HEAT | IS-209 | IS-209 | QC RECORD | 3/2 | - | 1/2 | |
| **2.0** | **IN-PROCESS** | | | | | | | | | | | |
| **2.1** | FABRICATION | 1.DIMENSIONS | MA | MEASUREMENT | 100% | APPD. DRGS. | APPD. DRGS. | QC RECORD | 2 | - | 1 | |
| | | 2.WELDING QUALITY | MA | VISUAL | 100% | GOOD WELDING PRACTICE | FREE FROM DEFECTS & SLAG | QC RECORD | 2 | - | 1 | WELDING IS TO BE DONE BY QUALIFIED WELDERS |
| | | 3.SURFACE FINISH | MA | VISUAL | 100% | SPECIFICATION | SPECIFICATION | QC RECORD | 2 | - | 1 | |
| **2.2** | SURFACE PREPARATION | 1.CLEANING, PICKLING, RINSING & FLUXING | MA | MEASUREMENT | PERIODIC IN EACH SHIFT | IS:2629 | IS:2629 | QC RECORD | 2 | - | - | |
| | | 2. SURFACE QUALITY | MA | VISUAL | 100% | IS:2629 | IS:2629 | QC RECORD | 2 | - | - | |
| **2.3** | GALVANISING | 1.TEMPERATURE OF BATH | MA | TEMPERATURE INDICATOR | CONTINUOUS | IS-2629 | IS-2629 | QC RECORD | 2 | - | - | |

| **BHEL** | **PARTICULARS** | **BIDDER/VENDOR** | |
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| | **SIGNATURE** | | |
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| | **QUALITY PLAN** | CUSTOMER : | PROJECT<br>TITLE | | | | | SPECIFICATION :<br>NUMBER : | | | | |
| | | BIDDER/ VENDOR : | QUALITY PLAN<br>NUMBER PED-507-00-Q-013/00 | | | | | SPECIFICATION :<br>TITLE | | | | |
| | SHEET 2 OF 2 | SYSTEM | ITEM : CABLE TRAY SUPPORT MATERIAL & ACCESSORIES (BOLTABLE) | | | | | SECTION | | VOLUME III | | |

| SL. NO. | COMPONENT/OPERATION | CHARACTERISTIC CHECK | CAT. | TYPE/ METHOD OF CHECK | EXTENT OF CHECK | REFERENCE DOCUMENT | ACCEPTANCE NORM | FORMAT OF RECORD | AGENCY P | AGENCY W | AGENCY V | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | | | 11 |
| | | 2. DROSS | MA | VISUAL | CONTINUOUS | IS - 2629 | IS - 2629 | QC RECORD | 2 | - | - | |
| | | 3. RATE OF IMMERSION | MA | VISUAL / MEASUREMENT | 100% | IS - 2629 / MFR'S PRACTICE | IS - 2629 / MFR'S PRACTICE | QC RECORD | 3 | - | 2 | |
| | | 4.SURFACE QUALITY | MA | VISUAL | 100% | IS - 2629 / | FREE FROM BURRS, SLAG, ROUGHNESS, FLUX. STAIN. ETC. | QC RECORD | 2 | - | - | |
| **3.0** | **FINISHED ITEMS** | | | | | | | | | | | |
| **3.1** | SINGLE / DOUBLE CHANNELS, CANTILEVER ARMS, CLAMPS | 1.DIMENSIONS DISTORTION | MA | MEASUREMENT | IS-2500 LEVEL IV | APPD. DRG | APPD. DRG | INSP. REPORT | 3 | 2, 1 | - | FASTENERS SHALL BE OF REPUTED & APPROVED MAKE |
| | | 2.SURFACE FINISH | MA | VISUAL | IS-2500 LEVEL IV | SPECIFICATION | FREE FROM BURRS, SLAG, ROUGHNESS, FLUX. STAIN. ETC. | INSP. REPORT | 3 | 2, 1 | - | |
| | | 3.MASS OF ZINC COATING | MA | CHEM. TEST | IS-4759 / SPECIFICATION | IS-6745 / SPECIFICATION | SPECIFICATION/ | INSP. REPORT | 3 | 2, 1 | - | |
| | | 4.UNIFORMITY OF ZINC COATING | MA | CHEM. TEST | IS-4759 / SPECIFICATION | IS-2633 | IS-2633 | INSP. REPORT | 2 | 1 | - | |
| | | 5.THICKNESS OF ZINC COATING | MA | ELCOMETER | IS-4759 / SPECIFICATION | SPECIFICATION. | SPECIFICATION. | INSP. REPORT | 3 | 2, 1 | - | |
| | | 6.ADHESION | MA | MECH.TEST | IS-4759 | IS-2629 | IS-2629 | INSP. REPORT | 3 | 2, 1 | - | |
| **3.1.1** | TYPE TESTING | | CR | TEST | 1 SAMPLE | SPECIFICATION./ APPD. TYPE TEST PROCEDURE | SPECIFICATION./ APPD. TYPE TEST PROCEDURE | INSP. REPORT | 2 | 1 | - | |
| **3.1.2** | WELD INTEGRITY TEST | SOUNDNESS | CR | MPI | SAMPLE TESTED DURING TYPE TESTING | SPECIFICATION. | NO DEFECT | INSP. REPORT | 2 | 1 | - | AFTER CARRYING OUT TYPE TEST, WELD INTEGRITY TEST TO CHECK THE WELD SOUNDNESS/ ACCEPTANCE SHALL BE DONE BY MANUFACTURER |

**NOTE: INSTRUCTIONS FOR QUALITY PLAN IS ATTACHED AS ANNEXURE-1.**

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| | **QUALITY PLAN** | | CUSTOMER : | | | PROJECT<br>TITLE | | | SPECIFICATION :<br>NUMBER : | | | |
| | | | BIDDER/ :<br>VENDOR | | | QUALITY PLAN<br>NUMBER PED-509-00-Q-001/02 | | | SPECIFICATION :<br>TITLE | | | |
| | SHEET 1 OF 2 | | SYSTEM | | | ITEM : EARTHING & LIGHTNING PROTECTION CONDUCTOR | | | SECTION | | | VOLUME III |
| SL. NO. | COMPONENT/OPERATION | CHARACTERISTIC CHECK | CAT. | TYPE/ METHOD OF CHECK | EXTENT OF CHECK | REFERENCE DOCUMENT | ACCEPTANCE NORM | FORMAT OF RECORD | AGENCY | | | REMARKS |
| | | | | | | | | | **P** | **W** | **V** | |
| **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | | | **11** |
| 1.0 | RAW MATERIAL | | | | | | | | | | | |
| 1.1 | MILD STEEL & COPPER (AS SPECIFIED) | 1.CHEMICAL & PHYSICAL PROPERTIES | MA | CHEM & PHYS TESTS | 1/ LOT/SIZE | APPD. DRGS/ DATA SHEETS/ TECH. SPEC. | APPD. DRGS/ DATA SHEETS/ TECH. SPEC. | MILL TEST CERTIFICATE | 2 | - | - | Steel shall be procured from SAIL/TISCO/RINL/authorised re-rollers/manufacturer as per BHEL approved sources |
| | | 2.SURFACE FINISH | MA | VISUAL | 100% | -DO- | -DO- | IR | 3/2 | - | 2 | |
| | | 3.DIMENSIONS | MA | MEASUREMENT | 1/ LOT/SIZE | -DO- | -DO- | -DO- | 2 | - | - | |
| 1.2 | ZINC FOR GALVANISATION | 1.CHEM.COMP. | MA | CHEM.TEST | SAMPLE | RELEVANT IS. | RELEVANT IS. | TC | 3/2 | - | 2 | |
| 2.0 | IN-PROCESS | | | | | | | | | | | |
| 2.1 | CUTTING, DRILLING | 1.WORKMANSHIP DIMENSIONS & DISTORTION | MA | VISUAL & MEASUREMENT | 100% | APPD. DRGS/ TECH. SPEC. | APPD. DRGS/ TECH. SPEC. | IR | 2 | - | - | |
| 2.2 | SURFACE PREPARATION FOR GALVANISING | 1.CLEANING PICKLING & RINSING, BATH STRENGTH/ PURITY & TEMPERATURE | MA | CHEM. & MEASUREMENT | PERIODIC IN EACH SHIFT | IS:2629/ RELEVANT : IS | IS:2629/ RELEVANT : IS | IR | 3/2 | - | | |
| | | 2.SURFACE QUALITY | MA | VISUAL | 100% | IS:2629/ RELEVANT : IS | IS:2629/ RELEVANT : IS | IR | 3/2 | - | - | |
| 2.3 | GALVANISING | 1.TEMPERATURE OF BATH | MA | TEMPERATURE INDICATOR | CONTINUOUS | -DO- | -DO- | -DO- | 3/2 | - | - | |
| | | 2.DURATION OF DIP | MA | VISUAL | PERIODIC | -DO- | -DO- | -DO- | 3/2 | - | - | |

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| | **QUALITY PLAN** | | CUSTOMER : | | | PROJECT<br>TITLE | | | SPECIFICATION :<br>NUMBER : | | | | |
| | | | BIDDER/ VENDOR : | | | QUALITY PLAN<br>NUMBER PED-509-00-Q-001/02 | | | SPECIFICATION :<br>TITLE | | | | |
| | | SHEET 2 OF 2 | SYSTEM | | | ITEM : EARTHING & LIGHTNING PROTECTION CONDUCTOR | | | SECTION | | | VOLUME III | |
| SL. NO. | COMPONENT/OPERATION | CHARACTERISTIC CHECK | CAT. | TYPE/ METHOD OF CHECK | EXTENT OF CHECK | REFERENCE DOCUMENT | ACCEPTANCE NORM | FORMAT OF RECORD | AGENCY | | | REMARKS | |
| | | | | | | | | | **P** | **W** | **V** | | |
| **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | | | **11** | |
| | | 3.DROSS QUANTITY AGITATION | MA | TEST | PERIODIC | RELEVANT : IS | RELEVANT : IS | -DO- | 2 | - | - | | |
| | | 4.BATH AGITATION | MA | VISUAL | PERIODIC | MFR'S STD | MFR'S STD | -DO- | 2 | - | - | | |
| | | 5.SURFACE QUALITY | MA | VISUAL | 100% | -DO- | -DO- | IR | 3/2 | - | 2 | | |
| 3.0 | FINAL TESTS | 1.APPEARANCE | MA | VISUAL | SAMPLE | IS:2629 | IS:2629 FREE FROM ROUGHNESS LUMPS ETC | IR | 2 | 1 | - | | |
| | | 2.DIMENSION | MA | MEASUREMENT | -DO- | TECH.SPEC./ APPD.DRG. | TECH.SPEC./ APPD.DRG. | IR | 2 | 1 | - | | |
| | | 3.UNIFORMITY OF ZINC COATING | MA | CHEM. TEST | SAMPLE AS PER IS-2633 | IS:4759 | IS-2633 | IS-2633 | 2 | 1 | - | | |
| | | 4. WEIGHT OF ZINC COATING | MA | -DO- | IS-4759 | IS-6745 | TECH. SPEC. / 610 GMS./ SQ. MTR./ 460 GMS./ SQ. MTR. 150 GMS./ SQ. MTR. | IR | 2 | 1 | - | | |
| | | 5.ADHESION | MA | MECH. TEST | -DO- | IS-2629 | IS-2629 | IR | 2 | 1 | - | | |
| | | 6.THICKNESS OF ZINC COATING | MA | ELKOMETER | -DO- | TECH. SPEC. | TECH. SPEC./ 75 MICRONS (MIN.)/ 60 MICRONS (MIN.) 150 GMS./ SQ. MTR. | IR | 2 | 1 | - | | |

**NOTE : INSTRUCTIONS FOR FILLING QUALITY PLAN IS ATTACHED AS ANNEXURE - 1.**

| **BHEL** | **PARTICULARS** | **BIDDER/VENDOR** | |
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