

manufactured and put into operation in accordance with the latest recognized rules of workmanship, modern engineering practice and with good standards of prudence applicable to the international electricity generation industry which would have been expected to accomplish the desired result at the lowest reasonable cost consistent with reliability, safety and expedition.

The regulations, standards and guidelines listed in the Specification as well as all applicable laws and governmental decrees, regulations, orders, etc. shall be observed in the design, calculation, manufacture, erection, installation, testing, commissioning and start-up of all parts of the Plant.

The following shall be considered in the design and engineering of the Plant facilities:

- All parts of the Plant shall be suitable in every respect for continuous operation at maximum output as well as part loads and expected transient operating conditions peculiar to the site and shall be able to safely withstand the stresses arising from the operating conditions without any reduction in its planned life.
- The Contractor shall familiarize himself with the conditions on site.
- Suitable and automatically acting protection and safety measures shall be provided for automatic load reduction or shut down of equipment in case of abnormal operating conditions.
- Switchover to stand-by units shall be automatically, as far as required for continuous Plant operation without interruption of Plant operation.
- In case of equipment and/or system shut down process conditioned drainage of components (such as pipelines, tanks, etc.) shall be performed automatically from the control room.
- Minor equipment which, in case of failure would cause a failure of a power generation unit and/or the Plant is to be provided with a stand-by facility in order to ensure further operation of the power generation unit or the Plant.
- All live, moving and rotating parts shall be provided with appropriate effective protection in order to avoid danger to the operating staff. All metal parts shall be electrically grounded.
- All equipment shall be designed to ensure start-up from any condition, i.e. from long term shut-down, cold, warm or hot condition without necessitating special or preparatory measures.
- The project language shall be English.

B0.6.2 Standards and codes

The work must be performed according to the most recent relevant codes, standards, accident prevention regulations and local rules and legal regulations.



All materials and equipment supplied and all work carried out as well as calculation sheets, drawings, quality and class of goods, methods of inspection, specific design features of equipment and parts and acceptances of partial plants shall comply in every respect with the applicable standards, codes and regulations to be chosen from the following:

- American Association of State Highway and transportation Officials AASHTO
- American Concrete Institute ACI
- American Gear Manufacturers Association AGMA
- American Institute of Steel Construction AISC
- American Iron & Steel Institute AISI
- American Moving and Conditioning Association AMCA
- American National Standards Institute ANSI
- American Petroleum Institute API
- American Public Health Association APHA
- American Society for Testing and Materials ASTM
- American Society of Civil Engineers ASCE
- American Society of Heating, Refrigeration & Air Conditioning Engineers ASHRAE
- American Society of Mechanical Engineers ASME
- American Water Works Association AWWA
- American Welding Society AWS
- American Wire Gauge AWG
- Anti-Friction Bearing Manufactures Association AFBMA
- Architectural Institute of Japan AIJ
- Association Francaise de Normalisation AFNOR
- British Standards Institute BS
- Chlorine Institute CI
- Crane Manufacturers Association of America CMAA
- Deutsches Institut für Normung DIN
- Diesel Engine Manufacturers Association DEMA
- European Norm EN
- Expansion Joint Manufacturer Association EJMA
- Fédération Européene de Manutention FEM
- Heat Exchanger Institute HEI
- Hydraulic Institute HI
- Illuminated Engineers Society IES
- Institute of Electrical and Electronics Engineers IEEE
- Instrument Society of America ISA
- Insulated Power Cable Engineers Association IPCEA
- International Electrotechnical Commission IEC
- International Standards Organization ISO
- Japanese Architectural Standard Specification JASS



• Japanese Electrical Manufacturers Association	JEMA
• Japanese Electrotechnical Institute	JEC
• Japanese Industrial Standards	JIS
• Manufacturers Standardization Society	MSS
• National Association of Corrosion Engineers	NACE
• National Electrical Code (USA)	NEC
• National Electrical Manufacturer's Association (USA)	NEMA
• National Electrical Safety Code	NESC
• National Fire Protection Association	NFPA
• National Structural Code for Building	NSCB
• Occupation Safety and Health Administration	OSHA
• Portland Cement Association	PCA
• Properties of Water and Steam	IFC
• Scientific Apparatus Manufacturers Association	SAMA
• Society of Automotive Engineers	ASE
• Standards of Japanese Electrotechnical Committee	JEC
• Steel Structures Painting Council	SSPC
• Technische Vereinigung der Grosskraftwerksbetreiber	VGB
• Tubular Exchanger Manufacturers Association	TEMA
• Underwriters Laboratory	UL
• Uniform Building Code	UBC
• Verband Deutscher Elektrotechniker	VDE
• Verein Deutscher Ingenieure	VDI
• Vereinigung Deutscher Elektrizitätswerke (Association of German Power Plants)	VDEW
• Water Pollution Control Federation	WPCF

Generally, all internationally and nationally recognized standards as above will be applied, except if specific standards called for by:

- a) Occupational Safety Board of Bangladesh
- b) Department of Inspection for Factories and Establishments, Bangladesh
- c) Department of Environment, Bangladesh
- d) Bangladesh Power Development Board
- e) Bangladesh Energy Regulatory Commission
- f) Ministry of Power, Energy and Mineral Resources
- g) Bangladesh Fire Service and Civil Defence Ministry
- h) All relevant Bangladesh National Statutory Regulations
- i) Bangladesh National Building Code
- j) Bangladesh Standards
- k) Local Authorities.



All steam boilers and unfired pressure vessels together with associated pipework and fittings shall comply with the Bangladesh Boiler Act, 1923 with amendments.

All pressure parts shall be designed in accordance with applicable ASME codes.

All services, supplies and works shall comply with the requirements of the relevant laws of Bangladesh and the IFC/World Bank Group Standards and Guidelines in their latest edition, including but not limited to:

- Environmental Conservation Rules
- Bangladesh Energy Regulatory Commission Act;
- BERC Licensing Regulation
- BERC Technical Quality Standards;
- Bangladesh National Building Code;
- other applicable laws in Bangladesh;
- IFC Performance Standards on Environmental and Social Sustainability;
- IFC / World Bank Group Environmental, Health and Safety (EHS) General Guidelines ;
- IFC / World Bank Group EHS Guidelines for Thermal Power Plants;
- IFC / World Bank Group EHS Guidelines for Electric Power Transmission and Distribution.

It is the Contractor's responsibility to provide sufficient evidence that any national or other standard the Contractor proposes (other than those mentioned above) will ensure an equivalent or higher standard.

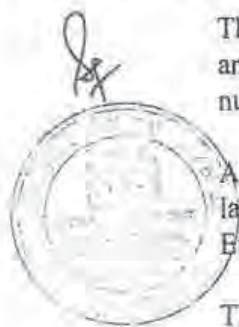
Immediately after effective date of the Contract the Contractor shall supply an indexed list of all standards, codes and associated standards referred to, to which the work is to be performed. A copy of all applied standards shall be forwarded to the Employer. The Contractor shall supply preferably two (2) searchable softcopies, else two (2) hardcopies each.

B0.6.3 Plant and equipment identification

The Contractor shall apply a plant identification system showing the name and number of each item of Plant and its respective arrangement drawing number and add any additional items necessary to fully identify the Plant.

All design submissions shall include a detailed labelling list indicating the label text, size of the lettering and fixing details for the approval of the Employer or its representative.

The identification and numbering of equipment, systems, items, etc. of supply, as well as of all documents and drawings shall be in accordance with



the VGB guideline RDS-PP (Reference Designation System for Power Plants - KKS system).

There is to be only one approved description for any one item of Plant and this must be used consistently for Plant, electrical and instrumentation designations throughout.

The Contractor shall supply all labels (Plant and Equipment Identification Plates), nameplates, manufacturer's equipment nameplate, instruction and warning plates necessary for the identification and safe operation of the Plant, and all inscriptions shall be in the English language and Bangla language.

All labels, nameplates, instruction and warning plates shall be securely fixed to items of Plant and equipment with stainless steel rivets, plated self-tapping screws or other approved means. The use of adhesives will not be permitted.

Nameplates for Plant and equipment identification and record purposes shall be manufactured from stainless steel or aluminium with a mat or satin finish, and engraved with black lettering of a size which is legible from the working position.

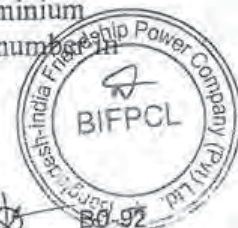
Warning plates shall be manufactured from stainless steel or aluminium, engraved red lettering on a white background and sited in the position where they afford maximum safety of personnel.

All equipment within panels and desks shall be individually identified by satin or mat finish stainless steel or aluminium labels.

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 black lettering in accordance with the circuit designation system. Circuit designations must be precise and convey complete information. There should be no doubt whatsoever for the operation as to which area of the Plant a particular feeder is supplying with power. Labels such as interconnector 1 or feeder 2 are not acceptable. Corridor type panels shall in addition have circuit designation labels within the panels.

Pipework systems shall be identified with a colour identification systems in conformity with the colours according to the Employer's specification, with colours at the nameplates and, if necessary by colour bands and with KKS numbering and plain language. The direction of flow shall be shown.

Each valve/instrument shall be fitted with a stainless steel or aluminium nameplate indicating the valve/instrument service and reference number in accordance with the approved equipment coding system.



Where possible valve nameplates shall be circular and shall be fitted under the handwheel captive nut. They have to be of such a diameter that there is no danger for persons operating the valve or that they do not prevent lock-off of this valve; on check valves and small valves the Contractor may provide rectangular nameplates fitted to brackets on the valve or attached to a wall or steelwork in a convenient position adjacent to the valve.

B0.6.4 Marking and labelling

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, where the weight is bearing and the correct position of the slings and are to bear an identification mark relating them to the appropriate shipping documents.

All stencil marks on the outside of cases are either to be made in waterproof material or protected by shellac or varnish to prevent obliteration in transit.

B0.6.5 Corrosion protection, coating and galvanizing

This specification shall be used for the corrosion protection of steel structures, components, pipings and equipment in general which are installed in confined areas (indoors) or outdoors.

Surface preparation, as well as protective coatings and coating systems are based on this specification in order to assure that structural parts of different suppliers will get a corrosion protection of similar and high quality.

Coating material shall only be supplied by manufacturers with international experience and their products can be obtained internationally.

Regarding maintenance work (storage), application and supervision of coating work, choice of coating suppliers should be minimized. At any rate, similar parts of structures/components (such as structural steel, containers, piping, etc.) shall only be coated with products of one individual manufacturer.

The materials and equipment used, the methods of application and the quality of work shall at all times be subject to the inspection and approval of the Employer or his Representative.

To mitigate crevice corrosion, the designs and construction of structures and equipment shall ensure that no collection of water occurs in crevices which could lead to crevice corrosion.



It is the responsibility of the Contractor to ensure that, for all supplied equipment (including that from sub suppliers):

- The protection system is perfectly suitable for the Site conditions and for the specific purpose.
- The shop paints provide a sufficient protection during transport, storage and erection.
- The shop paints are suitable for handling and erection conditions (slinging, Site welding works etc.) and are compatible with the Site finishing coats
- All necessary precautions are taken in order to prevent damage to paints during storage, handling, welding.
- The necessary repairs are carefully executed as soon as possible.
- The colour RAL number of the finishing coat has been approved by the Employer, including identification code for piping.
- Standardised equipment will be painted according to the manufacturer's standard.
- All corrosion protection and coating on site shall be done in a workshop specifically for the purpose of the application of corrosion protection and coating.

Codes and standards

Applicable standards are:

- Product data of coating manufacturer
- DIN 2403 Indication of pipe-lines according to flowing material
- DIN 4762 Surface roughness
- ISO 8503 Surface roughness
- DIN 8201 Part 1-9 tight blasting agents
- DIN 50976 Corrosion protection, hot dip batch galvanizing of single parts, requirements and testing
- DIN 55928 Part 1-9 corrosion protection of structural steel work through protective coatings and topcoats
- ISO 8501 Preparation of steel substrates before application of paints and associated products
- ISO 12944 Paints and varnishes – corrosion protection of steel structures by protective paint systems
- RAL Colour card
- ISO 8501-1 Preparation of steel substrates before application of paints and related products
- SSPC Vol. 1 and 2 Steel structure painting council

Surface preparation and cleaning of surfaces in the shop

Prior to blasting, areas have to be cleaned from oil, grease, paint residues, splatters, welding splashes and welding slag using a suitable aqueous degreaser, or solvent for more severe grease contamination. The cleaning should be to provide a "water break free surface".

Sharp edges have to be rounded off.

Contaminations caused by salts, acids and alkali solutions shall be eliminated by rinsing with water up to a pH value of 6-8. Soluble salt contamination is to be tested using the Weber Reilly test method (or similar approved) and pH is to be tested using universal indicator paper strips prior to continuation with the blasting.

The preparation of substrates shall be carried out on the basis of the specifications of ISO 12944 part 4 and ISO 8501. The preparation of steel before application of paint and related products shall be in line with ISO 11124 for metallic blast cleaning abrasives and ISO 11126 for non-metallic blast cleaning abrasives. No recycled blast grit may be utilised.

After blasting, an anchor profile of 25 - 50 μm shall be achieved. Blasted surfaces have to be provided with a prime coat of the approved coating system immediately within 4 hours of blasting. All blasting and priming must take place outside of the high humidity periods of the day (i.e. maximum relative humidity of 80%).

Cleaning to be performed on site

Steel work protected by shop primer after arrival on site must be cleaned of salt, sand, oil, etc. before the first coat of paint is applied on site. Shop primer damaged during transport must be rectified by blast-cleaning and coating before application of the site coats.

Wood surfaces shall be sanded clean. All nail holes shall be puttied and sanded before priming, , unless the specific coating system allows for coating onto damp concrete, in which case only with approval from the Employer.

If a protective coating of concrete is required, concrete shall be allowed to cure before painting.

Transport and erection damages, as well as damages which result out of additional welding have to be repaired as soon as possible. The damaged areas have to be derusted with rotating or steel brushes, abrasive wheels, and abrasive blasting according to DIN ISO 8501-1.

Cleaning of prime and intermediate coats (if required)

To prevent contamination by mineral oil products, areas with prime and intermediate coat have to be treated with suitable cleaning agent. Cleaning has to be done free of residues, e.g. with alkaline detergents and thorough washing done with fresh water. Rusty spots have to be removed according to required purity. Metallic areas which are provided with temporary corrosion protection have to be cleaned. No oxidation products shall remain on the surface. Further care shall be taken that on hot components, no destructive or reaction products will be released when heating which could injure insulation.



Application procedure

When using the provided coating material, strict adherence to all application instructions given in product data of coating manufacturer is necessary. To obtain the maximum performance, technical data as well as application instructions for the individual coating material have to be strictly followed. For a multi-layer coating system each layer has to have a different colour shade in order to clearly identify number of coats applied. The last finish coat has to be applied in the specified colour shade.

All paintings shall be performed according to ISO 12944. The durability of all paintings shall be "high" which corresponds to 15 years.

The interval between applying the different coats has to follow according to supplier's precautions. Each layer has to be cleaned and released from spray dust before the next layer will be applied. Prior to applying a further layer, the last one has to be repaired. All coatings have to be applied without retarding.

Following application procedures are allowed:

- prime coats by airless spray
areas like disconnections, angles, corners, etc. which are difficult to be reached can be applied by brush or roller
- repair of prime coat by brush
- finish coats
 - at works by airless spray, roller or brush
 - at site by roller or brush or airless spray.



When applying coating systems by roller, rollers have to be of kind and quality which make an appropriate application possible.

Control areas in accordance with the coating supplier's instructions have to be applied. For this procedure, a schedule for control areas has to be prepared by the Contractor and coating supplier which corresponds with the requirements of the warranty agreement.

Number and performance of the control areas have to be done in accordance with ISO 12944 part 7 and have to be documented in writing.

No application shall take place either in the condition of the relative humidity not within the given limit or in case of poor weather conditions such as fog, dust, rain, snow, hail or when it can be assumed that such conditions of poor weather will arise within 2 hours after application.

Temperature of the coated parts has always to be above 5 °C and 3 K above dew point.

All specified dry film thicknesses (DFT) are minimum thicknesses.

Welding seams executed at site have to be taped with an adhesive tape of about 30-50 mm after surface preparation (blasting or manual derusting) and prior to application in the manufacturing plant and to be coated with stripping coat.

Chequered plates, nap plates, etc. have not to be covered with adhesive tape, but have to be coated with stripping coat in a dry film thickness of at least 150 μm .

Edging lines on steel structure have to be taped prior to application and after blasting in sufficient width or have to be protected with varnish before application. Thickness of prime coat may be 50 μm maximum.

During repairing works at site on shop-primed structures, it is important that different coats will have different colour shades. Numbers of layers have to be the same as the original coating system to be used.

Application of temporary primer on structures which have to be insulated has to be in accordance with a sufficient corrosion protection for the period of storage respectively erection time.

Galvanizing

Galvanizing work shall conform in all respects to ISO 1461 or equivalent standards and shall be performed by the hot dip process unless otherwise specified.

It is essential that details of steel members and assemblies which are to be hot-dip galvanized should be designed to suit the requirements of the process. They should be in accordance with ISO 12944.

Vent holes and drain holes shall be provided to avoid high internal pressures and air locks during immersion and to ensure that molten zinc is not retained in pockets during withdrawal.

Careful cleaning of welds is necessary before welded assemblies are dipped. All defects of the steel surface including cracks, surface laminations, laps and folds shall be removed in accordance with BS 4360. All drilling, cutting, welding, forming and final fabrication of unit members and assemblies shall be completed, where feasible, before the structures are galvanized.

The minimum coating thickness shall be as specified in Table 1 of BS 729. Structural steel items shall be first grit-blasted to BS 4232, second quality, (Sa 2 1/2) or pickled in a bath, and the minimum average coating weight on steel Sections 5 mm thick and over shall be 900 g/m^2 , on steel Sections 2 - 5 mm thick 600 g/m^2 .

Galvanized contact surfaces to be joined by high-tensile friction-grip bolts shall be roughened before assembly so that the required slip factor is achieved. Care shall be taken to ensure that the roughening is confined to the area of the mating faces.

Protected slings must be used for off-loading and erection. Galvanized work, which is to be stored at the works or on site shall be stacked so as to provide adequate ventilation for all surfaces to avoid wet storage staining (white rust).

Small areas of the galvanized coating damaged in any way shall be restored by:

- cleaning the area of any weld slag and thorough wire brushing to give a clean surface
- The application of two coats of zinc-rich paint, or the application of a low melting point zinc alloy repair rod or powder to the damaged area, which is heated to 300 °C or the treatment with suitable cold galvanizing paint, such as ORAPI n.z.a.b 706. All zinc rich paint used for such repairs must contain a minimum of 81% by mass of zinc in the dry film.

Connections between galvanized surfaces and copper, copper alloy or aluminium surfaces shall be protected by suitable tape wrapping.



Coating Systems System-No.	Surface location	Temp. °C	Surface preparation	Coating systems	No of coats	Generic type	Dry film thickness (DFT) per coat µm	Total DFT µm
1	Structural steel works, piping, vessels, tanks INDOOR	up to 120	SA 2.5	Primer Finish	1 1	Zinc-Epoxy Epoxy High Solid	80 80	80 160
2	Structural steel works, piping, vessels, tanks OUTDOOR	up to 120	SA 2.5	Primer Intermediate Finish	1 2 1	Zinc-Epoxy Epoxy High Solid 2 Comp. Polyurethane	80 160 50	80 160 50 290
3	Piping, tanks, etc. INDOOR and OUTDOOR Insulated	up to 120	SA 2.5	Primer	1	Zinc-Epoxy	50	50
4	Pumps, motors, other equipment OUTDOOR	up to 120	SA 2.5	Primer Intermediate Finish	1 1 1	Zinc-Epoxy Epoxy High Solid 2 Comp. Polyurethane	80 110 50	80 110 50 240
5	Pumps, motors, other equipment INDOOR	up to 120	SA 2.5	Primer Finish	1 2	Zinc-Epoxy Epoxy High Solid	80 50	80 100 180
6	Piping, reactors OUTDOOR Insulated	> 120	SA 2.5	Primer	1	Zinc Ethylsilicate	75	75
7	Stacks OUTDOOR	< 120	SA 2.5	Primer Finish	1 2	Zinc Ethylsilicate Silicone Acrylic	75 50	75 100 175

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Coating System No.	Surface location	Temp. °C	Surface preparation	Coating systems	No. of coats	Generic type	Dry film thickness (DFT) per coat µm	Total DFT µm
8	Steel surfaces (uninsulated)	200-450	SA 2.5	Primer Finish	1 2	Zinc/Ethylsilicate Silicone Aluminium	75 35	75 50 125
9	Galvanized surfaces	up to 120	Mechanical cleaning from contaminants and zinc salts by means of washing or steam jetting or sweep-blasting with fine sand	When Finish Coat is required, such as sea climate with chloride exposure	1	Epoxy High Solid*	125	125
10	Steel surfaces permanently in contact with water, also river water splash zone	Medium temp. °C up to 50	SA 2.5	Primer and Finish Epoxy	1	Glassflake reinforced High Solid Epoxy	500	500
11	Plant / Cooling water pipes	GRP, or steel lined concrete pipes						

* Additional 1 x Finish Coat 2-Comp. Polyurethane, 50 µm, when exposed to UV or weathering conditions and colour retention is required.

Handwritten initials/signature



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B0.6.6 Vibration

Steam turbine generator

The steam turbine and generator have to be statically and dynamically balanced in the workshop such that the following levels of vibrations can be achieved:

- For the steam turbine and the generator the vibration level, measured on the rotating parts at each main bearing shall not exceed the upper limit of the zone "A" as defined in ISO 7919 at steady conditions.
- For the steam turbine and the generator, the vibration level, measured on the rotating parts at each main bearing shall not exceed the upper limit of zone "B" as defined in ISO 7919 for transient operation at rated speed.
- In no case (except alarm condition), the vibrations measured on the rotating parts shall exceed 0.5 of the minimal clearance of the bearings, for the measurements installed near the bearings. This requirement is valid for all speed ranges and load conditions. If conflicts exist between the different specifications, the more restrictive value shall be applied.

The location of sensor element shall be according established standards and generally recognised codes of practice.

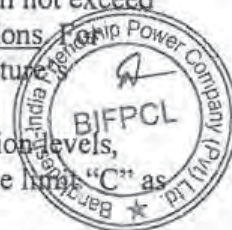
Other rotating equipment

Unless otherwise stated or agreed by the Employer all rotating equipment must have statically and dynamically balanced in the workshop such that the following levels of vibrations can be achieved:

- For large rotating equipment (boiler feedwater pumps, main cooling water pumps, fans (PAFs, FDFs, IDFs), condensate pumps, etc.) the vibration levels, measured on the non-rotating parts, shall not exceed the upper limit of zone "A" as defined in ISO 10816 at steady conditions. For other areas e.g. min flow or run out flow, zone limit "B" shall be maintained.
- For standard pumps, other rotating equipment and reciprocating pumps, the vibration levels, measured on the non-rotating parts, shall not exceed the zone limit "B" as defined in ISO 10816 at steady conditions. For equipment which is not covered by ISO 10816, the manufacturer standard shall be applied.
- For all rotating equipment at transient conditions, the vibration levels, measured on the non-rotating parts, shall not exceed the zone limit "C" as defined in ISO 10816.

For all motors, the vibration levels, measured on the non-rotating parts, shall not exceed the limit as described in the relevant Sections for MV and LV motors.

The vibrations measured on the rotating parts may not exceed 0.5 of the minimal clearance of the bearings. This requirement is valid for all speed ranges and load conditions. If conflicts exist between the different specifications, the more restrictive value must be applied.



Whenever necessary, equipment shall be put on vibration dampers.

Vibration Monitoring System

Vibration shall be measured at large rotating or reciprocating machinery for protection and predictive maintenance. This includes the turbine, the generator, large rotating equipment (boiler feedwater pumps, main cooling water pumps, fans (PAFs, FDFs, IDF's), condensate pumps, etc.).

Suitable indications shall be provided in the control room for each measurement point and the measurement shall be suitably alarmed where high vibration levels may cause possible damage or affect the safety of the Plant. All the vibration signals, unprocessed, which are present on the machine as well the result of the VMS shall be available in the PADO as well as in DCS.

The vibration monitoring system (VMS) shall be reliable, accurate, easy to maintain, and suitable for use in such ambient conditions appertaining to the intended plant installation. Vibration monitoring signals for trip commands, protection functions or process interlocks shall be hardwired. The VMS shall comprise all the necessary hardware and software modules and shall be configured according the design and the needs of the specific installation and technology.

Standardization and interchangeability of components shall be implemented where feasible.

The following features and requirements shall be considered for the vibration and displacement monitoring system:

- self-checking and single fault tolerant system
- modular and reliable system
- 2 out of 3 voting, if signals shall be used for trips (shaft vibration measurement shall be as per ISO 7919-2)
- hardwired or redundant serial communication have to be foreseen
- All buffered outputs signals shall be passed through to the analysis system as unprocessed (raw) input signals.

The following criteria shall be used as a guideline for rotating machinery such as steam turbine, generator, blowers and fans, mills and main feed water pumps as well as other main pumps, in order to ascertain the monitoring points, principles of what signal shall be measured, what is displayed, and what mechanical conditions entail alarm and/or trip status:

- non-contacting proximity probes shall be provided unless otherwise specified for measuring rotor shaft vibration and axial position,
- vibration measurements shall be in displacement microns peak to peak,



- in cases which, because of process conditions, accessibility or non-critical service, may entail the use of machine casing mounted vibration transmitters, the transmitters shall be of the "acceleration" type incorporating a filter network, if necessary along with integration in the monitor unit for vibration read-out in velocity mm/sec RMS. For alarm only, one transducer may be used. For alarm and trip conditions 3 transmitters shall be used with a voting system (i.e. one high reading out of three = alarm, two out of three = trip). Contacting type of equipment shall meet the requirements of ISO 2954,
- velocity type transmitters shall be used as an alternative to velocimeters when machine rotational speed and generated vibration frequency conditions dictate,
- individual read-out of all channels shall be provided in HMI as well as in the vibration monitoring module. Display shall be by means of a multi-point indicator and digital selector,
- facilities for trend monitoring using trend functions of the DCS shall be provided on the turbo-generator bearings as an aid for predictive maintenance purposes,
- vibration parameters of the turbine shall also be fed in the turbine control system
- buffered signals at the monitor shall be a requirement to enable external data acquisition, if such is necessary,
- facilities shall be provided for the calibration of the instrumentation system.

Further requirements on the analysis functions of the VMS are given in Section B8.

B0.6.7 Standardization of makes

The works shall be designed to facilitate access and facility for inspection; cleaning, maintenance and repair. Continuity of supply is a prime concern. The design shall incorporate every reasonable precaution and provision for the safety of all those concerned in the operation and maintenance of the works. The Plant shall be designed to operate satisfactorily under all variations of load, pressure, and temperature.

Corresponding parts throughout shall be made to gauge and be interchangeable wherever possible.

No prototype will be permitted. Continuity of operation and lowest maintenance requirements are of prime concern. The design shall incorporate every reasonable precaution and provision for the safety of all those concerned in the operation and maintenance of the equipment and plant.

The equipment must be standardized as much as possible.



All equipment performing similar duties shall be of the same type and manufacture in order to limit the stock of spare parts required and maintain uniformity of plant and equipment to be installed. Especially the number of types and manufacturers of actuators, valves and instruments shall be reduced to a minimum.

If a piece of equipment is present several times, then all of these pieces shall be identical. All their constituting parts must be exchangeable between them.

The Employer reserves the right to advise the Contractor of preferred type and manufacture to secure the above-mentioned requirements.

Bidder's/Contractor's sub-suppliers and vendors shall comply with Provennes Criteria as stipulated elsewhere in the bidding document.

Throughout the Power Plant metric units, scales and measures shall be used; this applies especially to all fittings.

B0.6.8 Accessibility

The Contractor shall supply and erect sufficiently large safe platforms, galleries, stairways or ladders and access ways necessary for providing safe and easy access to all the plant items for operation and maintenance. The Contractor shall ensure that the whole of the access ways is of uniform design and pattern throughout the works.

The design of all stairways, access ways etc. shall conform to the requirements of the relevant chapters is **Section B0**.

B0.6.9 Signs & colour code

General

Safety colours, safety symbols and safety signs must comply in construction, geometrical form, colour and meaning with the ISO 3864.

Signs for plant identification during the erection period must be to Employer's approval.

The signs should be of a material which is weather-resistant and of sufficient durability for the conditions prevailing on site.

Mounting and installation

The positions for the signs must be chosen so that they are within the field of vision of the persons to whom they apply. The signs should be permanently attached. Temporarily dangerous areas (e.g. construction sites, assembly areas) may also be marked by movable signs. The safety signs



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must be mounted or installed in such a manner that there is no possibility of misunderstanding.

Information signs

Information signs should supply the necessary information to acquaint personnel with the physical arrangement and structure of site, buildings and equipment, e.g. floor numbers, load-carrying capacities including marking of floor areas, working loads of cranes, lifting gear and lifts, room identification, etc. The routing of underground pipes and cables is to be indicated by substantial marker blocks showing the relevant identification numbers.

In the choice of information signs in situations not covered by ISO Draft Recommendation 507 the possibility of using pictograms should be considered. Pictograms are particularly suitable for the identification of rooms, areas and buildings in the non-technical areas of the Plant, sanitary and amenities buildings, etc.

Emergency signs

In the event of accidents, all necessary information should be available immediately to those affected. Thus, a sufficient number of signs of appropriate size should 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 (CO₂), first aid equipment, first aid points, accident reporting points, telephones, etc.

Mandatory signs

Signs indicating obligatory actions must be provided installed wherever certain action is necessary, e.g. do not obstruct the entrance; keep right, etc. Signs should 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 should refer to the existence or possible existence of danger, e.g., flammable substances, explosive substances, corrosive or noxious substances, suspended loads, general danger, width/height restriction, steps, risk of trapping, slipping, falling, etc.

In addition to warning signs, appropriate black-yellow strip markings should also be used where necessary.

Equipment and Piping Colour Code

For colour code for all equipment and piping see table below, for any other items Employer's approval shall be obtained. For safety issues relevant standards and regulations shall prevail in case of discrepancy. Final colour selection is to be discussed and approved by Employer.



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Colour Code (based on DIN 2403:2007-05 & DIN 5381)

Medium	Base	RAL	Band/ Ring	RAL	Let- tering	RAL
Flammable liquids and solids e.g. high speed diesel, lube oil, seal oil, hydraulic oil, coal	Signal Brown	8002	Signal Red	3001	Signal White	9003
Flammable gases e.g. hydrogen	Signal Yellow	1003	Signal Red	3001	Signal Black	9004
Non-flammable liquids and solids e.g. ash	Signal Brown	8002	Signal Black	9004	Signal White	9003
Non-flammable gases e.g. nitrogen, carbon dioxide	Signal Yellow	1003	Signal Black	9004	Signal Black	9004
Fire fighting, e.g. fire fighting water	Signal Red	3001			Signal White	9003
Water e.g. service, demin., condensate, feed, tower, cooling, closed cooling water except fire fighting water	Signal Green	6032			Signal White	9003
Steam e.g. main steam, HRH, CRH, aux. steam	Signal Red	3001			Signal White	9003
Acids e.g. HCl, ferrous sulphate	Signal Orange	2010			Signal Black	9004
Alkali, e.g. ammonia, caustic	Signal Violet	4008			Signal White	9003
Air e.g. station air, service air, instrument air	Signal White	9003			Signal Black	9004
Oxygen	Signal Blue	5005			Signal White	9003
Driven machines (e.g. fans and pumps) including motor, Vents, drains, vacuum	Follow medium color					
Structural steel, steel skids for equipment	Window Grey RAL 7040					
Safety caution, e.g. fall or trip hazards, handrails, head room clearance	Alternating stripes Signal Yellow RAL 1003 / Signal Black RAL 9004					
Panels, cubicles, junction boxes	Light Grey RAL 7035					



B0.6.10 Units of measurement

The Contract shall be conducted in the Systems International d'Units (SI) system of units in accordance with the provisions of ISO 31 and ISO 1000.

In all correspondence, technical schedules, drawings and instrument scales, the following units shall be used:

Quantity	Name of Unit	Symbol
Length	Millimeter	mm
Mass	Kilogram	kg
Time	Second	s
Temperature	Degree Celsius	°C
Temperature Difference	Kelvin	K
Electric Current	Ampere	A
Luminous Intensity	Candela	cd
Area	Square meter	m ²
Volume	Cubic meter Liter	m ³ l
Force	Newton	N
Pressure	Bar	bar
Pressure below 1 bar	Millibar	mbar
Stress	Newton per square millimeter	N/mm ²
Velocity	Meter per second	m/s
Rotational speed	Revolutions per minute	rpm
Flow	Cubic meter per day Cubic meter per hour Kilogram per hour Liter per second metric ton per hour	m ³ /d m ³ /h kg/h l/s t/h
	For gaseous substance: standard cubic meter per hour	Nm ³ /h
Density	Kilogram per cubic meter Kilogram per standard cubic meter	kg/m ³ kg/Nm ³
Torque, moment of force	Newton meter	Nm
Moment of inertia (mr ²)	Kilogram square meter	kgm ²
Work, energy or heat	Joule	J
Heat capacity, entropy	Joule per Kelvin	J/K
Specific heat capacity, specific entropy	Joule per kilogram Kelvin	J/kgK
Calorific value	Joule per cubic meter Joule per gram	J/m ³ J/g



Quantity	Name of Unit	Symbol
Power, radiant flux	Watt	W
Heat release rate	Watt per square meter	W/m ²
Thermal conductivity	Watt per meter Kelvin	W/mK
Dynamic viscosity	Newton second per square meter	Ns/m ²
Kinematic viscosity	Meter squared per second	m ² /s
Surface tension	Newton per meter	N/m
Concentration	Parts per million	ppm
Electrical conductivity	Microsiemens per meter at 25 °C	μS/m
Frequency	Hertz	Hz
Electric charge	Coulomb	C
Electric potential	Volt	V
Electric field strength	Volt per meter	V/m
Electric capacitance	Farad	F
Electric resistance	Ohm	Ω
Conductance	Siemens	S
Magnetic flux	Weber	Wb
Magnetic flux density	Tesla	T
Magnetic field strength	Ampere per meter	A/m
Luminous flux	Lumen	lm
Illuminance	Lux	lx
Thermal resistivity	Kelvin meter per Watt	Km/W
Energy	Kilowatt hour	kWh

For the thermodynamic properties of steam and water, "The IAPWS Industrial Formulation 1997 for the Thermodynamic Properties of Water and Steam" or the latest version thereof shall be used.

B0.6.11 Ways, stairs, ladders, balustrades

The Contractor shall supply all platforms, galleries and stairways necessary for providing safe and proper access to the Plant for operation and efficient maintenance. The Contractor shall ensure that the type of flooring, stair treads and handrails conform to a uniform pattern throughout the whole Project.

The loads for the design of platforms, galleries etc. shall be in accordance with the Section 'Design Loads' of the special civil part of these specifications.

All platforms, galleries, stairways and hand railing shall be of galvanized steel unless otherwise specified.



All platforms and galleries shall be designed with a minimum headroom clearance of 2200 mm and shall have a minimum width of 1500 mm clear passageway and shall be enclosed by hand-railing on both sides. Ladders are only to be provided as an extra means of escape.

All aspects of platforms, stairways, ladders and other access ways shall comply with the requirements of applicable DIN standards, BNBC or equivalent.

B0.6.12 Hazardous areas, fire fighting & prevention systems

Hazardous areas

The Contractor shall take full account of any special requirements concerning the nature, handling and storage of all fuels, flammable 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.

The Contractor shall provide drawings to define all the hazardous zones taking account of all sources of hazards under normal and abnormal operating conditions (regardless of whether or not these areas are specifically listed in the specification). The zoning philosophy shall be subject to the approval of the Employer. All equipment necessary for mounting in these areas shall meet the requirements of BS 5345 or equivalent.

In particular, equipment directly concerned with Plant which may give rise to a hazardous situation shall be designed to IEC 60079 Zone 1 or 2 requirements with electrical connection safety barriers or intrinsically safe equipment equivalent to VDE 0171 Type Exi. Where required by the Employer/Engineer, certification shall be provided to confirm the suitability of the equipment and devices.

The Contractor shall be responsible for ensuring that all electrical equipment installed in any hazardous zone is designed and tested to suit the relevant zone classification and shall be to the approval of the Employer. Cables shall not be laid in trenches etc. with fuel pipe work.

All electrical equipment part of a following system installed in hazardous areas shall be of flame/explosion proof type:

- fuel oil handling systems
- burner operating floors
- turbine lubrication oil tank area
- generator sealing oil tank area
- diesel generator area
- hydrogen bottle house
- others required by the above standards.



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All equipment offered for use in the above areas shall have the necessary certification by the appropriate National Certification Bureau and its proposed application shall fully comply with all conditions of the certificate.

At least all electrical equipment part of the systems in hazardous area as stipulated in the specification shall be of flame/explosion proof type. For other systems the approach as described by the Bidder/Contractor can be applicable.

All electrical equipment associated with any part of a system within the following areas shall be of dust explosion proof type:

- station bunker rooms,
- conveyor transfer towers,
- 3 meters radius from coal feeders, pulverizers and the center point of pulverized fuel pipes.

Fire Fighting & Prevention Systems
See Section B12.

B0.6.13 Maintenance isolation

All major equipment shall be arranged to facilitate safe isolation from all hazards for maintenance purposes. In addition all valves must be capable of being locked either in the open or closed position by means of a chain and padlock.

Non return valves are not acceptable as a means of isolation.

B0.6.14 Materials



B0.6.14.1 General material requirements

All materials shall be new and of the best quality for use in the conditions and the variations in river water quality (refer to **Part C Annexes**), the temperature and pressure that will be encountered in service without undue distortion or deterioration or the setting up of undue strains in any part that might affect the efficiency and reliability of the Plant.

All materials shall correspond either to the approved standards and the respective code number or to exact analysis data, and full information concerning properties and applied heat, chemical and mechanical treatment shall be submitted.

Special attention must be paid to eliminating the possibility of corrosion resulting from galvanic effects. Design, selection of materials and all methods of erection shall be such as to keep these effects to a minimum.

Materials complying with codes and standards listed below shall be used for the design and construction work.

Unless the materials meet these codes and standards the equivalent ASME/ASTM standard shall be used.

Materials and standards

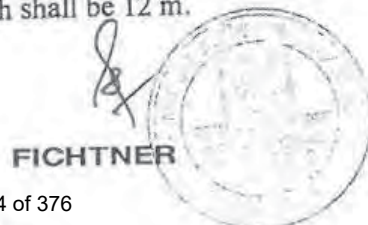
(A)	a.	Structural Steel Built-up Members	DIN EN 10 027-1 Formerly DIN 17 100 and EN 10 025	all steel brands S235 and S355 Formerly St. USt & RS137-2, St37-3, St52-3 or Fe360B, BFU, BFN, C & D1, and Fe S10
	b.	Structural Steel Hot Rolled Members	DIN 1024 Series DIN 1025 Series DIN 1026 Series DIN 1027 Series DIN 1028 Series DIN 1029 Series	all steel brands S235 and S355, Formerly St. USt & RS137-2, St37-3 and St52-3, or Fe 360B, BFU, BFN, C & D1, and Fe S10
	c.	Structural Steel Tubes	DIN EN 10 210-1, 2	S235 and S355
	d.	Crane rail	DIN 4132	
(B)	a.	Bolts and Anchor Bolts	DIN ISO 898, DIN 18 800-1	4.6 (fy ≥ 240 N/mm ²) 5.6 (fy ≥ 300 N/mm ²)
	b.	High Strength Bolts	DIN ISO 898, DIN 18 800-1	8.8 (fy ≥ 640 N/mm ²) 10.9 (fy ≥ 900 N/mm ²)
	c.	Stud Bolts	DIN 32 500 Part 1 & DIN 18 800-1 DIN 32 500, Part 3 & DIN 18 800-1	4.8 (fy ≥ 320 N/mm ²) St 37-3 per DIN 17 100, (fy ≥ 350 N/mm ²)
(C)	Electrodes for Arc Welding	DIN 1913/ DIN EN 499		
(D)	Ordinary Portland Cement	DIN 1164-1 / 1164-2 EN 197-1		
(E)	Reinforcing Bars	DIN 488-2 / 488-4		

Material properties and allowable strengths

- **Concrete steel reinforcement**
High yield steel deformed bars, types as per DIN 488-2
The max. bar length shall be 12 m.



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- **Concrete steel fabric reinforcement**
Reinforcement quality
Wire of grade 500 ($f_y = 500 \text{ N/mm}^2$) as per DIN 488
Welding of reinforcement as per DIN 4099.
- **Fabric types**
Preferred range of designated fabric types: see part 4 of DIN 488.
- **Concrete grade and specified strength**
Concrete for blinding grade C12/15 as per DIN 1045. Min. thickness of blinding = 75 mm.
Concrete for all other structures grade 25/30 as per DIN 1045.
All concrete grade 30/37 or higher as well as special qualities, like waterproofed concrete, have to be mixed in accordance with a special design concept, approved by a third party assessment.
- **Concrete cover to reinforcement bars**
The minimum concrete cover for durability to any reinforcing bar shall be in accordance with ZTV-K, Section 6.

Concrete grade 25/30 as per DIN 1045 are minimum requirements, if not mentioned otherwise.

Note:

- a) Cover noted is to the outside bar regardless of whether it is main or secondary reinforcement.
- b) For concrete exposed to brackish water, brine and seawater splashing a special design concept is required.
- c) For water or liquid retaining structures, the cover should be reviewed in conjunction with design, to limit the allowable crack widths. Linings could also need to be applied.

Structural steel

DIN 18800 / DIN 18801 / DIN 18807 shall be followed.

For all above mentioned material standards, the equivalent standards as per BS, ASME/ASTM are also accepted.

B0.6.14.2 Specific requirements for high temp./high pressure part materials

The purpose of this part is to provide the additional requirements for the purchase, manufacturing and fabrication of:

- austenitic stainless steels used for high temperature superheater and reheater tubing,
- ferritic/ martensitic steels used for high temperature pressure parts.



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All manufacturers and suppliers of the base metals, from raw materials until finished products, shall be ISO 9001:2000 certified for the duration of the contract or being renewed during the duration of the contract as appropriate.

Only seamless tubes and pipes are acceptable for power piping. For low pressure systems (< 6 bar (g)) welded pipes will be accepted. Welded pipes may be used for sizes above DN500 if the design pressure and design temperature are such that it calls for pressure rating of ASME 300 class or below. The fittings shall correspond to ASTM A234 with Grade corresponding to the pipe material. The welded pipes provided shall be of certified source.

All materials and manufacturing procedures shall be certified by an independent 3rd party. The approval shall be part of the quality documentation.

The use of SA213-T24 material for membrane walls is not accepted.

The material SA213-T23 is known for cracking sensitivity. It shall be demonstrated and documented in the final data package that all such materials are free from any cracks and that all hardness values are within the required limits.

For SA213-T23 the Contractor must provide a detailed procedure for the calculation, design, purchase, manufacturing, erection, cleaning and pressure testing of this material. The relevant ASME code cases must be respected.

For SA213 T91 and SA335 P91 the latest stress values and the latest information according to ASME code cases must be used. Also the EPRI „Guidelines and Specifications for High-Reliability Fossil Power Plants Best Practice Guideline for Manufacturing and Construction of Grade 91 Steel Components“ shall be respected.

Bidder/Contractor at his sole discretion may use ASME SA-335, P-92 or approved equivalent material for superheater/reheater headers and interconnecting piping, i.e. for the components which are outside the flue gas path. However, use of T92 material for boiler tubes is not permitted.

In case it is proposed by the Bidder/Contractor to use ASTM-A-335, P-92 or equivalent material, Bidder/Contractor shall furnish a certificate of provenness of the material certifying the usage and satisfactory performance of the proposed material in main steam/hot reheat piping for a reference plant (or applicable unit of reference plant) having rated main steam and/or hot reheat steam temperature at turbine inlet at least equal to or higher than the rated main steam and/or hot reheat steam temperature at turbine inlet envisaged by the Bidder/Contractor. Such reference plant(s) (or unit) should have been executed by the Bidder/Contractor himself or by others and should have been under operation for at least 50,000 hours or 6 years from date of commissioning of the applicable unit (of the reference plant).



Maximum allowable stress values for ASME SA-335: P-92 or approved equivalent material as per code shall be reduced by 10% for calculating the thickness of pressure parts.

For SA335 P92 the Contractor shall provide a detailed procedure for the calculation, design, purchase, manufacturing, erection, cleaning and pressure testing of this material. The relevant ASME code cases must be respected. SA213-T92 may be used for header nipples outside of the flue gas pass, while meeting the above mentioned requirements for quality control.

The details on preheating for welding and PWHT shall be stated in detail. Special consideration shall be given to record the metal temperatures during manufacturing, erection and operation.

In case of any repair of any of such materials at site the 3rd party engineer must be involved concerning the proposed repair method.

B0.6.15 Pre-service cleaning and protection of plant equipment

This clause covers mechanical and pre-service cleaning and protection of the plant items and equipment at the Manufacturer's workshop and at site 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 manufacturers' works or at site, as appropriate.

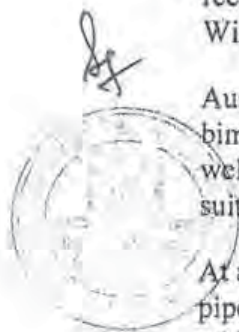
In the event of the surfaces not being cleaned to the Employer's satisfaction, such parts of the cleaning procedures or agreed alternatives as are deemed necessary to overcome the deficiencies shall be carried out at the Contractor's sole expense.

Mechanical cleaning as opposed to alternative chemical cleaning is the preferred method for workshop 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 aluminium alloys, cast iron, bimetallic and metallic/plastic items, and components fabricated by spot welding or riveting shall not be chemically cleaned. All weld areas shall be suitably stress-relieved before chemical cleaning.

At an appropriate time, the Contractor shall submit drawings of temporary pipework necessary to carry out the pre-service cleaning simultaneously with a list of works to be carried out on the pipelines, heaters, feedwater



tanks, vessels etc. to connect the temporary pipework with the parts of equipment to be cleaned.

Further, the Contractor shall submit at the same time the basic draft of the cleaning procedure and of the treatment of wastes.

Not less than six months prior to the commencement of any site cleaning, the Contractor has to submit programs covering all procedures, lists of chemicals, calculations which quote the velocities, temperatures hand-pipework forces and movements imposed during site cleaning.

All necessary equipment, provisions, chemicals etc. are to be provided by the Contractor.

All tests, analyses, etc. as required are to be performed by the Contractor.

Besides this, the Contractor shall take over all responsibility for the treatment and disposal of wastes according to the local law and to the satisfaction of the Employer.

The date at which cleaning of plant equipment will be carried out at site shall be notified to the Employer at least 20 days in advance.

The Contractor shall take all necessary precautions to ensure that the internal surfaces of all 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 Employer for sub-assemblies, the installation shall undergo a procedure for site cleaning proposed by the Contractor and subject to the approval of the Employer.

B0.6.16 Welding

All pressure part welding must follow the requirements of ASME and connected standards.

Welding work and related heat treatment as well as inspections and test shall be performed in accordance with the specific and approved welding procedure specifications (WPS) and the respective material specifications.

WPS shall be prepared in accordance with relevant ASME standards, endorsed by 3rd party / inspector and submitted to the Employer.

Welding plans have to be prepared by every manufacturer for his scope of work.

No welding shall be undertaken until the applicable WPS and Procedure Qualification Record (PQR) are approved by the Employer.



The PQR shall be qualified in accordance with relevant ASME standard. Welding procedures must be qualified by a qualified independent testing authority engaged by the manufacturer.

Welding procedures shall be qualified in accordance with the requirements of the construction code/specification for the Item of plant concerned and in the case of critical plant items the tests shall be witnessed by an internationally recognized inspection authority.

Welders shall be qualified in accordance with the requirements of the construction code/specification for the Item of plant concerned for all types/positions of welding he may perform.

Welder tests shall be carried out in accordance with the approved standards within Contractor's scope. Test results are available for review in the work-shops.

If at any time in the opinion of the Employer the work of any welder appears questionable, such welder is required to pass additional qualification tests to determine his ability to perform the type of work on which he is engaged. Any welder failing the retest may, at the discretion of the Employer be disqualified from further welding on items under this Contract.

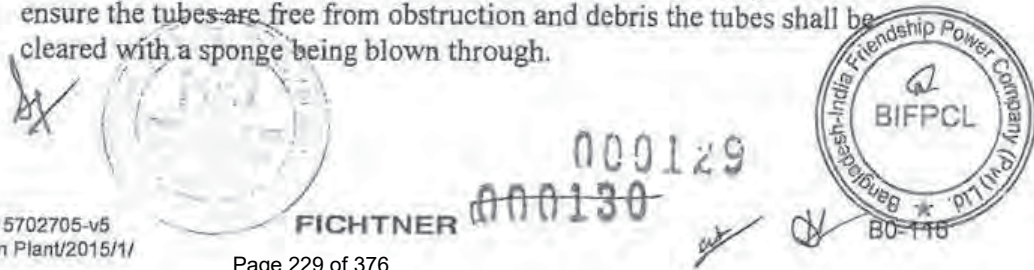
The 2 first production welds of every welder shall be 100% examined by volumetric NDE and only when the results are acceptable, shall the welder be released for production welding.

A system of positively identifying the work of each welder shall be maintained and any welder whose work is the subject of multiple rejections shall be required to undergo a requalification test. Any welder failing the retest may, at the discretion of the Employer's Representative be disqualified from further welding on items under this contract.

Welded fabrications shall be stress relieved when specified by the applicable standard or for dimensional stabilization prior to machining.

Copies of temperature charts referenced with load items shall be included in the test certification supplied for the relevant items.

All welds shall be visually examined and shall be of smooth contour, free from cracks, undercut and other significant defects. Wherever possible the interior of tubes etc. shall be examined using a suitable optical device where necessary. The manufacturer shall make every effort to avoid any contamination of the tube interior during the manufacturing process. To ensure the tubes are free from obstruction and debris the tubes shall be cleared with a sponge being blown through.



Fillet welds shall be checked for size using suitable gauges which shall be available for use on request by the Employer's Representative during an inspection visit.

For single side butt welds, all root passes shall be welded using a TIG welding process.

Preheating shall be in accordance with the applicable WPS and the respective material specification. The preheat temperature shall be in function of welding process, wall thickness, type of welding consumables, ambient temperature and climatic conditions

Welding performed outside a workshop is authorised if an approved wind and rain protection (welding bay) is installed around the working place. Anyway, when ambient temperatures falls below 5°C, preheat is required for all ferritic materials and thicknesses. Gas burners or oxy-fuel torches can be used for pre-heating. Preheat shall be maintained over a distance of not less than 4 times the nominal thickness with a minimum of 75mm on either side of the weld. If the material required pre-heating, the same pre-heating shall be done for oxy-fuel or plasma cutting.

Welding consumables such as TIG-rods, electrodes, wires shall be clearly marked in order to avoid any mix-up of material grades. Positive Material Identification to be carried out on where a doubt for mix-up exists.

Any post welding heat treatment (PWHT) shall be performed in accordance with an approved procedure. The procedure shall describe the method, the heat treatment parameters (e.g. holding temperature and time, heating/cooling rates, heated/insulated band...), the number and location of thermocouples, records and calibration. The procedure shall be available on Site and or in the workshops.

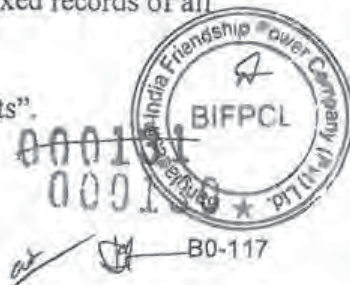
Before welding and/or heat treating valves, valve-manufacturer instructions shall be taken into consideration.

In the case of sensitive materials, grinding of the welds or other grinding work may only be carried out with special grinding wheels so as to avoid overheating or an increase in the hardness of the material.

Welding defects of all kinds must be documented and be available to the Employer on Site or in the workshop.

The Contractor maintains and makes available to the Employer or his representative, both at works and Site, adequately indexed records of all welds, weld inspections, weld controls and repair.

Please refer also to Section B0 for "Manufacturing tests".



Additional welding requirements for welding of civil steel structures are stated under **Section B9**.

B0.6.17 Mechanical equipment

B0.6.17.1 Pumps

General

All pumps shall be designed for continuous operation unless otherwise specified.

Pumps shall be installed in positions convenient for operation and servicing. Where multiple pump installations are required, each pump and its associated equipment shall be arranged in such a manner as to permit easy access for operation, maintenance and pump removal without interrupting plant operation.

Pumps installed for parallel operation or as stand-by sets are to be of identical design, i.e. interchangeable.

Lifting lugs and eyes and other special tackle shall be provided as necessary to permit easy handling of the pump and its components.

General design and construction

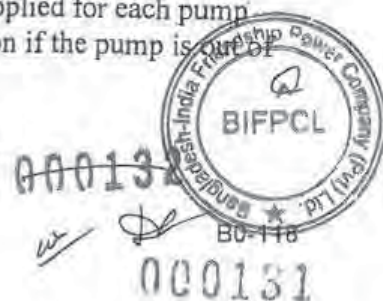
All pumps shall be designed to withstand a test pressure of 1.5 times the maximum possible pump shutoff pressure under maximum suction pressure conditions. If a pump can operate at sub-atmospheric suction conditions, the entire pump shall be designed for full vacuum.

All pump shafts shall be of ample size to transmit the maximum possible output from the prime mover. The pump shaft and coupling are to be so dimensioned that the maximum permissible torque of the shaft is higher than the maximum transmissible torque of the coupling. Directly coupled pumps shall be used preferably.

Renewable wear rings shall be provided at points of running clearance and shall be made from appropriate materials.

All pumps and accessories in contact with the pumped fluid shall be constructed of materials specifically designed for the conditions and nature of the pumped fluid, and be resistant to erosion and corrosion.

Product water flushing lines and drains are to be supplied for each pump handling the prevailing river water to avoid corrosion if the pump is in operation for extended periods.



The pump glands or mechanical seals shall be so arranged that repackaging or fitting of replacement seals can be carried out with the minimum of disruption to plant operation. In case of operating under vacuum conditions liquid sealing is to be provided.

The pump casing shall preferably be split for ease of maintenance and be designed such that the impeller and shaft are capable of being withdrawn from the casing without disturbing any of the main pipework and valves carrying the pumped fluid. In general, all horizontal pumps with draw-out-rotors are to be fitted with a coupling to facilitate disassembly without removing the motor. Pull-out design of the shaft shall be applied to vertical wet pit and dry pit pumps as well.

Each horizontal pump shall be mounted with its drive on a common base plate of rigid construction. Vertical pumps are to be provided with foundation frames. In case of submersible pumps suitable frames shall be provided in the pump sump. It shall however be possible to remove these pumps without entering the sump.

Pumps must be carefully set to ensure that the net positive suction head available under all operating conditions will be adequate for the type of pump employed. The NPSH values are to be referred to the least favourable operating conditions - lowest atmospheric pressure, lowest level of water on the suction side of the pump, and highest temperature of the pumped fluid. An adequate safety margin of normally greater than 1 m to the max NPSH required shall be provided unless and otherwise specified for specific pump. Pumps shall operate smoothly throughout the speed range up to their operating speeds. The first coupled critical speed must be at least 20% higher than the maximum operating speed. The determination of the shaft diameter and the distance between two consecutive bearings must include a sufficiently large safety margin to satisfy this condition.

Where necessary, the pumps are to be fitted with devices to ensure a minimum throughput.

Bearings

For large pumps the bearings shall be of automatic oil lubricated sleeve type, unless otherwise specified. Bearings on vertical shaft pumps shall be so spaced to prevent shaft whipping or vibration under any mode of operation. Vibration sensors and temperature measurements incl. temperature transmitters for continuous monitoring shall be provided for large pumps.

Bearings housings on horizontal shaft pumps shall be designed to enable the bearings to be replaced without removing the pump or motor from its mounting. Bearing housings on horizontal shaft pumps shall be effectively protected against the ingress of water, pumped fluid and dust by suitable nonferrous deflectors.



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All bearing oil wells shall be fitted with visual oil level indicators. Non-pressure-oil lubricated bearings shall be equipped with constant level oilers.

Pumps characteristics

When several pumps are installed for the same service, they shall be suitable for unrestricted parallel operation.

The pump flow/head characteristics shall be such that within the operation range the head will continuously increase with decreasing flow, maximum head (shut off head) being at least 10% higher than the duty point head.

Unless otherwise specified all pumps shall be capable of operating at 110% of the rated capacity at the rated delivery head. Maximum size impellers for the pump body in question shall not be quoted for. By installation of a new impeller a head increase of 5% minimum shall be possible. The performance of the drive motor is to be determined according to the above mentioned technical requirements and to the requirements as specified in the electrical part.

Fittings

All pumps shall be installed with isolating valves, a non-return valve and suction and discharge pressure gauges unless otherwise stated. Accessible couplings shall be supplied with removable type guards.

Coupling halves shall be machine matched to ensure accurate alignment. Couplings as well as gears must have a rated capacity of at least 120% of the maximum potential power transmission requirement.

All pumps other than submersible pumps shall have temporary strainers fitted in the suction pipework during all initial running and commissioning phases. Permanent strainers shall be provided where specified.

Venting valves shall be fitted to all pumps at suitable points on the pump casing unless the pump is self-venting, due to the arrangement of the suction and discharge nozzles. Drainage facilities shall be provided on the pump casing or adjacent pipework to facilitate the dismantling of pumps.

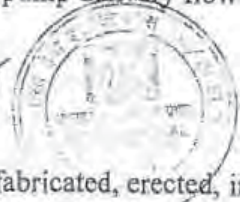
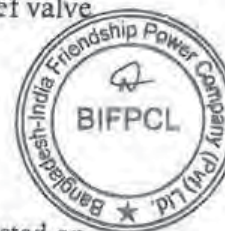
All positive displacement pumps shall be fitted with a discharge relief valve capable of passing the maximum pump delivery flow.

B0.6.17.2 Piping and accessories

Design criteria

The pipework shall be designed, fabricated, erected, inspected and tested on the basis of the applicable standards and codes, and the additional requirements as set out below.

For the plant water and cooling water system GRP is preferred, Bona-Pipe and coated carbon steel is acceptable. For saline water and the water treatment systems LPP piping will be accepted also. If a carbon steel system is offered, a cathodic protection system shall be employed for inside and



outside. For steel underground piping where cathodic protection is not feasible coal tar epoxy coating shall be applied. For painting and coating see chapter painting specification. A sufficient corrosion allowance shall be considered.

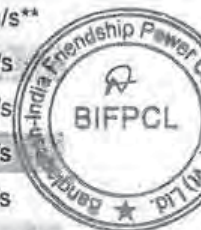
Plant water and cooling water piping system: If these pipes are buried cathodic protection system shall be employed for inside and outside. Further communicating lines (from above ground to underground and vice versa) will have to be provided with respective insulation joints. In any case protection against corrosion must be provided. GRP or other appropriate material is required.

Screening channel in the plant water pumping station as well as other equipment installed in pumping stations: In case all piping of mild steel is used require cathodic protection.

GRP piping shall be laid under the responsibility and supervision of the GRP pipe manufacturer.

The maximum flow velocities for the individual media must not be exceeded at maximum throughput (unless expressly specified in the documents or proven by the Contractor):

Type of Pipework	Max. Velocity
Steam lines:	
High-pressure live steam lines (PN \geq 63)	60 m/s
HP / LP turbine bypass lines	100 m/s
Intermediate-pressure steam lines (PN 25/40)	40 m/s
Low-pressure steam lines above 5 bar	35 m/s
Low-pressure steam lines < 5 bar	25 m/s
Vacuum lines	80 m/s
Saturated steam lines	20 m/s
BFP drive turbine exhaust	80 m/s
Water lines (Feedwater, Plant water / cooling water, condensate etc.):	
Feedwater suction lines	0.5-2.5 m/s**
Feedwater discharge lines	3-5 m/s
Other suction lines	1.5 m/s
Other discharge lines	3.0 m/s
River water lines	3.0 m/s
Fuel lines:	
Fuel oil / LDO suction lines	



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Type of Pipework	Max. Velocity
Fuel oil / LDO discharge	2.0 m/s
Air Lines:	
Compressed air lines	15.0 m/s
Combustion air lines	20 m/s
flue gas lines	18 m/s

** The design and routing of the feedwater suction lines must be optimized considering the allowable velocity of depressurization caused by load changes.

The maximum velocity for the LP extraction shall not exceed 60 m/s. For those media/systems where no maximum velocity is given in the specification, the maximum velocity shall be proposed by the Contractor and is subject to approval by BIFPCL during the basic/detailed engineering.

In addition pressure drop criteria shall govern the sizing of the key lines.

Nominal diameters (DN), nominal pressure (PN) and wall thicknesses shall be standardized.

Nominal diameters of < DN 25 shall not be used for pipe lines except for instrument lines, chemical dosing and analysis lines.

For the design of safety valves installed downstream of reducing stations, high pressure bypass valves or equivalent control valves, the maximum throughput of the fully open reducing or bypass valve including injection water quantity is to be taken as the basis for calculation. All cross Sections and lines for safety devices that protect against excess pressure (safety valves, rupture discs and similar items) must be designed to ensure the necessary blow-off rate and fault free functioning.

The design pressure is equal to the response pressure of the devices protecting the piping. In the case of pump discharge lines a pressure corresponding to 1.1 times of the shut-off head of the pump at the ambient temperature is to be taken as the minimum design pressure. The plant water and cooling water systems must be designed according to the water hammer calculation.

The design temperature is the highest possible fluid temperature occurring in the length of line concerned. Possible tolerances of the temperature control system and any temperature allowances provided by the requirements of the standards shall be considered.

For live steam lines the design pressure of the boiler shall be taken as the design pressure of these lines up to the inlet of the turbine main stop valves. In addition to the required wall thickness in accordance with calculations, corrosion allowance of 3 mm shall be added for unprotected carbon steel, 1.5 mm for alloy steel and 0.5 mm by stainless steel.



For the cold reheat piping downstream of the connection to the HP bypass exhaust, the selection of the design temperature shall also consider the case that the HP bypass station is operated for limited period without spray injection. The Contractor shall prove both operating cases: Operation of HP bypass with spray attemperation and without spray attemperation (limited time period). Both cases shall not lead to any damage to the cold reheat piping and downstream pressure part.

For the piping systems with a nominal pressure specified as $PN > 40$ as in DIN 2401 or equivalent and for vacuum systems, the drainage and ventilation facilities shall be fitted with double valves.

All vents, drains or dump points with more than 10 bar/100 °C operating pressure/temperature shall lead to the flash tanks and into funnels at visible points with covers.

Guidelines for the design and construction of pipework and accessories

- Design and construction of all parts of the power piping shall be according ASME B31.1 (Power Piping).
- Other piping and accessories should correspond to the present state of the art and shall be based on the latest standards and medium properties.
- The pipework and its accessories shall be designed and arranged so that all parts subject to operation and maintenance can be operated, inspected, maintained and replaced without difficulty and with a minimum of effort. All important parts must be accessible.
- Provisions to allow for isolation and for access must be foreseen on all parts subject to acceptance by the local authorities.
- None of the forces and moments transmitted by the pipes to connected machines, apparatus and other components must exceed the maximum permissible values, given by the manufacturers of these items. Attachments to turbine foundations shall be carried out only as agreed with the turbine manufacturer.
- All steam traps shall be provided with a bypass and lines which open to a funnel.
- As far as expansion joints and other parts of pipework are concerned it shall be borne in mind that differential settlement can occur. The reaction forces and moments of the piping system to be withstood by fixed points, walls, foundations and other civil structures shall be reduced to the utmost minimum by suitable means (e.g. expansion joints shall be provided where required).
- The pipe support structures shall be designed to minimize heat transfer.
- The installed pipework with its supports and other components shall not obstruct gangways (min. 1500 mm wide), maintenance, escape routes etc. Overhead piping shall have a minimum vertical clearance of 2.3 meters, 8 meters above main access roads and 6 meters above any other roadways.
- Pipe spools for HP steam, feedwater piping and all steel pipes $\geq DN 400$ shall be cleaned internally prior to delivery by shot blasting at the



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workshop with iron particles to SA2 1/2 or by acid cleaning, and shall be properly protected against corrosion.

- Pipe ends and branch connections of underground piping shall be sealed temporarily during installation if the connecting pipe is not immediately installed.
- The Contractor shall submit a detailed description of proposed steam blowing and other cleaning procedures for all pipelines, and no part of this work shall be started until these procedures have been approved by the Employer. Temporary silencers shall be provided for this.
- The cleaning of water - steam system shall comply to VGB R513e „Internal Cleaning of Water-Tube Steam Generating Plants and Associated Pipework“
- The Employer reserves the right to require the Contractor to modify any of his cleaning procedures if found necessary to obtain acceptable results. The Contractor shall furnish, install and dismantle all temporary pipes, hangers, anchors, etc. required for cleaning all piping systems.
- To the extent that hot fluids can accumulate in pipe Sections isolated for maintenance purposes (including control valves with injection water), drains with hand-operated shut-off valves are to be provided for the safety of the personnel (block and bleed systems). Furthermore the Contractor shall safeguard the piping systems against over-pressurization caused by thermal expansion of blocked-in fluids by adequate means.

Welding

- All welding shall be carried out according to relevant standards. The welding procedures of the Contractor shall be supplied before execution of welding works to the Employer for approval. For quality reasons as many welds as possible are to be carried out in the workshop.
- Welding ends of all piping must be carefully prepared before welding. The type of butt welding ends of valves, control devices, orifices, etc. shall be specified by the Contractor and must be given to the manufacturers of these components in due time prior to their start of work if necessary/postweld heating treatment. If there are differences in the wall thickness and/or different materials of piping and valves with butt-welding ends, the necessary transition pieces must be provided by the manufacturer of the valves.
- Socket welds are not permitted for lines above DN 50, for corrosive media lines or for lubricating oil lines.
- After completion of the weld joint, the welder must mark with indelible crayon his identity number and the last two digits of the year in which the work was completed on the pipes. The Contractor shall keep a record of welders.
- Testing of piping and welding shall be as per ASME standard. Minimum requirements for testing of welds are specified in Section B0.7.2.

Welding tests.



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Piping

- The Contractor shall provide suitable thimbles and flashing where pipelines pass through floors and walls. Floor thimbles shall be installed to provide 90 mm projection above the finished floor surface.
- A stress analysis shall be performed for all piping systems $DN \geq 50$ with an operating temperature ≥ 100 °C.
- For cross country low pressure piping with a straight length of more than 200 m a stress analysis shall also be conducted.
- The piping stress and flexibility analysis shall be based on the relevant standards. Recalculation must be taken into consideration as built condition, actual weight and dimensions.
- Tubes, pipes, bends and fittings shall be produced and tested in accordance with the applicable international standards (ASME/ASTM, EN, etc.).
- All pipe lengths under this package, including piping where alloy steel is used shall be subjected to 100 % ultrasonic examination as per material specification standard with acceptable notch depth of 5% of the selected wall thickness (1.5mm maximum) except for the following piping system: LP piping not under "ASME B31.1 Power Piping" for not dangerous and not explosive media.

Noise abatement measures

The Contractor shall take all necessary measures to limit noise in accordance with the requirements. On no account shall the sound level exceed the values as mentioned under the relevant subsection.

If this requirement cannot be met by adequate construction of the pipework and valves concerned, sound absorbing housing or insulation have to be provided. Where pipework and valves are installed outdoors, the above mentioned requirement may be fulfilled, if necessary, by providing silencers at the safety valve outlets and at the blowing out lines.

Pipe supporting elements

As used herein, the term "hangers and supports" shall include all hanger assemblies, support assemblies, constant support hangers, anchors, guides, sway braces, vibration dampers, trays, brackets, attachments, miscellaneous structural steel and other items required to support the piping in a proper manner.

For supporting points up to 25% variation and 40 mm movement variable spring supports shall be selected.

Constant support type spring assemblies shall be provided at all locations where it is necessary to avoid transfer of stress from that support to another support or to an equipment terminal, and at other support locations where vertical movements of the piping are too large to be properly handled by variable support springs. Constant support spring assemblies shall be of a design that will compensate for the normal variation in the supporting force of the helical coil springs, thus providing constant supporting force through-



out a total travel range which shall be at least 20 mm greater than the actual maximum movement of the piping.

Constant support assemblies shall be equipped with a means of locking the spring(s) against movement during erection, hydrostatic testing etc. The use of counterweights in substitution for support spring assemblies will not be permitted.

Support spring assemblies shall be of the enclosed spring type, and shall have an embossed on factory load indication scale showing the hot (operating) and cold (ambient) positions. Each spring assembly shall incorporate an adjustable hanger rod coupling to permit load adjustment. All support springs shall be designed to permit at least $\pm 10\%$ field load deviation from the factory calibrated load.

The supporting force provided by variable support type spring assemblies shall not change by more than 20% between the cold and hot positions, and supports of this type shall not be used at any point where such a change in supporting force cannot be safely permitted. Variable support spring assemblies shall incorporate springs with maximum working range length in order to reduce the overall length of the assembly.

All pipe hangers and support stands shall be attached to the piping and structural supports such that they will be vertical when the piping is at hot operating condition. So far as practicable, hangers and supports shall be of the same type and component assembly.

All hangers shall be carefully adjusted. After Plant start-up checks shall confirm that all hangers and supports are in the correct position.

The Contractor shall prepare a complete documentation of all pipe hangers and supporting elements. These documents shall contain the following information:

- loads, forces and moments, and their directions at all supports, hangers at normal operating conditions, etc.
- magnitude and directions of the movements at the loading points
- measurements of the loading points referred to the axes of the buildings
- item No. of the supports, hangers etc. according to the piping group
- material specification for the supporting parts.

Trace heating

Trace heating shall be provided for fuel oil pipes and other pipes as required. Electric type trace heating is preferred. The referenced Site Conditions as well as media properties shall be base for the design.

Protection of buried pipework systems

All buried pipework of steel or cast iron or other materials prone to corrosion shall be protected from corrosion by cathodic protection.



The design of the cathodic protection system(s) shall be executed by a specialist and authorized company. The designed cathodic protection shall be a completely functioning system in all respects according to the state of the art and shall also include the appropriate equipment for measurements.

For the plant water and cooling water piping system only: If these pipes are buried cathodic protection system shall be employed for inside and outside. Further communicating lines (from above ground to underground and vice versa) will have to be provided with respective insulation joints. In any case protection against corrosion must be provided. GRP or other appropriate material is required.

B0.6.17.3 Valves, steam traps, condensate drainers, safety valves

The Contractor shall design and supply all valves and their accessories required for the safe, efficient and sound operation and maintenance of the Plant based on the appropriate standards. They shall comply as a minimum with the design criteria of the relevant piping.

For reasons of Plant standardization, the Contractor shall co-ordinate types and makes of all valves in his supply and that of his subsuppliers.

Design, construction, fabrication and testing of the valves shall be in accordance with the ASME B16.34. The stipulations of this Section will take precedence if these are more stringent than the approved standards.

All valves shall be suitable for the media and for the service conditions and those performing similar duties shall be interchangeable.

Acceptance certificates for valves shall follow EN 10204 or approved equivalent codes.

The following types of valves are recommended:

- globe valves up to and including DN 50
- gate valves DN 65 and above
- butterfly valves DN 400 and above as metal seated type for LP steam and exhaust steam (DN 65 and above as soft seated type for waterlines (cooling water, process water etc., operating temp. max. 180 °C)
- lift check valves up to and including DN 50
- swing check valves DN 65 and above
- Ball valves DN 25 and above.
(fuel oil, natural gas, compressed air)



DN means 'diameter nominal'.

In vacuum service and wherever otherwise necessary to prevent the entry of air, valves shall be provided with suitable sealing facilities. Where applicable, the valves must be suitable for outdoor installation under consideration of the special climatic and environmental conditions of the site.

Unless otherwise agreed, all valves shall be fitted with the spindle in upright position.

All valves shall be positioned so as to be readily accessible for operation and maintenance from permanent floors, catwalks or platforms. Where required, valve spindles shall be lengthened to have the hand-wheel at a height approximately 1 meter above the operation level. All underground valves shall be installed in concrete culverts.

All valves shall be closed in a clockwise direction when looking at the face of the handwheel. The valves shall have rising spindles and non rising handwheels. Plastic valve handwheels will not be accepted.

HP- and large size gate valves to be opened under differential pressure shall be equipped with pressure equalizing valves (globe valves).

All valves shall be fitted with indicators to determine the valve position. In the case of valves fitted with extended spindles, indicators shall be fitted both to the extended spindle and to the valve spindle.

All globe valves shall be equipped with throttling cones with parabolic characteristic.

In general, I,P safety valves, butterfly valves, ball valves and orifices as well as all control valves shall be flanged. All valves including valves as mentioned above for steam, feedwater and condensate, HP safety valves (inlet side) shall have welded ends, corresponding to the connected pipes. Also all valves on heater drains and vents and in vacuum systems shall be welded.

Design of valves and materials used must comply with the relevant standards. They must be chosen in accordance with the requirements to be met and to corresponding pipework.

For limiting handwheel forces, for control and operation purposes it may be necessary to install gears and drives.

The maximum handwheel force of 500 N must not be exceeded.

The Contractor shall furnish and install steam traps at each low point. Each steam trap installation shall include a permanent strainer of 20 x 20 mesh



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size, upstream and downstream globe valves and a globe valve as free drain. Steam traps shall be supplied with weld ends.

Steam traps shall preferably be of the thermodynamic, thermostatic or bimetallic type with multistage nozzles and selected to suit the service conditions.

Traps which incorporate internal screens or check valves will also be accepted.

Each trap shall be sized to provide ample capacity at the minimum working differential pressure, and to open the orifice at maximum working differential pressure.

Condensate drainers such as used on LP saturated steam or compressed air lines shall be of the ball-float type.

HP gate valves shall be equipped with self sealing lid covers. The self-sealing lid covers shall be equipped with a safety device at the body with shut-off valve and interlocking system. This system must be approved by the authorities.

All valves of the HP/IP piping systems shall be suitable for pickling/acid cleaning (special temporary inserts).

The valves for live steam, HP feedwater and HP injection water shall be made of forged steel. Forged steel or cast steel bodies shall be used for the remaining systems. Valves made of gray cast iron are not acceptable.

Acceptance certificates for piping components and valves shall follow EN 10204.

At the economizer inlet a non-return valve shall be installed, but not shut-off valve.

Technical requirements of Butterfly Valve:

Applicable standard:

- ASME B16.10 2009 Face-to-Face and End-to-End Dimensions Valves
- ASME B16.34 2009 Valves - Flanged, Threaded, and Welding End
- ASME B31.1 2012 Power Piping
- API 609 2009 Butterfly Valves: Double Flanged, Lug- and Wafer-Type
- API 609 2009 Butterfly Valves: Double Flanged, Lug- and Wafer-Type
- ISO 5752 1982 Metal valves for use in flanged pipe systems - face to face and centre to face dimensions
- ISO 80000-1 2009 Quantities and units
- EN 10204 2004 Materials Testing Certificates

Valves assemblies shall be designed for the pressure and temperature rating of the class specified in the Piping Material Classes and Valve List.



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Hydrostatic testing for valves shall be in accordance with ASME B16.34 and API 598.

Carbon steel having carbon contents of more than 0.25% shall not be used in Welded construction valves.

Lug type valves shall not be used.

Valve stem packing, trim and bonnet gasket material shall be manufacturer's standards, unless otherwise specified.

The maximum force requested at the hand wheel shall not exceed 300N (30kgf).

The manually operated valves in the sizes and pressure classes shall be provided with a gear operator as minimum.

- Class Butterfly
- 150 DN 200 & larger
- 300 DN 150 & larger

Gear operator type: Worm-gear type

All valve actuators shall have local indicators fitted to show whether the valves are in an open or shut position. Where extended spindles are used, indicators shall be fitted to both the extended spindle and to the valve spindle.

Plastic or bakelite valve hand-wheels are not permitted.

The stops limiting the travel of any valve in the "open" or "shut" position shall be arranged externally to the valve body.

All valves shall be closed by turning the hand-wheel in the clockwise direction when looking on top of the hand-wheel.

The face of each hand-wheel shall be clearly marked with the words "open" and "shut" in English, with adjacent arrows to indicate the direction of rotation to which each refers.

Each valve hand-wheel shall be fitted with a name-plate of an approved material, indicating in English the valve reference number and function. The name-plate shall incorporate the colour code corresponding to the particular service of the piping.

Handwritten signature



B0.6.17.4 Thermal insulation

General

The thermal insulation shall be designed and installed in accordance with AGI, VDI and DIN or equivalent standards, considering the following minimum requirements:

Insulation shall be provided for personnel protection, heat conservation, noise reduction and for prevention of the formation of condensation on all pipework and equipment whose external surface temperature exceeds 60 °C.

For personnel protection all surfaces with a temperature above 50 °C and which are within the reach of personnel shall be provided with protection insulation and the maximum insulation surface temperature shall be 60 °C.

- All insulation material has to be made from non-asbestos materials.

Following design criteria for insulation shall apply: Design ambient temperature:

- Inside buildings: Ambient temperature of 40°C and wind speed of 0.5 m/s
- Outside buildings: Ambient temperature of 45°C and wind speed of 0.25 m/s

Thickness of the insulation shall be calculated according to ASTM C-680. The Emissivity of the cladding shall be 0.2.

Type of insulation materials

The mats shall be stable in shape, chemically inert, free of sulfur and alkali, resistant to water and steam, non-flammable and capable of withstanding continuous exposure to the pipe design temperature. The mats used for insulation of stainless steel equipment shall have a chloride content of less than 0.15%. Under no circumstances may asbestos or asbestos containing materials be used.

The material will have the following physical/chemical properties (± 10% allowance):

- service temperature up to 650 °C
- density 120 kg/m³
- water adsorption 0.5% weight
- specific heat capacity 0.84 kJ/kg °C
- compressive strength 20 kPa
- conductivity versus temperature:



Average temperature

Blanket (W/m °C)

0	0.034
50	0.040
100	0.048

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Average temperature	Blanket (W/m °C)
150	0.058
200	0.070
250	0.083
300	0.100

For temperatures above 300°C the conductivity required shall be determined by linearly extrapolation of the values presented in the above table.

- conductivity allowance is limited to + 5%.

For special purposes such as for turbines, boilers, etc. spray type insulation or insulation brickwork (for example calcium silicate) may also be applied. The special insulation materials shall be stated by the Contractor and their design shall match the overall design and guarantee the requirements stated in the specifications.

Type of insulation setting materials

The surface cladding shall be made of aluminium sheets, manufactured in sheets with the following minimum thickness:

- Outer insulation diameter up to 150 mm Sheet thickness 0.7 mm
- Outer insulation diameter up to 450 mm Sheet thickness 0.9 mm
- Tanks and other large equipment Sheet thickness 1.2 mm

Tank tops shall be provided with insulation strong enough to support a man's weight.

The sheets shall be secured and connected at the longitudinal seams with at least five stainless steel self-tapping screws per meter run.

Plain sheets for flat surfaces shall not exceed 1 meter square and shall be stiffened by crimping.

At the longitudinal and circumferential joints, the sheets shall overlap by at least 50 mm so as to drain off the liquid and not to trap the liquid in the insulation.

Places at which the metal sheets are penetrated for pipe hangers, thermometer sockets, etc. shall be sealed with funnel-shaped recesses of sheet metal rims.

The seams and penetrations of any sheet metal insulating jacket installed outdoors as well as in the boiler and turbine house in areas with risk of water spray etc., shall be sealed against penetration of water by means of a suitable silicon based sealant.



In the case of pipe insulation thicknesses greater than 60 mm, where insulation blankets are used spacers shall be provided at maximum intervals of 950 mm to ensure a uniform insulating thickness on all sides and a perfectly circular shape of the sheet metal jacket. The sheet metal jacket shall be supported by support webs (for pipe diameters below 100 mm) and enclosed support rings (for pipe diameters 100 mm and above). If the enclosed support rings are not provided with ceramic spacers, the spacers made of steel shall be insulated with one heat insulation strip in the case of operating temperatures of up to 200 °C, and with two heat insulation strips where the operating temperature exceeds 200 °C.

To provide protection against contact corrosion, the external circumference of the support ring shall be fitted with heat insulation tape 1 mm thick with two woven edges.

Insulation of flanges, valves and fittings

All flanges, valves and fittings shall be provided with two-piece or multi-part caps made of aluminium sheet of the specified thickness. Each piece or part shall be double jacketed and the various parts shall be held together by quick release clamps or lever hooks to facilitate assembly and disassembly:

All caps of the welded-in fittings shall be made longer by approximately twice the insulation thickness so that the welding seams will be exposed after removal of the cap.

All manholes shall be provided with heavy duty hinged covers which are to be protected from overheating and corrosion. Such covers shall be secured with easily accessible clamps. In addition, metallic stand-offs shall be provided for personnel protection.

Insulation of tanks and process equipment

Tanks and process equipment shall be insulated in the same way as pipes, except that the insulating material shall not be attached by wire but by using strong galvanized steel bands.

Spacers shall be welded to process equipment only if this is essential for satisfactory retention of the insulation. Welding of spacers to process equipment is subject to approval by its manufacturer in writing.

Insulation for personnel protection

Wherever insulation is necessary only for the protection of personnel, it shall be applied around that portion of the pipeline length or to that surface of the equipment that is located within 2.50 m above the passage way floor, or within 1.20 m horizontally to the side or at the end of any floor, platform, walkway, stair or ladder.

Where necessary, drain lines and valves shall be provided with a contact guard of minimum 30 mm thickness against accidental contact, and this shall be installed in the same way as the other insulation.



Where insulation is provided for heat conservation it shall reduce the heat loss to an economic minimum. The maximum heat loss shall be 200 W/m^2 at an ambient temperature acceptable at $30 \text{ }^\circ\text{C}$ and a wind speed of 2 m/s . For personnel protection all surfaces with a temperature above $50 \text{ }^\circ\text{C}$ and which are within the reach of personnel shall be provided with protection insulation. The maximum insulation surface temperature shall be $60 \text{ }^\circ\text{C}$.

B0.6.17.5 Vessels

All vessels shall be designed in accordance with the applicable standards and regulations.

The Contractor is held responsible for the correct design and dimensioning of the apparatus.

Connections shall be provided for all pipework, together with connection and tapping points for instrumentation. Manholes, vents, drains, safety devices and any platforms necessary for safe operation and easy maintenance have to be included in design and supply.

If under any operation conditions vacuum can occur in the vessels, they shall be designed for max. pressure and full (= 100%) vacuum.

The welding factor for all vessels is fixed to $v = 1.0$. The minimum wall thickness should not be less than 10 mm , and an appropriate corrosion allowance based upon the particular material, but not less than 1 mm .

Instrumentation and control equipment shall be provided according to the safe service requirements. A minimum requirement is to equip each vessel with a local level indicator, a temperature and a pressure indicator.

Manholes shall be provided as follows:

1. manholes (minimum nominal bore 600 mm) for vessels of 1.0 meter diameter and above
2. handholes (minimum size 200 mm) for vessels below 1.0 meter diameter

All nozzles shall be provided with flanges and shall be so arranged that practical pipe connections are possible. The stub length for all stub pipes shall be at least 200 mm , measured from the tank wall to the flange sealing surface. In the case of insulated vessels, the length shall be chosen so that there will be a clear space of at least 100 mm between the cover of the insulation and the underside of the flange. Nozzles below $\text{DN } 25$ are not acceptable.

For insulated vessels, provisions must be made for fixing and supporting the insulation.



All tank internals must be replaceable through the manhole unless by approval of the Employer. Prefabricated vessels must as a minimum have a coat of primer applied before transport. They shall be cleaned and internally dry. All openings must be secured closed before transport.

Tank and vessel capacities given for process relevant documents and for basic design calculations shall be *usable net* volumes and shall be in the relevant documents clearly referred as such.

B0.6.17.6 Heat exchangers

Heat exchangers are to be designed, manufactured and erected in accordance with the applicable standards.

Only proven products shall be delivered. No cast iron components are permitted.

It must be possible to install and remove the heat exchangers without undue difficulty. Lifting lugs and eyes and other special tackle shall be provided to permit easy handling.

Tubular heat exchangers or plate and frame type heat exchangers are acceptable where no specific requirements expressed. Where necessary the tubes are to be protected by impact shields. An adequate number of visual inspection ports are to be provided in critical areas to facilitate condition monitoring.

Unless otherwise specified, all heat exchanger tubes and casings must be designed to withstand 1.2 times the zero flow pressure of the relevant pump at cold conditions, or 1.2 times of the maximum positive operating pressure, as applicable. The test pressure must be 1.5 times the design pressure.

The heat exchangers shall be designed for the maximum temperature incurred plus 20 K.

Heat exchangers must be capable of continuous unrestricted operation with up to 10% of plugged tubes, and a corresponding factor of conservatism at least this amount must be used in the design of the heat transfer areas.

Considerable importance will be attached to the ease of cleaning the heat exchangers.

Where any heat exchanger part in contact with liquid can be isolated, and there is a possibility of being heated from the other side, safety valves are to be provided for pressure relief.

Pipes from drains, vents and safety valves are to be grouped together, and routed to easily observable points equipped with covered funnels or to the flash tanks.



The overall design and conception of the heat exchangers and accessories is to be such that they are suitable for the degree of automation envisaged for the individual system.

B0.6.17.7 Instrument and service air

To meet the compressed air requirements of the Plant two different compressed air systems, - instrument air and service air, will be provided.

The service and instrument air system shall produce and deliver compressed air for the following main consumer of the Power Plant and desalination plant:

- Service air for atomization of HSD (High Speed Diesel) and for operation of mechanical air tools, wrenches and other consumers during all operation modes of both units and for maintenance purposes.
- Instrument air for all pneumatically operated plant instrumentation and control devices and other consumers. The instrument air quality shall meet ISO 8573-1 Class 2".

For detail instruction on compressed air see **B12 Part 7**.

B0.6.17.8 Cranes, hoists and lifts

B0.6.17.9 Cranes

For erection and maintenance works, overhead travelling crane per unit shall be installed in:

- One EOT Crane for each turbine hall (Refer the below note)
- One EOT crane for the compressed air station building.

Note: If Bidder/Contractor intends to provide one EOT crane then turbine generator stator shall be moved by special device (to be handed over with special tools).

For handling of the generator stator the following alternative is also acceptable: Tandem/combined operation of two turbine hall EOT cranes for which the necessary arrangements shall be provided. In such case the combined capacity of two EOT cranes shall not be less than the 105% of weight of generator stator, including the weight of lifting beam with swiveling equipment and slings.

HP heater shall be moved by turbine hall crane.

For erection and maintenance works in the plant water screening and pumping station two (2) travelling bridge cranes shall be installed, one for pump and header bay area and one for screening plant area. The cranes shall



be calculated and designed in accordance with the principles of DIN or equivalent standards.

EOT crane shall only be used in closed pumphouses.

For installation and repair works in the cooling water pumping station one (1) gantry crane shall be installed.

Additional overhead travelling cranes are to be installed in pump houses, central work shop and all other locations and buildings for equipment of this Contract where cranes are needed. Refer also to the individual technical subsections of this specification.

The nominal carrying capacity of the cranes must be such that the heaviest object to be lifted including the spreader bar and other necessary auxiliary lifting devices can be transported with safety.

Cranes with a span of more than 8 m and/or a nominal carrying capacity of more than 5 t shall be in the form of double-girder cranes with the crab running on top.

Smaller cranes shall be in the form of single-girder cranes with the crab running on the lower flange or in the form of suspension cranes.

Cranes with a nominal carrying capacity of 30 t and above shall be fitted with an auxiliary hoist.

The overhead travelling cranes shall be fitted with gangways on the crane bridges or with gangways fitted to the sides of the crane.

The end-carriages of all cranes shall generally be of welded box-girder construction. Buffers shall be provided at the faces on the end-carriages. The end-carriages shall also be fitted with wheel-breakage supports designed to prevent derailment as well.

The deflection of the crane bridges at nominal load shall not exceed $1/1000$ of the span for cranes with capacity of 50 t or more, or $1/900$ of the span for cranes below 50 t capacities.

The crab assemblies shall be of rigid steel construction. Buffers shall be provided at the faces of the crabs.

The crabs shall as far as possible be covered with smooth sheet-metal and fitted with handrails.

The crane switchgear shall be accommodated in switchgear cabinets to be arranged on the crane bridge.



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The crane and crab running wheels shall be made of cast or forged steel and shall have double flanges. The wheels should have rolling bearings lubricated for life.

For cranes used for the removal and installation of pump rotors in vertical pumps (e.g. cooling water pumps), it is important to ensure that there is no lateral drift of the hook during lifting and lowering.

All cranes shall be equipped with pendant control units. The pendant control units shall be suspended on the bridge so that they can travel along it independently of the crab.

All pendant control panels shall be fitted with rocker-type or push-button switches for the crane functions. A key switch and an emergency stop switch shall also be provided on each panel. Additional switches or push buttons shall be provided as required.

The crane and crab drives are to be designed as two-corner drives with electric gear motors. 2 (two) motors are to be provided for the crane drives. The crab drives may consist of one motor and universal joint shaft.

All travelling and traversing drives are to incorporate pole-reversible squirrel-cage gear motors with sliding armature and brake.

The lifting gear may consist of standard electric hoists with sliding armature motor and cone brake or disc brake.

The precision speed control shall be provided for all crane and lifting gears.

Speeds for cranes shall be as below:-

- For TG hall crane-
 - Main hoist - 1.6 m/min (creep speed 0.16 m/min thro VFD)
 - Aux hoist - 7.5 m/min (creep speed 0.75 m/min thro VFD)
 - CT - 15 m/min (creep speed 1.5 m/min thro VFD)
 - LT - 30 m/min (creep speed 3.0 m/min thro VFD)
- For other cranes-
 - Main hoist - 3 m/min
 - CT - 10 m/min
 - LT - 10 m/min.



B0.6.17.10 Hoists

Hoists shall be provided throughout the entire installation where machines or other components provided under this contract are to be installed, removed, repaired, serviced or transported and these parts are not in the working area of a crane (refer also to the individual technical subsections of this specification).

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The final number of hoists to be supplied will be proposed by the Contractor, according to the requirements of the equipment. The Contractor has to include in his offer the number of hoists for the whole Plant. Any necessary change of hoists must not lead to any price change of the contract price.

The hoists used shall be standard production hoists.

The hoists shall be designed and calculated in accordance to applicable standards.

The nominal carrying capacity of the hoists and of their attachment points shall be such that the heaviest object to be lifted can be transported with safety.

For electric hoist, trolley travel speed and hoist speed shall be 15 m/min and 6 m/min respectively.

Manual hoists shall take the form of chain tackle blocks with load and drive chains. The crabs shall be fitted with a drive also operated by a chain. The runways shall be designed according to approved standards.

Electrically driven hoists and crabs shall be equipped with squirrel-cage motors. An inching control shall be provided on all electrically driven hoists and crabs.

The crab power supplies shall be in the form of sheet-steel-enclosed safety power tracks, which can be easily bent to follow the form of the hoist runways.

Electrical switchgear and control gear shall be mounted directly on the hoists in cabinets.

The electric hoists shall be operated by pendant control units fitted with pushbutton or rocker-type switches, which shall be fixed to the hoists in such a way that safe operation is guaranteed.

The control panels shall be equipped also with a key-operated switch and a mushroom-shaped emergency "off" switch.

Limit switches shall be fitted to all lifting and travel gear.

The electrically operated hoists shall be installed in a permanent location.

Where hoists are not easily accessible by simple means such as ladders or mobile scaffolds, maintenance platforms with means of access shall be provided.



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B0.6.17.11 Lifts

One (1) lift in each steam generator building for goods transport (minimum capacity 3,000 kg) and one (1) no. conventional passenger elevator in each the steam generator building for personnel transport (minimum capacity 16 persons and minimum 1,100 kg) shall be installed, reaching the highest accessible platform. Outdoor hoisting arrangements shall be included at one side of each boiler house for lifting long items of up to 4,000 kg.

Further Elevators shall be provided in the following building, reaching the highest floor of these buildings:

- 2 x elevators TG building
- 1 x elevator for service building
- 1 x elevator for crusher house
- 1 x elevator for highest transfer point before main plant.

For administration building 2 x nos. of 16 person capacity (minimum 1,100kg), panoramic type elevator shall be provided.

Lift for light material store shall be provided as follows:

- Quantity = 1
- Type = Goods lift
- Capacity = 1,000 kg.
- Speed=0.5 m/s.

The basic requirements for conventional passenger elevators are:

- Capacity: 16 person (minimum 1,100 kg)
- Speed: 1 m/s

The lift installations shall be designed as cable-operated lifts with traction machine. The car shall be provided with automatic telescope sliding doors.

The lifts shall be designed, manufactured, erected and tested according to OSHA (Operational Safety and Health Administration) and applicable standards.

During the construction period, the sides of the cars (without doors) and the floor of the cars shall be provided with protective coverings (hardboard panels or similar). The protective coverings shall be removed by the Contractor after the construction period.

The motors and switchgear must be designed for at least 180 starts/stops per hour. The type of enclosure of the switchboards and motors shall comply with the relevant requirements of Section B0.



B0.6.18 Electrical equipment and works

B0.6.18.1 Standards

The design and manufacture of all electrical equipment shall comply with the latest editions of the IEC Recommendations if not specified otherwise elsewhere in the specification. Compliance with ANSI/IEEE/NEMA, BS, EN or VDE standards will only be accepted in case no applicable IEC standards are available and subject to approval by the Employer/Engineer.

The Plant shall comply with:

- the Essential Electrical Requirements of the PPA
- the latest edition of the Electricity Grid Code of the Bangladesh Energy Regulatory Commission; and
- the Great Britain Grid Code.

In case of contradictions the order of precedence shall be as follows:

- Essential Electrical Requirements of the PPA;
- Electricity Grid Code of the Bangladesh Energy Regulatory Commission;
- Great Britain Grid Code.

Any other requirements of BPDB/PGCB shall also be considered (if available).

B0.6.18.2 Voltage levels

The following voltage levels shall apply:

- 400 kV and 230 kV, 50 Hz connection voltage to the public grid
- 18 to 27 kV, 50 Hz generator voltage, depending on manufacturer's standard
- 11 kV \pm 6%, 50 Hz voltage for motors equal to/bigger than 1500 kW and for power distribution within the Plant
- 3.3 kV \pm 6%, 50 Hz voltage for motors equal to/bigger than 160 kW and for power distribution within the Plant
- 240/415 V (+/-) 10%, 50 Hz standard voltage for power supplies to small electric power consumers and motors below 160 kW lighting and domestic power outlets
- 240/415 V (+/-) 10%, 50 Hz voltage for power supply of essential electric power consumers - the system shall be operated with ungrounded neutral
- 220 V DC + 10%/-15% voltage for emergency users of electricity, like turbine emergency oil pumps, circuit breaker control, inverters



- 240/415 V \pm 10%, 50 Hz uninterrupted voltage supplies to consumers, which require uninterrupted infeed like DDCMIS components, control actuators, burner control panels, VDUs.
- 24 V DC \pm 15% for power supplies to the DDCMIS system components
- 24 V \pm 10%, 50 Hz for erection work in enclosed plant items of metal

The general arrangement of the particular voltage level for each part of the Plant within the scope of the Contract and the connections of the power supply systems can be seen from the Key Single Line Diagram (Annex E).

B0.6.18.3 Insulation levels

- The 400 kV system shall be designed to limit the switching surge overvoltage to 2.3 p.u. and the power frequency over-voltage for the 400 kV system and the 230 kV system to 1.5 p.u. The lightning arrestors associated with the 400 kV reactors shall be of 336 kV.
- Following insulation levels shall be considered:

	Description	400 kV	230 kV	Generator *	11 kV	3.3 kV
1.	Highest voltage for equipment	420	245	24 or 36	12	3.6
2.	Power frequency withstand voltage	650*/630	460	50 or 70	28	10
3.	Lightning impulse withstand voltage	1425	1050	145 or 170	75	40
4.	Switching impulse withstand voltage (phase to earth)	1050	-	-	-	-

* According to manufacturer standard

The creepage distance of the outdoor insulators shall be minimum 31 mm/kV.

- 400 kV level:
 - rated switching impulse withstand voltage 1050 kV (phase-to-earth);
 - rated lightning impulse withstand voltage 1425 kV;
 - *rated power frequency withstand voltage for GIS 650 kV and for transformers 630 kV.
- 230 kV level:
 - rated short duration power-frequency withstand voltage 460 kV;
 - rated lightning impulse withstand voltage 1050 kV.
 - Remark: The insulation coordination study shall be carried out by the Contractor.



B0.6.18.4 Installation conditions and protection class for electrical operational equipment and control and monitoring equipment

If not specified otherwise the electrical operational equipment must be designed to meet protection classes stated below.

Switchgear, housings for electrical equipment and electrical equipment itself must be designed according to IEC 60529 at least to:

- Class IP 41 if located indoors in air-conditioned/ventilated areas
- Class IP 42 for ventilated enclosure of DDCMIS equipment if located indoors in air-conditioned/ventilated areas with suitable cannope ontop to prevent ingress of dripping water
- Class IP 22 for non-ventilated enclosure of DDCMIS equipment if located indoors in air-conditioned/ventilated areas with suitable cannope ontop to prevent ingress of dripping water
- Class IP 54 if located indoors
- Class IP 65 for all I&C field devices
- Class IP 55 for motors located outdoors and in indoor areas with high dust and humidity
- Class IP 65 for other outdoor electrical and control system equipment such as cubicles or panels with additional measures) if located outdoors in accordance with IEC 60529 (degrees of protection provided by enclosures (IP Code) or equivalent). The additional measures shall consist of sunshades, protection covers against splashing water, additional sealing, special acid resistive coating etc., depending upon the particular site conditions at the place of installation, subject to the approval of the Employer.
- Class IP 21 if located indoors with open doors.

The lamps for external lightning and internal lighting of not completely closed buildings must have protection class IP 55W. Furthermore for dust prone areas the lamps shall have protection class IP 65.

Electrical operational equipment which must be installed in areas exposed to danger from explosions must have the required explosion-proof design appropriate to the flash-point group classification of the explosive mixture as laid down in IEC 60079. Attention must be paid with respect to the use of electrical operational equipment in workshops and storage premises exposed to the risk of explosions.

In all rooms and areas where the local and operational conditions and surroundings can lead to the accumulation of gases, vapors, mists or dusts which, in combination with air, form explosive mixtures, the operational equipment and installations to be used in these circumstances must be of explosion-proof design. All operational equipment must be designed to comply with the class of protection dictated by the ignitable mixture (e.g. compression-proof casing, external ventilation, inherent safety, etc.).



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Electrical operational equipment should be located indoors in adjoining buildings rather than inside buildings or other structures exposed to the risk of explosion. Whenever operational equipment has to be installed within areas liable to the risk of explosion, protection against explosion must, in general, be applied wherever explosive mixtures can arise. In this connection, the ignition of explosive mixtures must be reliably prevented by adopting the correct choice of design and construction of the operational equipment and the incorporation of supplementary safeguards where applicable.

Electrical, chemical, thermal and mechanical influences must on no account impair, in any way, the protection afforded against explosion. In particular the high ambient temperatures and the influence of nearby heat sources at the installation point must be taken fully into account.

B0.6.18.5 Protective measures, earthing and lightning protection

In view of the potential dangers of electrical power, the following measures are required for the protection of life, equipment and materials. Basically, all 'live' parts, i.e. all parts of electrical, operational equipment at an electrical potential above or below earth potential when in operation, and with a rated voltage over 24 V, must be insulated or covered so that they cannot be touched accidentally.

In addition, measures must be taken by the Contractor to prevent the occurrence or persistence of excessively high contact potentials on conductive parts of electrical operational equipment (frames etc.) brought about by faults in insulation.

For installations up to 1000 V, voltages over 50 V are considered to be excessive contact voltages. Within enclosed electrical installations, with voltages over 1000 V, the contact potential shall be according to the values given in EN 50522 (VDE 0101-2) Earthing of power installations exceeding 1 kV: enclosure B.

The following rules and regulations are to be observed in carrying out protective measures and in earthing procedure:

- IEC 60079 and 60364 for installations up to 1000 V,
- EN 50522 (VDE 0101-2) Earthing of power installations exceeding 1 kV:

In areas exposed to the hazard of explosion, the protective measures outlined in IEC 60079 and IEC 61241 are to be adhered to in the erection and installation of electrical plant and equipment.



B0.6.18.5.1 Protective measures for installations up to 1000 V

Protection against direct contact

All 'live' parts of electrical operational equipment that can be reached by hand must be protected against direct contact either by means of insulation or through constructional design, position or arrangement, or by means of special devices. If, in the case of enclosed switchgear or control cabinets, access is required in the course of normal operation (e.g. for replacing fuses), protection against direct contact must still be ensured when the switchgear or control cabinet has been opened up.

Protective insulation

Protective insulation is to be provided by means of additional insulation over and above the insulation provided for operational purposes. This measure must prevent the occurrence of a dangerous contact potential.

Use of low voltages as a safety measure

This safeguard applies to all equipment, which is required to operate in metal enclosures, boilers, tanks etc. The operational voltage of tools and lighting equipment must not exceed 24 V AC.

Isolating transformers shall be provided by the Contractor for the purpose of producing the protective low voltage. A separate 24 V system will not be provided.

Connection of the neutral

The LV network shall be of the TN type, i.e. the LV neutrals of the auxiliary transformers are earthed directly.

Neutralization (protective multiple earthing) is intended to prevent the persistence of an excessively high contact potential on conductive parts of the installation which do not form part of the actual operating circuit.

Protective multiple earthing as a protective measure requires the neutral to be earthed close to the transformer. However, wherever possible the neutral shall be earthed at the main LV board. In this case the connection transformer to LV main board shall be carried out as TN-C type, i.e. three phases plus PEN:

The LV system for symmetrically as well as unsymmetrical connected power consumers shall generally be of the TN-S type, i.e. a five wire system. The separation of N and PE shall be carried out at the main LV board. Because of the clear demarcation between the neutral conductor N, carrying operational current, and the protective earthing conductor PE, which - under non-fault conditions - carries no current, NO connection between either N and PEN or N and PE is permissible beyond the point of separation of the PEN conductor into PE and N.



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The LV system for supply of essential consumers (emergency diesel supply) shall be of IT type. All required isolating transformers shall be included in the scope of supply.

The neutral conductor is to be insulated in the same manner as the phase conductors. The use of constructional parts of the switchgear as a neutral conductor is not permitted.

All earthing conductors have to be rated depending on the value of earth-fault current (see EN 50522 (VDE 0101-2) enclosure D). Separate installed earth conductors must be at least 16 mm² for copper and 100 mm² for galvanized flat-iron.

The earth electrode resistance shall ensure that potential contact will not be higher than 50V (see IEC 60364 - 4 -41).

B0.6.18.5.2 Protective measures for installations over 1000 V

Protection against contact

At least the following measures are to be taken for all parts that are 'live' when in operation:

- Protection outside of closed electrical operating areas:
 - complete protection from all sides against contact, the degree of protection shall be at least IP23D according IEC 62271-202 and IEC 60529
 - protective devices may only be removed by means of tools.
- Protection inside closed electrical operating areas:
 - protection against contact with 'live' parts within reach of personnel,
 - protection against accidental contact outside the reach of personnel.

The above-mentioned measures for protection against contact are also to be applied to 'dead' parts of the Plant where, in the case of a fault, a dangerous contact potential might arise, however, where the parts must not be connected to the protective earthing system for operational reasons.

Protection against contact voltages

Protective earthing is to be used as a safeguard against excessively high contact potentials for conductive parts of the installation, which do not form part of the operational circuit. Here, all normally 'dead' parts equipment and apparatus shall be earthed if it is possible for them to come into contact with 'live' parts as a result of faults due to the occurrence of surface leakage paths, arcs or direct connections to a 'live' part of the equipment.

In considering the dimensioning of the protective earthing system, the thermal loading and voltages on the earthing equipment are decisive factors and these should be based on the maximum possible earthing current, which can arise.



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Connection of the neutrals

- 400 kV system: neutrals of the 400 kV windings of the transformers shall be directly grounded
- 230 kV system: neutrals of the 230 kV windings of the transformers shall be directly grounded
- 11 kV system: neutrals of the 11 kV windings of the transformers shall be grounded by means of 400A resistors
- 3.3 kV system: neutrals of the 3.3 kV windings of the transformers shall be grounded by means of 400A resistors.

B0.6.18.6 Earthing and lightning protection**B0.6.18.6.1 Earthing and potential equalization system**

The earthing system and potential equalization shall comply with the following standards:

- IEC 60364-4-41: Electrical Installation of Buildings – Protection for Safety: Chapter 41: Protection Against Electric Shock
 - IEC 60364-5-54: Electrical Installation of Buildings – Part 5-54: Selection and Erection of Electrical Equipment - Earthing Arrangements, Protective Conductors and Protective Bonding Conductors
 - EN 50522 (VDE 0101-2) : Earthing of power installations exceeding 1 kV
 - VDE 0845, Part 1: Protection of Telecommunication Systems Against Lightning, Electrostatic Discharges and Over-voltages from Electric Power Installations; Provisions Against Over-voltages
 - IEC 61643: Low-voltage Surge Protective Devices
- For earthing, protective earthing, functional earthing, potential equalization and lightning protection-potential equalization, a common system shall be established.

Within all buildings, internal earthing rings shall be installed. These shall be linked by way of connection tags to the foundation ground and outdoor earthing system.

All system and plant components which are to be earthed as well as electrical components, like protection and control cubicles, sub-distribution boards, control systems, motors and transformers, shall be connected to the earthing rings/bars. All steel structures within a welded Section shall be connected to the main earthing system.



At pipelines for flammable liquids or gases, earthing tags shall be provided at each flange. All bolted flanges shall be bridged using a flexible braided copper conductor. Each pipe shall be connected at least once to the main earthing system.

No framework parts or other structural components shall be used for the ground bus.

An earthing cable shall be included in all main cable runs. Protective earthing and potential equalization of electronics cubicles, frameworks, racks etc. shall be executed as follows:

- Earthing rings shall be installed in the I&C rooms as buses, to be connected at several locations – at least two – to the earthing network.
- For each row of cubicles, at least two connections shall be made to the earthing ring. Cubicles in a row shall all be connected by conductors to each other.
- If cubicles are attached to a raised platform flooring of steel structural parts, it shall be ensured that these are electrically connected to each other throughout the area. The raised floor shall be connected to the earthing ring at several locations, and as a minimum at two corners of the room.

Foundation earthing

All buildings, including those with a steel skeleton, shall be equipped with foundation earthing. The foundation earthing shall be installed in addition to reinforcement that is likewise connected together with braided conductors.

The foundation earthing shall be used in connection with the other earthing systems like protective, operational, functional and lightning protection earthing.

In the case of pile foundations, earthing rods of the same length as the piles shall be installed along with the foundation piles at intervals of around 10 m and connected at around every 2 m to the pile reinforcement using braided conductors. The earthing rods shall project beyond the top of the piles and then be connected to the earthing system of the ring foundation.

In addition to the closed ring of the foundation earthing system, a net of mesh size around 10 x 20 m shall be embedded in the bottommost concrete layer. The foundation earthing shall be connected to the reinforcement by a braided conductor at intervals of about 2 m.

At intervals not exceeding 20 m, and with at least two in every room, connection tags from the foundation earthing shall be foreseen for connecting the internal earthing ring. Connection tags shall likewise be foreseen for connection to the external earthing system and to the lightning rods. Optionally, lightning rods can be connected to the external ring



earthing, with connections then made from this ring earthing to the foundation ground by way of the internal earthing ring at intervals not exceeding 20 m.

Earthing material

- Refer to Part B7.

Screening

The measures described in the following serve for screening and potential control within (see EN 50522 (VDE 0101-2) Annexes E and F) and for lessening overvoltages.

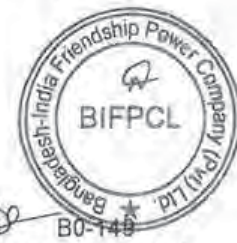
- For reinforced concrete buildings, at each corner of the building including the bottom slab, an additional mesh of rebars, of approximate mesh size 10 x 10 m, shall be provided at the topmost reinforcement. The meshes shall be produced by welding. This additional reinforcement, connected so that it is electrically conducting, may be dispensed with if it is ensured that the existing reinforcement is so connected by welding at appropriate points that it is electrically conducting.
- At intervals corresponding to the mesh-width, earthing wires from the reinforcement shall be incorporated into the building pillars, rising from the foundations to the roof, and so welded that they are continuous. These earthing wires shall terminate at the roof parapet. The meshes and earthing wires shall be welded to each other.
- For steel skeleton buildings, equivalent measures shall be taken. Framework Sections shall be welded to make up a defined, electrically conducting connection or shall be bolted together so that they are electrically conducting.
- Metal façades and coverings shall be preferred over non-conducting materials and at their topmost and bottommost points shall be connected at an adequate frequency to the lightning protection system.
- Reinforcement of cable ducts of reinforced concrete shall be connected to parallel running earthing cables. These earthing cables shall be connected to the screen of the building earthing system or to the foundation earthing system.

B0.6.18.6.2 Lightning protection

All buildings and structures shall be equipped with a lightning protection system. Lightning protection level I (LPL) according to IEC 62305 shall be considered.

The building lightning protection system is to be executed according to:

- IEC 62305-1
- IEC 62305-3 and
- IEC 62305-4



and alongside protection of human life to prevent damage not only to buildings, but also to electrical and electronic installations.

All buildings and structures are to be protected against lightning strikes by means of lightning collectors and conductors. The collectors are to be arranged in such a way that, as far as possible they collect all lightning strokes without these directly striking the parts to be protected. This condition is considered to have been fulfilled if no point on the roof surface is more than 5 m away from a collector. Collector lines suffice as collectors, e.g. along the ridge and at gables and eaves.

Ridge conductors must be taken right to the end of the ridge. Moreover roof conductors should run as natural continuations of all main conductors. Conductors at the gable extremities or eaves must be laid in the closest possible proximity thereto. In the case of steel-framed structures the ridge conductors must be connected to the roof supporting structure at least every 20 m. Lower level annexes are also to be provided with collectors.

Roof lines and other conductors are to be laid and fixed in such a way that they can withstand the stresses expected from storms, lightning strokes, roof work, etc.

One main conductor between the lightning collectors mounted on the top of the building and the potential grading ring laid in the ground is to be provided every 20 m of the before-mentioned lightning collector. The maximum spacing between conductor fixings may not exceed 1 m for horizontal runs and 1.2 m for vertical runs.

Lightning protection material

In case of buildings with steel structures and sheet steel cladding, the steel columns and the sheet steel cladding shall be used as lightning conductor. In case of masonry buildings or buildings with concrete structure, external lightning conductors made of copper or stainless steel shall be used. Lightning arrestors (arrestor tips and roof conductors) or Lightning air terminal shall also be made of copper or stainless steel rods. The conductor supports of the lightning protection system must be copper or bronze. Nuts and bolts at isolating or other points which are to remain detachable must be made of copper-nickel-silicon-bronze.

B0.6.18.7 Technical conditions for high voltage motors

If not specified otherwise all electric motors must be designed to meet IP 54 enclosures.

All motors with rated power (referred to 40° C ambient temp.) of 160 kW and above must be designed as HV motors.



B0.6.18.7.1 Constructive features

The following constructive features shall apply:

- a. Climatic protection provisions for mounting in the open in a humid and hot climate. Insulation class F. During operation at rated power of the driven machine, the motor insulation must only be stressed in accordance with the requirements of class B insulation.
- b. Motor parts made of iron internally and externally sandblasted and surface-protected.
- c. Paint finish resistant to chemicals and seawater.
- d. Bolts with adequate corrosion protection.
- e. All joint faces and gaps sealed.
- f. Anti-condensation heating to be switched into operation when the motor feed circuit is in the 'off' position. Heater supply power 'on' indicating lamp is to be provided.
- g. Special treatment of windings with resin impregnation plus immersion in varnish.
- h. Varnish-insulated laminations.
- i. Pressboard material protected by varnishing.
- j. For motor ratings the cooling air available at the specific location has to be considered.

All motors shall be either totally enclosed fan cooled (TEFC) or totally enclosed tube ventilated (TETV) or closed air circuit air cooled (CACA) type. However, motors rated 3000 kW or above can be Closed Air Circuit Water cooled (CACW). CW motors can be screen protected drip proof (SPDP) type.

- k. Condensation outlets to be provided at the lowest point in the housing.

Design and construction of the motors shall comply with IEC 60034-1, 60034-5 or VDE 0530 and DIN 40050.

B0.6.18.7.2 Electric features

The following electric features shall apply:

- a. Motor rating to be at least 110% of the maximum required electric power consumption of the driven machine.
- b. Continuous delivery of rated power at voltages of 90 - 110% of the rated voltage and allowable frequency range within the limits of thermal class F.
- c. Rated power output at ambient temperatures existing at the particular site of installation and under continuous running conditions.
- d. All motors shall be designed as 3-phase squirrel-cage motors suitable for direct on line starting. It must be possible, with 100% residual voltage, to switch them on to a large and stable power supply network without incurring damage or deformation. The motors must still be capable of



faultless running up to speed with a voltage drop to 80% of rated voltage and rated loading.

However, 75 % starting voltage shall be allowed for motors above 4000 kW. Mill motor being high starting torque motor, is specially designed and shall be suitable to operate at 85% rated voltage for 1 minute only, provided that the mill motor is suitable for starting/running with voltage variations for which aux. power supply system is designed.

- e. Motor starting current must not exceed 5.5 times rated current (referred to motor rating at 45 °C ambient temperature) for motors up to 2 MW and must not exceed 4.5 times rated current (referred to motor rating at 45°C ambient temperature) for motor ratings above 2 MW. The voltage drop at direct-on-line starting should be limited to 20% at the motor terminals except rating above 4000 kW. However starting of any motor shall not cause tripping of any other consumer. However, Bidder/Contractor is free to design his system with starting currents up to 600% maximum.
- f. From the cold state four consecutive starts up to full speed must be possible. The second start must be possible immediately after the first start, the third 20 minutes after the second, the fourth 20 minutes after the third.
- g. A minimum frequency of starting cycles of 1000 per year must be guaranteed.
- h. In general, motors must be capable of running without overheating when subjected to three consecutive starts within one hour after having run for an extended period on a voltage of 95% nominal voltage. Thereby the second start must be possible immediately after the first start and the third 30 minutes after the second start. In individual cases where operation depends on signals from pressure switches or other such sources, then a more severe duty with respect to the frequency of starting cycles per hour shall be necessary and the design of the motors must be carried out accordingly.

B0.6.18.7.3 Protective features

The following protective features shall apply:

- a. High voltage motors must be fitted with measuring points for the determination of slot and bearing temperatures.
- b. Six Pt 100 resistance thermometers (2 per phase) are to be provided for slot temperature measurement, and a double thermocouple or resistance thermometer per bearing must be provided for bearing temperature measurement. Type of temperature elements shall be finalized by the manufacturer.
- c. Each Pt 100 shall be connected, potential free, to a terminal strip. The connections to the thermometer as well as the associated over-voltage cutouts shall be brought into separate terminal boxes.



- d. Where motors have closed-cycle cooling, temperature-measuring points must be fitted in the cold air stream.
- e. The winding temperatures have to be detected with RTD's at high temperature and alarm to be produced, at extra high temperature the motor to be tripped.
- f. All motor gaps and joints between it and other units must be sealed.
- g. Earthing clamps at both sides of the stator have to be provided.
- h. All HV motors bearings shall be equipped with vibration sensors for vibration monitoring.

Considering the rating of CHP HT motors vibration monitoring is not required. For Coal Crushers vibration isolation & monitoring shall be provided.

- i. Temperature transmitter to be provided for all temperature measuring devices.

B0.6.18.7.4 Other features

Terminal Boxes

The main terminal boxes on the high voltage side shall be provided with a pressure relief joint for the purpose of reducing the danger of an accident as a result of short-circuits, and shall be fitted with a terminal block suitable for any desired type of connection.

Cable connecting boxes must be longitudinally divided to facilitate fitting of cable sleeves and end caps. Protection class shall be IP 55.

Inside the terminal box an earthing clamp for connection of the cable shield must be foreseen.

The opened terminal boxes must have provision for local earthing to be carried out.

All terminal boxes shall be provided with a removable undrilled gland plate. The gland plates shall be of non-magnetic material if single core cables are to be installed.

Connections, star-point terminal boxes etc.

All motors must have the star-point connection brought out separately to terminals.

For all motors with a rating of 2000 kW or above a differential relay for winding protection shall be provided and installed in the associated switch-gear. In that case the star-point connection shall be brought out separately to terminals. The differential current transformers are to be designed to class 5 P10 with a rating matched to the protection system. The CT's shall be accommodated in the star-point terminal box.



Coupling

The motor shaft halves of the couplings, finish-bored, balanced, and complete with key ways are to be drawn on to the motor shaft and balanced out together with the rotor.

Cooling

Air cooling for the motors is the preferred method. Where water-cooling is applied, conditioned and treated, water shall be used.

Motor air exchanger circuits should be suitable for the prevailing atmospheric conditions, i.e. ambient temperature, content of humidity and salt in the air, etc. are to be considered.

Running quality

The running quality must be within the classification of "Class C, Zone A" according to the ISO 10816-1 or equivalent, i.e. the vibration velocity must be not greater than 1.8 mm/s (rms).

Reverse speed

If reverse running, can occur in the case of equipment driven by a motor (e.g. cooling water pump), the motor must be designed for maximum, possible reverse speed.

A reverse rotation alarm and starting-circuit interlock are to be provided to ensure that the equipment cannot be started while running in reverse.

Lubrication

All MV and HV Motors shall preferably be equipped with on-line lube oil purification and auto-grease facility. These systems shall preferably be procured from one single manufacturer.

The above requirements of the specification to be considered only as a preferred solution. However OEM recommendation will be accepted.

B0.6.18.8 Technical conditions for low voltage motors

If not specified otherwise all motors must be designed to meet IP 55 enclosure according IEC60034-5.

All motors with rated power (referred to 40 °C ambient temp.) less than 160 kW must be designed as LV motors with premium efficiency class IE3.

The equipments which are only operating for short period shall not be covered under IE3 such as:

- a) Sootblower Motors- operates only during sootblowing sequence
- b) Seal air fan motor for damper sealing operation-operated only during maintenance.



B0.6.18.8.1 Constructive features

The same features as for high voltage motors shall apply.

Anti-condensing heating shall be provided for motors of 55 kW and above.

B0.6.18.8.2 Electric features

All motors shall be designed as 3-phase squirrel-cage motors suitable for direct on line starting.

The motors must be capable of being switched on to a large and stable network and with phases in opposition.

The electric features a), b) and c) of high voltage motors also apply here.

Motors starting current must not exceed 7.0 times rated current (referred to the motor rating and 45 °C ambient temp).

The Starting current of LV Motor (IE3) shall be inline with IEC 60034-30. Applicable de-rating factor for design temperature of 45 Deg C shall also be applied.

B0.6.18.8.3 Protective features

An earthing clamp inside the terminal box has to be provided.

B0.6.18.8.4 Other features**Cable leads**

All cable connecting boxes are to be designed to meet the requirements of IP 55 or IP 58 protection class respectively.

The cable connecting boxes are to be installed easily accessible on the motor. The connecting boxes must be capable of being turned by 90° or 180° and of being opened up longitudinally. The connection boxes are to be fitted with a terminal block.

Shafts

Where not otherwise specified, motors must be fitted with a free shaft end.

Protection against explosion hazards

Low-voltage motors, which are to be installed in areas exposed to the risk of explosion, must comply with the rules laid down in VDE 0165/0170/0171 for explosion-proof design in relation to the flash-point group classification for the particular explosive mixture.



B0.6.18.9 DC motors

The use of DC motors is to be avoided and must be agreed by the Employer. The maximum starting current must not exceed 1.8 of the rated motor current (referred to the motor rating at 45 °C ambient temperature). However any other value of starting current proposed by Bidder/Contractor during basic/detailed engineering shall be subject to Employer's approval

B0.6.18.10 . Actuator drives

As far as applicable the above "Technical conditions for low voltage motors" shall apply.

In addition, all actuators for valves, dampers etc are to be fitted with socket and plug of well-established make to IEC 60309 or equivalent for the power cable connection. For the control cable connection separate socket and plug shall be provided.

Self-cooling at respective ambient temperature conditions is mandatory. Fan cooling is not accepted.

Actuators shall have integrated starters. Regulation type shall be continuous modulation type (min. 3000 starts per minutes).

B0.6.18.11 Frequency converters

General

On the basis of the requirements of the driven equipment, the Contractor shall design, supply, install and commission a complete, fully operative, variable-speed converter drive (frequency converter and motor, for motors up to 400 kW, for motors 400 kW and above in addition to the converter a converter transformer shall be provided).

Converters made by reputable manufacturers are to be used.

Technical requirements

The design of the converter (maximum continuous rating) is to be based on the maximum shaft output required by the equipment assembly.

Maintenance work and cable connections must always be possible from the front of the converter cubicles

The terminals on the input and output sides are to be rated such that parallel cables can be connected.

The converter allows the speed of three-phase asynchronous motors to be adjusted steplessly. It must be fully equipped for remote control and monitoring in the control room.

An on-load disconnecter and a power contactor are to be provided at the power input of the converter.

For motors with a rating up to 400 kW the frequency converter shall be designed in at least a six-pulse circuit on both the line and motor sides.

Frequency converters using Insulated Gate Bipolar Transistors (IGBTs) should preferably be provided on both the line and the motor sides.

For motors with a rating above 400 kW the converter should be designed in a 12 pulse circuit supplied via converter transformer.

The converter is to be disconnected if the voltage drops to less than 80% of the rated voltage or if one or more phases of the line voltages are missed. When the line voltage is restored, the converter is to be connected again automatically, providing the break in the power supply did not last longer preferably than 5 seconds. The Plant check back signals (floating change-over contacts) must continue to be received during this period, while alarms are to be suppressed. It must be possible for the converter to be connected at any coasting-down drive speed and with in-phase voltages. The specified frequency set point is to be resumed automatically.

If the voltage reduction or the power failure lasts for a long time, the drive must remain switched off; in this case, it must subsequently only be possible to switch it on again either manually or by means of the higher order control.

The converters are to be designed for 10% more than the maximum power output required by the system. The purpose of regulating the converter is to ensure that the indirect current and voltage remain within the permissible limits during all control processes. This should apply both when the motor is started up and when the speed is adjusted during operation.

Forced ventilated converters are to be equipped with redundant fans (two double fans).

Flow monitors (not air vanes) are to be used to monitor the fans. Positive control is to be provided for fan drives with a master drive.

Converter transformers

The transformer shall meet the requirements in the IEC standards 60076-11 and 60146-1-3, shall be of cast-resin type and are to be installed in protective casings made of sheet steel, cooling method AN, thermal insulation class F (utilized according to class B only), type of protection at least IP 21.

The transformer output shall correspond to the power requirement of the frequency converters.



It should be possible to vary the high-voltage side within a range of $2 \times \pm 2.5\%$, by means of reversible clamp connectors.

The connections on the high-voltage side have to be carried out using cables.

Busbar connections with short-circuit protection are to be provided to the current converters on the low-voltage side.

Suitable earthing studs are to be provided for maintenance purposes (earthing and short-circuiting).

All accessories - especially sensors and terminal connections - must be arranged so that they are readily accessible.

The windings must be flame-retardant and self-extinguishing. The cast-resin mixture must not contain any flame-inhibiting additives which develop toxic vapors or gases either under the influence of secondary fires or in the electric arc. A report on this subject has to be enclosed with the bid.

Moisture-proof design:

It must not be necessary to dry the winding after shut-off periods. The protection against voltage surges and short circuits, the noise levels and the freedom from partial discharges up to twice the rated voltage must be verified by means of type tests.

The windings are to be protected by means of a temperature monitoring system, comprising the following minimum components:

- 3 PTC resistors (1 for each phase)
- 1 tripping unit with isolated change-over contacts for remote signalling (alarms).

Temperature transmitter to be provided for all temperature measuring devices

Instrumentation and control

The instrumentation is subdivided into a local Section in the converter cubicle and into a "remote" Section in the control room. All the measures necessary to enable the drive to be remote-controlled and remote-monitored must be implemented, i.e. all the 24 V DC interposing relays which are required to convert the on/off commands from the instrumentation and control system, signal transducers, etc (see also "remote control and remote indications" below).

A suitable automatic compensation facility is to be provided, to ensure that the transfer between LOCAL mode and REMOTE mode is bumpless in both directions. The emergency shutdown function of the equipment must act on the converter directly, regardless of whether 'local' or 'remote' mode is set.



Local instrumentation and control

The following are to be provided as a minimum in the converter cubicle:

Controls

- a) Local/remote converter control (key-operated switch)
- b) "On" and "off" converter controls
- c) Set point adjuster (speed)
- d) Incoming master switch, "on-off"
- e) All the controls necessary for internal converter settings and adjustments, as specified by the manufacturer

Indications, signals, monitoring

- a) Line voltage indicator
- b) Output frequency
- c) Output current
- d) Operating status signals, in accordance with the specifications of the instrumentation and control supplier, though at least "Ready", "Drive running" and "Zero and set speed reached"
- e) Motor temperature monitor - alarm Motor temperature monitor - shut-down
- f) Signals concerning internal operating states of the converter, in accordance with the manufacturer's standards, though at least:
 - Overtemperature
 - Line voltage monitoring
 - Line undervoltage
 - Overcurrent
 - Control voltage monitoring
 - Converter protection
 - Fan monitoring
 - Incoming air temperature
 - Motor feeder interruption
 - Motor feeder short circuit
 - Earth fault
 - Motor blocked
 - Other faults.

Remote control and remote indications

Account must be taken of the following types of remote control and indication in the control room, and suitable interposing relays, transducers and switchgears are to be provided in the cubicle:

- a) Converter "on/off" and "local/remote"
- b) Set point adjuster for speed (4 - 20 mA)
- c) Remote indication for speed as 0/4 - 20 mA standard signal
- d) Motor current as 4 - 20 mA standard signal
- e) Combined fault
- f) Remote indication of the set speed potentiometer as a 0/4 - 20 mA standard signal
- g) All Switchgear faults and "Racked-Out" events



h) Other controls and indications

All event signals and check back signals must be made available on the terminal strip as floating change-over contacts.

System perturbation

The perturbation caused by the voltage harmonics in the feeding three-phase system, which are a result of the converter drives, must not exceed the specified limit values, i.e. 5% for the 5th harmonic voltage, 4% for the 7th and 2% for each of the 11th and 13th. IEC 60801.1 - 60801.4 are also to be observed in this connection. The system perturbations are to be curbed by means of suitable measures if necessary. The contractor is responsible for demonstrating conformance with the above-mentioned limit values.

B0.6.18.12 Cable and cable trays**B0.6.18.12.1 Cable laying and routing requirements**

The Contractor responsible for cable routing and laying has to observe a strict unit separation. The cables must be routed in different cable channels or, as the minimum requirement, on different cable trays, so that in case of a fire or any accident in a cable channel or tray two units will not be affected. Further in case of two critical drives of the same unit with both drives operating in normal conditions cable for the same shall be routed through two completely redundant routes.

On vertical cable risers, walls and ceilings the cables must be secured with corrosion-resistant cable clips (e.g. cable clamps with cable protecting cable sleeves).

Cable risers near gangways or in electrical rooms that are exposed to possible mechanical damage are to be protected up to 1 meter from ground by suitable metal cover.

All holes in ceilings, floors and wall made for cable routing must be sealed fire-resistant, when the cables have been laid. This also applies to switchgear panels and cubicles, passages between cable ducts, at vertical risers etc. As there is an increased danger of fire during the construction period the holes shall be fire-resistant sealed at that stage already. This applies especially to vertical runs.

When the cables are no longer supported on cable trays or risers etc. the power, DC and instrument transformer cables must generally be run singly in galvanized steel conduit. With lighting cables, measuring and control cables and telephone cables, several similar cables can be run in one conduit. Surface-mounted conduits must be secured every 1.5 m.



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The control and communication cables must be laid sufficiently apart from the power cables so that no interference will occur and the transmission of fault signals is excluded. For this purpose the following minimum separations are to be observed:

- 300 mm between low voltage power cables and measuring and control cables at voltages of 60 V and below,
- 300 mm between power cables and measuring and control cables at voltages above 60 V,
- 600 mm between medium voltage power cables and measuring and control cables at voltages of 60 V and below.

The laying of cables outside of buildings should be preferably on cable bridges that preferably are to be naturally ventilated.

If the cables are laid in the ground, after excavating the trench a layer of sand must be introduced. On the sand the cables are laid separately from each other according to voltage systems. The cables must be laid at a depth of 0.8 m at least. The trench is filled with sand and covered with concrete covers or bricks. The thermal resistance of the backfilling shall not exceed 150 Kcm/W. A ground temperature of 28 °C has to be considered. Where cables have to pass under streets cable duct blocks with a suitable bore(s) should be provided. The marking of cable routes by cable warning tapes must be provided.

When laying the cables on cable trays, cable risers, cable channels, etc. and when choosing the size of the cables care must be taken that sufficient ventilation is available and that there is no possibility of thermal overheating, or strain on the cables.

Cables that must move with connected apparatus owing to thermal expansion (e.g. boilers) must be provided in a flexible form or they must have sufficient slack at the location.

All the ends of the cables must be prepared according to the particular requirements of the manufacturers and connected to existing terminal strips, terminal screws, apparatus terminals, etc.

The necessary cable sealing ends and the stripped and fanned-out cable ends, where no sealing ends are provided, must be fixed to the appropriate supporting structures.

B0.6.18.12.2 General cable construction requirements

The medium and low voltage cables shall be of Fire Retardant Low Smoke (FRLS) with XLPE insulation. For cables that are exposed to ambient temperatures above 60°C, teflon or silicone cables are to be provided.

For safety related equipment fire survival cables shall be provided.



The cables must be suitable for laying indoors, in the open (direct or indirect sunlight), in ducts, on trays, in the ground and in water. The cables must be resistant to solar radiation, the effect of oil, seawater, bacterial action, insects and rodents. Outer sheaths are to be manufactured from non-combustible or flame retardant low smoke material.

Manufacturers testing standard related to resistance to solar radiation, effect of oil, seawater, bacterial infection, insects and rodents, will be accepted.

All cables must be provided at both ends, at every 20 m and every bend with identification in the form of numbered labels corresponding to the coding system. The individual cores will be numbered or identified by colour-coding.

The cables must be laid to ensure that they can be replaced or renewed in a simple manner.

B0.6.18.12.3 Medium voltage (MV) power cables

The design of the MV cables shall be screened, stranded, single-core or three-core copper conductor cables of FRLS with XLPE insulation. The cable shall be sealed with a red, non-fading PVC outer sheath. Three-core cables shall be designed with individually screened cores.

The MV power cables must be designed for the thermal and short-circuit characteristics of the electrical systems, taking into consideration the following minimum short circuit duration:

- for incoming cables and cables to sub-distribution: fault clearing time of the back-up protection.
- for all other cables: the fault clearing time of the main protection.

The cables must be terminated and connected to the indoor metal-clad switchgear or the sealing ends are installed in cable connection hoods mounted on the power transformers.

In the event of outage of the air-conditioning plants of the switchgear buildings the internal and external conditions will become the same. Therefore, sealing ends are to be used which shall be suitable for the maximum conditions at site.



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B0.6.18.12.4 Low voltage (LV) power cables

The low voltage power cables shall be standard single and multi-core cables of FRLS with copper conductor and XLPE insulation.

To ensure the elimination of excessive contact potentials on any object, effective earthing must be carried out as a safety measure and suitable 3-core, 4-core and 5-core low voltage power cables must be provided. The minimum conductor cross-section of the low voltage power cables is 2.5 mm². If 3 1/2-core cables are used, the reduced conductor for protective neutral must have a cross-section of at least 16 mm². In lighting systems (especially discharge lighting circuits) the use of a reduced conductor for the protective neutral is to be avoided.

Depending on the site conditions the DC cables must be single-core, 2-core or 4-core. Between batteries or rectifiers and the DC switchgear single-core power cables should in general be used.

The LV power cables must be designed for the dynamic and thermal characteristics of the electrical system and for continuous operation.

B0.6.18.12.5 Current carrying capacity of power cables

The ratings for continuous loading of the cables shall be calculated according to the relevant IEC regulations. The Contractor must submit corresponding tabulations for all cables to be used.

The maximum voltage drop under normal conditions shall not exceed 2.5%.

Voltage drop during starting shall be considered as 15% & during running 3%.

The voltage drop between the the MCC and the terminal of the load shall not exceed 2.5%. It is assumed that the switchgear and the MCC are connected by bus-bars/- ducts means the voltage drop is very low.

The voltage drop for MV Cable Shall be limited to 3% and for LV Cables:

- The voltage drop on the LV cables from Main Distribution to subdistribution shall not exceed 2.5%
- The voltage drop up to the LV motor terminals shall not exceed 5% at normal operation and 15% during starting.

B0.6.18.12.6 Measuring and control cables above 60 V/ instrument transformer cables

For voltages above 60 V the cables shall be of Fire Retardant Low Smoke (FRLS) with PVC insulation and a mini-mum conductor cross-section of



1.5 mm². If they lead to outlying buildings, cables with a common core screen and protection against induction must generally be used.

For instrument transformer cables inside buildings the minimum conductor cross-section must be 2.5 mm².

Instrument transformer cables leading to outlying buildings must have a minimum size of 4 mm² and must generally have a common core screen.

The maximum voltage drop shall not exceed 2%.

B0.6.18.12.7 Measuring and control cables below 60 V

For voltages up to 60 V, measuring and control cables shall be of FRLS with PVC insulation and shall have stranded or solid copper conductors of minimum 0.8 mm diameter. Multi-pair control cables with paired lay-up of the leads and lay-up of the pairs themselves shall be used.

Instrumentation cables shall be identified by colour codes and bank marking as per VDE 0815.

Wherever necessary, e.g. for all cables leading outside the relay rooms and/or control rooms, the control cables shall have a common screen (Al-foil or Cu-foil).

Cables must generally have appropriate electrical protection against inductive/resistive influences and lightning.

The required compensating wires for temperature measurements must be at least 0.5 mm².

The maximum voltage drop shall not exceed 2%.

The individual cores of the multi-pair control cables shall be identified by numbers or a colour coding system.

Minimum size of 0.5 sq mm shall be considered for wiring including for control cabinets.

B0.6.18.12.8 Fiber optic cables (FOC)

All fiber optic cables as well as their deployment and the entire test procedure shall comply with IEC 60794. The cables shall be able to operate continuously in temperatures up to 70°C. The fiber optic cables shall be loose tube type with the fibers fed into tubes. The tubes shall be sufficiently strong to hold their shape and provide protection for the fibers against deformation and friction. Each fiber shall be colour coded acc. to IEC 60304.



Buried fiber optic cables shall always be laid inside adapted conduits. Installation shall ensure rodent protection and be water tight. The conduits system shall supply all equipment necessary for the deployment acc. to FOC manufacturer's specification. Occupancy shall allow future cable installation.

For out-door applications cables shall be suited for out-door deployment, longitudinally water tight, filling material standardized for all cables, yield minimum 3,000 N.

The fiber optic cables shall be complete with non metallic strain relief elements. Fiber optic cables that are installed outdoors shall be armored. Cables used indoors shall be reinforced with a steel wire braid.

Graded index fibers cables and monomode fiber cables shall comply with IEC 24702:

Graded index fibers cables shall consist of always 24 fibers

- fiber - type 50/125 μm , OM-3.

Monomode fiber cables shall consist of always 24 fibers

- fiber - type 9/125 μm , OS-1.

19" patch panels shall be used for termination, connectors shall be LC-Duplex as standardized by IEC 61076-3-106 var. 4. All fibers shall be terminated / connected.

Each fiber of all FOC shall be deployed and tested according to IEC 60794. Resulting test protocols of all single fibers of all FOC shall be handed over to the Employer, stating all details in written.

B0.6.18.12.9 Cable supporting structures

Construction requirements

Basically, pre-fabricated cable trays, cable risers, hanger rods, screws, clamps and all fixing material of corrosion-resistant finish, hot-dip galvanized, shall be used. If in certain sections the use of trays and risers is not possible, cable racks are to be provided in such places. These shall be made of corrosion-resistant, steel angle Sections, hot dip galvanized. The steel angles must be cut to size on site and exposed cut surfaces must be suitably treated on the spot to prevent corrosion before being fitted. The minimum requirement for this treatment is the application of an anti-corrosion layer of zinc coating.

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All cable tray T-junctions, cross-overs, vertical and other shelving, bends, etc. must consist of pre-fabricated tray elements so that crushing of the cables at these transition points is avoided.

The cables laid on the trays must be carefully arranged and ordered. All cable tray routings consisting of several individual cable trays that are located outside buildings and exposed to the sunlight shall be provided with sun-shades made of the material as described for the cable tray equipment. In all areas where an accumulation of coal dust must be expected, e.g. coal handling plant, conveyor belt ways, bunker area, the cable trays shall be installed vertically.

The trays and risers must be installed in such a way that in accessible manways an escape route at least 800 mm wide by 2100 mm high is available for the personnel.

For safety reasons the lower parts of the hanger rods and all other exposed parts in manways and escape routes must be fitted with plastic covers.

In indoor installations hot dip galvanized material with an average coating thickness according to ASTM A123/123M is to be used.

In all external areas, in semi closed buildings and in areas with corrosive gas or steam, Fibre Reinforced Plastic (FRP) cable trays tested according to international standards shall be provided.

The cable trays must be designed to ensure that there is 5% spare space on all trays when commissioning and handing-over is complete.

The fixing materials for the cable trays and risers must be corrosion-resistant or at least be hot-dip galvanized. The rods, brackets and risers must be fitted with appropriate support brackets to be fixed to anchor rails or fixed by dowels and screws in walls and ceilings.

Welding to steel structures and the welding together of hot-dip galvanized cable-laying accessories is not permitted.

After completion of the cable-laying work the maximum deflection of the cable trays shall not exceed 2.5 mm per 1.5 m (specified distance between two hanger rods).

B0.6.18.13 EMC measures

All EMC measures shall ensure that during subsequent operation, no impermissible malfunctions or damage to equipment occurs due to violating electromagnetic compatibility.



The description of the measures is not limited to this chapter, but also forms a part of other chapters, in particular "Protective measures", "Earthing and lightning protection" and "Cabling".

The EMC requirements are set out in the following.

Under consideration of the conditions and constraints, the equipment used shall emit the lowest interference signals and exhibit the highest immunity to interference.

All equipment items shall operate properly when connected to networks with a power supply corresponding to the maximum permissible tolerances as laid down in EN 50160 (as regards, harmonics, voltage fluctuations etc.).

Priority is given to reducing sources of interference.

Additionally, by means of high-capacity screening, generation of overvoltages due to inductive or capacitive coupling shall be reduced. Influencing by electrical and magnetic fields shall be reduced.

Earthing and potential equalization systems designed for low-impedance shall reduce generation of overvoltages due to ohmic coupling. If EMC resulting from the measures named above is still not adequate, further measures shall be taken within buildings, for example by isolation and suppressor circuits.

Thanks to the lightning protection and screening measures taken at the buildings, within them an EMC protection zone is formed.

All installations penetrating this protection zone, that is where they pass through the external walls of buildings, shall be incorporated into a lightning protection-potential equalization system as close as possible to the points of entry and exit of the building. This applies also for conductors carrying a potential. At entry or exit, these shall be included in the lightning protection-potential equalization system by way of suppressor circuits.

Cable runs to outdoor plant components and between buildings may also be screened by appropriate measures, and so form a part of the protection zone. If this is done, the suppressor circuit can be dispensed with.

A suppressor circuit shall be provided at all low-voltage main distribution boards.

Overtoltage protection shall be foreseen within the power supply for both central and distributed power supplies to electronic cubicles.

All conductive parts of the structures and installation within the scope of the contract must be connected to the main earthing system.



All steel Sections or frames must be provided with at least two earthing straps for every frame or Section that is fabricated from parts welded together. The earthing straps shall be located at the ends of the beam Section or frame Section in every case.

The Contractor must provide earthing straps in front of and behind the screwed connection in every case and these straps must be interconnected, using stranded copper, and connected, at least at one point, to the main earthing system, except the Contractor verifies that the type of screwed connection applied is a permanent electrically conducting one. Tanks and vessels containing flammable liquids or gas shall be earthed by a connection to the earthing grid or by bonding to earthed metal structures.

Each pipe shall have a minimum of one connection to the earthing system. In areas where flammable vapor-air mixtures may exist, electrically isolated Sections of metallic piping shall be connected to the earthing grid.

All flange connections in these lines shall be bridged by flexible stranded copper. Earthing tabs shall be provided at each flange.

When connecting differing materials together the required material transition plates must, in general, be inserted. All connecting materials must be corrosion-proof and suitable for the conditions prevailing at the installation point.

Railway lines, together with electrically conducting pipelines leading outside the power station place must be insulated or be fitted with intermediate insulating links or elements.

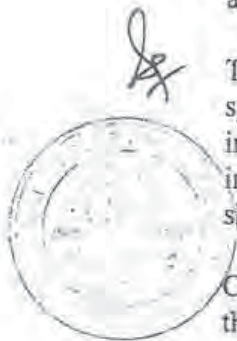
Each cable tray and cable riser of less than 20 m length have to be earthed once; structures of more than 20 m length have to be earthed twice.

B0.6.18.14 Requirements for local cubicles and local housings for e.g. switchgear, control, measurement and signalling equipment

Steel-clad cubicles and enclosures with fixed, integral switchgear and apparatus must be provided.

The switchgear cubicles must be partitioned off and incorporate a busbar system, the necessary instruments, control switches, switch panels of the individual switch and apparatus chambers. The main busbars are to be installed on the rear face, top side of the switchgear cubicle in a lockable shuttered compartment.

Connections to switching devices, MCB's fuses etc. are to be made from these busbars. The lower part of the cubicle will house the terminal strips and connecting blocks, the clamps for the cable terminals and, if required parallel connection copper straps for the connection of more than 2 cables in parallel. An adequate number of ball studs must be provided within the



switchgear cubicle suitable for earthing the main and distribution busbars as well as the switchgear itself by means of portable earthing and short circuiting equipment (to be provided once per switchgear panel row).

The space in the interior of the cubicles must be divided into a Section with 'live' parts, 'live' switching elements etc. and a Section with control and measuring equipment. The Sections are to be separated by reinforced sheet-steel.

Care must be taken that in the event of arcing hot gases will not escape to the front of the cubicles (the operational side).

Ammeters are to be provided on the cubicle front panel for the cubicle feeders and the supply outlets for motors higher than 55 kW or motors of lower rating, but particularly important for the process. A single voltmeter with 4-position voltmeter changeover switch must be provided for measurements of busbar voltage between each phase and neutral. Measuring instruments should, in general, be square in shape.

All cubicles, cabinets, panels, etc. shall be designed for an ambient temperature of 40 °C (outside the enclosure) in non-air conditioned areas. Special precautions shall be taken in the design of electronic devices for protection and control systems housed in the cubicle in order to allow for these conditions.

Heating elements are to be provided generally in each local cubicle or cabinet and shall be humidity controlled.

It must be possible to disconnect power supplies to the cabinets by means of manually operated power circuit-breakers (MCBs).

For easy monitoring and a rapid grasp of the operational state, collared mimic diagrams with the required switch position indicators, apparatus symbols and pilot lamps must be provided in every case on main process cubicles and switchgear cubicles. Lamp test facilities for all signed lamps connected shall be provided. All cubicles shall be provided with the required earthing screws.

Plastic-insulated, stranded conductors must be used for wiring within the switchgear cabinets, which must be numbered at each end with special tabs so that change by mistake is impossible.

Preferably plug-in type auxiliary relays are to be used. Apparatus being sensitive to impact must be protected against shock and vibration.

On completion of hand-over the cubicles must contain at least 5% of unfitted spare terminal capacity and 5% of spare space for the future installation of extra equipment. It shall be possible to replace indicating lamps on the front panels of cubicle feeders and motor-supply outlets



without isolating the equipment concerned. Furthermore the control system must be designed in such a way that lamps operate at less than their rated voltage in order to avoid their being overheated.

Incoming and outgoing cables have to be fixed by suitable metallic cable glands.

B0.6.18.15 Local control points and level control cabinets

B0.6.18.15.1 General

Any electrical consumer unit, which is not controlled automatically or from the central control room, is to be fitted with a suitable local control cabinet. The local control cabinets are to be installed in the immediate vicinity of the motor drive to be controlled.

Pump motors, which are level controlled locally, will be given an automatic and manual control. The respective level control cabinets are to be fitted in the immediate vicinity of the pump motors, gauge glasses or level monitoring instruments.

B0.6.18.15.2 Construction requirements

In general local control cabinets and level control cabinets with plastic casings resistant to impact, sand, light and water, mounted on walls or hot-dip galvanized supporting constructions, are to be provided. Hot-dip galvanized casings will be acceptable.

Protection class must be at least IP 54 if installed indoors and IP 55W if located outdoors. The necessary earthing terminals must be provided for earthing purposes.

The cabinets must be equipped with the necessary mini circuit breakers, fuses, auxiliary relays, power contactors, terminal blocks and cable attachment components.

For motors with pre-selection control (operation/stand-by) operation hours counters are to be provided.

In hazardous areas, the necessary explosion proof control cabinets and level control equipment must be provided in accordance with IEC 60079, IEC 61241 and VDE 0165/170/171.



B0.6.18.15.3 Local control points

The local control points are to be equipped as the minimum requirement with:

- ON button
- OFF button
- Running lamp
- FAULT LAMP
- TRIP HEALTHY indication
- Lamp test.

When two motors are installed, serving as operation and stand-by unit, then in addition to a double set of the above items, the following equipment has to be installed as the minimum requirement:

- MOTOR 1 - MOTOR 2 (running motor/stand-by motor) pre-selection switch,
- automatic transfer to the stand-by motor in case of failure of the running motor.

B0.6.18.15.4 Level controls

In the case of pump motors controlled by levels, in addition to the level control in each case the MANUAL - AUTOMATIC selector switch and the necessary local points are to be fitted. Control of individual pump motors must be effected as follows as the minimum requirement:

- MANUAL- AUTOMATIC selector switch
- level control with maximum and minimum contacts
- low level contact on motor - OFF
- bottom maximum contact on motor - ON
- top maximum contact as warning to the central control room
- low-low level contact as pump dry-running protection and alarm signal to the central control room
- local control point with ON and OFF button, running and fault lamp.

When two pump motors are installed for the same purpose the control is to be effected as follows, as a minimum requirement:

- MANUAL - AUTOMATIC selector switch
- PUMP 1 - PUMP 2 (running pump / stand-by pump) pre-selection switch
- level control with three high level contacts:
 - first (1): high level contact for pre-selected ON
 - second (2): high level contact for alarm signal to the central control room
- low level contacts for pumps OFF
- low-low level contacts as pump dry-running protection and alarm signal to the central control room



- local control and lamps as listed above for local control cabinets, for each motor

B0.6.18.16 Terminal boxes and terminal cabinets

In order to minimize the amount of cables and distribution of signals and to centralize connections in the Plant, terminal boxes or, wherever necessary, by larger amounts of terminals, terminal cabinets shall be fitted on all the necessary

- cable crossover terminal points
- central collecting points for individual analog and binary signals and local transmitters
- signal collecting and distribution points for fire alarm, telephone, loudspeaker and clock system
- central distribution points for local signals.

Terminal boxes and cabinets must at least have class of protection IP 54 if installed indoors and IP 55W if installed outdoors and must be equipped with the necessary terminal strips, cable glands and fittings components for the connection of the cables.

The necessary earthing terminals are to be provided for the earthing of the boxes and cabinets.

In any area subject to the danger of explosion, the necessary explosion-protected terminal boxes and cabinets are to be provided in accordance with IEC 60079 and IEC 61241 and VDE 0165/0170/0171.

B0.6.19 Instrumentation and control equipment

B0.6.19.1 Main design criteria

This Section applies to the design of the general Instrumentation and Control equipment. The following general requirements shall be strictly observed with regard to design and execution. In the event of contradictions the Contractor shall be responsible for obtaining written clarification from the Employer/Engineer.

Reference within this Section does not automatically indicate that the particular form of instrumentation is required on this project or will be acceptable for a particular application. The particular requirements for control and instrumentation shall take preference in the event of any disagreement between the two Sections.

Only requirements for technical performance of the equipment are stated herein, whilst the detailed requirements of the tasks to be performed by the control systems and the scope of delivery for each individual item of plant is stated in the relevant Sections of this specification.

This specification does not however relieve the Contractor of his responsibility for the basic design and execution of the instrumentation and control system per scope of supply in relevant Sections of this specification. The rules of good engineering practice and the relevant approved standards and regulations shall be observed.

A consistent instrumentation and control philosophy shall apply throughout the Plant and shall be implemented in terms of a range of equipment exhibiting a minimum diversity of type and manufacture. The objective shall be to standardize all measurement and control equipment throughout the Plant in order to rationalize operation, maintenance and reduce spares holding.

Generally equipment shall be supplied from one composite range of measurements and control equipment as marketed by a reputable manufacturer of international standing and shall have a minimum of two years operational use on similar projects. Where particular equipment is not included in the products of the manufacturer thus necessitating diversity of supply, this equipment shall be identified by the Contractor. The equipment shall be of modern, compact design incorporating the latest developments in proven technology. All instruments whether for local indication or remote transmission shall be of good quality and shall have an accuracy and repeatability appropriate to their duty. All fittings shall use metric threads.

Measurement and control instruments shall be matched to the main plant equipment ratings in all aspects. Instrument ranges, installation codes of practice and precautionary measures for safety of the Plant and the operating and maintaining personnel shall be observed.

Special attention shall be paid to the Plant safety. As a general rule, measuring points and measuring equipment for critical protection shall be separate from and not combined with measuring equipment for the automatic control equipment.

The material of all equipment installed in pipes, tanks, etc., shall correspond to the material of the relevant pipes, tanks etc. and shall fully meet the requirements regarding safety and operational conditions of the media to be measured. All the equipment shall be suitable for the location in which it is to be mounted and in particular all outdoor equipment shall be suitable for the prevailing climatic conditions.



The diversity of makes and types shall be kept to a minimum. The Employer/Engineer reserves the right to stipulate make and type following award of contract.

Any equipment to be installed within potentially explosives atmospheres shall comply with the requirements of international standards and codes, e.g. IEC-60079, NEC 500 etc.

The instrumentation and control equipment shall have high electro-magnetic and radio frequency interference immunity and shall not be affected by portable radio transmitters operated in the vicinity of the equipment. Any limitations shall be stated.

All instruments shall be protected by cases. The cases shall have enclosure classification not less than IP 42 according to EN 60529 when mounted indoors in totally enclosed rooms with provision for limited ingress of dust, IP 54 else in a enclosed building and IP 55W for mounting outdoors.

Electronic instruments shall not be located close to hot lines, vessels or other hot equipment. Ambient sun temperatures exceeding 80 °C shall not result in calibration difficulties or rapid deterioration of electronic components.

B0.6.19.2 Distributed Digital Control, Monitoring and Information System (DDCMIS)

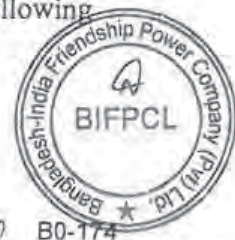
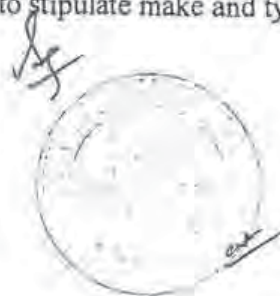
The Plant will be controlled generally through a DDCMIS. The DDCMIS contains of process stations, operator workstations, engineering workstations, archiving facilities and signal exchange to management and third party systems. In general the DDCMIS will be DCS based hardware only in some exceptions PLC based systems may be applied.

For detailed technical specification and design requirements please refer to **Section B8** of this technical specification.

B0.6.19.3 Programmable logic controllers

Programmable logic controllers (PLC) shall be deployed in subsidiary installations and systems of higher complexity and shall provide a more open access for operation. Standard products of PLC manufacturers shall be used for which software developed by the process suppliers and proven for the specialized process is available.

The diversity of makes and types shall be kept to a minimum. The Employer/Engineer reserves the right to stipulate make and type following award of contract.



The use of auxiliary packages with PLCs or local controls for ancillary plants or systems shall be limited and minimized. Only some special cases can be considered subject to the Employer/Engineer's approval.

Typical and acceptable reasons for a specialized control system can be high speed of response or special safety requirements, which may require a separate safety-related system.

For signal exchange with the main DCS, PLCs shall be compatible with this system. Depending on the amount of information to be exchanged, parallel or serial interfacing shall be considered. The sequence of events signals should be directly physically connected to Sequence of Events Recording System (SER).

If only few signals are to be exchanged, parallel interfacing is preferred. Binary signals shall be exchanged via volt free signals. Analogue signals (4 - 20 mA) must be suitably decoupled.

If serial interfacing is used, the interface equipment between the PLC and the DCS must be capable of communication using an industrial standard protocol. The transmission baud rate shall be selected dependent on the application (minimum 19200 baud or higher). If commands are issued from the DCS to the PLC, the time between operator command input and PLC signal output shall not be more than 1.5 seconds. The same requirement goes for answer back signals from the PLC and updating of displays of analogue values coming from the PLC on the DCS monitor displays.

As a minimum requirement, the offered serial link shall have a data integrity checking and retransmission facility in case of error detection, independent of the DCS or external system software. Hardware and software failures during data transmission shall be monitored and alarmed onto the DCS.

The communication link shall be redundant. In case of failure in the communication, quick manual automatic switch-over to the standby communication link shall be possible with automatic switchover and fault reporting and diagnostic facilities.

The functions realized in the PLC and the method by which they are invoked shall be represented graphically similar to IEC 61131-3.

Additionally, a verbal program description supported where required for easy understanding of complex functions with functional diagrams according to IEC 60848 shall be provided.

Programming devices with keyboard, VDU and printer for ease of programming, effective on-line monitoring and diagnostic functions, together with the necessary equipment to write in and to erase EPROMs shall be provided.

The Contractor shall guarantee that spare parts for the offered PLC system will be available for at least 15 years after commissioning of the Power



Plant as well as upward/forward compatibility for future upgrades of the system. If necessary, the Contractor shall provide successive system upgrades to ensure spare part compatibility for that time span.

For local operation and monitoring a panel or desk mounted Human Machine Interface (HMI) unit, operable by keypad or touch screen with LED-displays shall be provided. Protection class of panel mounted HMI (front side) shall be IP 22 according to IEC 60529.

B0.6.19.4 Control cubicles

DCS, PLC hardware and other associated control equipment shall be installed in suitable control cubicles. The cubicles shall be set up in local switchgear/ electronic rooms (CER or LER) or in local control centers (LCC). The protection class required is specified under **Section B0.6.18**.

Outdoor installed cubicles shall be provided with thermostatically controlled heating elements in order to prevent the formation of condensate which may occur due to large variations of ambient conditions, if necessary. Adequate lighting and sockets for hand tools protected by 30 mA Residual Current Differential Switch (RCDS) shall also be provided for cubicles and panels, if necessary.

The cubicles shall be secured in such a way that failure of one node cannot cause the failure of the whole system.

The required control elements and displays (annunciation and status lights, analogue displays, switches etc.) shall be so configured that as far as possible they can be viewed from the associated secondary system. Should it be necessary to place the control and monitoring elements in the field, these shall be installed in separate, robust housings (protection class IP 55W). All alarms/ annunciations shall as well be available in DCS.

In preference LED displays shall be used. Ease of access and operation of the equipment shall be ensured.

Visual display unit (VDUs) will be employed for field operation and monitoring.

All cubicles shall be adequately ventilated in order that the heat generated by the equipment mounted there shall remain within the specified limits, even in the case of high ambient temperatures that may occur in the event of failure of the air-conditioning system.

Locally installed cubicles shall be suitable for the location in which they are situated and shall provide adequate protection against dust, moisture or mechanical damage for the equipment mounted therein. Cubicles shall be designed in such a way that vibrations of the building shall be absorbed to a large extent. Sunshades shall be provided for all cubicle located outdoors.



Cable connections to cubicles, panels and desks shall be made via suitable seals so as to prevent the ingress of dust, vermin or the propagation of a possible fire. During installation period, a provisional sealing of cable penetrations shall be ensured.

B0.6.19.5 Racks, junction boxes

Marshalling racks

Separate cubicle type marshalling/ termination panels shall be provided, i.e. field signals shall not be terminated in the rear side of the system cabinets.

Open type racks constructed of angle steel may be used for the marshalling and termination of low voltage control cables within the Central Electronics Rooms (CER & LER). Cubicle type marshalling racks may also be considered.

For voltages exceeding 60 V, a suitably separated Section with isolation cover shall be provided.

Instrument racks

Wherever possible, instruments and devices, e.g. transmitters, thermo element cold junctions, terminal boxes, located in the field, shall be mounted on local instrument racks. The instrument racks shall be installed with due regard to control engineering needs, material-saving assembly and easy accessibility for maintenance and checking work, and shall be constructed of standard angle Section steel.

Junction boxes

In order to simplify local collection of cables and distribution of signals and to centralize connections in the Plant the junction boxes shall be fitted on all the necessary:

- cable crossover terminal points,
- electrical actuators,
- central collecting points for individual analog and binary signals and local transmitters,
- central distribution points for local signals.

The necessary intermediate terminal boxes must at least have degree of protection IP 55 in accordance with EN 60529 and must be equipped with the necessary terminal strips and attachment components for the connection of the cables. The necessary earthing terminals shall be provided for the earthing of the boxes. In hazardous areas, terminal boxes shall be in accordance with EN 50019 or 50020, depending on zone classification.

After commissioning, the junction boxes, marshalling racks, instrument racks, etc. must contain at least 10% of spare space. The Contractor shall furthermore provide at least 10% of fully fitted spare terminal capacity.



B0.6.19.6 Mimic diagrams

Mimic diagrams shall be offered where specified or alternatively where their presence would assist Plant operators in assimilating the operational state of the Plant.

Where used, the mimic diagram shall harmonize with the other equipment in the control room. Mimic diagrams shall be of the mosaic type.

On mimic diagrams for electrical systems, the different voltage levels shall be distinguished by the use of mosaic elements having an inlaid coloured strip. These elements shall be fitted together to show the location of the different busbars. The operational position of circuit breakers and isolators shall be indicated by semaphore indicators, and the operation of switchgear from the mimic diagram shall be by means of discrepancy switches or pushbuttons designed to operate in a similar manner.

On process mimic diagrams, methods shall be used to clearly indicate the path of the various media, the preferred technique being by means of raised plastic strips which shall have a distinctive colour. Also a uniform scheme of colours for different media shall be adopted.

Where pushbuttons are proposed for operation, enabling pushbuttons shall also be provided and it shall require the operation of both the pushbutton actuating the device and the enabling pushbutton to operate the device.

The Contractor shall propose the mimic colour code for process and electric system identification of the P&ID and electric single line mimics in the VDU or mimic panel.

B0.6.19.7 Power supply and fusing

The power supply for the equipment requiring uninterrupted supply (UPS) (e.g. emergency valves, flame monitors, measuring and control system, recorders, printers, VDUs, OWS and servers) shall be taken from the safe AC as described in other parts of the specification, especially **Section B0** and **Section B7**.

The 24 V DC independent supply systems shall be provided for the control cubicles of independent control systems. Ni-Cd or lead-acid planté batteries shall be used in the main plant area whereas in offsite plant areas only Ni-Cd batteries shall be used.

The 24 V DC systems shall consist of 2 sets of power supply with each set consisting of 1 x 100% battery charger, 1 x 100% batteries for 1 hour duty and 1 x 100% DC distribution board.



Each individual consumer shall be provided with an infeed from each set with diode decoupling at the consumer.

The supply voltages for the control cubicles within the central electronic rooms (CER & LER) shall preferably be 24 V DC and must be arranged as separately fused double infeeds. The individual feeders can serve either a single cubicle or several cubicles combined as a logical group.

Intelligent Battery health management system shall be provided for each set of 24VDC power supply system and UPS batteries (except mini-UPS). It shall be connected to DCS.

All battery systems shall be provided with a manual discharge resistance bank.

All equipment shall be adequately protected against overcurrent by means of fuses or other current protection devices. The main power supply fuses shall be located in functional groups within separate power distribution cubicles. Fuse ratings and time characteristics shall be such that in all cases, a fault within an individual item will cause the fuse associated with that item to rupture and thus disconnect that item from the power supply, before the main fuse is affected.

Failure of a main fuse shall affect the overall operation of the Plant as little as possible and shall be indicated in the central control room (CCR) by means of an alarm. This alarm shall state the identity of the failed main fuse.

Failure of an individual cubicle, module or component fuse shall be indicated by a general alarm and a detailed diagnostic message. The Section of the control cubicle in which the fuse is located shall be indicated. It shall also be possible to locate visually the fuse that has failed.

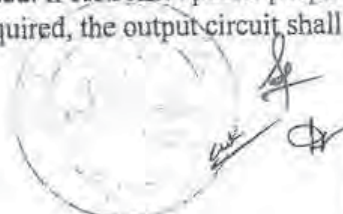
The design of the electrical power supplies and fusing system must ensure that any faults in modules or other devices, which may block sequence logic interlocks, automatic control systems or other control systems, are restricted to the system in which the fault has occurred.

All electronic devices shall be protected against transient voltage levels which would otherwise damage the device.

B0.6.19.8 Transmitters

All transmitters shall have an impressed output signal of 4 - 20 mA corresponding to zero to full range input. However, digital communication shall also be acceptable.

Generally, 2-wire transmitters shall be used. If for some special purposes (e.g. analyzers) 230 V AC power supply is required, the output circuit shall be isolated.



As far as possible, all transmitters shall be of the SMART-type. This applies also to field mounted temperature transmitters.

All transmitters shall be fitted with a local analog or digital indicator displaying appropriate physical units which may be read clearly from an easily accessible position.

Transmitters with accuracy class "0.5" or better must be used. The repeatability shall be within a range of $\pm 0.1\%$ of full span.

The output signal of all transmitters must be independent of the burden of the transmitter output circuit including cable resistance over a wide range.

The removal of connected devices must not open the transmitter output circuit or cause malfunction of this circuit. In the case of failure and return of the supply voltage within a measuring circuit, no false signals endangering the system shall be issued. All transmitters shall be individually fused. If not specified otherwise, local parameterization at the transmitter or via modem and PC/laptop or hand held communicator using HART-protocol shall be possible.

For the continuous remote position indication of valves, dampers etc. also transmitters with impressed output signal of 4- 20 mA shall be employed.

All transmitters shall be suitable for field installation and shall have strong, moisture and dustproof cases of IP 65 or better according to EN 60529. This applies also for temperature transmitters when installed in the field.

Diaphragm seals shall be provided to serve as a barrier for corrosive process fluids, slurries or highly viscous oils. The seal shall be of the flanged type, suitable for the same conditions as those for the transmitter. The material selection shall be according to the requirements of the fluids to be measured. The seal shall be provided with a flushing connection.

Transmitters to be used in hazardous areas shall be explosion proof. Suitable intrinsically safe circuits are to be provided in accordance with EN 60079-11.

All transmitters potentially subjected to vacuum shall be capable of withstanding 100% vacuum without damage.

No stress shall be imposed through the connections between Plant and the transmitter. As far as possible, the transmitters shall be grouped together into enclosed racks or panels for easy access. Sunshades shall be provided for all outdoor panels.

Individually installed transmitters shall have their own weather proof enclosure of robust construction and be suitable for the proposed



environment. All field equipment terminals shall be wired to a terminal box using screwed connections.

Transmitters shall be provided with all necessary isolating, vent and blow-down valves and facilities shall be provided for the connection of test instruments at the input and output of each transmitter, to enable calibration to be carried out.

In general limits (for alarms or switching actions) shall be derived from the analogue measurement value in the DCS (use of switches shall be avoided). Where binary signals cannot be derived from an analog value, **binary transmitters** e.g. temperature switches, pressure switches etc. may be used. Indicators with integrated limit switches are allowed within package units. Preferably limit switches shall be of the proximity type.

All switches shall be of robust design and reliable performance. Temperature switches, pressure switches, level switches, and etc. shall be of the snap-action and change over type. The switches shall have an adjustable switching hysteresis. Parity checks shall be supplied for switches. (Note: Parity checks refer to the supervision of switches, i.e. it shall be supervised that switches have one defined state and are not undefined e.g. neither open nor closed. Finally this means that there have to be 2 DI to be used for each switch, one for "open" detection and one for "closed" detection.)

The set point and the deadband (reset point) of each switch shall be adjustable from inside the case, over the full range specified. The set point and reset point shall be indicated on the adjusting mechanism.

For the sensing of level in tanks, vessels or bunkers float switches, vibration level switches or other suitable switching devices with conductive or capacitive electrodes shall be provided.

For monitoring of machine coolant or lubricant flow (dry running protection) suitable flow or level sensors shall be employed.

The switches shall be housed in robust, dust and moisture proof cases having glanded cable entries and shall be suitable for the ambient conditions local to the equipment on which they are mounted.

B0.6.19.9 Temperature measurements

Glass thermometers, bi-metallic and capillary remote thermometers are used for local temperature measurement. For both, class 1.0 shall be provided.

Glass thermometers are to be inserted into pockets provided for the purpose. The use of mercury is forbidden.

Capillary remote thermometers shall be with a case diameter of preferably 160 mm and must be mounted on fixtures or instrument panels in such a



way that they are protected from vibration, jarring and sprayed water. The capillary tube must be laid in a protected position.

If possible, resistance thermometers (Pt-100) in accordance with IEC 60751 shall be used for remote measurements. All resistance thermometers shall be wired according to the four-conductor principle.

Otherwise, thermocouples with appropriate heat resistance in accordance with DIN IEC 60584-1 or equivalent may be used for remote measurements.

All thermocouples shall be of the quick response type, ungrounded and preferably of double element type.

Thermocouples shall be arranged in such a way that the ambient temperature of the head is lower than 100 °C, and that the measuring inserts can easily be exchanged.

All thermocouples and extension leads shall be terminated with a suitable gland and the conductor to sheath resistance shall be greater than 100 M-Ohms when tested after termination.

Thermometers and thermocouples shall generally be fitted in protective wells. They shall be provided with weatherproof terminal heads and shall be installed so as to totally prevent the ingress of foreign matter.

High speed response pockets shall be provided for all applications involving control of critical process temperatures. Thermowells with high speed of response shall be used.

Where more than one temperature measurement e.g. for redundant loops, recording, indication, automatic control is to be made at one location, individual protective wells with sensors shall be provided at the common place of measurement. Protective wells for unoccupied test measuring points shall be arranged with the opening inclined downwards wherever possible and shall be provided with a screw-on protection cover.

Insofar as local conditions or extreme temperature do not require otherwise, screw-in immersion wells for exhaust gas and air shall meet the following requirements:

- nominal length not less than 0.5 m
- attachment of the well in the wall of the exhaust gas channel or air duct must be gas-proof.

For the measurement of temperature of other media the following requirements shall be observed:

For all pipework a minimum immersion depth of 55 mm in the internal pipeline cross-section and a minimum distance of 15 mm from the opposite



pipe wall must be provided. If the diameter of the pipeline does not allow the thermometer to be inserted perpendicular to the pipe axis while still maintaining the above mentioned measurements, another solution must be found in cooperation with the Employer/ Engineer. When determining the lengths of the insertion and connecting tubes the insulation thickness is to be taken into consideration.

For all remote temperature measurements (i.e. for RTDs and TCs) transmitters shall be installed locally in a transmitter protecting box on a DIN rail.

B0.6.19.10 Pressure measurements

Pressure gauges of class 1.6 or better must be used. The standard measuring ranges must be selected with regard to the maximum operating pressure.

A pressure instrument installed for measurement of steady pressure at varying pressure shall operate in a band centered on 60% of its maximum range.

When the pressure impulse line is liquid filled the measuring unit shall be compensated for static head. The head correction shall be stated on the unit.

Pressure gauges shall have a dial size of 160 mm and shall be located in such a way that they can be easily observed or shall be combined in groups on local gauge boards or cubicles.

Pressure gauges shall be resistant against vibrations. Furthermore, pressure gauges shall be designed in such a way that the measured value may reach the end of the indicating range without affecting the calibration of the gauge.

Pressures to be remotely indicated, recorded or used for automatic control loop inputs shall be measured by means of pressure transmitters (refer to relevant part of **Section B0**).

Pressure measurement tapping points shall generally be in accordance with the specification for the pipeline in which they are installed and shall be equipped with one, and for high pressure installations (45 bar) two, isolating valves arranged directly at the tapping point. Excluded from this stipulation are measuring points for vacuum and measuring points for combustion air and exhaust gas.

Piping shall be of approved quality and sized for the particular service. In all cases the pipe size shall be chosen to ensure strength and freedom from blockage. Instrument impulse pipework shall be manufactured from a suitable grade of stainless steel to the approval of the Employer/Engineer.

Pressure transmitters for remote measurement shall not be mounted directly at the tapping point, but shall be arranged at a distance from the tapping



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point by means of enclosures. The impulse line between tapping point and transmitter shall be arranged in such a way as to form a siphon loop, when steam pressure measurements are involved.

A valve combination or multiway cock shall be provided directly on each pressure gauge or transducer connection. They shall be equipped with a connection for test gauges, and it shall be possible to shut off the test connection without isolating the service pressure gauge at the same time.

Open blowdown / drain connections shall not be arranged within panels and local equipment. Instead it shall be led to a drain external to the panel. All valves shall be installed so that they are accessible for in-situ maintenance from a floor or permanent structure landing.

Transmitters are to be protected from the measuring media, if required.

In addition to the above requirements, special valve block equipment shall be provided, where differential pressure is to be measured. Alternatively, differential pressure type transmitter can be considered.

B0.6.19.11 Flow measurements

Remote flow measurements of water, steam, combustion air, flue gas etc. shall, unless otherwise specified, be carried out by means of differential pressure, ultrasonic, electromagnetic, annubar, coriolis, turbine meters, oval-wheel flow meters.

The transmitters shall be as specified under **Section B0**. Changes in density, pressure or temperature of the measured medium shall be compensated wherever necessary.

Tags on orifice plates shall be stamped with the basic design information (i.e. flow rate, pressure and temperature of the passing fluid, the orifice diameter and the pressure differential generated).

Primary elements such as orifices or nozzles located in steam or high pressure feed water pipes shall be of the weld-in type. Material, dimensions and installation of orifices, nozzles and tapping points etc. shall be in accordance with the specification for the pipes in which they are installed

Orifice Plate installation using Weldneck Flange assemblies shall be offered. Tappings shall be on the flange and not on pipe.

Isolating valves shall be provided at the tapping points of the orifices/nozzles. In the case of steam flow measurements condensing vessels (steam traps) shall be provided between the tapping point and the isolating valve.



The material and dimensions of the piping shall conform to those laid down for the piping concerned. The welds shall be executed in such a manner as to avoid turbulence that can affect the measurement.

In order to achieve exact installation, the vendor supplying the orifice plate or nozzle for high pressure pipes shall install the orifice plate or nozzle in its own works in a Section of pipe of about 3.5 times the pipe diameter (1.0 x NB in the outlet, 2.5 x NB in the inlet). For orifice plates or nozzles installed in pipes with a nominal bore smaller than 80 mm, complete meter runs shall be supplied.

Orifice plates and nozzles shall be manufactured of ANSI 316 Stainless Steel unless specified otherwise. Orifice plates shall be sized according ISO 5167-2.

Orifice plates shall be sized for a d/D ratio not less than 0.20 and not greater than 0.70. Higher rather than lower d/D ratio are preferred to minimize line restrictions. All sizing calculations shall be submitted to the Employer/ Engineer for approval.

Tags on orifice plates shall be stamped with the basic design information (i.e. flow rate, pressure and temperature of the passing fluid, the orifice diameter and the pressure differential generated).

Venturi tubes according to ASME MFC-3M shall only be considered when operating economy requires low permanent pressure losses.

The erection welding seams shall be executed in such a manner that no turbulence, which will affect the measurement, can occur.

Rectangular venturi tubes may be considered where other measuring devices are impossible or impractical (e.g. in large rectangular air duct of boilers).

For flow measurements in LP-systems e.g. water or condensate, orifice plate installation using slip-on orifice flanges shall be provided. All orifice plates for installation between flanges shall have their own tapings for differential pressure measurements incorporated in the plate. Simple orifice plates with the tapings situated in the pipe are not allowed. The flow direction shall be consistently marked on the orifice or nozzle by means of an arrow.

Special conditions may dictate the use of devices such as:

- venturi tubes for low pressure gases
- pitot tubes such as Annubar.

Ultrasonic flow sensors shall provide a double transmitter/ receiver system and be for installation with a calibrated pipe. The tube lining material shall be as required for the fluid and its temperature and be as specified in other chapters of this **Section B0**. The use of ultrasonic clamp on flow meters shall be avoided and requires dedicated approval of the Employer/ Engineer.



The accuracy shall be 1% of the calibrated span. An overpressure security shall be provided of 50% above the maximum pressure range.

Electromagnetic measurements may be used for flow measurements of inhomogenous liquids with or without solids content in completely filled pipes. The limits of application of the measuring system due to the medium parameters planned on a case-by-case basis shall be observed. Inductive flow sensors shall be of alternating field or pulsating DC field type and be for inline installation with a pipe.

The tube lining material shall be as required for the fluid and its temperature and be as specified in other chapters of this **Section B0**. The accuracy shall be 1% of the calibrated span. An overpressure security shall be provided of 50% above the maximum pressure range.

Coriolis measurements shall be used for mass flow measurements of homogenous liquids and gases without solids content in completely filled pipes, in particular for natural gases, fuel oils and solvents as well as other media with fluctuating densities. The accuracy shall be typically at 0.5% of the measured value.

B0.6.19.12 Level measurements

Where detection of discrete levels is required, the simple float operated switch should be used, however each switch shall have snap action with limited hysteresis to prevent contact bounce caused by small fluctuations in level. For sumps the level should be measured using non-contactive measuring principles such as ultra sonic with local control box.

Switches used for level detection shall provide facilities for testing the mechanical and electrical operation of the switch without its removal from the process. Isolation by means of shut-off valve will be allowable during testing.

Generally, the use of switches shall be avoided. Instead limit values shall be derived from analog transmitters.

For measurement of large storage tanks, the load indication and transmitting mechanism shall be located at the base of the tank.

For the measurements of boiler separator water level, feed water tank levels etc., differential pressure transmitters shall preferably be used.

The transmitters shall be as specified under **Section B0**.

For special applications such as chemical tanks, techniques such as ultrasonic, radar, capacitance probes, etc. should be considered. For level measurement in tanks with underpressure (vacuum) guided wave radar shall be used.

For level measurement of the fabric filter (FF) hopper dust radio frequency (RF) / Capacitance type level switch can be considered.



For measurements where a reference leg of process fluid is used, the design of the system shall ensure that the reference leg is fully maintained at its prescribed height during all conditions of process level change and changes in process conditions and the density of the reference leg does not vary from that of the process fluid due to temperature changes or other reasons.

All measurement transmitters for differential pressure shall be provided with:

- a. shut-off valves to be arranged directly at the condensing vessels and active pressure tapping points
- b. valve blocks enabling the transmitter to be isolated from the active pressure and enabling the transmitter zero point to be checked
- c. separate blow-off valves for cleaning the active pressure tubes.
- d. 2 ways for relative pressure, 5 ways for DP.

The aforementioned valves shall be of the weld-in type.

Where a standpipe exists, the level transmitters or level switches must be connected to the standpipe by means of shut-off valves, so that the units can be replaced easily in service.

Local level indicators for water shall be provided with an illumination device and indicators shall be designed so that the water column can be seen as whole, i.e. level indicators only showing the level as a point will not be accepted. Level indicators shall be equipped with shut-off valves which permit exchange or replacement of glasses or mica during operation.

The indicating range of local level indicators shall cover all switching points of level switches mounted on the tank or similar as a minimum requirement.

On all forms of measurement all parts of the switch, transmitter, etc. in contact with the process fluid shall be made of material compatible with the process fluid. Stainless steel shall normally be used for all corrosive duties.

B0.6.19.13 Analysers and monitoring systems

B0.6.19.13.1 Analyses of steam and water (SWAS)

The steam and water analyzer core instruments shall comply with EPRI (Electric Power Research Centre Inc.) guidelines.

The main analyzers for steam and water shall be arranged in groups in such a way that excessively long process pipes will not be necessary.

