

Project: 400kV GIS Switchyard at Singrauli Super Thermal Power Project Stage III (2800MW)
 Customer: NTPC Ltd.
 Ref. No. NTPC/GIS/PQR REV00

5.13 400kV GIS SWITCHYARD

Technical Qualifying Requirements for 400kV Gas Insulated Switchgear (GIS)

ROUTE - I:

- 5.13.1 The Bidder/Sub vendor should have designed, manufactured, erected/supervised erection, tested/ supervised testing and commissioned/ supervised commissioning of one (1) Gas Insulated Switchgear (GIS) equipment(s) installation having at least TWO (2) bays of 400kV or above voltage class with short circuit current of not less than 40 kA for 1 second, which should have been in successful operation for minimum two (2) years, prior to the date of tech-commercial bid opening (i.e. 22.12.2023).

ROUTE - II:

- 5.13.2(a) The Bidder/Sub vendor should have designed, constructed/erected, tested and commissioned one (1) Air Insulated Substation/ Switchyard of 400 kV or above voltage class having at least six (6) bays which should have been in successful operation for a minimum period of two (2) years, prior to the date of tech-commercial bid opening (i.e. 22.12.2023).

AND

- 5.13.2(b) The Bidder/Sub vendor associates with a GIS manufacturer for sourcing of GIS equipment who meets the requirement indicated at 5.13.1 above. The associate will also be fully responsible for the performance of the GIS portion of the contract.

In such an event the Bidder shall arrange a Letter of Technical Support to this effect from its Associate as per the format enclosed in the bidding document. This Letter of Technical Support should be submitted prior to the placement of order on approved vendor.

ROUTE - III:

- 5.13.2 The Bidder/Sub vendor should have established manufacturing facilities for GIS equipment in India based on technological support of an associate (who meets the requirement at 5.13.1 above) and Bidder/Sub vendor should have designed, manufactured, and supplied one (1) Gas Insulated Switchgear (GIS) equipment(s) installation having at least TWO (2) bays of 400kV or above voltage class. The associate will be fully responsible for the performance of the GIS portion of the contract.

In such an event the Bidder shall arrange a Letter of Technical Support to this effect from its Associate as per the format enclosed in the bidding document. This Letter of Technical Support should be submitted prior to the placement of order on approved vendor.

Note:

- 1) For the purpose of qualifying requirement, one no. of bay shall be considered as a comprising of at least one circuit breaker, two disconnectors and single-phase current transformers.
- 2) Bidder/ Sub vendor shall provide duly filled, signed and stamped copy of ATTACHMENT 3K- DOCUMENT(SWITCHYARD) (Copy of format is attached) with this document at the time of tech-commercial bid submission.

Prepared by
[Signature]
 10/10/24

Checked by
[Signature]
 10/10/24

Approved by
[Signature]
 10/10/24

[Signature]
 14/10/24

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SINGRULI SUPER THERMAL POWER PROJECT STAGE-III
(2X800MW) EPC PACKAGE

(Experience Details - Applicable to all the Bidders)

ATTACHMENT 3K- DOCUMENT(SWITCHYARD) :

Sub: Sub-Qualifying Requirements for 400KV GIS Switchyard : (Route-I)

In order to satisfy the requirement of as indicated in Technical Specification, Clause No. 5.13.I of Sub-Section-IA, Part-A, Section-VI, We/ Sub vendor hereby confirm that M/s..... is the Bidder / Sub vendor have designed, manufactured, erected/ supervised erection, tested/ supervised testing and commissioned/ supervised commissioning of one (1) Gas Insulated Switchgear (GIS) equipment(s) installation having at least six (6) bays of 400kV or above voltage class with short circuit current of not less than 40 kA for 1 sec as per stipulated requirements mentioned under Clause no. 5.13.1 of Sub-Section-IA, Part-A, Section-VI of Bidding documents. The details of above are as under:

Sl. No.	Item Description	Details
1.	Name and Address of Bidder /sub vendor and Name of contact person with email ID, Telephone & Fax Nos.	
2.	Client Name and its Address, including Tel. No. and Fax no.	
3	Name of the plant / project & its location for which the Bidder / Subvendor have designed, constructed / erected, tested and commissioned one (1) Gas insulated Switchgear (GIS) Substation installation having at least six (6) bays of 400kV or above voltage class with short circuit current of not less than 40 kA for 1 sec .	
4.	Name and designation of the responsible person in Clients organisation.	
5	Name & locatin of the substation / switchyard	
6.	i)Contract No. & Date	
	ii)Brief scope of work	
	iii) Value of Order	
07	Scope of work for the aforesaid contract includes the following for Bidder /sub vendor	

Signature of authorized signatory.....

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	(i) Manufactured	Yes/No
	(ii) Supplied	Yes/No
	iii)Type test	Yes/No
	iv)Constrction / Erection	Yes/No
	v)Testing	Yes/No
	vi)Commissioning	Yes/No
08	Details of 400kV or above Bays:	
	i)Voltage Level (in KV)	
	ii) No of Bays	
	iii) Short Circuit current rating (in kA for 1 Sec.)	
	iv)Whether GIS insulated Substation/Switchyard or not	Yes/No
09	Date of Commissioning	
10	Date of commencement of successful Operation & No of years of service	
112	Whether one (1) GIS insulated substation of 400kV or above voltage class having at least Six(6) bays which should have been in successful operation for a minimum period of two(2) years prior to the date of Tech-commercial bid opening .	Yes / No
11.	Client(s) certificate(s) enclosed in support of stated experience above at Annexure.....to this Attachment-3K.(Use separate sheet for each experience/Contract)	YES* / NO*

Note :

Signature of authorized signatory.....

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1. For the purpose of qualifying requirement, one no. of bay shall be considered as a bay comprising of at least one circuit breaker, two disconnectors and three single phase current transformer.
2. Bidder May give details of more than one installation for Employer's reference, if he so desires.

*Bidder to strike-off whichever is not applicable.

Date :
 (Signature).....

Place : (Printed Name).....

(Designation).....

(Common Seal).....

Route-II:

In order to satisfy the requirement of as indicated in Technical Specification, Clause No. 5.13.2(a) of Sub-Section-IA, Part-A, Section-VI, We/ Sub vendor hereby confirm that M/s..... is the Bidder / Sub vendor have designed, manufactured, erected/ supervised erection, tested/ supervised testing and commissioned/ supervised commissioning one (1) Air Insulated Substation/ Switchyard of 400 kV or above voltage class having at least six (6) bays which should have been in successful operation for a minimum period of two(2) years as per stipulated requirements mentioned under Clause no. 5.13.2(a) of Sub-Section-IA, Part-A, Section-VI of Bidding documents. The details of above are as under:

Sl. No.	Item Description	Details
1.	Name and Address of Bidder /sub vendor and Name of contact person with email ID, Telephone & Fax Nos.	

Signature of authorized signatory.....

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2.	Client Name and its Address, including Tel. No. and Fax no.	
3	Name of the plant / project & its location for which the Bidder / Subvendor have designed, constructed / erected, tested and commissioned one (1) Air insulated substation of 400kV or above voltage class having at least Six (6) bays.	
4.	Name and designation of the responsible person in Clients organisation.	
5	Name & locatin of the substation / switchyard	
6.	i)Contract No. & Date	
	ii)Brief scope of work	
	iii) Value of Order	
07	Scope of work for the aforesaid contract includes the following for Bidder /sub vendor	
	(i) Manufactured	Yes/No
	(ii) Supplied	Yes/No
	iii)Type test	Yes/No
	iv)Constrction / Erection	Yes/No
	v)Testing	Yes/No
	vi)Commissioning	Yes/No
08	Details of 400kV or above Bays:	
	i)Voltage Level (in KV)	
	ii) No of Bays	
	iii) Short Circuit current rating (in kA for 1 Sec.)	
	iv)Whether Air insulated Substation/Switchyard or not	Yes/No
09	Date of Commissioning	

Signature of authorized signatory.....

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10	Date of commencement of successful Operation & No of years of service	
112	Whether one (1) Air insulated substation of 400kV or above voltage class having at least Six(6) bays which should have been in successful operation for a minimum period of two(2) years prior to the date of Tech-commercial bid opening .	Yes / No
11.	Client(s) certificate(s) enclosed in support of stated experience above at Annexure.....to this Attachment-3K.(Use separate sheet for each experience/Contract)	YES* / NO*

Note :

- i) For the purpose of qualifying requirement, one no. of bay shall be considered as a bay comprising of at least one circuit breaker, two disconnectors and three single phase current transformer.
- ii) Bidder May gove details of more than one installation for Employer's reference, if he so desires.

*Bidder to strike-off whichever is not applicable.

Date :
 (Signature).....

Place : (Printed Name).....

(Designation).....

(Common Seal).....

Signature of authorized signatory.....

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In order to satisfy the requirement of as indicated in Technical Specification, Clause No. 5.13.2(b) of Sub-Section-IA, Part-A, Section-VI, We/ Sub vendor hereby confirm that M/s..... is the associates with a GIS manufacturer for sourcing of GIS equipments who meets the requirement indicated at 5.13.1 above. The associate will also be fully responsible for the performance of the GIS portion of the contract.

In such an event the Bidder shall arrange a Letter of Technical Support to this effect from its Associate as per the format enclosed in the bidding document. This Letter of Technical Support should be submitted prior to the placement of order on approved vendor.

Sl. No.	Item Description	Details
1.	Name and Address of associate and Name of contact person with email ID, Telephone & Fax Nos.	
2.	Client Name and its Address, including Tel. No. and Fax no.	
3	Name of the plant / project & its location for which the Bidder / Subvendor have designed, constructed / erected, tested and commissioned one (1) GIS insulated substation of 400kV or above voltage class having at least Six (6) bays. with short circuit current of not less than 40 kA for 1 sec .	
4.	Name and designation of the responsible person in Clients organisation.	
5	Name & locatin of the substation / switchyard	
6.	i)Contract No. & Date	
	ii)Brief scope of work	
	iii) Value of Order	
07	Scope of work for the aforesaid contract includes the following for Bidder /sub vendor	

Signature of authorized signatory.....

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	(i) Manufactured	Yes/No
	(ii) Supplied	Yes/No
	iii)Type test	Yes/No
	iv)Constrction / Erection	Yes/No
	v)Testing	Yes/No
	vi)Commissioning	Yes/No
08	Details of 400kV or above Bays:	
	i)Voltage Level (in KV)	
	ii) No of Bays	
	iii) Short Circuit current rating (in kA for 1 Sec.)	
	iii)Whether GIS insulated Substation/Switchyard or not	Yes/No
09	Date of Commissioning	
10	Date of commencement of successful Operation & No of years of service	
112	Whether one (1) GIS insulated substation of 400kV or above voltage class having at least Six(6) bays which should have been in successful operation for a minimum period of two(2) years prior to the date of Tech-commercial bid opening .	Yes / No
11.	Client(s) certificate(s) enclosed in support of stated experience above at Annexure.....to this Attachment-3K.(Use separate sheet for each experience/Contract)	YES* / NO*

Note :

Signature of authorized signatory.....

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i)For the purpose of qualifying requirement, one no. of bay shall be considered as a bay comprising of at least one circuit breaker, two disconnectors and three single phase current transformer.

ii)Bidder May give details of more than one installation for Employer's reference, if he so desires.

*Bidder to strike-off whichever is not applicable.

Date :
 (Signature).....

Place : (Printed Name).....

(Designation).....

(Common Seal).....

ROUTE-III:

We have established manufacturing facilities for GIS Equipment in India based on technological support of an associate M/s Who meet the requirements specified in clause no. 5.13.1 of Sub-Section-IA, Part-A, Section-VI of Bidding Documents and in support of same we give the following details:

We the Bidder/Sub vendor have established manufacturing facilities for GIS equipment in India based on technological support of an associate (who meets the requirement at 5.13.1 above) and Bidder/Sub vendor should have designed, manufactured, and supplied one (1) Gas Insulated Switchgear (GIS) equipment(s) installation having at least six (6) bays of 400kV or above voltage class. The associate will be fully responsible for the performance of the GIS portion of the contract.

Signature of authorized signatory.....

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In such an event the Bidder shall arrange a Letter of Technical Support to this effect from its Associate as per the format enclosed in the bidding document. This Letter of Technical Support should be submitted prior to the placement of order on approved vendor as per stipulated requirements mentioned under Clause no. 5.13.3 of Sub-Section-IA, Part-A, Section-VI of Bidding documents. The details of above are as under:

For Bidder/sub-vendor's having GIS Manufacturing facility in India:

Sl. No.	Item Description	Details
1	Name & Location of the GIS manufacturing facilities	
2.	Name of contact person with email ID, Telephone & Fax Nos of GIS manufacturing facility.	
3	Name and address of the associate providing technological support with Telephone, Fax and email etc	
4	Whether manufacturing facility for GIS available in India based on technological support of Associate.	Yes*/ No*
5	Name of the plant / project & its location for which the Bidder / Subvendor have designed, constructed / erected, tested and commissioned one (1) GIS insulated substation of 400kV or above voltage class having at least Six (6) bays. with short circuit current of not less than 40 kA for 1 sec .	
4.	Name and designation of the responsible person in Clients organisation.	
5	Name & locatin of the substation / switchyard	
6.	i)Contract No. & Date	
	ii)Brief scope of work	
	iii) Value of Order	
07	Scope of work for the aforesaid contract includes the following for Bidder /sub vendor	
	(i) Manufactured	Yes/No
	(ii) Supplied	Yes/No
	iii)Type test	Yes/No

Signature of authorized signatory.....

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	iv)Construction / Erection	Yes/No
	v)Testing	Yes/No
	vi)Commissioning	Yes/No
08	Details of 400kV or above Bays:	
	i)Voltage Level (in KV)	
	ii) No of Bays	
	iii) Short Circuit current rating (in kA for 1 Sec.)	
	iii)Whether GIS insulated Substation/Switchyard or not	Yes/No
09	Date of Commissioning	
10	Date of commencement of successful Operation & No of years of service	
112	Whether one (1) GIS insulated substation of 400kV or above voltage class having at least Six(6) bays which should have been in successful operation for a minimum period of two(2) years prior to the date of Tech-commercial bid opening .	Yes / No
11.	Client(s) certificate(s) enclosed in support of stated experience above at Annexure.....to this Attachment-3K.(Use separate sheet for each experience/Contract)	YES* / NO*

Note :

i)For the purpose of qualifying requirement, one no. of bay shall be considered as a bay comprising of at least one circuit breaker, two disconnectors and three single phase current transformer.

ii)Bidder May give details of more than one installation for Employer's reference, if he so desires.

Signature of authorized signatory.....

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*Bidder to strike-off whichever is not applicable.

Date :
(Signature).....

Place : (Printed Name).....

(Designation).....

(Common Seal).....

Signature of authorized signatory.....

**SUPPORT FOR SATISFACTORY PERFORMANCE OF 400kV GIS FOR SONGRULI-III
STPP(2X800MW)**

TO:

[EMPLOYER'S NAME & ADDRESS]

Sub: Letter of Support submitted From(name of the Associate) undertaking the responsibility for satisfactory performance of 400kV GIS.

Dear Sirs,

1. In accordance with the Award of the Contract by (Name of the Contractor) to M/s. (Name of the sub-vendor), we, the aforesaid Associate, (M/s) shall be fully responsible for the satisfactory performance of the 400kV GIS.
2. Further, the manner of achieving the objective set forth in point 1 above shall be as follows For (Equipment name):
 - (d) We the Associate shall be fully responsible for design, engineering, manufacture, assembly, testing and inspection at manufacturer's works before despatch, packing, insurance, supply, transportation, delivery to project site, handling, storage and preservation at site store, transportation to place of installations, complete work of site assembly, erection, testing at site and commissioning of 400 KV GIS Equipment and putting into satisfactory operation.
 - (e) Further, we shall depute our technical experts from time to time to the Contractor's/*Sub-Vendor's works/Employer's project site as and when necessary to facilitate the successful performance of the 400 KV GIS.
 - (f) Further, We shall ensure proper design, manufacture, supply, installation, testing and commissioning for the successful performance of the 400 KV GIS Equipment covered under the said Contract in accordance with stipulations of Bidding Documents and if necessary the we shall advise the Contractor/*Sub-Vendor suitable modifications of design and implement necessary corrective measures to discharge the obligations under the contract.
 - (g) We shall participate in Technical Co-ordination meetings (TCMs) from time to time, as and when required by Employer.

Signature of authorized signatory.....

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- (h) We shall promptly carry out all the corrective measures and shall promptly provide corrected design and shall undertake replacements, rectifications or modifications to the equipment as and when required by Employer in case the equipment fails to demonstrate successful performance as per contract at site.
3. We, the Associate do hereby undertake and confirm that this Letter of Support shall be valid till 90(ninety) days after the end of the defect liability period of the contract.

Representative:.....

Signature of the Authorised

For M/s

(Associate)

Name

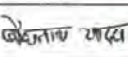
Designation

Date:.....

Common Seal of the Company

***: Strike off whichever is not applicable.**

Signature of authorized signatory.....

	BHARAT HEAVY ELECTRICALS LIMITED TRANSMISSION BUSINESS ENGINEERING MANAGEMENT NOIDA					
	DOCUMENT NO.	TB-429-316-001	REV 00	Prepared	Checked	Approved
	TYPE OF DOC.	TECHNICAL SPECIFICATION	NAME	BY	AK	DKS
	Title: 400kV Gas Insulated Switchgear & its accessories		SIGN			
			DATE	09.10.24	09.10.24	09.10.24
			GROUP	TBEM		
			WO No.	CS-1150-001(R)-2-FC-NOA-7407 dtd. 05.03.2024		
	CUSTOMER	NTPC Ltd.				
	PROJECT	400kV GIS Switchyard at Singrauli Super Thermal Power Project Stage-III (2x800MW)				
	<u>Contents</u>					
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	Annexure-A: Compliance Certificate to Technical Specification					
	Annexure-B: Deviation/ Change Request to Technical Specification					
	Annexure-C: Guaranteed Technical Particulars					
	Annexure-D: Technical Checklist					
Remarks: Bidder to note that data and details of guaranteed technical particulars shall not be reviewed during technical evaluation/ scrutiny, hence compliance of guaranteed technical particulars in line with technical specification shall be bidder's responsibility.						
	Rev. No.	Date	Altered	Checked	Approved	
Distribution				To		
				Copies		

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Bharat Heavy Electricals Limited**Project:** 400kV GIS Switchyard at Singrauli Super Thermal Power Project Stage- III (2x800MW)**Customer:** NTPC Ltd.**Technical Specification:** 400kV Gas Insulated Switchgear & its accessories**Doc No.** TB-429-316-001 **Rev** 00**Contents**

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Bharat Heavy Electricals Limited**Project:** 400kV GIS Switchyard at Singrauli Super Thermal Power Project Stage- III (2x800MW)**Customer:** NTPC Ltd.**Technical Specification:** 400kV Gas Insulated Switchgear & its accessories**Doc No.** TB-429-316-001 **Rev** 00**SECTION 1:****SCOPE, PROJECT SPECIFIC TECHNICAL REQUIREMENTS & BILL OF QUANTITIES****1. Scope & Intent of Specification**

This technical specification covers the requirements of design, manufacture, inspection and testing at manufacturer's works, proper packing and delivery to project site, supervision of unloading and verification of material at site, supervision of installation, site testing and commissioning along with necessary equipment, training of BHEL/ NTPC personnel for 400kV Gas Insulated Switchgear as per the specification complete in all respect for efficient & trouble free operation mentioned under this specification with all auxiliaries, accessories and spare parts.

Hence, the electrical scope of work under this requisition shall include but not be limited to basic and detailed engineering, as required, manufacturing, supply, transportation to site, inspection at manufacturer's work, supervision of installation only and site testing and commissioning along with necessary equipment, training, insulation coordination studies, supply of all mandatory spares, commissioning spares, special tools and tackles as defined in the equipment data sheet, drawings, standard specifications, standards and BOQ etc. attached or referred with technical specification.

This section covers the specific technical requirements of 400kV Gas Insulated Switchgear. This constitutes minimum technical parameters for the above item as specified by NTPC. The offered 400kV Gas Insulated Switchgear shall also comply with the Section-3 (Project Details and General technical requirements for all equipment under the Project) of this specification.

The specification comprises of following sections:

Section-1	:	Scope, Project Specific Technical Requirements & Bill of Quantities
Section-2	:	Equipment Specification under scope of Supplies/ Service
Section-3	:	Project Details & General Technical Requirements (For all Equipment under the Project)
Section-4	:	Annexures
		Annexure-A: Compliance Certificate to Technical Specification
		Annexure-B: Deviation/ Change Request to Technical Specification
		Annexure-C: Guaranteed Technical Particulars
		Annexure D- Technical Checklist

The following order of priority shall be followed. In case of conflict between requirements specified in various documents, the more stringent one shall be followed. BHEL/ NTPC concurrence shall, however, be obtained before taking a final decision in such matters.

1. Statutory Regulations

In particular, the latest version of the following statutory regulations, as applicable, shall be followed for system,

- o Indian Electricity Act
- o CEA regulations
- o The Factory Act
- o Requirements of other statutory bodies as applicable, e.g. CEA etc.

2. Section-1**3. Section-2****4. Section-3****5. Codes & Standards**

Bidder shall furnish list of conflicts/ ambiguities/ deviations, if any, along with their technical offer and also furnish the basis that is considered for submitting technical offer. BHEL/ NTPC will resolve

Bharat Heavy Electricals Limited**Project:** 400kV GIS Switchyard at Singrauli Super Thermal Power Project Stage- III (2x800MW)**Customer:** NTPC Ltd.**Technical Specification:** 400kV Gas Insulated Switchgear & its accessories**Doc No.** TB-429-316-001 **Rev** 00

listed conflicts prior to award. In case of ambiguity, bidder shall inform BHEL/ NTPC of their interpretation. In case bidder fails to convey the same prior to award, BHEL/ NTPC decision on interpretation shall be considered final if need arises during the execution. No additional cost or extra time on account of conflicts/ ambiguities/ deviations shall be admissible.

In general, no deviation from the requirements specified in various clauses of this specification shall be allowed and hence, a certificate to this effect shall have to be furnished along with the offer (Annexure-A), however bidder shall furnish list of conflicts/ ambiguities/ deviations (Annexure-B), if any. Any conflicts/ ambiguities/ deviations mentioned elsewhere in technical offer shall not be reviewed.

The Bidder shall be deemed to have understood completely all the tender drawings and documents and quoted accordingly.

It is not the intent to specify herein all the details of design and manufacture. However, the equipment shall conform in all respect to high standards of design, engineering and workmanship and shall be capable of performing the required duties in a manner acceptable to Purchaser / Owner, who will interpret the meaning of drawings and specifications and shall be entitled to reject any work or material, which in his/their judgment is not in full accordance with the specifications.

The equipment (**400kV Gas Insulated Switchgear & its accessories**) is required for the following project:

Name of the Customer	:	NTPC Ltd.
Name of Main Contractor	:	Bharat Heavy Electricals Limited
Name of the Project	:	400kV GIS Switchyard at Singrauli Super Thermal Power Project Stage- III (2x800MW)

The scope of supplies shall be as per commercial terms and conditions enclosed separately with the notice inviting tender/ enquiry.

2. Codes & Standards

The equipment (**400kV Gas Insulated Switchgear & its accessories**) shall comply with the latest edition of the following standards as applicable,

IEC 56-1/6	AC High Voltage circuit breaker
IEC 68-3	Seismic test methods for equipments
IEC 129	Alternating Current Dis-connectors & Earthing Switches
IEC 60137	Insulated bushings for alternating voltages above 1000 V
IEC 62271-1	High voltage switchgear and control gear Part 1: Common clauses for high voltage Switchgear and control-gear standards
IEC 62271-100	High voltage switchgear and control gear Part 100: High voltage alternating current Circuit breakers
IEC 62271-101	High voltage switchgear and control gear Part 101: Synthetic testing disconnections, earthing switches
IEC 62271-102	High voltage switchgear and control gear Part 102: Alternating current disconnections (isolators) and earthing switches
IEC 62271-203	Gas Insulated metal-enclosed switchgear for rated voltages above 52KV
IEC 62271-207	Seismic qualification for gas-insulated switchgear assemblies for rated voltages above 52kV
IEC 62271-303	High voltage switchgear and control gear- Gas Insulated metal-enclosed switchgear for rated voltages above 52KV
IEC 61000	Electromagnetic compatibility (EMC)

Bharat Heavy Electricals Limited**Project:** 400kV GIS Switchyard at Singrauli Super Thermal Power Project Stage- III (2x800MW)**Customer:** NTPC Ltd.**Technical Specification:** 400kV Gas Insulated Switchgear & its accessories**Doc No.** TB-429-316-001 **Rev** 00

IEC 60060	High voltage test techniques
IEC 60071	Insulation coordination
IEC 60255	Electrical relays
IEC 60265	High voltage switches
IEC 60270	High voltage test techniques- Partial discharge measurements
IEC 60376	Specification and acceptance of new sulphur hexafluoride
IEC 60480	Guide to checking of sulphur hexafluoride taken from electrical equipment
IEC 60529	Degrees of protection provided by enclosures (IP code)
IEC 60815	Guide for the selection of insulators in respect of polluted conditions
IEC 61869	Instrument transformers
IEC 60044-1	Current transformers
IEC 60044-2	Voltage transformers
IEC 60099-1/4	Non-linear resistor type arresters for AC systems
IEC 61439-1	Low voltage switchgear and control gear assemblies Part1- General rules EMC
IEEE 80-2000/	
IEC 60364/	Standards for Substation grounding
60479/ 60621	
CIGRE-44	Earthing of GIS- an application guide

The equipment may conform to the standards of the country of manufacture, provided these standards are based on, or equivalent or better to the above referred standards. The bidder proposing any other standards than the above referred standards must specifically indicate the standards to which the switchgear conforms. The bidder is required to furnish the English version copy of all the standards.

3. Specific Technical Requirements

Specific technical requirements for the equipment (**400kV Gas Insulated Switchgear & its accessories**) shall be as follows,

Sl. No.	Description	Technical Parameters
1.	Type of GIS	Indoor type, metal enclosed, SF6 gas insulated switchgear (Single Phase segregated type)
2.	Location	Place: Singrauli District: Sonbhadra State: Uttar Pradesh
3.	Design ambient temperature	50°C
4.	Maximum Relative humidity	95%
5.	Nominal voltage class	400kVrms
6.	Maximum System Voltage	420kVrms
7.	Lightning Impulse Withstand Voltage	±1425kVpeak
8.	Switching Impulse Withstand Voltage	±1050kVpeak
9.	Power Frequency Withstand (for 1 min rms) Phase to Earth & Between Phases	650kVrms
10.	Maximum Fault Level (1 second)	63kA
11.	Dynamic Withstand Current	157.5kApeak

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12.	Rated Continuous Current Capacity (Bay)	3150A
13.	Rated Continuous Current Capacity (Bus), Minimum	4000A
14.	Leakage Rate of SF ₆ Per Annum for Each Compartment Individually as well as Complete Installation, Maximum	Not More than 0.5% per year
15.	PD Level for GIS/ Partial discharge level for complete bay	<5pC
16.	Rated frequency	50 Hz
17.	Number of phases	3 nos.
18.	Type of Earthing	Solidly grounded/ Effectively earthed
19.	Duty Cycle of Circuit Breaker	0 – 0.3 sec – CO – 3 min – CO
20.	Operating mechanism of circuit breaker	Pneumatic/Spring/Hydraulic/ a Combination of These
21.	Total number of interrupting chambers per phase of 400kV Circuit breaker	One no.
22.	Enclosure	Aluminium Alloy
23.	Minimum total creepage distance for outdoor equipment	13020mm (31mm/kV)
24.	3 phase AC power supply	415V±10%, 50 (+3% -5%), 3-phase 4 wire
25.	1 phase AC power supply	240V±10%, 50 (+3% -5%), 1-phase , 2 wire
26.	DC power supply	220V+10% to -15%, 2-wire ungrounded

Notes:

1. All current carrying components of the equipment specified shall be capable of continuous operation at the specified rated current without exceeding the maximum temperature rise specified in the relevant IEC standards.
2. Thermal calculations shall be based on the climatic conditions as per technical specification.
3. Bidder shall offer their latest type tested compact model to accommodate in the specified & allocated space. In case, bidder fails to meet above requirement, its technical offer is liable for non-evaluation.
4. Bidder shall conduct insulation co-ordination & very fast transient overvoltage (VFTO) studies in line with IEC 60071 for establishing suitability of surge arrester rating, and any other technical requirement for successful operation of GIS. Prices if VFTO study shall be included in the price quoted for Insulation Co-ordination Study.
5. Bidder shall check and ensure adequacy of system protection for successful operation of GIS. After checking of system by bidder, GIS shall be installed and if any failure, malfunction of any part occurs after/ during commissioning, same shall be replaced immediately without any extra cost.
6. Bidder shall submit 3D model (surface model/ light weight model) compatible with Primtech/ any other 3D software for complete GIS and its accessories.
7. GIS building shall have EOT (Electric overhead travel) crane of capacity of maximum 8T safe working load and height of crane shall be 9.5meters from GIS floor level. The EOT crane will be

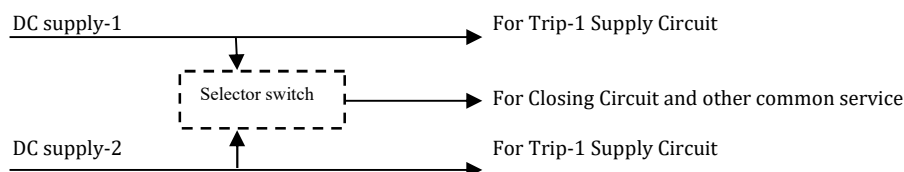
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- provided by BHEL, however, bidder shall provide all other technical requirements for EOT crane for suitability of crane for installation and maintenance of GIS including EOT crane capacity calculations etc.
8. Bidder to quote the prices of complete 3 phase GIS bus bar (2 sets for two nos. 3 phase bus bar) in the BOQ line item mentioned as **"Busbar GIS module"**.
 9. However, during detailed engineering if there is any change in the length of bus bar due to reasons not attributed to bidder, payment of additional length of bus bar shall be covered as per actual length under the BOQ line item mentioned as **"GIS Bus bar Extension Module"**.
 10. BOQ line item mentioned as **"GIS Bus bar Extension Module"** shall be applicable **ONLY IN** case where shifting of GIS bays is called for by BHEL/ NTPC (during contract stage/ detailed engineering stage) due to layout requirement /cost optimization / revision / change in civil architectural requirement or due to building column fouling/ expansion joint requirement in the GIS building, Bidder to incorporate the same with full compliance of technical requirement. Bidder to note that the item quantity shall be reduced to **ZERO** if no change is done on account of reasons not attributed to BHEL/ NTPC.
 11. In case of any change in bus bar length or any other connection/ extension module is proposed by bidder on its own/ or due to reasons not attributed to BHEL/ NTPC, no additional cost implication shall be admissible.
 12. Bidder shall include painting and marking of all buses, individual incomers, all outgoing feeders etc. with details such as tag no., feeder rating, sending end source reference etc.
 13. All supporting structures including foundation bolts/ fixing bolts/ embedded plate/rails/ chemical anchor bolts and hardware etc. required for fixing and erection of GIS and bus duct shall be in bidder's scope.
 14. Bidder shall submit the drawings of structure along with BOM.
 15. Fixing and erection of GIS duct in GIS building and outside of GIS building including foundation/ fixing bolts/ embedded plate/ rail shall be in bidder scope of supply.
 16. All hardware and structure required for fixing and erection of GIS on GIS floor including foundation bolts/ fixing bolts/ embedded plate/ rail/ wall sealing plates shall be in bidder scope of supply.
 17. All supporting structures including foundation bolts/ fixing bolts/ embedded plate/ chemical anchor bolts and hardware etc. for SF6 to air bushing shall be in Bidders' scope.
 18. Bidder shall ensure installation/ supervision of installation, testing and commissioning any subsystem of GIS, including online gas monitoring/ partial discharge system etc.
 19. The quantification including details, supply and supervision of installation of interconnecting cables including cable tags, glands, ferrules, lugs etc. between GIS to LCC and between LCC to LCC shall be in the scope of bidder.
 20. GIS shall be designed in such a way that suitable walkways are provided all around the switchgears so that the operators will be able to have free access to all the operating mechanism.
 21. GIS Equipment shall be complete with all necessary supports, ladders, galleries, staircases, catwalks, movable platforms or walkways (for accessing the equipment above two meters for maintenance and operation), mechanism cabinets, internal cable raceways etc. for each bay and it shall be of modular construction and extendable design.
 22. Each end of the main bus bars of GIS shall be designed for convenient future extension of the switchgear and related technical details shall be provided by bidder to meet the requirements of other make /GIS supplier.
 23. Controlled Switching Device (CSD) shall be supplied for ST/Reactor/associated Tie Bay Circuit breakers. CSD shall be mounted in respective GIS Bay LCC Panels. Special cable, if required for integration is deemed to be included in bidder's scope. The CSD shall be type tested as per EN/ IEC 61000-4-16 & IEC 60255 and other relevant standard as mentioned in the specification.
 - For online continuous partial discharge monitoring system, the requirement of any structure materials, hardware, cabling work and other associated items etc. for

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completion of complete system (i.e. for 400kV GIS) shall be in the scope of bidder. The online PD system shall have provision (necessary compatible ports etc.) for integration with Substation Automation System (SAS based on IEC 61850 Edition 2). Tentative distance between 400kV GIS Building & SAS room shall be 200 m.

24. The DC distribution logic for LCC panels shall be as follows,



25. A state-of-the art Partial Discharge Monitoring system shall be provided to monitor the entire GIS installation. An on-line continuous Partial Discharge Monitoring (PDM) system shall be designed to provide an automatic facility for the simultaneous collection of PD data at multiple points on the GIS & its associated GIB ducts and Voltage Transformers adopting UHF technique. The data stored shall provide a historical record of the progress of PD sources and shall identify the areas of maximum activity.
26. GIS shall have in Built UHF Based Sensors for On-Line PD Measurement for ready Connection and interfacing with a continuous on-Line PD Measurement System. These shall be a definite scope of supply and the number and location of PD Sensors built in the GIS Equipment supplied shall be supported with the necessary documentation for confirming the sufficiency/ adequacy of the PD sensors provided, considering the coverage of all portions of the GIS equipment.
27. All steel structure members shall be hot-dip galvanized after fabrication. All field assembly joints shall be bolted. Field welding shall not be acceptable. Noncorrosive metal or plated steel shall be used for bolts and nuts throughout the work. Manufacturer shall provide suitable foundation channels and anchor bolts to support the switchgear assemblies. All mounting bolts, nuts and washers shall be provided to fasten the switchgear base frames to the foundation channels.

4. Other General Requirements

The other general requirements for the equipment (**400kV Gas Insulated Switchgear & its accessories**) shall be as follows,

1. Schedule

- Bidder shall submit detailed activity schedule for engineering approval, site installation, testing and commissioning activities.
- In addition to this, packing of GIS & its accessories shall be suitable for long term storage without any deterioration in quality and performance (min. 2 years, if required).

2. Open/ closed store

- Open/ closed store area shall be provided by BHEL, However, bidder shall provide their tentative space requirement for covered and/ or open store area during tender stage only. In addition to this, bidder shall submit their standard storage instruction manual specifically specifying the item with type of storage.
- In addition to this, bidder shall also provide their standard recommendations for precautions to be taken during unloading and storage etc. for approval of BHEL/ NTPC.
- Supervision of unloading of materials at site, supervision for storage in open/ closed store as per requirement shall be in bidder's scope.
- During storage of materials in BHEL provided open/ closed store, watch and ward shall be provided by BHEL.

3. Office facility at project site

- Office facilities including sitting arrangement, stationary, printer etc. for OEM/ bidder's staff at project site shall be in BHEL scope.

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- Arrangement of drinking water and electrical supply for official work shall be provided by BHEL, however, personal protective equipment for bidder/ OEM's staff /workers shall be in bidder's scope.
- 4. Transportation of Special Tools & Tackles, Testing Instruments
 - Transportation of special tools & tackles, testing instruments, special plant including HV test on returnable basis is deemed to be included in bidder's scope, however unloading/ loading, unpacking/ packing and shifting at working place shall be in BHEL scope.
- 5. Power supply for construction/ testing
 - For construction/ testing requirements, the necessary power supply at site shall be provided by BHEL at suitable point free of cost.
- 6. Site Installation, Testing & Commissioning
 - Special tools & tackles for installation and testing kits for testing & commissioning shall be in bidder's scope, however, it shall be brought at site on returnable basis only.
 - Bidder shall provide list of general tools, tackle, slings, spanners, gauges, slings and other lifting devices, drills, instruments, testing kits and appliances necessary for the complete assembly, installation, gas filling, maintenance, site testing of the GIS, however, it shall be arranged by BHEL/ its sub-contractor.
 - Bidder shall arrange all Consumables as per manufacturer requirement for successful erection, testing & commissioning.
 - HV test kit required for HV testing and partial discharge measurement shall be provided with operator along with valid calibration certificate by bidder on returnable basis. HV test kit may be brought at site multiple times as per site requirements, reasons not attributable to BHEL/ NTPC.
 - Bidder shall depute his qualified testing & commissioning engineer at site for successful testing and commissioning of GIS system.
 - Bidder shall submit complete methodology for conduction of site tests for further approval of BHEL/ NTPC before testing & commissioning activities.
 - GIS bays may be commissioned at different point of time depending on the site conditions and the L2 schedule for the project, and hence deployment of the resources at multiple times at site by bidder in line with actual requirement is envisaged and payment for the same shall be made to bidder, for the reasons not attributable to bidder.
- 7. Training of BHEL/ NTPC personnel
 - Training of BHEL/ NTPC personnel on 400kV GIS & its accessories shall be provided at vendor's works as well as project site. However, to & fro travelling charges, lodging and boarding charges for BHEL/ NTPC personnel shall not be borne by bidder.
- 8. Modular Design of GIS
 - The GIS switch gear shall be of modular design offering high degree of flexibility. Each module shall be complete with SF6 gas circuit breaker, disconnectors, Maintenance Grounding switches, fast Earthing switches, voltage transformers, Current transformers, bus sections, Gas Insulated Bus-duct, local control cubicle and all necessary components required for safe & reliable operation and maintenance.
 - Documents indicating sequence of repair work steps and description of necessary restrictions during work shall be submitted during detailed engineering stage.
 - Each bay module should be equipped with suitable arrangement for easy dismantling and refitting during maintenance without disturbing other units.
- 9. Future Extension of GIS
 - The GIS system shall be suitable for future extension on either end. The arrangement of gas sections or compartments shall be such as to facilitate future extension without any drilling, cutting or welding on the existing equipment. To add equipment, it shall not be necessary to move or dislocate the existing switchgear bays.
 - The layout shall ensure that GIS bus link section is provided for future extension of the

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GIS buses to avoid de-gassing and modification of the existing bus.

- The physical layout shall ensure free movement of the SF6 Gas Cart and easy access to all components of the GIS for maintenance purposes.

10. Service continuity requirements and sectionalization of GIS

- The offered GIS should completely meet the requirement of modular design & sectionalization as mentioned in Section-2 of this specification.
- The GIS equipment with the given bus switching arrangement is divided into different gas compartments. During the work such as a fault repair or major maintenance, requiring the dismantling of a gas compartment for which more than one compartment may needed to be de-gassed.
- The positioning of the circuit breaker in the GIS shall be such that it shall be possible to access the circuit breaker of any feeder from the front side for routine inspection, maintenance and repair without interfering with the operation of the adjacent feeders.
- Working conditions, method statements and procedures are to be furnished by the GIS manufacturer in order to ensure equipment and operating personnel's safety and to achieve following service continuity conditions to the extent possible in line with Annexure-F of IEC 62271-203:
 - a) During a fault in Circuit Breaker compartment, no bus-bar is permitted out of service during maintenance and repair / replacement.
 - b) During a fault in GIS compartment other than CB compartment, maximum one busbar and/or one feeder permitted out of service during maintenance and repair / replacement.

11. GIS will be placed in a non-air-conditioned building during service, however, ventilation system shall be provided.
12. Bidder shall check and ensure adequacy of the system protection for successful operation of GIS. After checking of system/site by bidder, GIS shall be installed and if any failure, malfunction of any part occurs after commissioning bidder shall replace the part unconditionally within 15 days. Further root cause analysis (RCA) shall be submitted and necessary changes to be done as per the RCA report wherever required.
13. No support structure shall be placed within 2 meters around the GIS building periphery.
14. All essential and desirable accessories are deemed inclusive of offer i.e. and not limited to Gas Monitoring Devices, Pressure Switches, PD sensors, Pressure relief device, insulator, expansion joint/ flexible, bellows/ compensators like lateral mounting units, Axial compensators, Parallel compensators, tolerance compensators and vibration compensators etc. complete in all respect.
15. Any Item not quoted mentioning "Not Applicable" in bid price schedule and found applicable as per technical specification and system requirement shall be supplied free of cost by bidder without any time / cost implication to BHEL /Customer.
16. Length & route of GIB in BOQ/BPS is purely indicative and same shall be finalized during detailed engineering stage. Bus duct lengths shall be taken from the end of bay equipment (VT, LA etc.) to termination equipment (SF6 to Air bushing). This includes indoor as well as outdoor portions of GIB. Tees/ bends/ elbows required for completion of gas insulated bus duct connection shall be treated as part of gas insulated bus duct only.
17. BHEL reserve rights to amend Bay sequence during contract stage, no separate claim shall be admissible in this regard.
18. Main Bus 1 / 2 etc. Gas Insulated Bus Bars running across the length of the switchgear to interconnect each of the bay modules (as per layout) and necessary interfaces (as applicable under the technical requirement) is deemed inclusive in the scope. The same may or may not be indicated with break-up in BOQ / BPS.

5. Earthing of GIS

The earthing of the GIS shall be carried out considering the safety requirements as per relevant standards. All parts to which access is required for maintenance work shall have provision for

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earthing. In addition, after opening of enclosure it shall be possible to have continuity of earth for the duration of work. The continuity of earthing shall be ensured considering electrical and thermal stresses caused by current they may have to carry.

- The grounding system shall be designed and provided as per IEEE-80-2013 and CIGRE-44 to protect operating staff against any hazardous touch voltages and electro-mechanical interferences.
- The Bidder shall define clearly what constitutes the main grounding bus of the GIS. The Bidder must supply, commission the entire grounding work of GIS viz conductor, clamps, joints, bimetallic strips (for connection between different type of earthing materials), operating and safety platforms etc.
- The enclosure of the GIS shall be grounded at several points so that there shall be grounded cage around all the live parts. A minimum of two nos. of grounding connections should be provided for each of circuit breaker, transformer terminals, cable terminals, surge arrestors, earth switches and at each end of the bus bars. The grounding continuity between each enclosure shall be effectively interconnected with links or straps to bridge the flanges. Subassembly-to-subassembly bonding shall be provided to provide gap & safe voltage gradients between all intentionally grounded parts of the GIS assembly & between those parts and the main grounding bus of the GIS.
- The enclosure grounding system shall be designed to minimize circulating currents and to ensure that the potential rise is kept to an acceptable level. Each marshalling box, local control panel, power and control cable sheaths and other non-current carrying metallic structures shall be connected to the grounding system of GIS via connections that are separated from GIS enclosures.
- The Bidder shall provide suitable measure to mitigate transient enclosure voltage caused by high frequency currents caused by lightning strikes, operation of surge arrester, phase/earth fault and discharges between contracts during switching operation. The grounding system shall ensure safe touch & step voltages in all the enclosures. The Bidder shall provide suitable barrier of non-linear resistor/ counter discontinued SF6/ Transformer and SF6/ HV cable bushing etc. to mitigate transient enclosure voltage.
- Only supply of MS Rod (40mm diameter for outdoor below ground earth mat) and GI Flat of 75x12 or, 50x6 mm, as recommended by bidder (for earth mesh on floor), shall be in BHEL's scope. Any other earthing material, if required, shall be in bidder's scope of supply and erection.
- GIS earthing mesh shall be extended suitably to enable connection to the outdoor switchyard earthmat.

Details of earthing system,

Items	Size	Materials
Main Earthing conductor	40mm dia rod	Mild steel
Conductor above ground & earthing leads (for equipment)	75x12mm/ 50x6mm	G.S. Flat
Rod Electrode	40mm dia, 3000mm	Mild steel
GI Earthwire	7/8 SWG	GI

Copper Flat (if required) as per requirement – In Bidder's scope

For Step and Touch Potential the following parameters shall be considered

- Current distribution factor – 1 (one)
- Duration of fault current – 1 sec
- Human body weight – 50kg

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Grid resistance shall be less than 1(one) ohm.

- Bidder to submit detailed calculations, sizing and layout drawings for earthing system during detailed engineering stage. Bidder to provide the bill of quantity for entire items required for the earthing of the GIS including the BOQ of free issue items from BHEL (as mentioned above). Installation of earth mat shall be done by BHEL under supervision of bidder/ manufacturer as per manufacturer's design. Any other earthing material except 40mm MS Rod, 75X12/50x6mm GI Flat, if required shall be in bidder's scope of supply only & bidder shall quote price for the same against the relevant item of price schedule.
- If any other special earthing including high frequency earthing etc., if required shall be in bidder's scope of supply.

6. Bill of Quantities

1. Schedule of quantities for supply & services for the equipment (**400kV Gas Insulated Switchgear & its accessories**) shall be as per **ANNEXURE- BOQ for 400kV GIS & its Accessories**. However, any supply/ service not appearing herein but required for completeness of the work is deemed to be included in bidder's scope.
2. BHEL reserves the right for quantity variation due to any reason upto **±20% of total value** at same unit rate and terms during execution of contract. The quantity of individual items may however vary up to any extent.

7. Drawings / Documents required for Technical Clearance for Manufacturing

Drawings/ documents detailed as per **Annexure B- Details for Technical Clearance for Manufacturing** shall be used for providing technical clearance for manufacturing of the equipment (**400kV Gas Insulated Switchgear & its accessories**), which shall be used for delay analysis, if applicable for respective group.

Technical clearance for manufacturing shall be issued after approval of drawings in category-I (approval without any comments)/ category-II (approval with comments) from customer/ BHEL, however it shall be sole discretion of BHEL engineering department to include/ exclude the drawing/ document earmarked for consideration for any particular Lot. In case drawing/ document are not duly stamped in category-1/ category-2 by customer, BHEL stamp in Category-1 & 2/ confirmation shall be treated final to proceed further.

Date of Submission of drawings/ documents shall be counted only from the date of submission of reasonably correct drawings/ documents.

The successful bidder shall have to extend all possible supports like timely submission/ re-submission of drawings, visit to end customer to facilitate documents approval without any commercial implications to BHEL. Acceptance of bidder's documents shall be subject to end customer/ NTPC approval.

8. Type Testing (for 400kV Circuit Breaker)

The Bidder shall carry out the type tests as listed in this specification on the equipment to be supplied under this contract. The Bidder shall indicate the charges for each of these type tests separately in the relevant schedule of BPS/ BOQ and the same shall be considered for the evaluation of bids. The type test charges shall be paid as per the charges quoted for each of these type tests separately in the relevant schedule of BPS/ BOQ & no quantity variation is allowed only for the test(s) conducted successfully under the contract and upon certification by the Employer/ customer's engineer.

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The type tests shall be carried out in the presence of the Customer's representative, for which minimum 30 days' notice shall be given by the Bidder. The Bidder shall obtain the Customer's approval for the type test procedure before conducting the type test. The type test procedure shall clearly specify the test set up, instrument to be used, procedure, acceptance norms, recording of various parameters, interval of recording, precautions to be taken etc. for the type test(s) to be carried out.

In case the bidder has conducted such specified type test(s) according to the relevant standard and / or specification as per CEA Guidelines for the validity period of Type test(s) conducted on Major Electrical equipment in power Transmission-May2020 & with latest amendments as on date of bid opening, submit the type test reports to the Employer/ customer for waiver of conductance of such type test(s). These reports should be for the test conducted on the equipment similar to those proposed to be supplied under this contract and the test(s) should have been either conducted at an independent laboratory or should have been witnessed by a Client. The Employer/ customer reserves the right to waive conducting of any or all the specified type tests(s) under this contract. In case the type tests are waived, the type test charges shall not be payable to the bidder.

Common requirements (For GIS):

The Customer will have the right of getting any test of reasonable nature carried out on any component or completely assembled equipment at Bidder's premises or at site or in any other place in addition to the aforesaid type and routine tests, to satisfy that the materials/equipment comply with the specification.

Failure of any equipment to meet the specified requirements of tests carried out at works or at site shall be sufficient cause for rejection of the equipment. Rejection of any equipment will not be held as a valid reason for delay in the completion of the works as per schedule. Bidder shall be responsible for removing all deficiencies, and supplying the equipment that meet the requirement.

All equipment with their terminal connectors, control cabinets, main protective relays, energy meters etc as well as insulators, insulator strings with hardware, clamps and connectors, marshalling boxes etc shall be subjected to routine and acceptance tests in accordance with the requirements stipulated under respective equipment sections. Charges for the same shall be deemed to be included in the equipment price.

The following type tests (as applicable) are proposed to be conducted on a complete single pole assembly of one typical GIS switchgear bay module as per IEC 62271-203: (The one Typical GIS switchgear bay module consists of equipment like Circuit breakers, Current transformers, Disconnectors / isolator, earth switches etc. of each type / rating.)

Sl. No.	List of Type tests as per IEC
--------------------	--------------------------------------

- | | |
|----|---|
| 1. | Lightning impulse voltage dry tests |
| 2. | Switching impulse voltage dry tests. |
| 3. | Power frequency voltage dry tests |
| 4. | Partial discharge tests |
| 5. | Radio Interference Voltage test (as applicable) |
| 6. | Test to prove the temperature rise of any part of the equipment and measurement of the resistance of the main circuit |
| 7. | Test to prove the ability of the main circuit and earthing circuit to carry the rated peak |

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- and the rated short time withstand current
8. Test to verify the making and breaking capacity of the included switching devices.
 9. Test for satisfactory operation of the included switching devices
 10. Test to prove the strength of enclosures
 11. Gas tightness test
 12. Electromagnetic capability test (if applicable)
 13. Test on partitions
 14. Internal arc tests.
 15. Mechanical operation tests
 16. Mechanical operation tests.
 17. Verification of degree of protection of auxiliary and control circuits
 18. Test to prove performance under thermal cycling and gas tightness test on gas barrier insulators
 19. Capacitive Current switching test
 20. Shunt reactor current switching test

The components forming parts of the GIS which are covered by other standards shall comply with and shall be type tested according to those standards.

For surge arrestor and Bus VT following type tests are proposed to be conducted as per relevant IEC.

Surge Arresters (As per IEC 60099-4)

- | | |
|------------|---|
| Sl.
No. | List of Type tests as per IEC |
| 1. | Insulation with stand test on housing |
| 2. | Residual voltage test |
| 3. | Long duration current impulse with stand test |
| 4. | pressure relief test (if applicable) |
| 5. | operating duty test |
| 6. | Partial discharge test |
| 7. | Leakage test |

Bus VT (As per IEC 60044-2/ Latest IEC Standard)

- | | |
|------------|-------------------------------------|
| Sl.
No. | List of Type tests as per IEC |
| 1. | Temperature rise test |
| 2. | Lightning impulse test |
| 3. | switching impulse test |
| 4. | Determination of errors |
| 5. | short circuit with stand capability |
| 6. | chopped lightning impulse test |

9. Quality Plan

The successful bidder shall submit Quality Assurance Plan for **400kV Gas Insulated Switchgear & its accessories** etc. including in-process inspection methods, tests, records, etc. for BHEL/ NTPC approval. Customer hold points will also be included in the plan, which shall be mutually agreed by the BHEL/ NTPC. In case bidder has ref. Quality Assurance Plan agreed with BHEL/ NTPC, same shall be submitted for specific project to BHEL/ NTPC approval. There shall be no commercial implication to BHEL/ NTPC on account of Quality Plan approval.

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The bidder shall carry out the works in accordance with sound quality management principles which shall include such as controls which are necessary to ensure full compliance to all requirements of the specification & applicable international standards. These quality management requirements shall apply to all activities during design, procurement, manufacturing, inspection, testing, packaging, shipping, inland transportation, storage, site erection & commissioning. Bidder shall submit detailed Manufacturing Quality Assurance Plan (MQP) and Field Quality Plan for BHEL / customer's approval.

Superior quality control system shall be adopted to assure high product quality. Raw materials of the best commercial grade quality and high reliability shall be used in the manufacture of the equipment (**400kV Gas Insulated Switchgear & its accessories**). All materials shall be procured, manufactured, inspected and tested by vendor/ sub-vendor as per approved quality plan. The supplier shall perform all tests necessary to ensure that the material and workmanship conform to the relevant standards and comply with the requirements of the specification. Charges for all tests for the equipment (**400kV Gas Insulated Switchgear & its accessories**) shall be deemed to be included in bidder's scope.

10. Inspection & Testing

1. GIS and its associated materials shall be subject to inspection by BHEL/NTPC or authorized representative at bidder/manufacturers' works. Hence, Bidder shall furnish all necessary information concerning the supply to BHEL/ NTPC.
2. Routine and acceptance tests as listed in relevant standard and section-2, technical specifications shall be complied.
3. Bidder shall also furnish factory acceptance test (FAT) from manufacturers for BHEL/ NTPC approval in line with specific requirements mentioned in section-2, technical specification.

11. Field Testing & Commissioning

1. Bidder/ OEM shall carry out field testing and commissioning of 400kV GIS & its Accessories, however for installation, only supervision of installation shall be done by bidder. Further appropriate test and commissioning reports along as-built documentation as necessary shall be submitted.
2. Bidder shall also submit site acceptance testing (SAT) procedures and get them approved from BHEL/ NTPC before carrying out the activities at site.
3. Bidder shall coordinate with manufacturers of other equipment wherever required and shall freely and readily supply all technical information for this purpose as and when called for.
4. In general, field testing and commissioning shall be as per section-2, technical specification and applicable standards.

12. Packing and Dispatch

1. The equipment shall be carefully packed for transport by sea, rail and road in such a manner that it is protected against the climatic conditions and for any damage during transportation, transit and storage.
2. The SF6 equipment shall be shipped in the largest factory assembled units within transport and loading limitations and considering handling facilities on site to reduce the erection and installation work on site to a minimum. Where possible all items of equipment or factory assembled units shall be boxed in substantial crates or containers to facilitate handling in a safe and secure manner.
3. Each individual piece to be shipped, whether crate, container or large unit, shall be marked special notations such as 'Fragile', 'This side up', 'Centre of gravity', 'Weight', 'Owner's particulars', 'PO no.' etc., and other details as per purchase order.
4. The equipment may be stored outdoors for long periods before installation. The packing shall be

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completely suitable for outdoor storage in areas with heavy rains and high ambient temperature. Hence, packing of the equipment shall be suitable for long storage (minimum 2 years).

5. Special precautions shall be taken to protect any parts containing electrical insulation against the ingress of moisture. This applies particularly to the equipment of which each gas section shall be sealed and pressurized prior to shipping. Either dry nitrogen/air or dry SF₆ gas shall be used and the pressure shall be such as to ensure that, allowing for reasonable leakage, it will always be greater than the atmospheric pressure for all variations in ambient temperature and the atmospheric pressure encountered during shipment to site and calculating the pressure to which the sections shall be filled to ensure positive pressure at all times during shipment.
6. All blanking plates, caps, seals, etc., necessary for sealing the gas sections during shipment to site shall be provided. Any seals, gaskets, 'O' rings, etc. that will be used as part of the arrangement for sealing off gas sections for shipment of site, shall not be used in the final installation of the equipment at site. Vendor to provide quantity of components accordingly considering permanent installation and commissioning.
7. **Bidder to furnish to BHEL complete list of consignments for QR-code generation & shall ensure to affix QR codes of RFID tags/Trackers on the item & punch the same before dispatch.**

13. Specific Exclusions (NOT IN BIDDER'S SCOPE)

The following items are specifically excluded from the bidder's scope of supply & services:

1. Any scope of supply / services mentioned in Section-2 or Section-3 of technical specification but not having any relationship with 400kV GIS, LCC & its Accessories and not covered in Section-1 or BPS / BOQ shall be deemed excluded from bidder's scope.
2. Installation / Erection of GIS with LCC & its Accessories except supervision work. However, complete supply and installation of Online PD Monitoring system for both 400kV GIS shall be in bidder's scope.
3. Cable laying & terminations, however supervision work & termination of special cables shall be in bidder's scope.
4. Local transportation/ conveyance for bidder's engineers shall be arranged by BHEL between local stay and site.
5. Office assistance shall be provided by BHEL including sitting facility etc.
6. Receipt & unloading of material at site except supervision work.
7. Terminal connector of SF₆ to Air Bushing to conductor or any other interfacing equipment/ materials/ items.
8. Open & Closed stores at site, however, bidder shall provide space requirement during tendering stage.
9. During storage of materials in BHEL provided open/ closed store, watch and ward shall be provided by BHEL.
10. Civil Construction works i.e. GIS buildings, civil works requirement for GIS System.
11. EOT crane, Ventilation System, Illumination System & Fire detection & alarm system, however complete input shall be provided for EOT and other related systems, however design input, applicable for GIS manufacture, shall be provided.
12. Control Relay & Protection Panels/ Merging Unit/SCU/Process Bus Panels, Numerical Relays, Bus Bar Protection Panel, SAS & DCS system, ACDB, DCDB, Battery & Charger as applicable.
13. 40 mm MS Rod and 75X12, 50x6 mm GI Flat for earthing.
14. Outdoor AIS Equipment not related with GIS & its accessories.
15. Power & Control cable beyond LCC (except any special cables, if required).
16. BHEL/ Customer/ BHEL appointed 3rd party inspector travel, lodging & boarding charges during testing/ inspection etc.

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14. MAKES OF EQUIPMENT/ COMPONENTS

Bidder while ordering shall ensure the availability of spare parts and maintenance support services for the offered equipment for at least for 15 years from the date of supply. Bidder shall give a notice of at least one year to the BHEL/ NTPC before phasing out the products/ spares to enable the owner for placement of order for spares and services.

15. Terms Used

The terms used in this specification namely, "Employer/ Purchaser/ Owner" refers to NTPC/ BHEL & "Contractor/ Sub-contractor/Manufacturer/ Bidder" refers to successful bidder.

16. List of Documents/ Drawings

Following drawing/ documents are attached for information purpose,

1. Annexure A- BOQ for 400kV GIS & its Accessories
2. Annexure B- Details for Lot wise Technical Clearance for Manufacturing
3. Single Line Diagram for 400kV GIS Switchyard at NTPC, Singrauli
4. Layout Drawing for 400/220kV GIS Switchyard at NTPC, Singrauli
5. Architectural Drawing for 400kV GIS Building at NTPC, Singrauli

ANNEXURE- BOQ for 400kV GIS & its Accessories

Sl. No.	Item Description	Detailed Description	Unit	Qty
A	Supply- GIS: 400kV, 63kA, 4000A GIS with one and half breaker scheme as per the enclosed SLD, latest IEC standard & type tested equipment as per technical specification	The 400KV, 4000A, 63kA for 1 sec, One and Half Breaker GIS complete with local control centre (LCC) etc with open future proof & flexible system in line with IEC 61850 & IEC 62271-203. GIS shall comprise following bays but not limited to (Refer attached Single Line Diagram), a) Six (6) Set of fully equipped Line Bays. b) Two (2) Set of fully equipped GT Bays. c) One (1) Set of fully equipped Bus Reactor Bay having CB with controlled switching device. d) Two (2) Set of fully equipped ST Bays having CB with controlled switching device e) Three (3) Set of fully equipped Tie Bays having CB with controlled switching device f) Two (3) Set of fully equipped Tie Bays. f) One (1) Set of fully equipped Tie Bay directly connected with Bus as per SLD. g) Two (2) Sets of fully equipped Bus Voltage Transformer Bays with Bus Isolator and Grounding Switches and Bus LA. Typical bay includes but not limited to SF6 gas, Single Phase (isolated) Busbar, circuit breaker, current transformer, bus-bar disconnectors with common grounding switch, Motorised disconnectors with safety grounding switch(es), high speed fault making motorised grounding switch, Local control cubicle, SF6 gas monitoring system for complete GIS, SF6 bus duct termination arrangement including SF6 to air bushing module, PD sensor (adequate number of UHF sensors in the offered GIS equipment for detection of Partial discharge (of 5 pC and above) as per IEC 60270 through Online Partial Discharge (PD) monitoring system, different gas compartment, O- ring & gaskets, Nuts, Bolts & Washers, Absorbent, Limit Switch etc. to complete GIS modules & its earthing arrangement for GIS equipment with earthing strips of adequate size (as per IEEE-80-2000 and CIGRE44 to protect operating staff against any hazardous touch voltages and electro-magnetic interferences) as per the technical specification. The Switchgear shall be complete with all necessary terminal boxes, inspection window, SF6 gas filling, inter-connecting wiring, grounding connections, gas monitoring equipment and piping, support structures etc. The scope of supply shall also include all erection and mounting hardwares and interconnecting power and control cables between GIS to LCC and between LCC to LCC including cable tray, glands, lugs, ferrules etc. However cables beyond LCC shall be supplied and laid by BHEL.	Header Item; Unit & Quantity as per A1 to A18 below.	
A1	Fully equipped 400kV, 63kA, 3150A GIS - Line bay module	400kV, 63kA for 1 sec, 3150A SF6 gas-insulated metal enclosed LINE bay module. Each set shall be complete & shall comprise of but not limited to: a) ONE set of 3-phase, SF6 insulated Circuit Breaker, complete with operating mechanism. b) THREE sets of 3-phase group operated Disconnecter complete with manual and motor driven operating mechanisms. c) TWO sets of 3x1-phase, group operated maintenance Earthing Switches, complete with manual and motor driven operating mechanisms. d) TWO set of 3x1-phase, group operated High Speed Earthing Switches, complete with manual and motor driven operating mechanisms. e) THREE nos. of 1-phase, 3-CORE, multi ratio, Current Transformers as per single line diagram (Core details shall be finalised at detail engg. stage). f) THREE nos. of 1-phase, 2-CORE, multi ratio, Current Transformers as per single line diagram (Core details shall be finalised at detail engg. stage). g) THREE nos. of 1-phase, 4-CORE, multi ratio, Current Transformers as per single line diagram (Core details shall be finalised at detail engg. stage). h) UHF PD sensors, gas monitoring device, pressure relief device, busbar, insulators/ barriers, expansion joint/ flexible joints and other items as required. GIS bus duct, SF6 to air bushing module etc. are not included in this bay module and hence, these items are covered in separate BOQ items.	Set	6
A2	Fully equipped 400kV, 63kA, 3150A GIS - GT bay module	400kV, 63kA for 1 sec, 3150A SF6 gas-insulated metal enclosed GT bay module. Each set shall be complete & shall comprise of but not limited to: a) ONE set of 3x1-phase, SF6 insulated Circuit Breaker, complete with operating mechanism. b) THREE set of 3-phase group operated Disconnecter complete with manual and motor driven operating mechanisms. c) FOUR set of 3x1-phase, group operated maintenance Earthing Switches, complete with manual and motor driven operating mechanisms. d) THREE nos. of 1-phase, 3-CORE, multi ratio, Current Transformers as per single line diagram (Core details shall be finalised at detail engg. stage). e) THREE nos. of 1-phase, 2-CORE, multi ratio, Current Transformers as per single line diagram (Core details shall be finalised at detail engg. stage). f) THREE nos. of 1-phase, 1-CORE, multi ratio, Current Transformers as per single line diagram (Core details shall be finalised at detail engg. stage). g) UHF PD sensors, gas monitoring device, pressure relief device, busbar, insulators/ barriers, expansion joint/ flexible joints and other items as required. GIS bus duct, SF6 to air bushing module etc. are not included in this bay module and these items are covered in separate items in the BOQ.	Set	2
A3	Fully equipped 400kV, 63kA, 3150A GIS - Bus Reactor bay module - with CSD	400kV, 63kA for 1 sec, 3150A, SF6 gas-insulated metal enclosed BUS REACTOR bay module. Each set shall be complete & shall comprise of but not limited to: a) ONE set of 3x1-phase, SF6 insulated Circuit Breaker, complete with operating mechanism and Controlled Switching Device (CSD) b) THREE set of 3-phase group operated Disconnecter complete with manual and motor driven operating mechanisms. c) FOUR set of 3x1-phase, group operated maintenance Earthing Switches, complete with manual and motor driven operating mechanisms. d) THREE nos. of 1-phase, 3-CORE, multi ratio, Current Transformers as per single line diagram (Core details shall be finalised at detail engg. stage). e) THREE nos. of 1-phase, 2-CORE, multi ratio, Current Transformers as per single line diagram (Core details shall be finalised at detail engg. stage). f) THREE nos. of 1-phase, 1-CORE, multi ratio, Current Transformers as per single line diagram (Core details shall be finalised at detail engg. stage). g) UHF PD sensors, gas monitoring device, pressure relief device, busbar, insulators/ barriers, expansion joint/ flexible joints and other items as required. GIS bus duct, SF6 to air bushing module etc. are not included in this bay module and these items are covered in separate items in the BOQ.	Set	1
A4	Fully equipped 400kV, 63kA, 3150A GIS - ST bay module - with CSD	400kV, 63kA for 1 sec, 3150A, SF6 gas-insulated metal enclosed ST bay module. Each set shall be complete & shall comprise of but not limited to: a) ONE set of 3x1-phase, SF6 insulated Circuit Breaker, complete with operating mechanism and Controlled Switching Device (CSD) b) THREE set of 3-phase group operated Disconnecter complete with manual and motor driven operating mechanisms. c) FOUR set of 3x1-phase, group operated maintenance Earthing Switches, complete with manual and motor driven operating mechanisms. d) THREE nos. of 1-phase, 3-CORE, multi ratio, Current Transformers as per single line diagram (Core details shall be finalised at detail engg. stage). e) THREE nos. of 1-phase, 2-CORE, multi ratio, Current Transformers as per single line diagram (Core details shall be finalised at detail engg. stage). f) THREE nos. of 1-phase, 1-CORE, multi ratio, Current Transformers as per single line diagram (Core details shall be finalised at detail engg. stage). g) UHF PD sensors, gas monitoring device, pressure relief device, busbar, insulators/ barriers, expansion joint/ flexible joints and other items as required. GIS bus duct, SF6 to air bushing module etc. are not included in this bay module and these items are covered in separate items in the BOQ.	Set	2
A5	Fully equipped 400kV, 63kA, 3150A GIS - Tie GIS bay module - with CSD	400kV, 63kA for 1 sec, 3150A, SF6 gas-insulated metal enclosed TIE bay module. Each set shall be complete & shall comprise of but not limited to: a) ONE set of 3x1-phase, SF6 insulated Circuit Breaker, complete with operating mechanism and Controlled Switching Device (CSD) b) TWO sets of 3-phase group operated Disconnecter complete with manual and motor driven operating mechanisms. c) TWO sets of 3x1-phase, group operated maintenance Earthing Switches, complete with manual and motor driven operating mechanisms. d) SIX nos. of 1-phase, 3-CORE, multi ratio, Current Transformers as per single line diagram (Core details shall be finalised at detail engg. stage). e) Three (3) nos. single phase (isolated) bus bars to inter connect the Tie Bay circuit breaker bay modules with Circuit breaker bay Modules of Line/ICT/Bus Reactor in full diameter of one and half breaker bus system f) UHF PD sensors, gas monitoring device, pressure relief device, busbar, insulators/ barriers, expansion joint/ flexible joints and other items as required.	Set	3
A6	Fully equipped 400kV, 63kA, 3150A GIS - Tie GIS bay module - without CSD	400kV, 63kA for 1 sec, 3150A, SF6 gas-insulated metal enclosed TIE bay module. Each set shall be complete & shall comprise of but not limited to: a) ONE set of 3x1-phase, SF6 insulated Circuit Breaker, complete with operating mechanism. b) TWO sets of 3-phase group operated Disconnecter complete with manual and motor driven operating mechanisms. c) TWO sets of 3x1-phase, group operated maintenance Earthing Switches, complete with manual and motor driven operating mechanisms. d) SIX nos. of 1-phase, 3-CORE, multi ratio, Current Transformers as per single line diagram (Core details shall be finalised at detail engg. stage). e) Three (3) nos. single phase (isolated) bus bars to inter connect the Tie Bay circuit breaker bay modules with Circuit breaker bay Modules of Line/ICT/Bus Reactor in full diameter of one and half breaker bus system f) UHF PD sensors, gas monitoring device, pressure relief device, busbar, insulators/ barriers, expansion joint/ flexible joints and other items as required.	Set	2
A7	Fully equipped 400kV, 63kA, 3150A GIS - Tie GIS bay module for half diameter, directly connected to Main Bus	400kV, 63kA for 1 sec, 3150A, SF6 gas-insulated metal enclosed TIE bay module. Each set shall be complete & shall comprise of but not limited to: a) ONE set of 3x1-phase, SF6 insulated Circuit Breaker, complete with operating mechanism. b) TWO sets of 3-phase group operated Disconnecter complete with manual and motor driven operating mechanisms. c) TWO sets of 3x1-phase, group operated maintenance Earthing Switches, complete with manual and motor driven operating mechanisms. d) SIX nos. of 1-phase, 3-CORE, multi ratio, Current Transformers as per single line diagram (Core details shall be finalised at detail engg. stage). e) Three (3) nos. single phase (isolated) bus bars to inter connect the Tie Bay circuit breaker bay modules with Circuit breaker bay Module of Line and connecting module to Main bus bar in half diameter of one and half breaker bus system f) UHF PD sensors, gas monitoring device, pressure relief device, busbar, insulators/ barriers, expansion joint/ flexible joints and other items as required.	Set	1
A8	400kV, 63kA, 4000A GIS - Busbar GIS module	One set of three single phase (isolated), 400kV, 4000A, 63kA for 1 sec, SF6 gas-insulated metal enclosed bus bars, each comprising of but not limited to: a) Three individual 4000A bus bars enclosures running across the length of the switchgear to inter connect each of the circuit breaker bay modules in one and half breaker bus system. b) UHF PD sensors, Gas monitoring systems, pressure switches, telescopic enclosure etc. as required. c) UHF PD sensors, gas monitoring device, pressure relief device, pressure switches, telescopic enclosure, insulators/ barriers, expansion joint/ flexible jointsetc. and any other items as required. Length of bus bar to be indicated by bidder.	Set	2
A9	400kV, 63kA, 3150A GIS - Bus VT Modules & Bus Earth Switch for Main Bus	400kV, 63kA for 1 sec, 3150A, SF6 gas insulated Bus VT bay module, Disconnecter module with Earth switches connected to Main Bus Bars, each comprising of but not limited to: b) ONE set of 3-phase group operated Disconnecter complete with manual and motor driven operating mechanisms. c) TWO sets of 3x1-phase, group operated maintenance Earthing Switches, complete with manual and motor driven operating mechanisms. d) THREE nos. of 1-phase, 3-secondary, Voltage Transfromer as per single line diagram. e) UHF PD sensors, gas monitoring device, pressure relief device, busbar, insulators/ barriers, expansion joint/ flexible joints and other items as required.	Set	2
A10	400kV, 63kA, 3150A GIS - Gas Insulated Bus Duct from GIS bay modules upto SF6 Air bushings of Outgoing Lines/ Bus Reactor/ GT/ ST	400kV, 63kA for 1 sec for insulated Bus Duct, 3150A, SF6 gas insulated GIS Bus Duct shall be complete & shall comprise of but not limited to: a) Single phase (isolated) SF6 ducts along with all accessories, bends, joints etc to connect 400kV GIS bay modules to SF6 Air bushings of Outgoing Lines/ Bus Reactor/ GT/ ST b) UHF PD sensors, Gas monitoring devices, barriers, pressure switches, etc. as required. The total tentative length indicated is the sum of all 1 phase SF6 bus duct from end of respective bay to SF6 to air bushing/ connection. However, exact length shall be decided during detailed engineering stage.The GIBus duct length is to be calculated from the end of the GIS module and shall include both the indoor and outdoor GIB.	Mtr	2250
A11	400kV, 63kA, 3150A GIS - SF6 to air bushing	400kV, 3150A, 63 kA for 1 sec, 31mm/kV creepage, SF6 to Air Bushing for Over head connection of Outgoing Lines/ Bus Reactor/ GT/ ST bays with GIS.	No	33

A12	400kV, 63kA GIS - LA/ Surgre arrester Module	LA/ Surge Arrester Module, comprising of following but not limited to, (a) ONE no. of single phase LA/Surge Arrester along with enclosure for one bus bar section with surge monitor/ counter (b) LA/ Surge Arrester Module shall have the provision of link for temporary isolation during HV testing at site. (c) Number of LA/ Surge arrester and their rating shall be decided based on insulation co-ordination / transient analysis studies for the GIS system. Insulation Coordination study is in bidder scope. However the LA indicated in SLD are the minimum numbers of LA to be provided by bidder.	No.	6
A13	400kV, 63kA, 4000A GIS - GIS Bus bar Extension Module (Applicable only in case of change in standard lengths of busbar modules of GIS/ standard bay pitch during detailed engineering, on account of reasons not attributed to bidder. In case there is no such change, the quantity of this item shall be reduced to zero.)	400kV, 63kA for 1 sec, 4000A, Bus bar extension module for connection between bays, comprising of following but not limited to, (a) 1 phase isolated Bus bar module section shall be used for connection between sections of bus bars to create electrical connectivity due to shifting of GIS bays, arising due to civil and architectural requirements, avoiding building column fouling or expansion joint in the building that houses GIS. (b) This module shall include the bellows/ compensators like lateral mounting units, Axial compensators, Parallel compensators, tolerance compensators and vibration compensators etc. as per requiremnts. c) UHF PD sensors, gas monitoring device, pressure relief device, insulator, expansion joint/ flexible joints etc. as required.	Mtr	6
A14	400kV GIS - Local Control Cabinet (LCC)	Local Control Cabinet (LCC) shall be provided for all Outgoing Lines/ Bus Reactor/ GT/ ST bays including cables between GIS & LCC. However, it may please be noted that any additional requiremenst of LCC (for Bus VT, DS, ES & Bus LA etc.), other than quantity mentioned in BOQ, during detailed engineering stage shall not be payable. All equipments are to be incorporated in BOQ quantity by bidder.	Nos.	17
A15	400kV GIS - SF6 gas required for placing GIS into successful operation	First filling of SF6 gas for the equipment supplied plus an additional quantity sufficient for conducting all tests on equipment at site before placing it into successful operation. Bidder to indicate quantity with break up.	MT	20
A16	Supply of structure material for Installation of 400kV GIS including support structure for GIS ducts, SF6 to air bushings, supports, platforms, ladders, foundation bolts, embedded parts in floors, Rails etc., which are required for installation of GIS as per the specification.	Structure Materials for support of GIS, Bus Ducts, SF6 to air bushing/ connection including Foundation Bolts, Embedded Items, Rails and/ or any other structural items required. All steel structure members shall be hot-dip galvanized after fabrication. Unless otherwise specified, minimum mass of zinc coating for Galvanizing shall be 610 gm/square meter . All field assembly joints shall be bolted and hence, Field welding shall not be acceptable. Noncorrosive metal or plated steel shall be used for bolts and nuts throughout the work. Bidder shall provide suitable foundation channels and anchor bolts to support the switchgear assemblies. All anchor fasteners, mounting bolts, nuts and washers shall be provided to fasten the switchgear base frames to the foundation channels. In addition to above, supports, platforms, walkway, catwalk, foundation bolts, embedded parts in floors etc., are also included in the scope as per the specification, but not limited to the following. (a) Base Plate, Channel, Metallic / Structural Member / Rail for seating of GIS system (b) Lattice / Pipe structure required for GIS bay, GIB, SF6 to air bushing/ connection. (c) Foundation bolt / Anchor Fastener for GIS system, if required. (d) Equipment fixing hardware. (e) Cable tray arrangement (mounted on structures of) GIS bay, GIB, SF6 to air bushing/ connection. (f) Any other structural item required to complete the system in all respects but not limited to above. The civil works shall be done based on bidder's design & drawings.	MT	65
A17	Supply of Earthing material for 400kV GIS including High frequency earthing material, if required. The quantity shall be estimated & provided by bidder	Earthing Materials, except 40mm MS rod, 75x12mm/ 50x6 GI Flat, which shall be provided by BHEL as free issue items, but, exact quatity requirement shall be intimated by bidder based on the approved earthing philosophy, and Supervision of erection of all earthing connection for GIS to Earth Mesh on Floor shall be in scope including any special requirements including high frequency earthing. In case, high frequency earthing is not required, necessary design and calculations shall be submitted by bidder in line with IEEE-80-2000 and CIGRE44 to protect operating staff against any hazardous touch voltages and electro-magnetic interferences as per the technical specification. For further details, Please refer Section-2 along with applicable drawing. Bidder shall define clearly what constitutes the main grounding bus of the GIS. Bidder must supply, commission the entire grounding work of GIS viz conductor, clamps, joints, bimetallic strips (for connection between different type of earthing materials), operating and safety platforms etc. Bidder shall provide suitable measure to mitigate trasient enclosure voltage caused by high frequency currents caused by lightning strikes, operation of surge arrester, phase/earth fault and discharge between contracts during switching operation.	Lot	1
A18	Online continuous Partial Discharge Monitoring System (PDM) with all necessary accessories & auxiliaries) complete for 400kV GIS & Busducts	Online continuous Partial Discharge Monitoring System (PDM) for 400kV GIS have following but not limited to, 400kV GIS equipment system shall have Online continuous Partial Discharge Monitoring System (PDM) system to provide an automatic facility for the simultaneous collection of PD data at multiple points on the GIS & its associated GIB ducts and Voltage Transformers adopting UHF technique & the data stored shall provide a historical record of the progress of PD sources and shall identify the areas of maximum activity. PDM system shall be interfacing with UHF PD couplers provided.The PD Monitoring PC Work Station alongwith all accessories shall be considered. Power supply to PDM PC shall have protection against surges, overload and short circuit. A dedicated on-line UPS system shall also be provided as a backup during supply interruption, to ensure trouble-free & reliable running of the PDM System for a minimum of 15 minutes duration.	Lot	1
B	Supply: Mandatory Maintenance Equipment & Monitoring Equipment	Mandatory Maintenance Equipment shall be shipped in separate containers, clearly marked with the name of the equipment for which they are intended.	Header Item; Unit & Quantity as per B1 to B9 below.	
B1	SF6 gas filling and evacuating equipment (Portable)		No.	1
B2	SF6 gas filtering, drying, storage and recycling plant		No.	1
B3	SF6 Gas leak detector		No.	1
B4	Operational analyser with DCRM kit		No.	1
B5	Hydraulic portable type ladder		No.	1
B6	Dew Point Meter		No.	1
B7	Portable PD Monitoring System for Gas Insulated Switchgear		No.	1
B8	SF6 gas analyzing equipment and instrument		No.	1
B9	Portable Leakage current analyzer (for Gapless Surge Arrester),		No.	1
C	Supply- Mandatory Spares for 400kV GIS		Header Item; Unit & Quantity as per C1 to C17 below.	
	400kV Gas Insulated Switchgear			
C1	SF6 gas pressure Relief Devices,	1 Set= 3 nos. of each type	Set	2
C2	SF6 Pressure gauge with coupling device cum switch or density monitors and pressure gauge, as applicable	1 Set= 1 nos. of each type	Set	1
C3	Rubber gaskets, "O" Rings and seals for SF6 gas, including Circuit Breaker, Disconnecter and other GIS equipment's	1 Set= 6 nos. of each type	Set	1
C4	Molecular filter for SF6 gas with filter bags	1 Set=20% total quantity of absorber bags used in GIS	Set	1
C5	SF6 gas	1 Set= 20% of total Gas used in GIS in cylinders of 50Kgs / cylinder capacity	Set	1
C6	Covers with all accessories necessary to close a compartment in case of dismantling of any part of the Enclosure to ensure the sealing of the compartment- For 1 phase enclosure	1 Set= 3 nos. of each type	Set	1
C7	Locking device to keep the Dis-connectors and Earthing switches in close or open position in case of removal of the driving mechanism (If applicable)		No.	3
C8	Bus support insulator of each type for single phase enclosure	1 Set= 6 nos. of each type	Set	1
C9	SF6 to air bushing for 1 phase enclosure		No.	2
C10	Spares for Local control cabinet: MCB, fuses, timers, Aux Relay of each type & rating, terminals of each type (Set)	1 Set= 1 nos. of each type	Set	1
C11	All types of Corona shield	1 Set= 3 nos. of each type	Set	1
C12	Windowscope/ Observing window, (if applicable)	1 Set= 3 nos. of each type	Set	1
C13	Circuit Breaker			
C13.1	Complete Circuit Breaker 1 phase pole of each type & rating complete with interrupter, main circuit and enclosure with operating mechanism		Set	3
C13.2	Trip Coil assembly with resistor as applicable, 3 Nos. of each type	1 Set= 3 nos. of each type	Set	2
C13.3	Closing Coil assembly with resistor as applicable, 3 Nos. of each type	1 Set= 3 nos. of each type	Set	2
C13.4	Relays, Power contactors, push buttons, timers & MCBs etc of each type & rating(If applicable)		Set	1
C13.5	Closing assembly/ valve, If applicable	1 Set= 3 nos. of each type	Set	2
C13.6	Trip assembly/ valve, If applicable	1 Set= 3 nos. of each type	Set	2
C13.7	Aux. switch assembly	1 Set= 3 nos. of each type	Set	1
C13.8	Operation counter	1 Set= 3 nos. of each type	Set	1
C13.9	Rupture disc, if applicable	1 Set= 3 nos. of each type	Set	1

C13.10	Spare of pneumatic/ spring/ hydraulic operated mechanism (as per Main Supply) 1)Spare of pneumatic operated mechanism (complete) a. Motor for compressor – 1 no. b. Pressure switch and valve etc – 1 no. of each type 2)Spare of spring operated mechanism (complete) a . Motor – 1 no b. Limit switch etc- 1 no. of each type 3)Spare of hydraulic operated mechanism(complete) a. Motor – 1 no. b. Limit switch – 1 no. of each type	1 Set= 1set for each type of Circuit Breaker	Set	1
C14	Disconnecter			
C14.1	Complete set of 3 nos. of single phase disconnecter including main circuit, enclosure and driving mechanism	1 Set= 3 nos. of single phase disconnecter including main circuit, enclosure and driving mechanism complete in all respect	Set	1
C14.2	High speed/ fast acting fault making grounding switch, 3 nos. of single phase of each rating, including main circuit, enclosure and driving mechanism	1 Set= 3 nos. of single phase of each rating of High speed/ fast acting fault making grounding switch , including main circuit, enclosure and driving mechanism	Set	1
C14.3	3 nos. of single phase Earthing switch including main circuit, and driving mechanism	1 Set= 3 nos. of single phase Earthing switch including main circuit, and driving mechanism	Set	1
C14.4	Open/ close contactor assembly, timers, key interlock for one complete (3phase) disconnecter and earthing switch of each type & rating (if applicable)		Set	1
C14.5	Limit switches and Aux. switches for complete 3-phase equipment- a) For Disconnecter		Set	3
C14.6	Limit switches and Aux. switches for complete 3-phase equipment- b) For earth switch		Set	1
C14.7	Limit switches and Aux. switches for complete 3-phase equipment- c) For High speed earth switch		Set	1
C14.8	Relays. Power contactors, resistors, fuses, push buttons, timers & MCBs, if applicable- a) For Disconnecter	1 Set= Complete for one 3 phase equipment	Set	3
C14.9	Relays. Power contactors, resistors, fuses, push buttons, timers & MCBs, if applicable- b) For earth switch	1 Set= Complete for one 3 phase equipment	Set	1
C14.10	Relays. Power contactors, resistors, fuses, push buttons, timers & MCBs, if applicable- c) For High speed earth switch	1 Set= Complete for one 3 phase equipment	Set	1
C15	Current Transformer- Complete CT, as applicable, with enclosure, as applicable	1 Set= 1 no. of each type & rating	Set	1
C16	Voltage Transformer- Gas Insulated complete VT with enclosure		No.	1
C17	SF6 Gas Insulated Surge Arrestor with enclosure		No.	3
D	Services- 400kV GIS- Supervision of Erection, Testing & Commissioning and handing over to Customer	These activities shall be carried out at site in stages as per front availability at site, and hence multiple visits for completion of work are envisaged.	Header Item; Unit & Quantity as per D1 to D11 below.	
D1	Site visit for supervision of unloading & verification of 400kV GIS materials for proper storage and up-keeping at site	Site visit for supervision of unloading & verification of materials for proper storage and up-keeping at site includes following activities but not limited to, (a) Supervision of safe unloading of GIS & its accessories at site. (b) Reconciliation, storage & upkeeping of materials, with due instructions/ training to site persons for long storage.	Lot	1
D2	Supervision of erection of 400kV GIS bays including LCC	Supervision of complete GIS bays along with all bay equipment such as GIS extension module, GIS bus extension module, voltage transformer, Surge Arrestor, LCC including structure, cabling, earthing & other associated activities shall be included in the scope. Consumables required for successful erection is included in bidder's scope. Payment shall be made on actual measurement basis, if required.	No	17
D3	Supervision of erection of 400kV Gas insulated bus duct	Supervision of erection of GIS- gas insulated bus duct including support structure, earthing & other associated activities shall be included in the scope. The GIS bus duct quantity will be calculated from the end of the GIS module and shall include both the indoor and outdoor GIS. Consumables required for successful erection is included in bidder's scope. Payment shall be made on actual measurement basis, if required.	Mtr	2250
D4	Supervision of erection of 400kV SF6 to air bushing/ connection	Supervision of erection of SF6 to Air bushing including support structure, earthing & other associated activities shall be included in the scope. Consumables required for successful erection is included in bidder's scope. Payment shall be made on actual measurement basis, if required.	No	33
D5	Testing & commissioning of 400kV GIS bays including LCC	Testing & commissioning of complete GIS bays including other associated activities in line with site acceptance testing as per customer approved SAT procedure shall be in bidder's scope. Consumables required for successful commissioning is included in bidder's scope. Payment shall be made on prorata basis, if required.	No	17
D6	Testing & commissioning of 400kV GIS Gas insulated bus duct	Testing & commissioning of GIS- gas insulated bus duct including support structure, earthing & other associated activities shall be included in the scope. Consumables required for successful commissioning is included in bidder's scope. Payment shall be made on actual measurement basis, if required.	Mtr	2250
D7	Testing & commissioning of 400kV SF6 to air bushing/ connection	Testing & commissioning of SF6 to Air Bushing including support structure, earthing & other associated activities shall be included in the scope. Payment shall be made on actual measurement basis, if required.	No	33
D8	Final Successful High Voltage/ Power Frequency Testing of complete 400kV GIS	Carrying out successful HV/ Power Frequency Testing of complete (all bays) GIS as per IEC including one time arrangement of HV Test kit (on returnable basis) shall be in scope of bidder, which includes charges of HV test kit with operator, accessories & tools required for completion of HV testing. No delay shall be permitted on account of the non availability of the HV test kit. Payment shall be made on the basis site certification. Bays may be commissioned separately. In case the HV testing of any bay is not completed due to reasons not attributed to bidder, the HV testing kit mobilization and demobilization shall be covered under separate unit ref. item of this BOQ. However, the payment of Successful High Voltage/ Power Frequency Testing of of balance bays in such a scenario, shall be done on prorata basis i.e. total cost quoted for complete GIS Lot/ total no. of bays.	Lot	1
D9	Insulation Co-ordination including VFTO Studies for 400kV GIS System	Bidder shall conduct insulation co-ordination study in line with IEC 600071-2006 and any other technical requirement for successful operation of GIS. In case of non availability of exact input details, same shall be done on basis of standard inputs available and shall be revised, if required after availability of exact input details. Payment shall be made on the basis engineering certification.	Lot	1
D10	Final Documentation of 400kV GIS	Final Documentation including As Built Drawing/ Document, Site Testing Reports/ Protocols, Handing over proptcols along with manuals shall be submitted etc. by bidder. Payment shall be made on the basis engineering certification.	Lot	1
D11	Erection, testing & commissioning of Online continuous Partial Discharge Monitoring System (PDM) for 400kV GIS	Supervision of erection, testing & commissioning of Online continuous Partial Discharge Monitoring System (PDM) for 400kV GIS including interfacing with SAS & other associated activities shall be included in the scope. Consumables required for successful erection is included in bidder's scope. Payment shall be made on actual measurement basis, if required. These activities shall be carried out at site in stages as per front availability at site, and hence multiple visits for completion of work are envisaged.	Lot	1
E	Service- Training for 400kV GIS		Header Item; Unit & Quantity as per E1 to E2 below.	
E1	400kV GIS Training of 10 nos. Engineers (8 nos. customer engineers+2 nos. BHEL engineers) for a period of at least 5 working days at Manufacturer's works	The scope shall include boarding & lodging charges of engineers, including local conveyance.	Lot	1
E2	400kV GIS Training of 8 nos. Engineers (6 nos. customer engineers+2 nos. BHEL engineers) for a period of at least 5 working days at project site	Lodging and Boarding of Training Participants shall be in BHEL scope.	Lot	1
F	Supply- Unit reference price of 400kV GIS part item/ equipment	GIS part item/ equipment shall be required for supply as a mandatory spares or any addition/ deletion of equipment, due to damage, theft, additional requirement by customer during detailed engineering or later stage. It is to be ensured by bidder that unit prices have a logical relationship with prices of assemblies in main items (Bay, Busbar etc). The reference prices shall be used for breakup rates, if required at any stage. The reference prices shall be considered for evaluation.	Header Item; Unit & Quantity as per F1 to F28 below.	
F1	400kV, 3150A Circuit breaker complete with enclosure without operating mechanism	1 set= 1 no. of 400kV, 3150A Circuit breaker, 1 pole complete with enclosure without operating mechanism	Set	1
F2	400kV, 3150A Disconnecter without operating mechanism	1 set= 1 no. of 400kV, 3150A Isolator (3 pole) complete with enclosure without operating mechanism	Set	1
F3	400 kV Maintenance Earthing switch without operating mechanism	1 set= 1 no. of 400 kV Maintenance Earthing switch (3 pole) with enclosure without operating mechanism	Set	1
F4	400kV High speed earth switch/ High speed make proof grounding switch without operating mechanism	1 set= 1 no. of 400kV High speed earth switch (3 pole) with enclosure without operating mechanism	Set	1

F5	Surge Arrestor including Surge Counter	Surge Arrestor with enclosure and surge count/ monitor. Rated arrester voltage may be changed after insulation coordination study. Rated arrester voltage considered is 390kV.	Set	1
F6	400kV Current transformer of Class PS	400kV Current transformer (1 pole) of Class PS (1 No. of each type) Without enclosure (Individual prices to be furnished).	Set	1
F7	400kV Current transformer of Class 0.2s	400kV Current transformer (1 pole) of Class 0.2s (1 No. of each type) Without enclosure (Individual prices to be furnished).	Set	1
F8	400kV Voltage transformer	400kV Voltage transformer (1 pole) (1 no. of each type) Without enclosure (Individual prices to be furnished).	Set	1
F9	Operating Mechanism box for 400kV, 3150 A Circuit Breaker	1 set= 1 no. of Operating Mechanism box for 400kV, 3150 A Circuit Breaker	Set	1
F10	Operating Mechanism box for 400kV, 3150 A Disconnecter	1 set= 1 no. of Operating Mechanism box for 400kV, 3150 A Isolator	Set	1
F11	Operating mechanism for 400kV, Maintenance Earthing Switch	1 set= 1 no. of Operating mechanism for 400kV, Maintenance Earthing Switch	Set	1
F12	Operating Mechanism for 400kV, High Speed Earthing Switch	1 set= 1 no. of Operating Mechanism for 400kV, High Speed Earthing Switch	Set	1
F13	400kV, 1 Phase bus bar conductor		Mtr	1
F14	400kV, 1 phase GIS metallic enclosure for bus bar/ any equipment		Mtr	1
F15	400kV, 1 Phase conductor for bus duct		Mtr	1
F16	400kV, 1 phase GIS metallic enclosure for bus duct		Mtr	1
F17	Gas permeable/ communication/ barrier type Insulator	1 Set= 1 No of each rating and type	Set	1
F18	Gas non- permeable/ non - communication/ non-barrier type Insulator	1 Set= 1 No of each rating and type	Set	1
F19	UHF PD sensors	1 Set= 1 No of each rating and type	Set	1
F20	Pressure/ density monitor monitor device & Switch	1 Set= 1 No of each rating and type	Set	1
F21	Pressure relief device	1 Set= 1 No of type	Set	1
F22	Rupture disc	1 Set= 1 No of type	Set	1
F23	Elbow/ bend/ cross and T section	1 Set= 1 No of type	Set	1
F24	Expansion joint	1 Set= 1 No of type	Set	1
F25	Flexible connection for conductor	1 Set= 1 No of type	Set	1
F26	Gas seals	1 Set= 1 No of type	Set	1
F27	Controlled Switching Device for ONE set of 3150A, 3x1-phase, SF6 insulated circuit breaker		Set	1
F28	Enclosure for LCC Panel		No.	1
G	Service- Unit reference price of GIS service item	Reference unit prices for service of Individual Item/ Equipment for any addition/ deletion of equipment, due to damage, theft, additional requirement by customer, any other reasons not attributable to vendor during detailed engineering/ contract execution. The reference prices shall be considered for evaluation. Total charges for one visit of engineer/ HV test kit operator shall include respective unit rate of item I.1/ I.2 man-day+ item of I.4.	Header Item; Unit & Quantity as per G1 to G6 below.	
G1	Services of supervision for Erection of 400kV GIS	Charges for repetition of services - (if required due to reasons not attributed to the bidder) This item will be executed only if repetition of services is required by BHEL.	Manday	10
G2	Services of Testing & Commissioning of 400kV GIS	Charges for repetition of services - (if required due to reasons not attributed to the bidder) This item will be executed only if repetition of services is required by BHEL.	Manday	10
G3	Demobilization & remobilization charges for GIS erection supervision team	This BOQ item shall be payable if required for reasons not attributable to bidder.	Set	2
G4	Demobilization & remobilization charges for GIS testing & commissioning team	This BOQ item shall be payable if required for reasons not attributable to bidder. Hv testing is not part of this item.	Set	2
G5	Demobilization & remobilization charges HV Test Kit along with operator	In this BOQ item, mobilization and demobilization charges for HV test kit is considered for second time or more, for reasons not attributable to bidder. HV testing charges are not included in this line item and the same may be referred from the main line item of supervision of ETC services of this BOQ.	Lot	1
G6	Type Test Charges for conduction of Type Test on 400kV GIS	Please refer Annexure- Break up of Type Test Charges on 400kV GIS for details of type test to be conducted on 400kV GIS.	Lot	1

Annexure- Break up of Type Test Charges on 400kV GIS

The following type tests on typical 400kV GIS (As Applicable) GIS bay module as per IEC 62271-203. The components forming parts of the GIS which are covered by other standards shall comply with and shall be type tested according to those standards.				
Sl. No.	Description of Test	Number of Type/ Rating	Charges for one Type/ Rating (Rs.)	Total Price (Rs.)
A.	The following type tests on typical 400kV (As Applicable) GIS bay module as per IEC 62271-203. The components forming parts of the GIS which are covered by other standards shall comply with and shall be type tested according to those standards.			
(i)	Lightning impulse voltage dry tests.			
(ii)	Switching impulse voltage dry tests.			
(iii)	Power frequency voltage dry tests.			
(iv)	Partial discharge tests.			
(v)	Test to prove the temperature rise of any part of the equipment and measurement of the resistance of the main circuit.			
(vi)	Test to prove the ability of the main circuit and earthing circuit to carry the rated peak and the rated short time withstand current.			
(vii)	Test to verify the making and breaking capacity of the included switching devices.			
(viii)	Test for satisfactory operation of the included switching devices.			
(ix)	Test to prove the strength of enclosures.			
(x)	Gas tightness tests			
(xi)	Electromagnetic capability test (EMC)			
(xii)	Test on partitions			
(xiii)	Internal arc tests			
(xiv)	Mechanical operation tests.			
(xv)	Test to prove the satisfactory operation at limit temperature.			
(xvi)	Verification of degree of protection of auxiliary and control circuit			
(xvii)	Test to prove performance under thermal cycling and gas tightness test on gas barrier insulators			
(xviii)	Capacitive Current switching test			
(xix)	Shunt reactor current switching test			
B	For surge arrester and Bus VT following type tests as per relevant IEC. 400kV (As Applicable) Surge Arrester (As per IEC 60099-4)			
(a)	Insulation withstand test on housing			
(b)	Residual voltage test			
(c)	Long duration current impulse withstand test			
(d)	Pressure relief test (if applicable)			
(e)	Operating duty test			
(f)	Partial Discharge Test			
(g)	Leakage Test			
C	400kV (As Applicable) Bus VT (As per IEC 60044-2)			
(a)	Temperature rise test			
(b)	Lighting Impulse test			
(c)	Switching Impulse test			
(d)	Determination of errors			
(e)	Short circuit withstand capability			
(f)	Chopped lighting impulse test			
	Total (Rs.):			

Annexure B- Details for Technical Clearance for Manufacturing

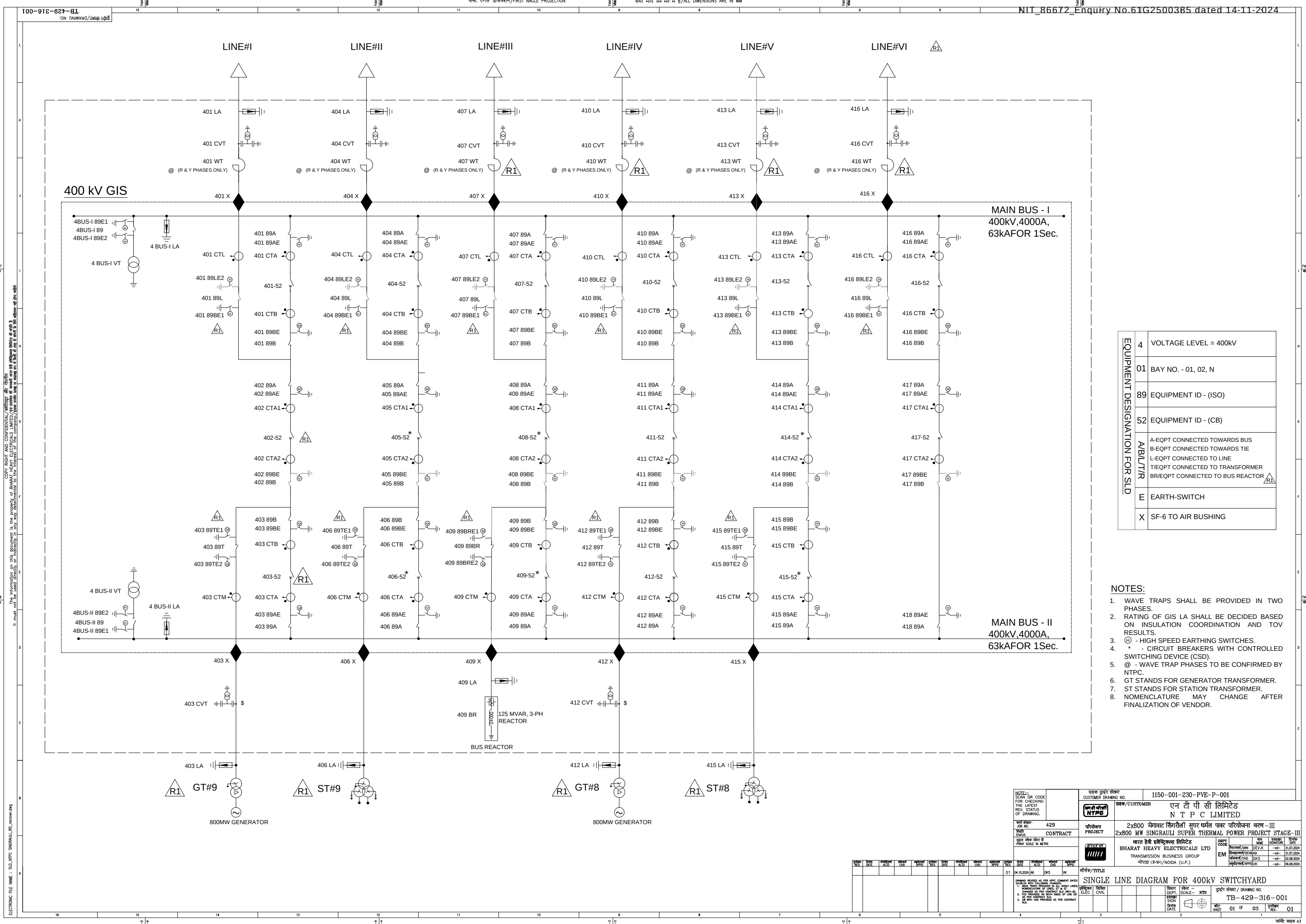
PROJECT NAME 400kV GIS Switchyard at Singrauli Super Thermal Power Project Stage- III (2x800MW)
CUSTOMER M/s NTPC Ltd.

Sl. No.	BHEL/ Customer Drawing/ Doc. No	Vendor Drawing/ Doc. No	Document Title	Approval Category (A- approval, I-Information)	Applicable for GIS items	Submission date	Remarks
1		--	GIS Gas Single Line Diagram (SLD) and Gas Schematics	A	GIS Bays, GIB ducts and SF6 to Air bushing module, LCC with gas monitoring system, CSD & PD monitoring system etc.		BHEL shall provide all the technical inputs requirements (e.g. Title Block, Master Drawing list, SLD, CT VT Parameters, Layout Plan & Section Drawings, interfacing drawings etc. as applicable) required for submission of drawings/ documents during detailed engineering stage, pendency of any input from BHEL, if required, bidder shall inform within two week time.
2		--	GIS Layout, Plan & Section and Isometric view (overall GIS) with BOM of GIB duct	A	GIS Bays, GIB ducts and SF6 to Air bushing etc.		
3		--	GIS Guaranteed Technical Particulars (GTP)	A	GIS Bays, GIB ducts and SF6 to Air bushing etc.		
4		--	GIS Manufacturing Quality Plan	A/ I	GIS Bays, GIB ducts and SF6 to Air bushing, LCC with gas monitoring system, CSD & PD monitoring system, Maintenance Equipment etc.		
5		--	GIS Type Test Reports	A/ I	GIS Bays, GIB ducts and SF6 to Air bushing etc.		
6		--	GIS Interface Drawing for SF6-TO-Air connection module	A	SF6 to Air bushing etc.		
7		--	GIS Secondary Engineering base Design (LCC Overview drawing and Interlock Logic Drawing)	A	LCC with gas monitoring system etc.		
8		--	CSD Manual/ Catalog	I	CSD etc.		
9		--	GIS LCC Schematics for GIS Bays	A	LCC with gas monitoring system etc.		
10		--	GIS GA Drawing, GTP, Schematics of Gas Monitoring System	A	LCC with gas monitoring system etc.		
11		--	GIS GA Drawing, GTP, Schematics of PD Monitoring System	A	PD monitoring system etc.		
12		--	GIS Maintenance Equipment Catalouge & GTP	A	GIS Maintenance Equipment etc.		
13		--	Insulation co-ordination study	A/ I	Surge Arrester etc., if applicable		
14		--	GIS Quantification of Spares	A/ I	Spares etc.		
15		--	GIS Earthing Layout Drawing with BOM and Design	A/ I	Earthing materials etc. *		
16		--	GIS Support Structure Layout Drawing with BOM and Design	A/ I	Structure & hardware etc. *		
17		--	GIS Civil Work Specification along Foundation loading and other interfacing details	A/ I	Input for civil engineering activities *		
18		--	GIS O&M Manual	A/ I	GIS Manual*		
19		--	GIS General and Special Tool List	A/ I	GIS general & special tools list, as applicable *		
20		--	Quantification of SF6 gas and Hydraulic Oil	A/ I	SF6 gas, Hydraulic Oil, as applicable *		

GIS PO	BOQ Item Sr. No.	Remarks
PO-1 (Main & ref. price Items Supply & Services)	A, D, E, F & G and/ or any other item not covered in PO 2 & PO 3	Based on engineering approval of drawing/ documents, as applicable, technical clearance for part/ full quantity shall be provided.
PO-2 (Maintenance Equipment)	B	Based on engineering approval of drawing/ documents, as applicable technical clearance for part/ full quantity shall be provided.
PO-3 (Spares)	C	Based on engineering approval of drawing/ documents, as applicable technical clearance for part/ full quantity shall be provided.

Notes:

- 1 Drawing/ document marked * shall not be considered for Engineering Delay Analysis.
- 2 Supply items such as SF6 gas/ Hydraulic oil, Structures & hardware, Earthing Material shall not be considered for Engineering Delay Analysis, However, bidder shall ensure timely supply, availability and completeness of work at site without any delay.
- 3 Drawings/ documents, not mentioned above but required for completeness of work shall be submitted for approval/ Information, if required.
- 4 In case drawing/ document are not duly stamped in category-1/ category-2 by Customer/ NTPC, BHEL stamped drawing in category-1 shall be treated final to proceed further.

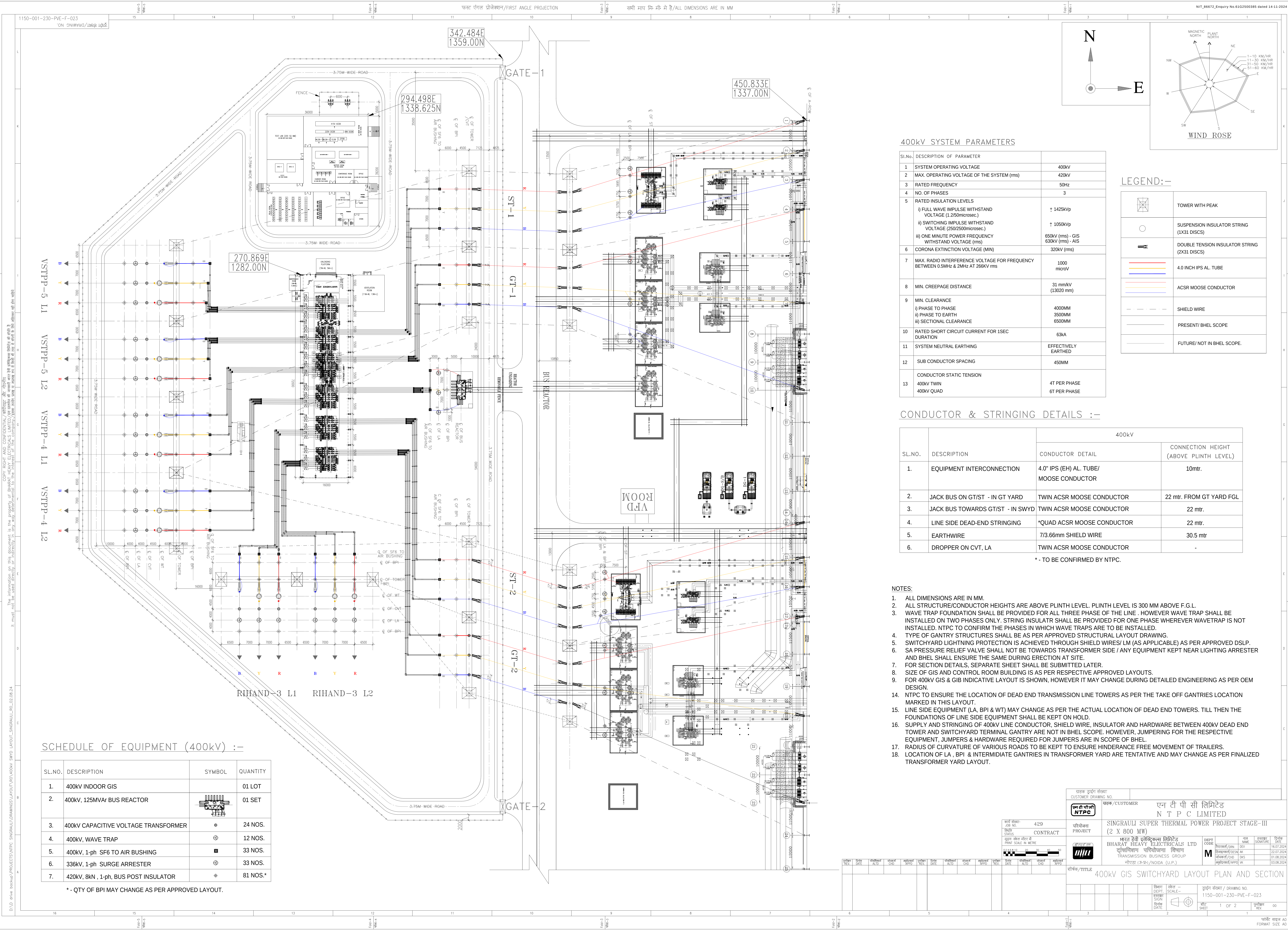


EQUIPMENT DESIGNATION FOR SLD	4	VOLTAGE LEVEL = 400kV	
	01	BAY NO. - 01, 02, N	
	89	EQUIPMENT ID - (ISO)	
	52	EQUIPMENT ID - (CB)	
	A/B/L/T/R	A-EQPT CONNECTED TOWARDS BUS	
		B-EQPT CONNECTED TOWARDS TIE	
		L-EQPT CONNECTED TO LINE	
		T/EQPT CONNECTED TO TRANSFORMER	
BR/EQPT CONNECTED TO BUS REACTOR			
E	EARTH-SWITCH		
X	SF-6 TO AIR BUSHING		

NOTES:

1. WAVE TRAPS SHALL BE PROVIDED IN TWO PHASES.
2. RATING OF GIS LA SHALL BE DECIDED BASED ON INSULATION COORDINATION AND TOV RESULTS.
3. ④ - HIGH SPEED EARTHING SWITCHES.
4. * - CIRCUIT BREAKERS WITH CONTROLLED SWITCHING DEVICE (CSD).
5. @ - WAVE TRAP PHASES TO BE CONFIRMED BY NTPC.
6. GT STANDS FOR GENERATOR TRANSFORMER.
7. ST STANDS FOR STATION TRANSFORMER.
8. NOMENCLATURE MAY CHANGE AFTER FINALIZATION OF VENDOR.

[illegible]



400kV SYSTEM PARAMETERS

Sl.No.	DESCRIPTION OF PARAMETER	
1	SYSTEM OPERATING VOLTAGE	400kV
2	MAX. OPERATING VOLTAGE OF THE SYSTEM (rms)	420kV
3	RATED FREQUENCY	50Hz
4	NO. OF PHASES	3
5	RATED INSULATION LEVELS i) FULL WAVE IMPULSE WITHSTAND VOLTAGE (1.2/50microsec.) ii) SWITCHING IMPULSE WITHSTAND VOLTAGE (250/2500microsec.) iii) ONE MINUTE POWER FREQUENCY WITHSTAND VOLTAGE (rms)	± 1425kVp ± 1050kVp 650kV (rms) - GIS 630kV (rms) - AIS 320kV (rms)
6	CORONA EXTINCTION VOLTAGE (MIN)	1000 microV
7	MAX. RADIO INTERFERENCE VOLTAGE FOR FREQUENCY BETWEEN 0.5MHz & 2MHz AT 26KV rms	31 mmkV (13020 mm)
8	MIN. CREEPAGE DISTANCE	4000MM 3500MM 6500MM
9	MIN. CLEARANCE i) PHASE TO PHASE ii) PHASE TO EARTH iii) SECTIONAL CLEARANCE	63kA
10	RATED SHORT CIRCUIT CURRENT FOR 1SEC DURATION	EFFECTIVELY EARTHED
11	SYSTEM NEUTRAL EARTHING	450MM
12	SUB CONDUCTOR SPACING	CONDUCTOR STATIC TENSION 400KV TWIN 400KV QUAD
13		4T PER PHASE 6T PER PHASE

LEGEND:-

	TOWER WITH PEAK
	SUSPENSION INSULATOR STRING (1X3 DISCS)
	DOUBLE TENSION INSULATOR STRING (2X3 DISCS)
	40 INCH IPS AL. TUBE
	ACSR MOOSE CONDUCTOR
	SHIELD WIRE
	PRESENT/ BHEL SCOPE
	FUTURE/ NOT IN BHEL SCOPE.

CONDUCTOR & STRINGING DETAILS :-

SL.NO.	DESCRIPTION	400kV	
		CONDUCTOR DETAIL	CONNECTION HEIGHT (ABOVE PLINTH LEVEL)
1.	EQUIPMENT INTERCONNECTION	4.0" IPS (EH) AL. TUBE/ MOOSE CONDUCTOR	10mtr.
2.	JACK BUS ON GT/ST - IN GT YARD	TWIN ACSR MOOSE CONDUCTOR	22 mtr. FROM GT YARD FGL
3.	JACK BUS TOWARDS GT/ST - IN SWYD	TWIN ACSR MOOSE CONDUCTOR	22 mtr.
4.	LINE SIDE DEAD-END STRINGING	*QUAD ACSR MOOSE CONDUCTOR	22 mtr.
5.	EARTHWIRE	7/3.66mm SHIELD WIRE	30.5 mtr
6.	DROPPER ON CVT, LA	TWIN ACSR MOOSE CONDUCTOR	

* - TO BE CONFIRMED BY NTPC.

NOTES:

- ALL DIMENSIONS ARE IN MM.
- ALL STRUCTURE/CONDUCTOR HEIGHTS ARE ABOVE PLINTH LEVEL. PLINTH LEVEL IS 300 MM ABOVE F.G.L.
- WAVE TRAP FOUNDATION SHALL BE PROVIDED FOR ALL THREE PHASE OF THE LINE. HOWEVER WAVE TRAP SHALL BE INSTALLED ON TWO PHASES ONLY. STRING INSULATR SHALL BE PROVIDED FOR ONE PHASE WHEREVER WAVETRIP IS NOT INSTALLED. NTPC TO CONFIRM THE PHASES IN WHICH WAVE TRAPS ARE TO BE INSTALLED.
- TYPE OF GANTRY STRUCTURES SHALL BE AS PER APPROVED STRUCTURAL LAYOUT DRAWING.
- SWITCHYARD LIGHTNING PROTECTION IS ACHIEVED THROUGH SHIELD WIRES/ LM (AS APPLICABLE) AS PER APPROVED DSLP.
- SA PRESSURE RELIEF VALVE SHALL NOT BE TOWARDS TRANSFORMER SIDE / ANY EQUIPMENT KEPT NEAR LIGHTING ARRESTER AND BHEL SHALL ENSURE THE SAME DURING ERECTION AT SITE.
- FOR SECTION DETAILS, SEPARATE SHEET SHALL BE SUBMITTED LATER.
- SIZE OF GIS AND CONTROL ROOM BUILDING IS AS PER RESPECTIVE APPROVED LAYOUTS.
- FOR 400kV GIS & GIB INDICATIVE LAYOUT IS SHOWN, HOWEVER IT MAY CHANGE DURING DETAILED ENGINEERING AS PER OEM DESIGN.
- NTPC TO ENSURE THE LOCATION OF DEAD END TRANSMISSION LINE TOWERS AS PER THE TAKE OFF GANTRIES LOCATION MARKED IN THIS LAYOUT.
- LINE SIDE EQUIPMENT (LA, BPI & WT) MAY CHANGE AS PER THE ACTUAL LOCATION OF DEAD END TOWERS. TILL THEN THE FOUNDATIONS OF LINE SIDE EQUIPMENT SHALL BE KEPT ON HOLD.
- SUPPLY AND STRINGING OF 400kV LINE CONDUCTOR, SHIELD WIRE, INSULATOR AND HARDWARE BETWEEN 400kV DEAD END TOWER AND SWITCHYARD TERMINAL GANTRY ARE NOT IN BHEL SCOPE. HOWEVER, JUMPING FOR THE RESPECTIVE EQUIPMENT, JUMPERS & HARDWARE REQUIRED FOR JUMPERS ARE IN SCOPE OF BHEL.
- RADIUS OF CURVATURE OF VARIOUS ROADS TO BE KEPT TO ENSURE HINDERANCE FREE MOVEMENT OF TRAILERS.
- LOCATION OF LA, BPI & INTERMEDIATE GANTRIES IN TRANSFORMER YARD ARE TENTATIVE AND MAY CHANGE AS PER FINALIZED TRANSFORMER YARD LAYOUT.

SCHEDULE OF EQUIPMENT (400kV) :-

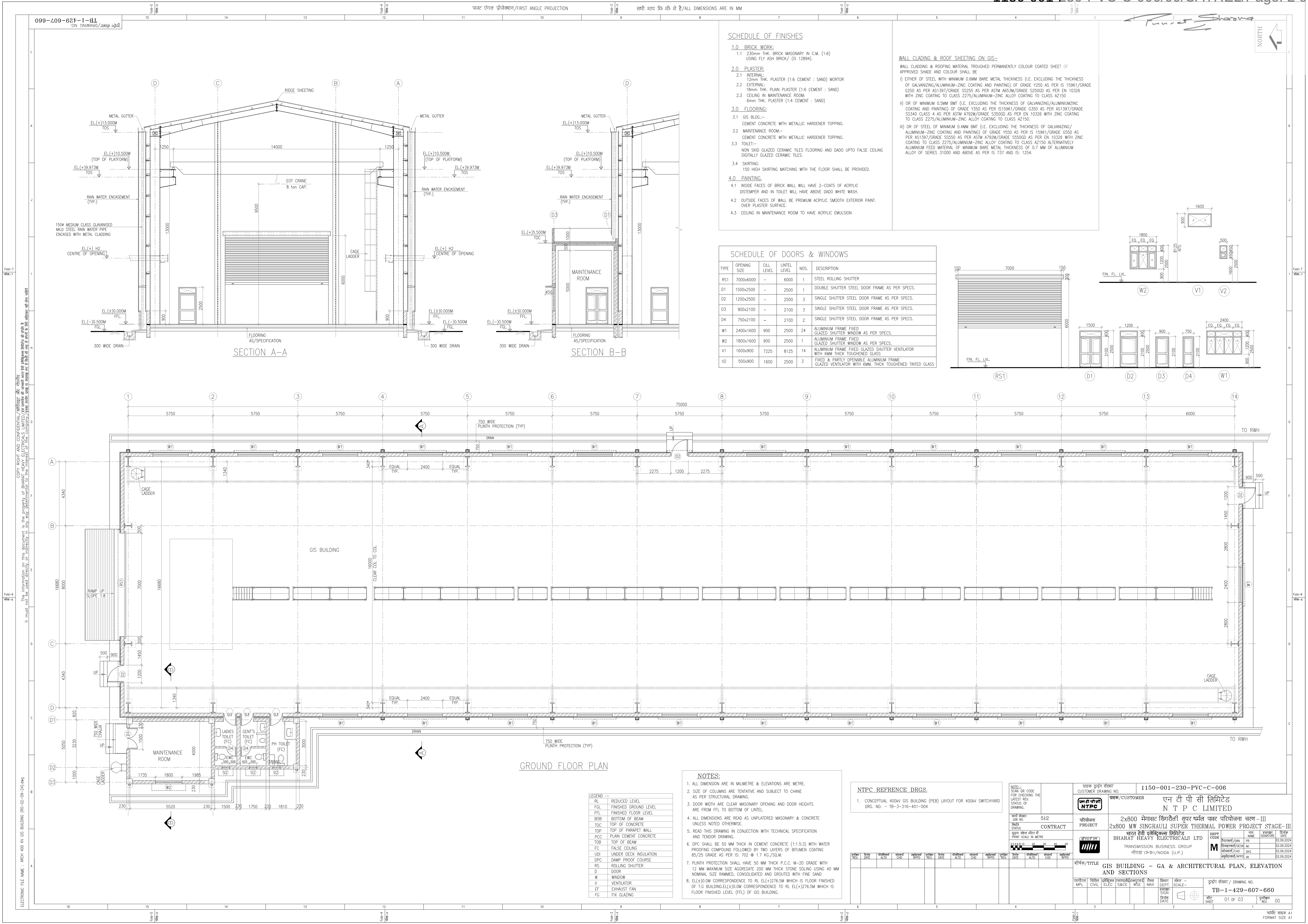
SL.NO.	DESCRIPTION	SYMBOL	QUANTITY
1.	400kV INDOOR GIS		01 LOT
2.	400kV, 125MVA BUS REACTOR		01 SET
3.	400kV CAPACITIVE VOLTAGE TRANSFORMER		24 NOS.
4.	400kV, WAVE TRAP		12 NOS.
5.	400kV, 1-ph SF6 TO AIR BUSHING		33 NOS.
6.	336kV, 1-ph SURGE ARRESTER		33 NOS.
7.	420kV, 8kN, 1-ph, BUS POST INSULATOR		81 NOS.*

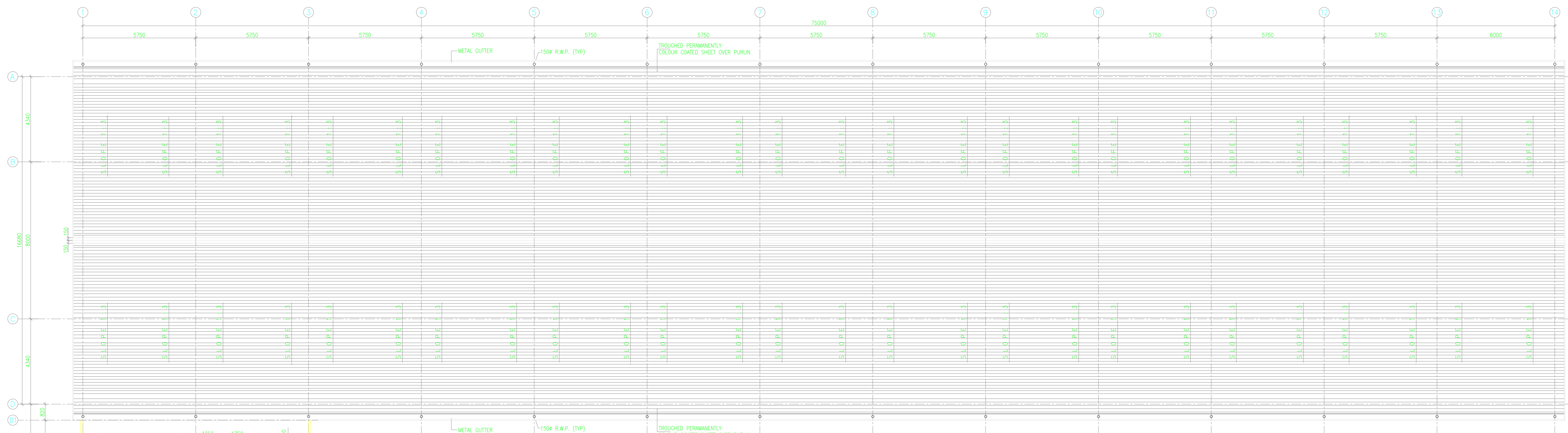
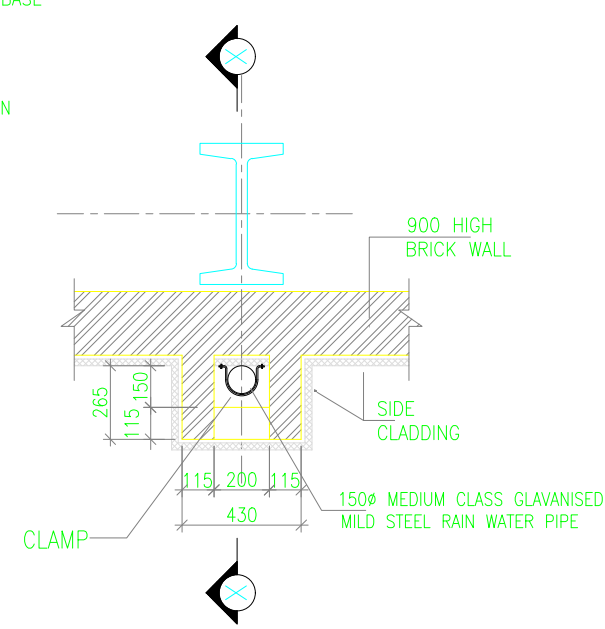
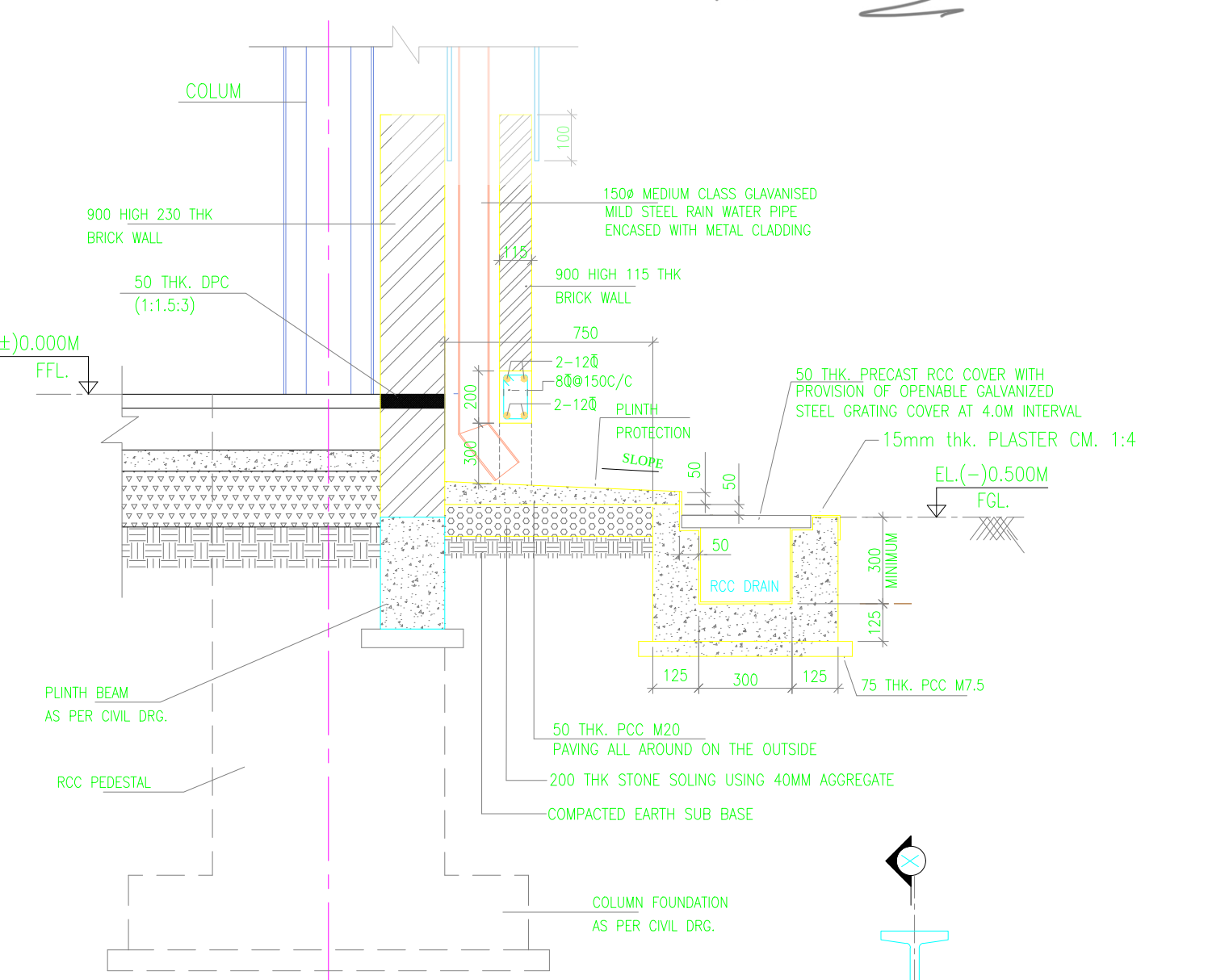
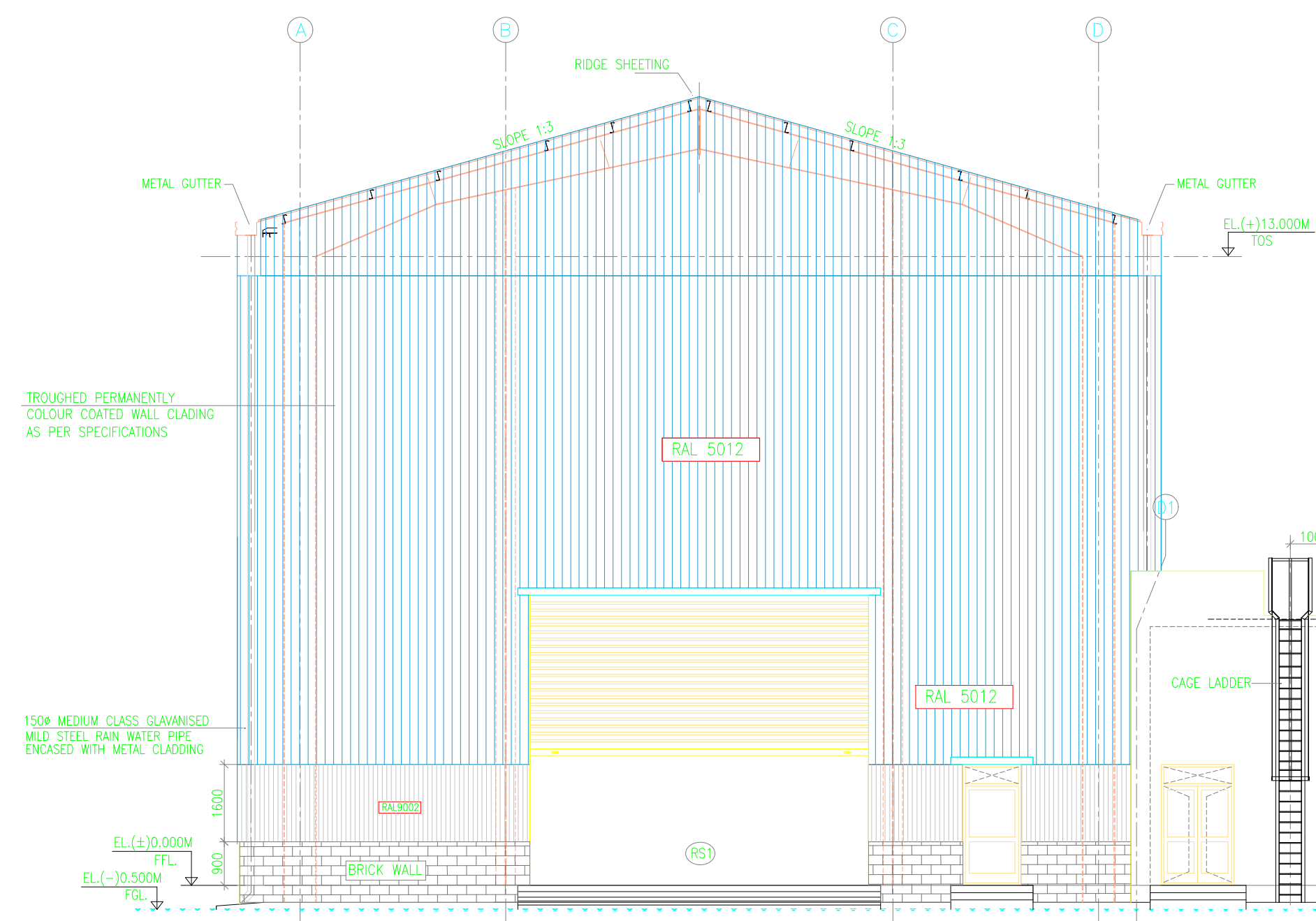
* - QTY OF BPI MAY CHANGE AS PER APPROVED LAYOUT.

यहक ड्राइंग संस्था CUSTOMER DRAWING NO.		यहक/CUSTOMER	
		एन टी सी लिमिटेड N T P C LIMITED	
कार्य संस्था- JOB NO.		परियोजना PROJECT	
429		SINGRAULI SUPER THERMAL POWER PROJECT STAGE-III (2 X 800 MW)	
ड्राइंग स्थिति DRAWING STATUS		ड्राइंग संस्था DRAWING STATUS	
CONTRACT		भारत हेवी इलेक्ट्रिकल्स लिमिटेड BHARAT HEAVY ELECTRICALS LTD	
ड्राइंग स्केल DRAWING SCALE		परियोजना समूह PROJECT GROUP	
1:1		नोएडा (उ.प्र.) NOIDA (U.P.)	
ड्राइंग संस्था DRAWING NO.		ड्राइंग संस्था DRAWING NO.	
1150-001-230-PVE-F-023		ड्राइंग संस्था DRAWING NO.	
1150-001-230-PVE-F-023		ड्राइंग संस्था DRAWING NO.	
1150-001-230-PVE-F-023		ड्राइंग संस्था DRAWING NO.	

शीट/TITLE: 400kV GIS SWITCHYARD LAYOUT PLAN AND SECTION

ड्राइंग संस्था DRAWING NO.	ड्राइंग संस्था DRAWING NO.	ड्राइंग संस्था DRAWING NO.	ड्राइंग संस्था DRAWING NO.
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1150-001-230-PVE-F-023	1150-001-230-PVE-F-023	1150-001-230-PVE-F-023	1150-001-230-PVE-F-023
1150-001-230-PVE-F-023	1150-001-230-PVE-F-023	1150-001-230-PVE-F-023	1150-001-230-PVE-F-023

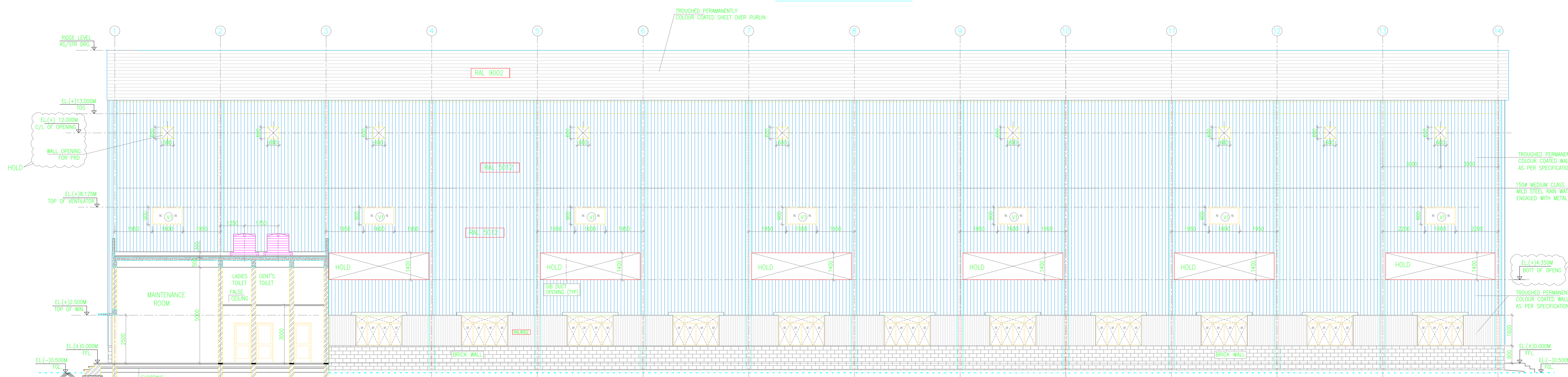
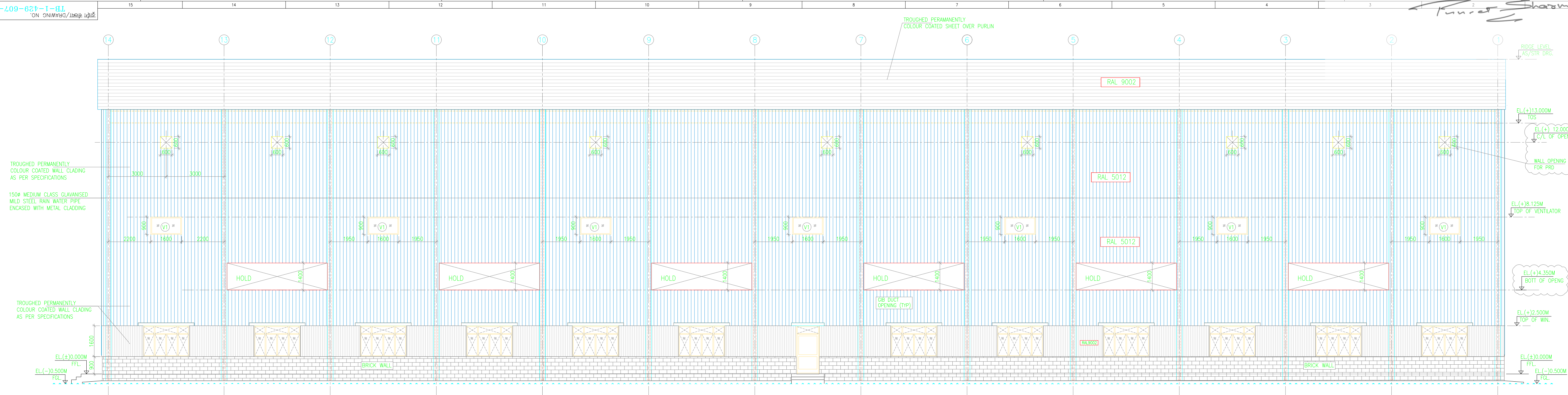




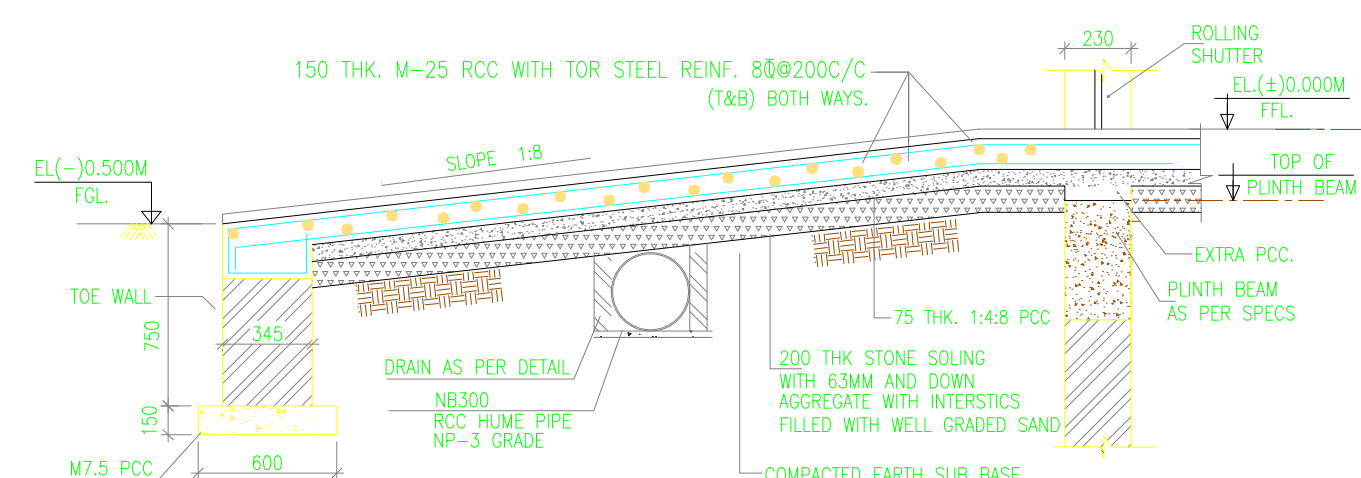
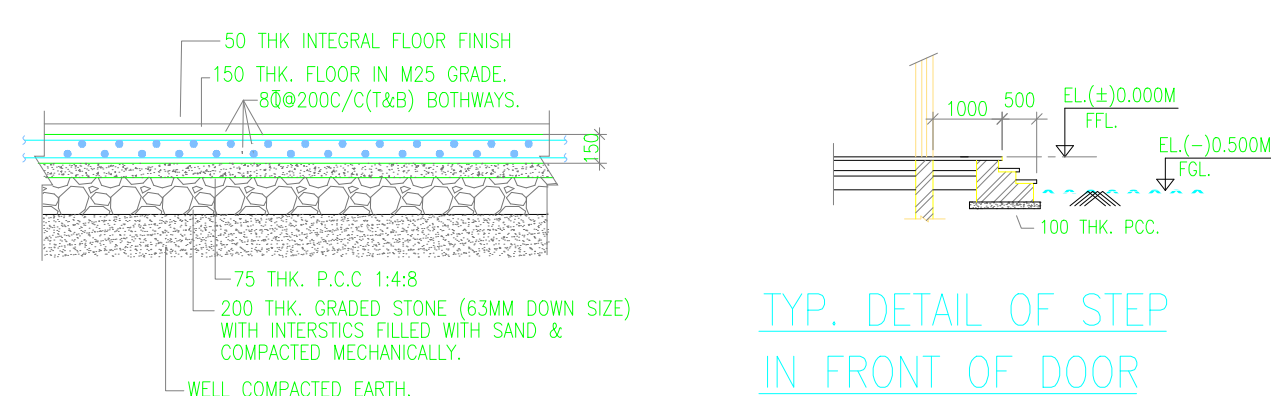
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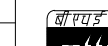
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ग्राहक / कर्ता योजना CUSTOMER DRAWING NO.		1150-001-230-PVC-C-006									
प्रक्राहक/CUSTOMER		एन टी पी सी लिमिटेड N T P C LIMITED									
परियोजना PROJECT		2x800 मेगावाट सिंगराउली सुपर थर्मल पावर परियोजना चरण -III 2x800 MW SINGRAULI SUPER THERMAL POWER PROJECT-STAGE-II									
भारत हीवी इलेक्ट्रिकल्स लिमिटेड BHARAT HEAVY ELECTRICALS LTD		DEPT CODE		पाना NAME	इजाजत DATE						
TRANSMISSION BUSINESS GROUP		M		पावरलै /जन POWER/GEN	PR	07.09.20					
नोएडा (ऊन-प)/NOIDA (U.P.)				डिवीज़न /सीडी DIVISION/CD	DES	02.09.20					
				इंजीनियरिंग/सीडी ENGINEERING/CD	DES	02.09.20					
शीट/TITLE:		GIS BUILDING – GA & ARCHITECTURAL PLAN, ELEVATION AND SECTIONS									
अपरोल MPPL		सिलिल CIVIL	लिङ्क ELECTR	स्तरावळी SURVEY	मेका MECH	विभा GA	कोल – SCALE=	दुवरी लॅआटा / DRAWING NO.			
								TB-1-429-607-660			
						दिना SIGN	दिवस DATE				
						मील REV.	परिवर्तन REV.				
							02 OF 03	दुवरी लॅआटा REV. (00)			



NOTE: 1. GA OF GIS BUILDING WILL BE SUBMITTED IN
NEXT REVISION AFTER APPROVAL OF ARCHITECTURAL DRAWING.
2. HOLD WILL BE REMOVED AFTER RECEIVING FINAL INPUT FROM
MECHANICAL AND ELECTRICAL.



NOTE:- SCAN QR CODE FOR CHECKING THE LATEST REV. STATUS OF DRAWING.										डाकूना ड्रॉइंग संख्या CUSTOMER DRAWING NO.										1150-001-230-PVC-C-006																																																																					
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क्रेडिट STATUS										CONTRACT										परियोजना PROJECT										2x800 मेगावाट सिंगरावली सुपर थर्मल पावर परियोजना चरण -III 2x800 MW SINGRAULI SUPER THERMAL POWER PROJECT STAGE-I																																																											
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भारत/INDIA										TRANSMISSION BUSINESS GROUP										मोडल (उप-)/INDIA (U.P.)										भारत/INDIA										02.09.20										भारत/INDIA										02.09.20										भारत/INDIA										02.09.20									
गैस बिल्डिंग / TITLE										GIS BUILDING – GA & ARCHITECTURAL PLAN, ELEVATION AND SECTIONS										ग्राहक संख्या / DRAWING NO.										TB-1-429-607-660																																																											
मैनोमैटर MANOMETER										ड्रॉइंग DRAWING										डिजाइन DESIGN										डिजाइन DATE										ड्राइंग SHEET										ड्राइंग REV.										ड्राइंग REV.																													
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Bharat Heavy Electricals Limited

Project: 400kV GIS Switchyard at Singrauli Super Thermal Power Project Stage- III (2x800MW)

Customer: NTPC Ltd.

Technical Specification: 400kV Gas Insulated Switchgear & its accessories

Doc No. TB-429-316-001 **Rev** 00

Contents

SECTION 2:

EQUIPMENT SPECIFICATION UNDER SCOPE OF SUPPLIES/
SERVICE

1. CUSTOMER TECHNICAL SPECIFICATION



SUB-SECTION-B – 17

SWITCHYARD ELECTRICAL

**SINGRAULI SUPER THERMAL POWER PROJECT
STAGE-III (2X800 MW)
EPC PACKAGE
BID DOC NO.: CS-1150-001R2**

**TECHNICAL SPECIFICATION
SECTION - VI
PART-B**

CLAUSE NO.	TECHNICAL REQUIREMENTS			एनडीपीसी NTPC
CHAPTER: SWITCHYARD ELECTRICAL				
1.00.00	SCOPE AND GENERAL INFORMATION:			
1.01.00	In addition to the detailed scope and other requirements specified in Part-A, the intent of the specifications for various electrical equipments shall also cover the following scope:			
1.01.01	Contractor shall be responsible for design and engineering of overall system/station, and all elements, systems, sub-systems, facilities, equipments, material, etc. The Contractor shall submit design calculations, drawings, codes, codes of practices, construction drawings, etc. for Employer's approval.			
1.01.02	The basic design shall include, but not limited to, the following: a) Development of general arrangement. b) Development of detailed layout (plan & section/elevation) drawings. c) Development of single line diagram with parameters of equipment and details of protection. d) Protection and control philosophy and selection of protection, control and annunciation schemes. e) Development of interlocking schemes. f) Development of switchyard structure loading details. g) Development of earthing system. h) Development of direct stroke lightning protection system. i) Insulation coordination of the EHV equipment. j) Calculation of static and dynamic force load, and selection of spacer spans and equipment terminal loading. k) Development of clearance diagrams. l) Lighting design, Lux level calculation and conduit wiring diagram. m) Development of power & control cable laying and termination schedules. n) Relay setting calculations. o) Development of erection key diagram with bill of material. p) Foundation design and construction drawings. q) Development of cable trench layout and sections and construction drawings.			
1.01.03	Contractor shall furnish the detailed drawings for the various equipments covered in their scope , design calculations and construction drawings for all civil works, schematics, schedules, panel wiring diagrams , general arrangement drawings, schedules, interconnection schemes, cable schedules , interconnection schedules. etc for employers approval. Contractor shall also furnish the recommended relay settings to be adopted			
1.01.04	Exposed live parts shall be placed high enough above ground to meet the requirements of Indian Electricity Rules and other statutory codes. All responsibilities regarding co-ordination with Electrical Inspection Agencies and obtaining clearance certificate from them rests with the Contractor. The necessary fees for such clearances shall be borne by the Owner.			
1.01.05	All equipment shall be supplied with suitable terminal connectors. The terminal connectors shall be well coordinated with type/size of conductor and equipment to be connected. The conductor terminations for equipment shall be either rigid or expansion type suitable for horizontal or vertical take off suitable for tube/quadruple/twin/single moose conductor. For Jack Bus Line side Quad ACSR Moose and rest Twin ACSR Moose shall be used. The sub conductor spacing for quadruple and twin moose ACSR conductor shall be 450 mm for 400kV. The terminal pads shall preferably be capable of taking the required conductor span under normal, short circuit and meteorological conditions, without effecting the performance of the equipment.			
SINGRAULI STPP STAGE-III (2X800 MW) EPC PACKAGE		TECHNICAL SPECIFICATION SECTION – VI, PART-B	SUB-SECTION-B-17 SWITCHYARD	Page 1 of 100

CLAUSE NO.	TECHNICAL REQUIREMENTS	एनडीपीसी NTPC		
1.01.06	The rigid busbars for equipment inter connections shall have rigid connections at one end and expansion /flexible at other end. The tubular Al. connections shall have not more than one joint per span. Corona Bell shall be provided at the end of the rigid busbars.			
1.01.07	Not used			
1.01.07A	The line take off arrangement from GIS building up to line take off/intermediate gantry (as required) shall be through GIS ducts as indicated in Single line diagram. The line side insulators and hardware shall be provided by the line contractor for the lines which are not in the scope of contract, however the clamps and connectors for droppers to equipments are in the bidders scope. Location of line take off gantry and intermediate gantry (as required) for termination of Transmission line dead end tower to switchyard shall be finalized during detailed engineering based on the technical requirements. All the terminations shall be done as indicated in the Single line diagram. High speed earth switches(HES) shall be provided wherever required, HES shown in the SLD are the minimum requirements.			
1.01.08A	The minimum sizing criteria of the control room and GIS building shall be as given below: i)The GIS building shall be adequately designed so as have a passage of 2.0 m on either side and adequate overhead clearance for the movement of equipments without any obstruction, from the top of the GIS equipment to EOT Crane. The GIS Control Room Building shall have with provision of Switchgear room, Battery room, charger room, office, cable vault, SAS room, Lab room, CRP Panel room, conference room, Pantry, toilet etc. The GIS & control room building is to be designed keeping future provision for extension if any as shown in the Single line diagram. The GIS building shall have adequate provision (at least 4.0m) for maintenance bay shall be provided one side of GIS building considering the future provision for GIS extension. ii)Maintenance room (as a part of GIS building) shall be constructed for carrying out repair works / small part assembly, storage of material, test equipment and tools and tackles to be stored separately from GIS hall in this room. iii) GIS building shall have with provision of Toilet room etc..			
1.01.08B	The EOT crane to be provided inside the GIS building shall be of min. 6T capacity or as per the calculation of capacity required to move heaviest part for maintenance.			
1.01.09	All equipments shall be suitable for hot lie washing .The sag tension, conductor spacing, short circuit forces, spacer location, conductor swing and clearances shall be carried out in accordance with IEC 60865 to achieve the specified clearances. Short circuit force calculation shall be submitted by the bidder as per relevant IEC for Flexible bus and rigid bus. This short circuit force shall be considered for designing of Tower, Girder and equipment structure and their foundation.			
1.01.10	All overhead stringing shall be carried out by minimum double tension string insulator assembly. The earth wire for shielding purpose shall be double anchored at the towers/ other locations and shall run through with out cutting wherever feasible so as to avoid snapping. The earth wires crossing each other shall also be bolted together for additional safety.			
1.01.11	Bus Post insulators shall be provided at line entry and near transformers and other jumpers to avoid mechanical forces on the LA's and Bushings etc.			
1.01. 12	Necessary fire wall shall be provided between single phases of reactors. The fire wall height shall be 500mm above reactor bushing.			
SINGRAULI STPP STAGE-III (2X800 MW) EPC PACKAGE		TECHNICAL SPECIFICATION SECTION – VI, PART-B	SUB-SECTION-B-17 SWITCHYARD	Page 2 of 100

CLAUSE NO.	TECHNICAL REQUIREMENTS			एनटीपीसी NTPC								
1.01. 13	The pit size of reactors shall be designed for minimum 1000mm beyond the physical dimension of the reactor.											
1.01. 14	i)The towers and gantries shall be suitable for a normal conductor tension of minimum 2T/conductor in case of twin moose and 1.5T/conductor in case of quad moose conductor. The foundations and structures etc. shall be designed accordingly. ii)The minimum vertical distance from the bottom of the lowest porcelain part of the bushing, porcelain enclosures or supporting insulators to the bottom of the equipment structure, where it rests on the foundation pad shall be 2550 mm. All gantries and towers (including intermediate/required for turning etc.) as required for GT & ST O/H stringing & its anchoring on A-Row column of TG Building and line take off, are to be provided by the contractor. Minimum height of 400KV gantry for AIS shall be 16M+8.5MPeak however intermediate gantry height for O/H connection for GT shall be min. 22m+8.5m. Minimum height of 400KV AIS equipment level shall be 8.0M from the plinth level. The gantry width for 400kV AIS shall be min.27mt. In case of space constraint in the switchyard, the bidder may design considering the bay width of <27mtr for 400KV Level subjected to meet the statutory electrical clearances etc. Various minimum heights of the 400KV AIS switchyard shall be as given below from plinth level: <table><tr><th>Voltage Level</th><th>Equipmt.1st level</th><th>2nd level</th><th>3rd level</th></tr><tr><td>400KV (1½ breaker scheme.)</td><td>8000mm</td><td>16000mm</td><td>23000mm</td></tr></table>				Voltage Level	Equipmt.1 st level	2 nd level	3 rd level	400KV (1½ breaker scheme.)	8000mm	16000mm	23000mm
Voltage Level	Equipmt.1 st level	2 nd level	3 rd level									
400KV (1½ breaker scheme.)	8000mm	16000mm	23000mm									
1.01.15	The switchyard shall be provided with peripheral roads and roads for maintenance/approach for GIS equipment, GIS Duct, major AIS equipment for maintenance purpose. The specification for Roads (RCC / B.T) some where else specified in the specification.											
1.01.16	CVT JB shall have fuses for each core of the CVT.											
1.01.17	The illumination level for AIS shall be 20 lux in general and minimum 50lux on equipment boxes. No lighting fixture shall be mounted on gantries, they shall be mounted on Structured Lightning Cum Lighting Masts or Structured Lighting Masts / towers only . For Approach / work roads , Lighting pole to be used . Specification of lighting is provided elsewhere in the specification. Detailed specification covered in Section -VI, Part-B, B-11(Lighting)..											
1.01.18	Contractor shall provide panel mounted automatic start / stop type centrifugal self-priming pump for sump pit to drain the water in approximately one (1) hour. The contractor shall also provide suitable pedestal / foundation for this pump. The pump shall be complete with all necessary fittings such as NRV, inlet & outlet pipes of suitable length and dia. The out door cable trenches shall be connected to common sump pit with necessary slope shall be maintained. In side GIS building , Switchyard MCC room , control room etc for cable trenches , panel mounted automatic start / stop type centrifugal self-priming pump shall be provided to drain the water in approximately one (1) hour.											
1.01.19	All 'T' off connections at 'A' row of TG Building associated with transformers shall be provided with a bye pass utilizing two PG clamps for each T off. As far as possible the											
SINGRAULI STPP STAGE-III (2X800 MW) EPC PACKAGE		TECHNICAL SPECIFICATION SECTION – VI, PART-B	SUB-SECTION-B-17 SWITCHYARD	Page 3 of 100								

CLAUSE NO.	TECHNICAL REQUIREMENTS			एनटीपीसी NTPC
	conductor shall pass without cut/joint unless otherwise necessary for planned shutdown/maintenance.			
1.01.20	75mm thick base layer of M5 grade PCC shall be provided over the prepared sub grade in the entire area of the Switchyard inside the fence excluding foundations, roads, drains, cable trenches as per detailed engineering drawing. In switchyard area earth resistance measurement points shall be marked in the layout where the PCC shall not be provided. For easy drainage of water, adequate slope is to be provided from the ridge to the nearest drain. A final layer of minimum 75mm thickness of stone aggregate of 40mm nominal size shall be spread uniformly over PCC layer. In Switchyard before laying of PCC layer, the subgrade shall be properly compacted, and the top layer of the soil shall be treated for anti-weed considering the type of weeds found in the vicinity.			
1.01.21	Adequate AC & Ventilation of Control room building and Ventilation of GIS Building, switchgear room etc. is to be provided by the contractor. Specification of AC & Ventilation is specified elsewhere in the specification (Part-B Mechanical) .			
1.01.22	The cable trenches from control room to switchyard shall be designed to cater as required for bays indicated in SLD. The contractor shall construct the common sections suitably of appropriate sizes upto common points so that the same can be extended in future.			
1.01.23	Voltage drop for sizing of power cables shall not be more than 6%.			
1.01.24	one no(1no) suitable industrial socket and suitable power cable for oil filtration equipment for Bus reactor shall be provided.			
1.01.25	The cable trenches , cable trays & supports, accessories , Roads , drains & its interconnection to storm water drain , fencing with gate required for present scope of bays.			
1.01.26	Contractor shall make earth resistivity measurements at site (based on four electrode method) and design the earthing grid as per IEEE: 80 (Latest edition) and Gravel filling of switchyard . Earthing of all switchyard equipments and its connection to earthing grid. Also connection of switchyard earthing grid with main plant earthing grid. Earth pit as per IS 3043 as required.			
1.01.27	Complete Direct Stroke Lightning Protection using Lightning Mast and/or shield wire and its connection to earth mat as required of 400kV switchyard of present scope of Bays , Transformer yard.			
1.01.28	Supply & laying of power, control cables , Screen cable, Fibre optic cable and cabling between Contractor supplied equipment and Owner supplied equipment required. etc , from owner feeders , panels and from present scope of panels to existing panels to complete the system is in the scope of Bidder.			
1.01.29	Lighting, earthing , lightning protection of Present scope of bays. However any items though not specifically mentioned but which are required to make the switchyard complete in all respects for its safe, efficient, reliable and trouble free operation shall be supplied and erected by the Contractor, unless they are specifically excluded in the text of exclusions given in the specification.			
1.02.00	CLEARANCES : The minimum clearances for 400kV AIS shall be as given below:			
SINGRAULI STPP STAGE-III (2X800 MW) EPC PACKAGE		TECHNICAL SPECIFICATION SECTION – VI, PART-B	SUB-SECTION-B-17 SWITCHYARD	Page 4 of 100

CLAUSE NO.	TECHNICAL REQUIREMENTS		एनटीपीसी NTPC																					
	<table><tr><td>Description</td><td>400kV</td></tr><tr><td>Phase to earth clearance</td><td>3500mm</td></tr><tr><td>Phase to Phase clearance</td><td>4000mm</td></tr><tr><td>Sectional clearance</td><td>6500mm</td></tr></table> The Contractor shall supply the structures suitable to meet the above clearances. The Contractor shall furnish clearance diagram in support of same for approval of Owner.	Description	400kV	Phase to earth clearance	3500mm	Phase to Phase clearance	4000mm	Sectional clearance	6500mm															
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Phase to earth clearance	3500mm																							
Phase to Phase clearance	4000mm																							
Sectional clearance	6500mm																							
1.03.00	EARTHING : For earthing 50x6 mm GS flat shall be used in all cabinets, MOM boxes, panels and balance all other earthing such as all equipments, towers, cable trenches etc shall be through 75x12mm GS Flat. The Switchyard earthing criteria is given in Annexure-II of this specification.																							
1.04.00	LIGHTING :The illumination level shall be minimum 20 lux in general and 50 lux on equipment boxes, at equipments of switchyard . Detailed specification covered in Section -VI, Part-B, B-11(Lighting).																							
1.05.00	EQUIPMENT CONNECTOR RATING :The connectors and clamps shall be rated same as the connected equipments																							
1.06.00	CIVIL DESIGN :The civil design criteria is given in Civil Chapter of Technical specification																							
1.07.00	CONTROL PHILOSOPHY :The switchyard control philosophy and protection system is described in chapter B13 Substation Automation System of section-VI Part-B.																							
1.08.00	SERVICES TO BE PERFORMED BY THE EQUIPMENT BEING SUPPLIED: The system shall be designed to limit the power frequency over voltage of 1.5 p.u. and the switching surge over voltage to 2.5 p.u. In 400 kV system the initial value of temporary over voltage could be 2.0 p.u. for 1-2 cycles. All the equipment/materials covered in this specification shall perform all its function satisfactorily without undue strain, restrike etc. under such over voltage conditions.																							
1.09.00	SITE SUPERVISION OF EQUIPMENTS: The contractor shall ensure that, erection, testing and commissioning of, GIS, Circuit Breaker, Isolator, Instrument Transformer, Surge Arrestor, Substation Automation System & protective relays is carried out, under the supervision of manufacturer of respective equipment.																							
1.10.00	Insulation Co-Ordination and Selection of Surge Arrestor:																							
1.10.01	The contractor shall be fully responsible for complete insulation co-ordination of switchyard. Contractor shall ensure that adequate protective margin is available. If surge arrestors at some more locations other than those indicated in the tender drawings are required to be provided, the same shall be deemed to be included in the offer.																							
1.11.00	SYSTEM PARAMETERS For GIS (400kV) : <table><tr><td>Sl.no</td><td>Description</td><td></td></tr><tr><td>a</td><td>i)Highest System voltage</td><td>420kV rms</td></tr><tr><td></td><td>ii)Rated / Nominal system voltage</td><td>400kV rms</td></tr><tr><td>b)</td><td>Lightning impulse voltage (ph to earth& between phases)</td><td>±1425kVp</td></tr><tr><td></td><td>Across isolating distance</td><td>1425(+240) KVp</td></tr><tr><td>c)</td><td>Switching impulse voltage (ph to earth)</td><td>±1050kVp</td></tr><tr><td></td><td>Across isolating distance</td><td>900(+345) KVp</td></tr></table>			Sl.no	Description		a	i)Highest System voltage	420kV rms		ii)Rated / Nominal system voltage	400kV rms	b)	Lightning impulse voltage (ph to earth& between phases)	±1425kVp		Across isolating distance	1425(+240) KVp	c)	Switching impulse voltage (ph to earth)	±1050kVp		Across isolating distance	900(+345) KVp
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<table><tr><td>SINGRAULI STPP STAGE-III (2X800 MW) EPC PACKAGE</td><td>TECHNICAL SPECIFICATION SECTION – VI, PART-B</td><td>SUB-SECTION-B-17 SWITCHYARD</td><td>Page 5 of 100</td></tr></table>				SINGRAULI STPP STAGE-III (2X800 MW) EPC PACKAGE	TECHNICAL SPECIFICATION SECTION – VI, PART-B	SUB-SECTION-B-17 SWITCHYARD	Page 5 of 100																	
SINGRAULI STPP STAGE-III (2X800 MW) EPC PACKAGE	TECHNICAL SPECIFICATION SECTION – VI, PART-B	SUB-SECTION-B-17 SWITCHYARD	Page 5 of 100																					

CLAUSE NO.	TECHNICAL REQUIREMENTS																																																							
	d	Power frequency withstand (for 1 min. rms.) to earth & between phases	650kVrms																																																					
		Across isolating distances	815kVrms																																																					
	e	Max.fault level(1sec)	63kA																																																					
	d	Rated dynamic with stand current	157.5 kAP																																																					
	f	PD Level for GIS	<5pico coulomb																																																					
	g	Rated frequency	50Hz																																																					
	h	Rated Ambient Temperature	50.deg.Cen																																																					
	i	System earthing	Effectively earthed																																																					
	1.11.01	FOR AIS (400kV) :																																																						
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	Note: Bidder to consider above parameters for all the equipment's of GIS & AIS. For other Parameters bidder to refer respective chapter.																																																							
1.12.00	TYPE TEST REQUIREMENTS:																																																							
1.12.01	TYPE TEST REQUIREMENTS FOR EQUIPMENTS OTHER THAN GIS :																																																							
a)	All equipments to be supplied shall be of type tested design. During detail engineering, the contractor shall submit for Owner's approval the reports of all the type tests as listed in this specification. The validity period of reports shall be as per CEA Guidelines for the validity period of Type test(s) conducted on Major Electrical Equipment in power Transmission-May2020 & with latest amendments for the from the date of bid opening. These reports should be for the test conducted on the equipment similar to those proposed to be supplied under this contract and the test(s) should have been either conducted at an independent laboratory or should have been witnessed by a Client.																																																							
b)	However if contractor is not able to submit report of the type test(s) conducted as per CEA Guidelines for the validity period of Type test(s) conducted on Major Electrical equipment in																																																							
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1.12.02	power Transmission-May2020 & with latest amendments from the date of bid opening, or in the case of type test report(s) are not found to be meeting the specification requirements, the contractor shall conduct all such tests under this contract at no additional cost to the owner either at third party lab or in presence of client/ owners representative and submit the reports for approval.							
	c) All acceptance and routine tests as per the specification and relevant standards shall be carried out. Charges for these shall be deemed to be included in the equipment price.							
1.12.02	TYPE TEST REQUIREMENTS FOR 400 GIS CIRCUIT BREAKER:							
	a) The Contractor shall carry out the type tests as listed in this specification on the equipment to be supplied under this contract. The Bidder shall indicate the charges for each of these type tests separately in the relevant schedule of BPS and the same shall be considered for the evaluation of bids. The type test charges shall be paid as per the charges quoted for each of these type tests separately in the relevant schedule of BPS (Bid Proposal Sheet) & no qty variation is allowed. only for the test(s) conducted successfully under the contract and upon certification by the Employer's engineer.							
	b) Bidder refer to Sub section -IIB -Electrical Systems / Equipments Clause Type Test:							
1.12.03	c) In case the Contractor has conducted such specified type test(s) according to the relevant standard and / or specification as per CEA Guidelines for the validity period of Type test(s) conducted on Major Electrical equipment in power Transmission-May2020 & with latest amendments as on date of bid opening, submit the type test reports to the Employer for waiver of conductance of such type test(s). These reports should be for the test conducted on the equipment similar to those proposed to be supplied under this contract and the test(s) should have been either conducted at an independent laboratory or should have been witnessed by a Client. The Employer reserves the right to waive conducting of any or all the specified type tests(s) under this contract. In case the type tests are waived, the type test charges shall not be payable to the Contractor.							
	Common requirements (For GIS):							
	a) The Employer will have the right of getting any test of reasonable nature carried out on any component or completely assembled equipment at Contractor's premises or at site or in any other place in addition to the aforesaid type and routine tests, to satisfy that the materials/equipment comply with the specification.							
1.12.03	b) Failure of any equipment to meet the specified requirements of tests carried out at works or at site shall be sufficient cause for rejection of the equipment. Rejection of any equipment will not be held as a valid reason for delay in the completion of the works as per schedule. Contractor shall be responsible for removing all deficiencies and supplying the equipment that meet the requirement.							
	c) All equipments with their terminal connectors, control cabinets, main protective relays, energy meters etc. as well as insulators, insulator strings with hardware, clamps and connectors, marshalling boxes etc. shall be subjected to routine and acceptance tests in accordance with the requirements stipulated under respective equipment sections. Charges for the same shall be deemed to be included in the equipment price.							
	d) The following type tests (as applicable) are proposed to be conducted on a complete single pole assembly of one typical GIS switchgear bay module as per IEC 62271-203. The one Typical GIS switchgear bay module consists of equipment like Circuit breakers, Current transformers, Disconnectors / isolator, earth switches etc. of each type / rating.							
		<table><tr><td>Sl.No</td><td>List of Type tests as per IEC.</td></tr><tr><td></td><td></td></tr></table>			Sl.No	List of Type tests as per IEC.		
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	i)	Lightning impulse voltage dry tests.															
	ii)	Switching impulse voltage dry tests															
	iii)	Power frequency voltage dry tests.															
	iv)	Partial discharge tests															
	v)	Radio Interference Voltage test (as applicable)															
	vi)	Test to prove the temperature rise of any part of the equipment and measurement of the resistance of the main circuit.															
	vii)	Test to prove the ability of the main circuit and earthing circuit to carry the rated peak and the rated short time withstand current.															
	viii)	Test to verify the making and breaking capacity of the included switching devices.															
	ix)	Test for satisfactory operation of the included switching devices															
	x)	Test to prove the strength of enclosures															
	xi)	Gas tightness test															
	xii)	Electromagnetic capability test (if applicable)															
	xiii)	Test on partitions															
	xiv)	Internal arc tests.															
	xv)	Mechanical operation tests.															
	xvi)	Test to prove the satisfactory operation at limit temperature															
	xvii)	Verification of degree of protection of auxiliary and control circuits															
	xviii)	Test to prove performance under thermal cycling and gas tightness test on gas barrier insulators															
	xix)	Capacitive Current switching test															
	xx)	Shunt reactor current switching test															
	For surge arrestor and Bus VT following type tests are proposed to be conducted as per relevant IEC. <u>Surge Arrestor (As per IEC 60099-4)</u> <table><tr><td>a)Insulation with stand test on housing</td><td>b)Residual voltage test</td></tr><tr><td>c)Long duratrion current impulse with stand test</td><td>d)pressure relief test (if applicable)</td></tr><tr><td>e)operating duty test</td><td>f) Partial discharge test</td></tr><tr><td>g) leakage test</td><td></td></tr></table> <u>BUS VT (As per IEC 60044-2)</u> <table><tr><td>a) Temparature rise test</td><td>b)Lightning impulse test</td></tr><tr><td>c) switching impulse test</td><td>d) Determination of errors</td></tr><tr><td>e) short circuit with stand capability</td><td>f)chopped lightning impulse test</td></tr></table>			a)Insulation with stand test on housing	b)Residual voltage test	c)Long duratrion current impulse with stand test	d)pressure relief test (if applicable)	e)operating duty test	f) Partial discharge test	g) leakage test		a) Temparature rise test	b)Lightning impulse test	c) switching impulse test	d) Determination of errors	e) short circuit with stand capability	f)chopped lightning impulse test
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1.13.00	CORONA AND RIV TESTS AND SEISMIC WITHSTAND TEST (for 400kV AIS only): The corona and RIV tests shall confirm to the requirements as per Annexure- A to this chapter. The seismic withstand test shall conform to requirements as per Annexure -B to this section. Annexure – A CORONA AND RADIO INTERFERENCE VOLTAGE (RIV) TEST (For 400 kV AIS only)																
1.0)	General																
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	Unless otherwise stipulated, all equipment together with its associated connectors where applicable shall be tested for external corona both by observing the voltage level for the extinction of visible corona under falling power frequency voltage and measurement of radio interference voltage (RIV). 2.0) Test Methods for RIV: 2.1) RIV tests shall be made according to measuring circuit as per International Special – committee on Radio Interference (CISPR) Publication 16 -1 (1993) Part – I. The measuring circuit shall preferably be tuned to frequency with 10 % of 0.5 MHz but other frequencies in the range of 0.5 MHz to 2 MHz may be used, the measuring frequency being recorded. The result shall be in microvolts. Alternatively, RIV tests shall be in accordance with NEMA standard Publication No. 107 – 1964 except otherwise noted herein. In measurement of RIV only standard fittings of identical type supplied with the equipment and a simulation of the connections as used in the actual installation will be permitted in the vicinity within 3.5 meters of terminals. 2.2) Ambient noise shall be measured before and after each series of tests to ensure that there is no variation in ambient noise level. If variation is present, the lowest ambient noise level will form basis for the measurements. RIV levels shall be measured at increasing and decreasing voltages of 85%, 100%, 115% and 130% for the specified RIV test voltage for all equipment unless otherwise specified. The specified RIV test voltage for 420 KV is listed in the detailed specification together with maximum permissible RIV level in microvolts. 3.0) Test Methods for visible Corona : The purpose of this test is to determine the corona extinction voltage of the apparatus, connectors etc. The test shall be carried out in the same manner as RIV test described above with the exception that RIV measurements are not required during test and a search technique shall be used near the onset and extinction voltage, when the test voltage is raised and lowered to determine their precise values. The test voltage shall be raised to 130 % of RIV test voltage and maintained there for five minutes. In case corona inception does not take place at 130 %, the voltage level shall be raised till inception of corona or rated voltage whichever is lower. The voltage will then be decreased slowly until all visible corona disappears. The test procedure shall be repeated at least 4 times with corona inception and extinction voltage recorded each time. The corona extinction voltage for purposes of determining compliance with the specification shall be the lowest of the four values at which the visible corona (negative or positive polarity) disappears. Annexure – B SEISMIC WITHSTAND TEST (for 400 kV AIS only): The seismic withstand test on the complete equipment (except BPI) shall be carried out along with supporting structure. b.) The seismic level specified shall be applied at the base of the structure. The accelerometers shall be provided at the terminal pad of the equipment and at any other point as agreed by the owner. The seismic test shall be carried out in all possible combinations of the equipment. The seismic test procedure shall be furnished for approval of the purchaser.		
2.00.00	REQUIREMENTS FOR GAS INSULATED SWITCHYARD:		
2.01.00	GENERAL:		
2.01.01	The GIS shall comply to IEC – 62271-203. The GIS shall be modular in structure and shall be housed indoor. The modules shall be single phase encapsulated and provided with hooks for handling by EOT cranes to be provided in the building. The modular design shall		
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2.02.00 2.02.01 2.02.02 2.02.03	TECHNICAL REQUIREMENTS: The VT's for GIS shall be installed within the GIS enclosure and shall be SF6 gas insulated or cast resin type. The secondary terminals shall be brought out in a dust proof enclosure suitably. The Surge arrestors for main buses shall be of GIS type only . The earthing of the GIS shall be carried out considering the safety requirements as per relevant standards. The continuity of earthing shall be ensured considering electrical and thermal stresses caused by current they may have to carry. Each section & phase of the GIS enclosure shall be monitored for leakage of SF6 gas and suitable indication shall be provided in the control room. Each breaker module of the GIS shall have a local control cabinet suitably located and shall be ground mounted meeting the requirements specified elsewhere for cabinets. Suitable interlocking arrangements shall be provided for the entire GIS.			
2.03.00 2.03.01 2.03.02 2.03.03 2.03.04 2.03.05 2.03.06 2.03.07	DESIGN AND SAFETY REQUIREMENT The compartments shall be such that maintenance on one feeder may be performed without de-energizing the adjacent feeders. These compartments shall be designed to minimize the risk of damage to adjacent sections and protection of personnel in the event of a failure occurring within the compartments. Stainless steel carbon impregnated or nickel plate rupture diaphragms with suitable deflectors shall be provided to prevent uncontrolled bursting pressures developing within the enclosures under worst operating conditions.. Gas barrier insulators shall be provided to divide the GIS into separate compartments. They shall be suitably located to minimize disturbance in case of leakage or dismantling. They shall be designed to withstand 1.5 times full rated pressure on one side while vacuum is exerted on the other side. The material and thickness of the enclosures shall be such as to withstand an internal flash over without burn through for a period of 300ms till the backup relay protection clears the fault. Sufficient inspection windows/access openings shall be provided at the switchgear.. Each pressure filled enclosure shall be designed and fabricated to comply with the requirements of the applicable pressure vessel codes and based on the design temperature and design pressures as defined in IEC -62271-203. The contractor shall guarantee that the pressure loss within each individual gas-filled compartment shall not be more than half percent (0.5%) per year. Each gas-filled compartment shall be equipped with static filters, density switches, filling valve and safety diaphragm. Each gas compartment shall be fitted with separate non-return valve connectors for evacuating & filling the gas and checking the gas pressure etc. The thermal rating of all current carrying parts shall be minimum for one sec. for the rated symmetrical short-circuits current. The arrangement of gas section or compartments shall be such as to facilitate extension of any make on either end without any drilling, cutting, or welding on existing equipments.			
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	The GIS shall be designed such that a future requirement as per single line diagram can be extended with-out any necessity to move or dislocate the existing switchgear bays. It shall be kept in view that very little shutdown time is needed for adding future requirement.													
2.03.08	All the elements shall be accessible without removing support structures for routine inspections and possible repairs. The removal of individual enclosure part or entire breaker bays shall be possible without disturbing the enclosures of neighboring bays.													
2.03.09	The actual position of circuit breakers, disconnectors and grounding switches must be positively displayed by mechanical indicators visible from the operating position.													
2.03.10	The breaker enclosure shall have provision for easy withdrawal of the interrupter assemblies/complete CB pole.													
2.03.11	The enclosure shall be designed to practically eliminate the external electromagnetic field and thereby electrodynamic stresses even under short circuit conditions.													
2.03.12	The switchgear shall have provision for connection with ground mat risers. This provision shall consist of grounding pads to be connected to the ground mat riser in the vicinity of the equipment. The connection between the grounding pads of switchgear and ground mat risers shall be provided by the contractor. The contractor shall furnish the design details & drawings for ground mat for GIS.													
2.03.13	The layout of Switchgear such that each equipment shall be easily accessible for monitoring, maintenance, and testing purpose. The fixed type walkways , approaches shall be provided for access to the equipment for viewing, maintenance and testing purpose. In addition to this hydraulic portable ladder shall also be provided by the contractor.													
2.03.14	The heaters shall be rated for 240V AC supply and shall be complete with thermostat, control switches and fuses, connected as balanced 3-phase, 4-wire load. The distribution of AC / DC power supply to LCC, Switchgear equipments such that isolation of AC / DC supply to One particular Bay equipments will not effect the other bay equipments.													
2.03.15	Viewing window shall be provided to visually observe the contact position for all phases of disconnecting switches and earth switches. Also clearly identifiable local, positively driven mechanical position indicator, Open / Close Indication for all phases of disconnecting and earth switches shall be provided.													
2.03.16	The enclosure & support structure shall be designed that a mechanic 1780mm in height and 80 Kg in weight shall be able to climb on the equipment.													
2.03.17	The sealing provided between flanges of two modules / enclosures shall be such that long term tightness is achieved.													
2.03.18	Alarm circuit shall not respond to faults for momentary conditions. The following indications in addition to those required elsewhere in the specifications shall be provided in the alarm & indication circuits in Bay Module Control Cabinets:													
I)	I)Gas Insulating System													
	<table><tr><th>Sl.No</th><th>Description</th></tr><tr><td>a)</td><td>Loss of density, loss gas pressure</td></tr><tr><td>b)</td><td>Loss of Heater power (if required)</td></tr><tr><td>c)</td><td>Any other alarm necessary to indicate deterioration of the gas insulating system</td></tr><tr><td>II)</td><td>Operating System</td></tr></table>				Sl.No	Description	a)	Loss of density, loss gas pressure	b)	Loss of Heater power (if required)	c)	Any other alarm necessary to indicate deterioration of the gas insulating system	II)	Operating System
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	<table><tr><td>a)</td><td>Low operating pressure, loss of control, loss of heater power, loss of operating power</td></tr><tr><td>b)</td><td>Loss of control , pole discordance</td></tr></table>	a)	Low operating pressure, loss of control, loss of heater power, loss of operating power	b)	Loss of control , pole discordance			
a)	Low operating pressure, loss of control, loss of heater power, loss of operating power							
b)	Loss of control , pole discordance							
	In addition, all the above alarms shall also be hooked up to the Substation Automation system.							
2.03.19	The supplier shall submit guarantee that all offered SF6 GIS equipment has a Min.service life of 10,000 normal operations. The maintenance free period for any of its external components shall not be less than 5 years intervals. Internal components including refilling of gas shall not be less than 10 years. The supplier shall submit the O&M manuals of all GIS equipment, trouble shooting, recommended spares parts etc. The supplier shall propose the recommended period for schedule maintenance.							
2.03.20	Online Partial Discharge Monitoring system for GAS insulated switchgear and Busduct shall be provided to monitor the entire GIS installation as per the Specification mentioned at Annexure-C: Annexure-C: ONLINE PD MONITORING SYSTEM FOR GAS INSULATED SWITCHGEAR: GIS equipment shall be designed to minimize partial discharge or other electrical discharge. A state-of-the art Partial Discharge Monitoring system shall be provided to monitor the entire GIS installation. i)An on-line continuous Partial Discharge Monitoring (PDM) system shall be designed to provide an automatic facility for the simultaneous collection of PD data at multiple points on the GIS & its associated GIB ducts and Voltage Transformers adopting UHF technique. ii)On-line continuous Partial Discharge Monitoring (PDM) system shall be capable for measuring PD in charged GIS environment as EHV which shall have bandwidth in order of 100 MHz–2GHz with possibility to select a wide range of intermediate bandwidths for best measurement results. The principle of operation shall be based on UHF principle of detection. iii)The scope shall cover Engineering, supply, installation, testing and commissioning of partial discharge continuous monitoring system, with all necessary auxiliaries and accessories to make a complete system as per technical specification, including site demonstration of successful operation. The PDM system shall be provided with all its hardware and software, with readily interfacing to the UHF PD couplers installed in the GIS of present bays and future bays as shown in SLD plus 20% additional as extra. Details of this shall be submitted during engineering stage for approval. The number of UHF PD coupler for future bays shall be decided based on GIS layout finalized under present scope (considering present GIS equipment with future provision). iv)The PD Monitoring PC Work Station shall be in the control room of the GIS substation. Workstation PCs shall be pre-loaded with all necessary Hardware & Software. The PCs shall have each Combo drive & Retrievable disk drive (1 TB), Ethernet port 100Mbps, colour printer. The workstation PC shall be powered by suitable dedicated UPS. PDM system shall have built in self-checking facility. Design of on-line PDM System: 1.)The sensitivity of the offered system shall be in accordance with CIGRE Document No. 654 that will be verified as part of site sensitivity tests.							
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	2.) UHF attenuation data of GIS shall be submitted for the switching devices, spacers, bends etc. 3.) The signal attenuation level of co-axial cable per meter length and justification for the length of cable connection between the couplers and detector units shall be furnished. 4.) The overall sensitivity of PD detection system shall consider the spacing between couplers and the associated cabling, filters, amplifiers, etc. 5.) The PD sensors shall be identified / coordinated with the corresponding detector unit etc. with proper identification labelling and indicated in the substation PDM SLD. 6) Supply requirement (AC & DC) to be specified for the complete monitoring system. 7.) Power supply to PDM PC shall have protection against surges, overload and short circuit. A dedicated on-line UPS system shall also be provided as a backup during supply interruption, to ensure trouble-free & reliable running of the PDM System for a minimum of 15 minutes duration. 8.) PDM System shall be provided with a user security for accessing the system with a log-on and password entry procedure. The user levels shall be defined as a Master User and other users for the modification of system, update, and entry of parameters or manual operation. System shall be able to generate 3D point on wave pattern whenever any PD activity detected by the system. System shall be able to give online 3D point on wave pattern, online PRPD (phase resolved PD) and online short time trend etc. System shall be able to generate the all the logs related to system fault, system access, PD event, and any changes in system setting etc. 9.) The selected mode of propagation of PD signal (electromagnetic wave) inside GIS for the design of sensors shall be furnished. The applicable standards to meet IEC & IEEE requirements for electromagnetic compatibility shall be specified. The offered system should have been tested for the same for working in a 400kV & above substation environment. The necessary documentation must be submitted in this regard. 10) Calibration: i) The UHF Couplers must be first calibrated as per CIGRE procedure TF 15/330305 as part of factory acceptance tests to guarantee detection sensitivity of 5pC or better. The GIS of same design shall be used as test specimen during the coupler calibration. The pulse injection level determined through above factory calibration tests shall only be used as reference for site sensitivity checks during commissioning of PDM system. The data sheet/frequency response characteristics shall be submitted for reference. 11) The system shall generate alarms if suspected partial discharge activity is noticed or the system itself is in failure, thereby eliminating the necessity of periodic system access by the user and one such alarm shall be connected to Substation automation system (SAS). The alarms shall be configured coupler wise. 12) Filtering Facility: The filtering facility must be provided to distinguish real PD from internal/external noise such as switching operations, self-test signal, radio, communication signal etc. 13) Diagnostic Software: To interpret various types of PD defects, intelligent diagnostics software (expert system) shall be built- in as part of the PDM software capability. This is			
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	mainly to reduce the dependence on PD specialist. The bidder shall also make available typical point-on-wave patterns as library pictures to train the user. 14) Special tools and critical spare parts for trouble free operation of the system are also to be supplied along with the PDM system. Pulse generator for UHF sensor sensitivity test shall also be supplied as a standard accessory. 2.03.21 Adequate number of gas leak detectors shall be installed at various locations at the base of the GIS structure to detect presence of gas which may be harmful for human. The detector shall send alarm signal locally as well as at remote stations. 2.04.00 MANDATORY MAINTENANCE EQUIPMENTS: The maintenance equipment necessary for the operation and maintenance of GIS shall be supplied. In addition to this maintenance equipment specified at Annexure-D of this section shall also be supplied and covered in the contractor's scope. 2.05.00 MANDATORY MONITORING EQUIPMENTS: THE MONITORING EQUIPMENT NECESSARY FOR THE OPERATION AND MAINTENANCE OF GIS SHALL BE SUPPLIED. A LIST OF SUCH EQUIPMENTS IS ENCLOSED AT ANNEXURE-E OF THIS SECTION. 2.06.00 BELLOWS OR COMPENSATING UNITS: Adequate provision shall be made to allow for the thermal expansion of the conductors and of differential thermal expansion between the conductors and the enclosures. The metallic bellows (preferably of stainless steel) of following types or other suitable arrangement shall be provided wherever necessary: 2.07.00 INDICATION AND VERIFICATION OF SWITCH POSITIONS: Local Indicators shall be provided on all circuit breakers, For Disconnectors and earth switches local indicators (3ph / 1ph - preferably local indicators for all phases of disconnectors and earth switches) shall be provided, which shall clearly show whether the switches are open or closed. The indicators shall be mechanically coupled directly to the main contact operating drive rod or linkage and shall be mounted in a position where they are clearly visible through glass windows. 2.08.00 PRESSURE RELIEF : Pressure relief devices shall be provided in the gas sections to protect the main gas enclosures from damage or distortion during the occurrence of abnormal pressure increase or shock waves generated by internal electrical fault arcs (preferably in downward direction). Pressure relief devices shall be achieved either by means of diaphragms or plugs venting directly into the atmosphere in a controlled direction. 2.09.00 PRESSURE VESSEL REQUIREMENTS: The enclosure shall be designed for the mechanical and thermal loads to which it is subjected in service. The enclosure shall be manufactured and tested according to the pressure vessel code (ASME/CENELEC code for pressure Vessel.) The bursting strength of Aluminum casting must be at least 5 times the design pressure. A bursting pressure test shall be carried out at 5 times the design pressure as a type test on each type of enclosure. Each enclosure must be tested as a routine test at 1.5 times the design pressure for one minute. 2.10.00 BUSBARS: 2.10.01 The conductors of the bus bars shall be fabricated from aluminum/copper tubular sections of cross- sectional area suitable to meet the current rating requirements. The bus bars	
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	shall be housed in single phase enclosure. The tubular bus section shall be housed in corrosion resistant aluminum enclosures, filled with pressurized SF6 gas. The conductors shall be supported from the enclosures by insulators shaped to ensure uniform electrical field distribution and zero corona at rated voltage. The bus end connections shall be made with multi-contact connectors to allow for axial thermal expansion of the bus. The enclosure connections shall be flanged and shall be fitted with gaskets or O-ring seals to provide an effective gastight joint between sections.											
2.10.02	Main bus bars shall be designed to have future extension bay if any as indicated in the single line diagram. The bus conductor end connectors and enclosure flanges shall be designed accordingly.											
2.10.03	Each gas compartment barrier shall be easily identifiable from the outside of the switchgear. The means of identification used shall be a black band, approx. 10mm wide, permanently affixed to the barrier insulator on the outer surface of the enclosure at the location of the barrier insulator. In case of leakage of the gas from any compartment, indication of respective compartments should be provided on the annunciator.											
2.11.00	BAY MODULE CONTROL CABINETS:											
2.11.01	Each switchgear bay module shall be suitable for local control and remote control. The contractor shall supply the main control cabinet of the floor standing type along with GIS equipments. The cabinet shall have double, full height, hinged, gasketed, lockable doors. One door shall have a safety glass window through which the various switchgear controls can be viewed without opening the doors.											
2.11.02	The following equipment's shall be mounted on the cabinet door with Mimic diagram of the Bay . <table><tr><th>Sl.No</th><th>Description</th></tr><tr><td>a)</td><td>Remote/local control transfer switch for the circuit breakers and disconnector switches</td></tr><tr><td>b)</td><td>Normal operation/maintenance control transfer switch for disconnector of remote electrical controls</td></tr><tr><td>c)</td><td>Mimic diagram of the switchgear bay complete with semaphore indicators for the switchgear component position indication and local control switches for open / close or close-trip control of the circuit breaker, isolators and grounding switches as per the standard practice , system requirement for smooth operation , maintenance shall be provided.</td></tr></table>	Sl.No	Description	a)	Remote/local control transfer switch for the circuit breakers and disconnector switches	b)	Normal operation/maintenance control transfer switch for disconnector of remote electrical controls	c)	Mimic diagram of the switchgear bay complete with semaphore indicators for the switchgear component position indication and local control switches for open / close or close-trip control of the circuit breaker, isolators and grounding switches as per the standard practice , system requirement for smooth operation , maintenance shall be provided.			
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2.11.03	The annunciator system shall have sufficient modules and illuminated windows for providing annunciation for low / high gas pressure / density, alarms & trips for circuit breaker operating mechanism and all other abnormal conditions.											
2.11.04	Each annunciator panel shall be complete with an audible warning horn, acknowledge/reset for horn silence and lamp test push buttons. Apart from annunciator system in LCC, alarm contacts for remote alarm indication shall have to be wired separately in LCC terminal block. The control cabinets shall be suitable for bottom entry of cables.											
2.12.00	SUPPORTING STRUCTURES:											
2.12.01	The Contractor shall design, fabricate and supply the equipment supporting framework including all rails, transverse & longitudinal beams and supporting members with all necessary hardware & embedded parts. General structural designs and structural details shall be subject to the approval of the Employer.											
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2.12.02	Non-corrosive metal or cadmium plated steel shall be used for bolts and nuts throughout the work when either or both are subjected to frequent adjustment or removal. All steel structure members shall be hot dip galvanised.																										
2.13.00	MONITORING:																										
2.13.01	The gas density in each gas compartment shall be monitored by electrically isolated & independently adjustable temperature compensated density switches. The factory set density switches shall also be acceptable. Two level density switches shall be provided for each GIS bus compartment to initiate remote devices of level-I alarm and level-II tripping. The setting of level-I alarm and level – II tripping shall be such that the dielectric strengths of SF6 gas are maintained. The necessary indication shall be provided at the circuit breaker control cabinet identifying the gas compartment from which a level-I alarm is initiated. Two level density switches shall be provided for each circuit breaker compartment to initiate the following:																										
	i) Level-I- Remote alarm and prevent closing of the breaker in case it is open.																										
	ii) Level-II- Initiation of Zone trip, Contact shall be in accordance with the requirement.																										
2.13.02	Gas pressure monitoring devices shall be fitted with test valves such that field testing of the monitoring device can be performed without draining the main gas system. Each gas section shall be fitted with a suitable valve for routine gas sampling.																										
2.14.00	HIGH VOLTAGE TRANSIENTS:																										
	High voltage transients from switching operations and internal faults are coupled to the external enclosure of the GIS. .																										
2.15.00	HEATERS: All the heaters shall be suitable for connection to a 240V AC, single phase, 50 Hz supply. The heater in the mechanism housing shall be connected inside the housing to this supply and shall be thermostatically controlled. The leads to the tank heaters shall be enclosed in a conduit.																										
2.16.00	SERVICE LIFE:																										
	SF6 circuit breakers, disconnecting switches and grounding switches will be subjected to frequent and occasionally repetitive, no load / full load operations and switching off short circuit currents, capacitive and inductive currents within their ratings. The Contractor shall propose the recommended period for scheduled maintenance.																										
2.17.00	Shop test:																										
2.17.01	Each transport section of switchgear shall be shop tested. The routine tests of GIS equipments which have been covered under other relevant IEC standards)																										
	<table><tr><th>Sl.No</th><th>Routine tests (On transport section)</th></tr><tr><td>i)</td><td>Dry Power frequency voltage withstand tests on the main circuit.</td></tr><tr><td>ii)</td><td>Dielectric tests on auxiliary and control circuit</td></tr><tr><td>iii)</td><td>Tests to verify the resistance of the main circuit</td></tr><tr><td>iv)</td><td>Partial discharge tests</td></tr><tr><td>v)</td><td>Pressure test on enclosures</td></tr><tr><td>vi)</td><td>Gas tightness test.</td></tr><tr><td>vii)</td><td>Mechanical operation tests.</td></tr><tr><td>viii)</td><td>Tests of auxiliary, electrical, and hydraulic devices</td></tr><tr><td>ix)</td><td>Checking of wiring</td></tr><tr><td>x)</td><td>Power frequency voltage dry tests</td></tr><tr><td>xi)</td><td>Voltage tests on auxiliary and control circuits</td></tr></table>	Sl.No	Routine tests (On transport section)	i)	Dry Power frequency voltage withstand tests on the main circuit.	ii)	Dielectric tests on auxiliary and control circuit	iii)	Tests to verify the resistance of the main circuit	iv)	Partial discharge tests	v)	Pressure test on enclosures	vi)	Gas tightness test.	vii)	Mechanical operation tests.	viii)	Tests of auxiliary, electrical, and hydraulic devices	ix)	Checking of wiring	x)	Power frequency voltage dry tests	xi)	Voltage tests on auxiliary and control circuits		
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CLAUSE NO.	TECHNICAL REQUIREMENTS						
	<table border="1"><tr><td>xii)</td><td>Fluid leakage tests (where applicable).</td></tr><tr><td>xiii)</td><td>other tests as per OEM recommendations , practice</td></tr></table>	xii)	Fluid leakage tests (where applicable).	xiii)	other tests as per OEM recommendations , practice		
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	The applicable standards for the above tests shall be IEC 62271-203, IEC 62271-100, and IEC 62271-1. In addition, corrosion protection tests at random on all equipment shall be performed.						
	2.18.00	Type Tests:					
	For Type Test requirement, please refer clause No. 1.06.02 & 1.06.03.						
	2.19.00	Performance Tests:					
	The performance tests shall comprise of: a) Field stage tests, to be carried out during erection, to demonstrate that the equipment or any component or subassembly has been properly erected and functions correctly. b) Commissioning tests, precedent to the acceptance of work, in respect of the equipment or any section of the equipment, to demonstrate proper operation.						
	2.20.00	Field Stage Tests:					
	From time to time at various stages of erection, tests of sub-assemblies of the equipment shall be carried out as instructed by the Employer. The contractor shall make records of all measurements and shall make corrections or adjustments as required. A record of all stage tests shall be embodied in a report.						
2.21.00	Commissioning Tests:						
On completion of the erection and installation, following commissioning tests shall be performed as per IEC 62271-203, CIGRE working Group 23.03, 1975-Electra No.42, 7-29: a) One minute power frequency withstand tests for the main circuits. As per IEC 62271-203 high voltage tests at site with lightning impulse and switching impulse voltages are also acceptable as alternative. The Contractor may carry out either of the above tests but relative merits of particular type of test over the other tests to be carried out by the contractor should be indicated in the offer. b) Partial discharge measurement tests. c) Voltage tests for the main circuits d) Voltage tests for the auxiliary and control circuits. e) Tests to verify the resistance of the main circuits. f) Operation tests for various components. g) Gas leakage tests. h) Calibration/checking of SF6 gas pressure/density switches.							
Measurement of moisture.: After erection, a test shall be made to prove the absence of the dangerous voltages in the enclosure and other metal parts such as pipes and framework. If the tests prove the existence of any fault or faults in the equipment, or any failure to meet the requirements of the specifications the Employer may direct Contractor to rectify the defects or repair, reconstruct or replace faulty work and Contractor shall without delay, carry out the instructions of the Employer in this respect. Commissioning tests shall be as per the IEC standard and shall not be restricted to the tests stated above. The Contractor shall also recommend any additional commissioning tests.							
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2.22.00	Final Acceptance Tests: After commissioning tests have been satisfactorily completed, the contractor shall carry out tests as per relevant standards.						
2.23.00	Test Reports: The contractor shall record all the relevant facts and the quantities on the basis of which a final test report shall be prepared. Such reports will be prepared in a form approved by the Employer and reproduced at the expense of the contractor in six copies for submission to the Employer. TRAINING: BIDDER SHALL PROVIDE TRAINING TO THE EMPLOYER'S PERSONNEL AS PER THE DETAILS GIVEN BELOW:						
	Sl No.	Description of Training	Training Duration (Days)	Place of Training	Number of Trainees from Employer	Boarding & Lodging	
	1	GIS					
	a)	GIS equipments including system description, Basic Design and engineering, Quality Assurance concepts, Erection and operational aspects for the offered equipments.	5 days	Manufacturers works	8	To be provided by Bidder	
	b)	Operation, Maintenance, Site Testing and Trouble shooting for GIS.	5 days	Site	6	-	
1.0	Annexure-D -SPECIFICATION OF MANDATORY MAINTENANCE EQUIPMENT SF6 Gas Handling Plant:- a) SF6 gas filling and evacuating equipment (Portable), Qty : 1no The capacity of this plant shall be such that it shall not take appreciable time for filling or evacuating of a GIS bay including all equipments compartment. The required vacuum for complete evacuation shall be attained with the help of this plant. b) SF6 gas filtering, drying, storage and recycling plant- Qty : 1no . i)The plant shall be complete with accessories and fittings so that SF6 gas from the breaker can be directly filled in the plant storage reservoir. ii) In case purging of the equipment before filling with SF6 gas is desirable, then the required equipment for dry gases etc. shall be furnished as a part of the plant. iii)For heavy items within the plant, the lifting hooks shall be provided for lifting and moving with the overhead cranes.						
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	iv))This shall include all the necessary devices for measurement of purity, moisture content, decomposition products etc. of SF6 gas mixing with air/oil/moisture during above process should be proved to be Nil during testing. The capacity of the plant shall be such as to handle and store min 300 litres of SF6 gas or Sf 6 Gas quantity of largest compartment. v) These SF6 gas handling plants shall be complete with all the necessary pipes, couplings flexible tubes and valves for coupling to the equipment. vi) The design and construction of the plant, valves, couplings, connections shall be such that leakage of SF6 gas shall be minimum. Similarly valves, couplings and pipe work shall be so arranged that accidental loss of gas to the atmosphere shall be minimum.			
2.0	SF6 Gas leak detector - Qty: 1no. The SF6 gas leak detector shall meet the following requirements: a) The detector shall be free from induced voltage effects. b) The sensing probe shall be such that it can reach all the points on the GIS where leakage is to be sensed. c) The accuracy of the equipment shall be at least 10 ppm.			
3.0	Operational analyser with DCRM kit- Qty:1no a) It shall have facility to record the breaker contact movement during opening, closing, auto reclosing and make-break operation, the speed of contacts at various stages of operation, travel of contacts, opening time, closing time and make break time etc.The analyser shall have provisions for recording at least 12 different functions of the circuit breaker. All necessary transducers (i.e., three nos. for complete 3 phase speed and travel record of breaker), cables, pickups, attachments required for the breaker shall be supplied with the analyser. The cables supplied shall be sufficient for recordings at site on a completely assembled and erected breaker. b) All the necessary catalogues write up for operation and maintenance of the analyser shall be furnished along with each analyser and peripheral system. The necessary equipments for monitoring various parameters of circuit breaker termed as signature analysing shall be supplied along with all software, laptop computer, devices etc. with the breaker. The same shall be demonstrated at site on a fully assembled breaker.			
4.0)	Self-powered hydraulic aerial working platform with articulated and fly boom for General purpose maintenance in switchyard and Transformer yard. (Suitable for 24m working height)- Qty : 1no All above maintenance equipments shall be demonstrated at site during handover. Annexure-E			
1.0	MANDATORY MONITORING EQUIPMENTS: Dew Point Meter, Qty : 1no i) The meter shall be capable of measuring the dew point of SF6 Gas of the Circuit Breaker/GIS equipment It should be portable and adequately protected for outdoor use. The meter shall be provided with dew point hygrometer with digital indication to display the dew point temperature in degree C. or PPM. It should be capable of measuring the corresponding pressure at which dew point is being measured. The measurement direct without the use of any other material/chemical like dry ice/acetone etc. It should be battery			
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	operated with rechargeable batteries. The equipment should have the following parameters : a) Measuring range: Up to -100 degree C Dew Point (b) Accuracy: + 2-degree C. (c) Display: 4-digit LCD, inch. High 2.0 PORTABLE PD MONITORING SYSTEM FOR GAS INSULATED SWITCHGEAR , Qty: 1no i) GENERAL: The equipment shall be used for detecting different types of defects in Gas Insulated Stations (GIS) such as Particles, Loose shields and Partial Discharges as well as for detection of Partial discharges in other types of equipment such as Cable Joints, CTs and PTs. ii) It shall be capable for measuring PD in charged GIS environment as EHV which shall have bandwidth in order of 10 KHz – 500 KHz with possibility to select a wide range of intermediate bandwidths for best measurement results. The principal of operation and the method of measurement shall be non-intrusive. The instrument is able to detect partial discharges in cable joints, terminations, CTs and VTs etc., with the hot sticks. iii) Detection and measurement of PD and bouncing particles shall be displayed on built in large LCD display and the measurement shall be stored in the instrument and further downloadable to a PC for further analysis to locate actual source of PD such as free conducting particles, floating components, voids in spacers, particle on spacer surfaces etc. iv) The equipments should have the following parameters: a) Measurement shall be possible in noisy environment. b) The equipment shall be battery operated with built-in battery charger. It shall also be suitable for 230V AVC/50 Hz input. c) Measurement shall be possible in the charged switchyard in the presence of EMI/EMC. Supplier should have supplied similar detector for GIS application to other utilities. Performance certificate and the list of users shall be supplied along with the offer. d) Instrument shall be supplied with standard accessories i.e. connecting cables (duly screened) to sensors, Lap-top PC, diagnostic software, carrying case, rechargeable battery pack with charger suitable for 230V AC, 50 Hz supply connecting cables (duly screened) to view in storage. Contractor shall provide adequate number of sensors in the offered GIS for detection of Partial discharge, the number and location of these sensor shall be subject to approval of the employer. e) The function of software shall cover the following : - Data recording, storage and retrieval in computer - Data base analysis - Template analysis for easy location of fault inside the GIS - Evaluation of PD measurement i.e., Amplitude, Phase Synchronisation etc. - Evaluation of bouncing/loose particles with flight time and estimation on size of particle. - Report generation f) To prove the suitability of working in charged switchyard condition, practical demonstration shall be conducted before acceptance. g) Supplier shall have "Adequate after sales service" facility in India. k) Necessary training may be accorded to personnel to make use of the kit for locating PD sources inside the GIS. Instrument shall be robust and conform to relevant standard			
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3.0)	SF6 gas analyzing equipment and instruments should have capacity for performing the following functions: Qty: 1no - The moisture content measurement or alternatively dew point measurement. - The SF6 gas content measurement. - Sensitivity should not be affected by dust, humidity, heat & wind etc. - Acidic product detection	
4.0)	Portable Leakage current analyzer (for Gapless Surge Arrester), Qty: 1no	
3.00.00	CIRCUIT BREAKER:	
3.01.00	GENERAL : Circuit Breakers shall be metal enclosed SF6 gas insulated, single phase encapsulated for GIS, both comprising three identical single pole units, complete in all respects with all fittings and wiring. The controlled switching device for circuit breakers (as indicated in single line diagram) shall meet the requirements as specified in Annexure-I .	
3.02.00	DUTY REQUIREMENTS :	
3.02.01	The circuit breaker shall meet the requirements of Capacitive Class: C2, Mechanical Endurance: M2, Electrical Endurance class: E2 type of duty as per IEC for 400kV.	
3.03.00	CONSTRUCTIONAL FEATURES:	
3.03.01	All the three poles of the breaker shall be linked together either electrically/pneumatically or electro hydraulically, In case of 400kV.	
3.03.02	Circuit breakers shall be provided with two (2) independent trip coils, suitable for trip circuit supervision. The trip circuit supervision relay would also be provided. Necessary terminals shall be provided in the central control cabinet of the circuit breaker.	
3.04.00	SULPHUR HEXAFLORIDE (SF6) GAS CIRCUIT BREAKER: Circuit breakers shall be single pressure type. Each pole shall form an enclosure filled with SF6 gas independent of two other poles. Common monitoring of SF6 gas can be provided for the three poles of circuit breaker having a common drive. The interconnecting pipes in this case shall be such that the SF6 gas from one pole could be removed for maintenance purposes. Sufficient SF6 gas shall be supplied to fill all the circuit breakers installed plus an additional 20% of the quantity as spare.	
3.05.00	OPERATING MECHANISM:	
3.05.01	Circuit breaker shall be operated by pneumatic mechanism or electrically spring charged mechanism or electro-hydraulic mechanism or a combination of these. It shall be gang operated in case of 3-phase reclosing operation as applicable.	
3.05.02	The pneumatically operated mechanism shall offer unit compressor with each circuit breaker with the breaker local air receivers having a capacity for two 'CO' operations of the breaker at the lowest pressure for reclose duty without refilling.	
3.05.03	The Spring-operated mechanism shall be complete with motor, opening spring & closing spring with limit switch for automatic charging and other necessary accessories to make the mechanism a complete operating unit. If power is available to the motor, a continuous sequence of closing and opening operations shall be possible. The motor shall have adequate thermal rating for this duty. After failure of power supply to the motor, one close-	
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3.05.04	open operation shall be possible with the energy contained in the operating mechanism. Motor ratings shall be such that it requires not more than 30 seconds for fully charging the closing spring. The hydraulic mechanism shall be suitable for at least two close open operations after failure of ac supply to the motor starting at pressure equal to lowest pressure of auto-reclose duty. All hydraulic joints shall have no oil leakage under the site conditions and joints shall be tested at factory against oil leakage at a minimum of 1.5 times maximum working pressure.			
3.06.00	FITTINGS AND ACCESSORIES:			
3.06.01	UNIT COMPRESSED AIR SYSTEM:			
	a) The unit compressed air system for each breaker shall be provided with compressed air piping, piping accessories, control and non-return valves, filters, coolers of adequate capacity, pressure reducing valves (if any), isolating valves, drain ports, etc. The air compressor shall be driven by automatically controlled motor. It shall be of air-cooled type complete with preferably oil-less cylinder lubrication. The compressors or pumps shall be mounted within the operating mechanism housing or a separate weather-proof and dust-proof housing. Each compressor shall be equipped with a time totaliser. b) The compressor size shall be such that it can perform following operations satisfactorily: i) Total running time of compressor not exceeding 45 minutes per day, considering 2% leakage and 2 CO-operations. ii) Air charging time not exceeding 20 minutes after one CO operation of the breaker. c) Air Receivers: i) The capacity of receivers shall be sufficient for two (2) CO operations of the breaker. ii) Air receiver shall be designed in accordance with the latest edition of the ASME Code for Pressure Vessel - Section VIII of BS:5179. A corrosion allowance of 3.0 mm shall be provided for shell and dished ends. Receivers shall be hot dip galvanized. d) Controls and Control Equipment: i) The compressor control shall be of automatic start stop type initiated by pressure switches on the receiver. Supplementary manual control shall also be provided. ii) All control equipment shall be housed in a totally enclosed cabinet. Pressure gauges and other indicating devices, control switches shall be mounted on the control cabinet. iii) Facility to annunciate failure of power supply to the compressor control shall also be provided. e) Compressed Air Piping, Valves and Fittings: i) The flow capacity of all valves shall be at least 20% greater than the compressor capacity. ii) The high-pressure system shall be such that after one 0 - 0.3 Sec - CO operation, the breaker shall be capable of performing one CO operation within 3 minutes. iii) All compressed air piping shall be bright annealed, seamless phosphorous Deoxidized Non-Arsenical Copper alloy or stainless-steel pipe (C-106 of BS: 2871).			
3.07.00	TESTS : Type test : a) 400KV GIS circuit breaker shall be type tested in accordance with the requirement stipulated under clause no :1.112.00			
3.07.02	Routine Tests :			
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3.07.03	Routine tests as per IEC on the complete breaker/ pole along with its own operating mechanism and pole column shall be performed on all circuit breakers. SITE TESTS : All routine tests except power frequency voltage dry withstand test on breaker shall be repeated on the completely assembled breaker at site.																										
3.08.00	PARAMETERS :GENERAL <table><tr><th>Sl.no</th><th>Description</th><th></th></tr><tr><td>a)</td><td>Type of Circuit breaker</td><td>SF6 insulated</td></tr><tr><td>b)</td><td>No. of poles</td><td>Three(3poles)</td></tr><tr><td>c)</td><td>Rated operating duty cycle</td><td>O - 0.3 sec. - CO - 3min. – CO</td></tr><tr><td>d)</td><td>Total closing time</td><td>Not > than 150ms</td></tr><tr><td>e)</td><td>Reclosing</td><td>1ph & 3ph high speed auto reclosing</td></tr><tr><td>f)</td><td>Trip and closing coil voltage</td><td>220V DC</td></tr><tr><td>g)</td><td>Auxiliary contacts</td><td>As required plus10NO & 10NC contacts per breaker as spare.</td></tr></table>			Sl.no	Description		a)	Type of Circuit breaker	SF6 insulated	b)	No. of poles	Three(3poles)	c)	Rated operating duty cycle	O - 0.3 sec. - CO - 3min. – CO	d)	Total closing time	Not > than 150ms	e)	Reclosing	1ph & 3ph high speed auto reclosing	f)	Trip and closing coil voltage	220V DC	g)	Auxiliary contacts	As required plus10NO & 10NC contacts per breaker as spare.
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SINGRAULI STPP STAGE-III (2X800 MW) EPC PACKAGE		TECHNICAL SPECIFICATION SECTION – VI, PART-B	SUB-SECTION-B-17 SWITCHYARD																								
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4. 5. 6. 7. 8. 9. 4.00.00 4.01.01	The device should have display facility at the front for the settings and measured values, alternatively a laptop shall be supplied with each CSD to facilitate display at the front for the setting and measured values. The device shall have self-monitoring facility. During the switching operations, current and voltage waveforms and other parameters shall be recorded and saved together with calculated values. The control switching device provided shall be networked to an Engineering workstation (EWS) located in the switchyard control room. It shall be possible to extract the switching oscillographic records and to do CSD parameterization from this EWS. All necessary software & hardware shall be in bidder's scope. It shall have self-monitoring facilities. Faults which impair the functioning of the device or peripheral components, failure of trip voltage or sensors shall be displayed visually and shall give alarm. The device shall be designed to operate correctly and satisfactorily with the excursion of auxiliary A/C & DC voltages and frequency as specified elsewhere in the specification. The device shall have time setting resolution of 0.1 ms or better. Test reports for the following type tests shall be submitted: - Dielectric withstand test as per IEC 60255-27. - High voltage Impulse test as per IEC 60255-27. - Slow damped oscillatory wave test as per IEC 60255-26 - Fast transient test as per IEC 60255-26 (class 4 installation as per base standard IEC 61000-4-4) - Electrostatic Discharge test as per IEC 60255-26 (class 4 installation as per base standard IEC 61000-4-2) - Surge Immunity test as per IEC 60255-26 (class 4 installation as per base standard IEC 61000-4-5) - Power frequency magnetic field test as per IEC 60255-26 (class 5 installation as per base standard IEC 61000-4-8) - Radiated radio frequency electromagnetic field test as per IEC 60255-26 (class 4 installation as per base standard IEC 61000-4-3) - Conducted disturbance induced by radio frequency field as per IEC 60255-26 (class 4 installation as per base standard IEC 61000-4-6) - Power frequency immunity test on binary input as per IEC 60255-26 (class 4 installation as per base standard IEC 61000-4-16) DISCONNECTOR : GENERAL: The isolators and accessories shall conform in general to relevant IEC 62271-102 (or equivalent Indian Standard) except to the extent explicitly modified in specification. Earth switches shall be provided on isolators as marked on SLD. Isolators shall be horizontal centre break type.			
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4.01.02	The isolators and earth switches shall be A. C / D.C. motor operated.			
4.02.00	DUTY REQUIREMENTS:			
	Isolators and earth switches shall be capable of withstanding the dynamic and thermal effects of the maximum possible short circuit current of the system in their closed position. They shall be constructed such that they do not open under influence of short circuit current and wind pressure together. The earth switches wherever provided shall be constructional interlocked so that the earth switches can be operated only when the isolator is open and vice-versa.			
4.02.01	The earth switches wherever provided shall be constructional interlocked so that the earth switches can be operated only when the isolator is open and vice-versa. Mechanical Endurance : M2 type of duty as per IEC for 400kV earthing switches shall be of class M0 / M1 duty			
4.02.02	In addition to the constructional interlock, isolator and earth switches shall have provision to prevent their electrical and manual operation unless the associated and other interlocking conditions are met. All these interlocks shall be of failsafe type. Suitable individual interlocking coil arrangements shall be provided. The interlocking coil shall be suitable for continuous operation from DC supply and within a variation range as stipulated in relevant section. The interlock coil shall be provided with adequate contacts for facilitating permissive logic for 'DC' control scheme of the isolator as well as for AC circuit of the motor to prevent opening or closing of isolators when the interlocking coil is not energised			
4.02.03	The earthing switches shall be capable of discharging trapped charges of the associated lines. Isolator and earth switches shall be able to bear on the terminals the total forces including wind loading and electrodynamic forces on the attached conductor without impairing reliability or current carrying capacity.			
4.02.04	The isolator shall be capable for making / breaking normal currents when no significant change in voltage occurs across the terminals of each pole of the isolator on account of making / breaking operation.			
4.03.00 (A)	CONSTRUCTIONAL FEATURES (For GIS):			
	a) The three pole/ Single pole group operated disconnectors shall be operated by electric motor suitable for use on 220 V DC ungrounded system/415V AC system and shall be equipped with a manual operating mechanism for emergency use. The motor shall be protected against over current & short circuit.			
	b) Disconnectors shall be designed as per relevant IEC. These shall be suitable to make and break the capacitive charging currents during their opening and closing. They shall also be able to make & break loop current which appears during transfer between bus bars. The contact shielding shall also be designed to prevent restrikes and high local stresses caused by the transient recovery voltages when these currents are interrupted.			
	c) The disconnecting switches shall be arranged in such a way that all the three phases operate simultaneously. All the parts of the operating mechanism shall be able to withstand starting torque of the motor mechanism without damage until the motor overload protection operates.			
	d) It shall be possible to operate the disconnecting switches manually by cranks or hand wheels. The contacts shall be both mechanically and electrically disconnected during the manual operation.			
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CLAUSE NO.	TECHNICAL REQUIREMENTS										
e)	The operating mechanisms shall be complete with all necessary linkages, clamps, couplings, operating rods, support brackets and grounding devices. All the bearings shall be permanently lubricated or shall be of such a type that no lubrication or maintenance is required.										
f)	The opening and closing of the disconnectors shall be achieved by either local or remote control. The local operation shall be by means of a two-position control switch located in the bay module control cabinet.										
g)	Remote control of the disconnectors from the BCU in Relay room & switchyard control room shall be made through remote / local transfer switch.										
h)	The disconnector operations shall be interlocked electrically with the associated circuit breakers in such a way that the disconnector control is inoperative if the circuit breaker is closed.										
i)	Each disconnector shall be supplied with auxiliary switch having eight normally open and eight normally closed contacts for use by others over and above those required for disconnector operation purposes. The auxiliary switch contacts are to be continuously adjustable such that, when required, they can be adjusted to make contact before the main switch contacts. Additionally, MBB contact as required shall also be provided.										
j)	The signaling of the closed position of the disconnector shall not take place unless it is certain that the movable contacts will reach a position in which the rated normal current, peak withstand current and short time withstand current can be carried safely.										
k)	The signaling of the open position of the disconnector shall not take place unless the movable contacts have reached such a position that the clearance between the contacts is at least 80 percent of the rated isolating distance.										
l)	All auxiliary switches and auxiliary circuits shall be capable of carrying a current of at least 10 A DC continuously.										
m)	The auxiliary switches shall be capable of breaking at least 2 A in a 220-V DC circuit with a time constant of not less than 20 milliseconds.										
n)	The disconnectors and safety grounding switches shall have a mechanical key (padlocking key) and electrical interlocks to prevent closing of the grounding switches when disconnector switches are in the closed position and to prevent closing of the disconnectors when the grounding switch is in the closed position.										
o)	The local control of the disconnector and high-speed grounding switches from the bay module control panel should be achieved from the individual control switches with the remote/local transfer switch set to local.										
p)	All electrical sequence interlocks will apply in both remote and local control modes.										
q)	Each disconnector for all phases shall have a clearly identifiable local, positively driven mechanical position indicator, together with position indicator on the bay module control cabinet and provisions for taking the signals to the power house control room. The details of the inscriptions & colouring for the indicator are given as under: <table> <tr> <td>Sign</td><td>Background</td><td>Colour</td></tr> <tr> <td>Open position</td><td>Open</td><td>Green</td></tr> <tr> <td>Closed position</td><td>Closed</td><td>Red</td></tr> </table>	Sign	Background	Colour	Open position	Open	Green	Closed position	Closed	Red	
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r)	All the disconnector and earth switches shall be provided with inspection window so that the travel of the switch contacts in both open and close positions can be verified by visual										
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CLAUSE NO.	TECHNICAL REQUIREMENTS											
	inspection. Also for all 3phases of Disconnecter and earth switches local indication of close / open position indicator , viewing window shall be provided . s) The disconnecting switches shall be provided with rating plates and shall be accessible for inspection. t) The disconnecting switches shall be capable of being padlocked in both the open and closed positions with the operating motor automatically disengaged. The padlocking device shall be suitable for a standard size lock with a 10mm shank. The padlock must be visible and directly lock the final output shaft of the operating mechanism. Integrally mounted lock when provided shall be equipped with a unique key for such three-phase group. Master key is not permitted.											
4.04.00A	SAFETY GROUNDING SWITCHES & HIGH SPEED GROUNDING SWITCHES:											
	a) Three-pole/ Single pole, group operated, safety grounding switches shall be operated by electric motor for use on 220V DC ungrounded system and shall be equipped with a manual operating mechanism for emergency use. The motor shall be protected against over current and short circuit. b) In order to provide test facilities for CTs, transformers, cables etc., certain ground switches may require to be electrically insulated from the enclosures and have easily removable ground connections. c) Each safety grounding switch shall be electrically interlocked with its associated disconnecter and circuit breaker such that it can only be closed if both the circuit breaker and disconnecter are in open position. Safety grounding switch shall however be mechanically key interlocked with its associated disconnecter. d) Each safety grounding switch for all phases shall have clearly identifiable local positive driven mechanical indicator together with position indicator on the bay module control cabinet and provision for taking the signal to Powerhouse Control Room. e) The details of the inscription and colouring for the indicator are given as under: <table><tr><td>Sign</td><td>Background</td><td>Colour</td></tr><tr><td>Open position</td><td>Open</td><td>Green</td></tr><tr><td>Closed position</td><td>Closed</td><td>Red</td></tr></table> f) Each ground switch shall be fitted with auxiliary switches having six normally open and six normally closed contacts for use by others over and above those required for local interlocking and position indication purposes. g) Provision shall be made for padlocking the ground switches in either the open or closed position. h) The safety grounding switches shall conform to the requirements of IEC 62271-102 i) Mechanical position indication shall be provided locally at each switch along with remote indication at each bay module control cabinet & in the power house control room. j) The short circuit making current rating of each ground switch shall be at least equal to its peak withstand current rating of 125KA. The switches shall have inductive / capacitive current switching capability as per IEC-62271-102. k) The high speed grounding switches shall conform to the requirements of IEC-62271-102. The electrical duty class : E1 & Mechanical duty class : M1 as per IEC shall be provided . l) 400KV GIS disconnecter, Earth, Grounding/ safety / high speed earth switches shall be type tested in accordance with the requirement stipulated under clause no 1.12.00.			Sign	Background	Colour	Open position	Open	Green	Closed position	Closed	Red
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4.03.00 4.03.01 4.03.02 4.03.03 4.03.04 4.03.05 04.03.06 04.03.07	(B) CONSTRUCTIONAL FEATURES (For AIS) The isolators shall be provided with high pressure current carrying contacts on the hinge/ jaw ends and all contact surfaces shall be silver plated. The thickness of silverplating should not be less than 25 microns. The contacts shall be accurately machined and self aligned. The isolator shall be provided with a galvanised steel base provided with holes and designed for mounting on a lattice/pipe support structure. The base shall be rigid and self supporting. The position of movable contact system (main blades) of each of the isolator and earthing switch shall be indicated by a mechanical indicator at the lower end of the vertical rod of shaft for the isolator and earthing switch. The indicator shall be of metal and shall be visible from operating level. The isolator shall be provided with a galvanised steel base provided with holes and designed for mounting on a lattice/pipe support structure. The base shall be rigid and self supporting. The position of movable contact system (main blades) of each of the isolator and earthing switch shall be indicated by a mechanical indicator at the lower end of the vertical rod of shaft for the isolator and earthing switch. The indicator shall be of metal and shall be visible from operating level. The isolators shall be so constructed that the switch blade will not fall to the closed position if the operating shaft gets disconnected. Isolators and earthing switches including their operating parts shall be such that they cannot be dislodged from their open or closed positions by gravity, wind pressure, vibrations shocks or accidental touching of the connecting rods of the operating mechanism. The switch shall be designed such that no lubrication of any part is required except at very infrequent intervals The insulator of the isolator shall conform to the requirements stipulated under clause no: 08.00.00 as specified in the specification and shall have a min. cantilever strength of 800 kg for 400kV. Pressure due to the contact shall not be transferred to the insulators after the main blades full close. The insulators shall be so arranged that leakage current will pass to earth and not between terminals of the same pole or between phases. The terminal connectors shall conform to requirements stipulated under clause no:08.00.00 as specified else where in the specification. EARTHING SWITCHES: Where earthing switches are specified these shall include the complete operating mechanism and auxiliary contacts. The earthing switches shall form an integral part of the isolator and shall be mounted on the base frame of the isolator. Earthing switches shall be suitable for local operation only. The earthing switches shall be constructional interlocked with the isolator so that the earthing switches can be operated only when isolator is open and vice versa. OPERATING MECHANISM AND CONTROL: The Contractor shall offer, motor operated switches having padlock arrangement on both 'ON' and 'OFF' positions. Limit switches for control shall be fitted on the isolator/ earth switch shaft, within the cabinet to sense the open and close positions of the isolators and earth switches. It shall not be possible, after final adjustment has been made for any part of the mechanism to be displaced at any point in the travel sufficient enough to allow improper functioning of the isolator when the isolator is opened or closed at any speed. Control cabinet/operating mech. box shall conform to requirements stipulated in clause no: 08.00.00 else where in the specification and IS:5039/IS 8623/IEC 439 as applicable			
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04.03.08 OPERATION: Isolator shall be gang operated for main blades and earth switches. The operation of the three poles shall be well synchronized and interlocked. 04.03.09 The design shall be such as to provide maximum reliability under all service conditions. All operating linkages carrying mechanical loads shall be designed for negligible deflection. The length of inter insulator and interpole operating rods shall be capable of adjustments 04.03.10 The design of linkages and gears be such so as to allow one man to operate the handle with ease for isolator and earth switch 04.03.11 TESTS: 04.03.11 In continuation to the requirements stipulated under Part-I the isolator along with operating mechanism shall conform to the type tests and shall be subjected to routine tests and acceptance tests in accordance with IEC 62271-102. Minimum 50 nos. mechanical operations will be carried out on 1 (one) isolator assembled completely with all accessories as acceptance test. During final testing of isolator sequential closing/ opening of earth switch shall also be checked only after isolator is fully open/close. Acceptance test shall be carried out with operating box																																															
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5.00.00	INSTRUMENT TRANSFORMER : CODES AND STANDARDS,																							
	Current transformers IEC 61869-1&2, IS: 2705,IS:16227 Voltage transformers IEC 61869-1&5, IEC 60358, IS: 3156 Insulating oil IS: 335, IEC:60296																							
5.01.00	GENERAL REQUIREMENTS (FOR GIS):																							
	a) The instrument transformers i.e., current and voltage transformers shall be single phase transformer units. Polarity marks shall indelibly be marked on each instrument transformer and at the lead terminals at the associated terminal block.																							
	b) The contractor is required to submit the VA burden calculations and obtain approval from the Employer before proceeding with design of the cores. The other characteristics of CTs shall be as given below:																							
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5.02.02	Construction Details:																							
	a)The current transformers incorporated into the GIS will be used for protective relaying and metering. The secondary windings shall be air/gas insulated. All the current transformers shall have effective electromagnetic shields to protect against high frequency transients.																							
	b)Each current transformer shall be equipped with a marshalling box with terminals for the secondary circuits, which are connected to the local control cubicle. The star / delta configuration and the inter connection to the line protection panels will be done at the CT terminal block located in the local control cubicle.																							
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	c) The rated extended current rating voltage and rated thermal current shall also be marked on the name plate. The diagram plate shall show the terminal markings and relative physical arrangement of the current transformer cores with respect to the primary terminals(P1 & P2). d)The position of each primary terminal in the current transformer SF₆ gas section shall be clearly marked by two plates fixed to the enclosure at each end of the current transformer. e)Current transformers guaranteed burdens and accuracy class are to be intended as simultaneous for all cores. The current transformers shall be suitable for high-speed auto reclosing. f)Electromagnetic shields to be provided against high frequency transients typically 1-30 MHz. g)Provision shall be made for primary current injection testing of current transformers.			
5.03.00	BUS VOLTAGE TRANSFORMERS (GIS):			
5.03.01	General : a)The voltage transformers and accessories shall conform to IEC and other relevant standards except to the extent explicitly mentioned in the specification. Voltage transformers shall be of the electromagnetic type with SF₆ gas insulation. The earth end of high voltage winding and the ends of secondary winding shall be brought out in the terminal box. The rating and diagram plate shall be provided complying with the requirement of IEC specification incorporating the year of manufacture and including turn's ratio, voltage ratio, burden, connection diagram etc. b)The beginning and end of each secondary winding shall be wired to suitable terminals accommodated in a terminal box mounted directly on the voltage transformer section of SF₆ switchgear. c)All terminals shall be stamped or otherwise marked to correspond with the marking on the diagram plate. Provision shall be made for earthing of the secondary windings inside the terminal box. d)The transformer shall be able to sustain full line voltage without saturation of transformer. Core details are given in Table-II.			
5.03.02	Constructional Details: a)The voltage transformers shall be located in a separate bay module on the bus and will be connected phase-to ground and shall be used for protection, metering and synchronizing. The voltage transformers shall be of induction type, nonresistant and shall be contained in their own- SF₆ compartment, separated from other parts of installation.			
5.04.00	GENERAL REQUIREMENTS (For AIS):			
5.04.01	The instrument Transformers i.e Current and voltage transformers / CVT shall be single phase transformer units and shall be supplied with a common marshaling box for a set of three single phase units. All exposed mild steel shall be hot dip galvanised or painted with Grey color of shade RAL 9002. The instrument transformers shall be hermetically sealed units. The instrument transformers shall be provided with filling and drain plugs. Polarity marks shall indelibly be marked on each instrument transformer and at the lead terminals at the associated terminal block. For Current transformers , no oil shall come in contact with zinc galvanized surface.			
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5.04.02	The Instrument transformer shall be with Polymer Insulator. For Current transformer shall have cantilever strength of not less than 500kg for 400kV. For 400kV CVT cantilever strength shall not be less than 250kg..			
5.04.03	Polarity marks shall indelibly be marked on each instrument transformer and at the lead terminals at the associated terminal block			
5.05.00	CURRENT TRANSFORMERS (CTs): i)The CTs shall have single primary of either ring type or hair pin type or bar type. Wound primary is not acceptable. ii) In case of "Bar Primary" inverted type CTs, the following requirements shall be met: a)The secondaries shall be totally encased in metallic shielding providing a uniform equipotential surface for even electric field distribution. b) The lowest part of insulation assembly shall be properly secured to avoid any risk of damage due to transportation stresses. c) The upper part of insulation assembly sealing on primary bar shall be properly secured to avoid any damage during transportation due to relative movement between insulation assembly and top dome. iii)The insulator shall be one piece without any metallic flange joint. The CT shall be provided with oil sight glass. iv) The core lamination shall be of cold rolled grain oriented silicon steel or other equivalent alloys. The cores shall produce undistorted secondary current under transient conditions at all ratios with specified parameters. v) Different ratios shall be achieved by secondary taps only, and primary reconnections shall not be accepted. vi)The guaranteed burdens and accuracy class are to be intended as simultaneous for all cores. vii)The instrument security factor at all ratios shall be less than five (5) for metering core. If any auxiliary CT/reactor is used, then all parameters specified shall be met treating auxiliary CTs/reactors as integral part of CT. The auxiliary CT/reactor shall preferably be in-built construction of the CT. In case it is separate, it shall be mounted in secondary terminal box. viii)The physical disposition of protection secondary cores shall be in the same order as given under CT requirement table(s) given below. ix) The CTs shall be suitable for high speed auto-reclosing. x)The secondary terminals shall be terminated on stud type suitable no's of non disconnecting and disconnecting terminal blocks inside the terminal box of degree of protection IP:55 at the bottom of CT. xi)The CTs shall be suitable for horizontal transportation, xii)The CTs shall have provision for taking oil samples from bottom of CT without exposure to atmosphere to carry out dissolved gas analysis periodically. Contractor shall give his recommendations for such analysis, i.e. frequency of test, norms of acceptance, quantity of oil			
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	to be withdrawn, and treatment of CT. Contractor shall supply 2nos. oil sampling device for every 20nos. Minimum 2nos. oil sampling device for each substation. xiii)The CT shall have provision for measurement of capacitance and tan delta as erected at site								
5.06.00	VOLTAGE TRANSFORMERS (CVTs) (AIS):								
5.06.01	Voltage transformers shall be of capacitor voltage divider type with electromagnetic unit.The CVTs shall be thermally and dielectrically safe when the secondary terminals are loaded with guaranteed thermal burdens. The electro-magnetic unit (EMU) shall comprise of compensating reactor, intermediate transformer, and protective and damping devices. The oil level indicator of EMU with danger level marking shall be clearly visible to maintenance personnel standing on ground.								
5.06.02	The secondaries shall be protected by HRC cartridge type fuses for all windings. In addition fuses shall also be provided for protection and metering windings for connection to fuse monitoring scheme. The secondary terminals shall be terminated on stud type non-disconnecting terminal blocks via the fuse inside the terminal box of degree of protection IP: 55. The access to secondary terminals shall be without the danger of access to high voltage circuit.								
5.06.03	The damping device shall be permanently connected to one of the secondary winding and shall be capable of suppressing ferro-resonance oscillations.								
5.06.04	CVTs shall be suitable for high frequency (HF) coupling for power line carrier communication. Carrier signals must be prevented from flowing into potential transformer (EMU) metering circuit by means of RF choke/reactor suitable for effective blocking the carrier signals over the entire frequency range of 40 to 500 kHz. HF terminal shall be brought out through a suitable bushing and shall be easily accessible for connection to the coupling filters of the carrier communication equipment. The HF terminal shall be provided with earthing link with fastener.								
5.06.05	A protective surge arrester/spark gap shall preferably be provided to prevent break down of insulation by incoming surges and to limit abnormal rise of terminal voltage of shunt capacitor, tuning reactor, RF choke, etc. due to short circuit in transformer secondary. The details of this arrangement (or alternative arrangement) shall be furnished by Contractor for Employer's review.								
5.06.06	The accuracy of metering core shall be maintained through the entire burden range upto 50VA on all four windings without any adjustments during operations. The protection cores shall not saturate at about 1.5 times the rated voltage for a min. duration of 30 secs.								
5.07.00	MARSHALLING BOX : Marshaling box shall conform to all requirements as given in part auxiliary. The wiring diagram for the interconnection of three phase instrument transformer shall be pasted inside the box. Terminal blocks in the marshaling box shall have facility for star/delta formation, short circuiting and grounding of secondary terminals. The box shall have enough terminals to wire all control circuits plus 20 spare terminals								
5.08.00	GENERAL PARAMETERS FOR CURRENT TRANSFORMERS:								
	<table><tr><th>Sl.no</th><th>Description</th><th>Parameter</th></tr><tr><td>a)</td><td>One minute power frequency withstand voltage between secondary terminal and earth</td><td>5kV</td></tr></table>	Sl.no	Description	Parameter	a)	One minute power frequency withstand voltage between secondary terminal and earth	5kV		
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SINGRAULI STPP STAGE-III (2X800 MW) EPC PACKAGE		TECHNICAL SPECIFICATION SECTION – VI, PART-B	SUB-SECTION-B-17 SWITCHYARD						
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	b)	Partial discharge level	10 pico Coulombs max.																																	
	c)	Temperature rise	As per IEC																																	
	d)	Type of insulation	Class A																																	
	e)	Number of cores	Five (5): Details are given in table-1 below																																	
	f	Rated frequency	50 Hz																																	
	g)	System neutral earthing	Effectively earthed																																	
	h)	Installation	Outdoor (up right)																																	
	i)	Seismic acceleration	0.3 g horizontal																																	
	j	Number of terminals in marshalling box.	All terminals of control circuits wired up to box marshalling box plus 20 terminals spare.																																	
	5.08.01	400 kV Current Transformers (oil filled type) :																																		
	<table><tr><th>Sl.no</th><th>Description</th><th>Parameter</th></tr><tr><td>a)</td><td>Rated Short time thermal current</td><td>63kA for 1sec</td></tr><tr><td>b)</td><td>Rated Dynamic current</td><td>157.5kA(peak)</td></tr><tr><td>c)</td><td>Rated Extended Primary current</td><td>120% of rated primary current as per SLD</td></tr></table>	Sl.no	Description	Parameter	a)	Rated Short time thermal current	63kA for 1sec	b)	Rated Dynamic current	157.5kA(peak)	c)	Rated Extended Primary current	120% of rated primary current as per SLD																							
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5.09.00	PARAMETERS FOR VOLTAGE TRANSFORMERS (For AIS): General Parameters:																																			
	<table><tr><th>Sl.no</th><th>Description</th><th></th></tr><tr><td>a)</td><td>Standard reference range of frequencies</td><td>96% to 102% for protection. 99% to 101% for measurement</td></tr><tr><td>b)</td><td>High frequency .capacitance</td><td>With in 80% to 150%</td></tr><tr><td>c)</td><td>Equivalent resistance over entire carrier frequency range</td><td><40 ohms</td></tr><tr><td>d)</td><td>One min.power frequency with stand voltage (B/W LV(HF) terminal</td><td>10KV rms & earth for exposed terminals or 4kV rms for terminals enclosed in weather proof box</td></tr><tr><td>e)</td><td>No of terminals in cabinet mFor secondary winding</td><td>Required , plus 10nos spare.</td></tr><tr><td>f</td><td>Rated thermal burden</td><td>750VA.</td></tr><tr><td>g)</td><td>Partial discharge</td><td>Max.10 pico coulombs</td></tr><tr><td>h)</td><td>Rated voltage factor</td><td>1.2continuous, 1.5 for 30sec</td></tr><tr><td>i)</td><td>No of cores</td><td>As per details given I Table-II below</td></tr><tr><td>j)</td><td>CVT HF capacitance</td><td>4400/8800pf (as required)</td></tr></table>	Sl.no	Description		a)	Standard reference range of frequencies	96% to 102% for protection. 99% to 101% for measurement	b)	High frequency .capacitance	With in 80% to 150%	c)	Equivalent resistance over entire carrier frequency range	<40 ohms	d)	One min.power frequency with stand voltage (B/W LV(HF) terminal	10KV rms & earth for exposed terminals or 4kV rms for terminals enclosed in weather proof box	e)	No of terminals in cabinet mFor secondary winding	Required , plus 10nos spare.	f	Rated thermal burden	750VA.	g)	Partial discharge	Max.10 pico coulombs	h)	Rated voltage factor	1.2continuous, 1.5 for 30sec	i)	No of cores	As per details given I Table-II below	j)	CVT HF capacitance	4400/8800pf (as required)		
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j)	CVT HF capacitance	4400/8800pf (as required)																																		
5.10.00	TESTS:																																			
	a) 400KV GIS Instrument transformer shall be type tested in accordance with the requirement stipulated under clause no 1.12.00 b) The Current and voltage transformers (For AIS) shall confirm to type tests and subjected to routine tests in accordance with the relevant IEC/IS and shall also conform to the following additional type tests as applicable:																																			
	<table><tr><th>Sl.No</th><th>Description</th></tr><tr><td>i)</td><td>Radio Interference and Corona test</td></tr><tr><td>ii)</td><td>Thermal withstand test i.e. application of rated voltage and rated current simultaneously by synthetic circuit (For CT only)</td></tr></table>	Sl.No	Description	i)	Radio Interference and Corona test	ii)	Thermal withstand test i.e. application of rated voltage and rated current simultaneously by synthetic circuit (For CT only)																													
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	<table><tr><td></td><td>Seismic withstand test along with structure (for 400kV only)</td></tr><tr><td>iv)</td><td>Thermal co-efficient test i.e. measurement of Tan-Delta as function of temperature (at ambient and between 80 deg. C and 90 deg. C) and voltage (at 0.3, 0.7, 1.0 and 1.1 Um).(for CT only)</td></tr><tr><td>v)</td><td>Multiple chopped impulse test on Primary winding.</td></tr><tr><td>vi)</td><td>In addition to routine tests as per IEC/IS, measurement of partial discharge in continuation with power frequency withstand test required for 400 kV current transformer. ISF (Instrument Security Factor) test will be done as part of Routine acceptance test</td></tr><tr><td></td><td></td></tr></table> TABLE-I CORE DETAILS OF 400kV CTs-Protection (GIS) CT-A Following details shall be applicable for all protection class CT cores. The rated extended primary current of the CTs shall be 120% continuous of 3000A. <table><tr><th>CT No.</th><th>Current Ratio (A)</th><th>Output Burden (VA)</th><th>Accuracy Class as per IEC</th><th>Min Knee Point Voltage (Vk)</th><th>Max CT Sec Winding Res. (Ohm)</th><th>Max Exciting Current in mA at Vk</th></tr><tr><td>1</td><td>3000/ 2000/ 1000/1</td><td>-----</td><td>PS</td><td>6000/4000/ 2000</td><td>15/ 10/ 5 Ohm</td><td>20/ 30/ 60</td></tr><tr><td>2</td><td>3000/ 2000/ 1000/1</td><td>-----</td><td>PS</td><td>6000/4000/ 2000</td><td>15/ 10/ 5 Ohm</td><td>20/ 30/ 60</td></tr></table> Physical arrangement of CTs shall be as per Protection SLD. CORE DETAILS OF 400kV CTs-Protection (GIS) CT-B Following details shall be applicable for all protection class CT cores. The rated extended primary current of the CTs shall be 120% continuous of 3000A. Physical arrangement of CTs shall be as per Protection SLD.		Seismic withstand test along with structure (for 400kV only)	iv)	Thermal co-efficient test i.e. measurement of Tan-Delta as function of temperature (at ambient and between 80 deg. C and 90 deg. C) and voltage (at 0.3, 0.7, 1.0 and 1.1 Um).(for CT only)	v)	Multiple chopped impulse test on Primary winding.	vi)	In addition to routine tests as per IEC/IS, measurement of partial discharge in continuation with power frequency withstand test required for 400 kV current transformer. ISF (Instrument Security Factor) test will be done as part of Routine acceptance test			CT No.	Current Ratio (A)	Output Burden (VA)	Accuracy Class as per IEC	Min Knee Point Voltage (Vk)	Max CT Sec Winding Res. (Ohm)	Max Exciting Current in mA at Vk	1	3000/ 2000/ 1000/1	-----	PS	6000/4000/ 2000	15/ 10/ 5 Ohm	20/ 30/ 60	2	3000/ 2000/ 1000/1	-----	PS	6000/4000/ 2000	15/ 10/ 5 Ohm	20/ 30/ 60		
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CT No.	Current Ratio (A)	Output Burden (VA)	Accuracy Class as per IEC	Min Knee Point Voltage (Vk)	Max CT Sec Winding Res. (Ohm)	Max Exciting Current in mA at Vk
1	3000/ 2000/ 1000/1	-----	PS	6000/4000/ 2000	15/ 10/ 5 Ohm	20/ 30/ 60
2	3000/ 2000/ 1000/1	-----	PS	6000/4000/ 2000	15/ 10/ 5 Ohm	20/ 30/ 60

CORE DETAILS OF 400kV CTs-Protection (GIS) CT-C (ST / GT/ Bus reactor)

Following details shall be applicable for all protection class CT cores.
The rated extended primary current of the CTs shall be 120% continuous of 3000A.

CT No.	Current Ratio (A)	Output Burden (VA)	Accuracy Class as per IEC	Min Knee Point Voltage (Vk)	Max CT Sec Winding Res. (Ohm)	Max Exciting Current in mA at Vk
1	3000/ 2000/ 1000/ 500/1, (EM)	20/20/20/20	0.2S, ISF<5	-	-	-

Physical arrangement of CTs shall be as per Protection SLD.

CORE DETAILS OF 400kV CTs-Protection (GIS) CT-C CTL (Line Side)

Following details shall be applicable for all protection class CT cores.
The rated extended primary current of the CTs shall be 120% continuous of 3000A.
Physical arrangement of CTs shall be as per Protection SLD.

CT No.	Current Ratio (A)	Output Burden (VA) (*)	Accuracy Class as per IEC	Min Knee Point Voltage (Vk)	Max CT Sec Winding Res. (Ohm)	Max Exciting Current in mA at Vk
1	3000/ 2000/ 1000/1 (Main#1)	-----	PS	6000/4000/ 2000	15/ 10/ 5 Ohm	20/ 30/ 60
2	3000/ 2000/ 1000/1 (Main#1)	-----	PS	6000/4000/ 2000	15/ 10/ 5 Ohm	20/ 30/ 60
3	3000/ 2000/ 1000/ 500/1 ABT Metering (EM), PMU	20/20/20/20	0.2S, ISF<5	-	-	-
4	3000/ 2000/ 1000/ 500/1 ABT Metering (EM-Main, Check)	20/20/20/20	0.2S, ISF<5	-	-	-

TABLE – II

CORE DETAILS OF 400kV Bus VT / VT (GIS)

Secondary Core	Application	Rated Voltage (V)	Secondary Accuracy	Output Burden (Maximum) (*)
I	Protection	110/√3	3P	50 VA
II	Protection	110/√3	3P	50 VA
III	Metering	110/√3	0.2	50 VA

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The accuracy of 0.2 on secondary III should be maintained through the entire burden range up to total simultaneous burden 50 VA on all the three windings without any adjustments during operation.

* The rated burden of cores shall be closer to the maximum burden requirement of metering and protection system for better sensitivity and accuracy. The supporting calculation for burden to be furnished during detail engineering.

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	N CORE DETAILS OF 400kV CTs (AIS): Following details shall be applicable for all protection class CT cores. The rated extended primary current of the CTs shall be 120% continuous of 3000A./2000A <table><tr><th>CT No./Core No.</th><th>Current Ratio (A)</th><th>Output Burden (VA) (*)</th><th>Accuracy Class as per IEC</th><th>Min Knee Point Voltage (Vk)</th><th>Max CT Sec Winding Res. (Ohm)</th><th>Max Exciting Current in mA at Vk</th><th>Application</th></tr><tr><td>1 S U</td><td>3000/2000//1000/1</td><td>-----</td><td>PS</td><td>3000/2000/1000</td><td>15/10/5 Ohm</td><td>20/30/ 60</td><td>Bus Differential check</td></tr><tr><td>2 P O</td><td>3000/2000/1000/1</td><td></td><td>PS</td><td>3000/2000/1000</td><td>15/10/5 Ohm</td><td>20/30/ 60</td><td>Bus Differential main</td></tr><tr><td>3 T</td><td>3000/2000/1000/500/1</td><td>20/20/20/20</td><td>0.2S</td><td></td><td></td><td></td><td>Metering and synch.</td></tr><tr><td>4 N</td><td>do</td><td>do</td><td>0.2S</td><td></td><td></td><td></td><td>For ABT Metering</td></tr><tr><td>5 G A</td><td>3000/2000/1000/500/1</td><td></td><td>PS</td><td>3000/2000/1000/500/1</td><td>15/10/5/2.5Ohm</td><td>20/30/60/120</td><td>Transformer Back up / line protection</td></tr><tr><td>6 L C U</td><td>3000/2000/1000/500/1</td><td></td><td>PS</td><td>3000/2000/1000/500/1</td><td>15/10/5/2.5Ohm</td><td>30/ 60/120</td><td>Trans Diff./ Line protection</td></tr><tr><td>7 L</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr></table> Physical arrangement of CTs shall be as per Protection SLD. Note : The supporting calculation to be furnished during detail engineering For CT Parameters.	CT No./Core No.	Current Ratio (A)	Output Burden (VA) (*)	Accuracy Class as per IEC	Min Knee Point Voltage (Vk)	Max CT Sec Winding Res. (Ohm)	Max Exciting Current in mA at Vk	Application	1 S U	3000/2000//1000/1	-----	PS	3000/2000/1000	15/10/5 Ohm	20/30/ 60	Bus Differential check	2 P O	3000/2000/1000/1		PS	3000/2000/1000	15/10/5 Ohm	20/30/ 60	Bus Differential main	3 T	3000/2000/1000/500/1	20/20/20/20	0.2S				Metering and synch.	4 N	do	do	0.2S				For ABT Metering	5 G A	3000/2000/1000/500/1		PS	3000/2000/1000/500/1	15/10/5/2.5Ohm	20/30/60/120	Transformer Back up / line protection	6 L C U	3000/2000/1000/500/1		PS	3000/2000/1000/500/1	15/10/5/2.5Ohm	30/ 60/120	Trans Diff./ Line protection	7 L									
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	<table><tr><th colspan="4">CORE DETAILS OF 400kV CVT(AIS)</th><th colspan="2">TABLE – II</th></tr><tr><td colspan="5">Primary Voltage : 400/ v3 for Primary I,II,III</td><td colspan="2"></td></tr><tr><th>Secondary Core</th><th>Application</th><th>Rated Voltage (V)</th><th>Secondary Accuracy</th><th>Output Maximum (*)</th><th>Burden –</th><th></th></tr><tr><td>I</td><td>Protection</td><td>110/v3</td><td>3P</td><td>50 VA</td><td></td><td></td></tr><tr><td>II</td><td>Protection</td><td>110/v3</td><td>3P</td><td>50 VA</td><td></td><td></td></tr><tr><td>III</td><td>Metering</td><td>110/v3</td><td>0.2</td><td>50 VA</td><td></td><td></td></tr><tr><td>IV</td><td>ABT Metering</td><td>110/v3</td><td>0.2</td><td>50VA</td><td></td><td></td></tr></table>				CORE DETAILS OF 400kV CVT(AIS)				TABLE – II		Primary Voltage : 400/ v3 for Primary I,II,III							Secondary Core	Application	Rated Voltage (V)	Secondary Accuracy	Output Maximum (*)	Burden –		I	Protection	110/v3	3P	50 VA			II	Protection	110/v3	3P	50 VA			III	Metering	110/v3	0.2	50 VA			IV	ABT Metering	110/v3	0.2	50VA			The accuracy of 0.2 on secondary III should be maintained through the entire burden range up to total simultaneous burden 50 VA on all the three windings without any adjustments during operation. * The rated burden of cores shall be closer to the maximum burden requirement of metering and protection system for better sensitivity and accuracy .The supporting calculation for burden to be furnished during detail engineering.		
	CORE DETAILS OF 400kV CVT(AIS)				TABLE – II																																																		
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	6.00.00	SURGE ARRESTOR:																																																					
6.01.00	GENERAL : The surge arrestors shall conform in general to IEC-60099-4 and IS:3070 / IS:15086(part-4) except to the extent modified in the specification.																																																						
6.01.01	Arrestors shall be hermetically sealed single phase units, self-supporting construction, suitable for mounting on lattice/tubular type support structures.																																																						
6.02.00	DUTY REQUIREMENTS:																																																						
6.02.01	The Surge Arresters (SAs) shall be capable of discharging over-voltages occurring due to switching of unloaded transformers, reactors and long lines. The reference current of SAs shall be high enough to eliminate the influence of grading and stray capacitance on the measured reference voltage. The SAs shall be capable of withstanding meteorological and short circuit forces under site conditions.																																																						
6.03.00	CONSTRUCTIONAL FEATURES (FOR AIS):																																																						
6.03.01	The non linear blocks shall be sintered metal oxide material. The SA construction shall be robust with excellent mechanical and electrical properties. SAs shall have pressure relief devices suitable for preventing violent failure of insulator housing and providing path for flow of rated fault currents in the event of arrester failure.																																																						
6.03.02	Outer insulator of Surge arrester shall be of Polymer type. The SA shall not fail due to polymer contamination. Polymer housing shall be so coordinated that external flashover will not occur due to application of any impulse or switching surge voltage up to maximum design value for SA. The cantilever strength of the complete assembled surge arrester is min.350kg or as per the actual calculation which ever is higher shall be provided for 400kV and above voltage class system .																																																						
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6.03.03	The end fittings shall be made of corrosion proof material and preferably be non-magnetic. The sealing arrangement of the Surge Arrester stacks shall be done incorporating grooved flanges with O-rings/elliptical cross section gasket of Neoprene or Butyl rubber.			
6.04.0	CONSTRUCTIONAL FEATURES FOR GAS INSULATED SURGE ARRESTOR: a)It will be SF6 gas insulated, metal enclosed surge arrester of the gapless nonlinear zinc oxide, heavy duty, station type. The arrester enclosure shall be vertically or horizontally mounted to suit the layout of the switchgear and shall be fitted with a discharge counter located in an easily accessible position. b)The main grounding connection from the surge arrester to the earth shall be provided by the Contractor. The size of the connecting conductor shall be such that all the energy is dissipated to the ground without getting overheated.			
6.05.00	FITTINGS AND ACCESSORIES FOR AIS:			
6.05.01	Each SA shall be complete with insulating base for mounting on structure. SAs shall be provided with grading and/or corona rings as required.			
6.05.02	i)Self-contained discharge counters, suitably enclosed for outdoor use (with Min.IP:56 degree of protection) and requiring no auxiliary or battery supply shall be fitted with each SA along with necessary connections to SA and earth. Suitable leakage current meters shall also be supplied in the same enclosure. The reading of milliammeter and counter shall be visible through an inspection glass panel to a man standing on ground and the same shall be mounted at eye level height to facilitate easy reading of the counter and leakage current. A pressure relief vent/suitable provision shall be made to prevent pressure build up. ii)The surge counter shall be provided with a potential free contact which shall close whenever a surge is recorded by the surge monitor. Necessary arrangement shall be provided for extending the contact information to substation Automation system. iii) Insulated copper conductor of adequate size and length shall be used for connecting discharge counter terminal and lightning arrester earth terminal. Insulation level of the conductor shall not be less than 5 kV. Suitably sized bypass copper shunts shall be provided for bypassing the discharge counter for removal / maintenance of the counter. iv) (Note: Optional) : Surge monitor comprising a digital type counter, leakage current detector shall be provided for each arrester and the same shall be mounted at eye level height to facilitate easy reading of the counter and leakage current detectors. Necessary arrangement shall be provided for extending the reading of surge counter, leakage current indication in the SAS.			
6.06.00	PARAMETERS: General (400kV) :			
	Sl.no	Description		
	a)	Nominal discharge current	20kA of 8/20 microsec.wave	
	b)	Long duration discharge class	3 or 4	
	c)	Current for pressure relief test	63kA rms	
	d)	Prospective symmetrical fault current	63kA rms	
	e)	Low current duration test value	As per IEC.	
	f)	Partial discharge at 1.05MCOV	Not >than 50pc	
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06.06.01	(The arrester voltage / rating shall be as per the study of insulation co-ordination of system)			
	400kV Class Surge Arrester :			
	Sl.no	Description		
	a)	Rated Arrester Voltage	Min.336kV	
	b)	Minimum Discharge capability	12 kJ/kV	
	c)	Continuous operating voltage (COV) at 50 deg. C	267rms	
	d)	Min. Switching surge residual (1 kA)	730 kVp minimum, 780 kVp maximum	
	e)	RIV at 266 kV (rms)	Less than 1000 micro volts	
	(The arrester voltage / rating shall be as per the study of insulation co-ordination of system)			
	The surge arrestors are provided to protect the following equipment whose insulation levels are indicated in the Table#I given below. The contractor shall carry out the insulation coordination studies for deciding the location of the surge arrestors.			
TABLE#1:				
	Equipment to be Protected	Lightning impulse(kVp)	Switching impulse(kVp)	
a)	Power Transformer	± 1425	± 1050	
b)	Instrument Transformer	± 1425	± 1050	
c)	Reactor	± 1300	± 1050	
d)	CB/isolator (Ph to ground)	± 1425	± 1050	
	Across open contacts	± 1425(± 240)	± 900(± 340)	
Surge arrestors shall be capable of discharge on severe re-energisation switching surges on a 400 kV line upto 450 km. length with surge impedance of 300 ohms and capacitance of 11.986 nF/km amd over voltage factor of 2.3 p.u. Surge arrester shall be capable of discharging energy equivalent to class 3 or 4 of IEC for a 420 kV system on two successive operations followed immediately by 50 Hz energization.				
6.07.00	TESTS:			
6.07.01	Surge arrester (GIS) shall be type tested in accordance with clause no. 1.06.02 & 1.06.03. Surge arrestors (AIS) shall confirm to all type tests (as applicable) as per IEC 60099-4 and shall be subjected to routine and acceptance tests in accordance with IEC-60099-4. The resistive current drawn by the arrester for at rated voltage shall be indicated in the routine test report.			
7.00.00	POST INSULATOR:			
7.01.00	GENERAL : The post insulators shall conform in general to latest IS: 2544 and IEC – 60815, 60168.			
7.02.00	CONSTRUCTIONAL FEATURES:			
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7.02.01	Post type insulators shall consist of a porcelain / Polymer part permanently secured in a metal base to be mounted on the supporting structures. They shall be capable of being mounted upright. They shall be designed to withstand any shocks to which they may be subjected to by the operation of the associated equipment. Only solid core insulators shall be accepted. Height of post insulator shall be preferably as given under parameters of this part. The other requirements of insulator as given under auxiliary requirements shall also be applicable.																										
7.03.00	TESTS:																										
7.03.01	In accordance with the stipulations elsewhere the post insulators shall conform to type tests and acceptance, sample and routine tests as per IS: 2544, IEC-60168 shall be carried out.																										
7.03.02	In addition to acceptance/sample/routine tests as per IS: 2544, IEC-60168, the following tests shall also be carried out.																										
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7.04.01	400 kV class Post Insulators:																										
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Note:	If corona extinction voltage is to be achieved with the help of corona ring or any other similar device, the same shall be deemed to be included in the scope of the bidder without any price implication.																										
8.00.00	WAVE TRAP : GENERAL:																										
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	The Wave Trap covered under the package shall conform to IEC 353 or IS:8792, IS:8793 and relevant IEC/IS Specifications except to the extent modified by the specification.																							
8.01.00	LOCATION OF EQUIPMENT :																							
8.01.01	Wave Traps as specified under this section shall be installed at the respective transmission line bays as indicated in single line diagram.																							
8.02.00	TECHNICAL REQUIREMENTS:																							
8.02.01	Wave Trap shall be inserted into high voltage transmission line to prevent undue loss of carrier signal for all power system conditions. Its impedance shall be negligible at power frequency (50 Hz) so as not to disturb power transmission but shall be relatively high over the frequency band appropriate to carrier transmission.																							
8.02.02	Wave trap shall consist of a main coil designed to carry continuously the rated current without exceeding the limit of temperature rise. It shall be supplemented with a protective device and tuning device. Wave trap shall be Broad Band tuned for its entire carrier frequency range. Resistive component of impedance of the Wave trap within its carrier frequency blocking range shall not be less than 570 ohms.																							
8.02.03	Wave trap shall be provided with a protective device in the form of lightning arrestor which shall be designed and arranged such that neither significant alternation in its protective function nor physical damage shall result from either temperature rise or the magnetic field of the main coil at continuous rated current or rated short time current The protective device shall be shunt connected to the main coil and tuning device. The lightning arrestor provided shall have a rated discharge current of 10 kA. Coordination, however, shall be done by taking 20 kA discharge current into account.																							
8.02.04	The lightning arrestor provided with the Wave trap of each rating shall fully comply with the requirements of IS-3070-Part-I (1974)/IEC-60099. It shall conform to type tests as applicable and type test certificate for the same shall be submitted by the Bidder.																							
8.02.05	The lightning arrestor provided with the Wave trap shall be subject to routine and acceptance tests as per IEC – 60099. The Wave trap on 400 kV lines shall show no visual corona at extinction voltage of 320 kV rms. Suitable corona rings shall be incorporated in the line trap for 400 kV. Wave trap shall be equipped with bird barriers.																							
8.02.06	Wave trap shall preferably be spray painted with light admiralty Grey paint (shade 697 of IS-5) or may have its natural epoxy colour.																							
8.02.07	Wave trap shall conform to IEC - 60353 fulfilling the following technical particulars.																							
	<table><tr><th>Sl.no</th><th>Description</th><th></th></tr><tr><td>a)</td><td>Nominal discharge current of protective device</td><td>10kA</td></tr><tr><td>b)</td><td>Type of tuning</td><td>Broad band</td></tr><tr><td>c)</td><td>Rated Blocking band width</td><td>90-500KHZ</td></tr><tr><td>d)</td><td>inductance</td><td>8800 pf / 4400pf , 1.0 mH / 0.5 mH (matching with the remote end wave trap rating.)</td></tr><tr><td>e)</td><td>Radio interference voltage level at 266kV Total min. cantilever strength(kg)</td><td>Not > than500micro volts</td></tr><tr><td></td><td></td><td></td></tr></table>	Sl.no	Description		a)	Nominal discharge current of protective device	10kA	b)	Type of tuning	Broad band	c)	Rated Blocking band width	90-500KHZ	d)	inductance	8800 pf / 4400pf , 1.0 mH / 0.5 mH (matching with the remote end wave trap rating.)	e)	Radio interference voltage level at 266kV Total min. cantilever strength(kg)	Not > than500micro volts					
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8.02.08	In accordance with the requirements stipulated elsewhere, the Wave Trap shall confirm to following type tests and shall be subjected to routine and acceptance tests as per IEC-60353.		
	Sl.No	Description	
	a)	Measurement of inductance of the main coil	
	b)	Measurement of temperature rise	
	c)	Insulation tests	
	d)	Short time current tests	
	e)	Corona Extinction Voltage Measurement	
	f)	Radio Interference Voltage measurement	
8.03.00	WAVE TRAP MOUNTING:		
8.03.01	The Wave Trap for 400kV shall be suitable for outdoor pedestal mounting and shall be mechanically strong enough to withstand the stresses due to maximum wind pressure of 195 kg/square meter. For pedestal mounting, each Wave trap shall be mounted on a lattice structure formed by three solid core type insulators.		
9.00.00	REQUIREMENT OF AUXILIARY ITEMS:		
9.01.00	ALUMINIUM TUBULAR CONDUCTOR:		
9.01.01	The aluminium tube shall be grade 63401 WP (range2) as per IS 5082. There shall be no negative tolerance on OD and thickness of the tube. Other tolerances shall be as per IS:2678 and 2673.		
9.01.02	Tests: In accordance with stipulations of specification routine tests shall be conducted on tubular conductor as per IS:5082. Also, the wall thickness and ovality shall be measured by ultrasonic method. In addition, 0.2% proof tests on both parent material and aluminium tube after welding shall be conducted.		
	For 400KV :		
	a)	size	4"IPS(EH Type)
	b)	Outer diameter	114.20mm with no negative tolerance
	c)	Thickness of tube	8.51 mm with no negative tolerance
	d)	Cross-sectional area	2825.61 sq. mm.
	e)	weight	7.7kg/m
9.02.00	ACSR CONDUCTOR :		
	a)	Code and standard & Name	IS:398, MOOSE ACSR
	b)	Overall diameter	31.77mm
	c)	Strands and wire diameter of	
		a) Aluminium	54/3.53mm
		b) steel	7/3.53mm
9.03.00	CLAMPS AND CONNECTORS:		
9.03.01	The material of clamps and connectors shall be Aluminium alloy casting conforming to designation A6 of IS:617 for connecting to equipment terminals and conductors of aluminium. In case equipment terminals are of copper, the same clamps/connectors shall be used with 2mm thick bimetal.		
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9.03.02	The material of clamps and connectors shall be Galvanised mild steel for connecting to G.S. shield wire.																			
9.04.00	INSULATOR STRING HARDWARE:																			
9.04.01	The insulator hardware shall be of bolted type and shall be of forged steel except for insulator cap, which can be of malleable cast iron. It shall also generally meet the requirements of clamps and connectors as specified above. In one span, Tension string assembly at one end shall be supplied with suitable turn buckle.																			
9.04.02	Disc Insulator for porcelain type insulator The disc insulator shall meet the following parameters: <table border="1"> <tr> <td>a)</td><td>Type</td><td>Antifog type insulator</td></tr> <tr> <td>b)</td><td>Size of insulator</td><td>255X145</td></tr> <tr> <td>c)</td><td>Electro mechanical strength</td><td>120KN</td></tr> <tr> <td>d)</td><td>Leakage distance(mm)</td><td>Min.430 or as required to meet the total creepage</td></tr> <tr> <td>e)</td><td>Power frequency voltage- dry & wet</td><td>80kV, 50kV</td></tr> </table>	a)	Type	Antifog type insulator	b)	Size of insulator	255X145	c)	Electro mechanical strength	120KN	d)	Leakage distance(mm)	Min.430 or as required to meet the total creepage	e)	Power frequency voltage- dry & wet	80kV, 50kV				
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9.04.03	Insulator string (400KV) : Porcelain type / composite long rod type) <table border="1"> <tr> <td>a)</td><td>Creepage distance size</td><td>Min.13020mm</td></tr> <tr> <td>b)</td><td>One Minute Power frequency voltage</td><td>680KV</td></tr> <tr> <td>c)</td><td>Lightning impulse</td><td>+/- 1550 KV</td></tr> <tr> <td>d)</td><td>Switching impulse</td><td>+/- 1050 KV</td></tr> <tr> <td>e)</td><td>No of disc. insulator (for porcelain)</td><td>25nos</td></tr> <tr> <td>f)</td><td>Electro mechanical strength</td><td>120KN (porcelain)</td></tr> </table>	a)	Creepage distance size	Min.13020mm	b)	One Minute Power frequency voltage	680KV	c)	Lightning impulse	+/- 1550 KV	d)	Switching impulse	+/- 1050 KV	e)	No of disc. insulator (for porcelain)	25nos	f)	Electro mechanical strength	120KN (porcelain)	
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9.05.00	SPACERS : Spacers shall conform to IS:10162. They shall be of non-magnetic material except nuts and bolts, which shall be of hot dip galvanised mild steel.																			
9.05.01	Spacers shall generally meet the requirements of clamps and connectors as specified above. Its design shall take care of fixing and removing during installation and maintenance.																			
9.05.02	In addition to the type tests as per IS:10162, clamp slip test should have been conducted. In this test the sample shall be installed on test span of twin/quad bundle string at a tension of 44.2 kN (4500 kg). One of the clamps when subjected to a longitudinal pull of 2.5 kN (250 kg) parallel to the axis of conductor shall not slip, i.e. permanent displacement between conductor and clamp after the test shall not exceed 1.0 mm. This test should have been performed on all other clamps of the sample.																			
9.06.00	EARTHING CONDUCTOR: a)The main conductor buried in earth shall be 40mm dia rod for main and auxiliary mat. The earthing conductors over the ground shall be of 75x12 mm GS flat. The earthing leads for columns and auxiliary structures, cable trenches shall be of 75x12 mm GS flat. The earthing of the lighting fixtures shall be carried out by 16 SWG wire. b) All earthing conductors above the ground level shall be galvanised steel only. Refer Annexure-II																			
9.07.00	Earthwire for Lightning Protection : <table border="1"> <tr> <th>Sl.no</th><th>Description</th><th>parameters</th></tr> <tr> <td>1</td><td>Number of strands</td><td>7 of steel</td></tr> </table>	Sl.no	Description	parameters	1	Number of strands	7 of steel													
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9.08.00	2	Strand diameter	3.66mm
	3	Overall diameter	10.98mm
	4	Weight	583 kg/km approx.
	5	Ultimate tensile strength	68.4 kN minimum
	6	Total cross-sectional area	73.65 sq.mm
	7	Calculated d.c. resistance	2.5 ohms/km at 20 deg.C.
	8	Direction of lay of outer layer	Right hand
	CABLE RACKS INCLUDING SUPPORTS, TRAYS AND ACCESSORIES:		
i) Cable Support Structures & Accessories :			
The Contractor shall fabricate and install mounting arrangements for the cable tray supports or use the flexible cable tray supports and required accessories with bolted arrangement and installation of all the cables in Cable tray in the trenches / above ground.. These mounting shall be fabricated from structural steel members (channels, angles and flats) of the required size.			
i) Cable Trays:			
a)Hot dip galvanised ladder type , perforated type cable trays of adequate width are to be provided for cables in the control room building, out door, above ground cable tray arrangement.			
b)Aux. power cables are to be laid on the top tray and DC control cables in bottom trays. Cable trays shall be designed to carry cables load without bending and proper tray supports shall be provided at every 1 mt interval .			
c)Cable trays having power and control cable are spaced at Min.300 mm and between control cable trays, the spacing is min.225 mm. For tray lengths more than 2.5 m coupler plates are to be used for joining the two standard tray lengths. Suitable 'L' and 'T' bends are included under the scope of this contract			
d) Cable trays shall be made of 2 mm thick sheet steel having a slotted rung spacing of 250 mm. Height of cable tray channel shall be 75 mm and the standard length of trays shall be 2.5 mt			
e)All nuts, bolts, washers etc. to be supplied by the Contractor shall be hot dip galvanised after fabrication.			
f)The Contractor shall perform all tests and inspection to ensure that material and workmanship are according to the relevant standards			
For Detailed specification Refer Chapter B-10 (cabling , earthing, lighting) of Part-B, Section-VI.			
9.09.00	BUSHINGS, HOLLOW COLUMN INSULATORS, SUPPORT INSULATORS, AND DISC INSULATORS:		
9.09.01	Bushings shall be manufactured and tested in accordance with IS:2099 & IEC:60137 while hollow column insulators shall be manufactured and tested in accordance with IEC 62155/IS 5284. The support insulators shall be manufactured and tested as per IS:2544 /		
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	IEC 60168/IEC 60273. The insulators shall also conform to IEC 60815 as applicable having alternate long and short sheds. Support insulators/ bushings/ hollow column insulators shall be designed to have ample insulation, mechanical strength and rigidity for the conditions under which they will be used. 9.09.02 Porcelain used shall be homogenous, free from laminations, cavities and other flaws or imperfections that might affect the mechanical or dielectric quality and shall be thoroughly vitrified, tough and impervious to moisture. 9.09.03 Glazing of the porcelain shall be uniform brown in colour, free from blisters, burns and other similar defects. 9.09.04 The design of the insulator shall be such that stresses due to expansion and contraction in any part of the insulator shall be lead to deterioration. All ferrous parts shall be hot dip galvanised. 9.09.05 Post type insulators shall consist of a porcelain part permanently secured in metal base to be mounted on supporting structures. They shall be capable of being mounted upright. They shall be designed to withstand all shocks to which they may be subjected to during operation of the associated equipment. 9.09.06 Bushing porcelain shall be robust and capable of withstanding the internal pressures likely to occur in service. The design and location of clamps, the shape and the strength of the porcelain flange securing the bushing to the tank shall be such that there is no risk of fracture. All portions of the assembled porcelain enclosures and supports other than gaskets, which may in any way be exposed to the atmosphere shall be composed of completely non hygroscopic material such as metal or glazed porcelain. 9.09.07 All iron parts shall be hot dip galvanised and all joints shall be air tight. Surface of joints shall be trued, porcelain parts by grinding and metal parts by machining. Insulator/ bushing design shall be such as to ensure a uniform compressive pressure on the joints. 9.09.08 In accordance with the requirements stipulated elsewhere, bushings, hollow column insulators and support insulators shall conform to type tests and shall be subjected to routine tests and acceptance test/ sample test in accordance with relevant standards 9.10.00 CABINETS, BOXES, KIOSKS, PANELS, ETC: 9.10.01 All types of control cabinets, junction boxes, marshaling boxes, lighting panels, terminal boxes, operating mechanism boxes, Kiosks etc. shall generally conform to IS:5039, IS:8623 and IEC: 60439 as applicable. 9.10.02 Suitable 240V, single phase, 50Hz ac heaters with thermostats controlled by switch and fuse shall be provided to maintain inside temperature 10deg. above the ambient.			
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9.10.03	They shall be of Stainless steel or Aluminium. The thickness of Stainless steel shall be minimum 1 mm. The thickness of aluminium shall be minimum 3 mm and shall provide rigidity. Top of the boxes shall be sloped towards the rear of the box.			
9.11.00	BAY MARSHALLING BOX:			
9.11.01	Bay Marshaling Box located at a convenient location to receive and distribute cables shall be provided as required. It shall meet all the requirements as specified for cabinets/boxes.			
9.11.02	It shall have three separate distinct compartments for following purposes: - To receive two incoming 415V, three phase, AC supplies controlled by 100A four pole MCBs with auto changeover provision, and to distribute five (5) three phase ac supplies controlled by 32A four pole MCBs. It shall also be provided with 63A, 3 phase 4 pin industrial grade receptacle with rotary switch. - To receive three phase incoming from first compartment and to distribute ten (10) single phase ac supplies controlled by 16A two pole MCBs. - 150 nos. terminal blocks in vertical formation for interlocking facility.			
9.11.03	JUNCTION BOXES: Contractor shall supply and install junction boxes complete with terminals as required.			
9.12.00	TERMINAL BLOCKS:			
9.12.01	They shall be non-disconnecting stud type of extensible design equivalent to Elmex type CAT-M4.			
9.12.02	The terminal blocks shall be of 850 V grade, and rated to continuously carry maximum expected current. The conducting part shall be tinned or silver plated.			
9.12.03	Unless otherwise required (expected current rating) or specified, terminal blocks shall be suitable for connecting the following conductors on each side: a) All CT & VT circuits - Min. four 2.5 sq.mm. copper flexible conductor b) AC & DC power supply -Two 16 sq.mm. aluminium conductor. c) Circuits Other control circuits - Min. two 2.5 sq.mm. copper flexible conductor			
9.13.00	Wiring: All wiring shall be carried out with 1100 V grade stranded copper wires. The minimum size of the stranded conductor used for internal wiring shall be as follows: a) All circuits except CT circuits 2.5 sq.mm b) CT circuits 4 sq. mm (minimum number of strands shall be 3 per conductor.			
9.14.00	CABLE GLANDS AND LUGS:			
9.14.01	Cable glands shall be Double compression type, tinned/Nicked plated (coating thickness not less than 20 microns in case of tin and 10 to 15 microns in case of nickel) brass cable glands for all power and control cables. They shall provide dust and weather proof terminations. They shall comprise of heavy duty brass casting, machine finished and tinned to avoid corrosion and oxidation. Rubber components. used in cable glands shall be neoprene and off tested quality. Required number of packing glands to close unused openings in gland plates shall also be provided.			
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9.14.02	The cable glands shall be tested as per BS:6121. The cable glands shall also be duly tested for dust proof and weather proof termination.			
9.14.03	Cables lugs shall be tinned copper solder less crimping type conforming to IS:8309 and 8394 suitable for aluminum or copper conductor (as applicable). The cable lugs shall suit the type of terminals provided. The cable lugs shall be of Dowell make or equivalent.			
9.15.00	CONDUITS, PIPES AND ACCESSORIES :			
9.15.01	The Contractor shall supply and install all rigid conduits, mild steel pipes, flexible conduits, hume pipes, etc. including all necessary sundry materials, such as tees, elbows, check nuts, bushing reduces, enlargers, wooden plugs, coupling caps, nipples, gland sealing fittings, pull boxes, etc The size of the conduit/pipe shall be selected on the basis of maximum 40% fill criterion. All conduits/pipes shall have their ends closed by caps until cables are pulled. After cables are pulled, the ends of conduits/pipes shall be sealed in an approved manner, to prevent damage to threaded portion and entrance of moisture and foreign material.			
9.15.02	Rigid conduits shall be flow-coat metal conduits. The outer surface of the conduits shall be coated with hot-dip zinc and chromate conversion coatings. The inner surface shall have silicone epoxy ester coating for easy cable pulling. Mild steel pipes shall be hot-dip galvanised. All rigid conduits/ pipes shall be of a reputed make.			
9.15.03	Flexible conduits shall be heat-resistant lead coated steel, water-leak, fire and rust proof, and be of PLICA make or equivalent.			
9.16.00	Type tests: All equipment with their terminal connectors, control cabinets, main protective relays, etc. as well as insulators, insulator strings with hardwares, clamps and connectors, marshalling boxes, etc., shall conform to type tests and shall be subjected to routine and acceptance tests in accordance with the requirements stipulated under respective equipment sections.			
10.00.00	INSTALLATION:			
10.01.00	EARTHING: The earthing shall be done in accordance with requirements given in Annexure-II of this section and drawing enclosed with the specifications. Earthing of panels shall be done in line with the requirements given in respective equipment section of this specification.			
10.02.00	CIVIL WORKS : The civil works shall be done in accordance with requirements stipulated elsewhere in the specification .			
10.03.00	STRUCTURAL STEEL WORKS : The structural steel works shall be done in accordance with requirements stipulated elsewhere in the specification.			
10.04.00	LIGHTNING PROTECTION :			
10.04.01	Direct stroke lightning protection (DSLPP) shall be provided in the switchyard by lightning masts (at least 50 m high) or with shield wires.			
10.04.02	Lightning protection System down conductors shall not be connected to other conductors above ground level. Also no intermediate earthing connection shall be made to Surge arrester, Voltage Transformer, earthing leads for which shall be directly connected to rod electrode .Every down conductor shall be provided with a test joint at about 150mm above ground level. The test joint shall be directly connected to the earthing system. The lightning			
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10.06.00	protection system shall not be in direct contact with underground metallic service ducts and cables. EQUIPMENT ERECTION NOTES : a)All support insulators, circuit breaker interrupters and other fragile equipment shall be handled with cranes with suitable booms and handling capacity. The contractor shall strictly follow manufacturer's recommendations for handling and erection of equipment. b)The slings shall be of sufficient length to avoid any damage to insulator due to excessive swing, scratching by sling ropes etc. Handling equipment, sling ropes etc. should be tested before erection and periodically thereafter for strength. c)Bending of piping should be done by a bending machine and through cold bending only. Bending shall be such that inner diameter of pipe is not reduced. The pipes shall be thoroughly cleaned before installation.			
10.07.00	STORAGE OF EQUIPMENT: Contractor is responsible for the proper storage and maintenance of all materials/equipment entrusted to him. The Contractor shall provide & construct adequate storage shed for proper storage of equipment. Sensitive equipment shall be stored indoors. All equipment during storage shall be protected against damage due to acts of nature or accidents. Contractor shall take all required steps to carryout subsequent inspection of materials/equipment stored as well as erected until the same is taken over by the Employer. The storage instruction of the equipment manufacturers/Engineer-in-Charge shall be strictly adhered to.			
10.08.00	CABLING :			
10.08.01	Cabling shall be on cable trays with racks / on flexible cable tray support system with accessories , in trenches, vertical shafts, excavated trenches for direct burial, pulled through pipes and conduits run clamped on steel structures etc. in accordance with the requirements specified elsewhere in the specification.			
10.08.02	Cables inside the switchyard shall be laid on bolted GI angle / tray support system with accessories and supports shall be at an interval of 1000mm spacing with separate tiers for control and power cables in ladder type , perforated cable trays. The GI angles shall be bolted / welded to galvanized insert plates inside RCC trenches.			
10.08.03	All interpole cables (both power & control circuit) for equipments shall be laid in cable trenches/G.I. Conduit Pipe of NB 50/100mm which shall be buried in the ground at a depth of 300mm.			
ANNEXURE-II				
a)EARTHING NOTES FOR SWITCHYARD:				
GENERAL:				
i)Earthing of operating boxes, cubicles shall be done by 50 X 6 mm GS flat while cable trenches and structure by 75 X 12 mm GS flat. Neutral points of systems of different voltages, metallic enclosures and frame works associated with all current carrying equipments and extraneous metal works associated with electric system shall be connected to a single earthing system unless stipulated otherwise. Earthing system installation shall be in strict accordance with the latest editions of Indian Electricity Rules, relevant Indian Standards and Codes of practice and Regulations existing in the locality where the system is installed.				
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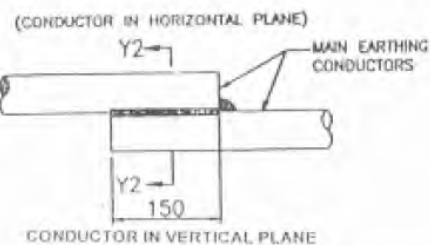
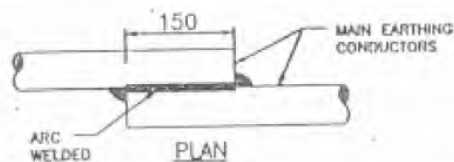
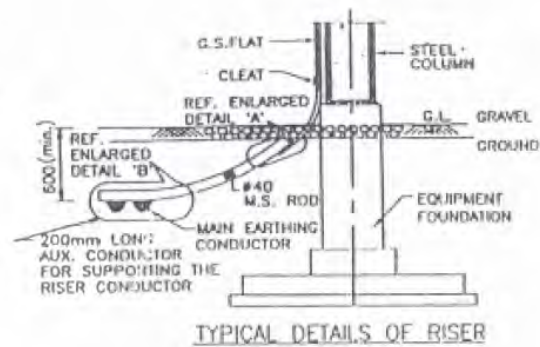
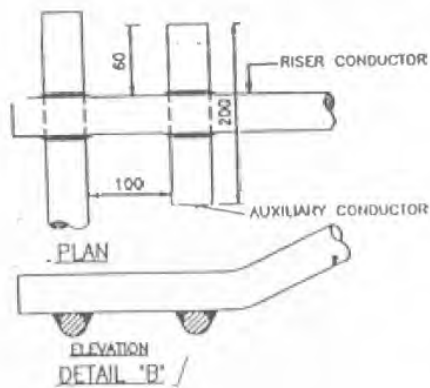
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	b)EARTHING OF GIS: i)The grounding system shall be designed and provided as per IEEE-80-2000 and CIGRE-44 to protect operating staff against any hazardous touch voltages and electro-mechanical interferences. ii)The GIS contractor shall define clearly what constitutes the main grounding bus of the GIS. The GIS contractor must supply, commission the entire grounding work of GIS viz conductor, clamps, joints, bimetallic strips (for connection between different type of earthing materials), operating and safety platforms etc. iii)The enclosure of the GIS shall be grounded at several points so that there shall be grounded cage around all the live parts. A minimum of two nos. of grounding connections should be provided for each of circuit breaker, transformer terminals, cable terminals, surge arrestors, earth switches and at each end of the bus bars. The grounding continuity between each enclosure shall be effectively interconnected with links or straps to bridge the flanges. Subassembly-to-subassembly bonding shall be provided to provide gap & safe voltage gradients between all intentionally grounded parts of the GIS assembly & between those parts and the main grounding bus of the GIS. iv)The enclosure grounding system shall be designed to minimize circulating currents and to ensure that the potential rise is kept to an acceptable level. Each marshalling box, local control panel, power and control cable sheaths and other non-current carrying metallic structures shall be connected to the grounding system of GIS via connections that are separated from GIS enclosures. v)The contractor shall provide suitable measure to mitigate transient enclosure voltage caused by high frequency currents caused by lightning strikes, operation of surge arrester, phase/earth fault and discharges between contracts during switching operation. The grounding system shall ensure safe touch & step voltages in all the enclosures. The contractor shall provide suitable barrier of non-liner resistor/counter discontinued SF6/Transformer and SF6/ HV cable bushing etc. to mitigate transient enclosure voltage. c)DETAILS OF EARTHING SYSTEM: <table><tr><th>item</th><th>Size</th><th>Material</th></tr><tr><td>Main Earthing conductor</td><td>40mm dia rod</td><td>Mild steel</td></tr><tr><td>Conductor above ground for equipments</td><td>75 x 12mm / 50 X6mm</td><td>Galvanized steel</td></tr><tr><td>Rod Electrode</td><td>40mm dia, 3000mm long</td><td>Mild steel</td></tr><tr><td>G.I. Earth wire</td><td>7/8 SWG</td><td>GI</td></tr><tr><td>Copper Flat or Copper cable : As per the requirement</td><td></td><td></td></tr><tr><td></td><td></td><td></td></tr></table> d) For Step and Touch Potential the following parameters shall be considered. i) Current distribution factor – 1 (one) ii) Duration of fault current – 1 sec iii) Human body weight – 50kg e) Grid resistance shall be less than 1(one) ohm.	item	Size	Material	Main Earthing conductor	40mm dia rod	Mild steel	Conductor above ground for equipments	75 x 12mm / 50 X6mm	Galvanized steel	Rod Electrode	40mm dia, 3000mm long	Mild steel	G.I. Earth wire	7/8 SWG	GI	Copper Flat or Copper cable : As per the requirement							
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	f) EARTHING CONDUCTOR LAYOUT i) Earthing conductors in outdoor areas shall be buried at least 600mm below finished grade level unless stated otherwise. ii) Minimum 6000mm or higher spacing between rod electrodes shall be provided based on the earth mat design calculations. iii) Wherever earthing conductors cross cable trenches, underground service ducts, pipes, tunnels, railway tracks etc., it shall be laid at least 300mm below them and shall be re-routed in case it fouls with equipment/structure foundations. iv) Earthing conductor along their run-on cable trench ladder columns, beams, walls, etc. shall be supported by suitable welding/cleating at intervals of 750mm. Wherever it passes through walls, floors etc. galvanized iron sleeves shall be provided for the passage of the conductor. Both ends of the sleeves shall be sealed to prevent the passage of water through the sleeves. v) Earthing conductor around the building shall be buried in earth at a minimum distance of 1500mm from the outer boundary of the building. In case high temperature is encountered at some location, the earthing conductor shall be laid minimum 1500mm away from such location. vi) In outdoor areas, tap connections shall be brought 300mm above ground level for making connections in future in case equipment is not available at the time of grid installations. vii) Earthing conductors crossing the road shall be either installed in Hume pipes or laid at greater depth to suit the site conditions. viii) Earthing conductors embedded in the concrete fibre shall have approximately 50mm concrete cover. ix) Contractor shall also provide interconnection (two interconnection per Unit) of Switchyard Earth mat with the Plant earth mat. g) EQUIPMENT AND STRUCTURE EARTHING: i) The connection between earthing pads and the earthing grid shall be made by short and direct earthing leads free from kinks and splices. ii) Metallic pipes, conduits and cable tray sections for cable installation shall be bonded to ensure electrical continuity and connected to earthing conductors at regular interval iii) Metallic conduits shall not be used as earth continuity conductor. iv) A separate earthing conductor shall be provided for earthing lighting fixtures, lighting poles, receptacles, switches, junction boxes, lighting conduits, etc. v) Wherever earthing conductor crosses or runs along metallic structures such as gas, water, steam, conduits, etc. and steel reinforcement in concrete it shall be bonded to the same. vi) Cable and cable boxes/glands, lockout switches etc. shall be connected to the earthing conductor running along with the supply cable which, in turn, shall be connected to earthing grid conductor at minimum two points, whether specifically shown or not. vii) Railway tracks within switchyard area shall be bonded across fish plates and connected to earthing grid at several locations.			
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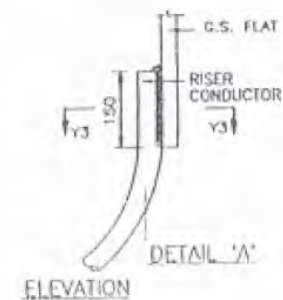
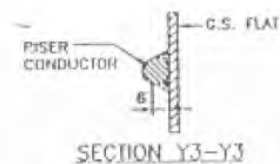
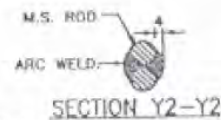
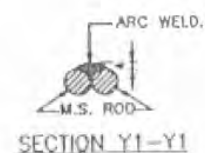
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	viii) Earthing conductor shall be buried 2000mm outside the switchyard fence. Every post of the fence and gates shall be connected to earthing loop by one lead. ix) Flexible earthing connectors shall be provided where flexible conduits are connected to rigid conduits to ensure continuity. h) JOINTING: shall be as per enclosed drawing equipment earthing standard drawing details shown in this specification:. i) POWER CABLE EARTHING: Metallic sheaths and armour of all multi core power cables shall be earthed at both equipment and switchgear end. Sheath and armour of single core power cables shall be earthed at switchgear end only. j) SPECIFIC REQUIREMENT FOR EARTHING SYSTEMS: i) Earthing terminal of each surge arrester, capacitor voltage transformer and lightning down conductors shall be directly connected to rod electrode which in turn, shall be connected to station earthing grid. ii) Auxilliary earthing mat of 1500mm X 1500mm size comprising of closely spaced conductors at (300mm x 300mm) spacing and at 300mm below ground shall be provided below the operating handles of the isolators. Operating handle shall be directly connected to earthing mat. k) SPECIFIC REQUIREMENTS FOR LIGHTNING PROTECTION SYSTEM: i) Conductors of the lightning protection system shall not be connected with the conductors of the safety earthing system above ground level. ii) Down conductors shall be cleated on the structures at 2000mm interval. iii) Connection between each down conductor and rod electrodes shall be made via test joint located approximately 150mm above ground level. iv) Lightning conductors shall not pass through or run inside G.I. conduits. v) Lightning protection system installation shall be in strict accordance with the latest editions of Indian Electricity Rules, Indian Standards and Codes of practice and Regulations existing in the locality where the system is installed.			
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TECHNICAL REQUIREMENTS

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NTPC

TYPICAL OVERLAPPING (JOINT OF TWO CONDUCTORS)



NOTE : WELDING OF EARTHING CONDUCTOR SHALL BE CONDUCTED IN VERTICAL PLANE
WHEREVER POSSIBLE

EQUIPMENT EARTHING DETAILS

STANDARD DRAWING

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11 .00.00	SITE TESTING AND COMMISSIONING:			
11.01.00	INTRODUCTION: An indicative list of tests for AIS and GIS as applicable is given below. Contractor shall perform any additional test based on specialties of the items as per the field QP/ instructions of the equipment supplier or Employer without any extra cost to the Employer. The Contractor shall arrange all instruments required for conducting these tests along with calibration certificates and shall get the list of instruments approved from the Employer.			
11.02.00	GENERAL CHECKS: a) Check for physical damage. b) Visual examination of zinc coating/ plating c) Check from name plate that all items are as per older/ specification. d) check tightness of all bolts, clamps and connecting terminals using toque wrenches. e) For oil filled equipment check for oil leakage, if any. Also check oil level and top up. f) Check ground connections for quality of weld and application of zinc rich paint over weld joint of galvanized surfaces. g) Check cleanliness of insulator and bushings. h) All checks and tests specified by the manufactures in their drawings and manuals as well as all tests specified in the relevant code of erection. i) Check for surface finish of grading rings (corona control ring.) j) Pressure test on all pneumatic lines at 1.5 times the rated pressure shall be conducted.			
11.03.00	CIRCUIT BREAKERS: a) Insulation resistance of each pole. b) Check adjustments, if any, suggested by manufacturer. c) Breaker closing and tripping time. d) Slow and power closing operation and opening e) Trip free and anti-pumping operation. f) Minimum pick-up volts of coils g) Contact resistance h) Functional checking of compressed air plant and all accessories i) Functional checking of control circuits, interlocks, tripping through protective relays and auto-reclose operation. j) Insulation resistance of control circuits, motor etc. k) Resistance of closing and tripping coils.			
11.04.00	ISOLATORS: a) Insulation resistance of each pole b) Manual and electrical operation on interlocks c) Insulation resistance of control circuits and motors. d) Ground connections e) Contact resistance f) Proper alignment to minimise the vibration to the extreme possible during operation. g) Measurement of operating torque for isolator and Earth switch h) Resistance of operating and interlocking coils.			
11.05.00	CURRENT TRANSFORMERS: a) Insulation Resistance Test b) Polarity test. c) Ratio identification test-checking of all ratios on all cores by primary injection of current. d) Dielectric test of oil (wherever applicable).			
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11.06.00	e) Magnetizing characteristics test. f) Capacitance and tan delta measurement at minimum 10kV. VOLTAGE TRANSFORMERS/CAPACITOR VOLTAGE TRANSFOREMER: a) Insulation resistance test. b) Polarity test. c) Ratio test. d) Dielectric test of oil (if applicable). e) Capacitance and tan delta measurement at minimum 10kV.			
11.07.00	SURGE ARRESTER: a) Grading leakage current. b) Resistance of ground connection. c) Resistive current drawn at rated voltage after energisation.			
11.08.00	PHASING OUT: The phasing out of all supplies in the station system shall be carried out.			
11.09.00	STATION EARTHING: a) Check soil resistivity b) Check continuity of grid wires c) Check earth resistance of the entire grid as well as various sections of the same. d) Check for weld joint and application of zinc rich paint on galvanised surface. e) Dip test on earth conductor prior to use.			
11.10.00	CONDUCTOR STRINGING AND POWER CONNECTORS: a) Physical check for finish b) Electrical clearance check c) Testing of torque by torque-by-torque wrenches on all bus power connectors and other accessories. d) Sag and tension check on conductors.			
11.11.00	INSULATORS: Visual examination for finish damage, creepage distance, etc.			
11.12.00	WAVE TRAP : a) Insulation resistance Test b) Visual check			
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12.00.00	400KV TRANSMISSION LINES – GENERAL:			
12.01.00	SCOPE AND GENERAL INFORMATION: In addition to the project information and scope of work given in Part-A, of this specification, the following is the scope of work for overhead Transmission line work:			
12.01.02	This specification covers preliminary and detailed route survey, tower spotting, optimization of tower location, soil resistivity measurements and geo-technical investigation, tower design, fabrication and supply of all types of transmission line towers including tower which are already designed and tested for equal or higher loads as specified in this specification, bolts, nuts and washers, hanger, D-shackle and all type of tower accessories like phase plate, number plate, danger plate, anti-climbing device, etc.; foundation design, selecting type of foundation for different towers and casting of foundation for towers and erection of towers, tack welding of bolts and nuts along with subsequent application of zinc coating on the welded portion, supply and application of zinc rich paint, tower earthing, fixing of insulator string, stringing of conductors and earth wires along with all necessary line accessories and testing and commissioning of the erected transmission lines. Further for type tested towers bidder shall furnish design calculation for transmission line tower structures along with foundation design and drawing meeting the requirements of this technical specification. Also Bidder may explore to use the Narrow based Transmission Towers, Mono-poles as per the CBIP-Manual-Transmission line -323 guidelines. where sufficient ROW Corridor is not available . The Transmission Lines shall be designed as per the CBIP-Manual -Transmission Line-323 guide lines with latest amendments etc.			
12.01.03	This specification includes the design and supply of insulator and their hardware conductor, OPGW and earthwire, earthwire suspension and tension clamps and all the other lien accessories to be incorporated in the towers during erection and stringing.			
12.01.04	All the raw materials such as steel, zinc for galvanising, reinforcement steel and cement for foundation, coke and salt for earthing, bird guards, anti climbing devices, bolts, nuts, washers, D-shackles, hangers, links, danger plates, phase plate, number plate etc. required for tower manufacture and erection shall be included in the scope of supply.			
12.01.05	The entire stringing work of conductor and earthwire shall be carried out as per standard stringing practice.			
12.01.06	The Contractor shall carry out the detailed survey and shall submit report/results for employer approval. No other details except those included in tender documents shall be furnished by the Owner. Also no topographical maps shall be furnished by Owner. However, Owner's assistance may be given in obtaining these maps from Survey of India.			
12.01.07	The tree-cutting shall be responsibility of the Contractor. The Contractor shall count, mark and put proper numbers with suitable quality of paint at his own cost on all the trees that are to			
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	be cut. Contractor may note that Owner shall not pay any compensation for any loss or damage to the properties or for tree cutting due to Contractor's work.			
12.02.00	ROUTE AND TERRAIN :			
12.02.01	Right of way and way leave clearance shall be arranged by the Owner. To evaluate and tabulate the trees and bushes coming within 26 meters on either side of the central line alignment, the trees will be numbered and marked with quality paint serially from angle point 1 onwards and the corresponding number will be painted on the stem of trees at a height of one meter from ground level. The trees list should contain the following: a) Girth (circumference) measured at a height of 1 meter from ground level. b) Approximate height of the tree with an accuracy of + 2 meters. c) Name of the type of the species/tree. d) The bushy and under growth encountered in the 1.5 meters belt should also be evaluated with its type, height, girth and area in square meters, clearly indicating the growth in the tree/bush statement.			
12.02.02	Payment of compensation towards the clearances, etc. will be the responsibility of the Owner.			
12.03.00	DETAILED SURVEY:			
12.03.01	The detailed survey shall be carried out along the Transmission Line alignment by successful bidder/contractor. The report shall be in line with CBIP-Manual-Transmission line -323 guidelines.			
12.03.02	Route Marking: At the starting point of the commencement of route survey, an angle iron spike of 65 x 65 x 6 mm section and 1000 mm long shall be driven firmly into the ground to project only 150 mm above the ground level. A punch mark on the top section of the angle iron shall be made to indicate location of the survey instrument. Teak wood peg 50 x 50 x 650 mm size shall be driven at prominent position at intervals of not more than 750 meter along the transmission line to be surveyed upto the next angle point. Nails of 100 mm length should be fixed on the top of these pegs to show the location of instrument. The pegs shall be driven firmly into the ground to project 100 mm only above ground level. At angle position stone/concrete pillar with "NTPC" marked on them shall be put firmly on the ground for easy identification.			
12.03.03	Profile Plotting & Tower Spotting: From the field book entries the route plan with route details and level profile shall be plotted and prepared as per approved procedure. Reference levels at every 20 meters along the profile are also to be indicated on the profile besides R/Ls at undulations. Areas along the profile, which in the view of the Contractor are not suitable for tower spotting, shall also be clearly marked on the profile plots. If the difference in levels is too high, the chart may be broken up according to requirement. A 10mm overlap shall be shown on each following sheet. The chart shall progress from left to right. Sheet shall be in accordance with the IS Standard. For 'as built' profile these shall be A1 size.			
12.03.04	Sag Template: Necessary data in respect of conductor, earthwire and insulator have been given in the specifications. On the basis of these, the Contractor shall prepare the sag template drawing			
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12.03.05	and tower spotting data and submit the same along with sag tension calculations for the approval of the Owner. Sag template prepared based on the approved sag-template curve drawing shall only be used for tower spotting on the profiles. Two numbers of the approved template, prepared on rigid transparent plastic sheets, shall be provided by the Contractor to the Owner for the purpose of checking the tower spotting. The templates shall be on the same scale as that of the profile. Tower Spotting: With the help of approved sag template and tower spotting data, tower locations shall be marked on the profiles. While locating the towers on the profile sheet, the following shall be borne in mind: a) Span : The number of consecutive spans between the section points shall not exceed 15 spans. Section point shall comprise of tension point with B type, C type or D Type towers as applicable. For all crossing spans such as major road crossings, railway crossings, power line crossings etc. the span shall not exceed 80% of design span. b) Extension : An individual span shall be as near to the normal design span as far as possible. In case an individual span becomes too short with normal supports on account of undulations in ground profile, one or both the supports of the span may be extended by inserting standard body extension designed for the purpose according to technical specification. c) Road Crossing: At all important road crossings, the towers shall be fitted with double tension insulator strings depending on the type of towers but the ground clearance at the roads under maximum temperature and in still air shall be such that even with conductor broken in adjacent span, ground clearance of the conductor from the road surfaces shall be in line with IE rules. At all national highway crossings, tension towers shall be used. d) Railways Crossings: i) At the time of detail survey all the railway crossings coming enroute the transmission line shall be finalised as per the regulation laid down by the Railway Authorities. The following are the important features of the prevailing regulations (revised in 1987): ii) The crossing shall be supported on D type tower on either side of railway line with double tension insulator strings. iii) The crossing shall normally be at right angle to the railway track. iv) The crossing span shall be limited to 80% of design span. v) The minimum distance of the crossing tower shall be at least equal to the height of the tower plus 6 meters away measured from the centre of the nearest railway track. vi) No crossing shall be located over a booster transformer, traction switching station, traction sub-station or a track cabin location in an electrified area. vii) Minimum ground clearance above rail level of the lowest portion of any conductor under condition of maximum sag shall be maintained as per IE rules.			
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	viii) The approval for crossing railway track shall be obtained by the Owner from the Railway Authority. However, six copies of profile and plan, tower and foundation design and drawings, required for the approval from the Railway Authority shall be supplied by the Contractor to the Owner. e) River Crossings : In case of major river crossing, towers shall be of suspension type and the anchor towers on either side of the main river crossing shall be C type tower. Clearance required by navigation authority shall be provided. For non navigable river, clearance shall be reckoned with respect to highest flood level (HFL). f) Power Line Crossing: Where this line is to cross over another line of the same voltage or lower voltage, towers with suitable extension shall be used. Provisions to prevent the possibility of its coming into contact with other overhead lines shall be made in accordance with the Indian Electricity Rules, 1956. The Contractor may be required to under-cross higher voltage lines by erecting gantry structures. g) Telecommunication Line Crossing : The angle of crossing shall be as near 90 degree as possible. However, deviation to the extent of 30 degree may be permitted under exceptionally difficult situations. When the angle of crossing has to be below 60 degree, the matter will be referred to the authority incharge of the telecommunication system. On a request from the Contractor, the permission of the telecommunication authority may be obtained by the Owner. Also, in the crossing span power line support will be as near the telecommunication line as possible, to obtain increased vertical clearance between the wires. h) Details Enroute: All topographical details, permanent features, such as trees, building etc. 13.5m on either side of the alignment shall be detailed on the profile plan. i) Ash Pipe Line (If applicable): Adequate clearances shall be maintained from ash pipe line and adjacent road.	
12.03.06	Clearance from Ground, Building, Trees, etc. Clearance from ground, buildings, trees and telephone lines shall be provided in conformity with the Indian Electricity Rules, 1956 as amended upto date.	
12.04.00	PRELIMINARY LINE SCHEDULE: The profile sheets, duly spotted, along with preliminary schedules indicating type of towers, wind span, weight span, angle of deviation, river, power line, railway or road crossing and other details shall be submitted for the approval of the Owner. After approval, the Contractor shall submit six more sets of the approved reports along with two sets in soft copy of final profile drawings to the Owner for record purpose.	
12.05.00	CHECK SURVEY OF TOWER LOCATIONS:	
12.05.01	The detailed survey shall be conducted to locate and peg mark the tower positions on ground conforming to the approved profile and tower schedule. In the process, it is necessary to have	
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12.05.02	the pit centers marked according to the excavation marking charts. The levels, up or down of each pit center with respect to the center of the tower locations shall be noted and recorded for determining the amount of earthwork required to meet the approved design parameters.																																																								
12.06.00	Changes, if required, after detailed survey in the preliminary tower schedule shall be carried out by the Contractor and he shall thereafter submit a final tower schedule for the approval of Owner. The tower schedule shall show position of all towers, type of towers, span length, type of foundation for each tower and the deviation at all angles as set out with other details. ELECTRICAL SYSTEM DATA: <table><tr><th>Sl.no</th><th>Description</th><th>Rating</th></tr><tr><td>1</td><td>Nominal voltage</td><td>400 kV</td></tr><tr><td>2</td><td>Maximum system voltage</td><td>420kV</td></tr><tr><td>3</td><td>Lighting Impulse</td><td>+1425kVp</td></tr><tr><td>4</td><td>Switching Impulse</td><td>+1025kVp</td></tr><tr><td>5</td><td>Power frequency withstand voltage (wet)</td><td>630 kV (rms)</td></tr><tr><td></td><td></td><td></td></tr></table> LIST OF STANDARDS : <table><tr><th>Sl.no</th><th>Standard No</th><th>Description</th><th>Equivalent code</th></tr><tr><td>1</td><td>IS:209</td><td>Specification for Zinc</td><td>ISO/R/752-1968,AST,B6</td></tr><tr><td>2</td><td>IS:2062</td><td>Structural Steel (Standard Quality</td><td>ISO/R/6F30-1967, CAN/CSA G40.21, BS-4360</td></tr><tr><td>3</td><td>IS:269</td><td>Ordinary rapid hardening & low heat</td><td>ISO/R/597-1967</td></tr><tr><td>4</td><td>IS:278</td><td>Specification for barbed wire</td><td>ASTM A 121</td></tr><tr><td>5</td><td>IS:383</td><td>Coarse and fine aggregates from natural sources for concrete</td><td>CSA A 23.1/A 23.2</td></tr><tr><td>6</td><td>IS:398</td><td>Alum. Condr. galvanised steel reinforced</td><td></td></tr><tr><td>7</td><td>IS:406</td><td>Methods of Chemical Analysis of Slab Zinc</td><td></td></tr></table>				Sl.no	Description	Rating	1	Nominal voltage	400 kV	2	Maximum system voltage	420kV	3	Lighting Impulse	+1425kVp	4	Switching Impulse	+1025kVp	5	Power frequency withstand voltage (wet)	630 kV (rms)				Sl.no	Standard No	Description	Equivalent code	1	IS:209	Specification for Zinc	ISO/R/752-1968,AST,B6	2	IS:2062	Structural Steel (Standard Quality	ISO/R/6F30-1967, CAN/CSA G40.21, BS-4360	3	IS:269	Ordinary rapid hardening & low heat	ISO/R/597-1967	4	IS:278	Specification for barbed wire	ASTM A 121	5	IS:383	Coarse and fine aggregates from natural sources for concrete	CSA A 23.1/A 23.2	6	IS:398	Alum. Condr. galvanised steel reinforced		7	IS:406	Methods of Chemical Analysis of Slab Zinc	
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	8	IS:432	Mild steel and medium tensile bars and hard drawn steel wire for concrete reinforcement	CSA-G-30
	9	IS:456-1978	Code of practice for plan and reinforced concrete	
	10	IS:731-1971	Porcelain Insulators for Overhead lines with Nominal Voltage greater than 1000volts	BS:137-1973 (I & II) Power, IEC:274-1968, IEC:383-1976
	11	IS:800-1984	Code of practice for use of structural in general Building construction.	CSA STEAM 16.1 steel
	12	IS:802	Code of practice for use of structural steel in overhead transmission Line (Load, Permissible stresses, Fabrication Glavanising , Inspection and packaging and testing)	IEC 826 ASCE 52, BS 8100.
	13	IS:1139-1966	Hot rolled mild steel medium tensile steel and high yield strength deformed Bars for concrete reinforcement	CAN / CSA G 30 18
	14	IS:1367-1967	Technical supply conditions for threaded fasteners	
	15	IS:1489-1991	Portland Pozzolena Cement	ISO/863-1968
	16	IS:1521-1972	Method of Tensile Testing of Steel wire	
	17	IS:1573-1976	Electroplated Coating of Zinc on Iron & steel	
	18	IS:1778-1980	Reels and Drums of Barewire	
	19	IS:1786-1985	High strength deformed steel bars and wires for concrete reinforcement	
	20	IS:1893-1984	Criteria of Earthquake resistant design of structures	IEEE 693
	21	IS:2016-1967	Plain Washers	ISO/R/887-1968, ANSI B 18.22.1
	22	IS:2070- 1962	Method of impulse voltage testing	
23	IS:2071	Method of high voltage testing		
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	24	IS:2121-1981	Specification for conductors and earthwire Accessories for Overhead Power Lines	
		Part-I	Armour Rods	
		Part-II	Mid-span joints & repair sleeves for conductors	
	25	IS:2131-1967	Method of Standard penetration test for soils	ASTM D 1883
	26	IS:2551-1982	Danger Notice Plates	
	27	IS:2486	Specification for Insulator Fittings for overhead Power Lines with a nominal voltage greater than 1000 volts.	
			Part- I General Requirements and Tests	BS:3288-1972
			Part-II Dimensional Requirements	IEC:120-1960
			Part-III Locking Devices	IEC:372-1976
	28	IS:2629-1985	Recommended practice for hot dip galvanising of iron & steel	ASTM A 123 CAN/CSA G 164
	29	IS:2633-1986	Method of testing uniformity of coating of zinc coated articles	ASTM A 123, CAN/CSA G164
	30	IS:3043-1987	Code of Practice for earthing	
	31	IS:3063-1994	Single Coil Rectangular Section spring washers for bolts, nuts, screws.	DIN - 127-1970
	32	IS:3138-1966	Hexagonal bolts and nuts	ISO/R 947 and ISO/R272
	33	IS:3188-1980	Characteristics of string insulator units	IEC:60305-2021
	34	IS:4091-1979	Code of practice for design and construction of foundation for transmission line tower and poles	ASCE / IEEE 691
	35	IS:4218-1976	Metric Screw Threads.	ISO:68-1969, R- 26-1963, R-262- 1969, R-965-1965
	36	IS:4826-1979	Galvanised coatings on round steel wire	BS:443-1969
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	37	IS:5300-1980	Porcelain Guy strain insulators	
	38	IS:5358-1969	Hot dip galvanised coatings on fasteners	ASTM A 153, CAN/CSA G 164
	39	IS:5613 (Part-II)	Code of practice for Design, installation & maintenance of overhead power lines	
	40	IS:6610-1972	Specification for heavy washers for steel structures	
	41	IS:6639 -1972	Hexagonal bolts for structure	ASTM A 394,CSA B33.4
	42	IS:6745-1972	Methods for determination of weight of Zinc coated iron and steel articles	ASTM A 90
	43	Pub. No. 19 (N)/700-1963	Regulation for Electrical Crossing of Railway Tracks	
	44	IS:7814-1985	Phosphor bronze sheet, strip and foil	BS:2870-1968
	45	IS:8263-1976	Method of Radio Interference tests on high voltage insulators	NEEMA:107 – 1964, CISPR/IEC:437-1973
	46	IS:8269-1976	Method of switching impulse test on high voltage insulators	
	47	IS:8500-1991	Specification for weld-able structural steel (Medium and High strength qualities)	BS : 4360
	48	IS:9708-1993	Specifications for Stockbridge Vibration Dampers for overhead power lines	
			Thermal mechanical performance test and mechanical performance test on String insulator units	IEC:60575
13.00.00	GENERAL DESCRIPTION OF TOWERS:			
13.01.01	The towers shall be of self supporting lattice steel type, designed to carry the line conductors with necessary insulators, earth wires and all fittings under all loading conditions.			
13.01.02	The tower shall be of a fully galvanised structure, using structural mild steel sections for members. Bolts and nuts with spring washers shall be used for connections.			
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13.01.03	Bidders can also use high tensile steel and cold formed steel for fabrication of towers provided they furnish the justification for use of such steel with reference to national or international standards. However, the factors of safety, limitation on member length, requirement of fasteners and galvanization shall be as specified in this specification. The towers shall be classified as given in Table -1 Table T-1 <table border="1"> <thead> <tr> <th>Type of Tower</th><th>Deviation limit (Degrees)</th><th>Typical use</th></tr> </thead> <tbody> <tr> <td>A</td><td>0 to 2</td><td>To be used as tangent/suspension tower</td></tr> <tr> <td>B</td><td>0 to 15</td><td>a) Angle towers/Tension tower with tension insulator string. b) To be used where the towers are subject to uplift loads. c) To be used as section tower</td></tr> <tr> <td>C</td><td>15 to 30</td><td>a) Angle tower/Tension tower with tension insulator string b) To be used where the towers are subject to uplift loads. c) To be used as section tower</td></tr> <tr> <td></td><td>NA</td><td>d) Complete dead end. (for 33kV line only)</td></tr> <tr> <td>D</td><td>30 to 60</td><td>a) Angle tower/Tension tower with tension insulator string b) To be used where the towers are subject to uplift loads. c) To be used as section tower</td></tr> <tr> <td></td><td>0</td><td>d) Complete dead end.</td></tr> </tbody> </table> NOTE: 1) For double circuit tower types, A, B, C and D shall be prefixed by 'D'. 2) Special type of tower/ higher voltage class towers, wherever required shall also be provided by the bidder under the contract at no extra cost.	Type of Tower	Deviation limit (Degrees)	Typical use	A	0 to 2	To be used as tangent/suspension tower	B	0 to 15	a) Angle towers/Tension tower with tension insulator string. b) To be used where the towers are subject to uplift loads. c) To be used as section tower	C	15 to 30	a) Angle tower/Tension tower with tension insulator string b) To be used where the towers are subject to uplift loads. c) To be used as section tower		NA	d) Complete dead end. (for 33kV line only)	D	30 to 60	a) Angle tower/Tension tower with tension insulator string b) To be used where the towers are subject to uplift loads. c) To be used as section tower		0	d) Complete dead end.	
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13.01.04	Extension: The single and double circuit tower shall be designed with 9 M body extension so as to be suitable for adding 3M, 6M and 9M body extension. In case of requirement of higher body extensions, the tower shall be designed for the highest extension required. For under line crossing of EHV transmission lines the bidder extensions to D type tower or provide tower-gantry arrangement.																						
13.01.05	Stub Setting templates:. Stub templates shall be designed and arranged by the contractor at his own cost for all types of tower with or without extension and also for leg extension. Stub templates for standard																						
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13.02.00	towers and tower with extension shall be of adjustable type. The stub templates shall be painted. One set of each type of stub setting template for single and double circuit tower shall be supplied to the Owner, on completion of the project, at no extra cost.				
13.02.01	SPANS AND CLEARANCES:				
13.02.01	Ruling Span:				
	The normal ruling span of the line shall be 400 meters for 400 KV towers.				
13.02.02	Wind Span”:				
	The wind span is the sum of the two half spans adjacent to the support under consideration. For normal horizontal spans this equals to normal ruling span.				
13.02.03	Weight Span:				
	The weight span is the horizontal distance between lowest point of the conductors on the two spans adjacent to the tower. For design of structures, the span limits given below shall prevail.				
	Tower Type	Normal Condition		Broken Wire Condition	
		Max(mt)	Min(mt)	Max(mt)	Min. (m)
	A	600	-200	360	-100
	B,C	600	0	360	-200
	D	600	0	360	-300
13.02.04	Electrical Clearance:				
	A) Ground clearance:				
	The minimum ground clearance from the bottom conductor shall be as per IE rules at the maximum sag conditions i.e. at maximum temperature and still air. However, to achieve the above clearance the height of tower shall be increased in the following manner:				
	a) Allowance of 150 mm shall be provided to account for errors in stringing.				
	b) Conductor creep shall be compensated by over tensioning the conductor at a temperature lower than the ambient temperature. The creep correction temperature along with calculations shall be furnished by the Contractor.				
	c) Minimum spacing				
	The minimum electrical clearance between conductors shall be as per relevant standards.				
	B) Rail Crossing:				
	In case of rail crossing the min. height above rail level of the lowest portion of any conductor under condition of max. sag, in accordance with the regulations for Electrical Crossing of Railway tracks as prevailing at the time of construction of line shall be applicable.				
	C) Power Line Crossing:				
	Minimum clearance between power line to power line crossing shall be as per IE rules.				
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	D) Live Metal Clearance: The minimum live metal clearance to be provided between the live parts and steel work of super-structure shall be as per relevant standards. NOTE: i) Bidder shall adopt same cross arm design where jumper is projecting outside of cross-arm for 'D' type tower to be used as dead end and angle tower. ii) The design of the tower shall be such that it will satisfy all the conditions when clearances are measured from any live point of the strings. E) Angle of Shielding: The angle of shielding is defined as the angle formed by the line joining the center lines of the earthwire and outer power conductor, in still air, at tower supports, to the vertical line through the center line of the earthwire. Bidders shall design the tower in such a way that the angle of shielding does not exceed 30 deg for double circuit tower. The drop of the earthwire clamp, which is in the scope of contractor supplied items, should be considered while calculating the minimum angle of protection. For estimating the minimum angle of protection the drop of earth wire suspension clamp alongwith shackle shall be taken as 150mm. F) Mid Span Clearance: The minimum vertical mid span clearance between the earthwire and the nearest power conductor shall be as per IE/relevant rules, which shall mean the vertical clearance between earthwire and the nearest conductor under all temperatures and still air condition in the normal ruling span. Further, the tensions of the earthwires and power conductors, shall be so co-ordinated that the sag of earthwires shall be at least 10% less than that of power conductors under all temperature loading conditions.	
13.03.00	LOADING CONDITIONS:	
13.03.01	Loads at Conductor And Earthwire Points: Contractor shall consider the ultimate external loadings at conductor and earthwire points base on IS 802-1, 1995. The Contractor shall develop the tower designs considering these loadings. The towers are to be designed to cater for the following loads: a) Reliability Loads (Normal condition) b) Security Loads (Broken wire condition) c) Safety Loads (Construction & Maintenance loads)	
13.03.02	Suspension towers shall be designed for full wind load under security condition Wind Loads on Tower Body: The wind load on tower body shall be calculated by the Contractor as per IS:802, Part-I, 1995.	
13.03.03	Maximum Tension: Maximum tension shall be based on either of the following (whichever is more stringent): a) at 0 deg C with 36% full wind pressure., or	
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	b) at 32 deg C with full wind pressure The value of drag co-efficient (Cd) shall be 1.2 for conductor/earthwire if the diameter of the conductor/earth is 15mm or less. 13.03.04 Sag tension calculation for design purpose shall be calculated considering normal ruling span. 13.03.05 The initial conductor and earthwire tension at 32 degree C and without wind shall be 22% of the ultimate tensile strength of the conductor and 20% of the ultimate tensile strength of the Earthwire. 13.03.06 Limiting Tensions of conductor & Earthwire: The ultimate tension of conductor and ground wire shall not exceed 70 per cent of the ultimate tensile strengths. 13.03.07 Broken Wire Condition: The loads for broken wire conditions shall be considered as per clause 16 of IS 802 (Part I/ Sec 1): 1995. The tower type B & C shall be considered as small and medium angle towers whereas tower type D shall be considered as large angle tension tower/ dead end tower. 13.03.08 Design Loads: Owner's requirement for most stringent design longitudinal and transverse loads is summarized in Table T1-2. 13.04.00 DESIGN OF TOWERS: 13.04.01 Design Criteria: Towers shall be designed based on spans and clearances, and loading conditions as detailed above. 13.04.02 Design Temperatures: The following temperature range for the conductors and ground wires shall be adopted for line design: <table><tr><td>Sl.No</td><td>Description</td><td>Temperature</td></tr><tr><td>a)</td><td>Minimum temperature</td><td>0 deg.C</td></tr><tr><td>b)</td><td>Everyday temperature of conductor</td><td>32 deg.C</td></tr><tr><td>c)</td><td>Max. temperature of Conductor</td><td>75 deg.C</td></tr><tr><td>d)</td><td>Max. temperature of Earthwire exposed to sun</td><td>53 deg.C</td></tr><tr><td></td><td></td><td></td></tr></table> 13.04.03 Redundant Design: All redundants in the towers are to be triangulated. Redundants, having an angle of 15 deg or less with horizontal are to be designed for a concentric vertical ultimate load of 1.5 KN acting at center of the unsupported length. The Contractor has to furnish the calculation for			Sl.No	Description	Temperature	a)	Minimum temperature	0 deg.C	b)	Everyday temperature of conductor	32 deg.C	c)	Max. temperature of Conductor	75 deg.C	d)	Max. temperature of Earthwire exposed to sun	53 deg.C			
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	the same. The redundants shall also be designed for 2.5% of max. axial load of connecting members (i.e. leg members, bracing members etc.).																	
13.04.04	Steel Sections:																	
	For designing of towers, preferably rationalised steel sections shall be used. During execution of the project, if any particular section is not available same shall be substituted by higher section at no extra cost to Owner and the same shall be borne by the Contractor. However, design approval for such substitution shall be obtained from the Owner before any substitution.																	
13.04.05	Thickness of Members:																	
	The minimum thickness of angle sections used in the design of tower, unless otherwise specified elsewhere in this Specification, shall be kept not less than the following values:																	
	a) Main corner leg members including the groundwire peak and main cross arm : 5 mm																	
	b) For all other members : 4 mm																	
13.04.06	Bolts & Nuts:																	
	A)The minimum bolt spacing and rolled edge distance and sheared edge distance from the centers of the bolt holes to be maintained are given below:																	
	<table><tr><td>a)</td><td>Diameter of bolts</td><td>16mm</td></tr><tr><td>b)</td><td>Hole diameter</td><td>17.5 mm</td></tr><tr><td>c)</td><td>Min. bolt spacing</td><td>40</td></tr><tr><td>d)</td><td>Min. rolled distance</td><td>20mm</td></tr><tr><td>e)</td><td>Min. sheared edge distance</td><td>23mm</td></tr></table>	a)	Diameter of bolts	16mm	b)	Hole diameter	17.5 mm	c)	Min. bolt spacing	40	d)	Min. rolled distance	20mm	e)	Min. sheared edge distance	23mm		
a)	Diameter of bolts	16mm																
b)	Hole diameter	17.5 mm																
c)	Min. bolt spacing	40																
d)	Min. rolled distance	20mm																
e)	Min. sheared edge distance	23mm																
	B)Bolts sizes mentioned above shall only be used. The minimum width of the flanges without bolt holes shall be 30mm.																	
	C)For the purpose of calculating shearing stress and bearing stress for bolts, IS:802-Part-II-1993 may be referred.																	
13.04.07	Slenderness Ratio:																	
	A)Slenderness ratio for members shall be computed in accordance with IS:802, Part-II, 1993. Slenderness ratio for compression and tension members shall not exceed the values specified therein.																	
	B)The following maximum limit of the slenderness ratio i.e. the ratio of unsupported length of the section in any plane to the appropriate radius of gyration will be adopted:																	
	<table><tr><td>a)</td><td>For main corner leg members including the corner members of earthwire peak and the lower corner members of the cross-arms</td><td>120</td></tr><tr><td>b)</td><td>For other members having calculated stresses</td><td>200</td></tr><tr><td>c)</td><td>For redundant members</td><td>250</td></tr><tr><td>d)</td><td>For members having tensile stress only</td><td>400</td></tr></table>	a)	For main corner leg members including the corner members of earthwire peak and the lower corner members of the cross-arms	120	b)	For other members having calculated stresses	200	c)	For redundant members	250	d)	For members having tensile stress only	400					
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13.04.08	C)The bracing pattern, including that of secondary bracings (redundants) shall be identical on transverse and longitudinal faces of the tower, i.e. staggering of primary and secondary bracings are not permitted. Primary bracings and redundants shall be properly triangulated, i.e. the overall pattern of bracing on tower body and cross arms shall be triangular only. Erection Stress: Where erection stress combined with other permissible co-existent stresses could produce a working stress in any member appreciably above the specified working stress, such other provisions are to be made as may be necessary to bring the working stress within the specified limit.			
13.05.00	TOWER MATERIALS:			
13.05.01	Tower Steel Sections: IS steel sections of tested quality in conformity with IS: 2062 are to be used in towers, extensions and stub setting templates. No individual member shall be longer than 6000mm. The Bidder can also use most efficient grades of structural steel angle sections and plates conforming to latest international standards. However, the Bidders are permitted to opt for not more than two (2) grades of steel for any particular package.			
13.05.02	Fasteners: Bolts, Nuts and Washers: A)All bolts and nuts shall conform to IS: 6639. All bolts and nuts shall be galvanised and shall have hexagonal head and nuts, the heads being forged out of the solid, truly concentric, and square with the shank, which must be perfectly straight. B)The bolt shall be of 16 mm dia and of property class 5.6 as specified in IS:1367 (Part-III) 1979 and matching nut of property class as specified in IS:1367 (Part-VI). C)Bolts upto M16 and having length upto 10 times the diameter of the bolt should be manufactured by cold forging and thread rolling process to obtain good and reliable mechanical properties and effective dimensional control. The shear strength of bolts for 5.6 grade should be 310 MP a minimum as per IS:12427. Bolts should be provided with washer face in accordance with IS:1363 Part-I to ensure proper bearing. D)To ensure uniformity of galvanizing, bolts and nuts should be galvanised by high temperature hot-dip galvanizing. E)Nuts should be double chamfered as per the requirement of IS:1363 Part-III. It should be ensured by the manufacturer that nuts should not be overlapped beyond 0.4 MM oversize on effective diameter for size upto M16. F)Fully threaded bolts shall not be used. The length of bolts shall be such that the threaded portion will not extend into the place of contact of the members. G)All bolts shall be threaded to take the full depth of the nuts and threaded enough to permit firm gripping of the members, but not further. It shall be ensured that the threaded portion of each bolt protrudes not less than 3 mm and not more than 8mm when fully tightened. All nuts shall fit and tight to the point where the shank of the bolt connects to the head.			
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	H) Flat and tapered washers shall be provided wherever necessary. Spring washers shall be provided for insertion under all nuts. These washers shall be of steel electro-galvanised, positive lock type and 3.5mm in thickness for 16mm dia. I) The Bidder shall furnish bolt schedules giving thickness of members connected, the nut and the washer and the length of shank and the threaded portion bolts and sizes of holes and any other special details of this nature. J) To obviate bending stress in bolts or to reduce to minimum, no bolt shall connect aggregate thickness of more than three (3) times its diameter. K) The bolt positions in assembled towers shall be as per IS:5613 (Part-II/Section-2). L) Bolts at the joints shall be so staggered that nuts may be tightened with spanners without fouling.	
13.06.00	Tower Accessories:	
13.06.01	Step Bolts & ladders: Each tower shall be provided with step bolts of not less than 16mm diameter and 175 mm long, spaced not more than 450mm apart and extending from about 3.5 meters above the ground level to the top of the tower. Step bolt shall be provided with two nuts on one end to fasten the bolt securely to the tower and button head at the other end to prevent the feet from slipping away. The step bolts shall be capable of withstanding a vertical load not less than 1.5 KN. For special structures, where the height of the super structure exceeds 50 meters, ladders along with protection rings shall be provided in continuation of the step bolts on one face of the tower from 30 meters above ground level to the top of the special structure. From 3.5 m to 30 m height of super structure step bolts shall be provided. Suitable railing for access from step bolts to the ladder and from the ladder to each cross arm tip and the groundwire support shall be fixed on tower by using countersunk bolts.	
13.06.02	Insulator Strings and Earthwire Clamps Attachments: a) For the attachment of suspension insulator string a suitable dimensioned swinging hanger on the tower shall be provided so as to obtain requisite clearance under extreme swinging conditions and free from swinging of the string. The hanger shall be designed to withstand an UTS equivalent to that of insulators. The supply of design & supply of hanger is in the scope of the Contractor. b) At tension towers strain plates of suitable dimensions on the underside of each cross-arm tip and at the top of earthwire peak, suitable plate should be provided for taking the hooks or D-Shackle of the tension insulator strings or earthwire tension clamps, as the case may be. Full details of the attachments shall be submitted by the bidder for Owner's approval before starting the mass fabrication.	
13.06.03	Earthwire peaks/crossarms are to be suitably designed to accommodate the shackle of the suspension clamp/tension clamps.	
13.06.04	Anti-climbing Device: Barbed wire type anti-climbing device shall be provided and installed by the Contractor for all towers. The height of the anti-climbing device should be provided approximately 3m above ground level. The barbed wire shall conform to IS-278-1978. The barbed wires shall be given chromating dip as per procedure laid down in IS:1340-1959.	
13.06.05	Danger plate, Number plates, Circuit Plate, Phase plate & Bird Guards.	
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	Danger, Number Plates, Phase Plates & Bird Guards shall be provided and installed by the Contractor: a) Each tower shall be fitted with a number plate, and danger plate. Each tension tower shall be provided with a set of phase plates also. The arrangement for fixing these accessories shall not be more than 4.5m above the ground level. b) The letters, figures and the conventional skull and bones of data plates shall conform to IS:2551-1963 and shall be in a single red on the front of the plate. c) The corners of the number and danger plate shall be rounded off to remove sharp edges. d) To prevent birds from perching immediately above the suspension insulator strings and thus fouling it with droppings suitable birdguards shall be provided at cross arm tips of all suspension towers. The arrangement shall conform to IS:5613 part-2/Sec.I.			
13.07.00	TOWER FABRICATION:			
13.07.01	Except where hereinafter modified, details of fabrication shall conform to IS:802 (Part-II) or the relevant international standards.			
13.07.02	Butt splices shall be used and the inside Angle and outside plate shall be designed to transmit the load and inside cleat angle, shall not be less than half the thickness of the heavier member connected plus 2mm. Lap splice may be used for connecting members of unequal size and the inside angle of lap splice shall be rounded at the heel to fit the fillet of the outside angle. All splices shall develop full stress in the member connected through bolts. Butt as well as lap splice shall be made as above and as close to the main panel point as possible.			
13.07.03	Joints shall be so designed as to avoid eccentricity as far as possible. The use of gusset plates for joining tower members shall be avoided as far as possible. However, where the connections are such that the elimination of the gusset plates would result in eccentric joints, gussets plates and spacer plates may be used in conformity with modern practices. The thickness of the gusset plates required to transmit stress shall not be less than that of members connected.			
13.07.04	The use of filler in connection shall be avoided as far as possible. The diagonal web members in tension may be connected entirely to the gusset plate wherever necessary to avoid the use of filler and it shall be connected at the point of intersection by one or more bolts.			
13.07.05	The tower structures shall be accurately fabricated to connect together easily at site without any undue strain on the bolts.			
13.07.06	No angle member shall have the two leg flanges brought together by closing angle.			
13.07.07	The diameter of the hole shall be equal to the diameter of bolt plus 1.5mm.			
13.07.08	The structure shall be designed so that all parts shall be accessible for inspection and cleaning. Drain holes shall be provided at all points where pockets depression are likely to hold water.			
13.07.09	All similar parts shall be made strictly inter-changeable. All steel sections before any work is done on them, shall be carefully leveled, straightened and made true to detailed drawings by methods which will not injure the materials so that when assembled, the adjacent matching			
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13.07.10	surfaces are in close contact through out. No rough edges shall be permitted in the entire structure. Drilling and Punching: A)Before any cutting work is started all steel sections shall be carefully straightened and trued by pressure and not by hammering. They shall again be trued after being punched and drilled. B)Holes for bolts shall be drilled on punched with a jig but drilled holes shall be preferred. The following maximum tolerance of accuracy of punched holes is permissible. a) Holes must be perfectly circular and no tolerance in this respect permissible. b) The max. allowable difference in diameter of the holes on the two sides of plates or angle is 0.8mm. i.e. the allowable taper in a punched holes should not exceed 0.8mm on diameter. c) Holes must be square with the plates or angles and have their walls parallel. C)All burrs left by drills or punch shall be removed completely. When the tower members are in position the holes shall be truly opposite to each other. Drilling or reaming to enlarge holes shall not be permitted.			
13.07.11	Erection mark: A)Each individual member shall have erection mark conforming to the component number given to it in the fabrication drawings. This mark shall be marked with marking dies of 16mm size before galvanising and shall be legible after galvanising. B)Erection Mark shall be "A - BB- CC – DDD", where A = Owner's code assigned to the Contractor Alphabet. BB = Contractor's Mark-Numerical CC = Tower Type-Alphabet DDD = Number mark to be assigned by Contractor.			
13.07.12	Quantities and Weights: A)The unit weight of each type of tower, stubs and extensions shall be furnished by the bidder. The weight of tower shall mean the weight of tower calculated by using the black sectional (i.e. un-galvanized) weight of steel members of the size indicated in the approved fabrication drawings and bills of materials, without taking into consideration the reduction in weights, holes, notches and bevel cuts etc, but taking into consideration the weight of the fasteners, anti-climbing devices etc.			
13.07.13	Galvanizing: Fully galvanized towers and stub shall be used for the line. Galvanization of the member of the towers shall conform to IS:2629 and IS:4759. The minimum weight of galvanization shall be 610 gms/sqm. The galvanization shall be done after all fabrication work is completed, except that the nuts may be tapped or re-run after galvanizing. Threads of bolts and nuts shall have a neat fit and shall be such that they can be turned with finger throughout the length of the threads of bolts and they shall be capable of developing full strength of the bolts. Spring washers shall be electro-galvanized as per Grade 4 of IS:1573.			
13.07.14	TOWER EARTHING:			
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	The footing resistance of all towers shall be measured by the Contractor in dry weather after tower erection but before the stringing of earthwire. All the tower are to be earthed. In no case tower footing resistance shall exceed 10 ohms. Pipe type earthing and counterpoise type earthing wherever required shall be provided in accordance with the stipulations made in IS:3043-1987 and IS:5613 (part-II/Section-2) 1985. The details for pipe and counterpoise type earthing are given in drawing enclosed with the specification.	
13.08.00	INSPECTION AND TESTS:	
13.08.01	All standard tests, including quality control tests, in accordance with appropriate Indian/International standard, shall be carried out unless otherwise specified herein.	
13.08.02	Inspection:	
	In addition to the provisions as specified elsewhere in this specification, the following shall also apply:	
A)	The Contractor shall keep the Owner informed in advance about the time of starting and the progress of manufacture and fabrication of various tower parts at various stages, so that arrangements could be made for inspection.	
B)	The acceptance of any part of items shall in no way relieve the Contractor of any part of his responsibility for meeting all the requirements of the Specification.	
C)	The Owner or his representative shall have free access at all reasonable times to those parts of the Contractor's works which are concerned with the fabrication of the Owner's material for satisfying himself that the fabrication is being done in accordance with the provisions of the specifications.	
D)	Unless specified otherwise inspection shall be made at the place of manufacture prior to dispatch and shall be conducted so as not to interfere unnecessarily with the operation of the work.	
E)	Should any member of the structure be found not to comply with the approved design, it shall be liable to rejection. No member once rejected shall be resubmitted for inspection, except in cases where the Owner or his authorised representative considers that the defects can be rectified.	
F)	Defect which may appear during fabrication shall be made good with the consent of, and according to the procedure proposed by the Contractor and approved by the Owner.	
G)	All gauges and templates necessary to satisfy the Owner shall be supplied by the manufacturer.	
H)	The correct grade and quality of steel shall be used by the Contractor. To ascertain the quality of steel used the inspector may at his discretion get the material tested at an approved laboratory.	
13.08.03	Tower Load Tests:	
A)	The Contractor shall submit one set of shop drawings along with the bill of materials. Further, Contractor shall submit one copy of test reports and final tracings of shop drawings and Bill of materials for Owner's reference and record.	
B)	The Contractor shall ensure that the specification of materials and workmanship of all towers actually supplied conform strictly to the towers which have successfully undergone the tests.	
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13.08.04	In case any deviation is detected, the Contractor shall replace such defective towers free of cost to the Owner. All expenditure incurred in erection, to and fro transportation and any other expenditure or losses incurred by the Owner on this account shall be fully borne by the Contractor. No extension in delivery time shall be allowed on this account. Tower Testing Procedure: The testing of towers shall be as per the procedure described below: A) Bolt Slip Test i) In the bolt slip test, the test loads shall be gradually applied up to the 50% of design loads under normal condition and held for two (2) minutes at that loads and then released gradually. ii) The initial and final readings on the scales (for measurement of deflection) before application and after the release of Loads respectively shall be taken with the help of theodolite. The difference between these readings gives the values of the bolt slip. B) Normal/Broken Wire Load Tests: All the loads, for a particular load-combination test shall be applied gradually upto the full design loads in the following steps and shall also be released in the similar manner: 50 percent 75 percent 90 percent 95 percent 100 percent C) Observation Périodes : a) Under normal and broken wire load tests, the tower shall be kept under observation for sign of any failure for two minutes (excluding the time for adjustment of loads) for all intermediate steps of loading up to and including 95 per cent of full design loads. b) For normal, as well as broken wire tests, the tower shall be kept under observation for five (5) minutes (excluding the time for adjustment of loads) after it is loaded upto 100 percent of full design loads. c) While the loading operation are in progress, the tower shall be constantly watched, and if it shows any tendency of failure anywhere, the loading shall be immediately stopped, released and then entire tower shall be inspected. The reloading shall be started only after the corrective measures are taken. d) The structure shall be considered to be satisfactory, if it is able to support the specified full design loads for five (5) minutes, with no visible local deformation after unloading (such as bowing, buckling etc.) and no breakage of elements or constituent parts. e) Ovalization of holes and permanent deformation of bolts shall not be considered as failure. D) Recording: The deflection of the tower shall be recorded at each intermediate and final stage of normal load and broken wire load tests by means of a theodolite and graduated scale. The scale shall be of about one meter long with marking upto 5 mm accuracy. E) Destruction Test:			
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	a) The destruction test shall be carried out under normal condition or broken wire condition. The Owner at the time of approval of rigging chart/test data sheet shall intimate the contractor. Under which load condition the destruction test is to be carried out. b) The procedure for application of load for normal/broken wire test shall also be applicable for destruction test. However, the load shall be increased in steps of five (5) percent after the full design loads have been reached. 13.09.00 PACKING: 13.09.01 The packings shall be properly done to avoid losses/damages during transit. Each bundle or package shall be appropriately marked. 13.10.00 DESIGN CALCULATION AND DRAWINGS: 13.10.01 The following design calculation and drawings are required to be furnished during detailed engineering. a) Computation of wind load b) Sag-tension calculation c) Tower loading d) Single line diagram of towers showing electrical clearances and steel sections. 13.10.02 The Contractor shall also furnish following to the owner: a) Detailed design calculation and drawing for towers and foundations. b) Detailed structural drawings indicating section size, length of members sizes of plate along with hole to hole distance, joint details etc. c) Bill of materials, indicating cutting and bending details against each member. d) Shop drawings showing all details relevant to fabrication. e) All the drawings for the tower accessories.			
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	TABLE-T1-2 DESIGN LOADS <table><tr><th rowspan="2">S.No</th><th rowspan="2">400 kV</th><th colspan="2">Longitudinal Loads</th><th colspan="2">Transverse Loads</th></tr><tr><th>Reliability Condition</th><th>Security Condition</th><th>Reliability Condition</th><th>Security Condition</th></tr><tr><th>1</th><th>2</th><th>3</th><th>4</th><th>5</th><th>6</th></tr><tr><td>a.</td><td>A</td><td>0.0</td><td>0.5 x MT For Conductor). 1.0 x MT (For Earth Wire)</td><td>WC + WI + DY</td><td>0.6 WC + WI +0.25 DY (For Conductor) 0.6 WC + 0.5 DY (For Earth Wire)</td></tr><tr><td>b.</td><td>B (Section Tower- 0° Deviation)</td><td>0.0</td><td>1.0 x MT</td><td>WC + WI + DY</td><td>0.6 WC + WI +0.5 DY</td></tr><tr><td>c.</td><td>B (15° Deviation)</td><td>0.0</td><td>1.0 x MT x Cos $\Phi/2$</td><td>WC + WI + DY</td><td>0.6 WC + WI +0.5 DY</td></tr><tr><td>d.</td><td>C (Section Tower- 0° Deviation)</td><td>0.0</td><td>1.0 x MT</td><td>WC + WI + DY</td><td>0.6 WC + WI +0.5 DY</td></tr><tr><td>e.</td><td>C (30° Deviation)</td><td>0.0</td><td>1.0 x MT x Cos $\Phi/2$</td><td>WC + WI + DY</td><td>0.6 WC + WI +0.5 DY</td></tr><tr><td>f.</td><td>D (60° Deviation)</td><td>0.0</td><td>1.0 x MT x Cos $\Phi/2$</td><td>WC + WI + DY</td><td>0.6 WC + WI +0.5 DY</td></tr><tr><td>g.</td><td>D (90° Deviation)</td><td>0.0</td><td>1.0 x MT x Cos $\Phi/2$</td><td>WC + WI + DY</td><td>0.6 WC + WI +0.5 DY</td></tr><tr><td>h.</td><td>D Complete Dead End</td><td>MT</td><td>1.0 x MT</td><td>WC + WI</td><td>0.1 WC + WI</td></tr></table> <table><tr><th>DESCRIPTION</th><th>SYMBOL</th><th>REMARKS</th></tr><tr><td>Maximum Tension Of Conductor/ Earth Wire under everyday temperature & full wind condition or minimum temperature & 36% Of max. wind which ever is more stringent</td><td>MT</td><td></td></tr><tr><td>Wind On Conductor</td><td>WC</td><td>Wind Span shall be the normal ruling span.</td></tr><tr><td>Wind On Insulator</td><td>WI</td><td>In case of Double String Insulators, both their strings shall be considered</td></tr><tr><td>Angle Of Deviation (Degrees)</td><td>Φ</td><td></td></tr><tr><td>Load Due To Deviation Of Tower</td><td>DY= 2 x MT x Sin $\Phi/2$</td><td></td></tr></table>					S.No	400 kV	Longitudinal Loads		Transverse Loads		Reliability Condition	Security Condition	Reliability Condition	Security Condition	1	2	3	4	5	6	a.	A	0.0	0.5 x MT For Conductor). 1.0 x MT (For Earth Wire)	WC + WI + DY	0.6 WC + WI +0.25 DY (For Conductor) 0.6 WC + 0.5 DY (For Earth Wire)	b.	B (Section Tower- 0° Deviation)	0.0	1.0 x MT	WC + WI + DY	0.6 WC + WI +0.5 DY	c.	B (15° Deviation)	0.0	1.0 x MT x Cos $\Phi/2$	WC + WI + DY	0.6 WC + WI +0.5 DY	d.	C (Section Tower- 0° Deviation)	0.0	1.0 x MT	WC + WI + DY	0.6 WC + WI +0.5 DY	e.	C (30° Deviation)	0.0	1.0 x MT x Cos $\Phi/2$	WC + WI + DY	0.6 WC + WI +0.5 DY	f.	D (60° Deviation)	0.0	1.0 x MT x Cos $\Phi/2$	WC + WI + DY	0.6 WC + WI +0.5 DY	g.	D (90° Deviation)	0.0	1.0 x MT x Cos $\Phi/2$	WC + WI + DY	0.6 WC + WI +0.5 DY	h.	D Complete Dead End	MT	1.0 x MT	WC + WI	0.1 WC + WI	DESCRIPTION	SYMBOL	REMARKS	Maximum Tension Of Conductor/ Earth Wire under everyday temperature & full wind condition or minimum temperature & 36% Of max. wind which ever is more stringent	MT		Wind On Conductor	WC	Wind Span shall be the normal ruling span.	Wind On Insulator	WI	In case of Double String Insulators, both their strings shall be considered	Angle Of Deviation (Degrees)	Φ		Load Due To Deviation Of Tower	DY= 2 x MT x Sin $\Phi/2$	
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	Note: 1. Vertical loads shall conform to IS 802 – Part I, 1995. Weight spans as furnished under Clause 2.03.00 shall be considered for computation of vertical loads. 2. Safety loads and Anti-cascade loads as specified in IS 802- Part I, 1995 shall also be considered for design of Towers. 3. Wind loads on the towers shall be considered in transverse loads as per clause 11, 12 and 13 of IS: 802 (Part-I/ Sec. I)- 1995. 4. Any additional loads apart from the loads mentioned above, as required as per IS: 802- 1995 shall be considered for design purpose. 14.00.00 TOWER FOUNDATIONS: 14.01.00 TYPES OF FOUNDATION : 14.01.01 General : A) Reinforced concrete footing shall be used for all type of normal tower in conformity with the present day practice followed in the country and the specifications laid herein. All the four footings of the tower and their extension shall be similar, irrespective of down thrust and uplift. B) Foundation includes supply of materials such as cement, sand, coarse aggregates, reinforcement steel etc., and all work related to construction of foundations including excavation and backfilling, form work, stub setting, placing of reinforcement, concreting etc. 14.01.02 Design criteria for Foundations: The foundation shall be designed for the actual soil parameters based on the soil investigation carried out by the bidder and approved by the owner. For design purposes: (a) The angle of repose shall be considered as two-third (2/3) of the value as obtained from the soil investigation (b) Water table shall be considered up to the ground level. (c) The weight of soil shall be considered as 1440 Kg/m³ under dry condition and 940 Kg/m³ under wet condition. Well foundation or pile foundation shall be provided by the bidder wherever necessitated. 14.02.00 SOIL INVESTIGATION: 14.02.01 The Contractor is required to carry out detailed soil investigation at various tower locations along the corridor, one borehole at centre of the tower, angle points, crossings, etc. and also where soil strata is different from the other locations investigated. In addition the soil investigation may be required to be carried at other locations at the discretion of the Engineer. The investigation comprises of field and laboratory testing. Field investigation includes boreholes, Standard Penetration Test (SPT), Static Cone Penetration Test (SCPT), Dynamic Cone Penetration Test (DCPT), collection of disturbed samples (DS) and undisturbed soil			
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14.02.02	samples (UDS), Trial Pits (TP), Plate Load Tests (PLT), Electrical Resistivity Test (ERT), collection of water samples, etc. Laboratory tests shall include, Physical, chemical and engineering properties of soil/rock.			
	This specification covers technical requirements for geotechnical investigation and preparation of a detailed geotechnical report. It shall include mobilization of necessary equipment, providing necessary engineering supervision and technical personnel, carrying out field investigation and tests, laboratory tests, analysis and interpretation of data and results, collecting data regarding change of course of rivers from local sources, velocity, scour, etc., giving flood details of the area (past history), safe bearing capacity for different sizes of foundations, different founding strata for the various locations along the transmission lines and preparation of geotechnical report.			
	The diameter of borehole shall be minimum 150 mm in soil and 76 mm in rock. Depth of bore holes at river/bridge crossings shall be 40m, at angle points depth shall be 15.0m and at the centre of tower along the corridor depth of BH shall be 10.0m. Boring shall be terminated at the above specified depth or 3.0m continuous in rock with RQD>25% for river crossings and for balance areas 3.0m in refusal whichever is earlier. Refusal means SPT 'N' value greater than 100. SPT shall be carried out in all types of soil deposits and in all rock formations with core recovery up to 20%, met within a borehole. This test shall be conducted at every 3.0 m interval or at change of strata, up to the final depth. At refusal penetration shall be measured and the same shall be reported in Borelog. UDS shall be collected at every 3.0 m interval or at change of strata up to depth of borehole. UDS may be replaced by additional SPT, if SPT'N' value in the strata is above 50. The diameter of UDS sampler shall be 100 mm minimum.			
	Laboratory tests shall be done as per relevant IS codes. The laboratory tests, not be limited to the following shall be conducted on disturbed and undisturbed soil samples, rock samples & water samples collected during field investigations in sufficient numbers. a) Laboratory Tests on Soil Samples: Laboratory tests shall be carried out on disturbed and undisturbed soil samples for Grain Size Analysis, Hydrometer Analysis, Atterberg Limits, Triaxial Shear Tests (UU), Natural Moisture Content, Specific Gravity and Bulk Unit Weight, Consolidation Tests, Unconfined Compression Test, Free swell Index, Shrinkage Limit, Swell Pressure Test, Chemical Analysis test on soil and water samples to determine the carbonates, sulphates, chlorides, nitrates, pH, organic matter and any other chemicals harmful to concrete and reinforcement/ steel. b) Laboratory Tests on Rock Samples: Moisture content, porosity & density, Specific Gravity, Hardness, Soundness, Slake durability index, Unconfined compression test (Both at saturated and in-situ water content), Point load strength index and deformability test (Both at saturated and in-situ water content) shall be carried out on rock samples.			
	The laboratory tests shall be carried out progressively during the field work after sufficient numbers of samples have reached the laboratory in order that the test results of the initial boreholes can be made use of in planning the later stages of the field investigation and quantum of laboratory tests. All samples brought from field, whether disturbed or undisturbed shall be extracted/prepared and examined by competent technical personnel and the tests shall be carried out as per the procedures laid out in the latest editions of the relevant IS codes. Soil shall be classified as per the provisions of Indian standards.			
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14.02.06	On completion of all field & laboratory work, geotechnical investigation report shall be submitted for Owner's review/approval. The Geotechnical investigation report shall contain geological information of the region, procedure adopted for investigation, field & laboratory observations/ data/ records, analysis of results & recommendations on type of foundation envisaged for all areas of work with supporting calculations. Recommendations on treatment for soil, foundation, based on subsoil characteristics, soft soils, aggressive chemicals, expansive soils, etc.			
14.02.07	The Geotechnical report shall include, but not limited to the following: a) Borelogs: A true cross section of all individual boreholes with reduced levels and coordinates, showing the classification and thickness of individual stratum, position of ground water table, details of various in-situ tests conducted and samples collected at different depths and the rock stratum, wherever met with. b) Results of all laboratory tests summarized for each Borehole along with a consolidated table giving the layer wise soil and rock properties. All the relevant charts, tables, graphs, figures, supporting calculations, conditions and photographs of representative rock cores shall be furnished. c) Recommendations : The report should contain specific recommendations on type of foundations to be adopted for various structures, duly considering the sub soil characteristics, water table, total/ differential settlement permissible for structures and equipments, minimum depth and width of foundation. The observation/recommendations shall include but not limited to the following: i) Geological information of the area, past observations or historical data, if available, for the area and for the structures in the nearby area, fluctuations of water table etc. ii) Net safe allowable bearing pressure on the soil at various depths for different sizes of the foundations based on shear strength and settlements characteristics of soil with supporting calculations for the recommendations. iii) Based on the chemical nature of soil and ground water and exposure condition, recommendations for protective measures on concrete and steel shall be mentioned. iv) If expansive soil is met with, recommendation and removal or retainment of the same under structures/ roads etc. shall be given. In the later case detailed specification of any special treatment required including specifications for materials to be used, construction method, equipments to be deployed, etc. shall be furnished. iv) Additional investigation other then specified above, if any, the same shall be carried out by the bidder at no extra cost to owner.			
14.02.08	Indian Standard References IS:1498 Classification and Identification of Soils for general Engineering Purposes. IS:1892 Code of practice for Subsurface Investigation for Foundation. IS:1904 Code of practice for design and construction of foundations in Soils: General Requirements. IS:2131 Method of Standard Penetration Test for Soils. IS:2132 Code of practice for Thin walled Tube Sampling of Soils. IS:2470 Code of practice for design and construction of SepticTanks. (Part-I)			
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	IS:2720 Method of Test for Soils (Relevant Parts). IS:5313 Guide for Core Drilling Observations. IS:4968 Method for subsurface Sounding for Soils - Dynamic (Part-II) method using Cone and Bentonite slurry. IS:4968 Method for subsurface Sounding for Soils- Static Cone Penetration (Part-III) Test			
14.04.00	LOADS ON FOUNDATIONS:			
14.04.01	The foundations shall be designed to withstand the specific loads of the superstructure and for the full footings reactions obtained from the structural stress analysis in conformity with the relevant over load factors. The over load factor for foundation design shall be 1.10 for all loads except dead loads.			
14.04.02	The reactions on the footings shall be composed of the following type of loads for which these shall be required to be checked : i) Max. tension or uplift along the leg slope. ii) Max. compression or down-thrust along the leg slope. iii) Max. horizontal shear or side thrust.			
14.04.03	The base slab of the foundation shall be designed for additional moments developing due to eccentricity of the loads.			
14.04.04	The additional weight of concrete in the footing below ground level over the earth weight and the full weight of concrete above the ground level in the footing and embedded steel parts will also be taken into account adding to the down thrust.			
14.05.00	STABILITY ANALYSIS:			
14.05.01	In addition to the strength design, stability analysis of the foundation shall be done to check the possibility of failure by over-turning, uprooting, sliding and tilting of the foundation.			
14.05.02	The following primary type of soil resistance shall be assumed to act in resisting the loads imposed on the footing in earth:			
A)	Resistance against uplift The uplift loads will be assumed to be resisted by the weight of earth in an inverted frustum of a conical pyramid of earth as per relevant formula on the footing pad whose sides make an angle equal to the angle of repose of the earth with the vertical, in average soil. The weight of concrete embedded in earth and that above the ground will also be considered for resisting the uplift. In case where the frustum of earth pyramids of two adjoining legs super-impose each other, the earth frustum will be assumed truncated by a vertical plane passing through the center line of the tower base.			
B)	Resistance against down thrust The down-thrust load combined with the additional weight of concrete above earth will be resisted by bearing strength of the soil assumed to be acting on the total area of the bottom of the footings.			
C)	Resistance against side-thrust			
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	The chimney portion of the foundation shall be designed as per limit load method described at clause 38.6 of IS-456-1978, or as per any other international standard, considering the chimney as a column subjected to axial loads (down thrust loads) and biaxial bending moments resulting from side thrust forces. The passive earth pressure (as per Rankine's formula) shall be considered for the design of chimney against side thrust. If uplift and down thrust are computed in vertical direction for the foundation design, full resultant horizontal shear shall be taken at footing tip for design of the footing to resist side thrust. 14.06.00 PROPERTIES OF CONCRETE: 14.06.01 The cement concrete used for the foundations shall be of grade M-20 corresponding to 1:1½:3 nominal mix ratio with 20mm coarse aggregate. 14.06.02 All the properties of concrete regarding its strength under compression tension, shear, punching and bend etc. as well as workmanship will conform to IS:456-1978. 14.06.03 The material properties for cement, aggregate and reinforcement steel shall be as specified elsewhere in the specification 14.06.04 The water used for mixing concrete shall be fresh, clean and free from oil, acids and alkalies, organic materials or other deleterious substances. Portable water is generally preferred. 14.07.00 DESIGN OF FOUNDATIONS: 14.07.01 Structural design of the foundations shall be done by limit State method conforming to IS 456. 14.07.02 The chimney should have all around clearance of 150mm from any part of stub angle limiting to 450mm sq. minimum. 14.07.03 The chimney top or muffing must be at least 225 mm above ground level and also the coping shall be extended upto lower most joint level between the bottom lattices and the main corner legs of the tower. 14.07.04 Minimum thickness of foundation shall be 300 mm. 14.07.05 The minimum distance between the lowest edge of the stub angle and the bottom surface of concrete footing shall not be less than 150 mm or more than 200mm. 14.07.06 The total depth of foundations below the ground level shall not be less than 1.5 meters. To maintain the interchangeability of stubs for all types of foundations, for each type of tower, the same depths of foundations shall be used for different types of foundations. 14.07.07 The portion of the stub in the pyramid (or slab) shall be designed to take full down-thrust or uplift loads by the cleats combined with the bond between stub angles and pyramid concrete. The Contractor shall furnish the calculation for uprooting of stub along with the foundation design. 14.07.08 Minimum 50mm thick pad of lean concrete corresponding to 1:3:6 nominal mix shall be provided to avoid the possibility of reinforcement rod being exposed due to unevenness of the bottom of the excavated pit. 14.07.09 Over Load Factor The overload factor for foundations shall be considered as 1.1 i.e. the reaction except due to dead loads on foundations shall be increased by 10 per cent. 14.08.00 CONSTRUCTION OF TOWER FOUNDATION:			
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14.08.01	Excavation : Excavation work must not be started until the tower schedule & profile and foundation drawing are approved by the Owner. Except specified otherwise, all excavation for footing shall be made to the lines and grades of the foundation. All excavation shall be protected so as to maintain a clean subgrade, until the footing is placed, using timbering/shuttering, shoring etc., if necessary. Any sand, mud, silt or other undesirable materials which may accumulate in the excavated pit shall be removed by the Contractor before placing concrete.			
14.08.02	Rock excavation requiring Blasting: Wherever blasting is required for excavation in rock, the same shall be done after obtaining license from the competent authority. Following shall be adhered to: i) All provisions of explosive acts shall be adhered to. ii) The magazine for the storage of explosive shall be to suit as per the requirements of explosive department. iii) Where blasting is required, same shall be controlled blasting. iv) Contractor shall prepare the detailed blasting scheme and get the same approved from Engineer-in-charge before carrying out the blasting operation. All blasting shall be done as per the approved blasting scheme. v) The Contractor shall obtain Licenses from Competent Authorities for undertaking blasting work as well as for procuring, transporting to site and storing the explosives as per explosives act. The Contractor shall be responsible for the safe transport, use, custody and proper accounting of the explosive Materials. vi) The Contractor shall also observe any specific instructions given by the Engineer-in-charge. The Contractor shall be responsible and liable for any accident and injury / damage which may occur to any person or property of the project or public on account of any operations connected with the storage, transportation, handling or use of explosives and the blasting operations. The Engineer-in-charge or his authorised representative shall frequently check the Contractor's compliance with these precautions and the manner of storing and accounting of explosives. The Contractor shall provide necessary facilities for this the above. vii) Controlled blasting shall be done by a specialised agency duly approved by Engineer-in-charge. All controlled blasting shall be done by using time delay detonators (i.e. excel type). viii) All rules under the Explosives Act and other local rules in force shall be fully observed. All blasting works shall be done in accordance with the stipulations contained in IS: 4081.			
14.08.03	Setting of Stubs: A) The stubs shall be set correctly in accordance with approved method at the exact location and alignment and precisely at correct levels with the help of stub setting templates and leveling instrument. Stubs shall be set in the presence of Owner's representative available at site where required and for which adequate advance intimation shall be given to the Owner by the Contractor. B) Setting of stub at each location shall be approved by the Owner's representative. C) Stub setting templates shall be designed and arranged by the Contractor at his own cost for all types of towers with or without extension and also for leg extension. Stub templates for standard towers and towers with extension upto 6M shall be of adjustable type. The stub			
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	templates shall be painted. Generally for each transmission line tower package, following numbers of stub setting templates shall be deployed by the Contractor: For each A type tower : 3 Nos. For each of B and C type : 2 Nos. However, if Owner feels that more number of templates are required for timely completion of a particular line the Contractor shall have to deploy the same without any extra cost to Owner. D) One set of each type of stub setting template as applicable, shall be supplied to the Owner, on completion of the project at no extra cost to Owner. 14.08.04 Mixing, Placing and Compacting of Concrete: A) The concrete shall be mixed in a mechanical mixer. However, in case of difficult terrain hand mixing may be permitted at the discretion of Owner. The water for mixing concrete shall be fresh, clean and free from oil, acids and alkalies. Saltish or blackish water shall not be used. B) Mixing shall be continued until there is uniform distribution of material and the mix is uniform in colour and consistency, but in no case the mixing be done for less than two minutes. Normally mixing shall be done close to the foundation, but in case it is not possible the concrete may be mixed at the nearest convenient place. The concrete shall be transported from the place of mixing to the place of final deposit as rapidly as practicable by methods which shall prevent the segregation or loss of any ingredient. The concrete shall be placed and compacted before setting commences. C) Form boxes shall be used for casting all type of foundations. The concrete shall be laid down in 150mm layers and consolidated well, so that the cement cream works up to the top and no honey-combing is left in the concrete. The mechanical vibrator shall be employed for compaction of the concrete. However, in case of difficult terrain, manual compaction may be permitted at the discretion of Owner. After concreting the chimney portion to the required height, the top surface should be finished smooth with a slight slope towards the outer edge, to drain off any rain water falling on the coping. D) In wet locations, the site must be kept complete de-watered, both during the placing of the concrete and for 24 hours thereafter. There should be no disturbance of concrete by water during this period. E) After the form-work has been removed if the concrete surface is found to be defective, the damage shall be repaired with rich cement and sand mortar to the satisfaction of the Owner's representative before the foundation pits are backfilled.			
14.08.05	Back-Filling and Removal of Stub Template: A) After opening of form-work and removal of shoring and timbering, if any, backfilling shall be started, after repairs, if any, to the foundation concrete. Backfilling shall normally be done with excavated soil, unless it consists of large boulders/stones, in which case the boulders shall be broken to a maximum size of 80 mm. At such locations where borrowed earth is required for backfilling, shall be done by the Contractor at his own cost, irrespective of lead. B) The backfilling materials should be clean and free from organic or other foreign materials. The earth shall be deposited in maximum 200 mm layers, leveled and wetted and tempered properly before another layer is deposited. Care shall be taken that the backfilling is started from the foundation ends of the pits, towards the outer ends. After the pits have been backfilled to full depth, the stub template may be removed. C) The backfilling and grading shall be carried to an elevation of about 75 mm above the finished ground level to drain out water. After backfilling 50 mm high earthen embankment			
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14.08.06	(bandh) will be made along the sides of excavation pits and sufficient water will be poured in the backfilled earth for atleast 24 hours. Curing: The concrete after setting for 24 hours shall be cured by keeping the concrete wet continuously for a period of 10 days after laying. The pit may be back filled with selected earth sprinkled with necessary amount of water and well consolidated in layers not exceeding 200 mm of consolidated thickness after a minimum period of 24 hours and thereafter both the backfilled earth and exposed chimney top shall be kept wet for the remainder of the prescribed time of 10 days. The uncovered concrete chimney above the backfilled earth shall be kept wet by providing empty cement bags dipped in water fully wrapped around the concrete chimney for curing and ensuring that the bags are kept wet by the frequent pouring of water on them.			
14.08.07	Benching: When the line passes through hilly/undulated terrain, for a few tower locations it may be required to level the ground for casting of tower footings on same elevation. All the activities related to make the required area of ground in same elevation for casting of foundation, shall be termed as benching work. Benching work shall include cutting of excess earth and removing the same to a suitable point of disposal as required by the Owner. Benching shall be resorted to only after getting specific approval from the Owner. Volume of the earth to be cut shall be measured before cutting and got approved from the Owner. This volume of earth shall be considered for the purpose of payment against the head of benching work. The earth removed for setting of stub template or for casting of foundation with difference of elevations of 1M between the tower legs shall not be entitled for payment.			
14.08.08	Protection of Tower Footing: A) The work shall include all necessary stone revetments, concreting and earth filling above ground level and the clearance from stacking on the site of all surplus excavated soil, special measures for protection of foundation close to or in nallahs, river bed hilly/undulated terrain etc, by providing suitable revetments or galvanized wire netting and meshing packed with boulders. The top seal cover of the stone revetments shall be done with M-15 concrete (1:2:4:mix). The Contractor shall furnish recommendations for providing protection at these locations wherever required. B) The quantity of excavated earth obtained from a particular location shall generally be utilized in back-filling work in protection of tower footing of same locations, unless it is unsuitable for such purpose. In the latter case, the back-filling shall be done with borrowed earth of suitable quality irrespectively of lead as per the rate provided in the letter of award. The consolidation of earth shall however be done after backfilling free of cost.			
15.00.00	TOWER LINE ERECTION AND STRINGING:			
15.01.00	GENERAL REQUIREMENTS:			
15.01.01	The details of the scope of erection work shall include the cost of labour, all tools and plants like tension stringing equipment and all other incidental expenses in connection with erection and stringing work.			
15.01.02	The Contractor shall be responsible for transportation of all the materials to be provided by the Contractor as per the scope of work to site, proper storage and preservation at their own cost till such time the erected line is taken over by the Owner.			
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15.02.00	TREATMENT OF MINOR GALVANISING DAMAGE: In case any minor damage to galvanizing is noticed, the same shall be treated with zinc rich paint (having at least 90% zinc content) before erection.			
15.03.00	ASSEMBLY:			
15.03.01	The method followed for the erection of towers, shall ensure the points mentioned below :			
	a)	Straining of the members shall not be permitted for bringing them into position. It may, however, be necessary to match hole positions at joints and to facilitate this, tommy bars not more than 450 mm long may be used.		
	b)	Before starting erection of an upper section, the lower section shall be completely braced and all bolts provided and tightened adequately in accordance with approved drawings to prevent any mishap during tower erection.		
	c)	All plan diagonals relevant to a section of tower shall be placed in position before assembly of upper section is taken up.		
	d)	The bolt position in assembled towers shall be as per IS:5613 (Part-II/Section 2)-1976.		
	e)	Tower shall be fitted with number plate, danger plate, phase plate and anti-climbing device as described.		
	f)	All bank holes, if any left, after complete erection of the tower, are to be filled up by bolts and nuts of correct size.		
15.03.02	Tightening and Punching of Bolts and Nuts			
	A)	All nuts shall be tightened properly using correct size spanner/torque wrench. Before tightening, it shall be ensured that filler washers and plates are placed in gaps between members wherever applicable, bolts of proper size and length are inserted, and one spring washer is inserted under each nut. In case of step bolts, spring washers shall be placed under the outer nut. The tightening shall progressively be carried out from the top downwards, care being taken that all bolts at every level are tightened simultaneously. The threads of bolts projecting outside the nuts shall be punched at their position on the diameter to ensure that the nuts are not loosened in course of time. If during tightening a nut is found to be slipping or running over the bolt threads, the bolt together with the nut shall be replaced.		
	B)	The threads of all the bolts projected outside the nuts shall be welded at two diametrically opposite places. The welding shall be provided from ground level to waist level for single circuit towers and to bottom cross arm level for double circuit towers. After welding, cold galvanised paint having at least 90% Zinc content shall be applied to the welded portion. At least two coats of the paint shall be applied. The cost of welding and paint including application of paint shall be deemed to be included in the erection price.		
	C)	In addition to the tack welding of nuts with bolts, as described above, the Contractor can also propose some alternative arrangements, like use of epoxy resin adhesive which can serve the purpose of locking the nut permanently with the bolt and thus preventing pilferage of the tower members.		
15.04.00	INSULATOR HOISTING: Suspension insulator strings shall be used on suspension towers and tension insulator strings on angle and dead end towers. These shall be fixed on all the towers just prior to the stringing. Damaged insulators and fittings, if any, shall not be employed in the assemblies. Before hoisting, all insulators shall be cleaned in a manner that will not spoil, injure or			
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	scratch the surface of the insulator, but in no case shall any oil be used for the purpose. Corona control rings/arching horn shall be fitted in an approved manner. The yoke arrangements be horizontal for tensions strings. Torque wrench shall be used for fixing different line materials and their components, like suspension clamp for conductor and earthwire, etc., whenever recommended by the manufacturer of the same of river crossing towers.			
15.05.00	HANDLING OF CONDUCTOR AND EARTHWIRE:			
15.05.01	The Contractor shall be entirely responsible for any damage to the towers or conductors during stringing. While running out the conductors, care shall be taken that the conductors do not touch or rub against the ground or objects which could cause scratches or damages to the strands. The conductors shall be run out of the drums from the top in order to avoid damage due to chafing. Immediately after running out, the conductor shall be raised at the supports to the levels of the clamps and placed into the running blocks. The groove of the running blocks shall be of such a design that the seat is semi-circular and larger than the diameter of the conductor earthwire and it does not slip over or rub against the sides. The grooves shall be lined with hard rubber or neoprene to avoid damage to conductor and shall be mounted on properly lubricated bearings.			
15.05.02	The running blocks shall be suspended in a manner to suit the design of the crossarm. All running blocks, especially those at the tension end, will be fitted on the cross-arm with jute cloth wrapped over the steel work and under the slings to avoid damage to the slings as well as to the protective surface finish of the steel work. In case suspension, or section towers are used even for temporary terminations, if this be unavoidable, they shall be well guyed and steps shall be taken by the Contractor to avoid damage. Guying proposal alongwith necessary calculations shall be submitted by the Contractor to Owner by the Contractor for checking the tensions in the guy made available to the Owner by the Contractor for checking the tensions in the guy wires. The drums shall be provided with a suitable braking device to avoid damages, loose running out and kinking of the conductor. The conductor shall be continuously observed for loose or broken strands or any other damage. When approaching end of a drum length, at least three coils shall be left when the stringing operations are to be stopped. These coils are to be removed carefully, and if another length is required to be run out, a joint shall be made as per the recommendations of the manufacturers.			
15.05.03	Repairs to conductors, if necessary, shall be carried out during the running out operations, with repair sleeves. Repairing of conductor surface shall be done only in case of minor damage, scuff marks etc. keeping in view both electrical and mechanical safe requirements. The final conductor surface shall be clean smooth and without any projections, sharp points, cuts, abrasions etc.			
15.05.04	Conductor splices shall be so made that they do not crack or get damaged in the stringing operation. The contractor shall use only such equipment/methods during conductor stringing which ensures complete compliance in this regard.			
15.05.05	Derricks shall be used where roads, rivers, channels, telecommunication or overhead power lines, railway lines, fences or walls have to be crossed during stringing operations. It shall be seen that normal services are not interrupted or damage caused to property. Shut down shall be obtained when working at crossing of overhead power lines. The Contractor shall be entirely responsible for the proper handling of the conductor, earth-wire and accessories in the field.			
15.05.06	The sequence of running out shall be from top to downwards i.e. the earthwire shall be run out first, followed by the conductors in succession. Unbalances of loads on towers shall be avoided as far as possible.			
15.05.07	The proposed 66 kV transmission line may run parallel for certain distance with the existing Transmission lines which may remain energized during the stringing period. As a result there			
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	is a possibility of dangerous voltage build up due to electromagnetic and electrostatic coupling in the pulling wire, conductors and earthwires, which although comparatively small during normal operations can be severe during switching. It shall be the Contractor's responsibility to take adequate safety precautions to protect his employees and others from this potential danger. 15.05.08 B and C type of towers are not designed for one side stringing. Therefore proper guying arrangement shall be made for B and C type of towers during stringing on one section while the other section is not strung. The Contractor has to submit the detailed proposal along with the calculation for guying which shall be approved by the Owner. Proper T&P shall be made available to the Owner by the Contractor for checking the tensions in the guy wires. All the expenditure on account of the above work is deemed to be included in the bid price and no extra payment shall be made for the same. 15.06.00 STRINGING OF CONDUCTOR AND EARTHWIRE: 15.06.01 The stringing of the conductor shall be done by standard stringing method. 15.06.02 After being pulled the conductor/earthwire shall not be allowed to hang in the stringing blocks for more than 96 hours before being pulled to the specified sag. 15.06.03 Conductor creep are to be compensated by over tensioning the conductor at appropriate temperature for which calculations are to be submitted by the contractor for Owner's approval. 15.06.04 The Bidder shall give complete details of the stringing methods which be proposes to follow. Before the commencement of stringing the Contractor shall submit the stringing charts for the conductor and earthwire for various temperatures and span alongwith equivalent spans for the approval of the Owner. 15.06.05 Jointing: A) All the joints on the conductor and earthwire shall be of compression type, in accordance with the recommendations of the manufacturer for which all necessary tools and equipment like compressors, dies, processes etc. shall have to be arranged by the Contractor. Each part of the joint shall be cleaned by wire brush to make it free of rust or dirt etc. and properly greased with anti- corrosive compound if required, and as recommended by the contractor before the final compression is done with the compressors. B) All joints or splices shall be made at least 30 meters away from the structures. No joints or splices shall be made in spans crossing over main road, railways, small rivers with tension spans. During compression or splicing operation the conductor shall be handled in such a manner as to prevent lateral or vertical bearing against the dies. After pressing the joint the aluminum sleeve shall have all corners rounded, burrs and sharp edges removed and smoothened. C) During stringing of conductor to avoid any damage to the joint, the Contractor shall use a suitable protector with mid span compression joints in case joints are to be passed over pulley blocks/aerial rollers. The size of the groove of the pulley shall be such that the joint along with protection can be passed over it smoothly. 15.07.00 Sagging-in-Operation: 15.07.01 The conductor shall be pulled upto the desired sag and left in running blocks for atleast one hour after which the sag shall be re-checked and adjusted, if necessary before transferring the conductor from the running blocks to the suspension clamps. The conductors shall be clamped within 36 hours of sagging in.			
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15.07.02	The sag will be checked in the first and the last span of the section in case of sections upto eight spans and in one intermediate span also for sections with more than eight spans. The sag shall also be checked when the conductors have been drawn up and transferred from running blocks to the insulator clamps.			
15.07.03	The running blocks, when suspended from the transmission structure for sagging shall be so adjusted that the conductors on running blocks will be at the same height as the suspension clamp to which it is to be secured,			
15.07.04	At sharp vertical angles, the sags and tensions shall be checked on both sides of the angle, he conductor and earthwire shall be checked on the running blocks for equality of tension on both sides. The suspension insulator assemblies will normally assume vertical positions when the conductor is clamped.			
15.07.05	Tensioning and sagging operations shall be carried out in clam weather when rapid changes in temperatures are not likely to occur.			
15.07.06	Tensioning and Sagging of Conductors and Earthwire The tensioning and sagging shall be done in accordance with the approved stringing charts before the conductors and earthwire are finally attached to the tower through the earthwire clamps for the earthwire and insulator strings for the conductor. The `Initial' stinging chart shall be used for the conductor and `final' stringing chart for earth-wire should be employed for this purpose. Dynamometers shall be employed for measuring tension in the conductor and earthwire. The dynamometers employed shall be periodically checked and calibrated with the standard dynamometer.			
15.07.07	Clipping In: A) Clipping of the conductors in positions hall be done in accordance with the recommendations of the manufacturer. Conductor shall be fitted with armour rods where it is made to pass through suspension clamps. B) The jumpers at the section and angle towers shall be formed to parabolic shape to ensure maximum clearance requirements and shall match the jumper drops shown in the tower drawings. C) Fasteners in all fittings and accessories shall be secured in position. The security clip shall be properly opened and sprung into position.			
15.07.08	Fixing of Conductor and Earthwire Accessories Vibration dampers for conductor and earthwire and other conductor and earthwire accessories shall be installed by the Contractor as per the design requirement and respective manufacturer's instructions within 24 hours of the conductor/earthwire clamping. While installing the conductor and earthwire accessories, proper care shall be taken to ensure that the surfaces are clean and smooth and no damage shall occur to any part of the accessories.			
15.08.00	REPLACEMENT:			
15.08.01	If any replacements are to be effected after stringing and tensioning or during maintenance, leg members and bracings shall not be removed without reducing the tension on the tower with proper guying or releasing the conductor. If the replacement of cross arms becomes necessary after stringing, the conductor shall be suitably tied to the tower at tension points or transferred to suitable roller pulleys as suspension points.			
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15.08.02	The Contractor shall not be required to return to the Owner, empty conductor and earthwire drums and shall dispose off the same at his cost except for steel drums which shall be returned to Owner.	
15.09.00	FINAL CHECKING TESTING AND COMMISSIONING:	
15.09.01	After completion of the works, final checking of the line shall be done by the Contractor to ensure that all the foundation works, tower erection, and stringing have been done strictly according to the specifications and as approved by the Owner. All the works shall be thoroughly inspected keeping in view of the following main points: a) Sufficient backfilled earth is lying over each foundation pit and it is adequately compacted. b) Concrete chimneys and their copings are in good finally shaped conditions. c) All the tower members are correctly used, strictly according to final approved drawing and are free of any defect or damage, whatsoever. d) All bolts are properly tightened and punched/tack welded. e) The stringing of the conductors and earthwire has been done as per the approved sag and tension charts and desired clearances are clearly available. f) All conductor and earthwire accessories are properly installed. g) All other requirements to complete the work like fixing of danger plate, phase plate, number plate, anti climbing device etc., are properly installed. h) Wherever required it should be ensured that revetment is provided. i) The original tracings of profile route alignment and tower, design, structural drawings, bill of material, shop drawings of all towers are submitted to the Owner for reference and record. j) The insulation of line as a whole is tested by the Contractor by providing his own equipment, labour etc. to the satisfaction of the Owner. k) All towers are properly grounded. l) The line is tested satisfactorily for commissioning purpose.	
16.00.00	TRANSMISSION LINE MATERIAL:	
16.01.00	GENERAL:	
16.01.01	All the equipment shall be of the latest design and conform to the best modern practice adopted in the extra high voltage field. The Bidder shall offer only such equipment as guaranteed by him to be satisfactory and suitable for 400 kV AC Double circuit transmission with quad moose conductor and will give continued good performance.	
16.01.02	The design, manufacturing process and quality control of all the materials shall be such as to give maximum factor of safety, maximum possible working load, highest mobility, elimination of sharp edges and a good finish.	
16.01.03	All ferrous parts shall be hot dip galvanized, after all machining has been completed, nuts may, however, be tapped (threaded) after galvanizing and the threads oiled. Spring washers shall be electrogalvanized. The bolt threads shall be under cut to take care of increase in diameter due to galvanizing. Galvanizing shall be done in accordance with IS:2629-1972.	
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	Fasteners shall withstand four dips while spring washers shall withstand three dips. Other galvanized materials shall be guaranteed to withstand at least six dips each lasting one minute under the standard preece tests for galvanizing.	
16.01.04	The zinc coating shall be perfectly adherent, of uniform thickness, smooth, reasonably bright, continues and free from imperfection such as flux, ash, rust stains, bulky white deposits and blisters. The zinc used for galvanising shall be of grade Zn. 99.95 as per IS:209-1966.	
16.02.00	EARTHWIRE :	
16.02.01	The galvanised steel earthwire shall generally conform to the specification of ACSR core wire as mentioned in IS 398 (Part-II)-1976 except where otherwise specified herein.	
16.02.02	Parameters of the earthwire (a) Size (strands & wire diameter) 7/3.15 mm (b) Overall diameter 9.45 mm (c) Stranded weight 428 Kg/km (d) Minimum ultimate tensile strength 56 kN	
16.02.03	The earthwire shall be pre-formed and post-formed to avoid opening of strands at the time of cutting or joining. The finished material shall have minimum brittleness, as it will be subject to appreciable vibration while in use. It shall withstand 3 and ½ number of one minute dips in the standard preece test.	
16.02.04	There shall be no joint of any kind in the finished steel wire strand entering into the manufacture of the earthwire. There shall be no strand joints or strand splicer in any length of the completed stranded earthwire.	
16.03.00	CONDUCTOR:	
16.03.01	The conductor shall be Aluminium Core Steel Reinforced (ACSR) type. The conductor shall confirm to IS:398 (Part-II) except where otherwise specified herein.	
16.03.02	Parameters of the conductor a) Code and standard IS 398 b) Name MOOSE ACSR c) Overall diameter 31.77 mm d) Weight 2.004 kg/m e) Ultimate tensile strength 161.2 kN minimum f) Strands and wire diameter of - Aluminium 54 / 3.53 mm - Steel 7 / 3.53 mm	
16.03.03	The steel strands shall generally comply with the requirements stipulated for earthwire at clause 16.02.00 above.	
16.03.04	Joints shall be permitted in the individual Aluminium wires in all layers except the outer most layer of the finished conductor. These joints shall be made by cold pressure butt-welding and shall be such that no two such joints are within 15 metres of each other in the complete stranded conductor.	
16.03.05	The standard length of the conductor shall be 1600 meters for conductor and 2x2000 metres for earth wire. A tolerance of ± 5% on the standard length offered by the bidder shall be permitted. All lengths outside this limit of tolerance shall be treated as random lengths. Random lengths will be accepted provided no length is less than 70% of the standard length and the total quantity of random lengths shall not be more than 10% of the total quantity ordered.	
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16.04.00	CONDUCTOR ACCESSORIES :			
16.04.01	Mid Span Compression Joint for Conductor As per details given in IS:2121 Part-2..			
16.04.02	Repair Sleeve: Repair Sleeve of compression type shall be used to repair conductor with not more than two strands broken in the outer layer. The sleeve shall be manufactured from 99.5% pure aluminium and shall have a smooth surface. The repair sleeve shall comprise of two pieces with a provision of seat for sliding of the keeper piece. The edges of the seat as well as the keeper piece shall be of rounded that the conductor strands are not damaged during installation.			
16.04.03	The Bidder shall clearly specify the before and after compression dimensions of the mid span compression joint and repair sleeve for owner's review. The compression pressure shall also be indicated by the Bidder.			
16.04.04	Vibration Damper for conductor and Earthwire: A) Vibration dampers of 4 R-Stock bridge type with four (4) different resonance spread within the specified aeolian frequency bandwidth shall be used at all suspension and tension points on each span to damp out the Aeolean vibrations of the conductors to the specified level as mentioned hereinafter. Two dampers minimum on each side per conductor/earthwire shall be used at tension points and one damper minimum on each side per conductor at suspension points for ruling design span. B) The clamp of the vibration damper shall be made of high strength aluminium alloy of type LM-6 or equivalent. C) The messenger cable shall be made of high strength galvanized steel/stainless steel with a minimum strength of 135 kg/mm ² . It shall be of pre-formed and post-formed quality in order to prevent subsequent droop of weight and to maintain consistent flexural stiffness of the cable in service. The number of strands in messenger cable shall be 19. The messenger cable other than stainless steel shall be hot dip galvanized in accordance with the recommendations of IS:4826-1979 for heavily coated wires. D) The manufacturer must indicate the clamp bolt tightening torque to ensure that the slip strength of the clamp is maintained between 2.5 KN and 5KN. The clamp when installed on the conductor shall not cause excessive stress concentration on the conductor leading to permanent deformation of the conductor strands and premature fatigue failure in operation. E) The vibration damper for conductor shall not have magnetic power loss more than 0.5 watt at 350 amps at 50 Hz alternating current. F) The vibration analysis of the system, with and without damper and dynamic characteristics of the damper shall have to be submitted by the Bidder . G) The damper placement chart shall be submitted by the Bidder. All the placement charts should be duly supported by relevant technical documents and sample calculations. H) The damper placement charts shall include the following: i) Location of the dampers for various combinations of spans and line tensions clearly indicating the number of dampers to be installed per conductor/earthwire per span. ii) Placement distances clearly identifying the extremities between which the distances are to be measured.			
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	iii) Placement recommendation depending upon type of suspension clamp (viz Free centre type, Armour grip type, etc.) iv) The influence of mid span compression joints, repair sleeves and armour rods (standard and AGS) in the placement of dampers.			
16.05.00	EARTHWIRE ACCESSORIES:			
16.05.01	Mid Span Compression Joint for Earthwire It shall be used for joining two lengths of earthwire. The joint shall be made of mild steel. The steel sleeve should not crack or fail during compression in it or service period. The Brinell Hardness of steel should not exceed 200. The steel sleeve shall be hot dip galvanized. The joints shall not permit slipping off, damage to , of failure of the complete earthwire or any part thereof at a load not less than 95% of the ultimate tensile strength of the earthwire. The joint shall have resistivity less than 75% of resistivity of equivalent length of earthwire. The details of the joint shall be submitted for owners approval.			
16.05.02	Vibration Damper For Earthwire : Refer Clause 16.04.04 detailed above.			
16.05.03	Flexible Copper Bond: As detailed in is:2121 part3.			
16.05.04	Suspension Clamp for Earthwire : As Detailed in IS:2121 Part3			
16.05.05	Tension Clamp for Earthwire: The details shall be as per IS:2121 part-3. Only Compression type tension clamp shall be used to hold galvanized steel earthwire. Anchor shackle shall be supplied which shall be suitable for attaching the tension clamp to strain plates. The strain plates supplied with the towers will have a minimum thickness of 8 mm with a hole of 17.5 mm diameter. Suitable lugs for jumper connection shall also be supplied along with necessary bolts and nuts.			
16.06.00	HARDWARE FITTINGS:			
16.06.01	The hardware fittings shall be as per the specification and IS/IES standards			
16.06.02	Each hardware fittings shall be supplied complete in all respects and include the following hardware parts:			
	a) Ball hook for suspension hardware fittings suitable for attaching to V-hanger of the tower. Anchor shackle shall be supplied, which shall be suitable for attaching the tension hardware fittings to strain plate, of the tower.			
	b) Suitable yoke plates			
	c) Suspension and dead end assembly to suit conductor size.			
	d) Other necessary fittings such as eye links, ball clevis, socket clevis, clevis eye, U-clevis, ball link, arcing horn etc. to make the hardware fittings complete.			
	e) 2.5% extra fasteners shall be supplied along with the hardware fittings.			
	f) Socket fittings shall be provided with only R-shaped security clip in accordance with IS-2486 (part-II).			
16.07.00	ANTI FOG DISC INSULATOR:			
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16.07.01	The size of disc insulator, the number to be used in different type of strings, their electromechanical strength and minimum creepage distance shall be as follows : <table border="1"> <thead> <tr> <th>Type of String</th><th>Size of disc insulator (mm)</th><th>Min. creepage distance of each disc (mm)</th><th>No. of standard discs</th><th>Electro-mechanical strength of insulator string (kN)</th></tr> </thead> <tbody> <tr> <td>Single Suspension</td><td>255/280 x 145</td><td>430</td><td>1x 23</td><td>120</td></tr> <tr> <td>Double Suspension</td><td>-do-</td><td>-do-</td><td>2x 24</td><td>2 x 120</td></tr> <tr> <td>Double tension</td><td>-do-</td><td>-do-</td><td>2x 24</td><td>2 x 120</td></tr> <tr> <td>Single tension</td><td>-do-</td><td>-do-</td><td>1x 24</td><td>120</td></tr> </tbody> </table> Note: Single Suspension (Pilot) string will be used for jumpers of tension type towers. It will be similar to single suspension type except the clamp of the conductor. A) Disc Insulator: The insulator shall be pin and cap ; ball and socket type. The disc insulator shall conform to IS:731. B) Ball and Socket Designation The dimensions of the balls and sockets shall be of 20 mm designation, for 90KN/120KN disc insulator in accordance with the standard dimensions stated in IS:2486-(Part-II)/IEC:120. As alternate contractor may also offer long rod composite insulator for the above application.	Type of String	Size of disc insulator (mm)	Min. creepage distance of each disc (mm)	No. of standard discs	Electro-mechanical strength of insulator string (kN)	Single Suspension	255/280 x 145	430	1x 23	120	Double Suspension	-do-	-do-	2x 24	2 x 120	Double tension	-do-	-do-	2x 24	2 x 120	Single tension	-do-	-do-	1x 24	120			
Type of String	Size of disc insulator (mm)	Min. creepage distance of each disc (mm)	No. of standard discs	Electro-mechanical strength of insulator string (kN)																									
Single Suspension	255/280 x 145	430	1x 23	120																									
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Double tension	-do-	-do-	2x 24	2 x 120																									
Single tension	-do-	-do-	1x 24	120																									
16.07.02	Materials: A) Porcelain : The porcelain used in the manufacture of shells shall be sound, free from defects thoroughly vitrified and smoothly glazed. B) Glaze: The finished porcelain shall be glazed in brown colour. The glaze shall cover all exposed parts of the insulator and shall have a good lustre, smooth, surface and good performance under the extreme weather conditions of a tropical climate. It shall not be cracked or chipped by ageing under the normal service conditions. The glaze shall have the same co-efficient of expansion as of the porcelain body throughout the working temperature range. C) Toughened Glass: In case of glass insulator, the glass used for the shells shall be sound, free from defects such as flows, bubbles, inclusions etc. and be of uniform toughness over its entire surface. All exposed glass surfaces shall be smooth. D) Cement: Cement used in the manufacture of the insulator shall not cause fracture by expansion or loosening by contraction. The cement shall not give rise to chemical reaction with metal fittings and its thickness shall be as small and uniform as possible. Proper care shall be taken to correctly centre and locate individual parts during cementing. E) Pins and Caps: Pins and Caps shall be made of drop forged steel and malleable cast iron/spheroidal graphite iron/drop forged steel respectively, duly hot dip galvanised and shall not be made by jointing, welding, shrink fitting or any other process from more than one piece of material.																												
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F) 16.07.03	Security Clips: Security clips shall be made of good quality stainless steel or phosphor bronze as per IS:1385-1968 2.5% extra Security clip shall be provided. OPTICAL GROUND WIRE AND ACCESSORIES: General: This specification covers the provision of one peak of 400kV tower with Optical Fiber (OPGW). This optical fiber cable will be connected to suitable optical line terminal and multiplex equipment to form part of the Plant's overall communications transmission system. Any expected variation shall be clearly identified in the Bidder's Proposal. Bidder to ensure that optical fiber characteristic of the OPGW cable to be supplied shall be compatible with the existing OPGW cable if any. Physical Characteristic Dual-Window Single mode (DWSM), G.652D optical fibres (minimum 24 fibres) shall be provided in the fibre optic cables. DWSM optical fibres shall meet the requirements defined in Table 1-1(a). Attenuation The attenuation coefficient for wavelengths between 1525 nm and 1575 nm shall not exceed the attenuation coefficient at 1550 nm by more than 0.05 dB/km. The attenuation coefficient between 1285 nm and 1330 nm shall not exceed the attenuation coefficient at 1310 nm by more than 0.05 dB/km. The attenuation of the fibre shall be distributed uniformly throughout its length such that there are no point discontinuities in excess of 0.10 dB. The fibre attenuation characteristics specified in table 1-1 (a) shall be "guaranteed" fibre attenuation of any & every fibre reel. The overall optical fibre path attenuation shall not be more than calculated below: ➤ Maximum attenuation @ 1550nm: $0.21 \text{ dB/km} \times \text{total km} + 0.05 \text{ dB/splice} \times \text{no. of splices} + 0.5 \text{ dB/connector} \times \text{no. of connectors}$ ➤ Maximum attenuation @ 1310nm: $0.35 \text{ dB/km} \times \text{total km} + 0.05 \text{ dB/splice} \times \text{no. of splices} + 0.5 \text{ dB/connector} \times \text{no. of connectors}$ Construction The OPGW (Optical Ground Wire) cable is proposed to be installed on the EHV transmission lines. The design of cable shall account for the varying operating and environmental conditions that the cable shall experience while in service. The OPGW cable to be supplied shall be designed to meet the overall requirements of all the transmission lines. The Bidder shall design the OPGW requirements to suit each span in the system, based on the applicable drawings and field surveys. The Bidder's proposal shall stipulate the characteristics of the OPGW required for each span in the system. Optical Fibre Identification Individual optical fibres within a fibre unit and fibre units shall be identifiable in accordance with EIA/TIA 598 or IEC 60304 or Bellcore GR-20 colour-coding scheme. Colouring utilized for colour coding optical fibres shall be integrated into the fibre coating and shall be homogenous. The colour shall not bleed from one fibre to another and shall not fade during fibre preparation for termination or splicing.			
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	Each cable shall have traceability of each fibre back to the original fibre manufacturer's fibre number and parameters of the fibre. If more than the specified number of fibres is included in any cable, the spare fibres shall be tested by the cable manufacturer and any defective fibres shall be suitably bundled, tagged and identified at the factory by the vendor. Table1-1(a) DWSM Optical Fibre Characteristics <table><tr><td>Fibre Description:</td><td>Dual-Window Single-Mode</td></tr><tr><td>Mode Field Diameter:</td><td>8.6 to 9.5 μm (± 0.6μm)</td></tr><tr><td>Cladding Diameter:</td><td>125.0 μm ± 1 μm</td></tr><tr><td>Mode field concentricity error</td><td>≤ 0.6μm</td></tr><tr><td>Cladding non-circularity</td><td>≤ 1%</td></tr><tr><td>Cable Cut-off Wavelength λ_{c,CC}</td><td>≤ 1260 nm</td></tr><tr><td>1550 nm loss performance</td><td>As per ITU-T G.652 D</td></tr><tr><td>Proof Test Level</td><td>≥ 0.69 Gpa</td></tr><tr><td>Attenuation Coefficient:</td><td>@ 1310 nm ≤ 0.35 dB/km @ 1550 nm ≤ 0.21 dB/km</td></tr><tr><td>Chromatic Dispersion; Maximum: Zero Dispersion Wavelength: Zero Dispersion Slope:</td><td>18 ps/(nm x km) @ 1550 nm 3.5 ps/(nm x km) 1288-1339nm 5.3 ps/(nm x km) 1271-1360nm 1300 to 1324nm 0.092 ps/(nm²xkm) maximum</td></tr><tr><td>Polarization mode dispersion coefficient</td><td>≤ 0.2 ps/km^{1/2}</td></tr><tr><td>Temperature Dependence:</td><td>Induced attenuation ≤ 0.05 dB (-60°C -+85°C)</td></tr><tr><td>Bend Performance:</td><td>@ 1310 nm (75±2 mm dia Mandrel), 100 turns; Attenuation Rise ≤ 0.05 dB @ 1550 nm (30±1 mm radius Mandrel), 100 turns; Attenuation Rise ≤ 0.05 dB @ 1550 nm (32±0.5 mm dia Mandrel, 1 turn; Attenuation Rise ≤ 0.50 dB</td></tr></table> Buffer Tube Loose tube construction shall be implemented. The individually coated optical fibre(s) shall be surrounded by a buffer for protection from physical damage during fabrication, installation and operation of the cable. The fibre coating and buffer shall be strippable for splicing and termination. Each fibre unit shall be individually identifiable	Fibre Description:	Dual-Window Single-Mode	Mode Field Diameter:	8.6 to 9.5 μm (± 0.6μm)	Cladding Diameter:	125.0 μm ± 1 μm	Mode field concentricity error	≤ 0.6μm	Cladding non-circularity	≤ 1%	Cable Cut-off Wavelength λ _{c,CC}	≤ 1260 nm	1550 nm loss performance	As per ITU-T G.652 D	Proof Test Level	≥ 0.69 Gpa	Attenuation Coefficient:	@ 1310 nm ≤ 0.35 dB/km @ 1550 nm ≤ 0.21 dB/km	Chromatic Dispersion; Maximum: Zero Dispersion Wavelength: Zero Dispersion Slope:	18 ps/(nm x km) @ 1550 nm 3.5 ps/(nm x km) 1288-1339nm 5.3 ps/(nm x km) 1271-1360nm 1300 to 1324nm 0.092 ps/(nm ² xkm) maximum	Polarization mode dispersion coefficient	≤ 0.2 ps/km ^{1/2}	Temperature Dependence:	Induced attenuation ≤ 0.05 dB (-60°C -+85°C)	Bend Performance:	@ 1310 nm (75±2 mm dia Mandrel), 100 turns; Attenuation Rise ≤ 0.05 dB @ 1550 nm (30±1 mm radius Mandrel), 100 turns; Attenuation Rise ≤ 0.05 dB @ 1550 nm (32±0.5 mm dia Mandrel, 1 turn; Attenuation Rise ≤ 0.50 dB		
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	utilizing colour coding. Buffer tubes shall be filled with a water-blocking gel. Optical Fibre Strain & Sag-Tension chart The OPGW cable shall be designed and installed such that the optical fibres experience no strain under all loading conditions defined in IS 802. Zero fibre strain condition shall apply even after a 25 year cable creep. While preparing the Sag-tension charts for the OPGW cable the following conditions shall be met: ➤ The Max Allowable Tension (MAT) / max strain shall be less than or equal to the MWT/ Strain margin of the cable. ➤ The sag shall not exceed the earth wire sag in all conditions. ➤ The Max Allowable Tension shall also be less than or equal to 0.4 times the UTS. ➤ The 25 year creep at 25% of UTS (creep test as per IEEE 1138) shall be such that the 25 year creep plus the cable strain at Max Allowable Tension (MAT) is less than or equal to the cable strain margin. ➤ The everyday tension (EDT) shall not exceed 20% of the UTS for the OPGW cable. 2.13.01 The Sag-tension chart of OPGW cable indicating the maximum tension, cable strain and sag shall be calculated and submitted for owners review. Cable Materials : The materials used for optical fibre cable construction, shall meet the following requirements: Filling Materials : The interstices of the fibre optic unit and cable shall be filled with a suitable compound to prohibit any moisture ingress or any water longitudinal migration within the fibre optic unit or along the fibre optic cable. The water tightness of the cable shall meet or exceed the test performance criteria as per IEC 60794-1-F-5. The filling compound used shall be a non-toxic homogenous waterproofing compound that is free of dirt and foreign matter, nonhygroscopic, electrically nonconductive and non-nutritive to fungus. The compound shall also be fully compatible with all cable components it may come in contact with and shall inhibit the generation of hydrogen within the cable. The waterproofing filling materials shall not affect fibre coating, colour coding, or encapsulant commonly used in splice enclosures, shall be dermatologically safe, non-staining and easily removable with a non-toxic cleaning solvent. Metallic Members : When the fibre optic cable design incorporates metallic elements in its construction, all metallic elements shall be electrically continuous. Optical Ground Wire (OPGW) : OPGW cable construction shall comply with IEEE-1138, 2009. The cable provided shall			
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	meet both the construction and performance requirements such that the ground wire function, the optical fibre integrity and optical transmission characteristics are suitable for the intended purpose. The cable shall consist of optical fibre units as defined in this specification. There shall be no factory splices within the cable structure of a continuous cable length. The composite fibre optic overhead ground wire shall be made up of multiple buffer tubes embedded in a water tight aluminium/aluminium alloy/stainless steel with aluminium coating protective central fibre optic unit surrounded by concentric-lay stranded metallic wires in single or multiple layers. Each buffer tube shall have maximum 12 no. of fibres. All fibres in single buffer tube or directly in central fibre optic unit is not acceptable. The dual purpose of the composite cable is to provide the electrical and physical characteristics of conventional overhead ground wire while providing the optical transmission properties of optical fibre. Central Fibre Optic Unit : The central fibre optic unit shall be designed to house and protect multiple buffered optical fibre units from damage due to forces such as crushing, bending, twisting, tensile stress and moisture. The central fibre optic unit and the outer stranded metallic conductors shall serve together as an integral unit to protect the optical fibres from degradation due to vibration and galloping, wind and ice loadings, wide temperature variations, lightning and fault current, as well as environmental effects which may produce hydrogen. The OPGW design of dissimilar materials such as stainless steel tube with aluminium or aluminium –clad-steel wire strands are not allowed. Central fibre optic unit may be of aluminium or stainless steel tube with aluminium protective coating. In case of aluminium protective coating, the coating must completely cover the tubes leaving no exposed areas of tubing that can make electrical contact either directly or indirectly through moisture, contamination, protrusions, etc with the surrounding stranded wires. The tube may be fabricated as a seamless tube, seam welded, or a tube without a welded seam. Basic Construction: The OPGW cable construction shall conform to the applicable requirements of this specification, applicable clauses of IEC 61089 related to stranded conductors and Table given below for OPGW Mechanical and Electrical Characteristics. In addition, the basic construction shall include bare concentric-laystranded metallic wires with the outer layer having left hand lay. The wires may be of multiple layers with a combination of various metallic wires within each layer. The direction of lay for each successive layer shall be reversed. The finished wires shall contain no joints or splices unless otherwise agreed to by the Employer and shall conform to all applicable clauses of IEC 61089 as they pertain to stranded conductors. The wires shall be so stranded that when the complete OPGW is cut, the individual wires can be readily regrouped and then held in place by one hand. Breaking Strength : The rated breaking strength of the completed OPGW shall be taken as no more than 90 percent of the sum of the rated breaking strengths of the individual wires, calculated from			
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	their nominal diameter and the specified minimum tensile strength. The rated breaking strength shall not include the strength of the optical unit. The fibre optic unit shall not be considered a load bearing tension member when determining the total rated breaking strength of the composite conductor. Electrical and Mechanical Requirements : Below table provides OPGW Electrical and Mechanical Requirements for the minimum performance characteristics. For the purposes of determining the appropriate Max Working Tension limit for the OPGW cable IS 802:1995 and IS 875: 1987 shall be applied. OPGW Electrical and Mechanical Requirements <table><tr><td>Everyday Tension</td><td>≤ 20% of UTS of OPGW</td></tr><tr><td>D.C. Resistance at 20°C:</td><td>< 1.0 ohm/Km</td></tr><tr><td>Short Circuit Current</td><td>≥ 6.32 kA for 1.0 second</td></tr></table> Since OPGW shall be located at the top of the transmission line support structure, it will be subjected to Aeolian vibration, Galloping and Lightning strikes. It will also carry ground fault currents. Therefore, its electrical and mechanical properties shall be same or similar as those required of conventional ground conductors. Assemblies and Line Accessories: a. General: The OPGW assemblies and line accessories shall consist of the hardware indicted herein. All hardware and accessories shall be made of aluminum, aluminum alloy, malleable iron, steel (metal mold of drop forging process), stainless steel, or non-ferrous metal, unless otherwise specified. In addition, all hardware and accessories shall have an ultimate tensile strength equal to or exceeding the rated ultimate tensile strength of the overhead ground wire. All metal shall be free from burrs, sharp edges, lumps and dross and shall be smooth so that interconnecting parts will fit properly, and so that the parts maybe assembled and readily. All bolts and other fasteners shall be installed according to manufacturer's recommendations. Materials no specifically covered herein by detailed specifications shall be of standard commercial quality suitable for the intended use. The Contractor shall determine the most suitable type of clamp to be used at each and every transmission tower location. b. Suspension Clamps: The suspension clamps for the OPGW shall be of bolt or performed type. The bolt type suspension clamps shall be complete with bolts, keeper pieces, and other required parts. Each clamp shall be capable of holding the OPGW without slipping under an unbalanced tension of 25% of the ultimate tensile strength of the OPGW. c. Tension Clamps :	Everyday Tension	≤ 20% of UTS of OPGW	D.C. Resistance at 20°C:	< 1.0 ohm/Km	Short Circuit Current	≥ 6.32 kA for 1.0 second		
Everyday Tension	≤ 20% of UTS of OPGW								
D.C. Resistance at 20°C:	< 1.0 ohm/Km								
Short Circuit Current	≥ 6.32 kA for 1.0 second								
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16.07.04	The tension clamps shall be of bolt or performed type, and cable of holding the OPGW without slipping or damaging the OPGW under a tension of 75% of the OPGW ultimate tensile strength. A suitable piece shall be of same material as the clamp body. Bolts, nuts and washers shall be hot-dipped galvanized malleable iron or steel. d. Grounding clamps and Parallel Groove Clamp: Each clamp shall be capable holding the OPGW using bolts and nuts. e. Vibration dampers: Stock bridge type vibration dampers, suitable for use on the OPGW shall be supplied. The dampers shall have an aluminum, clamping bolts, or other suitable device, on the galvanized wire between the weights, and be suitable for attachment to the OPGW. The damper clamp shall be designed to permit installation and removal using hot line tools. Each damper weight, subject to the accumulation of moisture, shall be provided with one drain hold positioned at the bottom of the weight when the damper is installed in the vertical plane. Damper weights shall be made of hot dip galvanized case iron or zinc. f. Armor rods: The armor rods for the OPGW shall be of the preformed type. They shall be smooth and free from corrosion, splitting, cracking, or any other defects. They shall be designed to effectively protect the OPGW from fatigue caused by vibration. Armor rods may or may not be employed, as per OPGW manufacturer recommendations, however the use of armor rods is preferred by the Employer. g. The joint box shall be air-tight, water-proof. The cover shall be securely fastened to the case by non-loosening fasteners. Both the case and the cover shall be made of non-corrosive aluminum alloy or hot dip galvanized steel or approved materials. The joint box shall be sufficiently rugged and sturdy to withstand outdoor climatic and environmental conditions. The joint box shall accommodate sheath protected arc-fusion splices and up to 1.5 m of additional fiber on each side of the splice; guides shall be provided to keep the extra fiber well above the allowable bending radius of the fiber. The spliced parts of the optical fiber within the joint box shall be reinforced and free from tension after completion of the splicing. The contractor shall provide one set of terminating materials with every joint box for optical fiber connection. All splices shall be encased in Fibre Optic Splice Enclosures. Suitable splice enclosures shall be provided to encase the optical cable splices in protective, moisture and dust free environment. Splice enclosures shall comply with ingress protection class IP 66 or better. The splice enclosures shall be designed for the storage and protection of required number of optical fibre splices and equipped with sufficient number of splice trays for splicing all fibres in the cable. No more than 12 fibres shall be terminated in a single splice tray. They shall be filled with suitable encapsulate that is easily removable should re-entry be required into the enclosures. Splice enclosures shall be suitable for outdoor use with each of the cable types provided under this contract. Splice enclosures shall be appropriate for mounting on transmission line towers above anti-climb guard levels at about 10 metres from top of the tower and shall accommodate pass-through splicing. Contractor shall be responsible for splicing of fibres and installation of splice enclosures. Hot Line Maintenance:			
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	The insulators offered shall be suitable for employment of hot line maintenance technique so that the usual hot line operations can be carried out with ease, speed and safety. Bidders shall indicate the methods generally used in the routine hot and dead line maintenance of HV lines for which similar insulator have been supplied by them. Bidders shall also indicate the recommended periodicity of such maintenance. 17.00.00 TESTS FOR TRANSMISSION LINE MATERIAL: 17.01.00 GENERAL REQUIREMENTS 17.01.01 The materials shall conform to all the type tests as per relevant standards. The acceptance, routine tests and tests during manufacturer shall be carried out on the line material as per relevant standards.			
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Bharat Heavy Electricals Limited**Project:** 400kV GIS Switchyard at Singrauli Super Thermal Power Project Stage- III (2x800MW)**Customer:** NTPC Ltd.**Technical Specification:** 400kV Gas Insulated Switchgear & its accessories**Doc No.** TB-429-316-001 Rev 00

SECTION- 3
PROJECT DETAILS AND GENERAL SPECIFICATIONS

3.0 GENERAL

This section stipulates the General Technical Requirements under the Contract and will form an integral part of the Technical Specification.

The provisions under this section are intended to supplement general requirements for the materials, equipment and services covered under other sections of tender documents and are not exclusive. However, in case of conflict between the requirements specified in this section and requirements specified under other sections, the requirements specified under respective sections shall prevail.

3.1 PROJECT DETAILS

	Particular	Details
a)	Customer	NTPC Ltd.
b)	Project Title	Singrauli Super Thermal Power Project Stage- III (2x800MW): 400kV GIS Switchyard at Singrauli STPP
c)	Project Location	Place: Singrauli District: Sonbhadra State: Uttar Pradesh
d)	Latitude & Longitude	Latitudes and Longitudes of the site are as follows: Latitude: 24.1990° N Longitude: 82.6676° E
e)	Nearest Railway Station	Shaktinagar Station (3.0 Km)
f)	Distance of project location from the Railway station	Nearest Railway Station is Shaktinagar Station which is About 3Km from Singrauli STPP. Other Nearby Important Stations are Renukoot Junction About 60 Km, Mirzapur Station About 198 Km, Mughal Sarai Junction About 196 Km and Varanasi Cantt About 202Km.
g)	Nearest Major Town	Nearest major city is Renukoot, located at a distance of 60Km to the project.
h)	Distance of the town from the project site	60Km
i)	Nearest commercial airport	Lal Bahadur Shastri International Airport, Varanasi
j)	Distance of airport from the project site	220km by Road
	<u>SITE CONDITIONS</u> (for design purposes)	
a)	Design ambient temperature	50°C
b)	Maximum Relative humidity	95 %
c)	Height above mean sea level	Less than 1000meter
d)	Pollution Severity	Heavily polluted
e)	Criteria for Wind Resistant design of structures and equipment	Standard Applicable - IS 875 (Part 3)
f)	Basic Wind speed "Vb" at ten meters above the mean ground level.	47m/sec
g)	Category of terrain	Category-2
h)	Risk Coefficient "K1"	1.07
i)	Seismic acceleration	0.3g

Bharat Heavy Electricals Limited**Project:** 400kV GIS Switchyard at Singrauli Super Thermal Power Project Stage- III (2x800MW)**Customer:** NTPC Ltd.**Technical Specification:** 400kV Gas Insulated Switchgear & its accessories**Doc No.** TB-429-316-001 Rev 00**3.1.1 SYSTEM PARAMETERS:**

Sl.No.	Parameters	400kV
1	Highest system voltage	420kVrms
	Rated/ nominal system voltage	400kVrms
2	Lightning Impulse voltage (Phase to earth & between phases)	±1425kVp
	Across isolating distance	1425(+240)kVp
3	Switching impulse voltage (Phase to earth)	±1050kVp
	Across isolating distance	900(+345)kVp
4	Power frequency withstand for 1 min (rms) (Phase to earth & between phases)	815kVrms
	Across isolating distance	815kVrms
5	Max. fault level (1 sec.)	63 kA
6	Minimum creepage distance (31mm/kV)	13020 mm

3.1.2 AUXILIARY POWER:

Sl.No.	Nominal Connection Voltage	Variations in Voltage	Frequency	Phase	Neutral
1	415V	±10%	50 (+3% -5%)	3Phase, 4 Wire	Solidly Earthed
2	240V	±10%	50 (+3% -5%)	1 phase	Solidly Earthed

Combined variation of voltage and frequency shall be + 10%. Design fault level of 415V system shall be restricted to 50kA rms for 1 second.

The operational limits for variation of DC voltage are (+) 10% to (-) 15%.

3.1.3 The towers and gantries shall be suitable for a normal conductor tension of minimum 2T/conductor in case of twin moose and 1.5T/conductor in case of quad moose conductor. The foundations and structures etc. shall be designed accordingly.

The minimum vertical distance from the bottom of the lowest porcelain part of the bushing, porcelain enclosures or supporting insulators to the bottom of the equipment structure, where it rests on the foundation pad shall be 2550 mm. All gantries and towers (including intermediate/required for turning etc.) as required for GT & ST O/H stringing & its anchoring on A-Row column of TG Building and line take off, are to be provided by the contractor. Minimum height of 400KV gantry for AIS shall be 16M+8.5M Peak however intermediate gantry height for O/H connection for GT shall be min. 22m+8.5m. Minimum height of 400KV AIS equipment level shall be 8.0M from the plinth level. The gantry width for 400kV AIS shall be min. 27m. In case of space constraint in the switchyard, the bidder may design considering the bay width of <27mtr for 400KV Level subjected to meet the statutory electrical clearances etc.

Various minimum heights of the 400KV AIS switchyard shall be as given below from plinth level:

Voltage	Equipment /1 st Level	2 nd Level	3 rd Level
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Bharat Heavy Electricals Limited**Project:** 400kV GIS Switchyard at Singrauli Super Thermal Power Project Stage- III (2x800MW)**Customer:** NTPC Ltd.**Technical Specification:** 400kV Gas Insulated Switchgear & its accessories**Doc No.** TB-429-316-001 Rev 00

400KV (1½ breaker scheme)	8000mm	16000mm	2300mm
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3.1.4 The minimum clearances for 400kV switchyards shall be as given below:

	400kV
Phase to earth clearance	3500 mm
Phase to phase clearance	4000 mm
Section clearance	6500 mm

3.2 INSTRUCTION TO BIDDERS:

The bidders shall submit the technical requirements, data and information as per the technical data sheets, provided in technical specification/ section-4.

The bidders shall furnish catalogues, engineering data, technical information, design documents, drawings etc fully in conformity with the technical specification.

The supplier should be approved by Customer/ Employer. If not, it is the responsibility of the bidder/ vendor to be assessed and approved Customer/ Employer, before placement of order by BHEL. Any cost involved in bidder/ vendor assessment/approval must be borne by the bidder/ vendor himself.

The Bidder's proposal shall be based upon the use of equipment and material complying fully with the requirements specified herein. It is recognized that the Bidder may have standardized on the use of certain components, materials, processes or procedures different than those specified herein. Alternate proposals offering similar equipment based on the manufacturer's standard practice will also be considered, provided the base offer is in line with technical specifications and such proposals meet the specified design standards and performance requirement and are acceptable to the Purchaser. Sufficient amount of information for justifying such proposals shall be furnished to Purchaser along with the bid to enable the Purchaser to determine the acceptability of these proposals.

Wherever a material or article is specified or defined by the name of a particular brand, Manufacturer or Bidder/ vendor, the specific name mentioned shall be understood to be indicative of the function and quality desired and not restrictive. Other manufacturer's products may be considered provided sufficient information is furnished to enable the Customer/ Employer to determine that the products proposed are equivalent to those named.

Equipment furnished shall be complete in every respect with all mountings, fittings, fixtures and standard accessories normally provided with such equipment and/ or needed for erection, completion and safe operation of the equipment as required by applicable codes, though they may not have been specifically detailed in the Technical Specifications unless included in the list of exclusions. Materials and components not specifically stated in the specification but which are necessary for commissioning and satisfactory operation of the switchyard unless specifically excluded shall be deemed to be included in the scope of the specification and shall be supplied without any extra cost. All similar standard components/parts of similar standard equipment under supply shall be inter-changeable with one another.

The bidder shall supply type tested (including special tests as per tech. specification) equipment and materials. The test reports shall be furnished by the bidder along with equipment/ material drawings. In the event of any discrepancy in the test reports, (i.e., if any test report is not acceptable due to any design/ manufacturing changes or due to non-compliance with the Technical Specification and/ or applicable standard), the tests shall be carried out without any additional cost implication to the BHEL. BHEL reserves the right to get any or all type/tests conducted/repeated.

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In addition to the codes and standards specifically mentioned in the relevant technical specifications for the equipment/ plant/ system, all equipment parts, systems and works covered under this specification shall comply with all currently applicable statutory regulations and safety codes of the Republic of India as well as of the locality where they will be installed, including the following:

- a) Indian Electricity Act
- b) Indian Electricity Rules
- c) Indian Explosives Act
- d) Indian Factories Act and State Factories Act
- e) Indian Boiler Regulations (IBR)
- f) Regulations of the Central Pollution Control Board, India
- g) Regulations of the Ministry of Environment & Forest (MoEF), Government of India
- h) Pollution Control Regulations of Department of Environment, Government of India
- i) State Pollution Control Board.
- j) Rules for Electrical installation by Tariff Advisory Committee (TAC).
- k) Building and other construction workers (Regulation of Employment and Conditions of services) Act, 1996
- l) Building and other construction workers (Regulation of Employment and Conditions of services) Central Rules, 1998
- m) Explosive Rules, 1983
- n) Petroleum Act, 1984
- o) Petroleum Rules, 1976,
- p) Gas Cylinder Rules, 1981
- q) Static and Mobile Pressure Vessels (Unified) Rules, 1981
- r) Workmen's Compensation Act, 1923
- s) Workmen's Compensation Rules, 1924
- t) NTPC Safety Rules for Construction and Erection
- u) NTPC Safety Policy
- v) CERC (Indian Electricity Grid Code) Regulations, 2023
- w) CEA (Flexible Operation of Coal Based Thermal Power Generating Units) Regulations, 2023
- x) Any other statutory codes / standards / regulations, as may be applicable.

Unless covered otherwise in the specifications, the latest editions (as applicable at the date fifteen (15) days prior to the date of bid submission), of the codes and standards given below shall also apply,

- a) Bureau of Indian standards (BIS)
- b) Japanese Industrial Standards (JIS)
- c) American National Standards Institute (ANSI)
- d) American Society of Testing and Materials (ASTM)
- e) American Society of Mechanical Engineers (ASME)
- f) American Petroleum Institute (API)
- g) Standards of the Hydraulic Institute, U.S.A.
- h) International Organization for Standardization (ISO)
- i) Tubular Exchanger Manufacturer's Association (TEMA)
- j) American Welding Society (AWS)
- k) National Electrical Manufacturers Association (NEMA)
- l) National Fire Protection Association (NFPA)
- m) International Electro-Technical Commission (IEC)
- n) Expansion Joint Manufacturers Association (EJMA)
- o) Heat Exchange Institute (HEI)

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p) IEEE standard

q) JEC standard

Other International/ National standards such as DIN, VDI, BS, GOST etc. shall also be accepted for only material codes and manufacturing standards, subject to the Customer/ Employer's approval, for which the Bidder shall furnish, adequate information to justify that these standards are equivalent or superior to the standards mentioned above. In all such cases the Bidder shall furnish specifically the variations and deviations from the standards mentioned elsewhere in the specification together with the complete word to word translation of the standard that is normally not published in English.

As regards highly standardized equipment such as Steam Turbine and Generator, National/ International standards such as JIS, DIN, VDI, ISO, SEL, SEW, VDE, IEC & VGB shall also be considered as far as applicable for Design, Manufacturing and Testing of the respective equipment. However, for those of the above equipment not covered by these National / International standards, established and proven standards of manufacturers shall also be considered.

In the event of any conflict between the codes and standards referred to in the above clauses and the requirement of this specification, the requirement of Technical Specification shall govern.

In case of any change in codes, standards & regulations between 06-June -2022 and the date when bidder/ vendors proceed with fabrication, the Customer/ Employer shall have the option to incorporate the changed requirements or to retain the original standard. It shall be the responsibility of the Contractor to bring to the notice of the Customer/ Employer such changes and advise Customer/ Employer of the resulting effect.

3.4 SERVICES TO BE PERFORMED BY THE EQUIPMENT BEING FURNISHED

The 400kV system is being designed to limit the power frequency over voltage of 1.5 p.u. and the switching surge over voltage to 2.5 p.u. In 400 kV system the initial value of temporary over voltage could be 2.0 p.u. for 1-2 cycles. All the equipment/materials covered in this specification shall perform all its function satisfactorily without undue strain, restrike etc. under such over voltage conditions.

All equipment shall also perform satisfactorily under various other electrical, electromechanical and meteorological conditions of the site of installation. All equipment shall be able to withstand all external and internal mechanical, thermal and electromechanical forces due to various factors like wind load, temperature variation, ice & snow (not applicable for this project), short circuit etc for the equipment.

3.5 ENGINEERING DATA**3.5.1 Drawings**

All drawings submitted by the supplier including those submitted at the time of bid shall be in sufficient detail to indicate the type, size, arrangement, material description, Bill of Materials, weight of each component, break-up for packing and shipment, the external connections, fixing arrangement required. The dimensions required for installation and interconnections with other equipment and materials, clearances and spaces required for installation and interconnections between various portions of equipment and any other information specifically requested in the specifications.

Each drawing submitted by the bidder (including those of sub-bidder/ vendors) shall bear a title block at the right-hand bottom corner with clear mention of the name of the Customer/ Employer, the system designation, the specifications title, the specification number, the name of the Project, drawing number and

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revisions. If standard catalogue pages are submitted, the applicable items shall be indicated therein. All titles, noting, markings and writings on the drawing shall be in English. All the dimensions should be in metric units.

After the approval of the drawings, further work by the bidder shall be in strict accordance with these drawings and no deviation shall be permitted without the written approval of the Purchaser, if so required.

The review of these document/data/drawings by the purchaser will cover only general conformance of the document/data/drawings to the specification and contract, interfaces with the equipment provided under specification, external connections and of the dimensions which might affect plan layout. This review by the purchaser may not indicate a thorough review of the dimensions, quantities and details of the equipment, material, any devices or items indicated or the accuracy of the information submitted. The review and/or approval by the purchaser shall not be considered by the bidder, as limiting any of his responsibilities and liabilities for mistakes and deviations from the requirements, specified under these specifications and documents.

All manufacturing, fabrication and execution of work in connection with the equipment/system prior to the approval of the drawings shall be at the bidder's risk. The bidder is expected not to make any changes in the design of the equipment /system, once they are approved by the Purchaser. However, if some changes are necessitated in the design of the equipment/system at a later date, the bidder may do so, but such changes shall promptly be brought to the notice of the Purchaser indicating the reasons for the change and get the revised drawing approved again in strict conformance to the provisions of the Technical Specification. Approval of bidder's drawing or work by the Purchaser shall not relieve the bidder of any of his responsibilities and liabilities under the Contract.

All engineering data submitted by the contractor after final process including review and approval by the purchaser shall form part of the contract document and the entire work performed under these specifications shall be performed in strict conformity with technical specification, unless otherwise expressly requested by the purchaser in writing.

3.5.2 Bidder's Drawing Submission and Approval Procedure

The following procedure for submission and review/approval of the drawings, data reports, information, etc. shall be followed by the bidder,

- All data/information furnished by Bidder/ vendor in the form of drawings, documents, Catalogues or in any other form for Customer/ Employer's information/interface and/or review and approval are referred by the general term "drawings".
- The 'Master drawings list' indicating titles, Drawing Number, Date of submission and approval etc. shall be furnished by the bidder. This list shall be updated if required at suitable interval during detailed engineering.
- All drawings (including those of sub-bidder/ vendor) shall bear at the right hand bottom corner the 'title plate' with all relevant information duly filled in. The bidder shall furnish this format to his sub-bidder/ vendor along with his purchase order for sub-bidder/ vendor's compliance.
- Contractor shall submit all the drawings in five (5) copies for review of Customer/ Employer. Customer/ Employer shall forward their comments within four (4) weeks of receipt of drawings.
- Upon review of each drawing, depending on the correctness and completeness of the drawings, the same will be categorised and approval accorded in one of the following categories:

CATEGORY I	Approved
CATEGORY II	Approved, subject to incorporation of comments/modification as noted. Resubmit revised drawing incorporating the

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	comments
CATEGORY III	Not approved. Resubmit revised drawings for Approval after incorporating comments/modifications as noted
CATEGORY IV	For information and records

- f. Bidder shall resubmit the drawings approved under Category II, III within one (1) week of receipt of comments on the drawings, incorporating all comments. Every revision of the drawing shall bear a revision index wherein such revisions shall be highlighted in the form of description or marked up in the drawing identifying the same with relevant revision number enclosed in a triangle (e.g 1.2.3. etc.).
- g. In case Bidder does not agree with any specific comment, he shall furnish the explanation for the same to Customer/ Employer for consideration. In all such cases Bidder shall necessarily enclose explanations along with the revised drawing (taking care of balance comments) to avoid any delay and/or duplication in review work.
- h. It is the responsibility of the Bidder to get all the drawings approved in the Category I or IV (as the case may be) and complete engineering activities within the agreed schedule. Any delay arising out of submission and modification of drawings shall not alter the contract completion schedule.
- i. Bidder shall not make any changes in the portions of the drawing other than those commented. If changes are required to be made in the portions already approved, the Bidder shall resubmit the drawings identifying the changes (along with reasons for changes) for Customer/ Employer's review and approval. **Drawings resubmitted shall show clearly the portions where the same are revised marking the relevant revision numbers and Customer/ Employer shall review only such revised portion of documents.**
- j. As Built Drawings

After final acceptance of individual equipment / system by the Customer/ Employer, the Bidder will update all original drawings and documents for the equipment / system to "as built" conditions and submit no. of copies as per clause 3.5.5.

- k. Approval of drawings will not in any way relieve the Bidder of his obligations of furnishing the equipment in accordance with the specification and shall not prevent subsequent rejection if such equipment is later found to be defective.

3.5.3 Erection Drawings

- a. Contractor shall furnish erection drawings for the guidance or commencement of erection or the first shipment, whichever is earlier. These shall generally comprise of fabrication/assembly drawings, various component/part details drawing, assembly, clearance data requirements, etc. The drawings shall contain details of components/ equipment with identification number, match marks, bill of materials, assembly procedures etc.
- b. For all major equipment apart from above details, assembly sequence and instructions with check-lists shall be furnished in the form of erection manuals.

3.5.4 Instruction Manual

- a. The Contractor shall submit to the Customer/ Employer preliminary instruction manuals for all the equipments for review. The final instructions manuals incorporating Customer/ Employer's comments and complete in all respect shall be submitted at least sixty (60) days before the first shipment of the equipment. The instruction manuals shall contain full details and drawings of all the equipments, the transportation, storage, installation, testing, commissioning, operation and maintenance procedures, etc. separately for each component/equipment along with log record format. These instruction manuals shall be submitted in five (5) copies for approval.

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- b. If after commissioning and initial operation of the plant, the instruction manuals require any modifications/additions/changes, the same shall be incorporated and the updated final instruction manuals shall be submitted.
 - c. The operating and maintenance instructions together with drawings (other than shop drawings) of the equipment, as completed, shall have sufficient details to enable the Customer/ Employer to maintain, dismantle, reassemble and adjust all parts of the equipment. They shall give a step by step procedure for all operations likely to be carried out during the life of the plant/equipment, including erection, testing, commissioning, operation, maintenance dismantling and repair. Each manual shall also include a complete set of approved drawings together with performance/rating curves of the equipment and test certificates, wherever applicable. The contract shall not be considered completed for purpose of taking over until such instructions and drawings have been supplied to the Customer/ Employer.
 - d. A separate section of the manual shall be for each size/type of equipment and shall contain a detailed description of construction and operation, together with all relevant pamphlets.
 - e. The manuals shall include the following
 - a) List of spare parts along with their drawing and catalogues and procedure for ordering spares.
 - b) Lubrication Schedule including charts showing lubrication checking, testing and replacement procedure to be carried daily, weekly, monthly & at longer intervals to ensure trouble free operation.
 - f. Where applicable, fault location charts shall be included to facilitate finding the cause of mal-operation or break down.
 - g. A collection of the manufacturer's standard leaflets will not accepted to be taken as a compliance of this clause. The manual shall be specifically compiled for the concerned project.

The Instruction Manuals shall comprise of the following:

3.5.4.1 Erection Manuals

The erection manuals shall be submitted atleast three (3) months prior to the commencement of erection activities of particular equipment/system. The erection manual should contain the following as a minimum.

- a) Erection strategy.
- b) Sequence of erection.
- c) Erection instructions.
- d) Critical checks and permissible deviation/tolerances.
- e) List of tools, tackles, heavy equipments like cranes, dozers, etc.
- f) Bill of Material
- g) Procedure for erection and General Safety procedures to followed during erection/installation.
- h) Procedure for initial checking after erection.
- i) Procedure for testing and acceptance norms.
- j) Procedure / Check list for pre-commissioning activities.
- k) Procedure / Check list for commissioning of the system.
- l) Safety precautions to be followed in electrical supply distribution during erection.

3.5.4.2 Operation and Maintenance Manuals

- a) The manual shall be a two rim PVC bound stiff sided binder able to withstand constant usage or where a thicker type is required it shall have locking steel pins, the size of the manual shall not be larger than international size A3. The cover shall be printed with the Project Name, Services covered and Volume / Book number Each section of the manual shall be divided by a stiff divider of the same size as the holder. The dividers shall clearly state the section number and title. All written

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instructions within the manual not provided by the manufacturers shall be typewritten with a margin on the left-hand side.

- b) The arrangement and contents of O & M manuals shall be as follows,
- 1) Chapter 1 - Plant Description: To contain the following sections specific to the equipment/system supplied,
 - (a) Description of operating principle of equipment / system with schematic drawing / layouts.
 - (b) Functional description of associated accessories / controls. Control interlock protection write up.
 - (c) Integrated operation of the equipment along-with the intended system. (This is to be given by the supplier of the Main equipment by taking into account the operating instruction given by the associated suppliers).
 - (d) Exploded view of the main equipment, associated accessories and auxiliaries with description. Schematic drawing of the equipment along-with its accessories and auxiliaries.
 - (e) Design data against which the plant performance will be compared.
 - (f) Master list of equipment, Technical specification of the equipment/ system and approved data sheets.
 - (g) Identification system adopted for the various components, (it will be of a simple process linked tagging system).
 - (h) Master list of drawings (as built drawing - Drawings to be enclosed in a separate volume).
 - 2) Chapter 2 - Plant Operation: To contain the following sections specific to the equipment supplied,
 - (a) Protection logics provided for the equipment along-with brief philosophy behind the logic, Drawings etc.
 - (b) Limiting values of all protection settings.
 - (c) Various settings of annunciation/interlocks provided.
 - (d) Start-up and shut down procedure for equipment along-with the associated systems in step mode.
 - (e) Do's and Don'ts related to operation of the equipment.
 - (f) Safety precautions to be taken during normal operation. Emergency instruction on total power failure condition/lubrication failure/any other conditions.
 - (g) Parameters to be monitored with normal value and limiting values.
 - (h) Equipment isolating procedures.
 - (i) Trouble shooting with causes and remedial measures.
 - (j) Routine testing procedure to ascertain healthiness of the safety devices along-with schedule of testing.
 - (k) Routine Operational Checks, Recommended Logs and Records
 - (l) Change over schedule if more than one auxiliary for the same purpose is given.
 - (m) Preservation procedure on long shut down.
 - (n) System/plant commissioning procedure.
 - 3) Chapter 3 - Plant Maintenance: To contain the following sections specific to the equipment supplied,
 - (a) Exploded view of each of the equipments. Drawings along-with bill of materials including name, code no. & population.

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- (b) Exploded view of the spare parts and critical components with dimensional drawings (In case of Electronic cards, the circuit diagram to be given) and spare parts catalogue for each equipment.
- (c) List of Special T/ P required for Overhauling /Trouble shooting including special testing equipment required for calibration etc.
- (d) Stepwise dismantling and assembly procedure clearly specifying the tools to be used, checks to be made, records to be maintained etc. Clearance to be maintained etc.
- (e) Preventive Maintenance schedules linked with running hours/calendar period along-with checks to be carried out.
- (f) Overhauling schedules linked with running hours/calendar period along-with checks to be done.
- (g) Long term maintenance schedules
- (h) Consumables list along-with the estimated quantity required during normal running and during maintenance like Preventive Maintenance and Overhauling.
- (i) List of lubricants with their Indian equivalent, Lubrication Schedule including charts showing lubrication checking, testing and replacement procedure to be carried daily, weekly, monthly & at longer intervals to ensure trouble free operation and quantity required for complete replacement.
- (j) Tolerance for fitment of various components.
- (k) Details of sub bidder/ vendors with their part no. in case of bought out items.
- (l) List of spare parts with their Part No, total population, life expediency & their interchangeability with already supplied spares to NTPC.
- (m) List of mandatory and recommended spare list along with manufacturing drawings, material specification & quality plan for fast moving consumable spares.
- (n) Lead time required for ordering of spares from the equipment supplier, instructions for storage and preservation of spares.
- (o) General information on the equipment such as modification carried out in the equipment from its inception, equipment population in the country / foreign country and list of utilities where similar equipments have been supplied.

After finalization and approval of the Customer/ Employer, the O & M Manuals shall be submitted as indicated in table below. The Contract shall not be considered to be completed for purposes of taking over until the final Instructions manuals (both erection and O & M manuals have been supplied to the Customer/ Employer.

If after the commissioning and initial operation of the plant, the instruction manuals (Erection and /or O & M manuals) require modifications/additions/ changes, the same shall be incorporated and the updated final instruction manuals shall be submitted by the Contractor to the Customer/ Employer for records and number of copies shall be as mentioned in table below:

Sl. No.	Description of Drawings/Documents	No. of Prints	No. of CD ROMs/DVDs/Portable Hard Disk/ Pen Drives
1	Erection Manual	4 Sets	2
2	Operation & Maintenance manual	1 Set	1
	i) First Submission		
	ii) Final Submission	4 Sets	2

3.5.5 Final Submission of drawings and documents:

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The Bidder shall furnish the following after approval of all drawings /documents and test reports:

- a. List of drawings bearing the Customer/ Employer's and Contractor's drawing number.
- b. Six (6) bound sets along-with two (2) sets of CD-ROMs/ DVD/Portable hard disk of all final drawings/documents.
- c. Bidder shall also furnish six (6) bound sets of all as-built drawings including the list of all as-built drawings bearing drawing numbers. The Contractor shall also furnish two (2) sets of CD-ROMs/ DVD/Portable hard disk of all as-built drawings as decided by the Customer/ Employer.
- d. The Bidder shall also furnish four (4) copies and two (2) sets of CD-ROMs/ DVD/Portable hard disk of instruction/ operations & maintenance manuals (after approval) for all the equipments.

3.5.6 TEST REPORTS

Two (2) copies of all test reports shall be supplied for approval before shipment of Equipment. The report shall indicate clearly the standard value specified for each test to facilitate checking of the reports. After final approval six (6) bound copies and two (2) sets of CD-ROMs/ DVD/Portable hard disk of all type and routine test reports shall be submitted to Customer/ Employer.

3.6 MATERIAL /WORKMANSHIP

Where the specification does not contain references to workmanship, equipment, materials and components of the covered equipment, it is essential that the same must be new, of highest grade of the best quality of their kind, conforming to best engineering practice and suitable for the purpose for which they are intended and shall ensure satisfactory performance throughout the service life.

In case where the equipment, materials or components are indicated in the specification as "similar" to any special standard the purchaser shall decide upon the question of similarity. When required by the specification or when required by the purchaser the contractor shall submit, for approval, all the information concerning the materials or components to be used in manufacture. Machinery, equipment, materials and components supplied, installed or used without such approval shall run the risk of subsequent rejection, it being understood that the cost as well as the time delay associated with the rejection shall be borne by the Contractor.

The design of the Works shall be such that installation, future expansions, replacements and general maintenance may be undertaken with a minimum of time and expenses. Each component shall be designed to be consistent with its duty and suitable factors of safety subject to mutual agreements. All joints and fastenings shall be devised, constructed and documented so that the component parts shall be accurately positioned and restrained to fulfill their required function. In general, screw threads shall be standard metric threads. The use of other thread forms will only be permitted when prior approval has been obtained from the Purchaser.

Whenever possible, all similar part of the works shall be made to gauge and shall also be made interchangeable with similar parts. All spare parts shall also be interchangeable and shall be made of the same materials and workmanship as the corresponding parts of the equipment supplied under the specification. Where feasible, common component units shall be employed in different pieces of equipment in order to minimize spare parts stocking requirements. All equipment of the same type and rating shall be physically and electrically interchangeable.

The equipment offered in the bid only shall be accepted for supply, with the minimum modifications as agreed/accepted.

3.7 PROVISIONS FOR EXPOSURE TO HOT AND HUMID CLIMATE

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Outdoor equipment supplied under the specification shall be suitable for service and storage under tropical conditions of high temperature, high humidity' heavy rainfall and environment favorable to the growth of fungi and mildew. The indoor equipment located in non-air-conditioned areas shall also be of same type.

SPACE HEATERS

The heaters shall be suitable for continuous operation at 240 V as supply voltage. On –off switch and fuse shall be provided.

One or more adequately rated thermostatically connected heaters shall be supplied to prevent condensation in any compartment. The heaters shall be installed in the compartment and electrical connections shall be made sufficiently away from below the heaters to minimize deterioration of supply wire insulation. The heaters shall be suitable to maintain the compartment temperature to prevent condensation.

The heaters shall be suitably designed to prevent any contact between the heater wire and the air and shall consist of coiled resistance wire centered in a metal sheath and completely encased in a highly compacted powder of magnesium oxide or other material having equal heat conducting and electrical insulation properties or they shall consist of resistance wire wound on a ceramic and completely covered with a ceramic material to prevent any contact between the wire and the air. Alternatively, they shall consist of a resistance wire mounted into a tubular ceramic body built into an envelope of stainless steel or the resistance wire is wound on a tubular ceramic body and embedded in vitreous glaze. The surface temperature of the heaters shall be restricted to a value which will not shorten the life of the heater sheaths or that of insulated wire or other component in the compartments.

Control cubicles installed in air-conditioned area need not be provided with space heaters. These cubicles shall, however, have space heaters in case of storage of cubicles for long duration.

FUNGI STATIC VARNISH

Besides the space heaters, special moisture and fungus resistance varnish shall be applied on parts which may be subjected or predisposed to the formation of fungi due to the presence or deposit of nutrient substances. The varnish shall not be applied to any surface of part where the treatment will interfere with the operation or performance of the equipment. Such surfaces or parts shall be protected against the application of the varnish.

Ventilation opening

In order to ensure adequate ventilation, compartments shall have ventilation openings provided with fine wire mesh of brass to prevent the entry of insects and to reduce to a minimum the entry of dirt and dust. Outdoor compartment openings shall be provided with shutter type blinds.

Degree of Protection

The enclosure of the Control Cabinets, Junction boxes and Marshalling Boxes, panels etc. to be installed shall provide degree of protection as detailed here under:

- a. Installed outdoor: IP- 55
- b. Installed indoor in air-conditioned area: IP-32
- c. Installed in covered area: IP-52
- d. Installed indoor in non-air-conditioned area where possibility of entry of water is limited: IP-41.
- e. For LT Switchgear (AC & DC distribution Boards): Indoor: IP-52, Outdoor: IP-54

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The degree of protection shall be in accordance with IS: 13947 (Part -I) / IEC-947 (Part-I) / IS 12063/IEC 529. Type test report for degree of protection test, on each type of the box shall be submitted for approval.

PRESERVATIVE SHOP COATING

All exposed metallic surfaces subject to corrosion shall be protected by shop application of suitable coatings. All surfaces which will not be easily accessible after the shop assembly, shall be treated beforehand and protected for the life of the equipment. All surfaces shall be thoroughly cleaned of all mill scales, oxides and other coatings and prepared in the shop. The surfaces that are to be finish-painted after installation or require corrosion protection until installation, shall be shop painted as per the requirements covered in the relevant part of the Technical Specification.

Transformers and other electrical equipments, if included shall be shop finished with one or more coats of primer and two coats of high-grade resistance enamel. The finished colors shall be as per manufacturer's standards, to be selected and specified by the Customer/ Employer at a later date.

Shop primer for all steel surfaces which will be exposed to operating temperature below 95 degrees Celsius shall be selected by the Bidder after obtaining specific approval of the Customer/ Employer regarding the quality of primer proposed to be applied. Special high temperature primer shall be used on surfaces exposed to temperature higher than 95 degrees Celsius and such primer shall also be subject to the approval of the Customer/ Employer.

3.8 RATING PLATES, NAME PLATES AND LABELS

- 3.8.1 Each equipment shall have permanently attached to it in a conspicuous position, a rating plate of non-corrosive material upon which shall be engraved manufacturer's name, equipment, type or serial number together with details of the ratings, service conditions under which the item of plant in question has been designed to operate, and such diagram plates as may be required by the Customer/ Employer.
- 3.8.2 Such nameplates or labels shall be of white non-hygroscopic material with engraved black lettering or alternately, in the case of indoor circuit breakers, starters, etc. of transparent plastic material with suitably coloured lettering engraved on the back.
- 3.8.3 Each equipment shall be provided with nameplate or label designating the service of the particular equipment. The inscriptions shall be approved by the Customer/ Employer or as detailed in appropriate section of the technical specifications.
- 3.8.4 The rated current, extended current rating and rated thermal current shall be clearly indicated in the name plate in case of current transformer.
- 3.8.5 Rated voltage, voltage factor and intermediate voltage shall be clearly indicated on the nameplate in case of capacitor voltage transformer.
- 3.8.6 Each switch shall have a clear inscription identifying its function. Switches shall also have a clear inscription of each position indication.
- 3.8.7 All such plates, instruction plates, etc. shall be bilingual with Hindi inscription first, followed by English. Alternatively, two separate plates one with Hindi and the other with English inscriptions may be provided.
- 3.8.8 All segregated phases of conductors or bus ducts, indoor or outdoor, shall be provided with coloured phase plates to clearly identify the phase of the system.

3.9 GALVANISING:

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- 3.9.1 All exposed ferrous parts shall be hot dip galvanised as per IS:2629 & IS:2633, Galvanising shall be uniform, clean, smooth continuous and free from acid spots. Should the galvanising of the sample be found defective, the entire batch of steel shall have to be re-galvanised at bidder's cost.
- 3.9.2 The amount of zinc deposit over threaded portion of the bolts, nuts and screws shall not be less than 300 gms. per sq. meter of surface area. The amount of zinc deposit on washers shall not be less than 340 gms. per sq. meter of surface area or a minimum of 30 microns. The threads shall have extra deposit of zinc which shall be removed by die cutting after the completion of galvanising. The removal of extra zinc shall be carefully done so that threads shall have the required deposits of zinc on them as specified.

3.10 PAINTING

Unless explicitly stated in relevant chapters of the specification, the painting of all electrical equipment shall be as follows:

Epoxy based with suitable additives. The thickness of finish coat shall be minimum 50 microns (minimum total DFT shall be 100 microns). However, in case electrostatic process of painting is offered for any electrical equipment, minimum paint thickness of 50 microns shall be acceptable for finish coat. Paint shade shall be as per technical specification.

3.11 QUALITY ASSURANCE PROGRAMME

- 3.11.1 The Bidder shall adopt suitable quality assurance programme to ensure that the equipment and services under the scope of contract whether manufactured or performed within the Bidder's works or at his subcontractor's premises or at the Customer/ Employer's site or at any other place of work are in accordance with the specifications. Such programmes shall be outlined by the Contractor and shall be finally accepted by the Customer/ Employer/authorised representative after discussions before the award of the contract. The QA programme shall be generally in line with ISO-9001/IS-14001.

A quality assurance programme of the contractor shall generally cover the following,

- i. His organisation structure for the management and implementation of the proposed quality assurance programme.
- ii. Quality System Manual
- iii. Design Control System
- iv. Documentation Data Control System
- v. Qualification data for Bidder's key Personnel.
- vi. The procedure for purchase of materials, parts, components and selection of subcontractor's services including bidder/ vendor analysis, source inspection, incoming raw-material inspection, verification of materials purchased etc.
- vii. System for shop manufacturing and site erection controls including process controls and fabrication and assembly controls.
- viii. Control of non-conforming items and system for corrective actions and resolution of deviations.
- ix. Inspection and test procedure both for manufacture and field activities.
- x. Control of calibration and testing of measuring testing equipments.
- xi. System for Quality Audits.
- xii. System for identification and appraisal of inspection status.
- xiii. System for authorising release of manufactured product to the Customer/ Employer.
- xiv. System for handling storage and delivery.

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- xv. System for maintenance of records, and
- xvi. Furnishing quality plans for manufacturing detailing out the specific quality control procedure adopted for controlling the quality characteristics relevant to each item of equipment/component as per format enclosed as Annexure-I.

3.12 GENERAL REQUIREMENTS - QUALITY ASSURANCE

- 3.12.1 All materials, components and equipment covered under this specification shall be procured, manufactured, erected, commissioned and tested at all the stages, as per a comprehensive Quality Assurance Programme. An indicative programme of inspection/tests to be carried out by the Bidder for some of the major items is given in the respective technical specification. This is, however, not intended to form a comprehensive programme as it is the Bidder's responsibility to draw up and implement such programme duly approved by the Customer/ Employer. The detailed Quality Plans for manufacturing and field activities should be drawn up by the Bidder and will be submitted to Customer/ Employer for approval.
- 3.12.2 Manufacturing Quality Plan will detail out for all the components and equipment, various tests/inspection, to be carried out as per the requirements of this specification and standards mentioned therein and quality practices and procedures followed by Bidder's/ Sub-contractor's/ sub-supplier's Quality Control Organisation, the relevant reference documents and standards, acceptance norms, inspection documents raised etc., during all stages of materials procurement, manufacture, assembly and final testing/performance testing. The Quality Plan shall be submitted on electronic media e.g. E-mail in addition to hard copy, for review. Once the same is finalised, hard copies shall be submitted for approval. After approval the same shall be submitted in compiled form on CD ROMs/ Pen drives.
- 3.12.3 The Bidder shall also furnish copies of the reference documents/plant standards/acceptance norms/tests and inspection procedure etc., as referred in Quality Plans along with Quality Plans. These Quality Plans and reference documents/standards etc. will be subject to Customer/ Employer's approval without which manufacturer shall not proceed.
- 3.12.4 These approved documents shall form a part of the contract. In these approved Quality Plans, Customer/ Employer shall identify customer hold points (CHP), i.e. test/checks which shall be carried out in presence of the Customer/ Employer's Project Manager or his authorised representative and beyond which the work will not proceed without consent of Customer/ Employer/Authorised representative in writing. All deviations to this specification, approved quality plans and applicable standards must be documented and referred to Customer/ Employer along with technical justification for approval and dispositioning.
- 3.12.5 No material shall be despatched from the manufacturer's works before the same is accepted subsequent to pre-despatch final inspection including verification of records of all previous tests/inspections by Customer/ Employer's Project Manager/Authorised representative and duly authorised for despatch by issuance of Material Dispatch Clearance Certificate (MDCC).
- 3.12.6 All material used for equipment manufacture including casting and forging etc. shall be of tested quality as per relevant codes/standards. Details of results of the tests conducted to determine the mechanical properties, chemical analysis and details of heat treatment procedure recommended and actually followed shall be recorded on certificates and time temperature chart. Tests shall be carried out as per applicable material standards and/or agreed details.
- 3.12.7 All welding and brazing shall be carried out as per procedure drawn and qualified in accordance with requirements of ASME Section IX/BS-4870 or other International equivalent standard acceptable to the Customer/ Employer.
- 3.12.8 All welding/brazing procedures shall be submitted to the Customer/ Employer or its authorised representative for approval prior to carrying out the welding/brazing.

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- 3.12.9 All brazers, welders and welding operators employed on any part of the contract either in Bidder's/his sub-contractor's works or at site or elsewhere shall be qualified as per ASME Section-IX or BS-4871 or other equivalent International Standards acceptable to the Customer/ Employer.
- 3.12.10 Test results or qualification tests and specimen testing shall be furnished to the Customer/ Employer for approval. However, where required by the Customer/ Employer, tests shall be conducted in presence of Customer/ Employer/authorised representative.
- 3.12.11 For all pressure parts and high-pressure piping welding, the latest applicable requirements of the IBR (Indian Boiler Regulations) shall also be essentially complied with. Similarly, any other statutory requirements for the equipments/systems shall also be complied with. On all back-gauged welds MPI/LPI shall be carried before seal welding.
- 3.12.12 All the heat treatment results shall be recorded on time temperature charts and verified with recommended regimes.
- 3.12.13 No welding shall be carried out on cast iron components for repair.
- 3.12.14 Unless otherwise proven and specifically agreed with the Customer/ Employer, welding of dissimilar materials and high alloy materials shall be carried out at shop only.
- 3.12.15 All non-destructive examination shall be performed in accordance with written procedures as per International Standards. The NDT operator shall be qualified as per SNT-TC-IA (of the American Society of non-destructive examination). NDT shall be recorded in a report which includes details of methods and equipment used, result/evaluation, job data and identification of personnel employed and details of co-relation of the test report with the job. In general all plates of thickness greater than 40mm & for pressure parts plates of thickness equal to or greater than 25mm shall be ultrasonically tested otherwise as specified in respective equipment specification. All bar stock/Forging of diameter equal to or greater than 40mm shall be ultrasonically tested.
- 3.12.16 The Bidder shall list out all major items/ equipment/ components to be manufactured in house as well as procured from sub-contractors (BOI). All the subcontractor proposed by the Contractor for procurement of major bought out items including castings, forging, semi-finished and finished components/equipment etc., list of which shall be drawn up by the Bidder and finalised with the Customer/ Employer, shall be subject to Customer/ Employer's approval. The Bidder's proposal shall include bidder/ vendor's facilities established at the respective works, the process capability, process stabilization, QC systems followed, experience list, etc. along with his own technical evaluation for identified subcontractors enclosed and shall be submitted to the Customer/ Employer for approval within the period agreed at the time of pre-awards discussion and identified in "DR" category prior to any procurement. Such bidder/ vendor approval shall not relieve the Bidder from any obligation, duty or responsibility under the contract.
- 3.12.17 For components/equipment procured by the Bidders for the purpose of the contract, after obtaining the written approval of the Customer/ Employer, the Bidder's purchase specifications and inquiries shall call for quality plans to be submitted by the suppliers. The quality plans called for from the subcontractor shall set out, during the various stages of manufacture and installation, the quality practices and procedures followed by the bidder/ vendor's quality control organisation, the relevant reference documents/standards used, acceptance level, inspection of documentation raised, etc.
- 3.12.18 Customer/ Employer reserves the right to carry out quality audit and quality surveillance of the systems and procedures of the Bidder's or their sub-contractor's quality management and control activities. The Bidder shall provide all necessary assistance to enable the Customer/ Employer carry out such audit and surveillance.
- 3.12.19 The Bidder shall carry out an inspection and testing programme during manufacture in his work and that of his sub-contractor's and at site to ensure the mechanical accuracy of components, compliance with drawings, conformance to functional and performance requirements, identity and acceptability of all materials parts and equipment. Bidder shall carry out all tests/inspection required to establish that the items/equipments conform to requirements of the specification and
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the relevant codes/standards specified in the specification, in addition to carrying out tests as per the approved quality plan.

- 3.12.20 Quality audit/surveillance/approval of the results of the tests and inspection will not, however, prejudice the right of the Customer/ Employer to reject the equipment if it does not comply with the specification when erected or does not give complete satisfaction in service and the above shall in no way limit the liabilities and responsibilities of the Bidder in ensuring complete conformance of the materials/equipment supplied to relevant specification, standard, data sheets, drawings, etc.
- 3.12.21 For all spares and replacement items, the quality requirements as agreed for the main equipment supply shall be applicable.
- 3.12.22 Repair/rectification procedures to be adopted to make the job acceptable shall be subject to the approval of the Customer/ Employer/ authorised representative.
- 3.12.23 Environmental Stress Screening

All solid-state electronic system / equipment / sub assembly shall be free from infant mortile components. For establishing the compliance to this requirement, the Bidder / sub – contractor should meet the following.

1. The Bidder / Sub – contractor shall furnish the established procedure being followed for eliminating infant mortile components. The procedure followed by the Contractor / Sub – contractor should be substantiated along with the statistical figures to validate the procedure being followed. The necessary details as required under this clause shall be furnished at the stage of QP finalization.

Or

In case the Bidder / Sub – contractor do not have any established procedure to eliminate infant mortile components then two or 10% whichever is less, most densely populated Panels shall be tested for Elevated Temperature Cycle Test as per the following procedure.

Elevated Temperature Test Cycle

During the elevated temperature test which shall be for 48 hours, the ambient temperature shall be maintained at 50° C. The equipment shall be interconnected with devices and kept under energized conditions so as to repeatedly perform all operations it is expected to perform in actual service with load on various components being equal to those which will be experienced in actual service.

During the elevated temperature test the cubicle doors shall be closed (or shall be in the position same as they are supposed to be in the field) and inside temperature in the zone of highest heat dissipating components / modules shall be monitored. The temperature rise inside the cubicle should not exceed 10° C above the ambient temperature at 50° C.

In case of any failure during the test cycle, the further course of action should be mutually discussed for demonstrating the intent of the above requirement.

Burn In Test Cycle

The test shall be conducted on all the panels fully assembled and wired including the panels having undergone the above-mentioned elevated temperature test.

The period of Burn in Test Cycle shall be 120 hrs and process shall be similar to the elevated temperature test as above except that the temperature shall be reduced to the ambient temperature prevalent at that time.

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During the above tests, the process I/O and other load on the system shall be simulated by simulated inputs and in the case of control systems, the process which is to be controlled shall also be simulated. Testing of individual components or modules shall not be acceptable.

During the Burn in Test the cubicle doors shall be closed (or shall be in the position same as they are supposed to be in the field) and inside temperature in the zone of highest heat dissipating components / modules shall be monitored. The temperature rise inside the cubicle should not exceed 10° C above the ambient temperature.

The Bidder / Sub-contractor shall carry out routine test on 100% item at Bidder's / sub-contractor's works. The quantum of check / test for routine & acceptance test by Customer/ Employer shall be generally as per criteria / sampling plan defined in referred standards. Wherever standards have not been mentioned quantum of check / test for routine / acceptance test shall be as agreed during detailed engineering stage.

3.13 QUALITY ASSURANCE DOCUMENTS

The Contractor/ bidder shall be required to submit two hard copies and two sets on CDROMs/ pen drive of the following Quality Assurance Documents as identified in respective quality plan with tick (√) mark.

Each QA Documentation shall have a project specific Cover Sheet bearing name & identification number of equipment and including an index of its contents with page control on each document.

The QA Documentation file shall be progressively completed by the Supplier's sub-supplier to allow regular reviews by all parties during the manufacturing.

The final quality document will be compiled and issued at the final assembly place of equipment before despatch. However, soft copies will be furnished not later than two (2) weeks.

3.13.1 Typical contents of Quality Assurance Document are as below: -

- a) Quality Plan,
- b) Material mill test reports on components as specified by the specification and approved Quality Plans.
- c) Manufacturer / works test reports/results for testing required as per applicable codes and standard referred in the specification and approved Quality Plans.
- d) Non-destructive examination results /reports including radiography interpretation reports. Sketches/drawings used for indicating the method of traceability of the radiographs to the location on the equipment.
- e) Heat Treatment Certificate/Record (Time- temperature Chart)
- f) All the accepted Non-conformance Reports (Major/Minor) / deviation, including complete technical details / repair procedure).
- g) CHP / Inspection reports duly signed by the Inspector of the Customer/ Employer and Contractor for the agreed Customer Hold Points.
- h) Certificate of Conformance (COC) whoever applicable.
- i) MDCC

3.13.2 Before dispatch/ commissioning of any equipment, the Supplier shall make sure that the corresponding quality document or in the case of protracted phased deliveries, the applicable

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section of the quality document file is completed. The supplier will then notify the Inspector regarding the readiness of the quality document (or applicable section) for review.

- i) If the result of the review carried out by the Inspector of the Quality document (or applicable section) is satisfactory, the Inspector shall stamp the quality document (or applicable section) for release.
- ii) If the quality document is unsatisfactory, the Supplier shall endeavour to correct the incompleteness, thus allowing to finalize the quality document (or applicable section) by time compatible with the requirements as per contract documents. When it is done, the quality document (or applicable section) is stamped by the Inspector.
- iii) If a decision is made for dispatch, whereas all outstanding actions cannot be readily cleared for the release of the quality document by that time, the supplier shall immediately, upon shipment of the equipment, send a copy of the quality document Review Status signed by the Supplier Representative to the Inspector and notify of the committed date for the completion of all outstanding actions & submission. The Inspector shall stamp the quality document for applicable section when it is effectively completed. The submission of QA documentation package shall not be later than 3 weeks after the dispatch of equipment.

3.14 TRANSMISSION OF QUALITY DOCUMENTS

As a general rule, two hard copies of the quality document and Two CD ROMs/ Pen drive shall be issued to the Customer/ Employer on release of QA Documentation by Inspector. One set of quality document shall be forwarded to Corporate Quality Assurance Department and other set to respective Site.

For the particular case of phased deliveries, the complete quality document to the Customer/ Employer shall be issued not later than 3 weeks after the date of the last delivery similarly as stated above.

3.15 INSPECTION, TESTING & INSPECTION CERTIFICATE

- 3.15.1 The word 'Inspector' shall mean the Project Manager and/or his authorised representative and/or an outside inspection agency acting on behalf of the Customer/ Employer to inspect and examine the materials and workmanship of the works during its manufacture or erection.
- 3.15.2 The Project Manager or his duly authorised representative and/or an outside inspection agency acting on behalf of the Customer/ Employer shall have access at all reasonable times to inspect and examine the materials and workmanship of the works during its manufacture or erection and if part of the works is being manufactured or assembled on other premises or works, the Bidder shall obtain for the Project Manager and for his duly authorised representative permission to inspect as if the works were manufactured or assembled on the Bidder's own premises or works.
- 3.15.3 The Bidder shall give the Project Manager/Inspector fifteen (15) days written notice of any material being ready for testing. Such tests shall be to the Bidder's account except for the expenses of the Inspector's. The Project Manager/Inspector, unless the witnessing of the tests is virtually waived and confirmed in writing, will attend such tests within fifteen (15) days of the date on which the equipment is noticed as being ready for test/inspection failing which the Bidder may proceed with test which shall be deemed to have been made in the inspector's presence and he shall forthwith forward to the inspector duly certified copies of test reports in two (2) copies.
- 3.15.4 The Project Manager or Inspector shall within fifteen (15) days from the date of inspection as defined herein give notice in writing to the Bidder, or any objection to any drawings and all or any equipment and workmanship which is in his opinion not in accordance with the contract. The

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Bidder shall give due consideration to such objections and shall either make modifications that may be necessary to meet the said objections or shall inform in writing to the Project Manager/Inspector giving reasons therein, that no modifications are necessary to comply with the contract.

- 3.15.5 When the factory tests have been completed at the Bidder's or subcontractor's works, the Project Manager /Inspector shall issue a certificate to this effect fifteen (15) days after completion of tests but if the tests are not witnessed by the Project Manager /Inspectors, the certificate shall be issued within fifteen (15) days of the receipt of the Contractor's test certificate by the Project Manager /Inspector. Project Manager /Inspector to issue such a certificate shall not prevent the Bidder from proceeding with the works. The completion of these tests or the issue of the certificates shall not bind the Customer/ Employer to accept the equipment should it, on further tests after erection be found not to comply with the contract.
- 3.15.6 In all cases where the contract provides for tests whether at the premises or works of the Bidder or any sub-contractor, the Bidder, except where otherwise specified shall provide free of charge such items as labour, material, electricity, fuel, water, stores, apparatus and instruments as may be reasonably demanded by the Project Manager /Inspector or his authorised representatives to carry out effectively such tests on the equipment in accordance with the Bidder and shall give facilities to the Project Manager/Inspector or to his authorised representative to accomplish testing.
- 3.15.7 The inspection by Project Manager / Inspector and issue of Inspection Certificate thereon shall in no way limit the liabilities and responsibilities of the Contractor in respect of the agreed Quality Assurance Programme forming a part of the contract.
- 3.15.8 To facilitate advance planning of inspection in addition to giving inspection notice, the Bidder shall furnish quarterly inspection programme indicating schedule dates of inspection at Customer Hold Point and final inspection stages. Updated quarterly inspection plans will be made for each three consecutive months and shall be furnished before beginning of each calendar month.
- 3.15.9 All inspection, measuring and test equipments used by contractor shall be calibrated periodically depending on its use and criticality of the test/measurement to be done. The Bidder shall maintain all the relevant records of periodic calibration and instrument identification, and shall produce the same for inspection by NTPC. Wherever asked specifically, the contractor shall re-calibrate the measuring/test equipments in the presence of Project Manager / Inspector.

3.16 PACKAGING & TRANSPORTATION

All the equipments shall be suitably protected, coated, covered or boxed and crated to prevent damage or deterioration during transit, handling and storage at Site till the time of erection. While packing all the materials, the limitation from the point of view of the sizes of railway wagons available in India should be taken account of. The Bidder shall be responsible for any loss or damage during transportation, handling and storage due to improper packing. The Bidder shall ascertain the availability of Railway wagon sizes from the Indian Railways or any other agency concerned in India well before effecting despatch of equipment. Before despatch it shall be ensured that complete processing and manufacturing of the components is carried out at shop, only restricted by transport limitation, in order to ensure that site works like grinding, welding, cutting & preassembly to bare minimum. The Customer/ Employer's Inspector shall have right to insist for completion of works in shops before despatch of materials for transportation.

Bidder shall ensure to affix RFID tags/Trackers on the item & punch the same before dispatch with RFID reader/BLE beacon & enter details of item associating with RFID tag no./Tracker no. For low value items QR code-based solution shall also be acceptable. Exact selection of type of tagging based on type & size of equipment/consignment/package will be decided during detail engineering.

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Bidder to provide RFID tags/Trackers/QR code for all items being supplied to the Contractor under the contract of this project.

- a) Each item identifiable with KKS / PGMA-DU / other identification scheme of the bidder/OEM/OES shall have a RFID/QR.
- b) Even if the BOQ is identified in tonnage/ cumulative of multiple items, unique identification shall be provided for each item as mentioned above (Eg – GIS Duct, Gis bay module, Panels etc., however each sub item shall have its own RFID/equivalent).
- c) For items which are interchangeable and dispatched together (eg Foundation bolts in a box / Identical beams in a single consignment), the entire consignment can be tagged with a single RFID if the software system has the capability to track partial consumption (eg 100 bolts consumed from a package of 1000 bolts) from a consignment.

3.17 CLAMPS AND CONNECTORS INCLUDING TERMINAL CONNECTORS

- 3.17.1 The material of clamps and connectors shall be Aluminium alloy casting conforming to designation A6 of IS:617 for connecting to equipment terminals and conductors of aluminium. In case the terminals are of copper, the same clamps/connectors shall be used with 2mm thick bimetallic liner.
- 3.17.2 The material of clamps and connectors shall be Galvanised mild steel for connecting to G.S.shield wire.
- 3.17.3 Bolts, nuts and plain washers shall be hot dip galvanised mild steel for sizes M12 and above. For sizes below M12, they shall be electro-galvanised mild steel. The spring washers shall be electro-galvanised mild steel.
- 3.17.4 All castings shall be free from blow holes, surface blisters, cracks and cavities. All sharp edges and corners shall be rounded off to meet specified corona and radio interference requirements.
- 3.17.5 They shall have same current rating as that of the connected equipment. All current carrying parts shall be at least 10 mm thick. The connectors shall be manufactured to have minimum contact resistance.
- 3.17.6 Flexible connectors, braids or laminated strips shall be made up of copper/aluminium.
- 3.17.7 Current rating and size of terminal/conductor for which connector is suitable shall be put on a suitable sticker on each component which should last atleast till erection time.

3.18 SPACERS

- 3.18.1 Spacers shall conform to IS: 10162. They shall be of non-magnetic material except nuts and bolts, which shall be of hot dip galvanised mild steel.
- 3.18.2 Spacers shall generally meet the requirements of clamps and connectors as specified above. Its design shall take care of fixing and removing during installation and maintenance.
- 3.18.3 In addition to the type tests as per IS: 10162, clamp slip test should have been conducted. In this test the sample shall be installed on test span of twin/quad bundle string at a tension of 44.2kN (4500 kg). One of the clamps when subjected to a longitudinal pull of 2.5kN (250 kg) parallel to the axis of conductor shall not slip, i.e. permanent displacement between conductor and clamp after test shall not exceed 1.0 mm. This test should have been performed on all other clamps of the sample.

3.19 BUSHINGS, HOLLOW COLUMN INSULATORS, SUPPORT INSULATORS, AND DISC INSULATORS

- 3.19.1 Bushings shall be manufactured and tested in accordance with IS: 2099 & IEC: 60137 while hollow column insulators shall be manufactured and tested in accordance with IEC62155/IS 5284. The support insulators shall be manufactured and tested as per IS: 2544/IEC 60168/IEC

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60273. The insulators shall also conform to IEC 60815 as applicable having alternate long and short sheds.

Support insulators/ bushings/ hollow column insulators shall be designed to have ample insulation, mechanical strength and rigidity for the conditions under which they will be used.

3.19.2 Porcelain used shall be homogenous, free from laminations, cavities and other flaws or imperfections that might affect the mechanical or dielectric quality and shall be thoroughly vitrified, tough and impervious to moisture.

3.19.3 Glazing of the porcelain shall be uniform brown in colour, free from blisters, burns and other similar defects.

3.19.4 The design of the insulator shall be such that stresses due to expansion and contraction in any part of the insulator shall be lead to deterioration. All ferrous parts shall be hot dip galvanised.

3.19.5 Post type insulators shall consist of a porcelain/polymer part permanently secured in metal base to be mounted on supporting structures. They shall be capable of being mounted upright. They shall be designed to withstand all shocks to which they may be subjected to during operation of the associated equipment.

3.19.6 Bushing porcelain shall be robust and capable of withstanding the internal pressures likely to occur in service. The design and location of clamps, the shape and the strength of the porcelain flange securing the bushing to the tank shall be such that there is no risk of fracture. All portions of the assembled porcelain enclosures and supports other than gaskets, which may in any way be exposed to the atmosphere shall be composed of completely non hygroscopic material such as metal or glazed porcelain.

3.19.7 All iron parts shall be hot dip galvanised and all joints shall be air tight. Surface of joints shall be trued, porcelain parts by grinding and metal parts by machining. Insulator/ bushing design shall be such as to ensure a uniform compressive pressure on the joints.

3.19.8 In accordance with the requirement stipulated elsewhere, bushing, hollow column insulators and support insulators shall conform to type tests and shall be subjected to routine tests and acceptance test/sample test in accordance with relevant standards.

3.20 CONTROL CABINETS, JUNCTION BOXES, TERMINAL BOXES & MARSHALLING BOXES FOR OUTDOOR EQUIPMENT

3.20.1 All types of control cabinets, junction boxes, marshalling boxes, lighting panels, terminal boxes, operating mechanism boxes, Kiosks etc. shall generally conform to IS:5039, IS:8623 and IEC:60439 as applicable.

3.20.2 They shall be of Stainless steel or Aluminium. The thickness of Stainless steel shall be minimum 1 mm. The thickness of aluminium shall be minimum 3 mm and shall provide rigidity. Top of the boxes shall be sloped towards the rear of the box.

3.20.3 BAY MARSHALLING BOX

Bay Marshalling Box located at a convenient location to receive and distribute cables shall be provided as required. It shall meet all the requirements as specified for cabinets/boxes.

It shall have three separate distinct compartments for following purposes:

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- To receive two incoming 415V, three phase, AC supplies controlled by 100A four pole MCBs with auto changeover provision, and to distribute five (5) three phase ac supplies controlled by 32A four pole MCBs. It shall also be provided with 63A, 3 phase 4 pin industrial grade receptacle with rotary switch.
 - To receive three phase incoming from first compartment and to distribute ten (10) single phase ac supplies controlled by 16A two pole MCBs.
 - 150 nos. terminal blocks in vertical formation for interlocking facility.

3.20.4 AUXILIARY SWITCH**The auxiliary switch shall conform of following type tests:**

- a) Electrical endurance test - A minimum of 1000 operations for 2A. D.C. with a time constant greater than or equal to 20 milliseconds with a subsequent examination of mV drop/ visual defects/ temperature rise test.
- b) Mechanical endurance test - A minimum of 5000 operations with a subsequent checking of contact pressure test/ visual examination
- c) Heat run test on contacts
- d) IR/HV test, etc.

3.21 CABLE GLANDS AND LUGS/FERRULES

- 3.21.1 Cable shall be terminated using double compression type cable glands. Testing requirements of Cable glands shall conform to BS:6121 and gland shall be of robust construction capable of clamping cable and cable armour (for armoured cables) firmly without injury to insulation. Cable glands shall be made of heavy-duty brass machine finished and nickel chrome plated. Thickness of plating shall not be less than 10 microns. All washers and hardware shall also be made of brass with nickel chrome plating Rubber components shall be of neoprene or better synthetic material and of tested quality. Cable glands shall be suitable for the sizes of cable supplied/erected.
- 3.21.2 The cable glands shall be tested as per BS:6121. The cable glands shall also be duly tested for dust proof and weather proof termination.
- 3.21.3 Cable lugs/ferrules for power cables shall be tinned copper solderless crimping type suitable for aluminium compacted conductor cables. Cable lugs and ferrules for control cables shall be tinned copper type. The cable lugs for control cables shall be provided with insulating sleeve and shall suit the type of terminals provided on the equipments. Cable lugs and ferrule shall conform to DIN standards.
- 3.21.4 Cables lugs shall be tinned copper solder less crimping type conforming to IS:8309 and 8394 suitable for aluminum or copper conductor (as applicable). The cable lugs shall suit the type of terminals provided. The cable lugs shall be of Dowell make or equivalent.

3.22 CONDUITS, PIPES AND ACCESSORIES

- 3.22.1 The bidder shall supply and install all rigid conduits, mild steel pipes, flexible conduits, hume pipes, etc. including all necessary sundry materials, such as tees, elbows, check nuts, bushing reduces, enlargers, wooden plugs, coupling caps, nipples, gland sealing fittings, pull boxes, etc.
- 3.22.2 The size of the conduit/pipe shall be selected to limit the fill to a maximum of 40%. All conduits/pipes shall have their ends closed by caps until cables are pulled. After cables are

Bharat Heavy Electricals Limited**Project:** 400kV GIS Switchyard at Singrauli Super Thermal Power Project Stage- III (2x800MW)**Customer:** NTPC Ltd.**Technical Specification:** 400kV Gas Insulated Switchgear & its accessories**Doc No.** TB-429-316-001 Rev 00

pulled, the ends of conduits/pipes shall be sealed in an approved manner to prevent damage to threaded portions and entrance of moisture and foreign materials.

- 3.22.3 PVC conduits shall be of high impact, heavy gauge (at least class 2) conduit conforming to BS-4607.
- 3.22.4 The outer surface of the steel conduits shall be coated with hot-dip zinc and chromate conversion coatings. The inner surface shall have silicone epoxy ester coating for easy cable pulling. Mild steel pipes shall be hot-dip galvanized. All rigid conduits/pipes shall be of a reputed make.
- 3.22.5 The hume pipes and accessories shall be of reinforced concrete conforming to class NP2 of IS-458. All tests on hume pipes shall be conducted as per IS-458.
- 3.22.6 Rigid conduits shall be flow-coat metal conduits. The outer surface of the conduits shall be coated with hot-dip zinc and chromate conversion coatings. The inner surface shall have silicone epoxy ester coating for easy cable pulling. Mild steel pipes shall be hot-dip galvanized. All rigid conduits/ pipes shall be of a reputed make.
- 3.22.7 Flexible conduits shall be heat-resistant lead coated steel, water-leak, fire and rust proof, and be of PLICA make or equivalent.

3.23 MOTORS

The voltage level for motors shall be as follows:

- | | |
|----------------------------------|--|
| a) Upto 0.2 KW | : Single phase 240V AC / 3 phase 415V AC |
| b) Above 0.2 KW and upto 200 KW | : 3 phase, 415V AC |
| c) Above 200 KW and upto 1500 KW | : 3 phase, 3.3 kV AC |
| d) Above 1500 KW | : 11 kV |

The bidder may adopt 415V/3.3 KV for the drives rated in the range of 160-210 KW.

The voltage rating of the drives indicated above is for basic guideline.

- 3.23.1 All motors shall conform to IEC-60034-5 / IS Standard and with principal dimensions in accordance with IEC 60072-1 (1991), IEC 60072-2 (1990) and IEC 60072-3 (1994).
- 3.23.2 All equipment shall be suitable for rated frequency of 50 Hz with a variation of +3% & -5%, and 10% combined variation of voltage and frequency unless specifically brought out in the specification
- 3.23.3 Paint shade shall be as per RAL 5012 (Blue) for indoor and outdoor equipment.
- 3.23.4 Degree of Protection

Degree of protection for various enclosures as per IEC60034-05 shall be as follows:

Indoor motors - IP 55

Outdoor motors - IP 55 (additional canopy to be provided)

Cable box-indoor area - IP 55

Cable box-Outdoor area - IP 55

3.23.5 Type:**AC Motors:**

- a) Squirrel cage induction motor suitable for direct-on-line starting.
- b) Continuous duty LT motors upto 200 KW Output rating (at 50 deg.C ambient temperature), shall be Premium Efficiency class-IE3, conforming to IS 12615, or IEC:60034-30.
- c) Crane duty motors shall be squirrel cage Induction motor as per the requirement.

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- d) Motor operating through variable frequency drives shall be suitable for inverter duty. Also these motors shall comply the requirements stipulated in IEC: 60034-18-41 and IEC: 60034-18-42 as applicable.

DC Motors Shunt wound

3.24 AUXILIARY SWITCH

The auxiliary switch shall conform of following type tests:

- a) Electrical endurance test - A minimum of 1000 operations for 2A. D.C. with a time constant greater than or equal to 20 milliseconds with a subsequent examination of mV drop/ visual defects/ temperature rise test.
- b) Mechanical endurance test - A minimum of 5000 operations with a subsequent checking of contact pressure test/ visual examination
- c) Heat run test on contacts
- d) IR/HV test, etc.

3.25 LAMPS AND SOCKETS**3.25.1 Lamps:**

All incandescent lamps shall use a socket base as per IS-1258, except in the case of signal lamps.

3.25.2 Sockets

All sockets (convenience outlets) shall be suitable to accept both 5 Amp & 15 Amp pin round Standard Indian plugs. They shall be switched sockets with shutters.

3.25.3 Hand Lamp:

A 240 Volts, single Phase, 50 Hz AC plug point shall be provided in the interior of each cubicle with ON-OFF Switch for connection of hand lamps.

3.26 SWITCHES AND FUSES

Each control panel shall be provided with necessary arrangements for receiving, distributing, isolating and fusing of DC and AC supplies for various control, signaling, lighting and space heater circuits. The incoming and sub-circuits shall be separately provided with switch-fuse units. Selection of the main and sub-circuit fuse ratings shall be such as to ensure selective clearance of sub-circuit faults. Potential circuits for relaying and metering shall be protected by HRC fuses.

All fuses shall be of HRC cartridge type conforming to IS 9228 mounted on plug-in type fuse bases. Miniature circuit breakers with thermal Protection and alarm contacts will also be accepted. All accessible live connection to fuse bases shall be adequately shrouded. Fuses shall have operation indicators for indicating blown fuse condition. Fuse carrier base shall have imprints of the fuse rating and voltage.

All control switches shall be of rotary type. Toggle/piano switches shall not be accepted.

3.27 TYPE, ROUTINE & ACCEPTANCE TESTS:**3.10.1 TYPE TEST REQUIREMENTS FOR EQUIPMENTS OTHER THAN GIS**

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- a) All equipments to be supplied shall be of type tested design. During detail engineering, the contractor shall submit for Owner's approval the reports of all the type tests as listed in this specification. The validity period of reports shall be as per CEA Guidelines for the validity period of Type test(s) conducted on Major Electrical Equipment in power Transmission-May2020 & with latest amendments for the from the date of bid opening. These reports should be for the test conducted on the equipment similar to those proposed to be supplied under this contract and the test(s) should have been either conducted at an independent laboratory or should have been witnessed by a Client.
- b) However if contractor is not able to submit report of the type test(s) conducted as per CEA Guidelines for the validity period of Type test(s) conducted on Major Electrical equipment in power Transmission-May2020 & with latest amendments from the date of bid opening, or in the case of type test report(s) are not found to be meeting the specification requirements, the contractor shall conduct all such tests under this contract at no additional cost to the owner either at third party lab or in presence of client/ owners representative and submit the reports for approval.
- c) All acceptance and routine tests as per the specification and relevant standards shall be carried out. Charges for these shall be deemed to be included in the equipment price.

3.11 CORONA AND RIV TESTS AND SEISMIC WITHSTAND TEST:

- a) The corona and RIV tests shall confirm to the requirements as per Annexure A.
- b) The seismic withstand test for shall conform to requirements as per Annexure B.

3.12 Enclosures:

1. ANNEXURE- A: CORONA AND RADIO INTERFERENCE VOLTAGE (RIV) TEST
2. ANNEXURE- B: SEISMIC WITHSTAND TEST
3. ANNEXURE- I: MQP (NTPC format)
4. ANNEXURE- II: QUALITY ASSURANCE FOR SWITCHYARD

Bharat Heavy Electricals Limited**Project:** 400kV GIS Switchyard at Singrauli Super Thermal Power Project Stage- III (2x800MW)**Customer:** NTPC Ltd.**Technical Specification:** 400kV Gas Insulated Switchgear & its accessories**Doc No.** TB-429-316-001 Rev 00**ANNEXURE – A: CORONA AND RADIO INTERFERENCE VOLTAGE (RIV) TEST****1.0 General**

Unless otherwise stipulated, all equipment together with its associated connectors where applicable shall be tested for external corona both by observing the voltage level for the extinction of visible corona under falling power frequency voltage and measurement of radio interference voltage (RIV).

2.0 Test Levels

The test voltage levels for measurement of external RIV and for corona extinction voltage are listed under the relevant clauses of the specification.

3.0 Test Methods for RIV (400kV):

3.1 RIV tests shall be made according to measuring circuit as per International Special committee on Radio Interference (CISPR) Publication 16 -1 (1993) Part – I. The measuring circuit shall preferably be tuned to frequency with 10 % of 0.5 MHz but other frequencies in the range of 0.5 MHz to 2 MHz may be used, the measuring frequency being recorded. The result shall be in microvolts.

3.2 Alternatively, RIV tests shall be in accordance with NEMA standard Publication No. 107 – 1964 except otherwise noted herein.

3.3 In measurement of RIV temporary additional external corona shielding may be provided. In measurement of RIV only standard fittings of identical type supplied with the equipment and a simulation of the connections as used in the actual installation will be permitted in the vicinity within 3.5 meters of terminals.

3.4 Ambient noise shall be measured before and after each series of tests to ensure that there is no variation in ambient noise level. If variation is present, the lowest ambient noise level will form basis for the measurements. RIV levels shall be measured at increasing and decreasing voltages of 85%, 100%, 115% and 130% for the specified RIV test voltage for all equipment unless otherwise specified. The specified RIV test voltage for 420kV is listed in the detailed specification together with maximum permissible RIV level in microvolts.

3.5 The metering instruments shall be as per CISPR recommendations or equivalent device so long as it has been used by other testing authorities.

3.6 The RIV measurement may be made with a noise meter. A calibration procedure of the frequency to which noise meter shall be tuned shall establish the ratio of voltage at the high voltage terminal to the voltage read by the noise meter.

4.0 Test Methods for visible Corona (400kV AIS only)

The purpose of this test is to determine the corona extinction voltage of the apparatus, connectors etc. The test shall be carried out in the same manner as RIV test described above with the exception that RIV measurements are not required during test and a search technique shall be used near the onset and extinction voltage, when the test voltage is raised and lowered to determine their precise values. The test voltage shall be raised to 130 % of RIV test voltage and maintained there for five

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minutes. In case corona inception does not take place at 130 %, the voltage level shall be raised till inception of corona or rated voltage whichever is lower. The voltage will then be decreased slowly until all visible corona disappears. The test procedure shall be repeated at least 4 times with corona inception and extinction voltage recorded each time. The corona extinction voltage for purposes of determining compliance with the specification shall be the lowest of the four values at which the visible corona (negative or positive polarity) disappears.

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ANNEXURE – B: SEISMIC WITHSTAND TEST (400kV AIS only)

- a.) The seismic withstand test on the complete equipment (except BPI) shall be carried out along with supporting structure.
- b.) The supplier shall arrange to transport the structure from his purchaser's premises / owner's sites for purpose of seismic withstand test only.
- c.) The seismic level specified shall be applied at the base of the structure. The accelerometers shall be provided at the terminal pad of the equipment and at any other point as agreed by the owner. The seismic test shall be carried out in all possible combinations of the equipment. The seismic test procedure shall be furnished for approval of the purchaser.

ANNEXURE-I

MFGR.'s LOGO	MANUFACTURER'S NAME AND ADDRESS	MANUFACTURING QUALITY PLAN		PROJECT :
		ITEM :	QP NO.:	PACKAGE :
		SUB-SYSTEM:	REV.NO.:	CONTRACT NO. :
			DATE:	MAIN-SUPPLIER:
			PAGE: OF....	

SL. NO	COMPONENT & OPERATIONS	CHARACTERISTICS	CLASS	TYPE OF CHECK	QUANTUM OF CHECK		REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD		AGENCY			REMARKS
					M	C/N						M	C		N
1.	2.	3.	4.	5.	6.		7.	8.	9.	D*	**	10.		11.

		LEGEND: * RECORDS, IDENTIFIED WITH “TICK” (✓) SHALL BE ESSENTIALLY INCLUDED BY SUPPLIER IN QA DOCUMENTATION. ** M: MANUFACTURER/SUB-SUPPLIER C: MAIN SUPPLIER, N: NTPC P: PERFORM W: WITNESS AND V: VERIFICATION. AS APPROPRIATE, CHP: NTPC SHALL IDENTIFY IN COLUMN “N” AS ‘ W”	 FOR NTPC USE	DOC. NO.:		REV..... CAT.....	
MANUFACTURER/ SUB-SUPPLIER	MAIN-SUPPLIER						
SIGNATURE				REVIEWED BY	APPROVED BY	APPROVAL SEAL	

FORMAT NO.: QS-01-QAI-P-09/F1-R1

1/1

ENGG. DIV./QA&I

EPC PACKAGE FOR SINGARAULI SUPER THERMAL POWER PROJECT STAGE-III (2X800 MW)			
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ENDORSEMENT SHEET FOR QP			
REFERENCE / STANDARD / FIELD QUALITY PLAN (RQP / SQP/RFQP/SFQP)			
TO BE FILLED IN BY SUPPLIER AT TIME OF SUBMISSION			To be filled in by NTPC
PROJECT NAME		REVIEW & ENDORSEMENT BY NTPC PROJECT SPECIFIC QP NUMBER ALLOTTED QP NO.: REV. NO.: DATE: ** The RQP/SQP/RFQP/SFQP once endorsed for a particular contract shall remain valid even though the original QP may have expired or revised, unless / otherwise mutually agreed with the supplier. ①	
CONTRACT NO.:			
MAIN SUPPLIER			
MANUFACTURER WORKS & ADDRESS	M/S		
ITEM/EQUIPMENT / SYSTEM/ SUB-SYSTEM DETAILS i.e. MODEL TYPE / SIZE /RATING etc.			
APPROVED QP NO.: RQP/SQP/RFQP/SFQP	0000-999-QV - -	REV. NO.:	DATED**:
Confirmation by Main Supplier (TICK WHICHEVER APPLICABLE)		(TICK APPLICABLE)	
I. That the item/ component is identical to that considered for QP approval. OR.		The QP is endorsed for this project without any change	
II. That there are minor changes in the item/ component with respect to that considered for QP approval, however the same do not affect the contents of QP. OR			
III. That there are minor changes in the item/ component with respect to that considered for QP approval, however the same affect the QP slightly, as indicated below / in attached sheet.		The QP is endorsed for this project with changes as indicated.	
		<u>DISTRIBUTION OF ENDORSEMENT OF</u> A) RQP/SQP: 1. MAIN SUPPLIER (WITH A COPY OF QP) 2. MANUFACTURER 3. RIO 4. CQA-SPL 5. CQA-O/C B) RFQP/SFQP: 1. MAIN SUPPLIER (with a copy of QP) 2. MANUFACTURER 3. NTPC FQA (with a copy of QP) 4. NTPC Erection (with a copy of QP) 5. CQA-SPL 6. CQA-O/C	
SIGN.: (Main Supplier)	DATE	SIGN.: (Manufacturer)	DATE:
		NTPC (Reviewed /Approved by/ Date & Seal)	



SUB-SECTION– E-45 SWITCHYARD

CLAUSE NO.

QUALITY ASSURANCE

**SWITCHYARD**

Attributes / Characteristics Items/Components Sub Systems	Make, model, Type & Rating, Test Certificate	Routine & Acceptance Test as per IS / IEC	Functional requirements as per NTPC Specification
765 kV GIS (IEC:62271-203)	Y	Y	Y
400 kV GIS (IEC:62271-203)	Y	Y	Y
220 kV GIS (IEC:62271-203)	Y	Y	Y
132 kV GIS (IEC:62271-203)	Y	Y	Y
Circuit Breaker (IEC:62271-100)	Y	Y	Y
Isolator (IEC:62271-102)	Y	Y	Y
Current Transformer (IEC:60044/BS:3938/IS2705/ IEC: 61869)	Y	Y	Y
Capacitor Voltage Transformer (IEC:186A / 358/IS3156/IEC60044/ IEC: 61869)	Y	Y	Y
Potential transformer (IEC 60044 / IS3156)			
Surge Arrestor (AIS) (IEC:99- 4/IS:3070)	Y	Y	Y
Wave Trap (IEC:353 / IS:8792 / 8793)	Y	Y	Y
Sub Station Automation system (IEC 61850)	Y	Y	Y
Protection Relays	Y	Y	Y
Energy meter	Y	Y	Y
Bus Post Insulator (IEC:168 / 815 / IS:2544)	Y	Y	Y
Disc, Pin & String Insulator (IEC:383 / IS:731)	Y	Y	Y
Aluminum Tube (IS:5082 / 2673 / 2678)	Y	Y	Y
Conductor (IS:398)	Y	Y	Y
Hardware fittings for Insulator (IS:2486 / BS:3288)	Y	Y	Y
Hollow insulator (IEC:233/ IS:5621)	Y	Y	Y
Spacers, Clamps & Connector (IS:10162 / 5561/ 617)	Y	Y	Y
Galvanized Steel Structures (IS:2062/2629/4759/6745)	Y	Y	Y
Vibration Damper (IS:9708)	Y	Y	Y

SINGRAULI SUPER THERMAL POWER
PROJECT STAGE-III (2X800 MW)
EPC PACKAGE

TECHNICAL SPECIFICATION
SECTION – VI
BID DOC. NO:

SUB SECTION E45
SWITCHYARD

PAGE
1 OF 2

CLAUSE NO.

QUALITY ASSURANCE



Attributes / Characteristics Items/Components Sub Systems	Make, Type Rating, and Model, Test Certificates	Routine & Acceptance Test as per relevant IS/IEC	Functional requirements as per NTPC Specification
Sag Compensating Spring DIN:2089/2096 IS:3195 / 7906	Y	Y	Y
Long rod Insulator	Y	Y	Y
SF6 Gas filling & evacuating plant	Y	Y	Y
SF6 Gas Leak Detector	Y	Y	Y
Leakage Current Analyzer	Y	Y	Y
Nitrogen Gas Filling Device	Y	Y	Y
Event Logger	Y	Y	Y
Operation Analyzer	Y	Y	Y
Disturbance Recorder	Y	Y	Y
Synchronizing Trolley	Y	Y	Y
Relay Test Kit	Y	Y	Y
Notes: 1) This is an indicative list of test/checks. The manufacture is to furnish a detailed Quality Plan indicating the practice and procedure along with relevant supporting documents during QP finalisation for all items. 2) All major Bought Out Items will be subject to NTPC approval.			

Bharat Heavy Electricals Limited

Project: 400kV GIS Switchyard at Singrauli Super Thermal Power Project Stage- III (2x800MW)

Customer: NTPC Ltd.

Technical Specification: 400kV Gas Insulated Switchgear & its accessories

Doc. No. TB-429-316-001 **Rev** 00

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ANNEXURE-A: Compliance Certificate of Technical Specification

The bidder shall confirm compliance to the following by signing and stamping this compliance certificate and furnishing same with the offer.

1. The scope of supply, technical details, construction features, design parameters etc. shall be as per technical specification & there are no exclusion/ deviation with regard to same.
2. There are no deviation(s) with respect to specification other than those furnished in the schedule of deviations.
3. Only those technical submittals which are specifically asked for in Notice Inviting Tender (NIT) to be submitted at tender stage shall be considered as part of offer. Any other submission, even if made, shall not be considered as part of technical offer.
4. Any comments/ clarifications on technical/ inspection requirements furnished as part of bidder's covering letter shall not be considered by BHEL, and bidder's offer shall be construed to be in conformance with the specification.
5. Any changes made by the bidder in the price schedule with respect to the description/ quantities from those given in 'BOQ' of the specification shall not be considered (i.e., technical description & quantities as per the specification shall prevail).

Date:

Bidder's Stamp & Signature

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ANNEXURE-B: Deviation/ Change Request of Technical Specification

Bidder shall list out all technical potential deviation/ change request (s) along with clause with respect to technical specifications.

Sl. No.	Page No.	Clause No.	Deviation	Reason/ Justification(s)
---------	----------	------------	-----------	--------------------------

Any deviation not specifically brought out in this section shall not be admissible for any commercial implication at later stage. Except to the technical deviations listed in this schedule, bidder's offer shall be considered in full compliance to the tender specifications irrespective of any such deviation indicated / taken elsewhere in the submitted offer.

Date:

Bidder's Stamp & Signature

Bharat Heavy Electricals Limited**Project:** 400kV GIS Switchyard at Singrauli Super Thermal Power Project Stage- III (2x800MW)**Customer:** NTPC Ltd.**Technical Specification:** 400kV Gas Insulated Switchgear & its accessories**Doc. No.** TB-429-316-001 Rev 00**ANNEXURE-C: Technical Checklist**

Sl.	Particulars	Reply by bidder	
1	TECHNICAL QUALIFYING REQUIREMENT		
1.1	The bidder should comply with Technical Qualifying requirement & furnish the relevant documents.	Confirmed	Yes/No
1.2	The bid shall be submitted by the Manufacturer of GIS/ Bidder who meets the PQR criteria. The bidder's scope includes supply and services like • supervision of erection, • testing and commissioning. Bids submitted by agents (who does not meet the PQR criteria) will not be considered.	Confirmed	Yes/No
1.3	All the documents shall be submitted in English. Translated pages should be attested by the bidder.	Confirmed	Yes/No
2	Un-priced Offer –.		
2.1.	Confirm that all items have been quoted. (If any item has not been quoted, the same shall be specifically brought out)	Confirmed	Yes/No
2.2.	Any other item /service required for the execution for the complete job is deemed to be included in the offer, whether specifically mentioned in the specification or not. List of items along with their respective quantities required for completeness (Attach list, if required).	List of Additional items required attached	Yes/No
2.3.	Foundation for GIS shall be constructed by Civil contractor based on the input (configuration, loads etc.) provided by bidder. The supply of all structural material to be embedded like foundation bolts as well as consumables like grouting material shall be in scope of bidder. The erection of structure shall be done by BHEL.	Confirmed	Yes/No
2.4.	SF6-GIS to Air bushing - Interface for connecting ICT/LINE/REACTOR with bus duct shall be complete with structures etc shall be provided by the bidder. Limit of supply as per technical specification and as per IEC 61639.	Confirmed	Yes/No
2.5.	Confirm that Consumables as per manufacturer requirement for successful erection, testing & commissioning shall be included in bidder's scope.	Confirmed	Yes/No
2.6.	Detailed list of Commissioning spares for testing & commissioning of GIS till handing over	Attached	Yes/No

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<u>Sl.</u>	<u>Particulars</u>	<u>Reply by bidder</u>	
2.7.	Detailed list of Tools & tackle & Testing Equipment	Attached	Yes/No
2.8.	Detailed list of Recommended Spares/operation & maintenance spare	Attached	Yes/No
2.9.	The Switchgear shall be complete with all necessary terminal boxes, SF6 gas filling, and interconnecting power and control Cables (between GIS to GIS/GIS to LCC/ LCC TO LCC), grounding connections (GIS to GIS and GIS to Earth Mesh on Floor), gas monitoring System and piping, support structures.	Confirmed	Yes/No
2.10.	The scope of supply shall also include all erection and mounting hardware and interconnecting cables within GIS.	Confirmed	Yes/No
2.11.	Design philosophy of earthing submitted with the bid. Design of Earthing of GIS shall be in bidder scope.	Confirmed	Yes/No
2.12.	Tentative GIS Hall PLAN & SECTION Layout including hook height of EOT crane submitted with the bid	Confirmed	Yes/No
2.13.	Tentative Outdoor yard PLAN & SECTION Layout submitted with the bid	Confirmed	Yes/No
2.14.	Technical Requirement of EOT Crane capacity & hook height mentioned in GIS Hall Layout	Confirmed	Yes/No
2.15.	EOT crane for 400kV GIS hall shall have capacity of minimum 8T safe working load and minimum height of crane shall be 9.5 meters or as per actual requirement, whichever is higher. However, bidder shall provide all the other technical requirements for EOT crane for suitability of crane for installation and maintenance of GIS including EOT crane capacity calculations etc.	Confirmed	Yes/No
2.16.	Tentative / estimated AC / DC Load requirement for GIS submitted with bid	Confirmed	Yes/No
2.17.	Earthing material as per Section 1	Confirmed	Yes/No
3	Technical		
3.1.	Location of site: <i>Project site is Singrauli, Distt. Sonebhadra, Uttar Pradesh; design and construction of GIS should be suitable for the climate/ Meteorological Condition as mentioned in Section-1 and in section-3.</i> <i>Bidder to inform what measures shall be taken to ensure the same at bid stage.</i>	Writeup attached with bid.	Yes/No
3.2.	Details regarding the design features of equipment which are	Enclosed	Yes/No

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Sl.	Particulars	Reply by bidder	
	intended to prevent burn through when an internal arc occurs.	with bid	
3.3.	Material of enclosure – Aluminium Alloy	Confirmed	Yes/No
3.4.	Material of bus bar - Aluminium	Confirmed	Yes/No
3.5.	Requirement of AC and DC auxiliary loads	Enclosed with bid	Yes/No
3.6.	Catalogues of GIS	Enclosed with bid	Yes/No
3.7.	Catalogues of all Mandatory Maintenance equipment. Bidder to confirm that offered equipment meets the requirements of specification.	Enclosed with bid	Yes/No
4	Calculations		
5.1	All calculations including Thermal calculations based on the climatic conditions indicated in Technical Specification shall be submitted during detailed engineering stage.	Confirmed	Yes/No
5.2	Devices or techniques deployed for reducing transients to an acceptable level enclosed along with offer.	Enclosed with bid	Yes/No
5.3	The design of the equipment shall be such that the agreed permitted movement of foundations and mechanical or thermal effects do not impair the assigned performance of the equipment.	Confirmed	Yes/No
5.4	Bidder shall conduct insulation co-ordination & very fast transient overvoltage (VFTO) studies in line with IEC 60071 for establishing requirement/ suitability of surge arrester, and any other technical requirement for successful operation of GIS.	Confirmed	Yes/No
5.5	Bidder shall check and ensure adequacy of system protection for successful operation of GIS. After checking of system by bidder, GIS shall be installed and if any failure, malfunction of any part occurs after/ during commissioning, same shall be replaced immediately without any extra cost.	Confirmed	Yes/No
5	Technical Deviations		
5.6	Confirm that the Complete systems have been offered as per the requirements of Technical Specification and Technical Deviation sheet has been submitted. Deviations mentioned elsewhere in the bid will not be considered.	Confirmed	Yes/No
5.7	Technical Deviation sheet has been submitted.	Confirmed	Yes/No
6A	Activity Schedule		
6A.1	Bidder will submit detailed activity schedule indicating all the	Confirmed	Yes/No

Bharat Heavy Electricals Limited**Project:** 400kV GIS Switchyard at Singrauli Super Thermal Power Project Stage- III (2x800MW)**Customer:** NTPC Ltd.**Technical Specification:** 400kV Gas Insulated Switchgear & its accessories**Doc. No.** TB-429-316-001 **Rev** 00

<u>Sl.</u>	<u>Particulars</u>	<u>Reply by bidder</u>	
	milestones from Engineering till manufacturing/ testing, dispatch to site and commissioning based on the drawing & document schedule attached in section1.		
6B	Conditions		
6B.1	Open/ closed store area shall be provided by BHEL; However, bidder shall provide their tentative space requirement for covered and/ or open store area during tender stage only. In addition to this, bidder shall submit their standard storage instruction manual specifically specifying the item detailed with details of type of storage.	Confirmed Details given with the bid.	Yes/No
7	Site Test		
7.1	Bidder to supply only special tools . For other tools bidder to submit list of tools, tackle, slings, spanners, gauges, slings and other lifting devices, drills, instruments and appliances necessary for the complete assembly and erection at site of the GIS, required for installation, gas filling, maintenance, site testing of the GIS which shall be arranged by BHEL.	Confirmed	Yes/No
7.2	Bidder to furnish detailed BOQ for non-returnable Tools and Tackles along with unit prices to be handed over to ultimate customer.	Details given with the bid.	Yes/No
7.3	All field tests including tests during installation, pre-commissioning, commissioning, field acceptance tests shall be conducted by the Contractor, in presence of representative of the Employer. No separate site test will be conducted by BHEL/Customer	Confirmed	Yes/No
8	TYPE TESTS REQUIREMENTS		
8.1	The Bidder shall carry out the type tests as listed in this specification on the equipment to be supplied under this contract. The Bidder shall indicate the charges for each of these type tests separately in the relevant schedule of BPS/ BOQ and the same shall be considered for the evaluation of bids.	Confirmed	Yes/ No
8.2	In case the bidder has conducted such specified type test(s) according to the relevant standard and / or specification as per CEA Guidelines for the validity period of Type test(s) conducted on Major Electrical equipment in power Transmission-May2020 & with latest amendments as on date of bid opening, submit the type test reports to the Employer/ customer for waiver of conductance of	Confirmed	Yes/ No

Bharat Heavy Electricals Limited**Project:** 400kV GIS Switchyard at Singrauli Super Thermal Power Project Stage- III (2x800MW)**Customer:** NTPC Ltd.**Technical Specification:** 400kV Gas Insulated Switchgear & its accessories**Doc. No.** TB-429-316-001 Rev 00

<u>Sl.</u>	<u>Particulars</u>	<u>Reply by bidder</u>	
	such type test(s). These reports should be for the test conducted on the equipment similar to those proposed to be supplied under this contract and the test(s) should have been either conducted at an independent laboratory or should have been witnessed by a Client. The Employer/ customer reserves the right to waive conducting of any or all the specified type tests(s) under this contract. In case the type tests are waived, the type test charges shall not be payable to the bidder.		
8.3	Any type tests, which has not been conducted on the offered design of GIS or there has been a change in the design after the type tests the requisite tests shall be conducted by bidder on the offered design of GIS without any commercial implication on BHEL/ NTPC.	Confirmed and enclosed with bid	Yes/ No



SECTION -4
TB-429-316-001 REV 00

SUB-SECTION-DB13

GAS INSULATED SWITCHGEAR

PAGES FROM 39 TO 71 ARE DELETED AS THEY ARE NOT RELEVANT.

EPC PACKAGE FOR
SINGRAULI SUPER THERMAL POWER PROJECT STAGE
-III (2X 800MW)

TECHNICAL SPECIFICATION
SECTION – VI

CLAUSE NO	GAS INSULATED SWITCHGEAR	
	Bidder's Name:	
I.	GIS MODULE The bidder shall submit with his bid the following technical particulars for the Each ' gas-insulated switchgear and accessories, complete with any additional data which, in bidder's opinion, will describe the merits of the equipment offered. - Name of manufacturer & address - Place of manufacture, inspection & testing - Manufacturer's type / designation - Standard applicable - Rated voltage - System frequency - Maximum (continuous) service rated voltage - Single phase or three phase design - Normal current rating - Generator Transformer feeder circuit Amp. - Line feeder circuit Amp. - Bus coupler circuit Amp. - Bus bars Amp. - Rated peak withstand current KA - Short time current rating 1 second rms. kA 3 second rms. kA - Rated Lightning impulse withstand voltage kV (peak) - Rated Switching impulse withstand voltage kV (peak)	

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CLAUSE NO	GAS INSULATED SWITCHGEAR .		
	Bidder's Name: 14. Rated one minute power frequency withstand voltage kV (peak) 15. Maximum temperature rise over 50 deg. ambient deg. C. 16. Thermal rating of current carrying parts at 420 kV for the rated symmetrical short circuit current Sec 17. a. Features adopted for preventing burn through in the various enclosures of SF6 GIS b. Time in m sec to withstand an internal flashover without burn through 18. Design pressure of the enclosures for a) Circuit breakers b) Disconnectors c) Surge arresters etc. d) GIS duct e) VT f) CT 19. No of gas compartments a) Each line bay b) Each Generator bay c) Bus coupler bay 20. a) Average leakage rate of SF6 gas %/year b) Quantity of SF6 gas required to completely charge the 3-pole equipment (Kg)		

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CLAUSE NO	GAS INSULATED SWITCHGEAR
	Bidder's Name: c) Quantity of SF6 gas required for largest gas compartment (Kg).....Compartment d) Operating pressure(bar) - Circuit breaker - GIS Duct - CT - VT - Disconnecter - SA 21. Creepage distance adopted for GIS/AIS termination (mm) 22. Heat generated in K.W. when the complete switchgear is operating at its rated capacity 23. a) Seismic level for which GIS is designed b) Noise level in (dB) at distance of (m) i) 0 ii) 50 iii) 100 iv) 150 24. Type and Material of a) Breaker main contact. b) Disconnecting switch contact

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CLAUSE NO	GAS INSULATED SWITCHGEAR	
	Bidder's Name:	
	c) Grounding switch contact d) Busbars e) Internal bus contact. f) Enclosure. g) Terminal pads.	
25.	Dimensions	
	a) Bus enclosure outside diameter .....(mm) b) Bus enclosure wall thickness (mm) c) Internal bus, outside diameter (mm) d) Internal bus thickness (mm)	
26.	Whether GIS are despatched filled with SF6 or required to be filled at site	
27.	Capacity of EOT crane in GIS building	
28.	Type and make of SF6 pipe coupling used	
29.	Type and make of mandatory maintenance equipment to be supplied	
	i) SF6 gas filling and evacuation plant (portable) ii) SF6 gas filtering, drying, storage and recycling plant iii) Operation analyzer with DCRM KIT iv) SF6 gas leak detector v) Gas analyzing equipments	
30.	Whether the following are enclosed	
	a) Type test reports	Yes/No

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CLAUSE NO	GAS INSULATED SWITCHGEAR (.	
	Bidder's Name:	
	b) Operation manual for equipments	Yes/No
	c) Leaflets & literature bringing out salient features of equipment offered	Yes/No
	d) The details of control room building	Yes/No
	e) The details of GIS building	Yes/No
31.	Details of equipments and procedure for conducting site test (including power frequency test) of the bay module as per IEC	
32.	Weight of the heaviest piece of equipment to be handled during installation on site. Kg	
33.	SF6 GAS	
	a. Name of manufacturer & address	.....
	b. standard applicable	.....
34.	Whether the common point of bus disconnectors alongwith Earth Switch has been brought out in a separate compartment	Yes/No
35.	Whether provision exists for extension of busbars on both ends	Yes/No
36.	Details of arrangement provided to account for thermal expansion for busbars enclosed	Yes/No
37.	Details of earthing arrangement adopted for the GIS enclosed	Yes/No
38.	Whether layout plan sections of each bay/equipment of GIS/AIS indicating the complete arrangement enclosed	Yes/No

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CLAUSE NO	GAS INSULATED SWITCHGEAR	
	Bidder's Name:	
II.	EQUIPMENTS INCLUDED IN GIS A. Circuit Breaker 1. Name plate data a. Manufacturer's name b. Type / designation c. Standard applicable d. Rated frequency Hz e. Rated voltage kV f. Rated current i) Under normal condition -----kA ii) Under site condition ----- KA g. Number of poles per unit h. Class (indoors) i. Number of interrupting chambers per pole (No of breaks per pole) j. Whether 3 pole or single pole design k. Maximum Operating Voltage for guaranteed Breaking Capacity kV l. Duty cycle as per IEC M1/M2&C1/C2	
III.	GUARANTEED RATINGS A) Making & Breaking 1. Breaking Capacity - Rated short circuit breaking Current KA(rms) KA - Symmetrical component at KA	

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CLAUSE NO	GAS INSULATED SWITCHGEAR . 
	Bidder's Name: highest system voltage - DC Component (%) - Asymmetrical breaking current at highest system voltage KA - Rated breaking MVA (Symmetrical) kA(rms) - Breaking time secs. b) Making Capacity - Rated making current kA - Rated making MVA symmetrical - Making time secs 2. Operating voltages of closing/opening coil - Maximum operating voltage V - Minimum operating voltage V 3. Current ratings - Rated continuous current at 27⁰C ambient temp. A - Rated interrupting current for 1s, ...kA - Rated symmetrical interrupting current kA - Rated asymmetrical interrupting current kA - Rated short circuit making current kA (peak) 4. Rated Insulation level a) One minute dry power

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CLAUSE NO	GAS INSULATED SWITCHGEAR	
	Bidder's Name: frequency withstand voltage i)Between live terminal and ground (kV rms) ii) Between terminals with breaker contacts open (kV rms) b) 1.2/50 micro second impulse withstand test voltage i) Between live terminal and ground (kV peak) ii) Between terminals with breaker contacts open (kV peak) c) 250/2500 micro second impulse switching surge withstand test voltage i) Between live terminal and ground (kV peak) ii) Between terminals with breaker contacts open (kV peak) d) Line to ground power frequency withstand voltage at gas pressure equivalent to atmospheric pressure kV e) Minimum allowable moisture content in interrupting medium ppm/vol. f) Maximum total break time for any current upto rated breaking current (ms) i) For Test duties 2,3 & 4 at rated values ii) For other duties at limiting conditions of voltage and pressure 	

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CLAUSE NO	GAS INSULATED SWITCHGEAR	
	Bidder's Name:	
	g) Closing time	
	h) Minimum opening time under any condition with limiting voltage and pressure (ms)	
	i) Maximum opening time under any condition with limiting voltage and pressure (ms)	.....
	j) First pole to clear factor	.....
5.	Maximum temperature rise above ambient at rated load and voltage for	
	- Contacts	deg C
	- Hottest part	deg C
6.	Operating data	
	- Rated operating duty cycle	
	a) Line Breakers	.....
	b) Generator Transformers, & Bus Coupler Breakers	.....
	- Reclosing duty cycle (Line Breakers)	.....
	- Permissible tripping delay	ms
	- Maximum arc duration at	
	a) 10% rated breaking current	ms
	b) 30% — do—	ms
	c) 60% — do—	ms
	d) 100% — do—	ms
	- Closing time,	ms
	- Total breaking time at	ms

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CLAUSE NO	GAS INSULATED SWITCHGEAR
	 Bidder's Name: a) 10% rated breaking current ms b) 30% — do— ms c) 60% — do— ms d) 100% — do— ms e) Arc duration from separation of arc at contact to instant of arc extinction for full rated interrupting capacity. ms - Longest time to interrupt current less than 25% of rated symmetrical short circuit current from energizing trip circuit ms - Minimum time from arc extinction to contact remake for auto reclosing. ms - Minimum dead time for a) 3 phase reclosing ms b) 1 phase reclosing ms - Maximum difference of time at opening of series contacts within one pole ms - Maximum difference of time at opening between phases ms - Maximum difference of time at closing between phases ms - Details of the curve enclosed for maximum opening time vs. 3 phase fault current - Number of interruptions before scheduled maintenance is required - Number of mechanical operations before scheduled maintenance is required

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CLAUSE NO	GAS INSULATED SWITCHGEAR
	 Bidder's Name: - Number of interruptions at rated S.C. current with associated TRV without changing any parts. - Description and frequency of scheduled maintenance required - Recovery voltage rate of rise at a) Rated symmetrical interrupting current kV/ms b) 60 percent of rated symmetrical interrupting current kV/ms c) 30 percent of rated symmetrical interrupting current kV/ms d) 10 percent of rated symmetrical interrupting current kV/ms data for Restrike voltage - Amplitude factor - Phase factor - Natural frequency(Hz) - Rate of rise of restriking voltage - Devices used for controlling RRRV - Devices used for uniform voltage distribution - Distribution of voltage across breaks - Pre-insertion resistor (if applicable) i) Value / pole (Ohms)/with tolerance ii) Minimum and maximum duration of insertion per pole (ms) iii) Thermal rating for the C-1m-0-CO-2m-C-1m-O-CO for terminal fault considering

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CLAUSE NO	GAS INSULATED SWITCHGEAR .
	 Bidder's Name: maximum resistance and time setting - Recovery voltage distribution between breaks in percent of rated voltage a) Single line to ground fault b) Interruption of short lines c) Switching off an unloaded transformer 7. Operating Mechanism a) Type of operating mechanism for i) Closing ii) Opening b) Normal power consumption (w) at rated voltage of i) Trip coil ii) Closing coil 7.1. Pneumatic operating mechanism a) Rated operating pressure (kg/sq.cm) b) Rated of pressure for (kg/sq.cm) i) Closing ii) Opening c) Air Consumption at rated pressure for i) Closing (m³)

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CLAUSE NO	GAS INSULATED SWITCHGEAR .
	 Bidder's Name: ii) Opening (m³) iii) Close -Open (m³) d) Pressure drop/metre length of piping e) Number and Capacity (m³) of breaker local air storage receivers f) No. of close operations for which sufficient air as available in local receiver g) Capacity of compressor (m³/hr) and working pressure (kg/cm²) h) Maximum time for which compressor can operate continuously (Minutes) i) Time to fill i) Air receiver after one C-O operation (Minutes) ii) For making up of losses occuring in 4 hours (Minutes) j) Pressure at which compressor i) Starts (kg/cm²) ii) Stops (Kg/cm²) k) Material of compressed air piping l) Inner & outer dia of piping (mm) m) Whether time totaliser for the compressor provided

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CLAUSE NO	GAS INSULATED SWITCHGEAR .
	Bidder's Name: n) Safety valve blow off at (Kg/Cm²) o) Alarm switch closes (Kg/Cm²) i) Closing ii) Opening iii) Auto reclose 7.2 Hydraulic operating mechanism a) Rated pressure of oil in operating cylinder (Kg/cm²) b) Limits of pressure (Kg/cm²) c) Quantity of oil (litre) d) Details of monitoring arrangement for hydraulic pressure e) No. of close-open operation possible after loss of AC supply to drive motor f) Pressure drop starting from lowest pressure at which motor starts for i) C-operation ii) O-operation iii) CO-operation iv) O-CO-operation v) 2CO-operation g) Time required to make up pressure upto loss of nitrogen pressure after i) C-operation

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CLAUSE NO	GAS INSULATED SWITCHGEAR	
	Bidder's Name: i) O-operation iii) CO-operation iv) O-CO-operation v) 2CO-operation h) Life expectancy & guaranteed leakage rate of nitrogen accumulators 7.3 Spring charged mechanism a) Number of close open operations possible after failure of AC supply to motor b) Time required for motor to charge the closing spring (minutes) c) Whether indication of spring charged condition provided in central control cabinet 8. Motor Data a) Type b) Rating at site conditions (kW) c) Rated voltage (V) d) Full load current (A) 9. SF6 gas system - Normal operating pressure bar - Normal operating density g/cc - Weight of gas per breaker Kg - Lockout pressure bar - Alarm pressure bar	

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CLAUSE NO	GAS INSULATED SWITCHGEAR .	
	NTPC	
	Bidder's Name: - Whether breakers work at single pressure or dual pressure - Type of SF6 gas flow(axial or radial) - Type of nozzles (single flow or double flow) - Compression ratio for puffer action - Quantity of compressed gas for puffer action - Total volume of SF6 gas required per circuit breaker at operating pressure. 10 Control power requirement - Tripping(3poles)current at rated supply voltage (220 V.D.C.) A - Closing(3 poles) current at rated supply voltage (220 VDC) A - Tripping voltage range (percent) - Closing voltage range (percent) 11. Heaters - Continuously current rating A - Thermostat power rating A 12. Noise level in (dB) at distance of (m) i) 0 ii) 50 iii) 100 iv) 150 13. Interrupters - Type of main contacts, arcing 	

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CLAUSE NO	GAS INSULATED SWITCHGEAR	
	Bidder's Name: contacts & Aux. contacts. - Material of main contacts/arcing contacts, silver coated or not - Contact pressure (Kg/sq mm) - Number of interrupters per pole - Length of contact travel mm - Rate of contact travel at tripping m/sec - Rate of contact travel at closing m/sec 14. Whether fixed trip or trip free 15. Details of anti pumping device 16. Maximum line charging breaking current with temporaty over voltage up to 1.4 p.u. (kA) 17. Rated capacitive breaking current 18. Rated small inductive breaking current - Generator transformer, Line & Bus coupler breakers 19. Rated characteristics for short line fault 20. a) Rated transient recovery voltage for terminal faults b) Parameters as per IEC 21. Rated value of phase making current kA(rms) 22. Max. interrupting capacity under phase opposition conditions 23. Maximum breaking Capacity under Kilimetric faults and rated TRV characteristic (kA peak) 24. Maximum period between closing	

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CLAUSE NO	GAS INSULATED SWITCHGEAR	
	Bidder's Name:	
	of first contact & last contact in a pole (ms)	
25.	Maximum pole discrepancy (ms)	.....
26.	Capacity for interrupting in-rush current of transformer	.....
27.	Max. over voltage factor of the circuit breaker when switching off	.....
	a) Unloaded transformer	.....
	b) Loaded transformer	.....
	c) Open circuited lines	.....
	d) Synchronous system	.....
28.	Details of operation counter	.....
29.	a) Number of auxiliary contacts per pole provided	.....
	i) NO	.....
	ii) NC	.....
	iii) Adjustable	.....
	b) Rated voltage of auxiliary contacts (V)	.....
	c) Current capacity of Aux. contacts	
	i) Continuous (Amps)	.....
	ii) DC breaking with 20 ms time constant (A)	.....
30.	Partial discharge level at 1.1 Un/√3	Pico-coulombs
31.	Radio interference level at 266 kV (rms)	 microvolt
32.	Maximum impact loading on foundation during breaker operations under	 Kg

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CLAUSE NO	GAS INSULATED SWITCHGEAR
	Bidder's Name: fault conditions. i) Closed conditions ii) Open conditions 33. Seismic withstand value i) Vertical ii) Horizontal 34. Tests to be conducted by the supplier at works (whether enclosed) a) Type tests yes/no b) Routine tests yes/no c) Tests to be conducted at site yes/no 35. Overall dimensions (LxBxH), m 36. Weight of breaker complete with operating mechanism, bushing, frame work, Kg a) with SF6 gas b) without SF6 gas 37. Descriptive bulletins and drawings of the circuit breakers giving general details of construction. 38. Out of phase switching capability of the circuit breaker 39. Comments regarding the suitability of the circuit breaker for restrike free operation of power transformer carrying full load current. 40. Guaranteed time difference between the first pole and last pole operation timing. ms

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CLAUSE NO	GAS INSULATED SWITCHGEAR (.
	 Bidder's Name: 41. Data on operating Coils (a) No. of trip coils/pole (No.) (b) No. of close coils/pole (No.) 42. Details of the standard accessories to be supplied alongwith the breaker 43 No. of the enclosed drg. showing the control scheme of circuit breaker 44 Details of the provision to be made on GIS to reduce H.V. transients to acceptable values. 45. Guaranteed degraded values of B.I.L. switching surges and 50 Hz rated values during the life of equipment (Test data to support this guarantee to be enclosed by the bidder). 46. Whether the following are enclosed a) Type test reports Yes/No b) Operation manual for breaker Yes/No c) OGA drawing of breaker Yes/No B) Disconnectors/Grounding Switches B-I Disconnecting Switches 1. Manufacturer's name & address 2. Type & designation 3. Standard applicable and duty M1/M2 4. Rated Frequency 5. Whether all the 3 poles are gang operated 6. Rated voltage

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CLAUSE NO	GAS INSULATED SWITCHGEAR (	
	Bidder's Name: i) Rated kV ii) Max. permissible 7. Dielectric with-stand capacity of Completely assembled DS and earth switch a) One minute power frequency withstand test voltage (kV) rms i) against ground (kV peak) - dry (kV rms) b) 1.2/50 micro second impulse withstand test voltage i) against ground (kV peak) ii) across open contacts (kV peak) c) 250/2500 micro second switching surge withstand test voltage (dry) i) against ground (kV peak) ii) across open contacts (kV peak) d) Radio interference level at 1.1 x Um/√3 (in micro volts) for frequency between 0.5 MHz to 2.0 MHz 8. Rated normal current - Generator Transformer module A - Line module A - Bus coupler module A	

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CLAUSE NO	GAS INSULATED SWITCHGEAR	
	Bidder's Name:	
9.	Rated peak short circuit current	kA
10.	Interruption of loop current	A/V
11.	a) Rated short time current of DS	.....
	i) for 1 sec. (kA rms)	.....
	ii) for 3 sec. (kA rms)	.....
	iii) Dynamic current	.....
	b) Opening time of	.....
	i) DS (sec)	.....
	ii) Earth switch (sec)	.....
	c) Closing time of	.....
	i) DS (sec)	.....
	ii) Earth switch (sec)	.....
	d) Temperature rise over 50°C ambient temperature corresponding to maximum continuous current (°C)	.....
12.	Rated peak withstand current	kA (peak)
13.	Rated inductive breaking current	A
14.	TRV caused by breaking/making inductive current	kV
15.	Rated capacitive breaking current	A
16.	TRV caused by breaking/making capacitive current	kV
17.	Maximum temperature rise above ambient at rated current	

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CLAUSE NO	GAS INSULATED SWITCHGEAR .		
	Bidder's Name:		
		voltage (Volts)	
	b)	Limits of voltage	
	c)	Power consumption of control coils (W)	.....
21	Constructional Features		
	a)	Whether position of earth switch can be interchanged at site to either side of pole	Yes/No
	b)	Main contacts	.....
	i)	Type of contacts	.....
	ii)	Contact area (cm ²)	.....
	iii)	Material of contacts	.....
	iv)	Contact pressure (Kg/cm ²)	.....
	v)	Maximum current density under normal current carrying capacity (Amp/cm ²)	.....
	vi)	Thickness of silver plating	.....
	c)	Auxiliary contacts on Disconnecting switch	.....
	i)	Total number	
	i)	NO	
	iii)	NC	
	iv)	Adjustable	
	v)	Make before break	
	vi)	Rated voltage (volts)	

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CLAUSE NO	GAS INSULATED SWITCHGEAR
	 Bidder's Name: vii) Rated continuous current (Amps) viii) Rated DC breaking current with 20 ms time constant (A) d) Auxiliary contacts on earth switch i) Total number ii) NO iii) NC iv) Adjustable v) Rated voltage (volts) vi) Rated continuous current (Amps) vii) Rated DC breaking current with 20 ms time constant (A) e) Whether counter balance spring provided for isolator and earth switch 22. Design data - Type of contacts - Contact area - Contact pressure - Surface treatment and thickness of surface coating/ silver electrolytic plating. - Overtravel distance after making of contacts mm

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CLAUSE NO	GAS INSULATED SWITCHGEAR	
	Bidder's Name:	
	- Distance between the contacts in the fully open position	mm
	- Current density at the minimum cross section of switch blade	A/mm ²
	- Speed of operation	m/s
23.	Partial discharge level at 1.1 Un / $\sqrt{3}$	pico-coulombs
24.	a) Total operating time of disconnector along with its operating mechanism	secs.
	b) Total operating time of disconnector after the command is given	secs.
25.	No. of operations the switch can withstand without any need for inspection	.....
26.	Type of mounting	.....
27.	No. of poles per phase	.....
28.	Safety factor taken into account while designing the disconnector.	.....
29.	Type and material used for arcing contacts, if provided	.....
30.	Weight of 3 pole isolating switch	
	- with earthing blades	Kg
	- without earthing blades	Kg
31.	Type of interlock between main isolator and earthing switch	.....
32.	Details of the type test reports enclosed and the standards as per which these tests have been carried out	.....
33.	Rated maximum time duration of short circuit	ms
34.	Rated mechanical terminal load.	Kg

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CLAUSE NO	GAS INSULATED SWITCHGEAR	
	Bidder's Name:	
35.	Rated supply voltage of operating devices and auxiliary circuits.	V
36.	Rated pressure of SF6 gas	bar
37.	Minimum pole discrepancy between poles with regard to insulation and forces caused by short circuit currents.	ms
38.	Tests to be conducted at site Whether the following are enclosed:	.....
	a) Type test reports	Yes/No
	b) OGA drawing for disconnecting switches with & without earth switches	Yes/No
	c) Operation manual	Yes/No
	d) Details of motor operating mechanism	Yes/No
	e) Leaflets & literature bringing out salient features of equipment offered	Yes/No
	f) Whether details of constructional interlock enclosed	Yes/No
B- II	Safety Grounding Switches	
1.	Manufacturer's name & address	.....
2.	Type / designation	.....
3.	Standard applicable	.....
4.	Maximum permissible operating voltage	kV
5.	Maximum make and carry current for one sec.	kA (peak)
6.	Rated inductive breaking current	A
7.	TRV caused by breaking/making inductive current	kV

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CLAUSE NO	GAS INSULATED SWITCHGEAR ()	
		
	Bidder's Name: 8. Rated capacitive breaking current A 9. TRV caused by breaking/making capacitive current kV 10. Operating Mechanism a) Rated torque of the mechanism b) Type and rating (KW) of motor c) Rated voltage of motor d) Full load current (A) 11. Operating voltage range & rated voltage V 12. Ground connection insulation kV 13. Type of contacts 14. Over travel distance mm 15. Distance of fully open contacts mm 16. Size of the removable link 17. Speed of make m/s 18. Partial discharge level at 1.1 Un / √3 pico-coulomb 19. Radio interference level at 266 kV (rms) microvolt 20. Details of type test reports enclosed and the standards as per which these tests have been carried out 21. Auxiliary contacts on earth switch i) Total number i) NO 	

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CLAUSE NO	GAS INSULATED SWITCHGEAR .		
	Bidder's Name:		
	iii)	NC	
	iv)	Adjustable	
	v)	Rated voltage (volts)	
	vi)	Rated continuous current (Amps)	.....
22.	Whether the following are enclosed:		
	a)	Type test reports	Yes/No
	b)	OGA drawing for disconnecting switches with & without earth switches	Yes/No
B-III High Speed Fault Making Grounding Switch			
	1.	Manufacturer's name &c address	.....
	2.	Type/ designation	.....
	3.	Standard applicable	
	4.	Maximum permissible operating voltage	kV
	5.	Maximum make and carry current for 1 sec.	kA (peak)
	6.	Rated inductive breaking current	A
	7.	TRV caused by breaking/making inductive current	kV
	8.	Rated capacitive breaking current	A
	9.	TRV caused by breaking/making capacitive current	kV
	10.	Operating Mechanism	
	a)	Rated torque of the mechanism	

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CLAUSE NO	GAS INSULATED SWITCHGEAR .	
	Bidder's Name:	
	b) Type and rating (KW) of motor	
	c) Rated voltage of motor	
	d) Full load current (A)	
11.	Making current kA	
12.	Induced current switching capability	
13.	Closing current A	
14.	Closing time S	
15.	Opening current A	
16.	Opening time S	
17.	Operating voltage range & rated voltage V	
18.	Ground connection insulation kV	
19.	Type of contacts	
20.	Over travel distance mm	
21.	Distance of fully open contacts mm	
22.	Size of the removable link	
23.	Speed of make m/s	
24.	Partial discharge level at $1.1 U_n / \sqrt{3}$ pico-coulomb	
25.	Radio interference level at 266 kV microvolt	
26.	Has equipment been type tested and to which standards ?	
27.	Auxiliary contacts on earth switch	
	i) Total number	
	ii) NO	
	iii) NC	

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CLAUSE NO	GAS INSULATED SWITCHGEAR .	
	Bidder's Name:	
	iv) Adjustable	
	v) Rated voltage (volts)	
	vi) Rated continuous current (Amps)	.....
28.	Total operating time of switch alongwith its operating mechanism	S
29.	Total operating time of switch after the command is given.	S
30.	Operating Mechanism	
	a) Rated torque of the mechanism	.....
	b) Type and rating (KW) of motor	.....
	c) Rated voltage of motor	.....
	d) Full load current (A)	.....
C)	CURRENT TRANSFORMERS (Bidder to fill up date separately for each type of CT)	
	1. Name of manufacturer	.....
	2. Type	.....
	3. Manufacturer's type / designation	.....
	4. Standard applicable	.....
	5. Mounted inside/outside SF6 Gas enclosure	.....
	6. Rated frequency	.....
	Rated continuous normal current (A)	
	7. Short time current withstand for 1 sec. (kA)	
	8. Dynamic current withstand	

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CLAUSE NO	GAS INSULATED SWITCHGEAR .						
	Bidder's Name: (kA peak) 9. Transformation Ratio 10. Rated primary current 11. Rated secondary current 12. Numbers of cores. 13. Number of secondary turns 14. Particulars of for each type of C.T.						
	1.	2	3	4	5	6	7
	C O R E	Rated output (VA)	Class of accuracy	Accuracy limit	Current error at rated primary current (%)	Phase displa- cement at rated primary current (minutes)	Composite errors at cement rated accuracy limited it primary current.
	I						
	II						
	III						
	IV						
	V						
		8	9	10	11	12	
	C O R E	Knee point voltage (V) (Volts)	Secondary limiting voltage	Secondary winding resistance (ohm)	Magnetising current (mA) at knee point voltage	Instrument security factor	
	I						
	II						
	III						
	IV						

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CLAUSE NO	GAS INSULATED SWITCHGEAR		
	Bidder's Name:		
	V		
	15.	One second over current factor & corresponding value of current.	kA
	16.	Rated dynamic current (peak value) in amps.	kA
	17.	Rated continuous thermal current temperature rise over ambient.	Deg C
	18.	Partial discharge level at 1.1 Un/ $\sqrt{3}$	Pico-coulomb
	19.	Radio Interference voltage at 266 kV (rms)	micro-volt
	20.	Total weight	Kg
	21.	Magnetisation curves of CT cores	.....
	22.	Mounting details	.....
	23.	Overall dimensions	.....
	24.	Temperature rise over an ambient temp. of 50 °C (°C)	.....
	25.	Whether CT characteristic curves enclosed	Yes/No
	26.	Type Test Reports enclosed	Yes/No
	27.	OGA drawing enclosed	Yes/no
	28.	Tests proposed to be conducted at site.	.....
	D) VOLTAGE TRANSFORMERS		
	1	Name of manufacturer	
	2.	Type designation	
	3.	Standard applicable	

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CLAUSE NO	GAS INSULATED SWITCHGEAR		
	NTPC		
	Bidder's Name:		
	Wdg - I Wdg - II Wdg - III		
4.	Rated primary voltage	kV	
5.	Rated secondary voltage	 V	
6.	Rated output per phase	VA	
7.	Rated burden	VA	
8	Rated frequency	 Hz	
9.	Standard values of rated voltage factor	.....	
10.	Limits of temperature rise	.....	
11.	One-minute power frequency withstand voltage	kV(rms)	
12.	1.2/50 microsecond lightning impulse withstand voltage	kV(peak)	
13.	250/2500 micro second impulse switching surge withstand test voltage of capacitor (dry wet) (kV peak)	.....	
14.	Total weight and dimensions	Kg	
15.	Limits of voltage error and phase displacement in %	.....	
16.	Phase angle error	.....	
17.	Voltage error	.....	
18.	Accuracy class at rated burden	.....	
19.	Voltage factor and rated time	.....	
20.	Total weight	.....	
21.	Details of the tests to be conducted by the manufacturer at works		
	i) Type tests		

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CLAUSE NO	GAS INSULATED SWITCHGEAR (GIS)
	 Bidder's Name: ii) Routine tests 22. Tests to be conducted at site E) SURGE ARRESTORS 1. Manufacturer 2. Type designation 3. Arrestor Class & Type 4. Rated Voltage of Arrestor kV 5. Normal continuous operating voltage (MCOV) kV 6. i) Minimum discharge capability (kj/kV) referred to rated voltage at minimum of discharge characteristics ii) Line Discharge class, as per IEC 7. Maximum discharge current (8/20 microsecond wave) kA 8. Maximum 0.5 microsecond discharge voltage kV 9. Maximum residual voltage for 8/20 micro sec current wave i) at 50% nominal discharge current (kVp) ii) at 100% nominal discharge current (kVp) iii) at 200% nominal discharge current (kVp) 10. Maximum switching surge protective voltage kV(peak) 11. a) One minute power frequency (dry) withstand voltage of arrester (kVrms)

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CLAUSE NO	GAS INSULATED SWITCHGEAR	
	Bidder's Name:	
	b) Impulse withstand test voltage of arrester housing with 1.2/50 micro sec wave, (kVp) 	
	c) Impulse current withstand 	
	i) High current short duration (4/10 micro sec. wave) kAp 	
	ii) Low current short duration (A peak) 	
	12. Partial discharge level at 1.1 Un/√3 pico-coulomb	
	13. Radio interference level at 266 KV (rms) Microvolts	
	14. High current short duration test value 	
	15. Short circuit capability & class of pressure relief device 	
	16. l)Maximum internal ionisation at 50 Hz voltage equal to 	
	i) 1.05 COV 	
	ii) 1.0 COV 	
	17. a) Reference voltage and corresponding reference current of arrester 	
	b) Maximum internal leakage current at (mA) 	
	i) COV 	
	ii) 1.1 COV 	
	iii) COV at 150 deg. C 	
	iv) Reference voltage 	
	c) Pressure relief class 	

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CLAUSE NO	GAS INSULATED SWITCHGEAR 	
	Bidder's Name: 18. Protective level provided by surge arrestor 19. Energy level kJ/kV 20. Details of the type test reports enclosed and the standards as per these tests have been carried out. 21. Whether SF6 Gas insulated Yes/No G) SUPPORT & BARRIER INSULATORS (Details for each type of insulator used to be indicated separately) Support Barrier 1. Manufacturer & address 2. Type of insulators used 3. One-minute power frequency dry withstand test voltage kV 4. Dry flashover value kV(rms) 5. Wet flashover value kV(rms) 6. 1.2/50 microsecond lightning impulse withstand test voltage kV(peak) 7. Creepage distance mm 8. Puncture value of insulator in SF6 gas kV 9. Weight of insulators in the SF6 GIS enclosure. Kg H) GROUNDING CONNECTION a. Type of conductor b. Arrangement for connecting conductor to ground c. Type of painting, if any required to be carried out at end points of ground riser I) DESIGN CLEARANCE	

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CLAUSE NO	GAS INSULATED SWITCHGEAR .
	Bidder's Name: Minimum insulating clearances at nominal rated SF6 gas pressure and rated voltage/BIL voltage for the following : a) Main bus to ground b) Circuit breaker - Contact to ground - Across the contacts c) Isolator switches - Contact to ground - Across the contacts d) Safety grounding switches - Contact to ground - Across the contacts J) TOLERANCES 1. Tolerance (vertical & horizontal) and at interface of SF6 to Transformer oil bushing 2. Tolerance (vertical & horizontal) and at interface of SF6 to GIS bus Reactor bushing SIGNATURE AND SEAL OF BIDDER

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CLAUSE NO.	BIDDER'SNAME	AS APPLICABLE
	EHV INSULATORS	
A.	BUSHING / HOLLOW INSULATORS	
	(Bidder shall furnish these data for each equipment separately i.e . for circuit Breakers, Instrument Transformer, Surge Arrestors, etc.)	
	1. Manufacturer's Name	.....
	2. Country of Manufacturer	.....
	3. Type	.....
	4. Applicable Standards	.....
	5. i) Height	.....
	ii) Diameter (Top)	.....
	iii) Diameter (Bottom)	.....
	6. Creepage distance	.....
	a) Total (mm)	.....
	7. Rated Voltage	.....
	8. Power frequency withstand voltage for 1 min. (kv rms)	.....
	i) Dry	.....
	ii) Wet	.....
	9. 1.2/50 micro sec. impulse withstand voltage (kVp)	.....
	10. 250/2500 Micro sec. switching impulse withstand voltage (kVp)	
	i) Dry	
	ii) Wet	

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CLAUSE NO.	BIDDER'S NAME	
B.	11. Weight (Kg)	
	12. Cantilever Strength (Kg)	
	13. OGA drawing enclosed	Yes/No
	BUS POST INSULATOR	
	(Bidder shall furnish these data for solid core Insulators for Disconnecting switches, bus support, etc. separately)	
	1. Manufacturer's Name	.....
	2. Country of Manufacturer	.....
	3. Type of Insulator (Product No.)	.....
	4. Applicable Standards	.....
	5. No. of units per Stack	.....
	6. Diameter & No. of Bolts	.....
	ii) Top	.....
	ii) Bottom	.....
	7. Bolt circle diameter (mm)	.....
	ii) Top	.....
	iii) Bottom	.....
	8. Height of complete stack (mm)	.....
	9. Total Creepage distance (mm)	.....
	10. Power frequency withstand voltage of insulator with corona ring	
	i) Dry (kV rms)	
	ii) Wet (kV rms)	

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CLAUSE NO.	BIDDER'SNAME	
	11. 1.2/50 micro sec. impulse withstand voltage (kVp) of insulator with corona ring i) Dry (kV rms) ii) Wet (kV rms)	
	12. Min. Corona Extinction Voltage (kV)	
	13. Radio Interference Voltage at 1.1 Um/√3(micro volts) for frequency between 0.5 to 2.0 MHz	
	14. Weight of complete stack (kg)	
	15. Cantilever strength i) Upright (kg) ii) Under (kg)	
	16. Tensile Strength (kg)	
	17. Torsional strength (kg/m)	
	18. Compression strength(kg)	
	19. OGA drawing enclosed	Yes/No
	20. Type test report enclosed	Yes/No
C.	STRING INSULATOR (Bidder shall furnish this data separately for each voltage rating)	
	1. Manufacturer a) Insulator b) Hardware	
	2. Applicable Standards	
	3. Type of Insulator	

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CLAUSE NO.	BIDDER'S NAME	
	a) Ball & Socket/other b) Normal/antifog 4. Insulating Material 5. No. of units per String 6. Size of each unit a) Diameter of disc (mm) b) Spacing between adjacent Units (mm) 7. Weight a) Each Disc (Kg) b) Complete String (Kg) 8. Creepage distance a) Each Disc (Kg) b) Complete String (Kg) 9. Power frequency withstand voltage a) Each Disc i) Dry (kV) ii) Wet (kV) b) Complete String (Kg) i) Dry (kV) ii) Wet (kV) 	

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CLAUSE NO.	BIDDER'S NAME	
	10. Impulse withstand voltage	
	a) Each Disc	
	i) Positive (kVp)	
	ii) Negative (kVp)	.....
	b) Complete String (Kg)	.....
	i) Positive (kVp)	.....
	ii) Negative (kVp)	.....
	11. Switching Surge Withstand	.....
	a) Each Disc (kVp)	.....
	b) Complete String (kVp)	.....
	12. Power Frequency Puncture withstand voltage of each disc (kV rms)	.....
	13. Elector Mechanical Strength	Yes/No
	a) Each Disc (Kg)	.....
	b) Complete String (Kg)	.....
	i) Single tension	.....
	ii) Double tension	
	14. OGA drawing enclosed	Yes/No
	15. Type test report enclosed	Yes/No

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CLAUSE NO.	BIDDER'S NAME	AS APPLICABLE
1.	MOTORS (Bidder shall fill up the data for Circuit breakers and Disconnectors/Isolator and earth switches/High speed earth switches separately)	
	a)	Manufacturer
	b)	Equipment
	c)	Motor type
	d)	Frame size & type designation
	e)	Applicable standard to which motor conforms
	f)	Rated output at 50 deg. C outside air ambient temperature(KW)
	g)	Max. power input to the driven equipment at design duty point (KW)
	h)	Max. power input to the driven equipment (KW) over entire operating range.
	i)	At rated speed
	ii)	AT 103% speed
	i)	Class and type of insulation
	j)	Type of enclosure, and method of cooling
	k)	Degree of protection
	l)	Rated voltage and frequency (HZ)
	m)	Rated speed
	n)	Efficiency at design duty point (without -ve tolerance)

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CLAUSE NO.	BIDDER'S NAME	
	o) Power factor at design duty point 	
	p) Type of mounting 	
	q) Type of terminal box for stator leads 	
	r) Bearing type 	

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