BPC 0007

ENQUIRY

TWO PART BID

भारत हैवी इलेक्ट्रिकल्स लिमिटेड, पिपलानी, भोपाल - ४६२०२२(भारत)
सामग्री प्रबंधन विभाग

BHARAT HEAVY ELECTRICALS LIMITED, PIPLANI, BHOPAL – 462022(INDIA)
MATERIALS MANAGEMENT DIVISION

TIN NO. 23573600001 | ECC NO.AAACB4146PXM009 | MPCT NO. HEL/05/01/0001/S15/11/79

PHONE: 91-755-2500100 (7 LINE) FAX: 91-755-2500023 WWW.BHELBHOPAL.COM

ENQUIRY NO	E1643160
ENQUIRY DATE	22/02/25
ENQUIRY DUE DATE	22/03/25

ENQUIRY

SUPP NAME AND ADDRESS	SUPP CODE	REV CD	REV NO	REV DATE	NO OF CATY2	NO OF CATY3	ENQ NO OF ITEMS	INDENT NO
OFFICE COPY		1	0	NA	0	0	6	340143008

GUARANTEE CERTIFICATE	Y	**SUPPLY CONDITION**	AS PER ITEM DESCRIPTION
TEST CERTIFICATE	Y		
INSTRUCTION BOOKLET	N	**TECHNICAL CONDITION**	AS PER ITEM DESCRIPTION
SAMPLE	N		
GATE PASS	Y	**INSPECTION CONDITION**	TPIA/BHEL/NPCIL

NOTE: QUOTE PRICE BOTH IN FIGURES & WORDS.IN CASE OF MISMATCH PRICE IN WORDS WILL BE VALID,QUOTATIONS NOT BEARING ENQUIRY NO AND DUE DATE LIABLE TO BE REJECTED.

SL NO	MATERIAL CODE	DESC	UNIT	ITEM QTY	LOT NO	LOT QTY	DEST	DELIVERY DATE
1	SM4120856003	PILOT OPERATED MAIN STEAM SAFETY VALVE AS PER SPECIFICATION NUMBER KAIGA -5&6/PC/E/08001.	NO	24.000	1	12.000	201	21/05/27
					2	12.000	201	26/11/27
2	SM4120856011	UNUSED SPARES FOR PILOT OPERATED MAIN STEAM SAFETY VALVE AS PER SPECIFICATION NUMBER KAIGA -5&6/PC/E/08001.	ST	2.000	1	1.000	201	21/05/27
					2	1.000	201	26/11/27
3	SM4120856020	UNUSED ERECTION AND MAINTENANCE TOOLS AND TACKLES FOR PILOT OPERATED MAIN STEAM SAFETY VALVE AS PER SPECIFICATION NUMBER KAIGA -5&6/PC/E/08001.	ST	2.000	1	1.000	201	21/05/27
					2	1.000	201	26/11/27
4	SM4120856038	TEST KIT FOR SET PRESSURE TESTING OF PILOT OPERATED MAIN STEAM SAFETY VALVE AS PER SPECIFICATION NUMBER KAIGA -5&6/PC/E/08001.	ST	1.000	1	1.000	201	21/05/27
5	SM4120876004	PILOT OPERATED MAIN STEAM SAFETY VALVE AS MANDATORY SPARES AS PER SPECIFICATION NUMBER KAIGA -5&6/PC/E/08001.	NO	3.000	1	3.000	201	26/11/27
6	SM4120856003	ASSISTANCE TO ERECTION AND COMMISSIONING FOR PILOT OPERATED MAIN STEAM SAFETY VALVE (1 NO = 1 WEEK WITH ENGINEER.)	NO	2.000	1	1.000	201	23/08/27
					2	1.000	201	12/03/28

REMARK 1. OFFER TO BE SUBMITTED IN TWO PART BID I.E, `TECHNICAL BID' & `PRICE BID'. 2. REFER GCC & `ANNEX' FOR COMMERCIAL TERMS AND TECHNICAL TERMS. 3. PLEASE FURNISH DULY FILLED AND ENDORSED COPY OF BHEL GTC (BP 200102), ANNEXURE B, ANNEXURE C ALONG WITH OFFER. 4. ALL THE ITEMS SHALL BE PROCURED FROM THESAME VENDOR. HENCE, EVALUATION TO BE DONE ON OVERALL BASIS. 5. INSPECTION SHALL BE DONE BY BHEL/ BHEL APPOINTED TPI AND NPCIL. 6. BEING GLOBAL TENDER ENQUIRY, MAKE IN INDIA CLAUSE: - PPP-MI ORDER DATED 04.06.2020 SHALL BE APPLICABLE, IN COMPLIANCE WITH THE LATEST AMENDMENTS. ALL THE CLASS-I & CLASS-II AND NON-LOCAL VENDOR SHALL BE CONSIDERED. 7. PURCHASE PREFERENCE SHALL BE GIVEN TO MSE BIDDER I.E. 100% QUANTITY SHALL BE OFFERED TO MSE VENDORS SUBJECT TO MATCHING OF L-1 RATE IF L2 RATE IS L1+15%. 8. SIGNED COPY OF INTEGRITY PACT SHALL BE FURNISHED BY VENDOR (DULY SIGNED AND SEALED). 9. REVERSE AUCTION IS APPLICABLE. 10. BIDDER EXCEPT OEM HAS TO SUBMIT AUTHORIZATION CERTIFICATE FROM OEM. 11. ITEM IS DIRECTLY DISPATCHED TO THE SITE. TO

NOTE:BHEL,BHOPAL'S Standard Terms & Conditions BP4255/MM5533 rev02 for imports and BP4255/MM5527 rev03 for indigeneous procurements form a part of this Enquiry.Bidders may obtain from us copies of these terms and conditions if not already available.

SPECIAL REMARKS

NAME : RASHMI PRATIMA KUJUR

DESG : MANAGER

SIGN & SEAL

BPC 0007

ENQUIRY

TWO PART BID

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सामग्री प्रबंधन विभाग

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ENQUIRY NO E1643160
ENQUIRY DATE 22/02/25
ENQUIRY DUE DATE 22/03/25

ENQUIRY

CONSIGNEEADDRESS: CHIEF CONSTRUCTION ENGINEER, KAIGA ATOMIC POWER PROJECT-5&6 (KAIGA-5&6) KAIGA SITE, VIA - KARWAR, DIST- UTTAR KANNADA, KARNATAKA- 581400.12. VENDOR TO SUBMIT AUDITED BALANCE SHEET/CA CERTIFICATE OF LAST THREE FY. 13. VENDOR TO SUBMIT VENDOR CREDENTIAL FOR NPCIL APPROVAL. 14. PRICE BIDSHALL BE OPEN ONLY NPCIL APPROVED VENDORS. 15.REQUIRED DELIVERY IS 720 DAYS(TENTATIVE) FROM THE DATE OF DOCUMENT APPROVAL AFTER PO PLACEMENT DATE.16. REVERSE AUCTION IS APPLICABLE. 17. ASSISTANCE TO ERECTION AND COMMISSIONING FOR PILOT OPERATED MAIN STEAM SAFETY VALVE (1 NO = 1 WEEK WITH ENGINEER.)

DRAWING Y **PURCH SPEC** Y **CATALOUGE** N **PLAN** Y **TWO PART BID** Y

S.NO	INDENT NO	ITEM NO	CATEGORY	ENQUIRY QTY.
1	340143008	1	759100	24.000
2	340143008	2	759100	2.000
3	340143008	3	759100	2.000
4	340143008	4	759100	1.000
5	340143008	5	759100	3.000
6	340143008	6	759100	2.000

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SPECIAL REMARKS

NAME : RASHMI PRATIMA KUJUR
DESG : MANAGER

SIGN & SEAL

Techno-Commercial Bid
(To be filled by supplier and submit with offer)

Tender No.		E1643160
SL No	quantity	Item description
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2	2 Set	UNUSED SPARES FOR PILOT OPERATED MAIN STEAM SAFETY VALVE AS PER SPECIFICATION NUMBER KAIGA -5&6/PC/E/08001.
3	2 Set	UNUSED ERECTION AND MAINTENANCE TOOLS AND TACKLES FOR PILOT OPERATED MAIN STEAM SAFETY VALVE AS PER SPECIFICATION NUMBER KAIGA -5&6/PC/E/08001.
4	1 Set	TEST KIT FOR SET PRESSURE TESTING OF PILOT OPERATED MAIN STEAM SAFETY VALVE AS PER SPECIFICATION NUMBER KAIGA -5&6/PC/E/08001.
5	3 No.	PILOT OPERATED MAIN STEAM SAFETY VALVE AS MANDATORY SPARES AS PER SPECIFICATION NUMBER KAIGA -5&6/PC/E/08001.
6	2 No.	ASSISTANCE TO ERECTION AND COMMISSIONING FOR PILOT OPERATED MAIN STEAM SAFETY VALVE (1 NO = 1 WEEK WITH ENGINEER.)
Remarks :		(1) OFFER TO BE SUBMITTED IN TWO PART BID I.E. 'TECHNICAL BID' & 'PRICE BID' THROUGH NIC PORTAL (HTTPS://EPROCUREBHEL.CO.IN/NICGEP/APP). (2) REFER GTC &'ANNEXURES' FOR COMMERCIAL TERMS AND TECHNICAL TERMS. (3) PLEASE FURNISH DULY FILLED AND ENDORSED COPY OF BHEL GTC (BP 200102), ANNEXURE B, ANNEXURE C AND ANNEXURE-D STAMPED ALONG WITH THE OFFER. (4) PLEASE ACCEPT OUR TECHNO COMMERCIAL OFFER IN TOTO. (5) ENQUIRY TECHNICAL TERM : AS PER DESCRIPTION. (6) INSPECTION TERMS : BHEL QC / BHEL APPOINTED TPI AND NPCIL. (7) ORIGINAL TC & GC IS REQUIRED ALONG WITH MATERIAL AT THE TIME OF SUPPLY TO BHEL. (8) BIDDER OTHER THAN OEM TO SUBMIT AUTHORIZATION CERTIFICATE FROM OEM ALONG WITH OFFER. (9) ANY DEVIATION FROM OUR COMMERCIAL CONDITION SHALL BE SUITABLY LOADED IN THE OFFERED PRICE. (10) SUPPLIER TECHNICAL TERM : TO BE PACKED PROPERLY WITH PHYSICAL PROTECTION. (11) All the credentials submitted by the vendors shall be reviewed & approved by BHEL & NPCIL and if any additional document required by NPCIL/BHEL, BIDDER shall furnish the same along with the offer. (12) Final price bid shall be opened only for those vendors who will be approved by the end customer (NPCIL) on the basis of credentials. (14) Integrity Pact shall be furnished by vendor(duly signed and sealed). (15) Purchase Preference shall be given to MSE bidder i.e. 100% quantity shall be offered to MSE Vendors subject to matching of L-1 Rate if L2 rate is L1+15%. (16) Financial Turnover criteria proposed to be kept as Rs. 7 Crore. Vendor to submit financial documents (i.e AUDITED BALANCE SHEET/CA CERTIFICATE OF LAST THREE FY). (17) Required delivery is 720 days(tentative) from the date of document approval after PO placement date. (18) Item is directly dispatched to the site. To consignee address: Chief Construction Engineer,Kaiga Atomic Power Project-5&6 (KAIGA-5&6),Kaiga Site,Via - Karwar, Dist-Uttar Kannada,Karnataka-581400. (19) ALL THE ITEMS SHALL BE PROCURED FROM THE SAME VENDOR. HENCE, EVALUATION TO BE DONE ON OVERALL BASIS. (20) Vendors to fulfills all the requirements mentioned in bid PQR and Technical Prequalification requirements (PQR) for MSIV MW Kaiga 5 & 6 . (21) ePBG OF 5% IS APPLICABLE. (22) BEING GLOBAL TENDER ENQUIRY, MAKE IN INDIA CLAUSE: - PPP-MI ORDER DATED 04.06.2020 SHALL BE APPLICABLE, IN COMPLIANCE WITH THE LATEST AMENDMENTS. ALL THE CLASS-I & CLASS-II AND NON-LOCAL VENDOR SHALL BE CONSIDERED (23) PQR NO STE-Z16-507-02 IS APPLICABLE.

Sr. No.	ELEMENTS	Standards	To be offered/confirmed by supplier	Remarks, if any
1	Quotation Reference & date	As per supplier		
2	HSN / SAC code	As per supplier		
2A	GST TYPE & ITS PERCENTAGE APPLICBALE item wise mentioned in the offer (IGST/CGST+SGST/UGST)	As per supplier		
3	Quotation Currency	In INR		
4	E-Mail	As per supplier		
5	Phone/Mobile	As per supplier		
6	Contact Person	As per supplier		
7	Order to be placed on	As per supplier		
8	Address	As per supplier		
9	Minimum delivery period to be quoted in no of weeks from the date of receipt of Purchase Order. If any document approval is required then the delivery period shall start from the date of document approval however vendor shall submit all documents with in 10 days of issue of PO. And subsequent submission shall be within 7 days in case any revision required.	As per supplier		
10	Prices shall be firm till delivery	Yes		

Techno-Commercial Bid
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11	**INSPECTION**: BHEL/customer and/or Third party appointed by BHEL shall do Inspection at your works. Third party inspection charges shall be borne by BHEL. Any other inspection/ testing charges if any are to be included in the quoted prices. Minimum 10 days' notice to be given for inspection. Please confirm.	Yes		
12	**Delivery Destination**: - The material is required to be **supplied** to Site. Consignee address: Chief Construction Engineer, Kaiga Atomic Power Project-5&6 (KAIGA-5&6),Kaiga Site, Via - Karwar, Dist-Uttar Kannada, Karnataka-581400.	Yes		

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13	Price to be furnished on **FOR destination Site**, duly insured basis inclusive of P&F charges.	Yes		
14	Quoted for all the items of tender enquiry	Yes / No. (If "No" please mention item number of regreted items)		
15	Technical Specifications	Accepted as per enquiry / Accepted with deviation (If select Accepted with deviation, please mention the deviation)		
16	TC , GC and ALL Inspection report as per tender enquiry and specification will be submitted along with each consignment.	Yes (In case of "No" your offer may be rejected).		
17	Brand Name, If any.	As per supplier		
18	Supply from	As per supplier		
19	Quotation Validity will be 120 days from the date of techno-commercial bid opening.	Yes		
20	Are you registered under MSMED ACT 2006 as small or micro.	Yes / No (If select Yes, please enclosed valid MSE/UAM/UDYAM certificate)		
21	Payment terms: 100% payment within 90 days of receipt (45 days for MSE & 60 days for Medium/ NSIC registered suppliers under as per relevant act in force) subject to acceptance of material at BHEL, on direct presentation of the documents. Any deviation from the above payment terms, if accepted (by BHEL), shall be loaded @ SBI base rate + 6% for the purpose of bid evaluation.	90 days /45 Days (If supplier is MSE, please select 45 days)		

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Sr. No.	ELEMENTS	Standards	To be offered/confirmed by supplier	Remarks, if any
22	Other Charges (If any)	Applicable / Not Applicable. (If applicable please mention percentage (%) / Value (along with type of charges).		
23	Transit Insurance will be in supplier scope	Yes		
24	Penalty: - LD shall be 0.5% of the total order value per week of delay or part thereof, subject a maximum of 10% of the total order value (Please refer clause 9 of GCC - BP-200102).	Yes / No (In case of "No", your offer will be loaded suitably)		
25	General terms and conditions of enquiry (Form No. BP-200102) is Acceptable.	Yes (In case of "No" your offer may be rejected).		
26	Special Terms and conditions of enquiry (Annexure B) is acceptable.	Yes (In case of "No" your offer may be rejected).		
27	Confirm whether bidder is Manufacturer or Trader or Dealer of items under enquiry. In case of Trader or Dealer, please furnish authorization certificate from OEM.	As per supplier		
28	Submitted duly seal & signed on all pages Annexure C , Annexure -D, Integrity Pact	Yes (In case of "No" your offer may be rejected).		
29	Submitted duly seal & signed on all pages – BHEL GTC (BP200102)	Yes (In case of "No" your offer may be rejected).		

NUCLEAR POWER CORPORATION OF INDIA LIMITED

(A Govt. of India Enterprise)

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TECHNICAL SPECIFICATION FOR

PILOT OPERATED MAIN STEAM SAFETY VALVE

BHARAT HEAVY ELECTRICALS LTD.				**NPCIL'S ACCEPTANCE**			
	NAME	**SIGN**	**DATE**		**NAME**	**SIGN**	**DATE**
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PILOT OPERATED MAIN STEAM SAFETY VALVES

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NPCIL PROPRIETARY

TABLE OF CONTENTS

SECTION	TITLE	PAGE NO.
1)	SCOPE	7
2)	APPLICABLE DOCUMENTS	7
3)	SYSTEM DESCRIPTION	8
4)	MATERIALS AND WORKMANSHIP	9
5)	DESIGN AND CONSTRUCTION REQUIREMENTS	9
6)	SPECIAL TOOLS AND TACKLES	13
7)	SPARES	13
8)	WELDING	13
9)	INSPECTION AND QUALITY SURVEILLANCE	14
10)	EXAMINATION AND TESTING	15
11)	PROCEDURE, DOCUMENTATION AND ANALYSES	18
12)	VALVE MARKING AND IDENTIFICATION	23
13)	PACKING AND SHIPMENT	23
14)	WARRANTY	24
15)	SPECIFICATIONS FOR SOLENOID PILOT VALVES	25
16)	DATASHEET FOR PILOT OPERATED MAIN STEAM SAFETY VALVE	26
17)	REFERENCES	29
ATTACHMENTS		
1)	TECHNICAL DATA TO BE SUBMITTED BY TENDERER ALONGWITH THE TENDER	30
2)	TYPICAL QUALITY ASSURANCE PLAN FOR POMSSV	36

3)	FLOOR RESPONSE SPECTRA AND G-VALUE FOR CONTROL BUILDING AT EL. 116m	43
4)	SCHEDULE OF BIDDER'S GENERAL PARTICULARS	73
5)	SCHEDULE OF BIDDER'S EXPERIENCE	75
6)	SCHEDULE OF DRAWINGS / DOCUMENTS TO BE SUBMITTED ALONG WITH THE BID	76
7)	SCHEDULE OF GUARANTEES	77
8)	SCHEDULE OF DEVIATIONS FROM TECHNICAL SPECIFICATIONS	79
9)	SCHEDULE OF ERECTION AND MAINTENANCE TOOLS AND TACKLES	80
10)	SCHEDULE OF WEIGHTS AND DIMENSIONS	81
11)	SCHEDULE OF ACTIVITIES	82
12)	SCHEDULE OF PERFORMANCE AND EFFICIENCY TEST INSTRUMENTS	84
13)	SCHEDULE OF PLACES OF TESTS AND INSPECTION	85
14)	SCHEDULE OF SUB CONTRACTORS & SUB VENDORS	86
15)	SCHEDULE OF ERECTION EQUIPMENT	87
16)	DOCUMENT DISTRIBUTION SCHEDULE	88
17)	GA DRAWING OF POMSSV	89

1.0 SCOPE

This specification covers the technical requirements for the design, manufacture, assembly, examination, testing, supply and guarantee of Pilot Operated Main Steam Safety Valves (POMSSVs) for Secondary System for 700MWe PHWR plants.

The scope of supply for the two units of the Atomic Power Projects shall be as follows:

(i) Safety Relief Valves: Twenty-four (24) nos.

(ii) Mandatory Spares - 3 Nos. of complete valve

(iii) Two (2) sets of unused spares

(iv) Two (2) sets of unused erection and maintenance tools and tackles.

(v) One (1) test kit for set pressure testing.

2.0 APPLICABLE DOCUMENTS

All documents listed below, of the issue in effect on the date of Notice Inviting Tender (N.I.T.), constitute a part of this specification. In the event that certain provisions of the codes and standards listed below conflict with the provisions of this specification, the provisions of this specification shall govern.

2.1 Codes and Standards

ASME	:	Boiler and Pressure Vessel Codes
Section II Part A	:	Ferrous Material Specification
Section II Part C	:	Specification on Welding Rods, Electrodes and Filler Metals
Section III Div.1	:	Sub-Section NC – Class 2 Components
Section V	:	Non-Destructive Examination (NDE)
Section IX	:	Welding and Brazing Qualifications
ANSI B-16.5	:	Steel Pipe Flanges and Flanged Fittings
ANSI B-16.10	:	Face to Face and End to End Dimensions of Ferrous Valves
ANSI B-16.11	:	Forged Steel Fittings Socket Welding &

		Threaded
IEEE Std. 344	:	IEEE Recommended Practices for Seismic Qualifications of Class-1E Equipment for Nuclear Power Generating Stations.
IEEE Std. 382	:	IEEE Standard for Qualification of Safety Related Valve Actuators
ANSI/ASME QME-1	:	Qualification of active mechanical equipment used in Nuclear Power Plants
PP-P-1819	:	Technical specification on methods and procedures for seismic qualification of valves, panels, devices rotating and reciprocating equipment, tanks, vessels & supports.

The Bidder shall indicate date of issue of applicable codes in their bid.

In case the Bidder refers to any other standards, these shall be equal to or better than the standards listed above. However, use of such standards shall be subject to approval of the Purchaser.

3.0 SYSTEM DESCRIPTION

The primary function of the Secondary System is to transfer the heat produced in the reactor core to the turbine for production of power. Steam is generated in four Steam Generators (SGs) in each unit of 700 MWe PHWR. These SGs are located inside Reactor Building (RB). From each SG a steam line of size 650 NB is taken out of RB after penetrating the containment walls. One Main Steam Isolation Valve (MSIV) on each steam line is provided. These steam headers lead steam to HP turbine.

Overpressure protection to SGs is taken care by three Pilot Operated Main Steam Safety Valves and Instrumented Atmospheric Steam Discharge Valves (ASDV). These are mounted on each steam line upstream of MSIV, outside RB, on pipe and cable bay of control building at an elevation of 116.5 M.

POMSSVs are required to operate automatically when steam pressure increases more than a specified value (set pressure). POMSSVs are also required to operate even at low steam pressure in remote manual mode or auto mode (during a station blackout accident for manual crash cool down or auto crash cool down in case of LOCA (Loss of Coolant Accident)/MSLB (Main Steam Line Break) of primary heat transport

system). To facilitate manual opening of POMSSVs from control room, pilot operated MSSVs have been envisaged. MANUFACTURER shall make provision such that these MSSVs can be opened remote manually/automatically from control room at pressure lower than set pressure.

The section of main steam system from SGs to MSIVs are classified as per ASME Section III – NC.

4.0 MATERIALS AND WORKMANSHIP

4.1 All materials shall be selected by the supplier to the appropriate ASME or equivalent specifications except that proprietary materials may be used for special items such as valve trims and the same will be indicated in the bid. It will be subjected to the approval of the Purchaser.

4.2 Material of construction for major parts of the valves shall be as follows:

Body, bonnet and yoke: ASME SA 350 LF2/ASME SA 352 LCB/ Alternative material to be proposed by Bidder.

Hard facing of parts / areas as appropriate shall be carried out. This shall be highlighted in the bid.

4.3 Materials and standard parts which are not specifically designated herein shall be of good quality and in accordance with the best practice pertinent to the manufacture of safety valves for main steam service.

4.4 The bidder may quote alternate materials suitable to withstand the specified duty. These shall be subject to Purchaser's approval. Equivalent ASME standard shall be indicated in the bid and the equivalence shall be established by the bidder.

4.5 All pressure retaining parts, nozzles, discs, spindles and springs shall be identified with correlating test certificates. Examination and repair of pressure retaining material shall be carried out as per NC-2500 of ASME Section III.

4.6 Workmanship shall be in accordance with the best practice adequate to ensure satisfactory operation, service life and ease of maintenance in accordance with the requirements of this specification.

5.0 DESIGN AND CONSTRUCTION REQUIREMENTS

5.1 General

The pilot operated main steam safety relief valves are located in main steam lines.

5.1.1 The main steam safety valves shall be designed and constructed to meet the requirements of ASME Boiler and Pressure Vessel Code, Section III, Sub-Section NC. The main steam piping on which these valves are mounted is designed for SSE (Safe

Shutdown Earthquake) corresponding to service level C. These valves shall be capable of operation during and after an SSE event. The valves shall be installed in an upright position.

5.1.2 The valve design shall be in accordance with high degree of engineering practice to ensure satisfactory operation over an expected life of 40 years.

5.1.3 The bidder shall indicate the life of all the components that would require replacement and the replacement schedule. The bidder shall also indicate the inspection required and its schedule for all the components of the valve.

Parts which are subjected to wear, corrosion or other deterioration and requiring adjustment, inspection or repair, shall be accessible and capable of removal for repair / replacement whenever required. Where applicable wearable parts shall have means of adjustment.

5.1.4 The operation of the MSSVs may be remote manual or automatic under normal conditions such as start-up, shutdown, etc. and under emergency conditions.

5.1.5 The lowest pressure at which the valves can operate in remote manual/auto mode has to be furnished by the Bidder.

5.1.6 All the MSSVs shall have position indicating arrangements and provision for annunciation shall be provided on the control panel in the main control room.

5.1.7 Requirement of supporting arrangements may be indicated with the proposal.

5.1.8 The closure at the joint between the body and the bonnet or other similar openings shall be one of the following:

a) Pressure seal type

b) Bolted type with metallic gasket (ring joint retained spiral wound gaskets or similar types).

The Bidder shall clearly describe the proposed method of closure. Alternatives to those listed above shall be subject to approval of the Purchaser.

Surface finish under spiral wound type gaskets shall be 3.2 micron RMS or better.

5.1.9 The valve design shall ensure that there is no accumulation of fluid in any part of the valve. If necessary, drain pocket shall be provided in the discharge connection.

5.1.10 Components and spare parts of valves shall be interchangeable to the maximum practical extent.

5.1.11 Weld repair on castings shall be subject to Purchaser’s approval. Welding procedure and welders shall be qualified prior to weld repair.

5.1.12 Operating and design requirements for safety valves shall be as per NC-7500.

a) The pilot operated pressure relief valve shall operate independently of any external energy source. The valve shall be actuated directly by the fluid pressure of the protected system.

The set pressure tolerance shall apply only to the pilot valve. The set pressure tolerance plus or minus shall not exceed 0.7031 kg/cm2g (10 psi). Conformance with these requirements shall be established for each production valve by test. [Ref. NC-7522.5(a), (b) and (c)].

The main valve shall operate in direct response to the pilot control device. The valve shall be constructed to attain rated lift under stable conditions at pressures which do not exceed the set pressure by 3%. [Ref. NC-7522.3].

Solenoid valves(SVs) used as pilot valves are required to open the relief valves at steam pressures lower than the normal setting also whenever remote manual actuation is required.

The arrangement of control line piping may be indicated.

5.1.13 The pressure parts of the safety valves shall be designed considering the following.

Inlet end : BW as per ANSI B 16.25

Outlet end : Flanged as per ANSI B 16.5

5.1.14 The valve body and flanges shall be designed to withstand forces and moments due to steam discharge.

5.1.15 The valve shall be demonstrated to meet the seismic design and performance criterion given in para 5.3 of the specification.

5.1.16 The design and materials for the valve trim shall provide maximum protection against the effect of corrosion, erosion, galling and leakage.

5.1.17 Bolts, studs and nuts for body bonnet shall meet the requirements of relevant standard and shall also be examined in accordance with the requirements of NC-2580.

5.1.18 The BIDDER shall indicate the reliability/availability figures of the valve and basis for arriving at the same.

5.1.19 The valves when opened remote manually at a pressure less than set pressure should remain open till the system pressure falls to 5 Kg/cm2(g). The valves may start closing at 5 Kg/cm2(g) and get fully closed at 2 Kg/cm2(g). Any limitation to meet this requirement should be brought out clearly by the BIDDER.

5.1.20 BIDDER shall consider the effect due to pressure drop in main steam lines from steam generator up to SRV inlet on SRV functioning.

5.2 Design and Service Conditions

5.2.1 Listed below are the service conditions of the valves for each unit of the power project.

	Service Conditions/Parameters		
	Fluid to be handled		Steam, 0.25% wet (max.)
	Design pressure of Secondary Sys		55 $Kg/cm^2(g)$
	Set Pressures	1st relief valve	53.5 Kg/cm^2g
		2nd relief valve	55 Kg/cm^2g
		3rd relief valve	56.5 Kg/cm^2g
	Capacity	a) **For Pilot Operated Safety Relief Valves** : 532.7 Te/hr at a nominal set pressure of 55 Kg/cm^2g for all the valves. Though set pressures differ, capacity is same to have identical constructional details.	
	Blowdown		Nominal 5% , As per ASME section III NC requirements
	Back pressure		Atmospheric
	Operating steam pressure & Temperature	Full load	44 $Kg/cm^2(g)$ & 256 ^0C
		No load	44 Kg/cm^2g & 256^0C
	Opening Time		Less Than 1.5 sec.

5.2.2 The valves shall not simmer at operating pressure (44.0 Kg/cm^2g).

5.2.3 All the above valves shall be able to perform it's intended function in the environment of steam which can be released due to any pipe rupture around the valves. The valve shall be operable when it is in steam bound conditions at atmospheric pressure and 170°C temperature. BIDDER shall confirm this requirement is met.

5.2.4 BIDDER shall note that pilot operated main steam safety valves is located out door and shall be suitable for service in outdoor environment.

5.3 Qualification of Valves

Qualification of valves along with valve actuator and other accessories call for structural integrity of pressure boundary, superstructure and also functional performance of the valve under seismic loading.

Structural integrity of valve actuator assembly shall be demonstrated for all loading combinations, including end loads. The valves shall be designed for various loads viz. Dead weight; Sustained load; Pressure and Thermal Process Transients etc. In

addition, mechanical transients of Operating Basis Earthquake (OBE) and Safe Shutdown Earthquake(SSE) should be taken into account.

The valves are to be seismically qualified by analysis and/or test to demonstrate their intended functional performance during and after the seismic event as per ANSI/ASME QME-1-Section QV & PP-P-1819 etc. Qualification shall account for 5 (five) consecutive OBEs followed by 1 (one) SSE with a proper combination of other applicable concurrent loads. It may be noted that as per ANSI/ASME QME-1-Section QV, the valve can be qualified by simple equivalent static loading test or dynamic test. The various loads and applicable response spectra for seismic qualification has been provided (refer page 43-72 for Floor response spectra).

The manufacturer shall submit design, analysis and seismic qualification test procedures and reports to the Purchaser for approval.

BIDDER shall note that main steam safety valves are located out door and shall be suitable for service in outdoor environment.

Bidder may note that if the offered valve has already been qualified as per ASMEQME-1, then such valves need not be qualified again. However, the qualification report justifying the identicality of the offered valve & the already qualified valve shall be submitted for purchaser's approval.

The previous qualification report also shall be furnished for purchaser's scrutiny.

6.0 SPECIAL TOOLS AND TACKLES

The bidder shall list out and quote for each project one complete unused set of special tools and tackles recommended by him for erection, maintenance and set pressure testing of these valves.

7.0 SPARES

The bidder shall list and quote for additional spares recommended by him for five (5) years of satisfactory service for each unit.

8.0 WELDING

8.1 Welding Design Requirements

All welding materials shall follow the requirements of NC-2400.

The design of the welded joints on portions of or forming parts of the pressure containing envelope shall be in accordance with the ASME B&PV Code Section-III - NC, and in particular in accordance with NC-4000 thereof.

All welding procedures must be approved by the Purchaser prior to use in production.

Welding procedure and performance qualification shall meet the requirements of ASME Section – III – NC-4300 and Section –IX. Procedure qualifications for the welding of castings shall be performed on cast test specimens.

Pressure bearing welds, support attachments to pressure bearing parts and weld repairs thereof shall be performed in accordance with NC, with the following additional requirements and deviations to the listed paragraphs of NC.

a) All examination and testing required by Section 8.2 hereof shall be carried out at the appropriate time (NC-5120) in addition to any different examination and testing that may be required by ASME Code.

b) All pressure bearing welds shall be full penetration and radiographic quality butt welds. Socket welds shall not be used.

c) The maximum allowable off-set will be as per NC 4232 and NC 4233.

d) All welds including repair welds shall be post weld heat treated to the requirements of NC-4622.

e) Backing rings shall not be used (NC-4421)

f) Peening is not allowed (NC-4423.3)

g) All welds shall be ground on the outside surfaces and where accessible on the inside surfaces, to a 125 RMS finish. Undercuts are not allowed (NC-4424).

h) Root concavity or suck-back is not allowed (NC-4426).

i) Defects detected visually or by the examination and testing procedures specified in this specification shall be removed completely up to the acceptable limit, preferably by mechanical means. If thermal gouging is used, the gouged area shall be ground to a minimum depth of 1.6 mm for carbon steel and a minimum of 3.2 mm for stainless steel before repair and re-examination (NC-4453).

j) Weld repair of castings and forging shall be carried out in accordance with the requirements of NC-2570 and NC-2540.

8.2 General Welding Examination Required

Pressure bearing welds, support attachments to pressure bearing parts, weld repairs thereof and weld edge preparation shall be examined in accordance with the requirements of ASME Section III NC-4400, NC-5130, NC-5200, NF-4400 and NF-5200.

9.0 INSPECTION AND QUALITY SURVEILLANCE

Manufacturer / Sub-Vendor shall establish and maintain a documented Quality System. QA Manual / documented procedures and practices as applicable to this product are to be maintained. NPCIL reserves the right to audit manufacturer's / Sub-Vendor's Quality System before or during execution of NPCIL jobs and carry out follow-up audit if any non-conformances were observed during the audit.

Manufacturer / Sub-Vendor should address the following as a minimum in their QA manual / documented procedures:

Design Control, Document Control, Control on purchase of product, Manufacturing Process Control, Identification and traceability, Inspection and Test, Test Status, Non-conformance Control, Corrective and Preventive action, Control of Calibration of equipment and measuring instruments and Training.

9.1 The manufacturer shall provide inspection facility to establish and maintain the quality of workmanship in his works and that of sub-contractors to ensure the mechanical accuracy of each component, identity and acceptability of all materials, parts and equipment. He shall conduct all tests required to ensure that the equipment furnished conforms to the requirements of the applicable codes (ASME Section III NC). Spares for the valves will also be subjected to the same quality and requirements as the components of the assembled valves.

9.2 The manufacturer's quality surveillance shall be under the control of a competent person whose primary responsibility is quality control and reporting directly to the management and not to the production department.

9.3 All examination and testing shall be carried out in a manner satisfactory to and shall be subject to the approval by the Purchaser. The manufacturer shall submit the quality assurance plan and examination and test procedures for the approval of the Purchaser.

9.4 All work covered by this specification shall be subject to quality surveillance by the Purchaser or his authorized representative. He may choose to involve in various stages of examination and testing. He shall be notified well in advance of the manufacturing and quality surveillance programme and shall be given full access to the shop in which the equipment are being manufactured or tested to enable him to access compliance with the provisions of this specification. All test records, reference documents, plant standards and manufacturing procedures shall be made available to him.

All inspection, measuring and test equipment used for inspection and testing of manufacturer's / sub-vendor's works should have valid calibration certificate. Quality surveillance by the Purchaser or his representative shall not relieve the Manufacturer / sub-vendor of his surveillance duties called herein. Manufacturer shall forward the list of sub-vendors for purchaser's approval before placing order on sub-contractor.

10.0 EXAMINATION AND TESTING

Following paragraphs state the requirements of examination and testing to be carried out. For NDEs relevant sections of ASME Section III-NC shall be referred by the Manufacturer. Manufacturer / sub-vendor should Submit the NDE procedures for Purchaser's approval.

10.1 Material Tests

All materials designated as in accordance with SA specification shall be subjected to all co-related mill test certificate (original) of chemical and physical properties required by the appropriate SA specification.

Proof in the form of certified test report as mill certificates that the required tests have been carried out at the source will be acceptable, but if these are not available, the tests shall be performed by the Manufacturer. The sample for Physical and Chemical test shall be drawn by NPCIL, QS and should be tested in NPCIL approved laboratories by manufacturer. NPCIL, QS reserves the right for witnessing the physical testing.

10.2 Impact Testing

Impact tests as applicable should be carried out as per SA 352 LCB/SA 350 LF2.

10.3 Radiographic Examination

10.3.1 Castings / Forgings and Weld Repairs to Castings

All pressure retaining castings / forgings and weld repairs to castings shall be radiographed / ultrasonic examined to the extent and by methods in accordance with ASME Sec.III NC and shall meet the requirements thereof.

10.3.2 Full Penetration Welds

All fabrication welds joining pressure retaining parts of valves shall be completely radiographed. Radiography shall be in accordance with Sec. V of ASME Code and shall meet the acceptance standards of NC-5320 of ASME Sec.III.

Radiography shall be carried out as per approved procedure with shooting sketch of the radiographs.

10.4 Magnetic Particle (M.P.) and Liquid Penetrant (L.P.) Examination

10.4.1 Magnetic particle / liquid penetrant examination shall be performed in accordance with the procedure specified in NC-5000 of ASME Section III. M.P. examination shall be preferred over L.P. examination wherever possible.

10.4.2 M.P. / L.P. examination shall be done after final machining operation.

10.4.3 The components to be examined by this method are as follows:

a) All external and accessible internal surfaces of pressure bearing parts.

b) The complete surface area of the stem.

Root, after back gauging final surface of full penetration weld, final pass of fillet welds.

c) Final surface of all welds (this includes full penetration welds as well as fillet and seal welds).

d) NPCIL approved chemicals shall be used for L.P. examination.

10.4.4 **Acceptance Standards for M.P. Examination**

a) Castings and forging shall meet the acceptance standards of NC-2545 of ASME Sec. III.

b) Welds shall meet the requirements of NC-5340 of ASME Sec. III.

10.4.5 **Acceptance Standards for L.P. Examination**

a) Castings and forgings shall meet the acceptance standards of NC-2546 of ASME Sec. III.

b) Welds shall meet the requirements of NC-5350 of ASME Sec. III.

10.5 Ultrasonic Examination

Where ultrasonic examination is called for in this specification, applicable codes for the method used and acceptance standards shall be in accordance with the ASME Section III NC-2500 or 5330, as applicable.

10.6 Hydrostatic Test

Hydrostatic test shall be carried out both on the inlet side and outlet side of the valve body at pressures consistent with their respective flange ratings and in accordance with the requirements of NC-6200 of ASME Section III.

10.7 Seat Leakage Test

Seat leakage test at 95% of set pressure shall be carried out with steam. There shall not be any visible or audible leakage. Above 95% of set pressure leak rate shall be observed and noted.

Air leak test for body and back seat shall be carried out at 6 Kg/cm2g.

10.8 Functional Test

10.8.1 Test medium for all tests shall be steam. [Ref. NC-7522.5(c)].

10.8.2 Capacity certification of safety valves shall meet the requirements of NC-7710 and NC-7730 of ASME Sec. III. Proposed method for certification of capacity shall be indicated.

10.8.3 Set pressure for each valve shall be established by test with steam to demonstrate conformance with the opening pressure tolerance allowed by the code i.e. +0.7031 kg/cm2g (10 psi)

10.8.4 Adjustment for blow down shall be done for each valve by test at the stamped set pressure as per NC-7522.6 of ASME Sec. III NC.

10.8.5 The functional test shall be carried out to demonstrate that valve opens at set pressure within the required opening pressure tolerance, achieves full lift, and recloses within required blow down.

10.8.6 The Manufacturer shall indicate facilities to be provided for testing the valves during routine plant outages during which normal motive power for valve actuation is not available. One set of test kit shall be supplied for carrying out set pressure testing in plant during service life of these valves.

10.8.7 As per ANSI/ASME QME-1 standard article QV 5000, following tests are applicable. These shall be demonstrated as a type test or alternatively details of parent valve qualification may be furnished for review and approval by Purchaser.

a) Valve sealing capability.

b) Operability under maximum pipe-reaction end loading.

c) Operability during and after loading representative of the maximum seismic incident.

d) Adequacy of the materials of construction to survive environmental and aging effects.

e) Set point verification.

f) Blowdown verification.

g) Thermal shock capability.

10.9 Examination on Test Failure

In the event of failure of a valve or any part thereof to fully meet any examination or test requirements specified herein, the Manufacturer shall notify the Purchaser. The Manufacturer shall obtain permission before repair or subsequent use of such equipment or part. In the case of repairs, including redesign, appropriate re-examination and re-testing shall be conducted.

11.0 PROCEDURE, DOCUMENTATION AND ANALYSIS

11.1 Procedures

11.1.1 Welding Procedure

All welding procedures must be approved by the Purchaser prior to use in production.

Welding procedure and performance qualification shall meet the requirements of ASME Sec. III NC-4300 and Section IX. Procedure qualifications for the welding of castings shall be performed on cast test specimens.

11.1.2 **Heat Treatment Procedures**

The heat treatment procedures for ASME Section III NC and NF components must be approved, prior to use in production.

11.1.3 **Repair Procedures**

The repair techniques, procedures for ASME Section III NC and NF components and technically important components must be approved prior to use in production.

Approval of such procedures may, at the discretion of the Purchaser, require the manufacture of samples / mock-ups in support of the proposed procedures or techniques.

11.1.4 **Non-Destructive Examination and Testing Procedures**

All non-destruction examination and testing procedures and techniques must be approved by the Purchaser before performing the non-destructive examination and testing.

11.1.5 **Procedure for Functional Test**

Procedure for functional test shall be approved by the Purchaser before conducting the functional test.

11.1.6 **Quality Assurance Plans**

The Bidder shall submit company's Quality Assurance Manual / documented procedures to the purchaser. The manufacturer shall prepare and submit to the Purchaser Manufacturing Sequence, Examination and Test Plan which meets the requirements of the quality control standard specified in the tendering documents. The manufacturer shall obtain the Purchaser's approval of the documents before commencing the work.

Indicative Quality Assurance Plan (QAP) has been given in Attachment-2. The manufacturer shall submit their final QAP covering all the aspects of the indicative QAP, for the manufacture of the MSSVs and take Purchaser's approval before commencing the work.

11.1.7 **Painting Procedure**

Painting procedure shall be approved by the Purchaser prior to painting.

11.1.8 **Packing Procedures**

Packing procedure shall be approved by the Purchaser prior to packing.

11.1.9 **Storage Procedures**

Storage procedure shall be approved by the Purchaser.

11.1.10 **Shipping Procedures**

The Manufacturer shall obtain the Purchaser's approval of procedures for preparation of the equipment of or sub-assemblies / components for shipment and instructions for off-loading the equipment at site prior to shipment of any parts of the equipment. This is also applicable for transportation of components between the Manufacturer and his Sub-suppliers

11.1.11 **Installation Instructions**

The Manufacturer shall submit detailed written instructions covering installations, alignments, checks and any other necessary work which must be carried out to ensure proper preparation of the equipment for operation. The manufacturer shall obtain the Purchaser's approval for the maintenance instructions prior to shipment of the equipment.

Manufacturer shall also provide assistance for erection and commissioning.

11.1.12 **Procedure for Dimensional Checking**

The Manufacturer shall indicate to the Purchaser the procedure describing dimensional checking methods of certain critical components which may require checking while in service. The Manufacturer will identify such components.

11.1.13 **Pre-Service Inspection Procedures**

The Manufacturer shall obtain the Purchaser's approval of Pre-Service Inspection procedures, recording procedures and recording format prior to commencement of any Pre-service Inspection.

11.2 Documentation

In addition to the supply of documents listed below in hard copy the information shall also be stored in electronic media and two sets of such electronically stored packages shall be supplied to the Purchaser.

It is emphasized here that the shipping release may not be given, if the documentation mentioned hereafter is not submitted and approved by the Purchaser. History docket shall be forwarded to NPCIL, QS for verification and checking for its completeness.

11.2.1 **Drawings**

Soft copies of all the drawings/documents shall be submitted.

11.2.2 **History Dockets**

The History Docket Volume(s) shall be in a bound form on letter head (A4) size paper with fold-out sheets where necessary. History Docket(s) shall be identified on the face thereof by the Equipment and Purchase Order to which they apply, and shall bear the Manufacturer's name and his shop reference.

Procedure shall bear reference to their approval by the Purchaser and / or Authorized Inspector, if such approval is a requirement of the Contract. Where there are a number of volumes of a history docket to cover multiple components, the approved procedures and other documents, which apply throughout need to be included in the first docket.

The list of documents which would form a part of History Docket is as below:

a) Cover sheet giving P.O. No., Valve tag no., etc.

b) Index (giving content and page number).

c) Copy of Purchase Order

d) Copy of approved Q.A. Plan.

e) All approved examination and test procedures.

f) Instruction and service manuals covering installation, operation and maintenance of valves.

g) Seismic Qualification Report.

h) Mill test reports of chemical analysis and physical properties. Reports for castings shall be identified with the heat number and item number of the particular casting.

i) All examination and test reports.

j) A copy of the welding operators and welding procedure records of qualification.

k) Report of heat treatment including furnace charts, and for castings identification of heat number of the particular components.

l) Design concession request, if any.

m) Purchaser's warranty and compliance certificates.

n) Other documents which Manufacturer feels to include or agreed between Purchaser and Manufacturer.

All the sheets will be numbered, legible and preferably typed.

History dockets / end documents prepared by Manufacturer / Sub-Vendor shall be signed by Purchaser's QA representative.

11.2.3 **Radiographic Films**

Radiographic films of pressure boundary material including welds form part of the permanent records. They shall not be included in the bound history docket but shall be compiled in a separate package with the history docket for approval and release prior to shipment. The history docket shall contain concise cross reference to such films to enable clear identification to be established between the film and location on the product. The soft copies of radiographs with high resolution also shall be submitted.

The radiographs shall be packaged separately, each film being enclosed in a paper interleaf and each set of films pertaining to an individual weld material on an item of Equipment shall be enclosed in a separate envelope.

Each envelope shall bear clear identification to product and to location to radiographs on the product. After approval and release by the Purchaser's representative, the history docket(s) and the radiographs shall be forwarded by the Manufacturer to a destination which shall be indicated in the Purchase Order.

11.3 Analysis

The Manufacturer shall perform the analysis / review as listed below and submit 3 copies of the reports for approval. Subsequent to approval, 10 copies of the reports shall be submitted.

a) Study of Previous Failures and reliability analysis.

b) Design Review.

c) Maintainability.

d) Stress Analysis.

e) Seismic Qualification.

The reports shall detail the methods of calculation, the input data, the principal assumptions and results of the analyses and references.

11.4 Installation, Operation and Maintenance Manuals

The manufacturer shall submit two (2) copies of the operating and maintenance manuals, in draft form for approval by the Purchaser. The preliminary draft shall be submitted not later than three (3) months before the start of valve testing, and the final draft will be submitted after completion of all testing. The operating and maintenance manuals shall comprise at least the following:

a) Description and principles of operation of valve

b) Detailed descriptive data on MSSV.

c) Detailed parts list for all the equipment supplied under this specification including any catalogue numbers.

d) List of applicable drawings.

e) Data sheets, which shall also include:
   - Manufacturer's job number,
   - Serial and / or tag number for each piece of an MSSV.

f) Design clearances and periodicity of verification.

g) Detailed instructions for installation, operation and maintaining the MSSVs including step-by-step installation, instructions, check points, trouble shooting, routine operating instructions, routine items to check, recommended frequency of overhaul and re-assembly of MSSV.

12.0 VALVE MARKING AND IDENTIFICATION

The Purchaser will indicate the tag numbers for the different valves during the approval of the manufacturing drawings for the respective type of valves. These tag numbers shall be printed in bold letters on thick aluminium labels, approximately 100 mm x 30 mm size and securely fixed to the respective valves by means of S.S. wire.

Each valve and accessories assembly shall be individually packed, tagged and protected.

13.0 PACKING AND SHIPMENT

All valves shall be prepared for shipment in accordance with the instructions stated below:

The interior of the valve shall be clean and dry.

All exterior finished or machined carbon steel surfaces shall be protected against corrosion with the liberal coating of an approved, easily removable compound. All machined surfaces shall be protected against mechanical damage.

All exterior unfinished carbon steel surfaces shall be painted with epoxy paint as per approved procedure.

All opening shall be adequately sealed. Flanged openings shall be covered with a 20 mm thick. plywood blank flange held in place with 4 bolts and sealed with a blank gasket of natural rubber or equivalent.

A perforated container of vapour phase inhibitor (shall VPI or 260 or equivalent) shall be firmly attached to the inner surface of the cover on one end of each valve.

All components shall be tropical export packed, suitably boxed and protected from damage in transit to the site. Equipment shall be prepared for a long period in transit as well as storage at site before erection. Any special storage precaution necessary for long term storage (= 5 years) shall be indicated by manufacturer.

The construction and lining of the boxes shall provide protection for their contents. The packaging shall also satisfy the requirements of the Ocean Shipping Agency and shall include adequate cushioning, blocking, bracing, hoisting and tie-down provisions. The packaging shall be carried out as per procedure approved by the Purchaser.

All lifting points shall be suitably indicated on the packages.

14.0 WARRANTY

Provided that the Purchaser supplies to the Manufacturer, on request, all reasonable data concerning operating conditions and provided that any conditions stated by the manufacturer to be deleterious and likely to reduce the operating life below that guaranteed, are corrected by the Purchaser, the manufacturer shall warrant the equipment as follows:

The Manufacturer shall replace or repair parts of the MSSV which fail or which are damaged by failure, before two years after first criticality of the reactor unit in which the MSSV is installed or before seven years from the date of shipment, whichever of these periods shall first expire. The Manufacturer must make sure that the storage condition and subsequent initial MSSV installation are as per the stipulations made by him towards discharge of the warranty.

On failure of a part in the warranty period, the cause of failure shall be determined. If the failure is primarily due to or precipitated by a fault in the design, the design shall be modified and redesigned replacement parts provided for all valves by the Manufacturer at no expense to Purchaser.

On failure of replacement parts, the Manufacturer shall redesign, repair and / or replace such parts which fail within one year of the replacement or before expiry of the original warranty period whichever is longest.

15.0 SPECIFICATIONS FOR SOLENOID PILOT VALVES

TYPE	DIRECT ACTING, ENERGISED TO OPEN TYPE
SERVICE	STEAM
OPERATING PRESSURE	44 KG/ CM ^{2} g
BACK PRESSURE	ATMOSPHERIC
DIFFERNTIAL PRESSURE FOR SIZING	44 KG/ CM ^{2} g
Cv REQUIRED FOR SV	TO BE DECIDED BY MANUFACTURER
TEMPERATURE OF FLUID	256.0 ^{0} C
AMBIENT TEMPERATURE	50 ^{0} C
DESIGN CODE	ASME SECTION III NC
BODY/TRIM MATERIAL	TO SUIT SPECIFIED PRESSURE, TEMPERATURE & FLUID
SOLENOID COIL RATING	240 V AC 50 HZ / 24 V DC
INSULATION CLASS	CLASS H AS PER IS : 2147
INSULATION RESISTANCE	100 MOHS AT 500 VDC
COIL ENCLOSURE	IP 65 AS PER IS : 2147 SUITABLE FOR OUT DOOR SERVICE
TERMINAL BOX ENCL	IP 65 AS PER IS : 2147 SUITABLE FOR OUT DOOR SERVICE
END CONNECTION TYPE	FLANGED / WELDED
QUANTITY	TO BE FINALISED BY MANUFACTURER
TESTS	a) DIMENSIONAL TEST b) HYDROSTATIC BODY LEAK TEST c) SEAT LEAK TEST d) AIR LEAK TEST e) INSULATION RESISTANCE TEST f) HIGH VOLTAGE TEST g) POWER CONSUMPTION TEST h) COIL PICK UP & DROP OUT TEST i) ENVIRONMENTAL TEST j) SEISMIC QUALIFICATION TEST k) FUNCTIONAL QUALIFICATION AS PER ASME QME-1/PP-P-1819

16.0 DATASHEET FOR PILOT OPERATED MAIN STEAM SAFETY VALVE

NUCLEAR POWER CORPORATION OF INDIA LTD

VALVE TYPE: PILOT OPERATED MAIN STEAM SAFETY VALVES	**VALVE SPECIFICATION SHEET NO.**	**KAIGA-5&6/36113/8002/VSS REV NO. : 0 PAGE : 1 OF 3**

GENERAL	**INLET/OUTLET SIZE**	:	250NB/ 350NB	ENVIRONMENT QUALIFICATION REQUIREMENT			
				TEST	REQUIREMENT		
	APPLICABLE TECHNICAL SPECIFICATION	:		THERMAL	YES		
				RADIATION	N.A.		
				LOCA	N.A.		
				MSLB	N.A.		
	APPLICABLE DESIGN CODES / STANDARDS:			**SEISMIC REQUIREMENT (COMPLETE VALVE ASSEMBLY)**			
	DESIGN		ASME SEC III NC	**CONDITION**	**STRUCTURAL INTEGRITY**	**OPERABILITY**	
	TESTING		ASME QME-1				
	BUTT WELD ENDS		ANSI B 16.25	**OBE**	YES	YES	
				SSE	YES	YES	
BODY	PRESSURE RATING	:	INLET : PN 100 (600 LB CLASS)		OUTLET: PN 20 (150 LB CLASS)		
	END CONNECTIONS	:	INLET: BUTT WELDED		OUTLET: SORF FLANGE		
	MATERIAL	:	BODY	ASME SA 350 LF2	GASKET	SS CLAD GRAPHOIL	
			BOLTS	SA 540 B24 CL.4	NUTS	SA 540 B24 CL.4	
	CONSTRUCTION FEATURES	:	-				
BONNET	TYPE	:	CLOSE				
	MATERIAL	:	ASME SA 350 LF2				
	BONNET GASKET	:	SS CLAD GRAPHOIL				
TRIM	SEAT & DISK	:	MANUFACTURER TO PROPOSE				
	GUIDE & RING	:	ASTM A479 TP 316				
	SPRING	:	CORROSION RESISTANT				
	BELLOWS	:	INCONEL 600				
	NOZZLE TYPE	:	FORGED SS TYPE 316L				
	ORIFICE AREA (MIN)	:	MANUFACTURER TO SPECIFY				
	ORIFICE DESIGNATION	:	MANUFACTURER TO SPECIFY				

NUCLEAR POWER CORPORATION OF INDIA LTD

VSS NOS: **KAIGA-5&6/36113/2002/VSS** | **REV NO: 0** | **PAGE : 2 OF 3**

SERVICE CONDITION

FLUID	:	STEAM									
PRESSURE KG/CM^2 (g)	:	DESIGN	:	55	NORMAL	:	44	RELIEF STARTS	:	53.5, 55 & 56.5
TEMPERATURE (^{0}C)	:	INLET	:	267	NORMAL	:	-	MIN	:	-
FLOW (T/HR) PER VALVE	:	MAX	:	-	NORMAL	:	532.7	MIN	:	-
SP. GR. @ 15 ^{0}C	:	-			VISCOSITY @ 15 ^{0}C	:	-			
ΔP (KG/CM^2)	:	-								
C_V	:	-								
PRESSURE (RECLOSURE)	:	MANUFACTURER TO SPECIFY								
BACK PRESSURE	:	ATMOSPHERIC								

TESTS

DESCRIPTION	PRESSURE [KG/CM^2(g)]	DURATION (MIN)	APPLICABLE CLAUSE OF SPECIFICATION	REMARKS
HYDROSTATIC BODY TEST (SHELL TEST)	REF. NOTE 9	10		
AIR LEAK BODY TEST	6	-		
GASKET LEAK TEST	1.05	-		
SEAT LEAK TEST	95% OF SET PRESSURE	-		WITH STEAM

<ACCESSORIES>

LIMIT SWITCH	OPEN		CLOSE		

CAP WITH NO LEVER	:	YES
LEVER(PLAIN/ PACKED)	:	-
GAG	:	-
OTHERS	:	-

NUCLEAR POWER CORPORATION OF INDIA LTD

VSS NOS: KAIGA-5&6/36113/8002/VSS | **REV NO: 0** | **PAGE : 3 OF 3**

NOTES :

1) REFERENCES ARE TO PURCHASER'S SPECIFICATION.
2) CAPACITY CERTIFICATION SHALL BE FURNISHED.
3) OVERPRESSURE (FULL LIFT PRESSURE) SHALL NOT EXCEED 10 % OF DESIGN PRESSURE.
4) FUNCTIONAL TEST (SET PRESSURE, LIFT, BLOW DOWN, ETC.) SHALL BE CARRIED OUT ON FULLY ASSEMBLED VALVE AS PER ASME SEC. III NC.
5) TOLERANCE ON SET PRESSURE FOR PILOT VALVES SHALL BE WITHIN +/- 0.703 KG/cm^2
6) THE MAIN VALVE SHALL OPERATE IN DIRECT RESPONSE TO THE PILOT CONTROL VALVE AND SHALL ATTAIN RATED LIFT UNDER STABLE CONDITIONS AT PRESSURES WHICH DO NOT EXCEED THE SET PRESSURE BY 3%.
7) FORGED COMPANION FLANGES (WELD NECK RAISED FACE) ALONG WITH STUDS AND NUTS SHALL BE PROVIDED FOR OUTLET CONNECTION ONLY.
8) SEAT LEAKAGE TEST SHALL BE CARRIED OUT WITH STEAM AT 95% OF SET PRESSURE. NO LEAKAGE IS ALLOWED.
9) BODY AND NOZZLE SHALL BE SEPARATELY HYDROTESTED AT A PRESSURE NOT LESS THAN 1.5 TIMES OF RESPECTIVE FLANGE RATING AT 38°C. (REF. ANSI B 16.34).
10) THE SIZE OF THE POMSSV SHALL BE WITHIN THE DIMENSIONS AS INDICATED IN THE PIPING GA AND 3D MODEL SCREENSHOT AS SHOWN IN ATTACHMENT 17.

VALVE TAG NOS	**OUTLET LINE NOS**	**FLOOR ELEVATION/BUILDING/ GRID**
FOR RELIEF PRESSURE – 53.5 kg/cm^2 (g)		
3612-MSSV-1204	350-S-3612-1020	116M/CB-PCB/GRID B-GRID C
3612-MSSV-1201	350-S-3612-1017	116M/CB-PCB/GRID B-GRID C
3612-MSSV-1207	350-S-3612-1023	116M/CB-PCB/GRID B-GRID C
3612-MSSV-1210	350-S-3612-1026	116M/CB-PCB/GRID B-GRID C
FOR RELIEF PRESSURE – 55 kg/cm^2 (g)		
3612-MSSV-1205	350-S-3612-1021	116M/CB-PCB/GRID B-GRID C
3612-MSSV-1202	350-S-3612-1018	116M/CB-PCB/GRID B-GRID C
3612-MSSV-1208	350-S-3612-1024	116M/CB-PCB/GRID B-GRID C
3612-MSSV-1211	350-S-3612-1027	116M/CB-PCB/GRID B-GRID C
FOR RELIEF PRESSURE – 56.5 kg/cm^2 (g)		
3612-MSSV-1206	350-S-3612-1022	116M/CB-PCB/GRID B-GRID C
3612-MSSV-1203	350-S-3612-1019	116M/CB-PCB/GRID B-GRID C
3612-MSSV-1209	350-S-3612-1025	116M/CB-PCB/GRID B-GRID C
3612-MSSV-1212	350-S-3612-1028	116M/CB-PCB/GRID B-GRID C

17.0 REFERENCES: -

1) Heat Balance Diagrams - KAIGA-5&6/DC/40000/00022
2) P&ID - KAIGA-5&6/36110/8001/PID
3) Layout Drawing – GHAVP-1/36110/2002/GA & GHAVP-2/36110/2002/GA
4) Technical specification on requirements of main steam safety valves for 700MWe PHWR - PC-E/626 Rev. No. 01
5) Valve specification sheet for pilot operated main steam safety valves - KAIGA-5&6/36113/8002/VSS
6) Technical specification on methods and procedures for seismic qualification of valves; panels, devices; rotating and reciprocating equipments; tanks, vessels and supports – PP-P-1819
7) Floor response spectra data at EL 116 m of control building - KAIGA-5&6/ DC/24200/00002

ATTACHMENT - 1

TECHNICAL DATA TO BE SUBMITTED BY TENDERER ALONG WITH THE TENDER

Sl. No.	Particulars	Details by Tenderer
1.0	**GENERAL**	
1.1	Quantity / 700 MWe Unit	
1.2	Type & Model No.	
1.3	Design Code	
1.4	Make & country of Manufacture	
2.0	**TECHNICAL DATA**	
2.1	**Physical Data**	
2.1.1	Valve Inlet size (OD X THK) in mm	
2.1.2	Valve Outlet size (OD X THK) in mm	
2.1.3	Dimensional GA drawing	Enclosed
2.2	**Service Particulars**	
2.2.1	Medium to be handled	
2.2.2	Design Pressure, Inlet side / Outlet side (Kg/cm^2 (g))	
2.2.3	Design temperature ,Inlet side / Outlet side (^oC)	
2.2.4	Rating, Inlet side / Outlet side	
2.2.5	Set pressures (Kg/cm^2(g))	/ /
2.2.6	Set pressure range (Kg/cm^2(g))	--- to----
2.2.7	Blow down (%age of set pressure)	/ /
2.2.8	Back pressure (Kg/cm^2)	
2.2.9	Allowable over pressure (%age of design pressure)	

Sl. No.	Particulars	Details by Tenderer
2.2.10	Orifice area (mm^2)	
2.2.11	Orifice designation	
2.2.12	Coefficient of discharge	
2.2.13	Relieving capacity for set pressures of 53.5 / 55 / 56.5 Kg/cm^2 (g)as specified (T/h)	
2.2.14	Normal operating system pressure (Kg/cm^2(g))	
2.2.15	Normal operating system temperature (^oC)	
2.2.16	Reaction Force (kgf)	/ /
2.2.17	Noise level (dBA)	
3.0	**CONSTRUCTION FEATURES**	
3.1	Valve Type	
3.2	Type of the pilot	
3.3	Ends	
3.4	Bonnet	
3.5	Disc	
3.6	Body seat	
3.7	Disc seat	
3.8	Blow down adjustment ring / Set pressure adjustment ring	
3.9	Lift(mm)	
3.10	Any other construction feature of valve offered.	
4.0	**MATERIALS OF CONSTRUCTION**	
4.1	Body	
4.2	Bonnet	
4.3	Disc	
4.4	Seat bushing(Nozzle)	
4.5	Yoke bush	

Sl. No.	Particulars	Details by Tenderer
4.6	Gland packing	
4.7	Stem	
4.8	Gasket	
4.9	Bolts & Studs	
4.10	Nuts	
4.11	Tag Plate	
4.12	Vendor shall include any other component based on the valve offered.	
5.0	**TESTS**	
5.1	Body hydrostatic test pressure	Kg/cm^2
5.2	Air leak body test	Kg/cm^2
5.3	Seat leakage hydrostatic test pressure	Kg/cm^2
5.5	Test code	
5.6	Duration of tests	
	Shell hydrostatic test	
	Seat Hydrostatic test	
	Set pressure test for each valve with steam	
	Operability of valve at pressure lower than set pressure	
	Lowest pressure at which valve can be operated	
	Functional qualification of valve as per ASME QME-1	
	Air leak test	
5.7	Leakage rates for various tests	
5.8	Extent of NDT as specified	
5.9	Procedure and accepted standard for NDT	
5.10	Additional tests	
a)	Functional qualification as per ASME QME-1 whether proposed by test or by demonstration of design similarity.	Tenderer shall furnish a detailed plan/ procedures for the tests.

Sl. No.	Particulars	Details by Tenderer
6.0	**MISCELLANEOUS**	
6.1	(a) End-to-end/face-to-face dimension of valve (b) Total height of valve	
6.2	Weights	
	Valve	
6.3	Whether the valves are designed as per the seismic qualification requirement as specified (furnish the details)	
6.4	Details of quality assurance program for design, manufacture, supervision of erection, testing etc. of the valves (furnish technical literature)	
6.5	Details of maintenance provisions incorporated for the valves	
6.6	Details of the arrangement provided for carrying out hydrotest of system	
6.7	Details of arrangement provided for gagging to facilitate in-situ leakage test and setting the pressures for valves	
6.8	Guaranteed design life of valves	
6.9	Whether the valves are designed as per the design and construction codes as specified	
6.10	Whether the valves are provided with all special requirements as specified	
6.11	Painting and corrosion protection details	
6.12	Equipment to be seismically qualified by analysis/test	Analysis/test
	What is the natural frequency of offered valves	
	Whether the offered valves had already been qualified	
	For what values of acceleration “g”, the valves were qualified	
6.13	Name plate and tags provided as specified	
6.14	Hardness of body seat	
6.15	(a) Hardness of disc seat (b) Hardness of spindle	

Sl. No.	Particulars	Details by Tenderer
6.16	List of nuclear power plants to which similar valves have been supplied. (Indicate with details such as date of order, actual delivery period achieved, operating record, problems encountered during operation etc.)	
7.0	**DRAWINGS & TECHNICAL LITERATURE**	
7.1	General arrangement drawing of valve, indicating outline dimensions, clearance dimensions for assembly/disassembly and weight of valve furnished.	Yes/No
7.2	Technical literature/catalogue furnished.	Yes/No
7.3	Quality assurance plan for the offered valves:	Yes/No
7.4	Whether stress analysis of the equipment will be done by Manufacturer.	Yes/No
7.5	If "Yes" for "7.4" above then furnish the following details :	
	Whether the analysis will be done by consultants or in-house expertise exists with the Manufacturer? The educational background and experience of the persons performing the analysis; details of the similar work done by company in the past and software/hardware facilities to be used for the analysis.	
7.6	List of special tools and tackles to be supplied for erection/maintenance of safety valves.	
7.7	Various testing facilities available at shop for tests as called for in the specification.	

The following drawings/documents shall be furnished along with the tender.

1) Completely filled-in Data sheet of this specification.
2) General arrangement and cross-sectional drawing indicating outline dimensions, clearance dimensions for assembly/disassembly, materials and design & construction features of valves, assembly details etc.
3) Technical literature/manufacturer's catalogue.
4) Schematic drawing for main steam safety Valves.

5) Shop tests and quality assurance details.
6) Details of seismic qualification of valves.
7) List of recommended spare parts.
8) Detailed bar chart for supply of valves and their accessories.
9) Details of quality assurance procedure to be followed.
10) Any other data, documents or information called for in various volumes of the specification.
11) Detailed Quality Assurance Plans for Safety valves.
12) Details of test facilities available at shop and test procedures.
13) Experience list indicating details of similar and/or identical type of valves supplied and feedback from users.
14) Detailed erection procedure.
15) Vendors shall furnish following information on reliability parameters for Main Steam Safety Valves (MSSV):
    a) Mean Time Between Failures (MTBF).
    b) Test interval for MSSVs if it is used as standby or not in operation during normal plant operation for achieving desired performance as per design intent.
    c) Mean Time Between Inspections.
    d) Apart from the normal functional requirement for operation, MSSVs will be operated 40 times during the life of plant. Vendors shall note this and take care of this requirement during design of the valves.
    e) Calibration frequency of these valves.

Vendors should furnish the above information along with supportive documents.

The TENDERER shall indicate hereunder a list mandatory spares as listed in the specification sheet and start up spares included in his offer.

The TENDERER shall give below a list of spare parts recommended for five (5) years trouble free performance of the Equipment offered by him.

ATTACHMENT – 2

TYPICAL QUALITY ASSURANCE PLAN FOR MSSV

1. SCOPE AND PURPOSE:

The purpose of this typical Quality Assurance Plan is to describe general practices and sequences of activities (such as inspection, testing, control, etc..) to be performed during the manufacture of the equipment. This is a typical QAP and should be tailored by suitable modifications keeping in mind requirements included in this QAP & else where in this specification, codes, standards and vendor/sub-vendor good practices.

2. ABBREVIATIONS AND DEFINITIONS:

P – PERFORMED BY **W – WITNESSED BY** **R – REVIEWED BY**

1 – NPC QS **2 – VENDOR QC** **3 – EXTERNAL LABORATORY OR SUB VENDOR.**

WHEREVER "CHP" IS MENTIONED, IT IS A CUSTOMER HOLD POINT.

CLASS OF CHECK:

MINOR - The characteristic of a component, process or operation whose failure neither materially reduces the usability of the product in operation, nor does it affect the aesthetic aspects.

MAJOR - The characteristic of a component, process or operation whose failure may cause operation failure which can not be readily corrected at site or cause substandard performance, increased erection and maintenance cost, reduced life or seriously affect aesthetics.

CRITICAL The characteristic of a component, process or operation whose failure will surely cause operation failure or intermittent troubles which is difficult to rectify at site or render the unit unfit for use or cause safety hazard.

NOTE: THIS TYPICAL QA PLAN IS ENCLOSED WITH TENDER SPECIFICATION FOR BIDDERS REFERENCE AND TO GIVE THEM AN IDEA OF INTENDED SCOPE OF QS ACTIVITIES TO BE UNDERTAKEN DURING EXECUTION OF THIS CONTRACT. IT IS TO BE NOTED THAT THIS IS NOT A COPY OF FINAL QA PLAN. THE FINAL DETAILED QA PLAN FOR MSSV IS TO BE PREPARED BY SUCCESSFUL BIDDER AND GOT APPROVED PRIOR TO EXECUTION OF CONTRACT.

1	2	3	4	5	6	7	8	9	10			11
S.NO.	**Component & Operation**	**Characteristic**	**Class**	**Type of Check**	**Quantum of Check**	**Reference Document**	**Acceptance Norms**	**Format of Record**	**Agency**			**Remarks**
									P	**W**	**R**	
1	**CASTINGS**	Chemical Composition	Major	Chemical Composition	Sample per heat as per matl. Spec.	Applicable approved Spec., Drg. & procedure	As per applicable approved Spec., Drg. & procedure	TC	3	--	2,1 CHP	1) In absence of integral test piece pouring will be witnessed by NPCIL, QS. (CHP) 2) Impact test as per fabrication code to be witnessed by NPCIL, QS. (CHP).
		Mechanical Properties	Major	Physical test	-do-	-do-	-do-	TC	3	2,1	2 CHP	
		MPE / LPE on machined area	Major	NDE	100%	-do-	-do-	TR	3	2,1	2 CHP	
		Dimensions	Major	Dimensional	100%	-do-	-do-	IR	3	2	1	
		Surface finish	Major	Visual inspection	100%	-do-	-do-	IR	3	2	1	
		RT	Major	NDE	100% (feasible area)	-do-	-do-	TC	3	2,1	1 CHP	
2	**FORGINGS** Body, Body Cover, Cover Piston, Cylinder, Spring	Mechanical Properties	Major	Chemical Composition	Sample per heat as per matl. Spec.	Applicable approved Spec., Drg. & procedure	As per applicable approved Spec., Drg. & procedure	TC	3	--	2,1 CHP	Impact test as per fabrication code to be witnessed by NPCIL, QS. (CHP).
		U.T.E.	Major	NDE	100%	-do-	-do-	TC	3	2,1	2,1 CHP	

		MPE / LPE	Major	NDE	100%	-do-	-do-	TR	3	2,1	2,1 CHP	
		Heat treatment	Major	NDE	100%	-do-	-do-	TR	3	2,1	2,1 CHP	
		Visual	Major	Verification of ITT Chart	100%	-do-	-do-	HTC Chart	3	2,1	2,1 CHP	
		Dimension	Major	Surface cond.	100%	NC-2580	As per NC-2580	IR	3	2,1	2,1	
		Cramp test on spring	Major	Measurement	100%	Applicable drg.	As per applicable drg.	IR	3	2,1	2,1	
		Load test on spring	Major	Measurement	100%	A 125	As per applicable spec.	IR	3	2,1	2,1 CHP	
				Measurement	100%	Applicable approved Spec. & Drg.	As per applicable approved Spec. & Drg.	IR	3	2,1	2,1 CHP	
3	**FASTENERS**	Dimensions & Visual	Major	Dimensional	1 Sample per supply	Applicable approved Spec., Drg. & procedure	As per applicable approved Spec., Drg. & procedure	TR	3	--	2,1	Impact test as per fabrication code to be witnessed by NPCIL, QS. (CHP).
		Mechanical & Chemical	Major	Mechanical and chemical	-do-	-do-	-do-	TC	3	2,1	2,1 CHP	
		MPE/LPE/UTE based on size	Major	NDE	100%	-do-	-do-	TR	3	2,1	2,1 CHP	
4	**IN-PROCESS CONTROL** A) WPS/PQR B) Mfg. Proc. / sequence, welder's	Verification will be furnished	Major	As per ASME Sec. IX & Sec. III, NC	As per ASME Sec. IX & Sec. III, NC	As per ASME Sec. IX & Sec. III, NC	As per ASME Sec. IX & Sec. III, NC	Appd. WPS, Mfg. Proc./ sequence				To be furnished for approval

	performance qualification											
5	**FABRICATION/ WELDING**	MPE / LPE / RT	Major	NDE	100% (on weld + HAZ)	Applicable approved Spec., Drg. & procedure	As per applicable approved Spec., Drg. & procedure	TR	2,3	2,1	1 CHP	
6	**MACHINING**	Dimensions	Major	Measurement	100%	Applicable approved Spec., Drg. & procedure	As per applicable approved Spec., Drg. & procedure	TR	3,2	2,1	1	
		Surface flaws	Major	MPE / LPE	100%	-do-	-do-	TR	2	2,1	2,1	
		NDT after hard facing	Major	MPE / LPE	100%	-do-	-do-	TR	2	2,1	2,1 CHP	
		Pressure Test of Body	Major	Hydrotest	100%	-do-	-do-	TR	2	2,1	2,1 CHP	
		NDT on Stem	Major	LPE	100%	-do-	-do-	TR	3,2	2	2,1 CHP	
7	**WELD EDGE**	Visual	Major	As per ASME Sec. III, NC	As per ASME Sec. III, NC	As per ASME Sec. III, NC	As per ASME Sec. III, NC	IR	2	2,1	2,1 CHP	
8	Closure joint between body & bonnet i.e. visual examination of gasket or threaded joint or any other proposed by Vendor	Visual	Critical		100%							

9	**FINAL ASSY. OPERATION & CONTROL**											
9.1	Hydrostatic Test	Integrity test	Critical	Leak detection through joint & no perma-nent/ distortion	100%	Applicable approved Spec., Drg. & procedure	As per applicable approved Spec., Drg. & procedure	TR	2	2,1	2,1 CHP	
9.2	Seat leakage test (steam)	Leakage through seat	Critical	Leak detection through seat	100%	-do-	-do-	TR	2	2,1	2,1 CHP	
9.3	Air leak test	Leakage through seat	Critical	Leak detection through seat	100%	-do-	-do-	TR	2	2,1	2,1 CHP	
9.4	Performance test (steam)		Critical	Valve opera-tion at set pressure & other requiremen t as per spec.	100%	-do-	Achieveme nt of full lift within required operating pressure tolerance and will release within required blowdown	TR	2	2,1	2,1 CHP	
9.5	Functional qualification as per ASME QME-1		Critical	Valve opera-tion at set pressure & other requiremen t as per spec.	100%	-do-	Achieveme nt of full lift within required operating pressure tolerance and will release	TR	2	2,1	2,1 CHP	

							within required blowdown					
9.6	Visual examination after disassembly of valve		Critical	To be done after all above tests	Individual components checked to ensure no damage or abnormality	As per approved procedure	As per approved procedure	TR	2	2,1	2,1 CHP	
9.7	**SEISMIC TEST :** Analysis report / Seismic test shall be carried out as per procedure approved by NPCIL. Test shall be witnessed by NPCIL, QS or NPCIL representative.											
10.0	**PACKING & SHIPPING CONTROL**											
10.1	Degreasing					As per approved procedure			2	2	1	
10.2	Packing					-do-		Packing list	2	2	1	
10.3	Despatch	Overall dimensions				As per appd. Drg.	As per approved drg.	QAC	2	1	--	
		Name Plate verification				As per appd. Drg.	As per approved drg.	QAC	2	1	--	
		Acceptance sampling				---	---		1	--	--	

Abbreviations :

CRITICAL : The characteristic of a component, process or operation failure of which will surely cause operating failure or intermittent troubles which is difficult to rectify at site or render the unit unfit for use or cause safety hazards.

MAJOR : The characteristic of a component, process or operation whose failure may cause operation failure which cannot be readily corrected at site or cause substandard performance, increased erection and maintenance cost, reduced life or seriously affect aesthetics

MINOR : The characteristic of a component, process or operation whose failure neither materially reduced the usability of the product in operation, nor does it affect the aesthetic aspects.

TR	-	TEST REPORT,	TC	-	TEST CERTIFICATE		
QCR	-	QUALITY CONTROL RECORD	CHP	-	CUSTOMER HOLD POINT	R	- REVIEW,
W	-	WITNESS	V	-	VERIFICATION OF REPORT	P	- PERFORMED BY
1	-	PURCHASER (NPCIL, QS)	2	-	PRIME SUPPLIER	3	- SUB-VENDOR /APPROVED LAB

"Failure" of a characteristics means failure to meet the "Acceptance norms"

NOTES :

i) In absence of co-related TCs Sampling for chemical and physical tests shall be drawn and witnessed by NPCIL. Physical and chemical tests shall be carried out in NPCIL approved laboratories only. Schedule for Physical tests shall be intimated to the Purchaser. Purchaser reserves the right for witnessing the tests.

ii) Calibrated equipment / instruments shall be used during inspection, examination and testing.

iii) Furnaces shall be calibrated and verified by NPCIL.

iv) QAP shall be stamped, signed by Sub-Vendors (if any) and Vendors's representatives, responsible for preparation, checking and finalizing the QAP, before submitting the QAP for Purchaser's approval.

v) The term Vendor / Contractor, wherever used in the specification should be treated as same. Manufacturer wherever is used in to be treated as Vendor or Sub-Vendor. The term Purchaser / Customer are used should be treated as same.

vi) P.O. no. should be mentioned while preparing QAP.

vii) In case of Imported Item all 'witness' points shall be 'reviewed.

ATTACHMENT – 3

FLOOR RESPONSE SPEACTRA AND G-VALUE FOR CONTROL BUILDING AT EL. 116 m

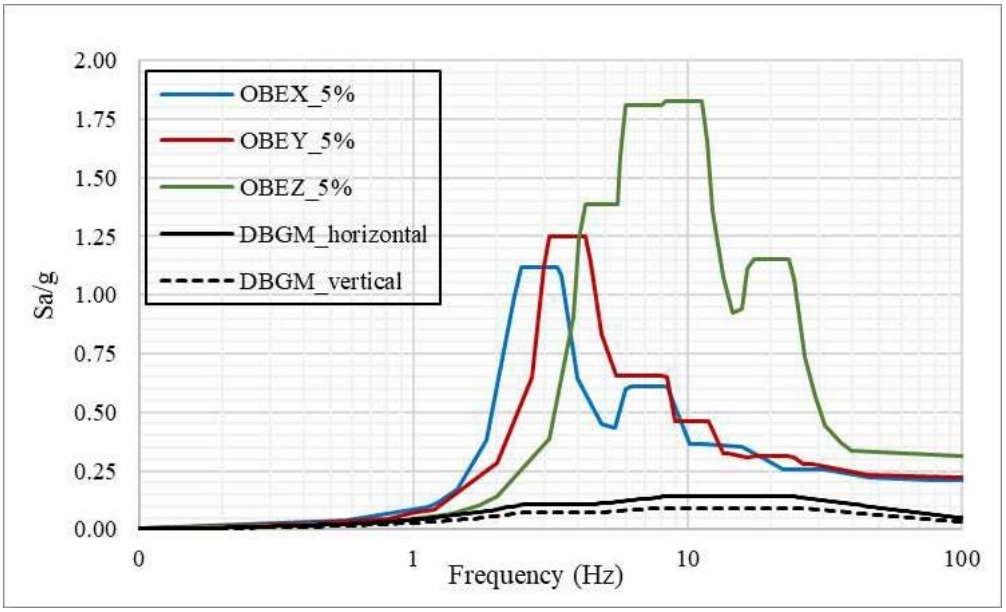


Figure-.33 5% damping OBE spectra for floor at EL.116000 of CB

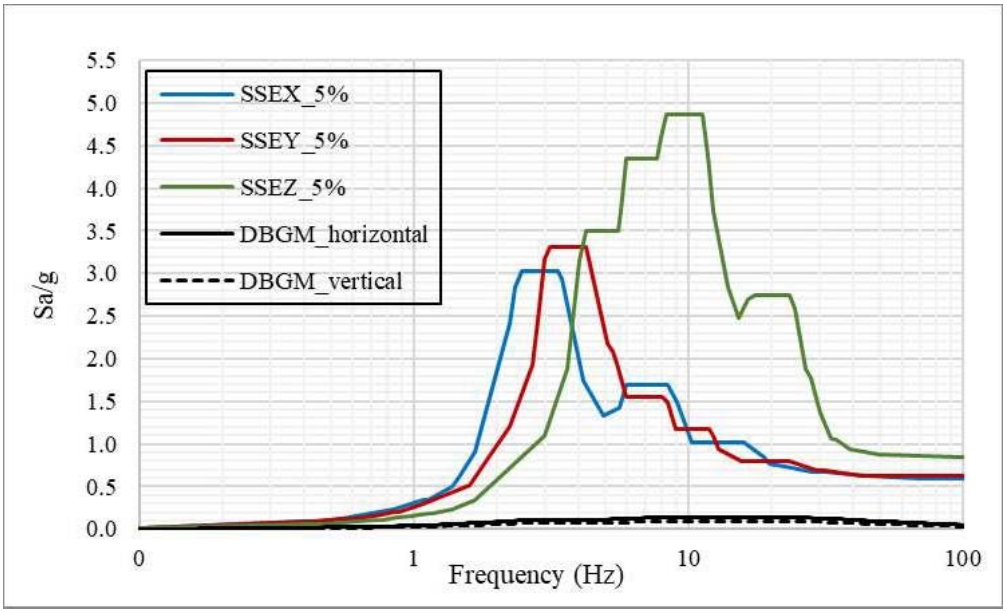


Figure-.34 5% damping SSE spectra for floor at EL.116000 of CB

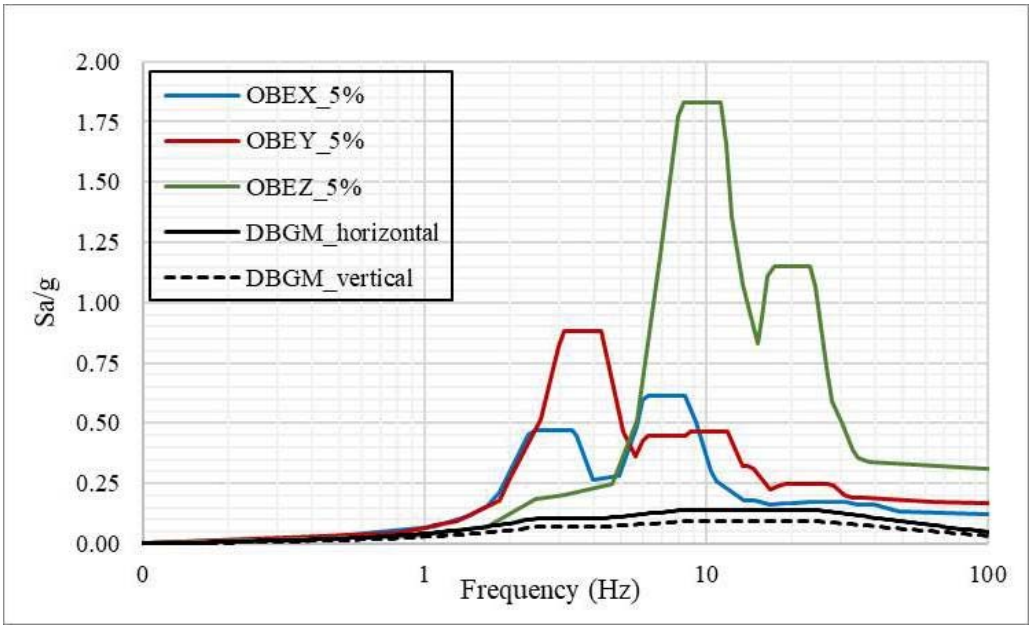


Figure-.35 5% damping OBE spectra for PCB floor at EL.116000 of CB

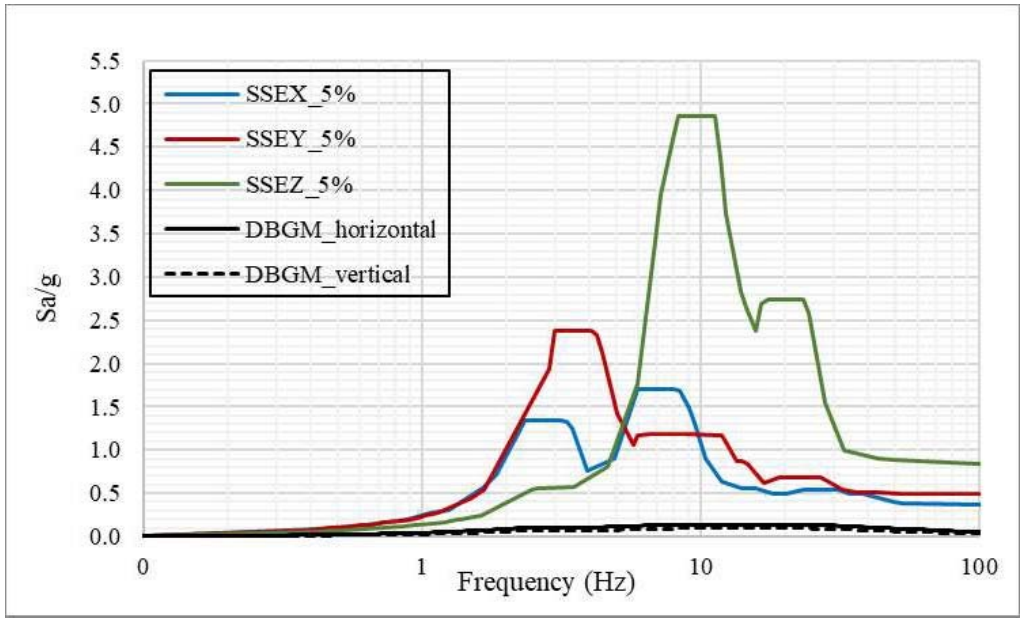


Figure-.36 5% damping SSE spectra for PCB floor at EL.116000 of CB

TABLE NO : 4.1.1.9(a) ACCELERATION RESPONSE SPECTRA (ELASTIC)

PROJECT : KAIGA-5&6 BUILDING : CB
INTENSITY : OBE LOCATION : Floor - 116 (m)
DIRECTION : X (E-W) ZPA : 0.2098 (g)

0.5%		1.0%		2.0%		3.0%		4.0%	
Freq (Hz)	Accl (g)	Freq (Hz)	Accl (g)	Freq (Hz)	Accl (g)	Freq (Hz)	Accl (g)	Freq (Hz)	Accl (g)
0.100	0.003	0.100	0.003	0.100	0.003	0.100	0.003	0.100	0.003
0.275	0.021	0.288	0.023	0.232	0.015	0.517	0.038	0.249	0.014
0.405	0.036	0.337	0.023	0.317	0.021	0.710	0.053	0.802	0.063
0.445	0.042	0.446	0.039	0.492	0.039	0.928	0.090	0.901	0.073
0.469	0.042	0.517	0.053	0.584	0.045	0.975	0.092	0.944	0.082
0.497	0.051	0.676	0.057	0.699	0.055	1.143	0.111	1.128	0.102
0.543	0.059	0.730	0.069	0.802	0.077	1.350	0.160	1.306	0.147
0.628	0.062	0.850	0.101	0.928	0.106	1.440	0.200	1.454	0.201
0.842	0.108	0.975	0.131	0.952	0.107	1.732	0.344	2.026	0.549
0.928	0.151	1.074	0.143	1.311	0.175	2.128	0.802	2.346	1.133
1.074	0.155	1.440	0.257	1.512	0.267	2.234	1.063	2.463	1.274
1.454	0.319	1.588	0.344	2.026	0.701	2.346	1.303	3.333	1.274
1.667	0.521	1.681	0.438	2.234	1.299	2.463	1.487	3.478	1.217
2.026	1.023	2.026	0.863	2.463	1.784	3.333	1.487	4.133	0.615
2.234	2.077	2.234	1.684	3.333	1.784	3.478	1.376	5.031	0.462
2.346	2.617	2.346	2.041	3.478	1.588	3.957	0.726	5.430	0.462
2.463	2.725	2.463	2.236	3.790	0.950	4.133	0.680	5.928	0.687
3.333	2.725	3.333	2.236	4.820	0.589	4.649	0.520	6.224	0.706
3.478	2.425	3.957	1.058	5.627	0.691	5.646	0.595	8.420	0.706
3.630	2.046	4.092	1.015	5.928	0.990	5.928	0.808	9.171	0.561
3.896	1.305	4.676	0.761	6.224	1.037	8.020	0.808	9.900	0.394
4.050	1.305	5.449	0.761	8.420	1.037	8.735	0.723	11.849	0.394
4.226	1.250	5.928	1.388	9.824	0.527	9.119	0.638	15.123	0.386
4.697	0.962	6.224	1.426	11.177	0.532	9.905	0.433	16.996	0.327
5.438	0.962	8.420	1.426	15.123	0.532	15.123	0.434	19.181	0.326
5.928	1.960	9.769	0.694	16.441	0.392	15.781	0.411	21.786	0.270
8.020	1.960	10.645	0.737	19.301	0.392	16.895	0.352	24.633	0.270
8.368	1.836	14.403	0.737	21.003	0.317	19.301	0.352	29.897	0.260
8.735	1.591	15.014	0.733	24.633	0.317	21.545	0.289	35.748	0.255
9.493	0.854	16.544	0.505	31.439	0.283	24.633	0.289	40.737	0.231
10.242	0.854	19.301	0.505	38.215	0.273	30.551	0.269	66.761	0.212
10.645	1.039	20.748	0.378	47.395	0.225	36.394	0.262	100.000	0.210
14.403	1.039	25.865	0.378	100.000	0.212	45.261	0.225		
15.029	0.985	26.990	0.370			100.000	0.211		
16.055	0.689	28.855	0.324						
19.301	0.689	31.439	0.324						
20.088	0.500	32.090	0.309						
26.990	0.499	38.215	0.309						
28.171	0.462	45.286	0.235						
29.996	0.386	53.330	0.216						
38.215	0.386	100.000	0.211						
41.620	0.290								
45.245	0.244								
58.081	0.214								
100.000	0.210								

TABLE NO : 4.1.1.9(a) ACCELERATION RESPONSE SPECTRA (ELASTIC)

PROJECT : KAIGA-5&6 BUILDING : CB
INTENSITY : OBE LOCATION : Floor - 116 (m)
DIRECTION : X (E-W) ZPA : 0.2098 (g)

5.0%		7.0%		10.0%		20.0%	
Freq (Hz)	Accl (g)	Freq (Hz)	Accl (g)	Freq (Hz)	Accl (g)	Freq (Hz)	Accl (g)
0.100	0.003	0.100	0.003	0.100	0.002	0.100	0.002
0.570	0.037	0.425	0.023	0.405	0.020	0.405	0.015
1.129	0.095	0.737	0.046	0.504	0.023	0.469	0.015
1.212	0.111	0.940	0.067	0.933	0.058	0.920	0.044
1.440	0.172	1.079	0.085	1.160	0.082	1.500	0.119
1.838	0.380	1.159	0.091	1.196	0.088	2.586	0.416
2.346	0.999	1.221	0.103	1.527	0.159	3.651	0.414
2.463	1.119	1.527	0.178	2.128	0.465	3.857	0.397
3.333	1.119	2.128	0.541	2.346	0.644	4.534	0.324
3.478	1.084	2.234	0.694	2.463	0.703	6.840	0.268
3.957	0.643	2.463	0.908	3.499	0.703	7.779	0.266
4.849	0.451	3.333	0.908	3.752	0.623	10.109	0.254
5.447	0.434	3.468	0.887	4.617	0.398	11.364	0.257
5.928	0.598	3.869	0.644	5.928	0.362	15.813	0.256
6.224	0.612	4.512	0.442	6.224	0.372	23.195	0.224
8.420	0.612	5.541	0.388	8.420	0.372	100.000	0.211
10.176	0.366	5.928	0.475	8.787	0.368		
11.541	0.366	6.224	0.481	10.137	0.297		
15.781	0.353	8.420	0.481	11.177	0.299		
18.756	0.307	10.167	0.333	15.123	0.299		
22.322	0.256	11.849	0.333	16.010	0.294		
31.439	0.253	15.686	0.322	21.990	0.239		
46.222	0.222	22.605	0.244	100.000	0.212		
80.264	0.211	35.748	0.241				
100.000	0.210	45.645	0.221				
		100.000	0.211				

TABLE NO : 4.1.1.9(b) ACCELERATION RESPONSE SPECTRA (ELASTIC)

PROJECT : KAIGA-5&6 BUILDING : CB
INTENSITY : OBE LOCATION : Floor - 116 (m)
DIRECTION : Y (N-S) ZPA : 0.2214 (g)

0.5%		1.0%		2.0%		3.0%		4.0%	
Freq (Hz)	Accl (g)	Freq (Hz)	Accl (g)	Freq (Hz)	Accl (g)	Freq (Hz)	Accl (g)	Freq (Hz)	Accl (g)
0.100	0.003	0.100	0.004	0.100	0.003	0.100	0.003	0.100	0.003
0.275	0.021	0.367	0.029	0.336	0.020	0.373	0.023	0.746	0.050
0.343	0.024	0.390	0.029	0.445	0.033	0.517	0.037	0.802	0.052
0.390	0.033	0.469	0.038	0.497	0.041	0.676	0.047	0.963	0.069
0.446	0.041	0.497	0.046	0.598	0.044	0.746	0.054	1.074	0.089
0.517	0.059	0.543	0.053	0.628	0.048	0.842	0.068	1.237	0.095
0.693	0.060	0.652	0.054	0.673	0.050	1.032	0.090	1.337	0.107
0.797	0.086	0.767	0.072	0.732	0.058	1.185	0.101	2.234	0.388
0.878	0.104	0.807	0.080	0.842	0.078	1.512	0.166	2.716	0.698
0.928	0.130	0.928	0.112	0.928	0.090	2.463	0.570	2.994	1.292
1.023	0.132	1.023	0.116	1.074	0.105	2.716	0.789	3.143	1.434
1.244	0.171	1.116	0.117	1.185	0.110	2.994	1.514	4.253	1.434
1.440	0.237	1.306	0.152	1.372	0.132	3.143	1.703	4.438	1.274
1.838	0.428	1.440	0.206	1.512	0.189	4.253	1.703	4.836	0.891
2.346	0.953	1.667	0.292	1.667	0.220	4.836	0.989	5.511	0.701
2.716	1.712	2.346	0.766	2.346	0.601	5.511	0.766	5.928	0.727
3.143	3.995	2.852	1.531	2.852	1.281	5.928	0.822	8.020	0.727
4.253	3.995	2.994	2.514	2.994	1.887	8.020	0.822	8.368	0.720
4.632	1.956	3.143	2.895	3.143	2.119	8.368	0.814	8.841	0.532
4.836	1.819	4.253	2.895	4.253	2.119	8.794	0.629	11.849	0.532
5.511	1.346	4.836	1.471	4.632	1.323	11.849	0.629	13.407	0.346
5.928	1.862	5.236	1.125	5.242	0.892	13.311	0.382	14.403	0.346
8.020	1.862	5.699	1.125	5.699	0.892	14.403	0.382	15.029	0.340
8.368	1.587	5.928	1.377	5.928	0.982	14.989	0.376	17.340	0.332
11.849	1.580	8.020	1.377	8.020	0.982	16.515	0.346	23.460	0.332
12.720	0.822	8.368	1.273	8.368	0.972	17.340	0.355	24.480	0.328
14.403	0.822	8.758	1.135	8.758	0.787	24.633	0.356	26.291	0.292
15.168	0.709	11.849	1.135	11.849	0.787	25.704	0.310	28.517	0.292
16.049	0.572	12.783	0.616	12.880	0.455	28.010	0.306	43.374	0.236
17.340	0.670	14.403	0.616	14.403	0.455	30.551	0.294	100.000	0.222
23.460	0.670	15.687	0.490	15.687	0.387	32.354	0.276		
24.480	0.641	17.340	0.500	17.340	0.400	36.394	0.276		
27.857	0.539	23.460	0.500	24.633	0.401	46.847	0.234		
28.703	0.437	24.480	0.493	26.403	0.332	100.000	0.223		
31.439	0.437	25.551	0.416	28.517	0.332				
38.162	0.424	27.857	0.405	31.058	0.313				
39.869	0.331	28.722	0.359	44.356	0.241				
43.446	0.259	31.439	0.359	100.000	0.224				
54.073	0.228	37.958	0.341						
100.000	0.222	43.215	0.252						
		53.842	0.228						
		100.000	0.222						

TABLE NO : 4.1.1.9(b) ACCELERATION RESPONSE SPECTRA (ELASTIC)

PROJECT : KAIGA-5&6 BUILDING : CB
INTENSITY : OBE LOCATION : Floor - 116 (m)
DIRECTION : Y (N-S) ZPA : 0.2214 (g)

5.0%		7.0%		10.0%		20.0%	
Freq (Hz)	Accl (g)	Freq (Hz)	Accl (g)	Freq (Hz)	Accl (g)	Freq (Hz)	Accl (g)
0.100	0.003	0.100	0.002	0.100	0.002	0.100	0.002
0.446	0.025	0.446	0.022	0.454	0.020	0.367	0.013
0.764	0.047	0.704	0.041	0.584	0.030	0.425	0.014
0.802	0.047	0.791	0.042	0.782	0.038	1.440	0.073
1.006	0.073	1.002	0.063	1.027	0.059	2.234	0.198
1.185	0.087	1.154	0.073	1.128	0.064	2.994	0.401
2.026	0.287	1.372	0.093	1.588	0.115	3.143	0.428
2.716	0.647	1.454	0.109	2.586	0.406	3.300	0.442
2.994	1.126	2.498	0.410	2.994	0.697	4.465	0.442
3.143	1.248	2.994	0.903	3.143	0.769	4.660	0.438
4.253	1.248	3.143	0.998	4.253	0.769	6.539	0.335
4.438	1.137	4.253	0.998	4.438	0.764	8.020	0.335
4.836	0.833	4.438	0.954	5.050	0.584	8.368	0.331
5.511	0.656	5.275	0.633	5.928	0.463	10.222	0.284
8.020	0.656	5.511	0.588	8.020	0.463	17.829	0.255
8.368	0.648	5.928	0.555	8.368	0.458	100.000	0.223
8.968	0.464	8.020	0.555	9.523	0.340		
11.849	0.464	8.368	0.548	10.664	0.308		
13.474	0.324	9.392	0.377	12.442	0.308		
14.069	0.323	11.849	0.377	16.145	0.275		
16.515	0.308	12.365	0.365	20.265	0.275		
17.340	0.315	13.217	0.312	44.380	0.232		
23.460	0.315	15.942	0.288	100.000	0.222		
24.480	0.309	17.340	0.292				
26.434	0.281	23.460	0.292				
28.517	0.281	27.573	0.270				
45.364	0.233	29.758	0.270				
100.000	0.222	44.272	0.233				
		100.000	0.223				

TABLE NO : 4.1.1.9(c) ACCELERATION RESPONSE SPECTRA (ELASTIC)

PROJECT : KAIGA-5&6 BUILDING : CB
INTENSITY : OBE LOCATION : Floor - 116 (m)
DIRECTION : Z (VER) ZPA : 0.3107 (g)

0.5%		1.0%		2.0%		3.0%		4.0%	
Freq (Hz)	Accl (g)	Freq (Hz)	Accl (g)	Freq (Hz)	Accl (g)	Freq (Hz)	Accl (g)	Freq (Hz)	Accl (g)
0.100	0.002	0.100	0.002	0.100	0.002	0.100	0.002	0.100	0.002
0.446	0.027	0.145	0.004	0.517	0.028	0.469	0.019	0.517	0.021
0.517	0.038	0.215	0.011	0.628	0.030	0.541	0.024	1.211	0.059
0.628	0.038	0.461	0.025	0.874	0.051	0.660	0.028	1.306	0.071
0.803	0.056	0.497	0.030	1.053	0.062	1.205	0.062	1.438	0.081
0.975	0.085	0.570	0.034	1.112	0.063	1.306	0.078	2.463	0.212
1.244	0.110	0.676	0.035	1.425	0.097	1.512	0.105	3.300	0.506
1.372	0.111	0.928	0.072	1.524	0.122	1.654	0.116	3.821	0.981
1.512	0.162	1.031	0.076	1.768	0.155	2.994	0.393	4.012	1.416
1.667	0.206	1.260	0.094	2.463	0.293	3.821	1.071	4.213	1.603
1.830	0.232	1.389	0.100	3.300	0.632	4.012	1.653	5.538	1.603
3.300	0.898	1.527	0.147	3.821	1.194	4.213	1.895	5.646	1.828
3.821	1.846	1.667	0.177	4.012	2.014	5.552	1.895	5.928	2.108
4.012	3.286	1.838	0.199	4.213	2.338	5.646	2.149	8.020	2.108
4.213	4.018	3.300	0.771	5.551	2.338	5.928	2.528	8.341	2.076
5.481	4.018	3.821	1.499	5.646	2.660	8.020	2.528	11.285	2.076
5.646	5.470	4.012	2.664	5.928	3.185	8.341	2.469	11.775	1.858
5.928	6.651	4.213	3.184	8.020	3.185	11.285	2.469	12.291	1.505
8.020	6.651	5.499	3.184	8.341	3.114	11.775	2.155	13.400	1.160
8.162	6.015	5.646	3.784	11.285	3.114	12.291	1.692	14.130	1.046
10.748	6.015	5.928	4.707	11.775	2.719	13.804	1.222	15.728	1.051
11.849	5.887	8.020	4.707	12.291	1.974	15.750	1.222	16.515	1.243
12.365	3.464	8.341	4.349	13.087	1.523	16.515	1.409	17.340	1.287
12.581	3.072	11.285	4.349	13.717	1.523	17.340	1.459	23.460	1.287
14.266	3.118	11.849	4.049	15.728	1.494	23.460	1.459	24.480	1.204
15.887	3.118	12.365	2.628	16.515	1.701	24.480	1.388	25.551	0.960
16.515	3.721	12.924	2.129	17.340	1.736	25.551	1.050	27.118	0.725
22.343	3.721	15.728	2.144	23.460	1.736	26.835	0.836	27.857	0.717
24.334	3.330	16.515	2.439	24.480	1.651	27.857	0.833	30.398	0.527
25.552	2.268	22.343	2.439	25.551	1.220	30.398	0.556	33.200	0.419
27.711	2.138	23.314	2.370	26.638	1.026	32.781	0.470	36.290	0.402
29.734	1.258	24.334	2.260	28.517	1.026	38.215	0.470	39.277	0.337
38.215	1.258	26.052	1.491	31.380	0.585	40.866	0.380	100.000	0.313
39.875	0.750	28.517	1.491	38.215	0.585	43.452	0.368		
43.452	0.668	30.878	0.827	40.869	0.446	47.395	0.327		
48.314	0.331	38.215	0.827	43.452	0.445	100.000	0.313		
100.000	0.313	39.875	0.613	46.706	0.329				
		43.452	0.573	100.000	0.313				
		47.195	0.331						
		100.000	0.313						

TABLE NO : 4.1.1.9(c) ACCELERATION RESPONSE SPECTRA (ELASTIC)

PROJECT : KAIGA-5&6 BUILDING : CB
INTENSITY : OBE LOCATION : Floor - 116 (m)
DIRECTION : Z (VER) ZPA : 0.3107 (g)

5.0%		7.0%		10.0%		20.0%	
Freq (Hz)	Accl (g)	Freq (Hz)	Accl (g)	Freq (Hz)	Accl (g)	Freq (Hz)	Accl (g)
0.100	0.002	0.100	0.002	0.100	0.001	0.100	0.001
0.764	0.030	0.770	0.027	0.884	0.030	2.586	0.139
1.374	0.066	0.980	0.036	0.980	0.032	3.300	0.262
1.722	0.100	1.334	0.060	1.355	0.056	4.012	0.443
2.026	0.144	1.684	0.088	2.852	0.227	4.213	0.468
3.143	0.388	2.852	0.251	3.639	0.520	4.451	0.476
3.821	0.906	3.639	0.609	4.012	0.780	5.370	0.501
4.012	1.238	4.012	0.999	4.213	0.838	5.646	0.554
4.213	1.389	4.213	1.101	5.411	0.838	5.928	0.591
5.522	1.389	5.470	1.101	5.646	0.967	6.536	0.637
5.646	1.590	5.646	1.259	5.928	1.056	6.862	0.660
5.928	1.809	5.928	1.403	6.862	1.153	8.341	0.696
8.020	1.809	6.862	1.467	8.341	1.164	11.285	0.696
8.341	1.828	8.341	1.479	11.285	1.164	11.775	0.694
11.285	1.828	11.285	1.479	11.775	1.107	18.039	0.468
11.775	1.657	11.775	1.381	13.371	0.814	24.633	0.468
12.291	1.356	12.584	1.079	15.560	0.646	26.829	0.440
13.400	1.077	14.622	0.810	16.515	0.732	32.464	0.351
14.552	0.924	15.612	0.773	17.340	0.749	100.000	0.313
15.728	0.940	16.515	0.914	23.460	0.749		
16.515	1.110	17.340	0.945	24.480	0.721		
17.340	1.150	23.460	0.945	25.551	0.664		
23.460	1.150	24.480	0.881	27.857	0.520		
24.480	1.067	25.551	0.783	31.765	0.403		
26.676	0.735	27.857	0.559	34.615	0.352		
29.096	0.563	33.200	0.385	100.000	0.314		
31.765	0.442	35.020	0.352				
36.290	0.370	43.619	0.328				
39.696	0.336	100.000	0.312				
100.000	0.313						

TABLE NO : 4.1.1.10(a) ACCELERATION RESPONSE SPECTRA (ELASTIC)

PROJECT : KAIGA-5&6 BUILDING : CB
INTENSITY : OBE LOCATION : Floor - 116(PCB) (m)
DIRECTION : X (E-W) ZPA : 0.1233 (g)

0.5%		1.0%		2.0%		3.0%		4.0%	
Freq	Accl	Freq	Accl	Freq	Accl	Freq	Accl	Freq	Accl
0.100	0.003	0.100	0.003	0.100	0.003	0.100	0.003	0.100	0.003
0.215	0.018	0.236	0.017	0.367	0.026	0.842	0.062	0.261	0.014
0.446	0.040	0.317	0.022	0.517	0.041	0.928	0.073	0.543	0.032
0.517	0.057	0.367	0.029	0.628	0.045	1.244	0.104	1.074	0.079
0.764	0.079	0.409	0.032	0.842	0.073	1.440	0.137	1.440	0.124
0.842	0.098	0.517	0.051	0.928	0.087	1.667	0.191	1.838	0.231
0.928	0.128	0.693	0.052	1.074	0.100	1.838	0.252	2.346	0.515
1.244	0.162	0.802	0.077	1.244	0.118	2.346	0.594	2.463	0.531
1.512	0.246	0.888	0.088	1.512	0.181	2.463	0.611	3.333	0.531
1.667	0.344	1.023	0.110	2.128	0.479	3.333	0.611	3.478	0.493
1.838	0.398	1.244	0.139	2.234	0.623	3.478	0.551	3.790	0.322
2.234	1.015	1.440	0.183	2.346	0.701	3.937	0.306	4.518	0.277
2.346	1.164	1.588	0.233	2.463	0.725	4.213	0.312	4.877	0.303
3.174	1.164	1.667	0.284	3.333	0.725	4.877	0.332	5.669	0.538
3.312	1.124	2.026	0.473	3.902	0.357	5.676	0.615	5.928	0.687
3.775	0.569	2.234	0.817	4.213	0.366	5.928	0.808	6.224	0.706
4.423	0.625	2.346	0.919	4.877	0.373	6.224	0.837	8.420	0.706
5.120	0.739	3.174	0.919	5.661	0.719	8.420	0.837	9.171	0.561
5.468	0.995	3.312	0.907	5.928	0.990	9.171	0.638	10.444	0.310
5.928	1.960	3.731	0.447	6.224	1.037	9.999	0.400	11.917	0.220
8.020	1.960	4.423	0.480	8.420	1.037	10.911	0.294	13.599	0.189
8.368	1.836	5.120	0.578	9.999	0.451	13.026	0.204	15.879	0.189
8.735	1.591	5.545	0.832	11.401	0.296	14.906	0.202	18.207	0.176
9.568	0.811	5.928	1.388	12.538	0.225	17.424	0.170	22.492	0.176
9.947	0.705	6.224	1.426	15.879	0.225	18.207	0.186	23.237	0.184
10.619	0.501	8.420	1.426	17.582	0.187	19.117	0.194	31.439	0.184
11.849	0.501	9.575	0.702	19.117	0.224	32.806	0.195	32.781	0.182
12.660	0.317	10.899	0.400	25.865	0.224	34.863	0.180	35.240	0.169
15.879	0.317	11.401	0.381	26.500	0.214	38.243	0.180	38.215	0.169
17.340	0.297	12.347	0.266	32.887	0.214	39.778	0.177	39.433	0.168
19.117	0.411	15.879	0.266	39.875	0.192	49.519	0.133	49.034	0.134
25.865	0.411	17.340	0.228	43.452	0.171	100.000	0.124	100.000	0.125
28.171	0.357	19.117	0.297	47.395	0.144				
28.524	0.344	25.865	0.297	52.868	0.130				
34.661	0.344	27.725	0.262	100.000	0.124				
37.751	0.304	34.661	0.262						
42.989	0.222	41.157	0.206						
49.977	0.135	42.989	0.199						
100.000	0.125	49.052	0.135						
		100.000	0.125						

TABLE NO : 4.1.1.10(a) ACCELERATION RESPONSE SPECTRA (ELASTIC)

PROJECT : KAIGA-5&6 BUILDING : CB
INTENSITY : OBE LOCATION : Floor - 116(PCB) (m)
DIRECTION : X (E-W) ZPA : 0.1233 (g)

5.0%		7.0%		10.0%		20.0%	
Freq	Accl	Freq	Accl	Freq	Accl	Freq	Accl
0.100	0.002	0.100	0.002	0.100	0.002	0.100	0.002
0.425	0.023	0.415	0.021	0.842	0.040	0.895	0.031
1.074	0.072	0.446	0.021	1.531	0.094	2.234	0.165
1.440	0.114	0.575	0.029	1.929	0.182	2.346	0.174
1.667	0.156	1.023	0.060	2.346	0.292	2.586	0.183
1.838	0.214	1.185	0.068	2.463	0.304	3.651	0.182
2.346	0.456	1.440	0.102	3.333	0.304	4.591	0.159
2.463	0.471	1.588	0.117	3.478	0.299	5.646	0.210
3.333	0.471	1.838	0.188	4.318	0.201	6.224	0.232
3.478	0.445	2.346	0.371	4.877	0.221	6.536	0.235
3.957	0.267	2.463	0.386	5.376	0.297	8.842	0.235
4.877	0.283	3.333	0.386	5.928	0.362	9.226	0.232
5.678	0.488	3.478	0.373	6.224	0.372	14.246	0.155
5.928	0.598	4.133	0.228	8.420	0.372	15.796	0.148
6.224	0.612	4.877	0.254	8.787	0.368	23.337	0.138
8.420	0.612	5.928	0.475	9.575	0.321	100.000	0.124
9.171	0.502	6.224	0.481	10.911	0.231		
10.444	0.298	8.420	0.481	13.891	0.169		
10.911	0.262	9.171	0.420	18.380	0.149		
13.622	0.182	9.575	0.376	100.000	0.125		
14.906	0.181	10.444	0.280				
16.922	0.160	11.616	0.214				
18.944	0.166	13.998	0.175				
20.074	0.168	14.870	0.171				
23.237	0.176	16.844	0.154				
31.439	0.176	18.207	0.158				
34.513	0.162	23.237	0.164				
39.728	0.161	31.439	0.164				
48.623	0.135	37.129	0.154				
100.000	0.125	39.875	0.152				
		50.957	0.131				
		100.000	0.124				

TABLE NO : 4.1.1.10(b) ACCELERATION RESPONSE SPECTRA (ELASTIC)

PROJECT : KAIGA-5&6 BUILDING : CB
INTENSITY : OBE LOCATION : Floor - 116(PCB) (m)
DIRECTION : Y (N-S) ZPA : 0.1688 (g)

0.5%		1.0%		2.0%		3.0%		4.0%	
Freq	Accl	Freq	Accl	Freq	Accl	Freq	Accl	Freq	Accl
0.100	0.003	0.100	0.003	0.100	0.003	0.100	0.003	0.100	0.003
0.215	0.018	0.236	0.017	0.328	0.019	0.326	0.018	0.728	0.047
0.288	0.024	0.325	0.022	0.469	0.032	0.746	0.051	0.770	0.047
0.350	0.025	0.367	0.029	0.517	0.043	0.842	0.065	0.984	0.068
0.398	0.033	0.407	0.032	0.628	0.046	0.989	0.076	1.074	0.082
0.517	0.057	0.517	0.052	0.699	0.051	1.074	0.089	1.185	0.087
0.693	0.058	0.733	0.063	0.742	0.056	1.306	0.113	1.306	0.103
0.764	0.079	0.764	0.072	0.842	0.075	1.512	0.154	1.512	0.138
0.867	0.100	0.830	0.086	0.928	0.086	2.463	0.570	2.463	0.505
0.989	0.128	0.859	0.090	1.074	0.098	2.852	0.837	2.994	0.939
1.185	0.130	0.928	0.109	1.185	0.104	2.994	1.110	3.143	1.007
1.306	0.167	1.074	0.113	1.372	0.128	3.143	1.188	4.253	1.007
1.492	0.241	1.185	0.120	1.825	0.281	4.253	1.188	4.932	0.528
1.667	0.345	1.306	0.150	2.346	0.601	4.836	0.615	5.579	0.384
2.346	0.953	1.588	0.236	2.852	0.957	5.646	0.421	5.928	0.473
2.716	1.423	1.667	0.281	2.994	1.382	5.928	0.536	6.224	0.496
2.864	1.423	1.838	0.323	3.143	1.483	6.224	0.565	8.420	0.496
2.994	2.203	2.716	1.101	4.253	1.483	8.420	0.565	8.758	0.532
3.143	2.803	2.852	1.156	4.836	0.695	8.758	0.629	11.849	0.532
4.253	2.803	2.994	1.839	5.438	0.457	11.849	0.629	13.407	0.346
4.632	1.208	3.143	2.057	5.928	0.629	12.365	0.529	14.403	0.346
5.190	0.733	4.253	2.057	6.224	0.690	12.905	0.399	15.029	0.340
5.612	0.733	4.632	1.046	8.420	0.690	14.656	0.376	16.917	0.241
5.928	1.079	5.231	0.561	8.758	0.787	16.697	0.258	18.207	0.258
6.224	1.173	5.646	0.593	11.849	0.787	18.207	0.282	20.074	0.263
8.392	1.173	5.928	0.845	12.880	0.455	28.010	0.278	27.158	0.263
8.758	1.580	6.224	0.922	14.403	0.455	30.551	0.215	28.339	0.259
11.849	1.580	8.421	0.922	15.687	0.387	33.507	0.204	30.880	0.208
12.661	0.822	8.758	1.135	16.646	0.288	38.215	0.204	33.189	0.195
14.403	0.822	11.849	1.135	18.207	0.318	43.452	0.185	36.394	0.195
15.168	0.709	12.783	0.616	25.889	0.318	100.000	0.171	45.138	0.182
16.354	0.444	14.403	0.616	28.171	0.308			67.407	0.171
19.117	0.563	15.687	0.490	29.410	0.256			100.000	0.169
25.865	0.563	16.533	0.350	32.136	0.220				
28.517	0.539	18.207	0.399	38.215	0.220				
29.735	0.347	19.117	0.416	39.875	0.214				
38.215	0.347	25.865	0.416	42.267	0.190				
39.875	0.266	28.171	0.388	100.000	0.171				
45.375	0.204	29.410	0.294						
51.743	0.182	30.723	0.268						
100.000	0.170	38.215	0.268						
		43.583	0.195						
		46.450	0.195						
		52.817	0.178						
		100.000	0.170						

TABLE NO : 4.1.1.10(b) ACCELERATION RESPONSE SPECTRA (ELASTIC)

PROJECT : KAIGA-5&6 BUILDING : CB
INTENSITY : OBE LOCATION : Floor - 116(PCB) (m)
DIRECTION : Y (N-S) ZPA : 0.1688 (g)

5.0%		7.0%		10.0%		20.0%	
Freq	Accl	Freq	Accl	Freq	Accl	Freq	Accl
0.100	0.002	0.100	0.002	0.100	0.002	0.100	0.002
0.740	0.044	0.704	0.038	0.458	0.019	0.367	0.013
0.777	0.044	0.774	0.039	0.582	0.027	0.577	0.021
0.941	0.058	1.074	0.068	0.728	0.034	0.884	0.032
1.001	0.065	1.440	0.098	0.811	0.035	1.588	0.078
1.074	0.077	2.026	0.246	1.074	0.059	2.994	0.307
1.306	0.095	2.716	0.493	1.838	0.147	3.143	0.317
1.838	0.180	2.994	0.661	2.026	0.211	4.465	0.318
2.026	0.278	3.143	0.703	2.994	0.521	4.660	0.311
2.586	0.516	4.253	0.703	3.143	0.543	5.786	0.245
2.994	0.821	4.438	0.660	4.253	0.543	6.305	0.230
3.143	0.879	5.050	0.426	4.438	0.533	8.420	0.230
4.253	0.879	5.646	0.332	5.511	0.305	9.362	0.225
5.050	0.464	5.928	0.362	6.536	0.319	12.442	0.225
5.586	0.360	6.224	0.376	8.842	0.319	19.749	0.189
5.928	0.427	6.536	0.378	9.351	0.306	100.000	0.170
6.224	0.446	11.849	0.377	12.442	0.306		
8.420	0.446	12.365	0.365	16.121	0.222		
8.758	0.464	13.474	0.300	18.023	0.208		
11.849	0.464	14.069	0.294	19.117	0.212		
12.365	0.427	16.768	0.219	27.158	0.213		
13.474	0.324	20.074	0.231	33.682	0.181		
14.069	0.323	27.158	0.231	100.000	0.170		
14.695	0.311	28.339	0.224				
16.943	0.227	29.578	0.208				
18.207	0.240	33.739	0.185				
19.117	0.247	100.000	0.170				
20.074	0.249						
27.158	0.249						
28.339	0.244						
30.880	0.203						
33.059	0.191						
36.394	0.191						
64.423	0.171						
100.000	0.169						

TABLE NO : 4.1.1.10(c) ACCELERATION RESPONSE SPECTRA (ELASTIC)

PROJECT : KAIGA-5&6 BUILDING : CB
INTENSITY : OBE LOCATION : Floor - 116(PCB) (m)
DIRECTION : Z (VER) ZPA : 0.3107 (g)

0.5%		1.0%		2.0%		3.0%		4.0%	
Freq	Accl	Freq	Accl	Freq	Accl	Freq	Accl	Freq	Accl
0.100	0.002	0.100	0.002	0.100	0.002	0.100	0.002	0.100	0.002
0.139	0.004	0.215	0.011	0.215	0.010	0.517	0.023	0.517	0.021
0.215	0.012	0.570	0.033	0.328	0.013	0.579	0.023	1.194	0.047
0.446	0.026	0.738	0.040	0.579	0.027	0.669	0.026	1.306	0.056
0.517	0.037	0.796	0.047	0.686	0.030	0.928	0.043	1.624	0.072
0.705	0.038	0.928	0.065	0.928	0.051	1.201	0.052	2.463	0.212
0.741	0.045	1.074	0.066	1.213	0.060	1.306	0.062	4.644	0.259
0.928	0.077	1.253	0.080	1.306	0.071	1.429	0.068	5.120	0.415
1.244	0.094	1.359	0.084	1.443	0.080	1.540	0.077	6.224	0.823
1.342	0.096	1.491	0.106	1.508	0.088	1.661	0.082	6.862	1.315
1.571	0.127	1.526	0.110	1.667	0.099	2.463	0.246	7.566	1.777
1.602	0.134	1.575	0.113	2.463	0.293	3.143	0.260	7.944	1.990
1.805	0.165	1.667	0.133	3.143	0.312	4.644	0.273	8.341	2.076
1.929	0.172	1.838	0.144	4.253	0.312	5.120	0.463	11.285	2.076
2.234	0.377	2.234	0.286	5.120	0.539	5.503	0.512	11.775	1.858
2.586	0.486	2.464	0.366	6.224	1.095	6.536	1.149	12.291	1.505
3.143	0.561	3.143	0.413	7.206	1.990	6.862	1.461	13.400	1.160
4.253	0.561	4.253	0.413	7.566	2.467	7.206	1.745	15.284	0.915
5.120	0.877	5.120	0.687	7.944	2.841	7.566	2.027	15.728	1.051
6.862	2.596	5.928	1.199	8.341	3.114	7.944	2.305	16.515	1.243
7.206	2.908	7.206	2.397	11.285	3.114	8.341	2.469	17.340	1.287
7.566	5.053	7.566	3.591	11.775	2.719	11.285	2.469	23.460	1.287
7.944	6.015	7.944	4.128	12.291	1.974	11.775	2.155	24.480	1.204
10.748	6.015	8.341	4.349	13.087	1.523	12.291	1.692	25.551	0.960
11.849	5.887	11.285	4.349	13.717	1.523	13.400	1.283	27.857	0.622
12.365	3.115	11.849	4.049	14.939	1.308	15.251	1.015	30.398	0.527
12.763	2.775	12.365	2.514	15.728	1.494	15.728	1.217	33.200	0.397
15.631	2.775	12.939	2.080	16.515	1.701	16.515	1.409	34.707	0.359
15.728	2.966	13.717	2.080	17.340	1.736	17.340	1.459	37.951	0.339
16.515	3.721	14.429	1.878	23.460	1.736	23.460	1.459	100.000	0.313
22.343	3.721	15.521	1.878	24.480	1.651	24.480	1.388		
24.334	3.330	15.728	2.144	25.551	1.220	25.551	1.050		
25.405	2.351	16.515	2.439	26.676	0.987	26.676	0.865		
26.530	1.744	22.343	2.439	27.857	0.723	27.857	0.654		
27.711	1.055	23.314	2.370	31.765	0.484	30.398	0.556		
29.165	0.905	24.334	2.260	35.098	0.361	33.200	0.404		
31.439	0.905	25.405	1.644	41.744	0.336	34.707	0.360		
34.154	0.546	26.530	1.276	100.000	0.313	39.360	0.339		
36.394	0.546	27.711	0.862			100.000	0.313		
41.280	0.356	28.743	0.709						
44.187	0.356	31.439	0.709						
54.859	0.329	33.737	0.475						
100.000	0.313	40.077	0.350						
		42.569	0.347						
		55.651	0.320						
		100.000	0.312						

TABLE NO : 4.1.1.10(c) ACCELERATION RESPONSE SPECTRA (ELASTIC)

PROJECT : KAIGA-5&6 BUILDING : CB
INTENSITY : OBE LOCATION : Floor - 116(PCB) (m)
DIRECTION : Z (VER) ZPA : 0.3107 (g)

5.0%		7.0%		10.0%		20.0%	
Freq	Accl	Freq	Accl	Freq	Accl	Freq	Accl
0.100	0.002	0.100	0.002	0.100	0.001	0.100	0.001
0.845	0.030	0.802	0.024	0.802	0.021	0.469	0.009
0.884	0.033	1.440	0.051	1.440	0.045	1.608	0.038
1.677	0.068	1.620	0.055	1.588	0.047	2.066	0.060
2.463	0.186	1.684	0.059	1.660	0.050	2.858	0.088
3.143	0.201	2.463	0.151	2.346	0.116	3.639	0.107
4.644	0.248	3.163	0.165	2.586	0.125	5.120	0.239
5.120	0.382	4.644	0.230	3.429	0.134	6.862	0.535
5.697	0.508	6.224	0.660	4.644	0.214	7.206	0.589
6.862	1.195	6.862	1.010	6.224	0.576	7.944	0.677
7.566	1.594	7.206	1.174	6.862	0.825	8.341	0.696
7.944	1.775	7.566	1.325	7.206	0.954	11.285	0.696
8.341	1.828	7.944	1.452	7.566	1.058	11.775	0.694
11.285	1.828	8.341	1.479	7.944	1.142	14.622	0.559
11.775	1.657	11.285	1.479	8.341	1.164	15.970	0.508
12.291	1.356	11.775	1.381	11.285	1.164	18.207	0.468
13.400	1.077	12.832	1.037	11.775	1.107	24.633	0.468
15.292	0.833	15.291	0.741	13.371	0.814	26.829	0.440
15.728	0.940	16.515	0.914	13.996	0.766	32.464	0.351
16.515	1.110	17.340	0.945	15.541	0.644	100.000	0.313
17.340	1.150	23.460	0.945	16.515	0.732		
23.460	1.150	24.480	0.881	17.340	0.749		
24.480	1.067	25.551	0.783	23.460	0.749		
26.676	0.735	27.857	0.559	24.480	0.721		
27.943	0.590	33.200	0.385	25.551	0.664		
30.398	0.506	35.020	0.352	27.857	0.520		
33.200	0.393	100.000	0.314	29.096	0.473		
34.707	0.359			34.562	0.352		
37.951	0.339			100.000	0.314		
100.000	0.313						

TABLE NO : 4.1.2.9(a) ACCELERATION RESPONSE SPECTRA (ELASTIC)

PROJECT : KAIGA-5&6 BUILDING : CB
INTENSITY : SSE LOCATION : Floor - 116 (m)
DIRECTION : X (E-W) ZPA : 0.5949 (g)

0.5%		1.0%		2.0%		3.0%		4.0%	
Freq (Hz)	Accl (g)	Freq (Hz)	Accl (g)	Freq (Hz)	Accl (g)	Freq (Hz)	Accl (g)	Freq (Hz)	Accl (g)
0.100	0.014	0.100	0.014	0.100	0.013	0.100	0.011	0.100	0.011
0.225	0.068	0.249	0.068	0.237	0.057	0.350	0.084	0.288	0.063
0.249	0.071	0.303	0.084	0.275	0.066	0.517	0.140	0.333	0.071
0.291	0.090	0.367	0.113	0.367	0.099	0.570	0.152	0.367	0.082
0.336	0.091	0.445	0.143	0.405	0.109	0.633	0.168	0.543	0.129
0.367	0.121	0.469	0.143	0.446	0.123	0.802	0.248	0.719	0.184
0.405	0.132	0.492	0.166	0.492	0.145	0.884	0.269	1.128	0.372
0.517	0.221	0.570	0.195	0.577	0.165	0.941	0.330	1.306	0.494
0.628	0.229	0.604	0.196	0.631	0.184	1.306	0.535	1.440	0.626
0.842	0.403	0.668	0.209	0.669	0.191	1.440	0.686	1.667	0.996
0.928	0.551	0.699	0.230	0.755	0.244	1.667	1.100	2.026	1.838
1.051	0.551	0.842	0.365	0.842	0.305	2.026	2.076	2.234	2.796
1.085	0.569	0.928	0.478	0.928	0.387	2.234	3.303	2.346	3.213
1.185	0.611	1.023	0.485	0.997	0.406	2.463	3.922	2.463	3.420
1.256	0.754	1.074	0.525	1.140	0.456	3.333	3.922	3.333	3.420
1.352	0.857	1.185	0.570	1.168	0.476	3.478	3.724	3.478	3.287
1.454	1.075	1.344	0.777	1.189	0.503	3.957	2.343	3.957	2.057
1.588	1.432	1.512	1.134	1.372	0.624	4.930	1.583	4.660	1.457
1.667	1.875	1.667	1.563	1.667	1.247	5.689	1.872	5.271	1.403
1.838	2.307	2.026	2.937	2.026	2.374	5.928	2.309	5.928	1.958
2.128	4.705	2.234	5.311	2.234	4.062	8.020	2.309	8.020	1.958
2.234	6.744	2.346	5.953	2.463	4.615	8.368	2.287	8.368	1.939
2.346	7.345	3.174	5.953	3.333	4.615	9.119	1.911	9.119	1.669
3.174	7.345	3.312	5.712	3.478	4.256	10.106	1.279	10.212	1.122
3.609	6.720	3.609	5.036	4.133	2.534	11.285	1.279	11.285	1.122
3.834	4.235	3.762	3.519	4.716	1.878	12.073	1.201	15.879	1.087
4.050	4.235	4.050	3.519	5.183	1.766	14.403	1.201	16.569	1.015
4.569	2.994	4.226	3.216	5.637	2.122	15.687	1.187	17.294	0.903
4.923	2.994	4.591	2.468	5.928	2.817	16.948	0.989	18.854	0.898
5.413	3.178	4.923	2.468	8.020	2.817	18.382	0.989	19.693	0.795
5.928	5.352	5.227	2.330	8.368	2.806	19.181	0.970	27.936	0.683
8.020	5.352	5.928	3.836	9.119	2.245	20.848	0.789	31.924	0.682
8.368	4.927	6.224	3.882	9.964	1.546	22.343	0.789	40.125	0.656
9.119	3.756	8.420	3.882	11.285	1.546	24.334	0.766	46.720	0.626
9.475	2.740	9.836	2.059	11.889	1.435	30.252	0.704	65.904	0.599
10.645	2.886	10.645	2.072	14.403	1.435	49.177	0.613	100.000	0.596
14.403	2.886	14.403	2.072	15.029	1.426	100.000	0.597		
15.029	2.621	15.029	1.973	15.687	1.373				
16.598	1.856	16.377	1.456	17.475	1.098				
19.301	1.856	19.301	1.388	18.382	1.098				
20.139	1.323	21.021	0.975	19.181	1.077				
21.287	1.233	23.938	0.933	20.902	0.844				
28.517	1.233	29.855	0.826	23.818	0.820				
29.615	0.953	36.394	0.750	26.599	0.741				
34.661	0.953	37.977	0.744	29.941	0.741				
36.168	0.943	51.505	0.619	31.243	0.738				
37.751	0.897	70.540	0.598	47.470	0.626				
38.243	0.830	100.000	0.595	53.000	0.610				

44.912	0.683	100.000	0.597
51.732	0.641		
65.973	0.601		
100.000	0.596		

TABLE NO : 4.1.2.9(a) ACCELERATION RESPONSE SPECTRA (ELASTIC)

PROJECT : KAIGA-5&6 BUILDING : CB
INTENSITY : SSE LOCATION : Floor – 116 (m)
DIRECTION : X (E-W) ZPA : 0.5949 (g)

5.0%		7.0%		10.0%		20.0%	
Freq (Hz)	Accl (g)	Freq (Hz)	Accl (g)	Freq (Hz)	Accl (g)	Freq (Hz)	Accl (g)
0.100	0.010	0.100	0.010	0.100	0.009	0.100	0.007
0.386	0.086	0.616	0.131	0.543	0.091	0.461	0.054
0.439	0.094	0.842	0.204	0.605	0.115	0.957	0.161
0.543	0.119	1.095	0.308	1.074	0.268	1.667	0.511
0.575	0.135	1.372	0.456	1.247	0.331	2.346	1.060
0.842	0.225	1.512	0.594	1.372	0.405	2.586	1.160
1.074	0.346	2.128	1.652	1.512	0.518	3.499	1.160
1.129	0.346	2.346	2.287	2.234	1.580	3.651	1.155
1.372	0.495	2.463	2.461	2.346	1.794	4.951	0.859
1.454	0.608	3.333	2.461	2.463	1.940	6.996	0.797
1.667	0.915	3.474	2.448	2.586	1.960	8.020	0.797
2.234	2.422	3.578	2.315	3.499	1.960	8.368	0.789
2.346	2.838	4.053	1.562	3.686	1.808	10.139	0.736
2.463	3.024	4.716	1.226	4.339	1.209	13.717	0.736
3.333	3.024	5.393	1.153	5.588	1.007	20.483	0.660
3.478	2.937	5.928	1.346	5.928	1.048	31.570	0.625
4.133	1.738	8.368	1.344	6.224	1.069	100.000	0.597
4.930	1.336	9.119	1.227	8.420	1.069		
5.637	1.425	9.523	1.124	8.787	1.039		
5.928	1.697	10.225	0.919	9.319	0.978		
8.020	1.697	11.177	0.933	10.645	0.860		
8.368	1.685	15.123	0.933	11.177	0.869		
9.119	1.485	15.781	0.923	15.123	0.869		
10.267	1.019	16.471	0.903	15.781	0.859		
15.879	1.015	17.956	0.807	16.471	0.842		
18.854	0.846	22.372	0.705	18.566	0.750		
19.693	0.762	27.605	0.656	23.392	0.679		
22.471	0.735	32.326	0.656	30.609	0.645		
28.170	0.671	55.460	0.605	54.038	0.604		
31.439	0.671	100.000	0.596	100.000	0.596		
40.125	0.648						
45.722	0.626						
71.027	0.598						
100.000	0.596						

TABLE NO : 4.1.2.9(b) ACCELERATION RESPONSE SPECTRA (ELASTIC)

PROJECT : KAIGA-5&6 BUILDING : CB
INTENSITY : SSE LOCATION : Floor – 116 (m)
DIRECTION : Y (N-S) ZPA : 0.6157 (g)

0.5%		1.0%		2.0%		3.0%		4.0%	
Freq (Hz)	Accl (g)	Freq (Hz)	Accl (g)	Freq (Hz)	Accl (g)	Freq (Hz)	Accl (g)	Freq (Hz)	Accl (g)
0.100	0.014	0.100	0.013	0.100	0.013	0.100	0.011	0.100	0.010
0.229	0.067	0.288	0.083	0.261	0.064	0.333	0.069	0.378	0.082
0.275	0.077	0.350	0.090	0.303	0.074	0.411	0.097	0.492	0.108
0.291	0.090	0.446	0.141	0.367	0.096	0.469	0.108	0.543	0.127
0.367	0.118	0.517	0.196	0.412	0.106	0.556	0.137	0.628	0.148
0.390	0.119	0.652	0.198	0.446	0.122	0.583	0.140	0.728	0.178
0.441	0.150	0.764	0.268	0.517	0.162	0.628	0.160	0.842	0.218
0.492	0.178	0.928	0.415	0.606	0.162	0.699	0.177	0.915	0.232
0.602	0.219	1.011	0.419	0.660	0.176	0.802	0.212	1.074	0.315
0.693	0.220	1.158	0.440	0.842	0.285	0.890	0.248	1.185	0.334
0.884	0.383	1.256	0.530	0.940	0.329	1.074	0.345	1.372	0.395
1.023	0.484	1.372	0.577	1.185	0.396	1.185	0.362	1.588	0.578
1.244	0.625	1.454	0.763	1.372	0.478	1.306	0.421	2.671	1.980
1.440	0.867	1.519	0.821	1.440	0.601	1.512	0.595	2.994	3.663
1.667	1.302	1.838	1.300	1.588	0.760	2.234	1.480	3.143	3.776
2.234	2.918	2.234	2.279	1.768	0.963	2.635	2.135	4.253	3.776
2.610	3.853	2.346	2.421	2.586	2.232	2.994	4.350	5.050	2.362
2.716	5.816	2.716	4.372	2.994	5.356	3.143	4.401	5.928	1.729
2.874	5.816	2.852	4.590	4.050	5.356	4.253	4.401	8.020	1.729
2.994	8.498	2.994	7.034	4.226	5.338	4.836	2.887	8.368	1.648
3.143	9.354	4.050	7.034	4.809	3.515	5.511	2.237	8.992	1.331
4.253	9.354	4.226	6.959	5.484	2.559	5.928	1.953	11.849	1.331
4.632	5.893	5.248	3.273	5.928	2.285	8.020	1.953	13.474	0.931
4.836	5.879	5.484	3.155	8.020	2.285	8.368	1.871	14.069	0.931
5.050	4.459	5.928	3.135	8.368	2.207	8.758	1.565	14.695	0.912
5.511	3.741	8.020	3.135	8.758	1.974	11.849	1.565	16.515	0.832
5.928	4.159	8.758	2.857	11.849	1.974	13.590	1.029	22.343	0.832
8.020	4.159	11.849	2.857	12.905	1.257	14.403	1.029	23.314	0.820
8.455	3.351	12.871	1.627	14.069	1.204	15.029	1.003	29.579	0.700
8.758	4.003	14.403	1.627	14.695	1.136	16.515	0.875	32.806	0.700
11.849	4.003	15.892	1.145	16.515	0.951	22.343	0.875	34.241	0.678
12.365	2.561	17.340	1.163	17.340	0.961	23.314	0.869	48.632	0.625
12.936	2.189	23.460	1.163	23.460	0.961	24.334	0.850	100.000	0.617
14.403	2.189	25.551	1.093	24.480	0.934	28.914	0.724		
15.029	1.893	26.676	1.037	29.323	0.764	31.439	0.724		
16.515	1.478	31.765	0.813	31.439	0.764	32.806	0.718		
17.340	1.490	38.215	0.794	48.632	0.626	48.632	0.625		
23.460	1.490	46.003	0.645	100.000	0.617	100.000	0.617		
25.865	1.456	48.771	0.645						
28.171	1.300	50.893	0.633						
29.350	1.017	100.000	0.618						
31.439	1.017								
32.724	0.947								
38.215	0.947								
41.620	0.707								
47.395	0.655								
59.326	0.619								
100.000	0.616								

TABLE NO : 4.1.2.9(b) ACCELERATION RESPONSE SPECTRA (ELASTIC)

PROJECT : KAIGA-5&6 BUILDING : CB
INTENSITY : SSE LOCATION : Floor - 116 (m)
DIRECTION : Y (N-S) ZPA : 0.6157 (g)

5.0%		7.0%		10.0%		20.0%	
Freq (Hz)	Accl (g)	Freq (Hz)	Accl (g)	Freq (Hz)	Accl (g)	Freq (Hz)	Accl (g)
0.100	0.010	0.100	0.009	0.100	0.009	0.100	0.007
0.425	0.090	0.458	0.083	0.457	0.072	0.441	0.051
0.493	0.099	0.571	0.111	0.628	0.116	0.884	0.118
0.543	0.118	0.628	0.127	0.728	0.130	1.306	0.225
0.598	0.127	0.728	0.148	0.842	0.143	1.440	0.243
0.660	0.145	0.842	0.168	0.928	0.165	2.331	0.660
0.764	0.166	1.023	0.236	1.023	0.207	2.852	1.027
0.842	0.196	1.097	0.258	1.512	0.354	2.994	1.121
0.884	0.199	1.244	0.310	2.586	1.198	3.143	1.189
1.074	0.292	1.667	0.504	2.994	1.937	3.300	1.227
1.588	0.521	2.234	1.023	3.143	2.053	3.466	1.232
2.234	1.207	2.716	1.668	4.253	2.053	4.688	1.232
2.716	1.922	2.852	2.122	4.438	2.043	5.107	1.198
2.852	2.584	2.994	2.500	5.511	1.529	5.568	1.141
2.994	3.165	3.143	2.659	6.292	1.121	6.937	0.929
3.143	3.312	4.253	2.659	8.020	1.102	9.089	0.792
4.253	3.312	4.438	2.569	8.368	1.091	16.259	0.677
5.050	2.179	5.050	1.960	9.947	0.827	19.115	0.677
5.275	2.089	5.511	1.743	11.865	0.798	22.031	0.665
5.511	1.944	6.073	1.311	14.478	0.723	69.694	0.618
5.928	1.552	8.020	1.311	14.979	0.728	100.000	0.616
8.020	1.552	8.368	1.276	21.280	0.728		
8.368	1.486	9.542	0.971	22.205	0.725		
8.946	1.171	11.849	0.971	30.114	0.665		
11.849	1.171	12.365	0.942	41.244	0.631		
12.365	1.097	14.643	0.748	100.000	0.617		
12.905	0.943	15.728	0.761				
15.558	0.791	22.205	0.760				
16.515	0.801	30.114	0.676				
22.343	0.801	41.244	0.633				
23.314	0.790	100.000	0.617				
29.459	0.689						
31.619	0.687						
43.305	0.631						
100.000	0.617						

TABLE NO : 4.1.2.9(c) ACCELERATION RESPONSE SPECTRA (ELASTIC)

PROJECT : KAIGA-5&6 BUILDING : CB
INTENSITY : SSE LOCATION : Floor - 116 (m)
DIRECTION : Z (VER) ZPA : 0.8363 (g)

0.5%		1.0%		2.0%		3.0%		4.0%	
Freq (Hz)	Accl (g)	Freq (Hz)	Accl (g)	Freq (Hz)	Accl (g)	Freq (Hz)	Accl (g)	Freq (Hz)	Accl (g)
0.100	0.009	0.100	0.009	0.100	0.009	0.100	0.008	0.100	0.007
0.275	0.050	0.288	0.055	0.293	0.049	0.261	0.040	0.275	0.037
0.295	0.059	0.322	0.056	0.317	0.050	0.317	0.045	0.317	0.043
0.333	0.060	0.367	0.073	0.367	0.064	0.416	0.066	0.469	0.066
0.367	0.079	0.397	0.076	0.410	0.070	0.517	0.089	0.498	0.075
0.397	0.083	0.464	0.093	0.615	0.108	0.669	0.106	0.705	0.107
0.476	0.101	0.570	0.127	0.688	0.119	0.731	0.124	0.730	0.114
0.543	0.141	0.628	0.127	0.759	0.145	0.794	0.139	0.891	0.149
0.628	0.141	0.679	0.130	0.887	0.186	0.842	0.160	0.976	0.161
0.728	0.174	0.756	0.169	0.975	0.223	0.931	0.174	1.034	0.180
0.794	0.205	0.796	0.184	1.074	0.234	0.990	0.189	1.128	0.200
0.842	0.248	0.842	0.223	1.189	0.236	1.132	0.213	1.266	0.241
1.185	0.313	0.928	0.268	1.397	0.309	1.185	0.216	1.387	0.255
1.244	0.405	1.041	0.276	1.517	0.437	1.306	0.278	1.512	0.327
1.372	0.409	1.512	0.527	1.667	0.496	1.541	0.374	1.667	0.374
1.757	0.809	1.563	0.536	2.994	1.551	2.994	1.333	2.994	1.196
2.234	1.347	1.667	0.637	3.821	3.420	3.821	2.903	3.821	2.632
3.300	2.942	1.838	0.720	4.012	5.146	4.012	4.194	4.012	3.579
4.012	8.178	3.300	2.487	4.213	5.703	4.213	4.710	4.213	4.022
4.213	9.400	3.639	3.849	5.568	5.703	5.581	4.710	5.576	4.022
4.423	9.709	4.012	6.778	5.646	6.139	5.928	5.939	5.646	4.255
5.439	9.709	4.213	7.588	5.928	7.388	7.981	5.939	5.928	5.016
5.646	13.087	5.488	7.588	8.020	7.388	8.341	6.388	7.799	5.016
5.928	14.926	5.646	9.005	8.341	7.825	11.285	6.388	8.341	5.502
8.020	14.926	5.928	10.700	11.285	7.825	11.775	5.612	11.285	5.502
8.527	14.335	8.020	10.700	11.775	7.050	12.291	4.596	11.775	4.874
8.758	14.755	8.341	10.830	12.291	5.429	13.992	3.276	12.114	4.243
11.849	14.755	11.285	10.830	13.170	4.375	15.123	3.276	13.400	3.371
12.483	8.158	11.775	10.428	13.717	4.375	15.799	3.141	15.280	2.755
14.069	8.158	12.291	6.886	15.670	3.764	16.515	3.495	16.515	3.053
14.266	8.556	12.929	5.984	15.728	3.852	17.340	3.500	17.340	3.074
19.301	8.556	13.717	5.984	16.515	4.096	23.460	3.500	23.460	3.074
19.355	8.355	14.266	5.785	22.343	4.096	24.480	3.403	24.480	2.928
22.343	8.355	19.301	5.785	24.334	4.085	25.745	2.603	26.223	2.171
23.314	8.215	19.406	5.620	25.482	3.183	27.857	2.319	27.857	2.007
24.334	7.895	22.343	5.620	27.711	2.788	30.721	1.522	29.096	1.698
26.530	6.420	23.314	5.524	28.950	2.190	33.201	1.245	33.200	1.128
27.711	5.494	24.334	5.393	32.179	1.492	36.394	1.245	34.707	1.125
28.950	4.060	25.405	4.616	34.661	1.492	37.977	1.194	37.951	0.989
31.420	2.852	26.530	4.359	37.751	1.442	41.168	1.050	41.528	0.933
38.215	2.852	27.711	3.868	40.606	1.236	44.238	1.050	49.818	0.877
39.875	2.054	28.950	2.876	44.238	1.236	46.216	0.904	100.000	0.840
43.452	1.809	31.872	2.000	46.807	0.901	65.446	0.858		
47.395	1.108	34.661	2.000	65.446	0.858	100.000	0.840		
51.549	0.893	37.751	1.945	100.000	0.840				
56.459	0.893	40.900	1.548						
100.000	0.839	44.238	1.548						
		48.252	0.897						

50.301	0.896
86.027	0.841
100.000	0.838

TABLE NO : 4.1.2.9(c) ACCELERATION RESPONSE SPECTRA (ELASTIC)

PROJECT : KAIGA-5&6 BUILDING : CB
INTENSITY : SSE LOCATION : Floor - 116 (m)
DIRECTION : Z (VER) ZPA : 0.8363 (g)

5.0%		7.0%		10.0%		20.0%	
Freq (Hz)	Accl (g)	Freq (Hz)	Accl (g)	Freq (Hz)	Accl (g)	Freq (Hz)	Accl (g)
0.100	0.007	0.100	0.006	0.100	0.006	0.100	0.005
0.395	0.054	0.425	0.054	0.295	0.033	0.377	0.033
0.473	0.063	0.460	0.054	0.380	0.043	0.446	0.035
0.610	0.084	0.513	0.060	0.476	0.048	0.903	0.077
0.716	0.103	0.547	0.067	0.572	0.061	2.463	0.396
0.770	0.109	0.577	0.070	0.633	0.073	4.012	1.124
0.812	0.121	0.641	0.083	0.678	0.079	4.213	1.197
0.858	0.131	0.684	0.089	0.704	0.081	4.644	1.279
0.983	0.146	0.772	0.096	0.884	0.103	5.928	1.467
1.036	0.166	0.855	0.115	0.987	0.114	6.862	1.559
1.133	0.189	0.931	0.119	1.244	0.183	7.944	1.815
1.165	0.192	0.985	0.128	1.667	0.262	8.341	1.853
1.373	0.235	1.090	0.162	2.716	0.615	11.285	1.853
1.667	0.342	1.312	0.217	3.821	1.676	11.775	1.840
2.994	1.103	1.667	0.302	4.012	1.985	12.291	1.789
3.639	1.874	2.994	0.963	4.213	2.105	15.970	1.388
4.012	3.153	3.639	1.672	5.409	2.105	18.255	1.218
4.213	3.503	4.012	2.561	5.646	2.400	19.976	1.191
5.569	3.503	4.213	2.775	5.928	2.634	20.901	1.171
5.646	3.730	5.509	2.775	6.862	2.648	22.892	1.113
5.928	4.346	5.646	3.059	7.566	2.885	30.177	0.972
7.662	4.346	5.928	3.463	10.236	2.885	100.000	0.843
7.944	4.590	7.464	3.463	13.263	2.346		
8.341	4.863	7.944	3.799	15.833	1.749		
11.285	4.863	8.341	3.971	17.340	1.776		
11.775	4.375	11.285	3.971	23.460	1.776		
12.291	3.730	11.775	3.672	24.480	1.689		
13.996	2.839	12.291	3.139	29.096	1.184		
15.280	2.481	13.400	2.774	30.398	1.097		
16.515	2.698	15.327	2.093	31.917	0.992		
17.340	2.744	16.515	2.198	52.155	0.872		
23.460	2.744	17.340	2.253	100.000	0.840		
24.480	2.584	23.460	2.253				
26.676	1.875	24.480	2.105				
27.857	1.770	27.857	1.445				
30.230	1.355	30.398	1.184				
33.200	1.066	34.095	0.968				
34.707	1.047	43.451	0.903				
38.780	0.942	49.818	0.878				
49.818	0.878	100.000	0.840				
100.000	0.840						

TABLE NO : 4.1.2.10(a) ACCELERATION RESPONSE SPECTRA (ELASTIC)

PROJECT : KAIGA-5&6 BUILDING : CB
INTENSITY : SSE LOCATION : Floor - 116(PCB) (m)
DIRECTION : X (E-W) ZPA : 0.3692 (g)

0.5%		1.0%		2.0%		3.0%		4.0%	
Freq	Accl	Freq	Accl	Freq	Accl	Freq	Accl	Freq	Accl
0.100	0.014	0.100	0.014	0.100	0.013	0.100	0.012	0.100	0.010
0.225	0.067	0.237	0.063	0.288	0.072	0.303	0.069	0.288	0.061
0.249	0.069	0.249	0.066	0.333	0.074	0.426	0.098	0.333	0.067
0.291	0.089	0.288	0.083	0.367	0.096	0.492	0.121	0.386	0.084
0.340	0.089	0.333	0.083	0.405	0.102	0.570	0.135	0.469	0.101
0.367	0.118	0.367	0.110	0.492	0.137	0.728	0.180	0.530	0.118
0.446	0.151	0.409	0.119	0.549	0.155	0.802	0.212	0.628	0.140
0.497	0.180	0.517	0.190	0.604	0.159	0.884	0.233	0.928	0.233
0.519	0.213	0.628	0.190	0.699	0.188	0.928	0.271	1.244	0.335
0.728	0.254	0.761	0.265	0.737	0.204	0.975	0.271	1.667	0.622
0.802	0.322	0.842	0.329	0.802	0.241	1.074	0.325	1.838	0.771
0.881	0.367	0.928	0.407	0.884	0.272	1.185	0.331	2.346	1.509
0.887	0.376	1.074	0.430	0.928	0.324	1.306	0.394	3.174	1.509
1.023	0.477	1.244	0.516	1.244	0.422	1.667	0.696	3.312	1.487
1.244	0.606	1.512	0.805	1.334	0.457	2.234	1.610	3.457	1.367
1.440	0.795	2.026	1.647	1.440	0.557	2.346	1.740	3.926	0.822
1.588	0.984	2.234	2.657	1.588	0.703	3.174	1.740	4.423	0.828
1.667	1.263	2.346	2.797	2.026	1.302	3.312	1.684	5.120	1.188
1.838	1.459	3.174	2.797	2.234	1.998	3.457	1.535	5.928	1.958
2.234	3.360	3.924	1.307	2.346	2.072	3.918	0.917	8.020	1.958
2.346	3.400	4.423	1.512	3.174	2.072	4.877	1.086	8.368	1.939
3.174	3.400	4.843	1.512	3.312	1.956	5.120	1.363	9.119	1.669
3.609	2.288	5.646	2.967	3.901	1.059	5.689	1.872	10.392	0.958
3.771	1.521	5.928	3.836	4.877	1.238	5.928	2.309	12.013	0.650
4.423	1.950	6.224	3.882	5.120	1.602	8.020	2.309	14.464	0.573
4.862	1.950	8.420	3.882	5.661	2.171	8.368	2.287	15.879	0.573
5.120	2.613	9.999	1.778	5.928	2.817	9.119	1.911	18.207	0.512
5.646	4.181	12.363	0.794	8.020	2.817	10.392	1.030	19.117	0.522
5.928	5.352	15.879	0.794	8.368	2.806	10.859	0.950	22.186	0.522
8.020	5.352	17.983	0.658	8.735	2.377	12.231	0.655	23.237	0.562
8.368	4.927	19.117	0.834	9.119	2.245	12.974	0.629	31.439	0.562
9.119	3.756	25.865	0.834	9.947	1.414	15.879	0.614	32.806	0.544
9.523	2.603	29.620	0.765	11.349	0.913	17.292	0.524	35.045	0.506
10.842	1.576	31.439	0.765	12.974	0.657	19.117	0.564	38.215	0.506
11.349	1.570	37.331	0.705	14.196	0.637	22.421	0.564	52.065	0.387
12.398	0.925	38.992	0.612	16.400	0.547	23.237	0.597	100.000	0.372
15.879	0.925	50.208	0.392	18.207	0.593	31.439	0.597		
17.340	0.830	55.651	0.385	21.077	0.608	35.169	0.533		
19.117	1.156	100.000	0.371	23.237	0.652	38.215	0.533		
25.865	1.156			31.439	0.652	45.375	0.442		
28.171	1.070			34.791	0.585	51.872	0.388		
29.489	0.953			38.215	0.585	100.000	0.372		
34.661	0.953			45.375	0.464				
36.168	0.943			50.594	0.391				
37.751	0.897			100.000	0.372				
39.549	0.688								
41.157	0.658								
49.052	0.406								

61.355	0.380
100.000	0.371

TABLE NO : 4.1.2.10(a) ACCELERATION RESPONSE SPECTRA (ELASTIC)

PROJECT : KAIGA-5&6 BUILDING : CB
INTENSITY : SSE LOCATION : Floor - 116(PCB) (m)
DIRECTION : X (E-W) ZPA : 0.3692 (g)

5.0%		7.0%		10.0%		20.0%	
Freq	Accl	Freq	Accl	Freq	Accl	Freq	Accl
0.100	0.010	0.100	0.009	0.100	0.009	0.100	0.007
0.425	0.087	0.570	0.105	0.548	0.085	0.446	0.049
0.517	0.106	0.693	0.137	0.693	0.123	0.693	0.093
0.884	0.192	0.842	0.165	0.884	0.148	0.886	0.110
1.074	0.268	1.074	0.234	1.023	0.189	1.838	0.354
1.244	0.309	1.440	0.360	1.372	0.279	2.128	0.459
1.667	0.565	1.929	0.687	1.559	0.342	2.346	0.513
1.838	0.708	2.346	1.085	1.929	0.575	2.586	0.525
2.346	1.334	2.463	1.098	2.346	0.845	3.499	0.525
3.174	1.334	3.333	1.098	2.463	0.869	3.651	0.522
3.312	1.329	3.478	1.047	3.333	0.869	4.371	0.471
3.457	1.240	4.267	0.645	3.478	0.850	5.376	0.580
3.936	0.753	4.877	0.797	4.341	0.568	5.646	0.621
4.877	0.901	5.376	1.075	5.376	0.899	5.928	0.650
5.928	1.697	5.928	1.346	5.646	0.994	6.224	0.665
8.020	1.697	8.020	1.346	5.928	1.044	8.842	0.665
8.368	1.685	8.368	1.344	6.224	1.069	9.630	0.642
9.119	1.485	9.119	1.227	8.420	1.069	10.054	0.623
9.523	1.309	9.523	1.124	8.787	1.039	11.565	0.537
10.392	0.908	10.392	0.836	9.171	1.001	17.936	0.418
11.959	0.637	11.979	0.611	9.575	0.944	100.000	0.372
14.135	0.551	16.860	0.451	10.911	0.696		
15.123	0.551	19.117	0.459	11.401	0.639		
15.781	0.548	23.237	0.500	14.453	0.501		
18.207	0.487	31.439	0.500	17.365	0.436		
20.074	0.497	38.029	0.463	20.074	0.441		
23.237	0.537	39.851	0.458	23.237	0.465		
31.439	0.537	49.491	0.395	31.439	0.465		
34.152	0.488	100.000	0.370	38.937	0.437		
38.215	0.488			100.000	0.370		
49.515	0.394						
52.947	0.386						
100.000	0.371						

TABLE NO : 4.1.2.10(b) ACCELERATION RESPONSE SPECTRA (ELASTIC)

PROJECT : KAIGA-5&6 BUILDING : CB
INTENSITY : SSE LOCATION : Floor - 116(PCB) (m)
DIRECTION : Y (N-S) ZPA : 0.4877 (g)

0.5%		1.0%		2.0%		3.0%		4.0%	
Freq	Accl	Freq	Accl	Freq	Accl	Freq	Accl	Freq	Accl
0.100	0.014	0.100	0.013	0.100	0.013	0.100	0.012	0.100	0.010
0.288	0.089	0.261	0.070	0.261	0.064	0.229	0.051	0.512	0.117
0.367	0.118	0.288	0.083	0.303	0.074	0.288	0.066	0.585	0.127
0.396	0.123	0.367	0.109	0.367	0.095	0.327	0.068	0.604	0.133
0.475	0.152	0.401	0.115	0.475	0.121	0.372	0.086	0.628	0.144
0.764	0.297	0.425	0.123	0.517	0.159	0.409	0.095	0.683	0.155
0.928	0.476	0.469	0.140	0.609	0.160	0.517	0.134	0.770	0.177
1.244	0.613	0.497	0.167	0.685	0.181	0.602	0.144	0.906	0.221
1.440	0.829	0.543	0.193	0.736	0.207	0.628	0.156	0.982	0.248
1.667	1.263	0.729	0.233	0.764	0.224	0.728	0.186	1.018	0.266
2.128	2.208	0.842	0.332	0.928	0.317	0.842	0.239	1.157	0.296
2.234	2.918	0.880	0.333	0.996	0.323	0.915	0.255	1.306	0.379
2.657	4.121	0.928	0.406	1.074	0.364	1.074	0.326	1.512	0.497
2.716	4.794	1.185	0.438	1.244	0.431	1.185	0.341	1.667	0.582
2.994	6.281	1.306	0.559	1.383	0.475	1.512	0.560	2.463	1.549
3.143	6.712	1.588	0.869	1.512	0.649	2.463	1.722	2.872	2.221
4.253	6.712	1.667	1.023	1.667	0.761	2.994	3.244	2.994	2.744
4.632	3.799	1.838	1.166	2.346	1.871	4.050	3.244	4.050	2.744
4.836	3.490	2.234	2.279	2.947	3.572	4.226	3.095	4.226	2.650
5.217	2.322	2.586	2.899	2.994	3.959	4.809	1.868	4.809	1.697
5.928	3.072	2.716	3.743	4.050	3.959	5.660	1.232	5.692	1.137
8.020	3.072	2.994	5.202	4.226	3.747	5.928	1.498	5.928	1.312
8.272	3.005	4.050	5.202	4.809	2.177	8.020	1.498	8.020	1.312
8.758	4.003	4.226	5.005	5.248	1.560	8.758	1.565	8.758	1.331
11.849	4.003	4.605	3.202	5.648	1.420	11.849	1.565	11.849	1.331
12.365	2.561	5.412	1.805	5.928	1.774	13.383	1.029	13.474	0.931
12.750	2.189	5.928	2.411	8.020	1.774	14.403	1.029	14.069	0.931
14.403	2.189	8.020	2.411	8.758	1.974	15.029	1.003	14.695	0.912
15.029	1.893	8.758	2.857	11.849	1.974	16.782	0.684	16.565	0.643
16.424	1.178	11.849	2.857	12.905	1.257	19.117	0.772	19.117	0.715
19.117	1.456	12.365	1.985	14.069	1.204	25.865	0.772	25.865	0.715
25.865	1.456	13.072	1.627	14.695	1.136	26.990	0.756	26.990	0.711
28.171	1.300	14.403	1.627	16.502	0.759	28.171	0.720	28.171	0.675
29.410	0.874	16.591	0.916	19.117	0.872	31.042	0.582	31.296	0.561
38.215	0.841	19.117	1.093	25.865	0.872	33.011	0.582	33.011	0.561
40.619	0.629	25.865	1.093	26.990	0.839	38.215	0.551	37.536	0.528
49.083	0.507	26.990	1.037	28.171	0.790	54.079	0.497	48.837	0.505
100.000	0.491	28.171	0.962	29.410	0.657	100.000	0.489	100.000	0.490
		29.410	0.731	34.064	0.589				
		32.776	0.669	38.215	0.589				
		38.215	0.669	42.019	0.525				
		42.745	0.546	46.432	0.525				
		45.375	0.544	57.606	0.497				
		57.523	0.498	100.000	0.489				
		100.000	0.489						

TABLE NO : 4.1.2.10(b) ACCELERATION RESPONSE SPECTRA (ELASTIC)

PROJECT : KAIGA-5&6 BUILDING : CB
INTENSITY : SSE LOCATION : Floor - 116(PCB) (m)
DIRECTION : Y (N-S) ZPA : 0.4877 (g)

5.0%		7.0%		10.0%		20.0%	
Freq	Accl	Freq	Accl	Freq	Accl	Freq	Accl
0.100	0.010	0.100	0.009	0.100	0.009	0.100	0.007
0.377	0.076	0.408	0.075	0.409	0.066	0.405	0.049
0.463	0.093	0.450	0.080	0.478	0.073	0.438	0.049
0.552	0.115	0.502	0.089	0.628	0.110	0.583	0.076
0.600	0.124	0.708	0.138	0.728	0.123	0.761	0.098
0.660	0.139	0.774	0.141	0.802	0.127	1.372	0.226
0.728	0.160	1.112	0.241	0.882	0.148	2.346	0.603
0.828	0.181	1.127	0.241	1.023	0.193	2.852	0.816
0.910	0.202	1.306	0.311	1.205	0.242	3.143	0.896
0.995	0.233	1.454	0.361	1.838	0.491	3.300	0.904
1.023	0.249	2.463	1.189	2.026	0.680	4.465	0.904
1.145	0.274	2.994	1.892	2.994	1.452	4.660	0.894
1.512	0.447	3.143	1.897	3.143	1.496	5.077	0.840
1.667	0.534	4.253	1.897	4.253	1.496	6.276	0.667
2.852	1.934	4.438	1.803	4.438	1.450	8.420	0.667
2.994	2.385	5.511	1.067	5.275	1.044	10.444	0.614
4.050	2.385	6.536	1.022	5.959	0.857	11.889	0.609
4.226	2.323	8.842	1.022	6.536	0.867	13.026	0.593
4.411	2.127	9.226	1.013	8.842	0.867	15.940	0.523
5.023	1.412	9.650	0.971	9.226	0.861	17.340	0.529
5.728	1.063	11.849	0.971	9.630	0.844	19.117	0.532
5.928	1.175	12.365	0.942	10.165	0.803	25.865	0.532
6.536	1.185	14.069	0.786	11.849	0.803	40.010	0.500
8.842	1.185	16.680	0.588	12.365	0.798	100.000	0.489
11.849	1.171	19.117	0.632	16.663	0.562		
12.365	1.097	27.158	0.633	19.117	0.592		
13.474	0.877	28.339	0.615	25.865	0.592		
14.069	0.867	32.247	0.526	26.990	0.590		
14.695	0.841	36.772	0.509	33.514	0.509		
16.860	0.625	100.000	0.490	100.000	0.489		
19.117	0.675						
20.074	0.680						
27.158	0.680						
32.247	0.545						
36.585	0.515						
43.933	0.511						
52.637	0.497						
100.000	0.489						

TABLE NO : 4.1.2.10(c) ACCELERATION RESPONSE SPECTRA (ELASTIC)

PROJECT : KAIGA-5&6 BUILDING : CB
INTENSITY : SSE LOCATION : Floor - 116(PCB) (m)
DIRECTION : Z (VER) ZPA : 0.8363 (g)

0.5%		1.0%		2.0%		3.0%		4.0%	
Freq	Accl	Freq	Accl	Freq	Accl	Freq	Accl	Freq	Accl
0.100	0.009	0.100	0.009	0.100	0.008	0.100	0.007	0.100	0.007
0.288	0.059	0.288	0.055	0.254	0.041	0.367	0.056	0.472	0.066
0.350	0.062	0.350	0.059	0.303	0.049	0.628	0.098	0.500	0.073
0.378	0.077	0.409	0.077	0.367	0.063	0.671	0.099	0.602	0.084
0.424	0.086	0.446	0.091	0.400	0.065	0.735	0.116	0.635	0.090
0.517	0.139	0.517	0.124	0.446	0.079	0.785	0.126	0.671	0.093
0.738	0.168	0.736	0.149	0.517	0.102	0.842	0.145	0.734	0.107
0.764	0.186	0.764	0.168	0.645	0.107	0.878	0.147	0.797	0.116
0.797	0.197	0.801	0.176	0.690	0.111	0.962	0.160	0.854	0.127
0.842	0.230	0.842	0.206	0.842	0.171	0.982	0.161	1.031	0.152
0.928	0.289	0.928	0.245	0.928	0.189	1.074	0.183	1.156	0.165
1.244	0.349	1.074	0.247	0.992	0.193	1.202	0.191	1.208	0.177
1.372	0.367	1.244	0.294	1.074	0.210	1.254	0.214	1.306	0.207
1.565	0.477	1.358	0.314	1.191	0.213	1.394	0.232	1.404	0.216
1.838	0.639	1.440	0.368	1.395	0.266	1.464	0.262	1.432	0.225
2.234	1.293	1.546	0.417	1.454	0.303	1.511	0.278	1.648	0.266
2.586	1.472	1.596	0.433	1.508	0.326	1.588	0.297	1.686	0.269
3.499	1.472	1.754	0.498	1.588	0.350	1.662	0.303	2.463	0.600
4.423	1.615	2.234	0.971	1.667	0.367	1.685	0.304	3.300	0.640
5.808	3.982	2.586	1.121	1.838	0.419	2.346	0.632	4.423	0.805
5.928	4.690	2.716	1.156	2.346	0.760	2.716	0.707	5.928	1.929
6.862	7.956	3.674	1.156	2.716	0.862	4.423	0.882	6.862	3.750
7.206	8.377	4.423	1.287	4.423	1.003	5.928	2.189	7.206	4.402
7.566	13.316	5.822	3.126	5.928	2.656	6.862	4.171	7.944	5.166
7.944	14.335	5.928	3.583	6.862	4.727	7.206	4.972	8.341	5.502
8.758	14.755	6.862	6.154	7.566	6.666	7.944	5.917	11.285	5.502
11.849	14.755	7.206	6.916	8.341	7.825	8.341	6.388	11.775	4.874
12.365	8.489	7.566	9.619	11.285	7.825	11.285	6.388	12.114	4.243
12.581	7.883	8.341	10.830	11.775	7.050	11.775	5.612	13.400	3.371
13.717	7.883	11.285	10.830	12.291	5.429	12.291	4.596	14.622	2.866
14.313	7.504	11.775	10.428	13.170	4.375	13.992	3.276	15.356	2.518
14.939	6.864	12.291	6.886	13.717	4.375	15.123	3.276	16.515	3.053
15.728	7.666	12.929	5.984	14.939	3.918	15.728	3.106	17.340	3.074
16.515	8.355	13.717	5.984	15.476	3.474	16.515	3.495	23.460	3.074
22.343	8.355	14.939	5.185	15.728	3.852	17.340	3.500	24.480	2.928
23.314	8.215	15.419	4.668	16.515	4.096	23.460	3.500	25.551	2.384
24.334	7.895	15.728	5.545	17.340	4.152	24.480	3.403	26.676	2.028
25.405	6.679	16.515	5.620	23.460	4.152	25.551	2.675	27.857	1.626
27.711	2.999	22.343	5.620	24.480	4.085	26.676	2.260	32.990	1.000
30.252	2.158	24.334	5.393	25.551	3.224	27.857	1.762	43.451	0.904
34.561	1.400	25.405	4.491	26.676	2.618	33.200	1.012	49.818	0.877
37.805	0.994	27.711	2.346	27.857	1.964	43.451	0.905	100.000	0.840
47.445	0.898	28.950	1.841	29.096	1.605	52.155	0.875		
75.450	0.846	30.252	1.773	30.398	1.508	100.000	0.840		
100.000	0.838	33.054	1.249	33.200	1.062				
		37.805	0.965	36.290	0.961				
		52.009	0.882	52.155	0.877				
		75.450	0.845	62.736	0.858				

100.000 0.838 100.000 0.839

TABLE NO : 4.1.2.10(c) ACCELERATION RESPONSE SPECTRA (ELASTIC)

PROJECT : KAIGA-5&6 BUILDING : CB
INTENSITY : SSE LOCATION : Floor - 116(PCB) (m)
DIRECTION : Z (VER) ZPA : 0.8363 (g)

5.0%		7.0%		10.0%		20.0%	
Freq	Accl	Freq	Accl	Freq	Accl	Freq	Accl
0.100	0.007	0.100	0.006	0.100	0.006	0.100	0.005
0.430	0.056	0.432	0.050	0.377	0.041	0.386	0.032
0.476	0.062	0.503	0.057	0.712	0.075	0.458	0.032
0.515	0.069	0.728	0.086	0.781	0.076	1.017	0.074
0.846	0.112	0.770	0.087	0.884	0.089	1.488	0.126
0.928	0.126	1.300	0.166	0.934	0.092	1.667	0.133
1.074	0.151	1.414	0.182	1.130	0.116	2.346	0.227
1.206	0.164	1.553	0.193	1.390	0.159	3.821	0.360
1.339	0.192	2.346	0.426	1.516	0.167	5.376	0.787
1.369	0.194	2.716	0.469	1.598	0.169	6.862	1.454
1.440	0.209	3.710	0.469	2.128	0.303	7.206	1.599
1.632	0.238	5.120	1.001	2.463	0.362	7.566	1.721
2.463	0.534	5.928	1.583	2.840	0.391	7.944	1.815
2.586	0.552	6.862	2.871	3.466	0.399	8.341	1.853
3.516	0.572	7.206	3.283	4.644	0.672	11.285	1.853
4.644	0.806	7.566	3.550	5.928	1.401	11.775	1.840
5.928	1.772	7.944	3.799	6.862	2.331	12.291	1.789
6.862	3.407	8.341	3.971	7.206	2.637	15.970	1.388
7.206	3.953	11.285	3.971	7.566	2.885	19.094	1.157
7.944	4.590	11.775	3.672	7.944	3.063	20.901	1.140
8.341	4.863	12.291	3.139	8.341	3.144	22.892	1.113
11.285	4.863	13.400	2.774	11.285	3.144	30.177	0.972
11.775	4.375	15.609	1.965	11.775	2.954	33.119	0.943
12.291	3.730	16.515	2.198	12.832	2.446	100.000	0.842
13.996	2.839	17.340	2.253	13.400	2.346		
14.622	2.638	23.460	2.253	16.180	1.678		
15.728	2.372	25.551	1.875	16.515	1.739		
16.515	2.698	27.857	1.431	22.343	1.739		
17.340	2.744	32.412	0.996	24.334	1.689		
23.460	2.744	36.290	0.951	28.950	1.184		
24.480	2.584	49.818	0.878	31.772	0.992		
27.857	1.544	100.000	0.840	36.144	0.947		
32.731	1.000			47.445	0.883		
43.451	0.904			100.000	0.841		
49.818	0.878						
100.000	0.840						

ATTACHMENT – 4

SCHEDULE OF BIDDER'S GENERAL PARTICULARS

1.0 Name of the BIDDER :

2.0 Address of the BIDDER :

3.0 Telephone, fax number, e-mail address of the BIDDER:

4.0 Name and designation of the officer of the BIDDER to whom all references shall be made for expeditious coordination :

5.0 (a) Foreign/indigenous collaborator if any role of foreign/indigenous collaborator: (Furnish complete particulars of collaboration, including copies of Government approval of collaboration agreement with overseas agencies). Evidence of clearance from his government in case of foreign bidder/collaborator

(b) Foreign / indigenous collaborations: Role of the BIDDER / collaborator / principal (as regards the extent & scope of the supply / services between BIDDER and his collaborator principal) shall be clearly brought out.

(c) Modus operandi for executing this contract covering all aspects from Design and engineering to handing over including services during erection, testing commissioning and trial operation.

(d) Evidence of clearance from his government in case of foreign BIDDER.

(e) Blank format (i.e. without price) of the price schedule shall be included along with Part-I with (*) mark against the respective serial numbers for the Supply items, Services, statutory levies etc., considered for pricing.

6.0 Are all technical particulars called in the specification filled-up? Yes/No

7.0 Are all deviations pointed out in Schedule of Deviations? Yes/No

8.0 Audited copies of profit and loss statement and balance sheets for last three years Enclose/Not Enclosed

9.0 Income tax clearance certificate: Enclose/Not Enclosed

SIGNATURE _____

NAME _____

COMPANY SEAL

DESIGNATION _____

COMPANY _____

DATE _____

ATTACHMENT – 5

SCHEDULE OF BIDDER'S EXPERIENCE

The BIDDER shall furnish here with a list of similar jobs executed by him to whom reference may be made by the PURCHASER in case the PURCHASER considers such a reference necessary

Sl. No.	Name and Description of work, including scope of work	Value of work	Client	Purchase Order No. & Date	Period of construction commissioning and date of	Persons to -whom reference may be made

SIGNATURE _____

NAME _____

COMPANY SEAL

DESIGNATION _____

COMPANY _____

DATE _____

ATTACHMENT – 6

SCHEDULE OF DRAWINGS / DOCUMENTS TO BE SUBMITTED ALONG WITH THE BID

The following documents shall be furnished along with the BID.

1.0 Completely filled in DATASHEETS/ ATTACHEMENTS of the specification.

2.0 Detailed organization chart of the BIDDER and his collaborator indicating the list of personnel who will be deployed for the contract and at projects site if the contract is Awarded

3.0 All Quality assurance plans covering entire' scope of contract.

4.0 Technical literature / catalogues.

5.0 List of makes of actuator

6.0 Bidder's experience

7.0 General arrangement drawing covering all the features of valves as noted below based on specification:

a. Constructional features.
b. Detailed part list with material specification.
c. Overall dimensions with tolerance.
d. End connection details including edge preparation details.
e. Test pressures for hydraulic and seat air tests.
f. Details of operator including make and overall dimension.
g. Weight of assembly.
h. Details of accessories (locking arrangement, extension drive, chain arrangement etc.) where called for.

ATTACHMENT – 7

SCHEDULE OF GUARANTEES

1.0 GUARANTEES

It is guaranteed that the material and workmanship of all components, installation, erection, commissioning and operation of the equipment supplied under this contract meet the requirements of these specifications.

2.0 With respect to the goods covered in the enquiry specifications the MANUFACTURER shall provide to the PURCHASE, guarantees:

2. 1 OF TITLE

It is guaranteed that the goods are not subject to any security interest, lien or other encumbrance.

2. 2 AGAINST PATENT INFRINGEMENTS

Except when the PURCHASER furnishes design specifications to the MANUFACTURER, the MANUFACTURER will at his own expense, defend and save the PURCHASE harmless from the expenses and consequences of any suit or procedure brought against the PURCHASER, so far as said suit or procedure is based on a claim that the goods furnished constitute an infringement of any patent in existence on the date of the order. In addition, the MANUFACTURER shall secure at his own expense a fully paid up license or licenses that will permit the PURCHASER to continue use of the goods furnished free of further free of further claim for infringement.

2. 3 OF QUALITY

a) It is guaranteed that the goods are new and of high quality and that the goods will be free of defects in design, materials and workmanship for a period of twelve (12) months from the date of commercial operation of the unit with Reactor Steam.

b) If within the expiry of the above stipulated guarantee period, the subject goods or any parts thereof are found defective because of design, workmanship or materials, it will be repaired or replaced. The guarantee period for the replaced parts or repair work shall be the same as above.

c) The guarantee period will be extended by the length of time required to make any adjustments, changes or repairs necessary to fulfil the guarantees.

d) Similar guarantees will be obtained from each SUB-CONTRATOR, However, the overall responsibility will be with the MANUFACTURER.

2. 4 OF PERFORMANCE

It is guarantees that the goods furnished are in full accordance with the requirements of this specification including codes and standards referred herein.

SIGNATURE _____

NAME _____

COMPANY SEAL

DESIGNATION _____

COMPANY _____

DATE _____

ATTACHMENT – 8

SCHEDULE OF DEVIATIONS FROM TECHNICAL SPECIFICATIONS

All deviations from the Specification shall be filled in by the BIDDER clause by clause in this schedule. BIDDER shall also indicate herein whether he would agree to withdraw the deviations if insisted upon by PURCHASER and whether such withdrawal would be at extra cost/no extra cost to PURCHASER. The extent of cost implications, if any, for withdrawal of deviations shall however be mentioned in Section E

SL NO.	SECTION NO.	CLAUSE NO.	DEVIATION	WHETHER AGREEABLE TO WITHDRAW IF INSISTED BY PURCHASER (YES/NO.)

The BIDDER hereby certifies that the above mentioned are the only deviations from Technical specification of the enquiry.

SIGNATURE _____

NAME _____

COMPANY SEAL DESIGNATION _____

COMPANY _____

DATE _____

ATTACHMENT - 9

SCHEDULE OF ERECTION AND MAINTENANCE TOOLS AND TACKLES

The BIDDER shall give below the list of maintenance tools and tackles included by him in his quoted prices for carrying out complete disassembly/assembly/ overhauling of equipment offered. BIDDER shall confirm that the maintenance tools/kit are complete in all respects.

SL. NO.	PARTICULARS	QTY.

SIGNATURE _____

NAME _____

COMPANY SEAL DESIGNATION _____

COMPANY _____

DATE _____

ATTACHMENT - 10

SCHEDULE OF WEIGHTS AND DIMENSIONS

The BIDDER shall state below the weights and dimensions of various packages for shipment comprising the complete scope.

SL. NO.	DESCRIPTION	DIMENSION IN METRES)	WEIGHT (IN TONNES)

SIGNATURE _____

NAME _____

COMPANY SEAL

DESIGNATION _____

COMPANY _____

DATE _____

ATTACHMENT - 11

SCHEDULE OF ACTIVITIES

The BIDDER shall indicate the times for manufacture, delivery and other activities of each Equipment as shown below unit wise.

For KAIGA U-1

Sl. No.	Equipment	Time from date of order to works test (weeks)	Time for works test, dismantling, packing and ready for dispatch from works (weeks)	Time required for shipment to site (weeks)	Total time from date of order to shipment to site (weeks)	Time required for erection, testing & commissioning (weeks)	Total time from date of order to commissioning and handing over, (weeks)

For KAIGA U-2

Sl. No.	Equipment	Time from date of order to works test (weeks)	Time for works test, dismantling, packing and ready for dispatch from works (weeks)	Time required for shipment to site (weeks)	Total time from date of order to shipment to site (weeks)	Time required for erection, testing & commissioning (weeks)	Total time from date of order to commissioning and handing over, (weeks)

We, the undersigned, hereby undertake to meet the above time schedule from the date of order. (BIDDER shall submit the detailed bar chart covering complete scope of this package)

SIGNATURE _____

NAME _____

COMPANY SEAL DESIGNATION _____

COMPANY _____

DATE _____

ATTACHMENT – 12

SCHEDULE OF PERFORMANCE AND EFFICIENCY TEST INSTRUMENTS

The BIDDER should indicate hereunder (**only if required**) all necessary instruments to be loaned by him to the PURCHASER for performance and efficiency tests on the Equipment supplied by him.

Sl. No.	Measurement point	Measured variable	Instrument required	Quantity required	Remarks

The BIDDER shall furnish all instruments with calibration certificates or otherwise as required for performance evaluation of complete plant as specified in this contract.

SIGNATURE _____

NAME _____

COMPANY SEAL DESIGNATION _____

COMPANY _____

DATE _____

ATTACHMENT - 13

SCHEDULE OF PLACES OF TESTS AND INSPECTION

The BIDDER shall indicate the item of equipment supplied, name of the MANUFACTURER or SUB-CONTRACTOR and place of test and inspection as shown below:

Sl. No.	**Item / equipment**	**Manufacturer or subcontractor**	**Place of test or inspection**

The BIDDER shall indicate the item of equipment supplied, name of the MANUFACTURPR or SUB-CONTRACTOR and place of test and inspection as shown below:

Sl. No.	**Item / equipment**	**Manufacturer or subcontractor**	**Place of test or inspection**

SIGNATURE _____

NAME _____

COMPANY SEAL DESIGNATION _____

COMPANY _____

DATE _____

ATTACHMENT - 14

SCHEDULE OF SUB CONTRACTORS & SUB VENDORS

The BIDDER shall indicate the details of SUB- CONTRACTORS. Details of each SUB-CONTRACTORS shall be provided in following format.

Sl. No.	Item/equipment	Name of sub vendor /sub-contractor	List of plants where equipment supplied	Rating of plant where equipment / system supplied / service provided	Complete address, telephone numbers, e-mail ID	Location of works	Remarks

SIGNATURE _____

NAME _____

COMPANY SEAL DESIGNATION _____

COMPANY _____

DATE _____

ATTACHMENT – 15

SCHEDULE OF ERECTION EQUIPMENT

The BIDDER shall furnish herein the details of all erection equipment and tools as required for the execution of the contract.

Sl. No.	Item	Details of quantity, capacity , etc.	Remarks

SIGNATURE _____

NAME _____

COMPANY SEAL DESIGNATION _____

COMPANY _____

DATE _____

ATTACHMENT – 16

DOCUMENT DISTRIBUTION SCHEDULE

MANUFACTURER shall distribute the documents as per the distribution schedule indicated below:

SL. No.	Item	OWNER's OFFICE
1.0	Correspondence	O+1
2.0	Minutes of meeting	1
3.0	Contract drawing / documents a) Preliminary b) Final c) As built (Including 2 CD)	 1 1 3
4.0	Test Certificates	O + 1
5.0	Progress report	1
6.0	All Photographs	2
7.0	Instruction manuals	
	(Final instruction manual on soft copy in MS office copied into CD)	
	a) Preliminary	1
	b) Final (including 2 CD)	3

O-Original

ATTACHMENT – 17

PIPING GA AND 3D MODEL SCREENSHOT

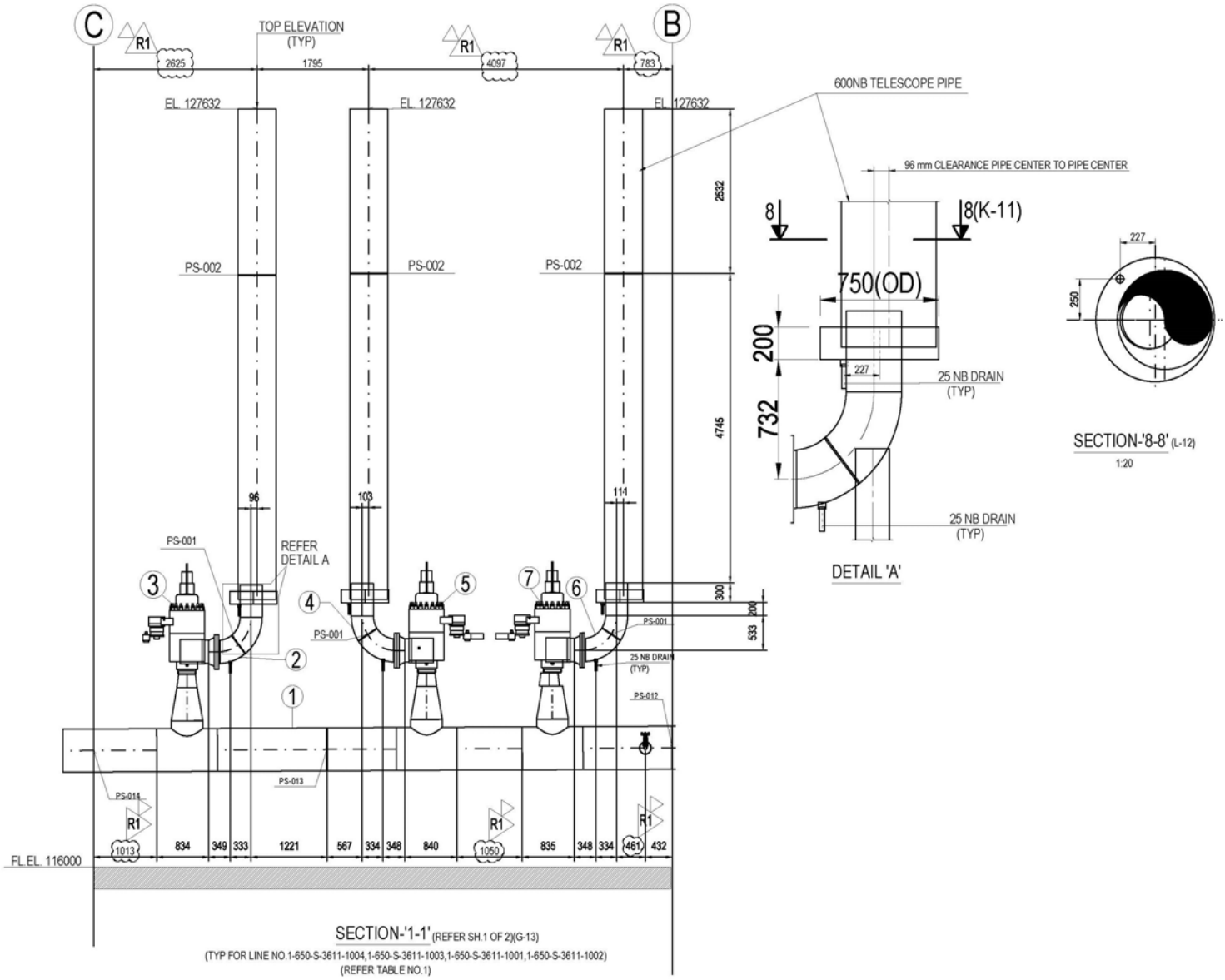
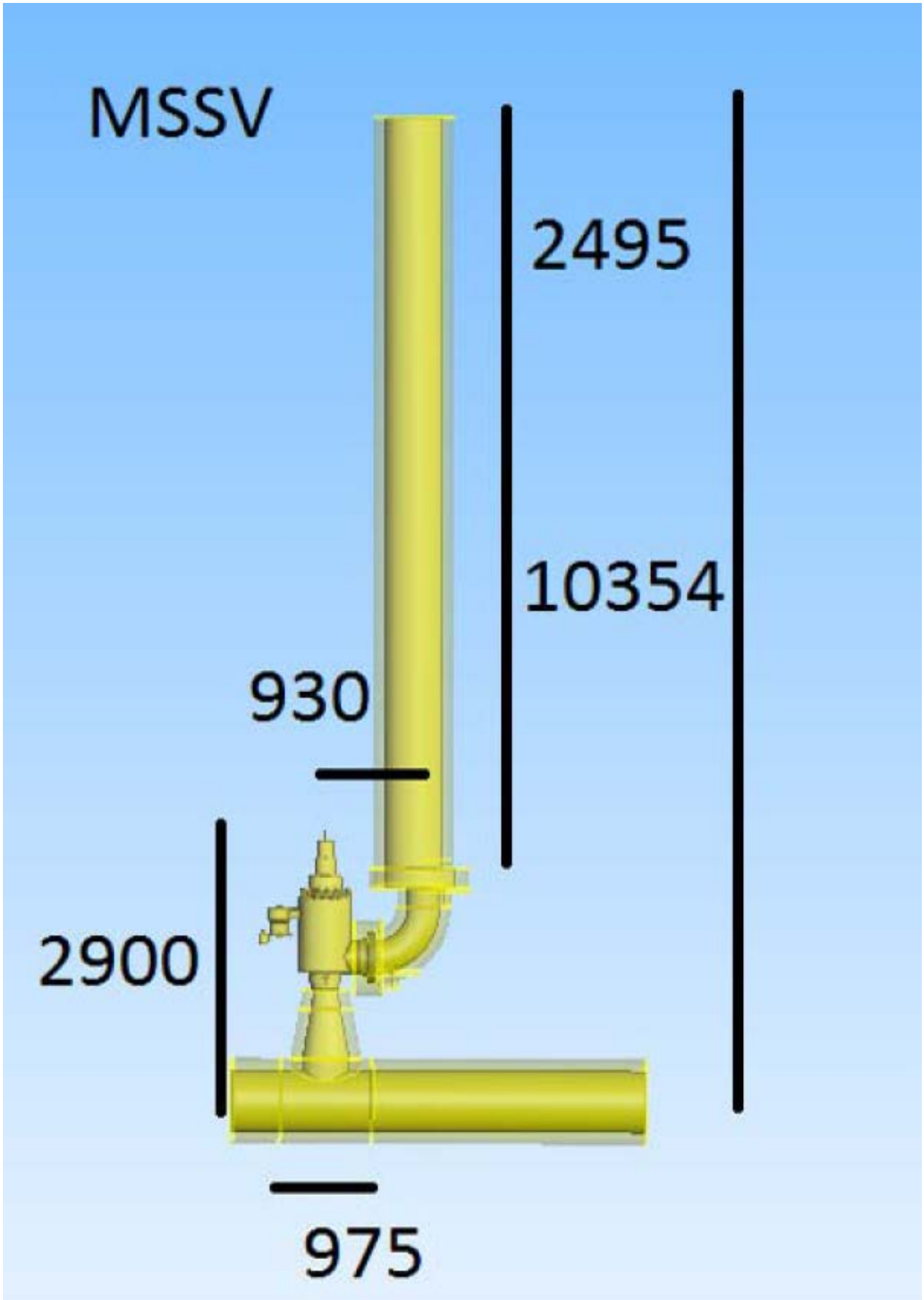


TABLE NO.1

LINE NO. ①	LINE NO. ②	VALVE ③	LINE NO. ④	VALVE ⑤	LINE NO. ⑥	VALVE ⑦	TOP ELEVATION
1-650-S-3611-1004	1-350-S-3612-1028	1-3612-MSSV-1212	1-350-S-3612-1027	1-3612-MSSV-1211	1-350-S-3612-1026	1-3612-MSSV-1210	EL.127632
1-650-S-3611-1003	1-350-S-3612-1025	1-3612-MSSV-1209	1-350-S-3612-1024	1-3612-MSSV-1208	1-350-S-3612-1023	1-3612-MSSV-1207	EL.128150
1-650-S-3611-1001	1-350-S-3612-1019	1-3612-MSSV-1203	1-350-S-3612-1018	1-3612-MSSV-1202	1-350-S-3612-1017	1-3612-MSSV-1201	EL.128150
1-650-S-3611-1002	1-350-S-3612-1022	1-3612-MSSV-1206	1-350-S-3612-1021	1-3612-MSSV-1205	1-350-S-3612-1020	1-3612-MSSV-1204	EL.127632



NUCLEAR POWER CORPORATION OF INDIA LTD
(A Government of India Enterprise)

SPECIFICATION NO: PP-P-1819

TECHNICAL SPECIFICATION
ON
METHODS AND PROCEDURES FOR SEISMIC QUALIFICATION OF VALVES; PANELS, DEVICES; ROTATING AND RECIPROCATING EQUIPMENTS; TANKS, VESSELS AND SUPPORTS
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REV NO. DATE	DESCRIPTION OF REVISION	REVISED BY	CHECKED BY	REVIEWED BY	APPROVED BY
Rev-01 June 2014	Revised based on recommendations of Task force constituted by ED (Engg.) for revision of PP-P 1819 vide letter No. NPCIL(HQ)/ED(ENGG.)/00000/M/2013/01 dated 22/01/13	Anshuman Singh, SEE (ED & SA III and S)	S.D.Bhawsar, ACE (ED & SA III and S)	S.M.Ingole, CE (ED & SA III and S)	A.K. Balasubrahmanian AD (RC & SA&S)

NPCIL PROPRIETARY

1.0 CONTENTS

The specification has been presented under the following Sections and Annexures:

Section	Title
1	Contents
2	Scope
3	Definitions
4	Introduction
5	Applicable codes and standards
6	Qualification methods and procedures.
7	Specification for qualification of valves.
8	Specification for qualification of panels and devices.
9	Specification for qualification of rotating and reciprocating equipment
10	Specification for qualification of tanks, vessels, heat exchanger and their supports.

Annexure-1	Load Combinations for Design Condition and Service Levels for Equipment and Supports
Annexure-2	General design guideline for equipment
Annexure-3	List of shake table test facilities in India
Annexure-4	Static side load test
Annexure-5	Sample Seismic Test Procedure for Valve/Valve actuator/ Instrument/Device
Annexure-6	Impact Hammer Test for Frequency Determination of Valves

2.0 SCOPE

This specification describes methods and procedures for seismic qualification of Structures, Systems and Components (SSC) of a nuclear power plant. The methods and procedures described in section 6 are applicable to all SSC of a NPP. However, detailed procedures for seismic qualification of certain equipment viz. valves; electrical and Instrumentation & control equipment; rotating and reciprocating equipment; passive systems/equipment like tanks, vessels and heat exchangers are described in sections 7,8,9 & 10 of this specification. Qualification of primary civil structures and piping are excluded from the scope of this specification.

3.0 DEFINITIONS

3.1 Cut-off Frequency: The frequency in the response spectrum where the Zero Period Acceleration asymptote essentially begins. This is the frequency beyond which the single-degree-of-freedom oscillators exhibit very little or no amplification of motion and indicates the upper limit of the frequency content of the waveform being analyzed.

3.2 Damping: An energy dissipation mechanism that reduces the amplification and broadens the vibratory response in the region of resonance. Damping is usually expressed in terms of percentage of critical damping. Critical damping is defined as the least amount of viscous damping that causes a SDOF system to return to its original position without oscillation after initial disturbance.

3.3 Design Condition: The design conditions include those pressure, temperature, and mechanical loadings selected as the basis for the design of systems, structures or components within a facility.

3.4 Design Basis Events: The set of events which serves as part of the basis for the establishment of design requirements for systems, structures and components within a facility. Design basis events (DBEs) include normal operations, operational transients and certain accident conditions under postulated initiating events (PIE) considered in the design of the facility.

3.5 Level A Service Limits (Normal Operating Conditions): Level A Service Limits are those sets of limits that must be satisfied for all Level A Service Loadings identified in the Design Specifications to which the component or support may be subjected in the performance of its specified service function.

Normal Operation of a plant or equipment within specified operational limits and conditions. In case of a nuclear power plant, this includes, start-up, power operation, shutting down, shutdown state, maintenance, testing and refuelling.

3.6 Level B Service Limits (Upset Conditions): Level B Service Limits are those sets of limits that must be satisfied for all Level B Service Loadings identified in the Design Specifications for which these Service Limits are designated. The component or support must withstand these loadings without damage requiring repair.

All operation processes deviating from normal operation which are expected to occur once or several times during the operating life of plant that and which, in view of appropriate design provisions do not cause any significant damage to items important to safety nor lead to accident conditions.

3.7 Level C Service Limits (Emergency Condition): Level C Service Limits are those sets of limits that must be satisfied for all Level C Service Loadings identified in the Design Specifications for which these Service Limits are designated. These sets of limits permit large deformations in areas of structural discontinuity that may necessitate the removal of the component or support from service for inspection or repair of damage to the component or support. Level-C service Loadings has a low probability of occurrence.

3.8 Level D Service Limits (Faulted Condition): Level D Service Limits are those sets of limits that must be satisfied for all Level D Service Loadings identified in the Design Specifications for which these Service Limits are designated. These sets of limits permit gross general deformations with some consequent loss of dimensional stability and damage requiring repair, that may require removal of the component or support from service. Level-D service Loadings has extremely low probability of occurrence.

3.9 Response spectrum: A plot of the maximum response, as a function of oscillator frequency, of an array of Single Degree Of Freedom (SDOF) damped oscillators subjected to the same base excitation.

3.10 Required Response Spectrum (RRS): The response spectrum issued by the user or the user's agent as part of the specifications for qualification or artificially created to cover future applications. The RRS constitutes a requirement to be met for seismic qualification of equipment by shake table testing.

3.11 Rigid Equipment: Equipment, structures, and components whose lowest natural frequency is greater than the cut-off frequency on the response spectrum.

3.12 Seismic Anchor Movement (SAM): Seismic anchor movement (or "SAM") is the differential motion between pipe support attachment points (for example,

supports attached to an upper floor would sway with the building, with a larger amplitude than supports attached at a lower elevation), or the differential motion between equipment nozzles and pipe supports. Seismic anchor movements are input as displacements (translations and rotations) at the support attachments or at equipment nozzles. The resulting stresses and loads in the piping system are then combined by square root sum of the squares (SRSS) to the stress and loads due to inertia.

3.13 S1 Level Earthquake - Operating Basis Earthquake (OBE): An earthqauke which, considering the regional and local geology and seismology and specific characteristics of local sub-surface material, could reasonably be expected to affect the plant site during the operating life of plant. The features of nuclear power plant necessary for continued safe operation are designed to remain functional, during and after the vibratory ground motion caused by this earthquake.

3.14 S2 Level Earthquake - Safe Shutdown Earthquake (SSE) : The earthquake which is based upon an evaluation of the maximum earthquake potential considering the regional and local geology and seismology and specific characteristics of local sub-surface material. It is that earthquake which produces the maximum vibratory ground motion for which certain structures, systems and components are designed to remain functional. These structures, systems and components are those which are necessary to assure

a) The integrity of reactor coolant pressure boundary; or
b) The capability to shutdown the reactor and maintain it in a safe shutdown condition; or
c) The capability to prevent the accident or to mitigate the consequences of accidents which could result in potential off-site exposures higher than the limits specified by the Regulatory Body; or
d) The capacity to remove residual heat.

3.15 Seismic Category-1 : Seismic category-1 shall includes all SSCs

a) Whose failure could directly or indirectly cause accident conditions, or
b) Which are required for shutting down the reactor, monitoring critical parameters, maintaining it in a safe shutdown condition and removing decay heat on a long term basis, or
c) Which are required to prevent radioactive releases or to maintain release below limits established by AERB for accident conditions(e.g. containment system).

All seismic category-1 structures, systems and components should be designed or qualified for both S1 (OBE) and S2 (SSE).

3.16 **Seismic category-2** : Seismic category-2 shall includes all SSCs which are required to:

a) Prevent the escape of radioactivity beyond the limits prescribed for normal operation and not covered in category-1, or
b) Mitigate those accident conditions which last for such long periods that there is a reasonable likelihood of an earthquake of the defined severity occurring during this period and not covered in category-1.

All seismic category-2 structures, systems and components shall have demonstrated capability to withstand the effects of S1 (OBE).

3.17 **Seismic category-3**: Seismic category-3 includes SSCs which are not important to safety and those not covered in category 1 or 2.

3.18 **Test response spectrum (TRS)** : The response spectrum that is developed from the actual time history motion given to the shake table.

3.19 **Zero Period Acceleration (ZPA)**: The acceleration level of the high frequency, non amplified portion of the response spectrum. This acceleration corresponds to the maximum peak acceleration of the time history used to derive the response spectrum.

4.0 INTRODUCTION:

A Nuclear Power Plant (NPP) has variety of Structures, Systems and Components (SSC) comprising primary civil structures and secondary structures, systems and components viz., tanks, vessels, heat exchangers, piping, supports; valves; pumps, fans, blowers, motors; compressors, diesel generators, reciprocating pumps; instrumentation and electrical panels, instrumentation and electrical devices, reactor control and shutdown devices, etc. These NPP structures, systems and components are designed and qualified for various service conditions viz. design, normal, upset (pressure, temperature, mechanical, transients), emergency, faulted (pressure, mechanical) and test conditions as applicable, including natural phenomenon like earthquake. The seismic design considers two levels of earthquake i.e. Operating Basis Earthquake OBE (S1) alone or OBE (S1) and Safe Shutdown Earthquake SSE (S2) as specified. Design of structures, systems and components for dead weight, sustained loads, pressure and temperature and mechanical loads is a standard industrial design practice. However, seismic design is a special branch of engineering and has been specifically dealt within this specification.

The General guidelines for seismic design are given in Annexure-2.

As specified in the NPCIL's equipment specifications, for the qualification of an equipment, following requirements shall be met:

i) Structural integrity and pressure boundary integrity
and
ii) Intended functional operability as applicable.

The seismic qualification of structures, system and components should establish that the structures, systems or components perform their intended safety functions during and after the specified earthquake(s). The examples of safety functions are structural integrity, degree of leak tightness, mechanical or electrical functional operability, preservation of geometrical dimensions or combination of these and any other specified function related to the specific structure, system or component under consideration. The seismic analysis should be based on clear understanding of the functions which should be assured during or after the specified earthquake(s).

Various structures, systems and components are classified into either seismic category 1 or seismic category 2 or seismic category 3. Items in category 1 should be designed for both S1 (OBE) and S2 (SSE) level earthquake ground motions. Items in category 2 should be designed for S1 (OBE) level earthquake ground motions. Seismic category 3 items should be designed for earthquake resistance according to the National practice. Loads during normal operation, anticipated operational occurrences, and loads during accident conditions should be combined with specified seismic loads as applicable. The allowable limits for stresses and

deformations under different load combinations should be used to assess the safety function and design intent as per the applicable code or specification of the structure, system and component.

For passive equipment viz., tanks, vessels, heat exchangers and supports qualification requirement are structural integrity and pressure boundary integrity. However, for active equipment viz., valves; pumps, fans, blowers, motors; compressors, diesel generators; electrical and instrumentation panels and devices involving mechanical motion, the qualification requirements shall also include functional operability.

This specification covers the procedure for qualification of secondary support structures, systems and components except civil structures, piping, to meet the above qualification requirements. For an equipment any specific requirement, other than the general requirement specified in the code shall also be met.

5.0 APPLICABLE CODES AND STANDARDS

Applicable codes and standards for design and qualification of various structures, systems and equipment are given below.

5.1. ASME Boiler and Pressure Vessel code, Section-III, Division-1, Subsection NB, Class 1 components, 2012.

5.2. ASME Boiler and Pressure Vessel code, Section-III, Division-1, Subsection NC, Class 2 components, 2012.

5.3. ASME Boiler and Pressure Vessel code, Section-III, Division-1, Subsection ND, Class 3 components, 2012.

5.4. ASME Boiler and Pressure Vessel code, Section-III, Division-1, Subsection NF, Component Supports, 2012.

5.5. ASME Boiler and Pressure Vessel code, Section-III, Division-1, Appendices, 2012.

5.6. ASME Boiler and Pressure Vessel code, Section-VIII, Pressure Vessels, Division 1, 2012.

5.7. ASME Boiler and Pressure Vessel code, Section-VIII Pressure Vessels, Division 2, Alternative Rules 2012.

5.8. ASME/ANSI B-31.1, Code for Power Piping, 2010

5.9. ASME Boiler and Pressure Vessel code section II, Material Specifications, 2012.

5.10. ACI 349-85, Code Requirements for Nuclear Safety Related Concrete Structures and commentary ACI-349 R-85, 1985.

5.11. ASCE 4-98, Seismic Analysis of safety related nuclear structures and commentary on standard for seismic analysis of safety related nuclear structures, 1998.

5.12. IS-800, Code of practice for use of structural steel in general building construction, 2007.

5.13. IS-456, Code of practice for plain and reinforced concrete, 2000.

5.14. Mechanical standard TEMA, class C, 2007.

5.15. Welding Research council bulletin WRC 107, Local stresses in spherical and cylindrical shells due to external loading, 2002.

5.16. Welding Research Council bulletin WRC 297, Local stresses in cylindrical shells due to external loading on nozzle, 1987.

5.17. Combined modal response and spatial components in seismic response analysis USNRC RG 1.92, 2006.

5.18. USNRC RG 1.100 revision 3 "Seismic Qualification of Electrical & Active Mechanical equipment and Functional Qualification of Active Mechanical equipment for Nuclear Power Plants", September 2009.

5.19. Paper on response combination by R.P.Kennedy, NUREG 1061 Vol. 4, Appendix A of SMA 1211.02.R2.0, March 1984.

5.20. NUREG/CR-6241, BNL-NUREG-52422, Technical guidelines for Aseismic design of Nuclear Power Plants, 1994.

5.21. IEEE Std-344, IEEE recommended practice for seismic qualification of Class 1E equipment for nuclear power generating stations, 2013.

5.22. IEEE Std-382, IEEE standard for qualification of actuators for power operated valve assemblies with safety related function for Nuclear Power Plants, 2006.

5.23. IEC-60780, Nuclear Power Plants – Electrical equipment of the safety system qualification, 1998.

5.24. IEC-60980, Recommended practice for seismic qualification of electrical equipment of the safety system for nuclear generating stations, 1998.

5.25. ASME QME 1-2007 Qualification requirements for active mechanical equipment for nuclear power plants, 2012.

5.26. IAEA Safety Guide 50-SG-S2, Seismic analysis and testing of Nuclear Power Plants, 1980.

5.27. IEEE C37.98-1987, IEEE standard Seismic Testing of Relays.

5.28. IS-1893, Criteria for earthquake resistant design of structures, 2002.

5.29. IEEE-693 - IEEE recommended practice for Seismic Design of sub-stations, 2005.

5.30. ACI-318/318 R-95: Building Code Requirement for Structural Concrete and Commentary.

5.31. IEEE-420 – IEEE Standard for design of class 1E Electrical Boards, Panels, Racks, 2001.

5.32. AERB Guide No. AERB/NPP-PHWR/SG/D-23 Seismic Qualification of Structures, Systems and Components of Pressurised Heavy Water Reactors, 2009.

5.33. AERB SAFETY GUIDE NO. AERB/NPP-PHWR/SG/D-1 Safety Classification and Seismic Categorisation for Structures, Systems and Components of Pressurised Heavy Water Reactors, 2003.

5.34. USNRC RG 1.29 Revision 3 "Seismic Design Classification", September 1978.

5.35. USNRC RG 1.26 Revision 4 "Quality Group Classifications and Standards for Water, Steam and Radioactive Waste Containing Components of Nuclear Power Plants", March 2007.

5.36. IEEE-323 – IEEE Standard for qualifying class 1E Equipments for Nuclear Power Generating Station, 2001.

5.37. U.S. Atomic Energy Commission, "Nuclear Reactors and Earthquakes", TID-7024, Washington, D.C., 1963.

5.38. Program on technology innovation, "The effects of high frequency ground Motion on structures, components, and Equipment in nuclear power plants" EPRI, June 2007.

5.39. EPRI Draft White Paper, "Considerations for NPP Equipment and Structures Subjected to Response Levels Caused by High Frequency Ground Motions", March 2007.

5.40. "Seismic Screening of Components Sensitive to High Frequency Vibratory Motions", EPRI White Paper, June 2007.

5.41. "Seismic Design and Retrofit of Piping Systems", ASCE, July2002.

5.42. "Seismic Evaluation Procedure for Equipment in US Department of Energy Facilities DOE/EH-0545, March 1997.

The codes and standards referred above or any of their latest revisions can be used in concurrence with NPCIL. The general requirements of other standards and codes or guides applicable for manufacture, design and qualification for specific equipment which are not listed above shall also be met. For example IEEE-387 guide for emergency diesel generator sets, IEEE-628 for cable trays, IS-9000 for environmental qualification of electrical & instrumentation etc.

6.0 SEISMIC QUALIFICATION METHODS AND PROCEDURES

The seismic qualification in terms of structural and pressure boundary integrity and /or functional operability as applicable can be performed by any of the following commonly used methods viz.,

a) Analysis
b) Testing
c) Analysis and Testing

These methods, or other justifiable methods, may be adequate to verify the ability of the SSC to meet the seismic qualification requirements. The choice should be based on the practicality of the method for the type, size, shape, complexity of the SSC configuration, whether safety function can be assessed in terms of structural integrity/pressure boundary integrity alone and/or in terms of functional operability.

6.1 Qualification for Structural and Pressure Boundary Integrity

Qualification of SSCs, whether passive or active, can be performed by analysis to assess their intended function in terms of structural integrity and pressure boundary integrity as per the requirements of governing code.

6.1.1 Qualification by Analysis using Simplified Method

Wherever feasible analytical methods using classical bending and direct stress equations, where free body diagram determine a simple stress distribution that is in equilibrium with applied loads may be used with prior approval from NPCIL. Empirical formulae and equations as given in relevant codes & guides for specified equipment may be used.

6.1.2 Qualification by Analysis using FEM

Qualification of SSCs are required to be performed for various loads viz., design loads, loads during normal and upset conditions (pressure, temperature, mechanical, cycles, transients), including OBE; loads during emergency and faulted conditions (pressure, mechanical) including SSE; test loads; etc. as specified in NPCIL's equipment specification and in the Vendor's General Equipment Specification (VGES).

The general steps involved to meet the qualification requirements are:

i) Preparation of the finite element model which represents the SSC adequately.

The guidelines on modeling are given in para 6.1.2.1

ii) Identification of the applicable loads.

iii) Determination the structural response for these loads in terms of forces, moments, displacements and stresses. The seismic response shall be determined by using response spectrum analysis/time history analysis/ equivalent static analysis method.

iv) Combination of the seismic responses with other operating stresses and displacements as per the load combinations given in Annexure-1.

v) Comparison of the combined stresses and displacements with those that ensure compliance with design/ codal requirements. The stresses and displacements shall be less than allowable values.

6.1.2.1 FEM Modeling

Seismic analysis of SSCs generally uses Finite Element (FE) methods. Most of the commercially available computer codes have the capability to perform the analysis. The following are some of the acceptable methods of modeling the SSC.

i. Finite Element Model using Beam or One-Dimensional Element

This modeling is typically applied to beams, columns, frames, ducts, cable trays, conduits, cabinets, storage racks, which are expressed as a continuous or one dimensional finite element in a two or three- dimensional space. Masses are represented by lumped parameters, which develop a diagonalised elemental mass matrix. Tanks, pressure vessels and heat exchangers can also be modelled this way, especially when using the equivalent static method.

ii. Finite Element Model using Plate & Shell Element

This type of modeling is adopted for items whose primary mode of failure is by biaxial bending stress, plane stress or plane strain. Typically included in this category are : cabinets, tanks, pressure vessels and heat exchangers whose shells support significant eccentric loads which would tend to excite shell or local modes of vibration.

iii. Finite Element Model using Solid Element

In this, the SSC is modeled by using solid elements. This type of modeling is expensive and is preferable for local analysis to obtain correct stress picture at openings, shell-nozzle junctions etc.

While modelling the equipment apart from beam & shell/plate elements, solid elements and other type of elements or combination thereof may be used. The mathematical model should not be oversimplified nor over-discretised. If FEM is to be used, the model should adequately represent the dynamic and static characteristic of the equipment as realistically as practicable. The model should be able to predict functional performance as well as structural adequacy.

6.2 Qualification for Functional Operability

Qualification of SSCs can be demonstrated by analysis and/or testing for assessing their intended functional operability.

6.2.1 Functional Operability by Analysis

The qualification of rotating equipment viz., pumps, fans, blowers, motors etc. and reciprocating equipment viz., compressors, diesel generators, reciprocating pumps etc. may be performed by analysis to assess their functional operability.

The general steps involved in qualification of these equipment to meet the qualification requirements of functional operability are the same as in para 6.1.1. In addition, the displacements of the moving components shall be demonstrated to be less than the clearances/gaps between the moving and stationary components/parts viz., impeller-casing, stator-rotor etc. The alignment of equipment shaft & motor shaft shall also be demonstrated to be within the specified value. The reactions at the bearing location shall be shown to be less than the specified bearing capacity.

6.2.2 Functional Operability by Test

Qualification of various types of active equipment, valves, electrical and instrumentation items (panels, instruments and devices including reactor control and shutdown devices, batteries, transformer, switchgear, MCC etc.) can be performed by test to demonstrate their functional operability. In general, the seismic test shall be conducted by mounting the equipment/ component on a shake table. While a seismic motion is given to the shake table corresponding to the location of equipment/component, the equipment/ component shall be checked for its intended functional operability. During the test, the operating loads/conditions of the equipment/ component shall also be simulated adequately. The test should conservatively simulate the seismic motion at the equipment/ component mounting

location. The multidirectional nature of earthquake should be simulated. The list of the test facilities available in the country is given in Annexure-3.

6.2.3 Functional Operability by a Combination of Analysis and Test

Electrical & instrumentation panels, devices and other active equipment/ component can be qualified by a combination of analysis and test. The panel as a structure supporting the various active devices mounted at different locations in the panel can be analysed to calculate the seismic motion at the base of the active devices. The active devices then can be qualified on a shake table for the seismic motion determined at the base of these devices.

Moreover, it is not always practical to qualify all the equipment by testing. This may be because of the size of the equipment, its complexity, nature of equipment, etc. Large equipment, such as multibay equipment racks and consoles/panels etc., may be impractical to test at full scale due to limitations of the shake table. These type of equipment can be qualified by using combination of analysis and testing.

6.3 Qualification by Previous Seismic Analysis & Test Reports

If two or more equipment of same type, make, size, model and design are used in same or different nuclear power plant or different application and if any one of them is seismically qualified for one application requirement then other equipment can be accepted for different application provided following requirements are met:

1. It should be established that equipment design is similar to the reference equipment already qualified.
2. Equipment are mounted/ anchored with similar bolting/welding/EP/support arrangement.
3. Required response spectra of new application is same or lower than the previous application, when compared for same values of damping and OBE & SSE levels of earthquake as applicable.
4. If equipment is qualified by testing then Test Response spectra is enveloping the new RRS of the equipment to be qualified, for same values of damping in the frequency range of interest.
5. Adequate and sufficient documentation in terms of qualification report and justification as above are available to verify the qualification requirement.

6.4 Vendor's General Equipment Specifications (VGES)

For demonstrating structural integrity and pressure boundary integrity by analysis, the various loadings on the equipment as specified in the NPCIL's equipment specification shall also be specified in Vendor's General Equipment Specification (VGES). These loadings shall include design loads, loads during normal and upset

conditions (pressure, temperature, mechanical), number of cycles of transients experienced by the equipment, including OBE; loads during emergency and faulted conditions (pressure, mechanical), including SSE; test loads, etc., as specified in NPCIL's equipment specification. Above list is not complete, and as such, any additional loading coming on equipment due to specific design features shall also be specified in the VGES. The equipment is also required to be qualified for it's intended functional operability for the earthquake loading in combination with other operating loads as specified in NPCIL's technical specification and should form part of the VGES.

In order to meet the functional operability requirement of the equipment as brought out in this technical specification, various functions to be performed and functional parameters to be measured by the various devices and sub-devices in the equipment and which are to be monitored during the shake table test shall be brought out in the VGES. These include opening and closing time of valves, change in status of electrical contacts and relays; electrical contact and relay chattering; pressure, temperature, resistance, voltage, current settings etc as applicable.

7.0 SPECIFICATION FOR QUALIFICATION OF VALVES

This section covers the procedure for qualification of a general valve assembly including actuator, in terms of structural integrity, pressure boundary integrity and functional operability as brought out in NPCIL's equipment specification and in the VGES. The procedure shall be applicable to various power operated valves such as gate valve, globe valve, ball valve, butterfly valve, diaphragm valve, solenoid valve etc and relief valves. Manually operated valves and check valves are not required to be seismically qualified either by analysis or seismic test. However general requirements of design given in ASME Section-III, Division-1, Subsection-NB, NC and ND whichever is applicable shall be met for manually operated valves and check valves. For a specific valve, due to its specific design features if any additional technical requirements are to be met, same shall also be included in the VGES and shall also become part of the below mentioned qualification procedure.

In case of valves, general requirements of design are given in ASME Section-III, Division-1, Subsection-NB, NC and ND whichever is applicable. If any supports are used in the valve to support the valve component or the valve actuator from the valve body, those should be designed as per the general requirements given in ASME Section III, Division-1, Subsection NF. The material used for the valve assembly shall be as given in NPCIL's specification or as given in VGES. Structural integrity and pressure boundary integrity of the valve assembly shall be demonstrated by carrying out analysis, as applicable. For active valve assemblies, such as active power operated valve assemblies, and pressure relief valve assemblies, the functional operability of valve assembly shall be demonstrated by a test as applicable. The test covered in the specification pertain only to a seismic test. The list of shake table test facilities presently available in the country is given in Annexure-3.

The detailed procedure for qualification of a typical power operated valve assembly is given below:

7.1 Qualification for Structural Integrity and Pressure Boundary Integrity

7.1.1 Qualification by Analysis

Structural integrity and pressure boundary integrity of the valve assembly shall be assessed by performing an analysis. Simplified analysis may be performed based on static forces resulting from equivalent earthquake accelerations acting at the centres of gravity of the extended masses. Classical bending and direct stress equations, where free body diagrams determine a simple stress distribution that is in equilibrium with the applied loads, can be used (Ref-ASME Sec III NB-3524 & NB 3592.3 Earthquake) or FEM method as described below can be used.

7.1.1.1 **Finite Element Modeling**

Valve body, stem, bonnet, yoke, brackets for actuators, gear boxes and any other component may be modelled with appropriate material properties and section properties as calculated from the component detailed drawing using beam elements, shell elements, 3D brick element or combination thereof with justification of assumptions.

Connection between valve body-stem, valve body-yoke, valve yoke-stem, gearbox housing-stem, actuator shaft-gear, bearings, and any other connection specific to the valve may be appropriately modelled.

Concentrated masses of actuators, gearboxes, handwheel, disc of butterfly valve, limit switches or any other devices of the valve may be modelled as lumped mass at the C.G. location. The eccentricity of mass in the finite element model shall be taken into account. The bearings if any shall be modeled by suitable spring elements. The spring constants for bearings shall be used from authenticated document and shall be referred/attached with the report.

Valve ends should be modeled appropriately using boundary elements, spring element or fixed boundary condition.

Any other peculiar construction details of valve assembly may also be modelled appropriately using spring or mass or spring-mass system.

Finite element model of the valve assembly using above considerations shall adequately represent the realistic static/dynamic characteristics of the valve assembly. While modeling the valve assembly apart from beam elements, shell, plate, 3D brick element or combination thereof may also be used with justification. The Finite Element Model shall be forwarded to NPCIL both in soft and hard copies for review and approval before proceeding for further analysis. The assumptions made in the finite element idealization with justifications shall be brought out in the report and all the inputs used in the data preparation shall be from authenticated documents and shall be referred/attached with the report.

7.1.1.2 **Finite Element Analysis**

Using validated software, the valve assembly as modelled above shall be analysed to extract the natural frequencies of the valve. Two different sets of seismic qualification procedures exist depending upon whether the first natural frequency of the valve assembly is less than or greater than rigid/cutoff frequency as determined from the applicable spectra. When the first natural frequency is less than rigid/ cutoff frequency, the valve assembly is called as flexible assembly, whereas when the first natural frequency is greater than or equal to rigid/cutoff frequency it is

called as rigid assembly. All the valve assemblies shall be qualified for OBE alone or for OBE and SSE as applicable as given in NPCIL specification. Worst combinations of unsigned earthquake stresses with signed stresses to non seismic loads, shall be considered for qualification.

In case of rigid valve, the valve model shall be further analysed to evaluate seismic forces/stresses/displacements using equivalent static analysis method. In case of flexible valve assembly, either equivalent static analysis or response spectrum analysis may be performed.

In the equivalent static analysis method for rigid valves, force equivalent of 1.5 times the floor spectral peak acceleration shall be applied in 3 orthogonal directions at all mass points and the static analysis be carried out. In the equivalent static analysis method for flexible valves, force equivalent of 2.25 times (i.e. 1.5 x 1.5) the floor spectral peak acceleration shall be applied in 3 orthogonal directions at all mass points and the static analysis be carried out. The floor response spectra for OBE (2% damping) and SSE (3% damping) corresponding to the valve location, will be given by NPCIL as applicable.

For the response spectrum analysis to be performed on the flexible valve assembly, the applicable response spectra are the spectra at the valve mounting location on the piping system or equipment. These response spectra for OBE and SSE for 2% & 3% damping respectively will be derived by NPCIL & given by NPCIL corresponding to the valve location.

The response spectrum analysis shall include the addition of modal responses in each direction after accounting for closely spaced modes as per USNRC RG 1.92 and missing mass response as per NUREG 1061 vol. 4 (missing mass is the mass of the equipment which has not participated upto rigid/cutoff frequency) and three orthogonal directional responses combination by SRSS method.

If response spectra at the valve mounting locations are not available then floor response spectra accelerations scaled up by a factor of 1.5 shall be used (Ref-ASME QME 1-2012).

The valve assembly shall be analysed for various loads viz., design loads, loads during normal and upset conditions (pressure, temperature, mechanical, cycles, transients), including OBE; loads during emergency and faulted conditions (pressure, mechanical), including SSE; test loads; hydrodynamic, electromagnetic loads or any valve specific load, etc. as specified in the NPCIL's equipment specification and in the VGES.

If the valve actuator assembly is supported at multiple locations & subjected to different seismic motion, then the assembly shall be analysed for seismic anchor

movement (SAM). The SAM values at the support locations for OBE & SSE will be given by NPCIL as applicable.

The seismic displacements as obtained by seismic analysis shall be combined with displacements/deflections due to other loads and shall be checked for operational/allowable clearances specified at various component sub-assemblies viz. piston-cylinder of pneumatic actuator, stem-bush or steam-gland at the bush and gland location of the yoke, valve disk to valve seat deflections etc.

For fatigue analysis if applicable, fifty stress cycles corresponding to five numbers of OBEs (ten stress cycles per OBE) and ten stress cycles corresponding to one SSE event shall be accounted in addition to the stress cycles due to other loads as specified in the NPCIL's equipment specification and in the VGES.

7.1.2 **ASME Codal Qualification**

Load combinations to be adopted for ASME Class-1, 2 & 3 valves for design condition and various service levels are given in Annexure –1.

The combined stresses calculated in the valve assembly shall meet the relevant codal requirements viz. ASME Section-III, Division-1, Subsection-NB-3000, NC-3000, ND-3000 whichever is applicable.

The combined stresses in the bracket, supporting structure of actuator etc shall meet the requirements of ASME-III, Division-1, Subsection-NF-3000.

If there are any bearings, the load at the bearing location shall be less than the bearing load capacity.

The stresses in the weld connections if any shall be checked. The stresses may be checked as per NUREG CR-6241, IS 800, IS 456 or any other applicable code.

The seismic displacements as obtained by seismic analysis shall be combined with displacements/deflections due to other loads and shall be checked for operational/allowable clearances specified at critical locations of valve actuator assembly, if applicable.

7.2 **Qualification for Functional Operability**

7.2.1 Qualification by Analysis

The functional qualification of certain valves can be demonstrated by Analysis with prior approval of NPCIL. The seismic response as obtained by seismic analysis shall be combined with responses due to other loads and shall be checked for

operational/allowable values specified at various component sub-assemblies. For example, the functional operability of relief valves can be demonstrated by analysis, showing that valve disc does not lift up by seismic inertial force.
The functional qualification of large size valves viz. Main Steam Isolation Valve (MSIV) etc. is not possible to demonstrate by shake table test. In such cases for such large size valves, the functional operability can be checked by performing analysis by showing that the deflections and so the resultant clearance being less than allowable clearances i.e. between piston-cylinder of pneumatic actuator, stem-bush or steam-gland at the bush and gland location of the yoke, valve disk to valve seat deflections.

7.2.2 Qualification by Test

7.2.2.1 Determination of Natural Frequency

The first natural frequency or all modes below the cutoff frequency or rigid frequency of valve assembly may be determined by exploratory vibration test. Exploratory vibration test on a valve assembly may be conducted on a shake table, using resonance search test as per IEEE 344, with the modification that the vibration test shall be over a frequency range of 1 to 100 Hz or cutoff frequency as applicable. Natural frequency determination can also be done by Impact Hammer test, or any other justifiable method. The procedure for the Impact hammer test is given in Annexure-6.

The procedure covering the details of test method; mounting arrangements; test setup; test sequence; test equipment, instruments; measuring parameters; etc. shall be prepared as per the clauses given in this specification and shall be submitted to NPCIL for prior approval.

Exploratory vibration test Impact Hammer test shall then be conducted meeting the requirements of approved procedure.

7.2.2.2 Environmental Aging Test

Any environmental (temperature, pressure, humidity, plant operating vibration, irradiation) aging effects on the valve assembly, if specified in NPCIL's valve specification, shall be performed before conducting the equivalent static loading test or shake table test. The guidelines for these tests viz., normal thermal aging test, normal pressurization cycle test, normal radiation test, vibration aging test, Design Basis Event (DBE) environment test are given in Part-III of IEEE 382 (2006). If the valve is determined not to have significant aging mechanisms by virtue of periodic inservice surveillance, maintenance etc., then periodic surveillance, maintenance interval becomes qualified life, if applicable as per NPCIL specification or VGES. In view of the above, omission or partial fulfillment

of the environmental aging tests with justification shall be forwarded to NPCIL for approval.

7.2.2.3 **Qualification of Actuator**

Since valves are mostly rigid and are tested by equivalent static load test, whereas actuators see the earthquake motion at the valve top which is amplified by piping and support. Hence the valve actuators shall be separately qualified seismically as per the requirements of IEEE 382. However, the test frequency range should be from 1-100Hz in case of hard rock sites. In case, the actuator has already been seismically qualified by the actuator supplier, qualification report shall be submitted to NPCIL for approval.

7.2.2.4 **Qualification of Valve by Testing**

The valve assembly is required to be tested for demonstrating the functional operability by any one of the following methods:

1. Single frequency input on uniaxial shake table,
2. Multi frequency input on tri-axial shake table,
3. Static side load test.

For quick acting solenoid valves e.g. solenoid valves in SSS (Secondary Shutdown System) / SDS#2 (Shut Down System # 2) or Pilot Operated Valves in Shutdown system of BWRs, and critical valves that are required to perform during OBE and/or after SSE event or the valves important to reactor safety, housing flexible components in it e.g. springs etc they shall be shake table tested.

For other power actuated valves, static side load test may be conducted as per ASME QME 1-2012.

If the valve is required to be functional during OBE and SSE, only one test corresponding to SSE level loading need to be performed.

7.2.2.4.1 **Qualification using Single Frequency Inputs on Uniaxial Shake Table**

The tests on valve actuator assembly can be conducted on uniaxial shake table capable of giving horizontal and vertical motion, one at a time. The valve actuator assembly shall be mounted on the shake table. While a seismic motion is given to the table the valve assembly should be checked for its intended functional operability. As specified in the approved procedure, during the test, the operating loads on the valve assembly should also be simulated adequately. Single (Discrete) frequency tests using sinusoidal waveforms shall be used for frequencies from 1 Hz to 100 Hz or cutoff frequency as applicable. The test frequencies may be spaced

at 1/3 octave interval upto 50 Hz and at 1/6 octave interval beyond 50Hz, if required. The acceleration values shall be taken as 1.5 times of spectral peak acceleration of envelope of the floor response spectra of the floors on which valve mounted pipelines are supported. The floor response spectra of all three directions with 2 % damping for OBE and 3% damping for SSE shall be used. The acceleration value of OBE and SSE whichever is maximum shall be used as input motion. The test duration at each frequency shall be 30 second or more to verify the opening and closing of the valve assembly or for intended functional operability. The acceleration at low frequencies i.e below 4Hz shall be given upto the capability of the shake table. The test shall be conducted in two horizontal directions and one vertical direction.

If accelerations values are not available, then tests at 3.5g acceleration level as input can be permitted (Ref. Fig.1 of IEEE-382, 2006) with proper justification.

Typical procedure for uniaxial shake table test is given in Annexure-5.

The procedure for seismic qualification test of valve on uniaxial shake table covering the details of mounting arrangements, loadings, shake table description, test sequence etc. shall be prepared as per clauses given above/Annexure and as per IEEE 344 and shall be submitted to NPCIL for prior approval.

The seismic qualification test on shake table, for valve assembly shall then be performed at a test facility and shall meet the requirements of IEEE 344/IEC 60980 and/or approved procedure.

7.2.2.4.2 **Qualification using Multi Frequency Input on tri-axial Shake Table**

The valve actuator assembly shall be mounted on the shake table. While a seismic motion is given to the table the valve assembly should be checked for its intended functional operability. As specified in the approved procedure, during the test, the operating loads on the valve assembly should also be simulated adequately. The test should conservatively simulate the seismic event at the valve mounting location. The SSE and OBE required response spectra (RRS) at valve mounting location will be given by NPCIL. If response spectra at the valve mounting locations are not available, then floor response spectra accelerations scaled up by a factor of 1.5 times may be used (Ref-ASME QME 1-2012). The multidirectional nature of earthquake shall be accounted. In general, the shake table motion shall be such that it

i) produces a Test Response Spectra (TRS) that envelopes the Required Response Spectra (RRS).
ii) has a peak acceleration equal to or greater than RRS Zero Period Acceleration (ZPA).

iii) does not include frequency content above the RRS ZPA asymptote.
iv) has sufficient duration commensurate with strong motion part and fatigue inducing potential of the time history.

The procedure for seismic qualification test of valve on triaxial shake table covering the details of mounting arrangements, loadings, shake table description, test sequence etc. shall be prepared as per clauses given above/Annexure and as per IEEE 344 and shall be submitted to NPCIL for prior approval.

The seismic qualification test on shake table, for valve assembly shall then be performed at a test facility and shall meet the requirements of IEEE 344/IEC 60980 and/or approved procedure.

7.2.2.4.3 **Qualification using Static Side Load Test**

ASME QME 1-2012 permits the use of static side load test for power actuated valves.

Static side load testing is a seismic test intended to demonstrate the functional capability of the valve actuator assembly when subjected to loading that is representative of a specified seismic load qualification level.

The static side load test method for Power actuated valves are given in Annexure-4**.**

For static side load test, accelerations corresponding to 1.5 times the spectral peak acceleration of the floor response spectra corresponding to valve location in three orthogonal directions at 2 % damping for OBE and 3% damping for SSE shall be considered. Accelerations in three orthogonal directions shall be combined by SRSS method. Acceleration value thus obtained shall be further multiplied by following factors (Ref-ASME QME 1-2012).

1.1 (test margin) if the valve assembly is determined to be rigid, or
1.65 (amplification coefficient of 1.5 plus test margin) if the valve assembly is determined to be flexible, by carrying out analysis as per 7.1 or natural frequency determination test.

Typical procedure for Static side load test is given in Annexure-4.

The procedure for seismic qualification test of valve by Static side load test covering the details of mounting arrangements, loadings, test sequence etc. shall be prepared as per clauses given above/Annexure and as per IEEE 344 and shall be submitted to NPCIL for prior approval.

The seismic qualification by static side load test, for valve assembly shall then be performed at a shake table test facility and shall meet the requirements of IEEE 344/IEC 60980 and/or approved procedure.

7.3 Documentation

The valve assembly finite element model and the data giving details viz., nodal coordinates, element type used, element node relationship, material and section properties, lumped masses, rigid elements, and end release codes, details as to whether consistent mass matrix or lumped mass matrix, loads applied, boundary conditions etc. shall be submitted for prior approval of NPCIL in both soft and hard copies prior to taking up the analysis. The validation report of the software, describing the benchmark problem used to establish the dynamic analysis capabilities of the package along with the bench marking report shall also be submitted to NPCIL.

The qualification report shall be prepared covering the description of the finite element model, assumptions made in the modeling and their justification, input data with supporting reference documents, name and version of the software used for analysis and its validation, natural frequencies calculated, modal mass participation factors, missing mass correction calculations, equivalent static / response spectrum analysis results viz., stresses and displacements; combination of stresses for different service levels, compliance of stresses with codal requirements and displacements to be within the design clearances, results, conclusions stating the fulfillment of qualification requirements, etc. shall be submitted to NPCIL for approval.

The finite element model along with analysis input data files and results in hard and soft copies shall be submitted to NPCIL for records.

For the valve assembly qualified by testing (including impact hammer test), the test reports covering the approved test procedure, mounting methods, shake table details, test setup, test sequence, input motion and details of compliance with IEEE 344 and IEC 60980 etc. shall be prepared & submitted to NPCIL for approval & records.

The analysis/test reports shall be documented in the form such that the reports shall be self-explanatory and independently reviewable. Guidelines given in Clause-11 of IEEE 344 or Appendix-C of ASME section III, including the NPCIL VGES procedure are to be followed for the same.

8.0 SPECIFICATION FOR SEISMIC QUALIFICATION OF ELECTRICAL & INSTRUMENTATION ITEMS (PANELS, EQUIPMENT, INSTRUMENTS AND DEVICES)

This section covers the procedure for qualification of electrical and instrumentation items (panels, instruments, equipment and devices) in terms of structural integrity, pressure boundary integrity and functional operability as applicable, brought out in the respective NPCIL's equipment specification and in the VGES. This procedure shall be applicable to various panels such as instrumentation and electrical panels, standard electronic cabinet, control panels, panels used for A/c packages or switchgears, valve station racks, instrument racks, battery stands, instruments / devices / modules mounted on floor / walls / panels, etc. However, any additional functional requirement on account of specific design shall also be included in the below mentioned qualification procedure.

For the design of the panel as a structure, the general requirements of design are given in ASME Section III, Division-1, Subsection NF-3000 & IEEE 420. The material properties to be used for the equipment shall be as given in NPCIL's specification or as given in VGES. Structural integrity of the panel and pressure boundary integrity of any equipment mounted in the panel shall be demonstrated by carrying out an analysis and/or testing. Functional operability of the panel can be demonstrated by testing or by combination of analysis and testing. However, functional operability and structural integrity for the instrument and I&C devices shall be demonstrated by testing only wherever applicable. The test covered in this specification pertain only to seismic test. The list of recognized shake table test facilities presently available in the country is given in Annexure-3.

The detailed procedure for seismic qualification of a general panel assembly/ instruments/ equipment / devices is given below:

8.1 Qualification for Structural Integrity and Pressure Boundary Integrity

8.1.1 Qualification by Analysis

The structural integrity of the panel as a structure and instrumentation items requiring only structural integrity (e.g. orifice, venturi etc.) shall be assessed by analysis. The structural integrity and pressure boundary integrity of tanks, piping, tubing, heat exchangers etc. mounted on the panel can also be assessed by analysis.

The panel shall be analysed by finite element method. The various steps involved in finite element idealisation and the static & dynamic analyses of the panel are brought out below:

8.1.1.1 **Finite Element Modeling**

Major structural members of the panel may be modelled using beam elements with appropriate material and section properties calculated from detailed drawings of structural assembly. The plates used in the panel may be modelled as lumped mass or plate / shell element if required / justified.

Some of the panels may have heavy electrical components viz., blower, switch gear, transformers, coils, batteries, etc. and mechanical / instrumentation components viz., tanks, small heat exchangers, valves, transmitters, catchpots etc. Such components may be appropriately modeled using lumped mass at their CG locations with rigid link or spring element in the finite element model of the panel. The connection between heavy components and panel structure may be appropriately modelled with spring-mass system. For the components mounted on thin sheet metal of the panel, following may be adopted:

Light devices and various instruments (viz. relays, contactors, PCB's etc.) mounted on the plate (modules) may be modelled as lumped mass or combination of spring mass system with proper justification.

Cabling, tubing or any other connections connected with panel may be appropriately modelled by using spring/boundary elements. Similarly, the panel mounting/support arrangements may be appropriately modelled by using spring, boundary element or fixed boundary condition.

All the critical sections of panel, base plates, connections of instruments, mounting hardware of instruments, etc. shall be modelled adequately. The finite element model shall correctly represent the actual welding details viz. spot welds, line weld etc.

The finite element model using above considerations shall adequately represent the realistic dynamic/static characteristics of the panel assembly. While modelling the panel and the major mechanical and electrical components mounted on the panel like tanks, small heat exchangers, transformers, switchgears, etc., apart from beam, plate & shell elements, 3D brick element or combination thereof may also be used with proper justification. The finite element model prepared shall be forwarded to NPCIL both in soft and hard copies for review and approval before proceeding for further analysis. The assumptions made in the finite element idealization with proper justification shall be brought out in the report. All the inputs used in the data preparation shall be from authenticated document and shall be referred/attached with the report.

8.1.1.2 **Finite Element Analysis**

Using the validated software, the panel as modelled above shall be analysed using response spectrum analysis. The response spectrum analysis shall include the addition of modal responses in each direction after accounting for closely spaced modes as per USNRC RG 1.92 and missing mass response as per NUREG 1061 Vol. 4 (missing mass is the mass of the equipment which has not participated upto rigid frequency) the response upto rigid frequency and the missing mass response combined by SRSS and three orthogonal directional response combination by a SRSS method. The panel should be qualified for OBE alone or OBE and SSE as applicable. The floor response spectra at the mounting locations of panel for OBE (2% damping) and SSE (3% damping) will be supplied by NPCIL as applicable.

Some of the panels may have components like tubing, tanks, piping, coolers, blower, small heat exchangers like radiator, etc. The panels and such components shall be analysed for various loads viz. design loads, loads during normal and upset conditions (pressure, temperature, mechanical, cycles, transients), including OBE; loads during emergency and faulted conditions (pressure, mechanical), including SSE; test loads; hydrodynamic, electromagnetic loads, etc. as applicable and as specified in the NPCIL's equipment specification and in the VGES. Worst combinations of unsigned earthquake stresses with other signed stresses due to non seismic loads, shall be considered for qualification.

If the panel assembly is supported at multiple locations & subjected to different seismic motion, then the assembly shall be analysed for seismic anchor movement (SAM). The SAM values at the support locations for OBE & SSE will be given by NPCIL as applicable.

The seismic displacements as obtained by seismic analysis shall be combined with displacements/deflections due to other loads and shall be checked for operational/allowable clearances specified at various component sub-assemblies etc.

For fatigue analysis if applicable, fifty stress cycles corresponding to five numbers of OBEs (ten stress cycles per OBE) and ten stress cycles corresponding to one SSE event shall be accounted in addition to the stress cycles due to other loads as specified in the NPCIL's equipment specification and in the VGES.

8.1.2 **ASME Codal Qualification**

Load combinations to be adopted for ASME Class-1, 2 & 3 components (equipment, piping) and panel/component supports for design and service levels are given in Annexure-1.

The combined stresses in the components like tanks, piping, heat exchanger, etc. shall meet the requirements of ASME Section-III, Division-1, Subsection-NB-3000, NC-3000, ND-3000 whichever is applicable.

The combined stresses in panel/component support structural members shall meet the requirements of ASME Section-III, Division-1, Subsection-NF-3000.

The stresses in the base plate & weld connections if any shall be checked. The stresses may be checked as per NUREG CR-6241, IS 800, IS 456 or any other applicable code. The foundation bolts design shall be checked as per ACI-349.

If there are any bearings the load at the bearing location shall be less than the bearing load capacity.

The seismic displacements as obtained by seismic analysis shall be combined with displacements/deflections due to other loads and shall be checked for operational/allowable clearances specified at critical locations of the panel assembly, if applicable.

8.2 Qualification for Functional Operability

8.2.1 Qualification by Test

8.2.1.1 Environmental Aging Test

Before the shake table test of panel or the instrument/device/module on the panel, other environmental aging tests if specified viz. thermal, pressure, humidity, radiation, plant vibrations, OBE vibration shall be conducted in accordance with IEEE 323 and IEC 60780. The assessment of equipment aging effect is required to determine if aging has significant effect on intended functional operability of the devices in the panel. For example, electromechanical equipment shall be operated to simulate the expected mechanical wear and electrical contact degradation, contact pitting, etc. of the device to be tested. If the equipment is determined not to have significant aging mechanisms by virtue of periodic inservice surveillance, maintenance etc. then periodic surveillance, maintenance interval becomes qualified life. In view of the above, omission or partial fulfillment of the environmental aging tests with justification shall be forwarded to NPCIL for approval.

8.2.1.2 Qualification by Shake Table Test

The panel or the devices can be shake table tested by one of the two methods given below.

a) Full scale testing of a panel:

The functional operability of the panel including the devices/instruments mounted on the panel can be demonstrated by full scale testing of the panel on a shake table in accordance with IEEE 344 /IEC 60980. If the testing is done on a representative panel then, the panel shall be mounted with all the possible components, instruments, devices etc. at their respective locations to ensure maximum / optimum loading.

The panel shall be mounted on the shake table. While a seismic motion is given to the table, the instrument/devices in the panel should be checked for its intended functional operability and structural integrity as detailed in respective NPCIL equipment specification. To establish structural integrity of the panels, operating loads on the equipment should be simulated during the test adequately. The stresses at critical locations shall be monitored by mounting strain gauges and accelerometers, during the test. The locations for mounting strain gauge, accelerometer will be finalized in consultation with NPCIL engineers.

The test should conservatively simulate the seismic event at the equipment mounting location. The multidirectional nature of earthquake should be accounted. In general the shake table motion should be such that it

i) produces a Test Response Spectra (TRS) that envelopes the Required Response Spectra (RRS).
ii) has a peak acceleration equal to or greater than RRS Zero Period Acceleration (ZPA).
iii) does not include frequency content above the RRS ZPA asymptote.
iv) has sufficient duration commensurate with the strong motion part and fatigue inducing potential of time history.

In the panel testing, the RRS are the 5% damping Floor Response Spectra (FRS) of the floor on which the panel is mounted. The floor response spectra which is to be used for testing, for 5% damping for SSE and OBE will be given by NPCIL.

b) Testing of instruments devices mounted on the panel /support/rack, sections of multi-cabinet assemblies by combined analysis and test:

During analysis, if panel/support/rack is found to be rigid (i.e. first natural frequency greater than or equal to cutoff frequency) then the functional operability of the instrument/device/module mounted in the panel/support/rack can be demonstrated by testing individual instrument/device/module on shake table. In this case the floor response spectra are the Required Response Spectra (RRS) for testing.

If the panel/support/rack is found to be flexible (i.e. first natural frequency less than cutoff frequency. The functional operability of the instruments/devices/modules mounted in the panel can also be demonstrated by testing individual instruments/devices/modules on the shake table. In this case, response spectra at the base of instruments/devices/modules mounted in the panel are used as Required Response Spectra (RRS) for testing. These response spectra are obtained from time history analysis of the panel. The time history analysis of the panel shall be carried out using the same finite element model prepared as given in 8.1.1. Time history analysis shall be performed to calculate the time history and response spectra at the base of the instrument/device/module mounted in the panel. Any other method for generation of the RRS or accelerations at the base of the device in the panel can be used with proper justification. For example generic values of in-cabinet amplification (Table 6.2 of SQUG, DOE-GIP) can be used to arrive at the accelerations at the base of the devices from the floor response spectra. The intended functional operability of the instruments/devices/modules can be demonstrated by mounting them on a shake table and then perform the test in accordance with IEEE 344 / IEC 60980. In the device testing, response spectra at the base of the device on the panel are used as Required Response Spectra (RRS). If the RRS at the base of the devices are not available then, accelerations at the base of the devices derived from response spectrum analysis of the panel or other justifiable methods can be used for testing of devices. A sample test procedure for conducting seismic test on a typical instrument/ device is enclosed as Annexure-5.

For multi-cabinet assemblies like UPS, switchgear and MCC panels, cabinets containing 19” rack, few of the electrically and mechanically representative sections of multi-cabinet assembly can be seismically tested on shake table using appropriately increased RRS (usually more than 10%) accelerations and/or appropriate analytical justification for multi-cabinet assembly qualification as applicable.

The procedure for shake table test covering the mounting arrangement, pre-post intermediate inspection, monitoring parameters, input motion, shake table facility, environmental aging test, operational loads, acceptance criterion, etc. shall be prepared as per IEEE 344/ IEC 60980 and submitted to NPCIL for prior approval.

The shake table test shall then be conducted at a shake table test facility and shall meet the requirements of IEEE 344 / IEC 60980 or the approved procedure.

8.3 Documentation

The equipment finite element model and the data giving details viz., nodal coordinates, element type used, element node relationship, material and section properties, lumped masses, rigid elements, and release codes, details as to whether consistent mass matrix or lumped mass matrix, loads applied, boundary conditions etc. shall be submitted for prior approval of NPCIL in both soft and hard copies prior to taking up the analysis. The validation report of the software, describing the benchmark problem used to establish the dynamic analysis capabilities of the package along with the bench marking report shall also be submitted to NPCIL.

The qualification report shall be prepared covering the description of the finite element model, assumptions made in the modeling and their justification, input data with supporting reference documents, name and version of the software used for analysis and its validation, natural frequencies calculated, modal mass participation factors, missing mass correction calculations, equivalent static / response spectrum analysis results viz., stresses and displacements; combination of stresses for different service levels, compliance of stresses with codal requirements and displacements to be within the design clearances, results, conclusions stating the fulfillment of qualification requirements, etc. shall be submitted to NPCIL for approval.

The finite element model along with analysis input data files and results in hard and soft copies shall be submitted to NPCIL for records.

For the equipment qualified by testing, the test reports covering the approved test procedure, mounting methods, shake table details, test setup, test sequence, input motion and details of compliance with IEEE 344 and IEC 60980 etc. shall be prepared & submitted to NPCIL for approval & records.

The analysis/test reports shall be documented in the form such that the reports shall be self-explanatory and independently reviewable. Guidelines given in Clause-11 of IEEE 344, including the NPCIL VGES procedure are to be followed for the same.

9.0 SPECIFICATION FOR QUALIFICATION OF ROTATING AND RECIPROCATING EQUIPMENT

This section covers the procedure for qualification of rotating and reciprocating equipment in terms of structural integrity, pressure boundary integrity and functional operability as brought out in the NPCIL's equipment specification and in the VGES. The procedure shall be applicable to rotating equipment viz. pump-motor assembly, fan, blower etc. and reciprocating equipment viz. compressor, diesel generator, reciprocating pumps etc.

In case of pumps, general requirements of design are given in ASME Section-III, Division-1, Subsection-NB, NC and ND whichever is applicable. If any supports are used for the equipment, those should be designed as per the requirements given in ASME Section III, Division-1, Subsection NF. The material used for the qualification of the equipment shall be as given in NPCIL's specification or as given in VGES. Structural integrity, pressure boundary integrity and functional operability of the equipment shall be demonstrated by carrying out analysis. The functional operability of the equipment can also be demonstrated by a test. The tests covered in the specification pertain only to a seismic test. The list of shake table test facilities presently available in the country is given in Annexure-3.

Typical procedure for qualification of centrifugal pump-motor assembly (i.e. rotating equipment) is given below. Similar procedure shall be followed for qualification of all other rotating/reciprocating equipment in the scope of this specification. However, for specific equipment, due to its specific design features any additional specific functional requirement to be met shall also be included in the VGES and shall also be included in the below mentioned procedure.

9.1 Qualification for Structural Integrity and Pressure Boundary Integrity

9.1.1 Qualification by Analysis

The structural integrity and pressure boundary integrity of the centrifugal pump-motor assembly can be assessed by performing an analysis.

9.1.1.1 Finite Element Modeling

Pump casing, motor casing, stator, shaft and rotor, impeller, coupling, frame of motor and pump, bearings of motor, pump sealing arrangements, mounting base frame/structure and any other components may be modeled with appropriate section and material properties as calculated from/given in the component detailed drawings. These components may be modeled with beam/shell/plate/3 D brick elements or combination thereof so as to adequately represent the static/dynamic characteristics of the pump-motor assembly.

Motor casing, pump casing, shaft, supporting structure of motor and pump may be modeled with beam elements. Stator and rotor of motor, impeller of pump may be modeled as lumped mass/spring mass system at appropriate nodes. The bearings shall be modeled by suitable spring elements. Coupling may be modeled using spring elements/master-slave/rigid link element or with appropriate use of end release code. Sealing arrangement may also be modeled with appropriate spring mass system. The spring constants for bearings shall be used from authenticated document and shall be referred/attached with the report.

Extensions of a stationary component upto the rotating component may be modeled by appropriate rigid links.

Foundation bolts for base frame, bolts of motor casing with base frame, bolts of pump casing with base frame, coupling bolts if any and bolts of flanges may be appropriately modeled by using boundary elements.

Any other peculiar construction detail of pump-motor assembly may also be modeled appropriately by using mass and spring-mass system.

Finite element model constructed using above considerations shall adequately represent the realistic static/dynamic characteristics of the pump motor assembly. The model prepared both in soft and hard copies shall be forwarded to NPCIL for review and approval before proceeding for further analysis. The assumptions made in the finite element idealization with proper justification shall be brought out in the report. All the inputs used in the data preparation shall be from authenticated document and shall be referred/attached with the report.

9.1.1.2 **Finite Element Analysis**

Using validated software, the finite element model shall be analysed to extract the natural frequencies of the pump-motor assembly.

If the first natural frequency of support frame and pump casing & motor casing is above rigid/ cutoff frequency, then motor shaft, rotor of the motor and pump shaft & impeller model may be decoupled from motor support frame and pump-motor casings. The support frame and pump casing & motor casing shall be analysed using equivalent static analysis method. In the equivalent static analysis method, forces equivalent of 1.5 times floor ZPA may be applied simultaneously in the 3 orthogonal directions at all mass points and static analysis carried out.

The decoupled rotating-assembly shall be analysed by using either equivalent static analysis method or response spectrum analysis method. In the equivalent static analysis method, forces equivalent of 1.5 times floor spectral peak accelerations

may be applied simultaneously in the 3 orthogonal directions at all mass points and static analysis shall be carried out.

If the first natural frequency of the support frame and pump casing and motor casing is less than rigid/ cutoff frequency, then integral model of pump support, stationary components, rotating parts and other devices may be prepared and analysed by using either equivalent static analysis method or response spectrum analysis method. In the equivalent static analysis method, forces equivalent of 1.5 times floor spectral peak accelerations may be applied simultaneously in the 3 orthogonal directions at all mass points and static analysis carried out.

The response spectrum analysis shall include the addition of modal responses in each direction after accounting for closely spaced modes as per USNRC RG 1.92 and missing mass response as per NUREG 1061 vol. 4 (missing mass is the mass of the equipment which has not participated upto rigid/ cutoff frequency). The response upto rigid frequency and the missing mass response shall be combined by SRSS method and three orthogonal directional responses shall also be combined by SRSS method.

The pump-motor assembly shall be checked for their operating frequency & it should be away from the natural frequencies of building floor.

The pump-motor assembly shall be qualified for OBE alone or OBE and SSE as applicable. The applicable response spectra are the response spectra at equipment mounting location. OBE (2% damping) and SSE (3% damping) response spectra at the base of pump-motor assembly or floor will be given by NPCIL as applicable. Worst combinations of unsigned earthquake stresses with other signed stresses due to non seismic loads, shall be considered for qualification.

The pump shall be analysed for the loads experienced by it at the nozzle location from the connected piping. The pump shall be analysed for various loads viz. design loads, loads during normal and upset conditions (pressure, temperature, mechanical, cycles, transients), including OBE; loads during emergency and faulted conditions (pressure, mechanical), including SSE; test loads; hydrodynamic, electromagnetic loads, etc. as applicable and as specified in the NPCIL's specification and in the VGES.

If the pump motor assembly is supported at multiple locations & subjected to different seismic motion, then the assembly shall be analysed for seismic anchor movement (SAM). The SAM values at the support locations for OBE & SSE will be given by NPCIL as applicable.

The seismic displacements as obtained by seismic analysis shall be combined with displacements/deflections due to other loads and shall be checked for

operational/allowable clearances specified at various component sub-assemblies viz. impeller-casing, stator-rotor, coupling, attached piping/ducting/cabling etc.

For fatigue analysis if applicable, fifty stress cycles corresponding to five numbers of OBEs (ten stress cycles per OBE) and ten stress cycles corresponding to one event of SSE shall be accounted in addition to the stress cycles due to other loads as specified in the NPCIL's equipment specification and in the VGES.

9.1.2 **ASME Codal Qualification**

Load combinations to be adopted for ASME Class-1, 2 & 3 pumps and pump supports for design and service levels are given in Annexure-1.

The combined stresses in the individual components/elements shall meet the relevant codal requirements viz. ASME Section-III, Division-1, Subsection NB-3000, NC-3000 and ND-3000 whichever is applicable.

The combined stresses in the base frame/support shall meet the requirements of ASME Section-III, Division-1, Subsection-NF-3000.

The combined stresses in mounting bolts of pump casing to base frame between motor and base frame, coupling bolts, flanges connecting bolts shall meet the relevant codal requirement viz., ASME Section-III, Division-1, Subsection NB-3000, NC-3000, ND-3000 & NF-3000.

The combined stresses in the nozzle, as calculated using WRC-297/WRC-107 or any other justifiable method shall meet the requirements of ASME Section-III, Division-1, Subsection NB, NC and ND.

The stresses in the base plate & weld connections if any shall be checked. The stresses may be checked as per NUREG CR-6241, IS 800, IS 456 or any other applicable code. The foundation bolts shall be checked as per ACI-349.

If there are any bearings, the reaction at the bearing locations shall be less than the bearing load capacity.

The seismic displacements as obtained by seismic analysis shall be combined with displacements/deflections due to other loads and shall be checked for operational/allowable clearances specified at various component sub-assemblies viz. impeller-casing, stator-rotor, coupling, attached piping/ducting/cabling etc, if applicable.

9.2 Qualification for Functional Operability

9.2.1 Qualification by Analysis

The seismic displacements as obtained by seismic analysis shall be combined with displacements/deflections due to other loads and shall be checked for operational/allowable clearances specified at various component sub-assemblies viz. impeller-casing, stator-rotor, coupling, attached piping/ducting/cabling etc. The reactions coming at the bearing locations shall be less than bearing load capacity.

9.2.2 Qualification by Test

The functional operability of rotating and reciprocating equipment is generally demonstrated by analysis as brought out above. However, these equipment can as well be qualified for their functional operability by conducting a shake table test in accordance with IEEE 344 and IEC 60980.

The equipment shall be mounted on the shake table. While a seismic motion is given to the table, the equipment should be checked for its intended functional operability. During the test, the operating loads on the equipment should also be simulated adequately.

The test should conservatively simulate the seismic event at the equipment mounting location. The multidirectional nature of earthquake should be accounted. In general, the shake table motion should be such that it

i) produces a Test Response Spectra (TRS) that envelopes the Required Response Spectra (RRS).
ii) has a peak acceleration equal to or greater than RRS Zero Period Acceleration (ZPA).
iii) does not include frequency content above the RRS ZPA asymptote.
iv) has sufficient duration commensurate with strong motion part and fatigue inducing potential of time history.

In the equipment testing, the RRS are the floor response spectra (FRS) of the floor on which the equipment is mounted.

The procedure for shake table test covering the mounting arrangement, pre-post intermediate inspection, monitoring parameters, input motion, shake table facility, environmental aging test, operational loads, acceptance criterion, etc. shall be prepared as per IEEE 344/ IEC 60980 and submitted to NPCIL for prior approval.

The shake table test shall then be conducted at a shake table test facility and shall meet the requirements of IEEE 344 / IEC 60980 or the approved procedure.

9.3 **Documentation**

The equipment finite element model and the data giving details viz. nodal coordinates, element type used, element node relationship, material and section properties, lumped masses, rigid elements, and end release codes, details as to whether consistent mass matrix or lumped mass matrix, loads applied, boundary conditions etc. shall be submitted for prior approval of NPCIL in both soft and hard copies prior to taking up the analysis. The validation report of the software, describing the benchmark problem used to establish the dynamic analysis capabilities of the package along with the bench marking report shall also be submitted to NPCIL.

The qualification report shall be prepared covering the description of the finite element model, assumptions made in the modeling and their justification, input data with supporting reference documents, name and version of the software used for analysis and its validation, natural frequencies calculated, modal mass participation factors, missing mass correction calculations, equivalent static / response spectrum analysis results viz., stresses and displacements; combination of stresses for different service levels, compliance of stresses with codal requirements and displacements to be within the design clearances, results, conclusions stating the fulfillment of qualification requirements, etc. shall be submitted to NPCIL for approval.

The finite element model along with analysis input data files and results in hard and soft copies shall be submitted to NPCIL for records.

For the equipment qualified by testing, the test reports covering the approved test procedure, mounting methods, shake table details, test setup, test sequence, input motion and details of compliance with IEEE 344 and IEC 60980 etc. shall be prepared & submitted to NPCIL for approval & records.

The analysis/test reports shall be documented in the form such that the reports shall be self-explanatory and independently reviewable. Guidelines given in Clause-11 of IEEE 344 or Appendix-C of ASME section III, including the NPCIL VGES procedure are to be followed for the same.

10.0 SPECIFICATION FOR QUALIFICATION OF TANKS, VESSELS, HEAT EXCHANGERS AND THEIR SUPPORTS

This section covers the procedure for qualification of passive equipment like tanks, vessels, heat exchangers, supports, etc. in terms of structural integrity and pressure boundary integrity as brought in the NPCIL's equipment specification and in the VGES.

In case of tanks, vessels, pressure vessel and tubes of heat exchangers and supports general requirements of design are given in ASME Section-III, Division-1, Subsection-NB, NC, ND for safety class-1, 2 and 3 respectively and Subsection NF whichever is applicable. For safety class-4/NINS (Not Important to Nuclear Safety) tanks and vessels, the general requirements of design are given in ASME section VIII, Division-1 and Division-2 or applicable National design code/standard. For shell & tube heat exchanger, the general requirements of design are given in Mechanical standard TEMA class-C. The material used for the equipment shall be as given in NPCIL's specification or as given in VGES. Special attention is required to be given while analysing the nozzles on the tanks and vessels.

The procedure for seismic qualification of tanks, vessels, heat exchangers and their supports is given below. However, any additional specific functional requirement to be met for these passive equipment due to it's specific design features shall also be included in VGES and also in the procedure mentioned below:

10.1 Qualification of Structural Integrity and Pressure Boundary Integrity

10.1.1 Qualification by Analysis

The structural integrity and pressure boundary integrity of tanks, vessels, heat exchangers, supports etc. can be assessed by performing analysis.

The tank, vessel, heat exchangers (including plate type) and their supports shall be analysed by simplified method as given in ASCE 4-98 with prior approval of NPCIL or by finite element method as applicable. The various steps involved in finite element idealisation and the static and dynamic analysis of the tank, vessel, heat exchangers and their supports are brought out below.

10.1.1.1 Finite Element Modeling

The tank and vessel body may be modelled with beam, plate, shell, 3-D brick elements or combination thereof with proper justification.

The tank and vessel including the contained fluid & Heat exchangers internals viz. tube sheets, baffle plate, tube bundles, adsorber, sparger, tubing, etc. may be modelled appropriately to represent their dynamic/static characteristics.

The support structure of the tank may be modeled with beam/plate elements with appropriate section properties as obtained from detail drawing of supports.

The foundation bolts may be modeled with boundary elements.

All the other components of tanks and vessels viz. internal piping, nozzle and support, manholes etc. shall be taken into consideration while preparing the finite element model. Tangent and bend elements shall be used for modelling the internal piping if present.

The finite element model of the tank, vessel, heat exchangers (including plate type), and their supports shall adequately represent the realistic dynamic and static characteristics of the equipment. The model prepared both in soft and hard copies shall be forwarded to NPCIL for review and approval before proceeding for further analysis. The assumptions made in the finite element idealization with proper justification shall be brought out in the report. All the inputs used in the data preparation shall be from authenticated document, and shall be attached/referred in the report.

10.1.1.2 **Finite Element Analysis**

The model prepared based on above guidelines shall be analysed by response spectrum analysis using validated software. The response spectrum analysis shall include the addition of modal responses in each direction after accounting for closely spaced modes as per USNRC RG 1.92 and missing mass response as per NUREG 1061 vol. 4 (missing mass is the mass of the equipment which has not participated upto rigid/cutoff frequency) the response upto rigid/cutoff frequency and the missing mass response combined by SRSS and three orthogonal directional response combination by SRSS method.

The tank, vessel, heat exchangers and supports shall be qualified for applicable levels of earthquake viz. OBE alone or OBE and SSE as specified in NPCIL's specification and in the VGES. Worst combinations of unsigned earthquake stresses with other signed stresses due to non seismic loads, shall be considered for qualification.

The response spectra for SSE and OBE (as per applicable damping) at equipment foundation will be supplied by the NPCIL as applicable.

The applicable damping values as given in Appendix N, of ASME B &PV, Section III, Division 1, Appendices are given below :

	% critical damping	
	OBE	SSE
Equipment	2	3
Internal Piping.	5	5

The loads coming at the nozzle locations on the tank, vessel, Heat Exchanger due to piping reaction shall be used for design and analysis of tank, vessel, Heat Exchanger and their nozzles.

The equipment shall be analysed for various loads viz. design loads, loads during normal and upset conditions (pressure, temperature, mechanical, cycles, transients), including OBE; loads during emergency and faulted conditions (pressure, mechanical), including SSE; test loads, nozzle load due to connected piping etc as specified in NPCIL's equipment specification and in the VGES. The sloshing effect due to seismic excitation should also be accounted wherever applicable. The hydrostatic & hydrodynamic effects of contained fluid may be accounted as per TID-7024 if applicable.

If the tank, vessel, Heat Exchanger etc is supported at multiple locations & subjected to different seismic motion, then the assembly shall be analysed for seismic anchor movement (SAM). The SAM values at the support locations for OBE & SSE will be given by NPCIL as applicable.

For fatigue analysis if applicable, fifty stress cycles for five numbers of OBEs (ten stress cycles per OBE) and ten stress cycles for one SSE event shall be accounted in addition to the stress cycles due to other loads as specified in the NPCIL's equipment specification and in the VGES.

10.1.2 **ASME Codal Qualification**

Load combinations to be adopted for ASME Class-1, 2 & 3 tank, vessel & heat exchanger and internal piping and supports for design and various service levels are given in Annexure-1.

The combined stresses in tank, vessel & heat exchanger and internal piping shall meet the relevant codal requirements viz. ASME Section-III, Division-1, Subsection-NB-3000, NC-3000 or ND-3000 whichever is applicable.

The combined stresses in support structure etc. shall meet the requirements of ASME Section-III, Division-1, Subsection-NF-3000.

The combined stresses in the nozzle, as calculated using WRC-297/WRC-107 or any other justifiable method shall meet the requirements of ASME Section-III, Division-1, Subsection NB, NC and ND.

The stresses in the base plate and weld connections if any shall be checked. The stresses may be checked as per NUREG CR-6241, IS 800, IS 456 or any other applicable code. The foundation bolts shall be designed as per ACI 349/318.

If there are any bearings, the load at the bearing locations shall be ensured to be less than the bearing load capacity.

The seismic displacements as obtained by seismic analysis shall be combined with displacements/deflections due to other loads and shall be checked for operational/allowable clearances specified at various critical locations of tank, vessel, Heat Exchanger etc if applicable.

10.2 **Documentation**

The equipment finite element model and the data giving details viz. nodal coordinates, element type used, element node relationship, material and section properties, lumped masses, rigid elements, and release codes, details as to whether consistent mass matrix or lumped mass matrix, loads applied, boundary conditions etc. shall be submitted for prior approval of NPCIL in both soft and hard copies prior to taking up the analysis. The validation report of the software, describing the benchmark problem used to establish the dynamic analysis capabilities of the package along with the bench marking report shall also be submitted to NPCIL.

The qualification report shall be prepared covering the description of the finite element model, assumptions made in the modeling and their justification, input data with supporting reference documents, name and version of the software used for analysis and its validation, natural frequencies calculated, modal mass participation factors, missing mass correction calculations, equivalent static / response spectrum analysis results viz., stresses and displacements; combination of stresses for different service levels, compliance of stresses with codal requirements, qualification of nozzles & supports and displacements to be within the design clearances (if applicable), bearing reaction less than bearing capacity (if applicable) results, conclusions stating the fulfillment of qualification requirements, etc. shall be submitted to NPCIL for approval.

The finite element model along with analysis input data files and results in hard and soft copies shall be submitted to NPCIL for records.

The analysis reports shall be documented in the form such that the reports shall be self-explanatory and independently reviewable. Guidelines given in Appendix-C of

ASME section III, including the NPCIL VGES procedure are to be followed for the same.

ANNEXURE - 1

Load Combinations for Design Condition and Service Levels for Equipment & Supports

Plant Load Classification	Design/Service level	Load combination
Design	Design condition	Pressure, dead weight, sustained loads, temperature(1)
Normal	Service level A	Normal operating loads and transients (pressure, temperature, mechanical)
Upset	Service level B	Pressure, dead weight, sustained loads, upset condition transients (pressure, temperature(2), mechanical), including OBE(3)
Emergency	Service level C	Pressure, dead weight, sustained loads, temperature(1), emergency condition transients (pressure, mechanical), SSE (3),(4)
Faulted	Service level D	Pressure, dead weight, sustained loads, temperature(1), faulted condition transients (pressure, mechanical), pipe rupture loads, SSE (3)

Note No:

1) Temperature is used to determine allowable stress only

2) Thermal transients under Level C shall also be considered in Level B

3) OBE and SSE include both inertial and Seismic Anchor Movement (SAM)

4) SSE inertial & SAM can be considered in level-C service limits if specified, otherwise SSE inertial and SSE SAM are to be considered in level D only.

ANNEXURE-2

1.0 General Design Guidelines for Equipment

Following points should be taken into account to improve the resistance of equipment to an earthquake-induced vibration:

a) For the portions of the equipment with a certain degree of freedom in design, the position of the center of gravity should be made as low as possible, and the mounting should be as stable as possible.

b) In case when equipment with a lower safety class is closely located to equipment with a higher safety class, it is necessary to check the configuration plan to make sure that the damage to the equipment with a lower safety class due to earthquake does not affect the equipment with a higher safety class.

c) In addition, the seismic supports should be such that they do not cause difficulties in the maintenance and servicing of the machines/ equipment.

d) It is important to avoid, as far as practicable, resonance of equipment, piping, instrumentation and core internals at the frequency of the dominant modes of supporting structures. In most cases, stiffness can be increased to avoid resonance. In some cases, when systems are made stiffer, the effect of thermal stresses, other dynamic loads and differential motions of supporting points may become significant.

e) For S2 Level earthquake ground motion, equipment may enter the range of nonlinear/elasto-plastic behavior. In this case, it is necessary to make sure that the required ductility is present in the system, particularly in the Embedded Parts (EPs). The design of the embedded part (EP) of the support should be such that the failure in concrete is avoided. Therefore, the strength of the load path through concrete should be much more than the strength of the anchorage rod of the EP.

f) Particular attention should be paid to the possibility of collision between adjacent components, or between components and adjacent parts of a building, as a consequence of their dynamic displacement. It is also important to allow for flexibility of connections between such components, between components and building penetrations and underground connections to buildings, as well as between buildings.

2.0 General Design Guidelines for Valves

a) Valves with heavy operators should not be mounted on small lines (< 1" dia) or, valve, operator and the line should be well supported and anchored to the same support structure to avoid overstressing of adjacent piping.

b) Valve operator cantilever length (distance between centerline of pipe to the top of the operator) should not be too large.

c) The valve actuator and the yoke should not be independently braced to the structure unless the pipe is also braced to the same structure immediately adjacent to the valve. If the operator is independently supported from the valve and attached piping, it may act as a pipe support and attract considerable load through yoke and possibly fail or bind the shaft. If both the operator and the valve/pipe are restrained, and if they are both not tied to the same support structure, then differential motion may lead to high seismic loads.

3.0 General Design Guidelines for Panels and Devices

For components such as electrical and instrumentation panels, devices viz. relays, pushbuttons, switches, circuit breakers etc. seismic qualification by testing is the recommended method.

The active components of electrical and control and instrumentation systems get qualified by testing. If the panel/rack is not part of the test, it is essential that the panel/rack be checked for structural integrity by analysis. If the device is qualified for a 3.5 g flat spectrum, it is necessary to show that the acceleration at device location is less than 3.5 g. It has been observed that a significant cause of these systems failing to function properly during and after an earthquake, is lack of anchorage or inadequate anchorage. Analyses should be performed to compare the anchorage capacity to the demand imposed by the seismic loading. This capacity evaluation should extend down to the embedded parts and the concrete structure.

Following guidelines are provided to avoid failure of panels and devices:

a) Oversized washers or reinforcing plates are recommended for thin equipment bases. Lock washers are recommended where even lowlevel vibration exists.

b) There should be no gap at the bolt or stud anchor locations for equipment containing essential relays, since they have the potential for opening and closing due to the load reversals during earthquake. This may cause impact loading on the equipment leading to generation of high frequency vibrations and may result in chatter of essential relays mounted therein.

c) Lack of adequate stiffness in the anchorage raises two concerns. First, the natural frequency could be lowered into the resonance range. Second, it could cause lift up of the cabinet off the floor during an earthquake resulting in high frequency impact loading and chatter of relays. Such inadequate stiffness may arise due to use of thin frame members and clip angles in the construction of motor control centers, switchgear, and instrumentation and control cabinets. Stiff load paths with little eccentricity are preferable for anchorages.

d) Battery racks should have close-fitting, crush-resistant spacers between the cells, which fill about two-thirds of the vertical space between the cells, to avoid rocking and colliding during the earthquake causing malfunction and damage. The battery racks should also have end and side rails, which are close fitting against the cells (with shims, if needed) to avoid tipping the batteries or sliding off the rack.

e) Adjacent cabinets of motor control centers, switchgear, distribution panels, transformers which are close enough to impact each other should be bolted together to avoid unbolted cabinets responding out of phase to one another and impacting each other during an earthquake. The resulting high frequency vibration loadings could cause essential relays to chatter.

f) Cabinets for the above mentioned items should not have large size (> 150 mm wide and 300 mm high) cutouts in the lower half of the cabinet. The concern is that the shear load from the earthquake will not be able to be transferred through the shear walls to the anchorage. Alternatively, the cutouts should be adequately reinforced.

g) All doors and drawout panels should be secured by a latch or a fastener. The concern addressed is that the doors or drawout panels could open during an earthquake and repeatedly impact the housing, causing internal components such as relays and contactors to malfunction or chatter.

h) For floor-mounted units such as battery chargers and inverters, the transformer, which is the heaviest component of this equipment, should be positively anchored and mounted near the base of the cabinet.

i) For temperature sensors, the detrimental differential displacement between the mounting of the connection head and the mounting of the temperature sensor should not occur so as to prevent the wiring to be pulled out of the sensor.

4.0 General Design Guidelines for Active equipments

The guidelines provided for design of structures, systems and component (SSC) by analytical method provide assurance of structural integrity and pressure boundary integrity.

For active components, viz., valves, pumps, fans, blowers, motors, compressors, diesel generators; electrical; and instrumentation panels devices viz. relays, pushbuttons, switches, circuit breakers etc. apart from structural and pressure boundary integrity, an assurance is also required about the functionality of the equipment during and/or after earthquake. The performance of some 'active' equipment (e.g. pumps, valves and diesel generator sets) under earthquake conditions can be calculated with adequate confidence by analysis, when their potential failure modes can be identified and described in terms of stress, deformation (including clearances) or loads. Typically this would involve calculating the relative displacement between the members likely to rub against each other and showing existence of adequate clearance to justify its functionability. The integrity of shaft bearings should also be assessed for the seismic loads. This specific requirement should be a part of the component specifications. It should be understood that a high level of analytical sophistication requires a number of assumptions and produces at best only an indicator of seismic behavior. Therefore, it is recommended that test or experiment be conducted to validate such analytical results, particularly with regard to functionality of the equipment.

When functionality of typical equipment has been demonstrated by analytical or experimental means for an earthquake motion, similar equipment can be considered qualified.

For horizontal Pumps, fans and motor generators, the driver and the driven component should be connected by a rigid base or common skid to avoid differential displacement between the driver and the driven component, which could cause shaft misalignment.

For vertical pumps, the impeller shaft and casing should not be cantilevered for more than 6 m below the pump mounting flange. It should have a radial bearing at the bottom of the casing to support the impeller shaft. Otherwise, there is a possibility of misalignment and bearing damage due to excessive lateral loads, damage to the impeller due to excessive displacement and damage due to interfloor displacement on multi-floor supported pumps.

5.0 General Design Guidelines for tanks and vessels

As far as the pressure vessel itself is concerned, usually the plate thickness is controlled by the pressure (and not by seismic load) and the effect of the seismic force on the equipment is relatively small in comparison with the normal stress during operation. However, for the support structure, since the seismic force is dominant, appropriate strength check should be made considering the seismic force. It is also necessary to ensure enough stiffness for the support, particularly, in the design of the anchorage, where there is a likelihood of damage. It is of particular importance to ensure that base plates are sufficiently stiff to avoid prying effects and that anchor bolts are adequately tightened to avoid rocking effects, lowered frequencies, increased response levels, higher-than-design loads and increased risk of loosening, pull-out or fatigue. Over-designed or redundant bolts, pre-loaded on installation to the tensile force expected during a seismic event are therefore recommended.

All safety related mechanical equipment, such as tanks, vessels and heat exchangers, piping and supports must be qualified to demonstrate structural integrity and pressure boundary integrity when subjected to earthquake loads. Dynamic modal analysis using time history or floor response spectrum (floor response spectrum in this case) method is certainly the most accurate procedure, but equivalent static method is also acceptable.

For equipment such as (i) Vertical vessel with skirt support, (ii) Vertical vessel with leg support, and (iii) Horizontal vessel on two saddle type supports; an equivalent beam model can be constructed. The seismic response is predominantly associated with the first mode. Hence, it is sufficient to use spectral acceleration at the first frequency to calculate the equivalent static loads (equipment mass x spectral acceleration). A static analysis is then performed by applying this force to calculate the stresses in vessel as well as in supports. The equivalent static force together with the overturning moment acts on the anchorage system and should be designed to withstand them.

ANNEXURE-3

List of Shake Table Test facilities in India

S.No.	Shake Table Test facility	Size	Capacity	Frequency range (Hz)	Acceleration (g)
1.	ERDA, Vadodara	0.6m x 0.6m	150 Kg Uniaxial shaketable	1-50	3.5
2.	ECIL, Hyderabad	1m x 1m, 35 cm stroke length	100 Kg Uniaxial shaketable	1-50	3.5
3.	SERC, Chennai	4m x 4m, 4 vertical & 4 hori. Actuators	30 T Triaxial shaketable	0.1-50	1.0
		2m x 2m	5 T Uniaxial shaketable	5-50	3.0
		3m x 3m	10 T Triaxial shaketable	0.1-50	1.0
4.	CPRI, Bangalore	3m x 3m, 4 ver & 4 hor actuators	10 T Triaxial table	0.1-50	1.0
5.	IGCAR, Kalpakkam	3m x 3m, 4 ver & 4 hor actuators	10 T Triaxial table	0.1-50	1.0
6.	IIT Roorkee	3.5m x 3.5m, 2 ver & 1 hor actuator	20 T Biaxial shaketable	0.1-50	1.0
7.	IIT Kanpur	1.2m x 1.8m	4 T , Uniaxial shaketable	NA	NA
8.	IIT Guwahati	2.5m x 2.5m, stroke length=500mm, max horizontal acceleration = 2g	5 T, Uniaxial shaketable	NA	NA
9.	IIT Mumbai	1.2m x 1.2m	1 T, Uniaxial shaketable	NA	NA

Note:

1. Above details are for information and guidance only.
2. Other electrodynamic/hydraulic shake tables at test facilities like ERTL Labs, CWPRS Pune, ARAI Pune, FCRI Pallakkad Kerala and any other test facilities which can meet the test specification may be explored and shaketable specification may be forwarded to NPCIL for approval prior to actual seismic test on equipment.
3. NA: not available

ANNEXURE-4

Static side load test

1. Purpose

Static side load testing is a seismic test intended to demonstrate the functional capability of the combination of a QME-1 qualified valve and a QME-1 qualified actuator when subjected to loading that is representative of a specified seismic load qualification level.

2. Definition

Rigid Equipment: Equipment, structures, and components whose lowest natural frequency is greater than the frequency value at the start of the zero period acceleration (ZPA) or the cut-off frequency of the applicable response spectrum.

Essential-to-function parts/components: those parts or components of the assembly that are essential to cause, permit, or enable the assembly to perform the specified accident-condition function or whose failure could prevent the performance of this function.

3. GENERAL REQUIREMENTS

a). Static side load testing shall be performed on the QME-1 qualified valve assembly under the seismic load to which the valve assembly is to be qualified. The adequacy of qualification testing performed under this Code Case shall be evaluated where differential pressure cannot be maintained sufficiently to simulate the full range of design-basis conditions for which the valve/actuator assembly is being qualified.

b). The magnitude of the seismic loading is determined to simulate the effect of the specified triaxial acceleration g-levels for which the valve assembly is to be qualified. A single axial force concentrated at the center of gravity of the valve extended structure, and applied along the least rigid axis (unless a more critical axis can be determined) may simulate specific seismic g-loads. If desired, increased seismic g-levels may be used to extend the seismic qualification to similar constructions.

1. The first step in calculating the seismic test load force, Ft, is to convert the triaxial acceleration g-level components, acting on the valve assembly, into a single resultant axial acceleration g-level by using the

square-root-sum-of-squares (SRSS) method. If acceleration at the valve location is not available then 1.5 times the floor peak acceleration (corresponding to 2% for OBE and 3% for SSE) shall be used as the g-values. This single axial g-level is then multiplied by the weight of the valve assembly extended structure to obtain a qualification load force Fq. This qualification load force may need to be further adjusted to compensate for the effects of gravity on the test valve assembly, depending upon the orientation of the valve assembly during the test and minor adjustment of the location of the test load force to assure contact with a structural member. Regardless of the location, the load must still create an equivalent moment in the most highly stressed location of the extended structure.

2. The test load force, Ft, is determined to ensure adequate margin to account for any dimensional or material tolerance differences between the test valve assembly and any production valve assemblies. Unless a different factor is justified to account for material and dimensional tolerances, the following relationship should be used to determine the test load force:

$$Ft \geq (A)(Fq)$$

where:

Ft = test load force, lbf (N)
Fq = required qualification load force, lbf (N)
A = multiplication factor, dimensionless
= 1.10 (test margin) if the valve assembly is determined to be rigid, or
= 1.65 (amplification coefficient of 1.5 plus test margin) if the test valve assembly is determined to be flexible

c). Test Pressure, psig (kPag).

For Power Actuated Valve Assemblies as per QME-1, QV-7450, the test operating pressure shall be the design pressure rating, but no greater than the 100°F (38°C) cold-working pressure rating for the valve assembly being qualified. The test operating pressure shall be greater than that for which the test valve assembly is to be qualified by a factor equal to the ratio of the actual test bar yield strength of the tested body material divided by the specified minimum yield strength of the body material, but no greater than 1.5 times the 100°F (38°C) cold-working pressure rating.

d). Test Differential Pressure, psig (kPag). The test differential pressure shall be the pressure differential maintained across the valve disc during the opening stroke. The value of the differential test pressure shall be determined by valve/actuator margin analysis calculations. The test differential pressure is not considered a rating value for the actuator or valve, but creates a repeatable test condition for diagnostic data comparison.

e). All essential-to-function accessories shall be attached to the valve assembly to satisfy the rigidity requirements of QME-1, QV-7450(b). The essential-to-function accessories that have not been previously qualified in accordance with IEEE-344 as part of the actuator assembly shall be seismically qualified by test in accordance with the test section of IEEE-344 per QME-1, QV-7450(b).

f). Testing will be performed at normal room temperature, not to exceed 100°F (38°C).

5.0 TEST METHOD

5.1 Power Operated Valve Assemblies

a). The valve assembly shall be installed in a test fixture with suitable provision for imposing the static test load, and such that the valve assembly is mounted by its normal mounting points (usually the valve body ends). The valve mounting shall be sufficiently rigid to resist the applied seismic load and ensure that the load force remains essentially perpendicular to the centerline of the valve extended structure. The test load force, Ft, shall be applied as described in 4(b)(1) above.

b). The seismic functionality test shall be made starting with one full operating cycle utilizing normal motive power. With the valve fully open, the valve body is maintained at the designated test pressure (as defined in 4(c) above), and valve closure is initiated. Following valve closure, establish the test differential pressure (as defined in 4(d) above) in the specified flow direction (or in the most adverse direction for bidirectional valves). Valve opening is then initiated. Differential pressure need not be maintained after the test valve assembly is unseated. Thrust (and/or torque), diagnostic data and stroke time measurements in both directions are to be recorded to establish baseline measurements. For guidance, see QME-1, Section QV-G, "Guide to Section QV: Determination of Valve Assembly Performance Characteristics."

c). With the valve in the open position, test operating pressure (as defined in 4(c) above) shall be established in the valve, and (while pressure is maintained) the test load force, Ft, shall be applied as specified in 4(b)(2) above. Deflection measurements of the extended structure are to be recorded.

d). While maintaining the test load force, Ft, a seismic functionality test shall then be performed in accordance with 5.1(e), and 5.1(f) below.

e). Three full operating cycles shall be performed with the test valve depressurized and utilizing the maximum motive power for actuation. Data, similar to 5.1(b) above, shall be taken for comparison to the baseline measurements.

f). Three full operating cycles shall be performed utilizing minimum motive power. With the valve fully open, the valve is pressurized at the designated test pressure and valve closure shall be initiated and timed. Following valve closure, establish the test differential pressure in the specified flow direction (or in the most adverse direction for bidirectional valves). Valve opening is then initiated. Differential pressure need not be maintained after the test valve assembly is unseated. Data, similar to 5(b) above, shall be taken for comparison to the baseline measurements.

g). With the valve in the open position, remove the test load force, Ft, and record deflection measurements of the extended structure.

h). Repeating test 5.1(b) above, finish testing with one full operating cycle utilizing normal motive power. With the valve fully open, the valve body is maintained at the designated test pressure (as defined in 4(c) above) and valve closure is initiated. Following valve closure, establish the test differential pressure (as defined in 4(d) above) in the specified flow direction (or in the most adverse direction for bidirectional valves).Valve opening is then initiated. Differential pressure need not be maintained after the test valve assembly is unseated. Data, similar to 5.1(b) above, shall be taken for comparison to the baseline measurements.

ANNEXURE-5

Sample Seismic Test Procedure for Valve/Valve actuator/ Instrument/Device

a) **Mounting arrangement** :

Mount the Valve/Valve actuator/ Instrument/Device (here in after called as test sample) on the shake table with a suitable fixture, simulating the actual mounting condition in the plant, meeting the requirements specified in section 8.1.1 of IEEE-344. The mounting arrangement shall be proposed by the supplier for approval of NPCIL.

b) **Monitoring Requirements During Testing** :

Necessary arrangements shall be made to assess the functional operability of test sample as required, meeting the requirements specified in section 8.1.2 of IEEE-344 and NPCIL equipment technical specification. The detail scheme for the monitoring function shall be proposed by the supplier, subject to approval of NPCIL.

c) **Aging Requirements** :

Prior to the seismic test, the test sample shall be subjected to applicable environmental aging mechanisms, such as thermal aging, radiation aging etc., as mentioned in 8.2.1.1 of this specification and as detailed in the respective NPCIL equipment specifications according to the qualified life of test sample. However, vibrational aging and OBE seismic testing are not required to be done on the test sample as the SSE test accelerations are enveloping OBE accelerations as well as vibrational aging due to number of sinusoidal tests in all three directions separately each for 30 seconds during SSE test as mentioned below.

d) **Resonance Search Test:**

Sine sweep test (Resonant frequency search test) shall be conducted on the equipment, varying the frequency at the rate of 1 octave/minute from 1 Hz to 100 Hz or cutoff frequency as applicable (up sweep) and 100 Hz or cutoff frequency as applicable to 1 Hz (down sweep) maintaining acceleration at constant magnitude of 0.2g to determine the resonant frequencies of the equipment. Structural response in terms of acceleration and strains shall be monitored by mounting the accelerometers and strain gauges at the pre-identified locations on the equipment being tested. Sine sweep test can be conducted in both vertical and horizontal axes. Resonance frequencies in all the three axes shall be identified in the frequency range of 1.0 Hz to 100 Hz or cutoff frequency as applicable. The Resonant frequency search test parameters are shown in Table below:

1	Type of Motion	Sinusoidal sweep
2	Axis of Motion	X,Y & Z
3	Frequency range	1.0 to 100 Hz or cutoff frequency as applicable
4	Acceleration	0.2g
5	Sweep rate	1.0 Octave/minute

Based on the results of resonant search test, if no malfunction or no natural frequency is observed below 10 Hz then acceleration levels for single axis test can be lowered in low frequency range with prior approval from NPCIL. However, it should be ensured during resonant search test that devices are in energized condition and proper functional and response monitoring is ensured by suitable monitoring measures.

e) **Seismic Test Procedure (SSE Test)** :

i) **Motion** **:** Sinusoidal

ii) Frequently Range : 1 Hz to 100 Hz or cutoff frequency as applicable

iii) Test Frequencies : 1.0 Hz, 1.26 Hz, 1.59 Hz, 2.0 Hz, 2.52 Hz, 3.17 Hz, 4.0 Hz, 5.04 Hz, 6.35 Hz, 8.0 Hz, 10.08 Hz, 12.67 Hz, 16.0 Hz, 20.16 Hz, 25.0 Hz, 32.0 Hz, 40.31, 50.8 Hz, 57.02 Hz, 64 Hz, 71.84 Hz, 80.63 Hz, 90.51 Hz, 100 Hz.

iv) Peak acceleration : The peak acceleration at frequencies 1.0 Hz, 1.26 Hz, 1.59 Hz, 2.0 Hz, 2.52 Hz, 3.17 Hz shall be preferably between 1.0g and 3.5g or to the capability of shake table. However at these frequencies, excitation must be continued to be maintained to the capability of shake table. For and beyond 4 Hz the peak acceleration shall be 3.5 g as a minimum or to the capability of shake table. Beyond 50.0 Hz, the acceleration shall be maintained about 1.0g or to the capability of shake table.

v) Test duration : 30 Sec. at each test frequency

vi) Test axes : Test shall be carried out in 2 orthogonal horizontal axes and vertical axis (one axis at a time).

vii) The procedure for seismic qualification test of valve/valve actuator/instrument/device on shake table covering details of mounting arrangement, monitoring arrangement, shake table description, test sequence etc., shall be prepared as per the clauses given in applicable NPCIL equipment technical specification and/or IEEE-344 and shall be submitted to NPCIL for prior approval.

viii) The accelerations calculated at location of mounting of devices in stands, racks, cabinets, panels or line mounted devices, should be shown to be less than test accelerations by carrying out analysis of stands/racks/panels/ cabinets/piping either by vendor or NPCIL as per applicable scope in tender specification.

ix) The seismic qualification test on shake table shall then be performed at the test facility and shall meet the requirements of IEEE-344 and/or NPCIL approved test procedure for seismic qualification of respective valve/valve actuator /instrument/device.

f) **Test Acceptance Criteria** :

The test sample shall meet the performance requirements during and after completion of the tests as specified in applicable NPCIL equipment technical specification/NPCIL approved test procedures.

g) **Test Report** :

The external laboratory conducting this test shall issue an approved test report consisting mainly of the following:

i) Copy of approved seismic qualification test procedure.

ii) Description of test sample along with its mounting and monitoring procedure

iii) Specification of test facility

iv) Mounting arrangement with photograph

v) Video recording in the form of DVD/pen drive of the complete shake table testing.

vi) Performance results of the test sample.

ANNEXURE-6

Impact Hammer Test for Frequency Determination of Valves

Impact hammer test shall be used for estimation of modal frequencies of the valves. The test will require impact hammers instrumented with a force transducer to measure the impact force, response measuring transducers (accelerometers) to measure the response caused by the known impact force, signal conditioners to condition the signal for the required frequency band and amplification, two channel signal analyser for signal analysis; and for computing frequency response function and coherence function. The model frequencies shall be estimated by appropriate analytical curve fitting method.

The particular characteristics of each element of the test are described below:

1. **Impact Hammer:** The impact hammer shall have a built in force transducer. Two important characteristics of impact hammer are its weight and tip hardness. Appropriate range hammer with selectable tip (soft, medium and hard) shall be used. The force transducer shall be integrally fixed on the hammer for impact force measurement.

2. **Response Transducer (accelerometers)**: Transducer shall be used for measurement of response at atleast two locations on the valve body. Sensor sensitivity shall be high enough to get repeatable signal above background noise.

3. **Signal Conditioning Units**: The units shall be suitable for low signal-to-noise ratio (40dB) and must be able to detect over load in the response signal.

4. **Analysis System**: Two-channel dynamic signal analyser shall be used. The analyser shall have zoom transform capability, appropriate window functions for impulse input signal and decaying response signals, and analytical curve fitting capability to extract modal properties.

Measurement Procedure

1. The valve assembly should be mounted in the rigid flange fixture. This fixture should be anchored to the anchor bolts embedded in rigid heavy mass concrete platform. The machinery noise in the shop should be minimal.

2. Frequency Response Measurement (FRF) shall be made at many locations on the valve body to identify major resonances. Use impact hammer of appropriate weight and tip hardness. Determine two best locations along each axis for mounting response accelerometer either by a strong magnet or by adhesive.

3. Check the repeatability of FRF Test. Preload the valve body (if required) to minimize non-linearities caused by gaps and clearances. Confirm low non-linearity effect on the response signal by coherence measurement.

4. Ensure that input signal is not zero in the frequency band of interest.

5. Monitor input force signal and apply appropriate window function. Reject poor measurement. Ensure input auto spectrum.

6. Monitor response signals and apply exponential decay window. Reject poor measurement and overload.

7. Determine FRF from the ratio of Cross Spectrum to Power Spectrum of input signal. Average (at least 24) and process the signal to minimize bias error in the estimation of the Cross-Spectrum. Estimate the coherence function to monitor the quality of FRF measurement.

8. Display FRF as magnitude versus frequency in logarithmic scale. Display phase versus frequency in linear scale.

9. Estimate modal parameter (if specified) by fitting an analytical curve on the FRF function. Ensure reasonable fit for good estimation of modal properties.

10. Perform zoom analysis around closely spaced modal frequency (Resolution 10:1).

11. Determine the phase between two measurement locations (along the axis) at the identified natural frequencies.

12. Include one set of prints of input auto spectrum, FRF and coherence function, phase angle etc. for each direction of test in the report.

Technical Pre-qualification requirements (PQR)
For
Pilot Operated Main Steam Safety Valves (POMSSVs) –
Project: 2X700 MW Kaiga 5 & 6
PQR No. STE-216-507-02

Vendor must fulfill the following pre-qualification requirements (PQR):

Sr. No.	Description	Vendor Complied	Supporting Documents needed from vendor to accept the compliance
1	Offered valves should be qualified as per ASME QME-1.	YES /NO	If offered valve is ASME QME-1 qualified, Bidder shall submit the ASME QME-1 qualification report and procedure of offered valve. OR If offered valve is not ASME QME-1 qualified, then 1) Bidder to submit the ASME QME-1 qualification report of any identical type of valve (to be considered as a Parent) along with the procedure and also submit the letter of confirmation to carry out the qualification of offered valve as per ASME QME-1 after PO placement. OR 2) If there are no QME-1 qualified valves available with bidder, then the bidder must submit ASME QME-1 qualification procedure along with the Lab details, where QME-1 testing shall be performed. Bidder must also submit the Lab confirmation letter / document for QME-1 testing. QME tests are as follow for qualification: i) Valve sealing capability. ii) Operability under maximum pipe-reaction end loading. iii) Operability during and after loading representative of the maximum seismic incident. iv) Adequacy of the materials of construction to survive environmental and aging effects. v) Set point verification. vi) Blowdown verification. vii) Thermal shock capability.

Prepared by

Checked by

Approved by

Technical Pre-qualification requirements (PQR)
For
Pilot Operated Main Steam Safety Valves (POMSSVs) –
Project: 2X700 MW Kaiga 5 & 6
PQR NO. STE-216-507-02

2	The valves shall be seismically qualified for Operating Basis Earthquake (OBE) & Safe Shut down Earthquake (SSE).	YES /NO	If Yes, Bidder to submit the report of similar type of valve. If No, Bidder must submit the procedure along with confirmation to carry out OBE & SSE qualification.
3	Past experience	YES /NO	Bidder must have experience for supply of Pilot operated safety relief valve of size more than 4" as per design standard ASME SEC III-NC to any Nuclear Power Station. As an evidence of successful execution, vendor must submit PO copy, LR copy, data sheet & General arrangement drawing / SRV copy / customer completion certificate.

NOTE: All the credentials (as per Vendor assessment form) and documents (as per above requirements) submitted by the vendors shall be reviewed & approved by BHEL & NPCIL and if any additional document required by NPCIL/BHEL, BIDDER shall furnish the same.

Final price bid shall be opened only for those vendors who will be approved by the end customer (NPCIL) on the basis of credentials.

STE PQR TECHNICAL REVIEW COMMITTEE

Member -1	Member -2	Member -3
संजीव कुमार/SANJEEV KUMAR वरि. उप महाप्रबंधक/Sr.Dy.General Manager एस.टी. ई..विभाग/S.T.E. Division बी.एच.ई.एल.,भोपाल/BHEL. Bhopal	ओमकार कुमार/OMKAR KUMAR उप महाप्रबंधक/ Dy. General Manager एस.टी.ई.विभाग/ STE Division बी.एच.ई.एल.,भोपाल/B.H.E.L., BHOPAL	दिनेश चन्द्र निर्मल/Dinesh Chandra Nirmal वरि.उप महाप्रबंधक/Sr. DGM एस.टी.ई.विभाग/S.T.E. Division बी.एच.ई.एल.,भोपाल/B.H.E.L., BHOPAL

Prepared by

Checked by

Approved by

MAIN CONTRACTOR'S PROPOSAL CUM EVALUATION REPORT (FOR GHAVP- 1 & 2, KAIGA- 5 & 6 AND GHAVP- 3 & 4)

मुख्य संविदाकार प्रस्ताव सह मुल्यांकन रिपोर्ट

(GHAVP- 1 & 2, KAIGA- 5 & 6 AND GHAVP- 3 & 4 के लिये)

Ref No: संदर्भ सं.:	BHEL/VER /TRILLIUM/POMSSV, Rev 00	***Date:*** तिथिः	05.11.2022

i.	**Main *Contractor*** मुख्य संविदाकार	BHEL, Bhopal
ii.	**Project /** परियोजना	GHAVP- 1 & 2, KAIGA- 5 & 6 AND GHAVP- 3 & 4 (NPCIL)
iii.	**Package Name** पैकेज का नाम	TURBINE ISLAND PACKAGE
iv.	**Proposed Item /** प्रस्तावित मद	PILOT OPERATED MAIN STEAM SAFETY VALVES (POMSSV)
v.	**Name and Address of the proposed Sub-vendor's works** /प्रस्तावित सब-वेंडर का नाम तथा पता: Filled by Vendor	
vi.	**Brief description of the Sub-contractor, their products and capabilities in terms of manpower, machines, testing facilities etc.: -** Details are mentioned below; **Products: –** Filled by Vendor along with credentials **Capabilities:** - Filled by Vendor along with credentials **Manpower:** - Filled by Vendor along with credentials **Testing Facilities**:- Filled by Vendor along with credentials Vendor to furnish any additional details in Annexure	
vii.	**Supplier Performance Rating out of 100 (If applicable)**	NA.
viii.	**BHEL PO Numbers already Placed on Vendor**	Filled by vendor
ix.	Details of and financial capability of Sub-contractor: - Details are mentioned below Filled by Vendor along with credentials	

	MAIN CONTRACTOR'S PROPOSAL CUM EVALUATION REPORT (FOR GHAVP- 1 & 2, KAIGA- 5 & 6 AND GHAVP- 3 & 4) **मुख्य संविदाकार प्रस्ताव सह मुल्यांकन रिपोर्ट** **(GHAVP- 1 & 2, KAIGA- 5 & 6 AND GHAVP- 3 & 4 के लिये)**

	# Negative PBT of any company do not imply that vendor lacks resources to execute orders. It means margins are low in the present business scenario. Vendor has already successfully executed BHEL POs in year 2021 & 2020, in spite of negative PBTs in previous years.
x.	Whether the Sub-contractor supplied the Equipment/item/component to BHEL/NPCIL earlier. If supplied, please mention the project name and year; - Details are mentioned below Filled by Vendor along with credentials
xi.	Details of the other customers of the Sub-contractors: - Details are mentioned below. Filled by Vendor along with credentials
xii.	Details of their ISO and other certifications: - Details are mentioned below Filled by Vendor along with credentials

We confirm that as per BHEL assessment, the proposed sub-vendor is fully capable for supplying the item in the project.
BHEL के आकलन के अनुसार इस बात की पुष्टि करते हैं कि, प्रस्तावित उप-विक्रेता प्रस्तावित मद की आपूर्ति के लिए इस परियोजना में उपयुक्त है।
Additional Remarks: -

To be filled by BHEL

Name / नाम	**Design./** पद	**Sign & Date /** हस्ताक्षर व तिथि
BHEL Employee	**BHEL Employee**	**BHEL Employee**
BHEL Employee	**BHEL Employee**	**BHEL Employee**
BHEL Employee	**BHEL Employee**	**BHEL Employee**

NUCLEAR POWER CORPORATION OF INDIA LTD.
(A Government of India Enterprise)
CHECKLIST & RECOMMENDATION FOR EVALUATION OF VENDORS

Tender No	:	CMM/ETM/00/40/11/0005
Item/Package	:	TURBINE ISLAND PACKAGE
Name of Main Contractor	:	BHEL
Address and contact details of Main Contractor	:	Heavy Electrical Plant, BHEL Bhopal, MP-462022,
Name of Sub-contractor/Vendor	:	To be filled by vendor
Address of Sub-contractor	:	To be filled by vendor
Items for which approval is sought	:	To be filled by vendor

1.0 General:

1.1)	Key Personnel contacted	:	To be filled by vendor
	a) Senior Management	:	To be filled by vendor
	b) Quality Co-ordinator	:	To be filled by vendor
	c) Others (Production, Planning etc.)	:	To be filled by vendor

FOLLOWING ARE TO BE COMMENTED

1.2)	Recognition details if any code Stamps like U1, U2, ASME N, NPI or certification Like ISO 9001, 14000 etc. (Verify the records)	:	To be filled by vendor
1.3)	Floor space availability for present Activities/for future expansion	:	To be filled by vendor
	a) Indoor	:	To be filled by vendor
	b) Outdoor	:	To be filled by vendor
1.4)	Level of House keeping	:	To be filled by vendor

1.5)	Whether NPCIL jobs executed earlier	:	To be filled by vendor along with credentials
1.6)	Delivery Performance (Schedule vs Actual) (Verify records)	:	To be filled by vendor
2.0	**Technical**		
2.1)	Quality Control		
	(a) Incoming Material Inspection	:	Yes/No
	(b) Process Inspection	:	Yes/No
	(c) Final Inspection	:	Yes/No
2.2)	Plant & Machinery	:	To be filled by vendor with credentials
	(a) General condition & Age	:	
	(b)Confirms to the details submitted in application	:	
2.3)	Calibration facilities	:	To be filled by vendor with credentials
2.4)	Calibration records	:	To be filled by vendor with credentials
2.5)	NDE Qualification records	:	To be filled by vendor with credentials
2.6)	Is there a system of selecting/ short listing Sub-vendors?	:	To be filled by vendor
2.7)	Availability of Testing facilities	:	To be filled by vendor with credentials)
2.8)	Whether working of following are satisfactory?		
	(a) Production	:	To be filled by vendor
	(b) Quality control :	:	To be filled by vendor
2.9)	Understanding of scope of work	:	To be filled by vendor
2.9.1)	Understanding of technical requirement of Job	:	To be filled by vendor
2.10)	Availability and understanding of related standards.	:	To be filled by vendor

2.11)	Capacity of the Vendor to fabricate and inspect	:	To be filled by vendor
2.12)	Understanding of special Examination/ Testing (like ultrasonic Examination/ Helium Leak testing, Optical alignment testing etc.)	:	To be filled by vendor
2.13)	Availability of special facilities	:	To be filled by vendor with credentials
2.14)	Facilities/Machineries/testing equipment available in the shop floor to meet technical requirement of the job	:	To be filled by vendor with credentials
2.15)	Qualified and experience Manpower in the shop floor to execute the specified job	:	To be filled by vendor with credentials

3.0 <u>Quality System :</u>

3.1)	If ISO certified, check the availability and accessibility of Quality system manual	:	To be filled by vendor
3.2)	Validity of ISO certification	:	To be filled by vendor
3.3)	Whether Quality Control plan and Procedures are prepared?	:	To be filled by vendor
3.4)	Whether organisation chart is available?	:	To be filled by vendor with credentials
3.5)	What is the level of Quality Control in the organisation?	:	To be filled by vendor with credentials
3.6)	Whether working of following are Satisfactory?		
	(a) Document control	:	Yes/NO
	(b) Process Control	:	Yes/NO
	(c) Non-conformances control	:	Yes/NO
3.7)	Whether Internal Quality Audits are carried out?	:	Yes/NO

3.8) Whether non-conformities during Internal Audits are recorded and disposed off following laid down procedure? : Yes/NO

4.0 Assessment: To be filled by BHEL

4.1 Understanding and interpretation by vendor

Sl No	Area of Assessment	Observation	Remark
1	Scope of work	Good/Satisfactory/Unsatisfactory	
2	Related standard	Good/Satisfactory/Unsatisfactory	
3	Construction features	Good/Satisfactory/Unsatisfactory	
4	Functional Requirement	Good/Satisfactory/Unsatisfactory	

4.2 Capability of Vendor

Sl No	Area of Assessment	Observation	Remark
1	To design/develop	Good/Satisfactory/Unsatisfactory	
2	To fabricate	Good/Satisfactory/Unsatisfactory	
3	To inspect	Good/Satisfactory/Unsatisfactory	
4	Specify remark on the capability of vendor to execute the job	Good/Satisfactory/Unsatisfactory	

4.3 Comments if any w.r.t. delivery schedules: NA

4.4 Comments if any on quality of product: NA

5.0 Conclusion:

Signature of Team Members

Sl. No.	Name	Designation	Sign & Date
1	BHEL Employee	BHEL Employee	BHEL Employee
2	BHEL Employee	BHEL Employee	BHEL Employee
3	BHEL Employee	BHEL Employee	BHEL Employee

PQR- PILOT OPERATED MAIN STEAM SAFETY VALVE

Bharat Heavy Electrical Limited,
Bhopal

Tender No. …….

PRE-QUALIFICATION CRITERIA (FINANCIAL) FOR PILOT OPERATED MAIN STEAM SAFETY VALVE]

The bidder shall produce documentary evidence for meeting the following pre-qualification criteria along with their offer.

FINANCIAL CRITERIA

S.No	Criteria	Documents Required in Support	Doc Submitted
1.0.a	Indian Vendor:- Average, Annual financial turnover of bidder, during the Three financial years FY 2021-22, 2022-23 and 2023-24 shall be **INR 700 Lakhs** or more.	Bidder has to submit Audited Balance sheet, Profit & loss account statement for three financial years: 2021-22, 2022-23 and 2023-24 OR A certificate from the Chartered Accountant / Cost Accountant indicating the turnover details for FY 2021-22, 2022-23 and 2023-24 shall be uploaded with the bid. In case the date of constitution / incorporation of the bidder is less than 3-year-old, the average turnover in respect of the completed financial years after the date of constitution shall be taken into account for this criteria.	
1.0.b	Mandatory statutory Documents- PAN & GSTIN	a) Copy of PAN Card b) Copy of GSTIN document issued by appropriate Govt. Authority	
2.0.a	**Foreign Vendors** : In case of bidders from outside India, Average annual financial turnover of bidder, during the Three financial years shall be equivalent to **INR 700 Lakhs or more**. Bidder shall provide business information report (BIR) from third party business rating agencies e.g. Dun & Bradstreet/Credit reform/Experian etc. along with technical offer. BIR reports indicating turnover as mentioned above for the Financial year: 2021-22, 2022-23 and 2023-24 to be submitted along with Technical bid.	Business Information Report (BIR) report from third party business rating agencies e.g. Dun & Bradstreet/ Credit reform / Experian etc. for three financial years : 2021-22, 2022-23 and 2023-24	

Bharat Heavy Electrical Limited,
Bhopal

Tender No. …….

	Note - Exchange rate for conversion of equivalent INR -Exchange rate (TT selling rate of State Bank of India) applicable on the date of Part-I bid opening shall be considered for conversion of financial data of BIRs. If the relevant day happens to be a bank holiday in India, then the FOREX rate as on the previous bank working day shall be taken for evaluation.		
2.0.b	Appointment of Indian Agent- In case of availing services of an Indian agent, then bidder to provide Agency Agreement. The agency agreement should specify the precise relationship between the foreign OEM/ principal & their Indian agent and their mutual interest in business. In absence of any agency agreement, BHEL shall not deal with any Indian agent and shall deal directly with the foreign principal for all purposes.	Copy of Agency Agreements	

Note:

1. After satisfactory fulfilment of all the above criteria/requirement, offer shall be considered for further evaluation as per NIT and all other terms of the tender.
2. **All documentary evidences along with this PQR (pre-qualification criteria) shall be duly signed and stamped by Authorized person.**
3. BHEL reserves the right to verify information provided by vendor. In case the information provided by vendor is found to be false/incorrect, the offer shall be rejected.
4. In case of foreign vendor, vendor shall submit Tax Residency Certificate (TRC) & Permanent Establishment and Business Connection (PEBC) as per clause no. 16 of Enquiry General terms Condition BP-200102.
5. Kindly refer guidelines regarding dealings with Indian Agents of Foreign suppliers. (ref. separate attachment)

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ANNEXURE - B (COMMERCIAL FOR FOREIGN VENDORS)
(Submit *the document with company's seal and authorized signature*)
Enquiry No. :- E1643160

S.No	BHEL TERMS	Vendors Remarks
1.	**INSPECTION**: BHEL QC / BHEL APPOINTED TPI AND NPCIL. Please confirm. Prices shall be FIRM till execution of order inclusive of all testing & Inspection charges. Inspection charges shall be mentioned separately also.	
2.	Prices to be furnished on FCA basis inclusive of packing & forwarding charges.	
3.	Please also quote air freight charges i.e. C&F Charges from FCA port to Mumbai Air Port (Indian Port).	
4.	Agency commission if any to be included in FCA price and indicated separately as a percentage of quoted FCA value.	
5.	100% against irrevocable, unconfirmed LC, payable within 90 days of the bill of lading (BL) date. In case BHEL considers any deviation in payment terms i.e. early payment based on vendor's request, then bids shall be evaluated with loading of State bank of India Base rate plus 6%, for the credit period short of 90 days. The LC shall be established 2month prior to shipment date, valid for period of 90 days, unless agreed otherwise. Payment terms of CAD payable on 90th day of BL / HAWB date shall be preferred as the tender value is less.	
6.	L/C charges in India to BHEL A/C and outside India to vendor's account. In case of delay in supply by the vendor, charges for extension of L/C (Inside & Outside) will have to be borne by vendor.	
7.	Minimum delivery period to be Quoted in no. of weeks from the date of receipt of Purchase Order. If any document approval is required then the delivery period shall start from the date of document approval however, required delivery is 720 days (tentative). Required delivery is 720 days(tentative) from the date of document approval after PO placement date. vendor shall submit all documents within 15 days of issue of PO and subsequent submission shall be within 7 days in case any revision required.	
8.	Early delivery is acceptable subject to prior approval from BHEL.	
9.	Penalty: -LD shall be 0.5% of the total order value per week of delay or part thereof, subject a maximum of 10% of the total order value (Please refer clause 9 of GCC).	
10.	The offer must be valid for 120 days from the date of technical bid opening.	
11.	Exchange rate of technical bid opening date or latest available prior to technical bid opening date will be considered for evaluation of bids.	

12.	Please indicate the shipping weight of the unit quantity of the item	
13.	Please indicate the name of currency of the offer	
14.	Submitted duly seal & signed on all pages – BHEL GTC (BP200102)	
15.	Submitted duly seal & signed Annexure C	
16.	Submitted duly seal & signed Annexure B (Techno-commercial bid)	
17.	Submitted duly seal & signed on all pages Integrity Pact	
18.	PBG of 05 % shall be applicable.	
19.	**All the credentials submitted by the vendors shall be reviewed & approved by BHEL & NPCIL and if any additional document required by NPCIL/BHEL, BIDDER shall furnish the same.**	
20.	Vendor to submit financial documents. VENDOR TO SUBMIT AUDITED BALANCE SHEET/CA CERTIFICATE OF LAST THREE FY	
21.	**Final price bid shall be opened only for those vendors who will be approved by the end customer (NPCIL) on the basis of credentials.**	
22.	**Delivery Destination**: - The material is required to be **supplied** to Site. To consignee address: Chief Construction Engineer, Kaiga Atomic Power Project-5&6 (KAIGA-5&6) Kaiga Site, Via - Karwar, Dist- Uttar Kannada, Karnataka- 581400.	

NOTE- 1) DEVIATION IN ANY COMMERCIAL CONDITION SHALL BE SUITABLY LOADED IN THE OFFERED PRICE.

2) IN CASE OF ANY CONFLICT, CONFIRMATION BY VENDOR PROVIDED HERE WILL SUPERCEDE.

ANNEXURE-B (COMMERCIAL FOR INDEGENOUS VENDORS)
(Submit *the document with company's seal and authorized signature*)
Enquiry No – E1643160

S.No.	BHEL TERMS	Vendors Remarks
1.	**Prices shall be firm till delivery**	
2.	**INSPECTION**: BHEL/ BHEL APPOINTED THIRD PARTY AND NPCIL. Please confirm.	
3.	**Delivery Destination**: - The material is required to be **supplied** to Site.	
4.	Price to be furnished on **F.O.R. Site**, duly insured basis inclusive of P&F charges. To, Chief Construction Engineer, Kaiga Atomic Power Project-5&6 (KAIGA-5&6),Kaiga Site, Via - Karwar, Dist-Uttar Kannada, Karnataka-581400.	
5.	Minimum delivery period to be Quoted in no. of weeks from the date of receipt of Purchase Order. If any document approval is required then the delivery period shall start from the date of document approval however, required delivery is 720 days(tentative) from the date of document approval after PO placement date. vendor shall submit all documents within 15 days of issue of PO and subsequent submission shall be within 7 days in case any revision required.	
6.	**Payment terms**: 100% payment within 90 days of receipt (45 days for MSE and 60 days for Medium enterprises/ NSIC registered suppliers under as per relevant act in force) subject to acceptance of material at BHEL, on direct presentation of the documents. Any deviation from the above payment terms, if accepted (by BHEL), shall be loaded @ SBI base rate + 6% for the purpose of bid evaluation.	
7.	Confirm whether bidder is **Manufacturer or Trader or Dealer** of items under enquiry. In case of Trader or Dealer, please furnish authorization certificate from OEM.	
8.	**Penalty: -** LD shall be 0.5% of the total order value per week of delay or part thereof, subject a maximum of 10% of the total order value (Please refer clause 9 of GCC).	
9.	**Specify** HSN code OF MATERIAL item wise in the offer.	
10.	GST TYPE & ITS PERCENTAGE APPLICBALE item wise mentioned in the offer (IGST/CGST+SGST/UGST)	
11.	The offer must be valid for 120 days from the date of technical bid opening.	
12.	Submitted duly seal & signed on all pages – BHEL GTC (BP200102)	
13.	Confirm **UDYAM Certificate** is Submitted, In Case Bidder is an MSE Vendor. (As Per Order F. No. 1(2)(1)/ 2016-MA Dated 09/02/2017 From Min. Of MSME Traders/Agents Are Not Allowed For Benefits/Relaxations Extended to MSES.)	
14.	PBG of 05% is applicable after placement of PO.	
15.	**All the credentials submitted by the vendors shall be reviewed & approved by BHEL & NPCIL and if any additional document required by NPCIL/BHEL, BIDDER shall furnish the same.**	
16.	Supplier to Furnish All Inspection Reports, Material TC & GC to PO Issuing Authority After Supply / Along with Supply.	
17.	Guarantee / Warranty required and periods: 18 Months from supply or 12 months from the commissioning whichever is earlier. Please confirm.	
18.	Submitted duly seal & signed – Annexure C, Annexure -D	
19.	Submitted duly seal & signed – Techno commercial Bid	
20.	Submitted duly seal & signed - on each page of BHEL GTC & Integrity pact.	
21.	Submitted duly seal & signed Annexure B (Techno-commercial bid)	
22.	VENDOR TO SUBMIT AUDITED BALANCE SHEET/CA CERTIFICATE OF LAST THREE FY. 13. VENDOR TO SUBMIT VENDOR CREDENTIAL FOR NPCIL APPROVAL.	
23.	**Final price bid shall be opened only for those vendors who will be approved by the end customer (NPCIL) on the basis of credentials.**	

NOTE-
1) DEVIATION IN ANY COMMERCIAL CONDITION SHALL BE SUITABLY LOADED IN THE OFFERED PRICE.
2) IN CASE OF ANY CONFLICT, CONFIRMATION BY VENDOR PROVIDED HERE WILL SUPERCEDE.
3) IN CASE BIDDER IS NOT MAKING AN OFFER AGAINST THIS ENQUIRY, WE REQUEST THE BIDDER TO POST THE REGRET LETTER.

ANNEXURE- C

DECLARATION BY BIDDERS REGARDING CONFLICT OF INTEREST

"A bidder shall not have conflict of interest with other bidders. Such conflict of interest can lead to anti-competitive practices to the detriment of Procuring Entity's interests. **The bidder found to have a conflict of interest shall be disqualified**. A bidder may be considered to have a conflict of interest with one or more parties in this bidding process, if:

a) they have controlling partner (s) in common;· or

b) they receive or have received any direct or indirect subsidy/ financial stake from any of them; or

c) they have the same legal representative/agent for purposes of this bid; or

d) they have relationship with each other, directly or through common third parties, that puts them in a position to have access to information about or influence on the bid of another Bidder,· or

e) Bidder participates in more than one bid in this bidding process. Participation by a Bidder in more than one Bid will result in the disqualification of all bids in which the parties are involved. However, this does not limit the inclusion of the components/ sub-assembly/ Assemblies from one bidding manufacturer in more than one bid; or

f) In cases of agents quoting in offshore procurements, on behalf of their principal manufacturers, one agent cannot represent two manufacturers or quote on their behalf in a particular tender enquiry. One manufacturer can also authorise only one agent/dealer.

There can be only one bid from the following:

1. The principal manufacturer directly or through one Indian agent on his behalf; and

2. Indian/foreign agent on behalf of only one principal, or

g) A Bidder or any of its affiliates participated as a consultant in the preparation of the design or technical specifications of the contract that is the subject of the Bid, or

h) In case of a holding company having more than one independently manufacturing units, or more than one unit having common business ownership/management, only one unit should quote. Similar restrictions would apply to closely related sister companies. Bidders must proactively declare such sister/ common business/ management units in same/ similar line of business. "

We confirm to above conditions of NIT against **enquiry no**/ **GeM bid no- ……**

Sign/seal of bidder

(……)

For M/s. ……

BHARAT HEAVY ELECTRICALS LIMITED, BHOPAL

MATERIAL MANAGEMENT – THERMAL DIVISION

ANNEXURE-D

For this Procurement, Government of India Public Procurement (Preference to Make in India), Order 2017 with its amendments and subsequent Orders issued by the respective nodal ministries shall be applicable even if issued after issue of this NIT but before finalization of contract/PO/WO against this NIT.

*As per the Provisions of this order, please submit **a self-certification complying with the conditions below on company letterhead duly signed by competent authority**.*

Format:

I ……., hereby declare on behalf of M/s. ……. that we are participating in the Enquiry No. …… floated by BHEL, Bhopal (MP), India and shall comply with following:

1. Public Procurement (Preference to Make in India), Order 2017 *with its amendments* and subsequent Orders issued by the respective nodal ministries shall be applicable even if issued after issue of this NIT but before finalization of contract/PO/WO against this NIT.

2. As per the Provisions of this order, **only "Class-I Local Suppliers"** are eligible to bid for the tender.

(a) A supplier will be treated as **"Class-I Local Suppliers",** if the items quoted by bidder have local content equal to or more than 50%.

(b) '**Local Content'** means the amount of value added in India, which shall be total value of item quoted (excluding net domestic indirect taxes) minus the value of imported content in the item (including all custom duties) as a proportion of the total value, **in percent**.

3. I hereby declare that our firm qualifies as **"Class-I Local Suppliers"**.

a. The Local Content in the items quoted under this Enquiry is ……. Percent

b. Details of location(s) in India where this value addition shall be done, is/are as follows:

(a) ……..

(b) ……..

(c) ……..

(……)

For M/s. ……

(Seal & Sign)

GENERAL TERMS AND CONDITIONS OF ENQUIRY

Sl.No.	Description
1	**General:**
A	These General terms & conditions (GTC) shall apply to all enquiries, notice inviting tenders, request for quotations concerning the supply of goods and / or rendering of services to Bharat Heavy Electricals Ltd., Bhopal (hereinafter referred to as BHEL or the Purchaser) or its Projects / Customers. Special / supplementary enquiry conditions, if any, will override the conditions in this annexure.
2	**General Instructions - Common for Indigenous & Foreign enquiries**
A	**Through E- procurement**
A1	**1.** Offer shall be submitted by the bidders in single/two parts as called in Tender enquiry. Bid Part - I Technical cum Commercial bid Bid Part - II Price bid **2.** Suppliers shall quote ***price*** on BHEL authorised third party service provider **e-procurement site.** Any deviation from the price format shall be clearly brought out in the offer Bid part I. The offer shall be uploaded on BHEL e-procurement site using Class III digital signature. **Bidders to put sign and seal on all the uploaded documents.** The quotation should be uploaded on the site before due date and time. Part-I of the bid shall contain complete item-wise scope of supply as offered vis-à-vis the scope of supply as per enquiry, all commercial terms and conditions etc. It is expected that bidders shall meet all our technical and commercial requirements and shall not deviate from them.
B	**Through tender room**
B1	Sealed bids are invited for scope of Supply / Services as detailed in the enquiry. The quotation should be neatly typed and free from over writing/ erasures. Any correction or addition must be authenticated. The bid should be submitted in English or Hindi language. Relevant enclosures, supporting documents, catalogue, samples, if any, as required as per Notice Inviting Tender (NIT) conditions shall be sent along with technical offer. Rate should be quoted in the units asked for in the enquiry. The rates should be quoted both in figures and words. In case of discrepancy in figures and words, the rates quoted in words shall be considered.
B2	Bids shall be submitted in a Sealed cover with Enquiry No., Due date and Bidder's name indicated on the cover. In case of Two part Bid, technical bid containing technical offer, this GTC duly filled-in & signed; and **un-priced copy** of the Price Bid should be kept in one envelope. Price Bid containing only the price (as called for in the price format where required) should be kept in a separate envelope. Both envelopes indicating Part —I or Part-II as the case may be to be put in a bigger envelope, which should be addressed to In charge, Tender Room, Bharat Heavy Electricals Ltd. 2nd Floor, Jawahar Bhavan, Piplani, Bhopal 462022. Enquiry No., due date and bidder's name must be mentioned on all envelopes. Offer must reach tender room of BHEL Bhopal latest by 11.00 am IST on the enquiry due date. Bids submitted as single part bid against two – part bid, shall be rejected unless the offer is techno-commercially acceptable without seeking any clarification.
B3	Offer received after 11.00 AM IST of the due date will be termed as "Late" and shall not be considered. However, late offer received against single tender enquiry may be considered.
B4	Bidder can also submit offer through email, if called for in the enquiry, at the email address indicated in the enquiry. Such email offers shall be sent only on designated email-id to reach before 11.00 am IST on the tender due date. BHEL will not be responsible for incomplete offers and the ones delivered late through e-mail.
C	Commercial Conditions quoted by the vendor in any place including as stated in bidder's 'General Terms and Conditions' if any, shall not be binding on the Purchaser and the conditions contained in this annexure, including special conditions, if any, for this enquiry shall only prevail.
D	BHEL reserves the right to go for Reverse Auction (RA) (Guidelines as available on www.bhel.com) instead of opening the sealed envelope price bid, submitted by the bidder. This will be decided after techno-commercial evaluation. Bidders to give their acceptance with the offer for participation in RA. Non-acceptance to participate in RA may result in non-consideration of their bids, in case BHEL decides to go for RA. Those bidders who have given their acceptance to participate in Reverse Auction will have to necessarily submit 'Process compliance form' (to the designated service provider) as well as 'Online sealed bid' in the Reverse Auction. Non-submission of 'Process compliance form' or 'Online sealed bid' by the agreed bidder(s) will be considered as tampering of the tender process and will invite action by BHEL as per extant guidelines for suspension of business dealings with suppliers/ contractors (available on www.bhel.com). The bidders have to necessarily submit online sealed bid less than or equal to their envelope sealed price bid already submitted to BHEL along with the offer. The envelope sealed price bid of successful L1 bidder in RA, if conducted, shall also be opened after RA and the order will be placed on lower of the two bids (RA closing price /envelope-sealed price)

	thus obtained. The bidder having submitted this offer specifically agrees to this condition and undertakes to execute the contract on thus awarded rates. If it is found that L1 bidder has quoted higher in online sealed bid in comparison to envelope sealed bid for any item(s), the bidder will be issued a warning letter to this effect. However, if the same bidder again defaults on this count in any subsequent tender in the unit, it will be considered as fraud and will invite action by BHEL as per extant guidelines for suspension of business dealings with suppliers/ contractors (available on www.bhel.com). In case RA fails, sealed/E-proc price bids shall be opened in line with RA Guidelines. In case BHEL decides to open the sealed paper price bids, bids of all the techno-commercially acceptable bidders will be opened on the assigned date.
E	The goods offered shall conform to BHEL specifications and / or National/International standards as mentioned in the Enquiry and the bidder is required to confirm his unconditional acceptance to the same. Vendors, seeking deviations from the specifications and any other conditions, may indicate the same clearly on a separate sheet, with reasons for such deviations. BHEL reserves the right to reject the offer with deviations or load the deviations suitably for evaluation.
F	Offers shall be submitted directly by vendor or his authorized agent only. Unsolicited offers shall be summarily rejected.
G	Bid in single part or techno-commercial bid in **two-part** system (as the case may be) will be opened on the due date. In case of two part bid, price bids of techno-commercially acceptable bidder(s) only shall be opened on the assigned date, for which separate intimation will be sent to the acceptable bidders.
H	The bidder whose bid is technically not accepted will be informed & EMD wherever submitted shall be returned along with his price bid within *30 days* of contract finalization date. No interest will be payable on EMD amount. EMD shall however be forfeited in the event of bidder opting out after submission of the bid.
I	1. Any discount / revised offer submitted by a bidder on its own shall be considered, provided it is received on or before the due date and time of offer submission (Part-I). Conditional discounts shall not be considered for evaluation of tenders. 2. Unsolicited discounts / revised offers given after Part-I bid opening shall not be accepted. No change in price will be permitted within the validity period of offer. 3. In case of changes in scope and / or technical specification and / or commercial terms & conditions, having price implication, techno-commercially acceptable bidders shall be asked by BHEL to submit the impact of such changes on their price bids. In case a bidder opts to submit revised price bid instead of impact called for, then latest price bid shall prevail. However in both situations, original price bid will be necessarily opened.
J	The bidders will submit Integrity Pact, duly signed by its authorized signatory, where called for in the enquiry.
K	Wherever the enquiry is issued to unregistered vendor, the bidder shall visit ' www.bhel.com ' for submitting the online Supplier Registration Application. Price bids of such vendors, will be opened only on techno-commercial acceptance of bid & after supplier registration.
L	BHEL expects that the bidder must respond to the enquiry. Regret letter, with valid reasons for not participating in the tender will be submitted where the bidder is unable to submit offer. Repeated lack of response on the part of vendor may lead to his deletion from BHEL's approved vendor list.
M	Goods shall be properly packed to avoid transit damage. Suitable markings shall be provided to identify the goods with that of the PO No. and the consignee details.
N	Goods shall be consigned to AGM (CRX), BHEL, Piplani, Bhopal - 462022, India, unless otherwise specified in the PO.
O	In case of press tenders (i.e. those published in newspapers) all corrigenda, addenda, amendments, time extensions, clarifications etc. to the tender will be hosted on BHEL website. (www.bhel.com & www.bhelbpl.co.in) only. Bidders responding to press tender should regularly visit website(s) to keep themselves updated.
P	In the course of evaluation, if more than one bidder happens to occupy **L-1** status and the order is to be placed on a single vendor, effective **L-1** will **be** decided in the order of availability of goods from Indigenous sources, suitability of delivery period to BHEL's requirements, vendor performance rating and quantum of past business volumes with the vendor in last 3 years, preceding the current financial year, for the same item. BHEL's decision in such situations shall be final and binding.
Q	The Purchaser can consider awarding tendered quantities among more than one bidder (after acceptance of Ll price by the other bidders) in the manner and proportion disclosed in the tender conditions. Purchaser can also consider awarding of part of the tendered quantity to other than L-1 bidder at **Ll** counter offered rates, if the quantity offered by the L-1 bidder is less than the quantity tendered for.
R	The bidder shall submit price bid strictly in the price format, wherever provided for, in the enquiry. Any attempt on the part of the bidder to alter the contents of the price bid format in any manner, which in the opinion of BHEL can vitiate the tendering process, will lead to rejection of the bid, ***besides BHEL taking appropriate punitive action as deemed fit.***
3	**Delivery Terms**
A	**Indigenous Purchase**

GENERAL TERMS AND CONDITIONS OF ENQUIRY

A1	Goods shall be delivered on 'FOR Destination' basis to the named destination unless otherwise called for in the enquiry.	
B	**Foreign Purchase — Imports**	
B1	1. Goods shall be despatched by Sea, unless stated otherwise in the enquiry or purchase order. 2. Terms of Delivery for Sea shipment shall be on CFR / CIF basis with 14 days' detention free period preferably at Dry Port - ICD Mandideep (INMDD6) for FCL (Full Container Load) Cargo of GP & HC Containers. 3. For other cases - Other than GP & HC Containers, LCL Cargo shall be delivered at Nhava Sheva (JNPT) & Break-bulk Cargo at Mumbai (MPT). 4. For Air consignments, the terms of delivery shall be FCA at BHEL nominated Airport. 5. Freight amount shall be indicated separately in the offer in case of CIP/CFR/CIF. 6. The number of detention free days and destination charges payable to shipping line must be mentioned in your offer and also on the Bill of Lading. 7. Offer received on FOB basis may be considered on an exceptional basis. BHEL will load freight, marine insurance & shipping line port handling charges etc to work out landed cost at Sea Port. 8. Please visit BHEL Bhopal website www.bhelbpl.co.in for details of named Air ports and Sea ports. Name of the gateway port so chosen by the Seller shall be indicated by the Bidder in his offer.	
B2	1. For delivery of FCL (Full Container Load) cargo, the Bidder shall provide minimum **14 days' detention free period** from the date of delivery at Port of Discharge / Place of Delivery (in case of ICD). Wherever the detention free period offered is less than 14 days, the bids shall be **loaded** for the period short of 14 days' period. 2. *Port Congestion charges or any additional charges claimed by the shipping line at Port of Discharge / Place of Delivery shall be to the Seller's account.*	
4	**Vendor's particulars & logistics information (Bidder to give details against each of the provisions)**	
A	Name of the vendor's executive to deal with this tender / project	
B	E-mail address of the contact person	
C	Telephone no. of the contact person	
D	Name of location from where the goods shall be offered for inspection and dispatch	
5	**Additional logistics information for Imports**	
A	Bid currency	
B	Charges applicable at discharge port up to BHEL's CFS (Container Freight Station) to be indicated in your offer and on the B/L	
C	Name of Airport in the country of dispatch for FCA delivery terms	
D	Estimated number, type & size of containers for delivery of tendered quantity (applicable where the goods are to be sent in FCL)	
E	No. of packages with cumulative gross weight and CBM volume (applicable for LCL & Break-bulk shipment)	
F	Approx. distance in km. from Vendor's works to Port of Loading	Sea port /Air port
6	**Delivery Schedule & Completion date**	
A	• Instead of writing specific date against delivery offered, bidder shall commit delivery period in number of days / weeks/ months to suit the delivery period indicated in the enquiry. • Commencement of delivery period shall be reckoned from the date of PO / LOI or any other agreed milestone. • Seller shall deliver the goods in the manner and schedule agreed under the Purchase order. • Goods shall be delivered within contractual period or any extension thereof, if any, granted by the Purchaser. • If delivery is linked to approval of documents, time for submission of such documents to be indicated and delivery period to be indicated from approval of documents. This delivery schedule will be considered for processing delivery extension, wherever applicable. • BHEL reserves the right to cancel the order if material is not delivered within PO scheduled delivery.	
B	In case of foreign supplies, the date of Bill of Lading (B/L) or AWB shall be taken as actual date of delivery.	
C	In case of Indigenous bidders, the date of delivery at named destination in India shall be taken as contractual delivery completion date where delivery terms are FOR destination. In case of 'Ex-works' delivery terms, the date of LR / RR shall be the contractual delivery completion date.	
7	**Transit Insurance**	

A	Except where delivery terms are agreed on CIF basis for Imports & FOR destination basis for indigenous purchases, transit insurance will be covered by BHEL under its Open Marine Transit Insurance Policy. Seller shall inform dispatch particulars with value of consignment to the Purchaser within 07 days of dispatch for BHEL to arrange insurance coverage in its policy. Failure on the part of seller to inform dispatch particulars will make him liable to pay for any transit damages / losses suffered by the Purchaser.
8	**Force Majeure**
A	Notwithstanding anything contained in the contract, neither the Seller nor the Purchaser shall be held responsible for total or partial non-execution of any of the contractual obligations, should the obligation become unreasonably onerous or impossible due to occurrence of a 'Force Majeure' which directly affects the obligations to be performed by the Purchaser or the Seller; Such events include war, military operations of any nature, blockages, revolutions, insurrections, riots, civil commotions, insurgency, sabotage, acts of public enemy, fires, explosion, epidemics, quarantine restrictions, floods, earthquake, or acts of God, restrictions by Govt. authorities; over which the Seller or the Purchaser has no control. The party claiming to be affected by force majeure shall notify the other party in writing without delay, within two weeks on the intervention and on the cessation of such circumstance. Extension of time sought by the Seller along with supporting evidence and so granted by the Purchaser for the supply/ work affected, if any, shall not be construed as waiver in respect of remaining deliveries. Rescheduling of deliveries on account of force majeure conditions, if so agreed by the Purchaser, will not entail the Seller to claim any increase in the price on whatsoever account. Notwithstanding above provisions, Purchaser shall reserve the right to cancel the order/ Contract, wholly or partly, in order to meet the overall project schedule and make alternative arrangements. If deemed necessary, Purchaser may takeover partly processed material at a mutually agreed price.
9	**Penalty for delayed performance.**
A	I. Subject to force majeure conditions, penalty shall be 0.5% of the total order value per week of delay or part thereof, subject a maximum of 10% of the total order value. Total order value above shall be item wise, lot wise order value. Any deviation based on specific requirement shall be specified separately in the NIT. II. However, in case of Capital Machine / BOP *where* staggered deliveries may be applicable, the penalty will be levied on total order value. III. In case of any amendment / revision, the penalty shall be linked to the amended / revised PO. IV. Any loading on penalty clause shall be to the extent to which it is not agreed to by the bidder (at offered value)
B	If the material is not supplied within the agreed delivery period, BHEL reserves the right to cancel the order and purchase the material from alternate source(s) at the Risk and Cost of the Seller. In such an event, it shall be obligatory on the part of seller to make good any loss suffered by the purchaser.
C	In case the contractually agreed delivery date falls on a holiday in BHEL Bhopal, the next working day shall be taken as contractual delivery date for compliance and applicability of LD / penalty.
10	**Indian Agents and Agency commission**
A	BHEL prefers to deal directly with Foreign vendor, wherever required, for procurement of Goods. However if the Foreign Principal desires to avail services of an Indian Agent, then the Principal should ensure compliance to "regulatory guidelines" which will require submission of an agency agreement.
B	The CFR / CIF price quoted will be deemed to be inclusive of Indian Agency commission. Agency commission as disclosed by the bidder in his quoted CFR / CIF price will be paid in Indian Rupees on receipt & acceptance of Materials or it's installation at destination, as the case may be. The lower of the 'TT buying rate prevailing on the date of technical bid opening or price bid opening shall be considered for computation of Agency commission.
C	In a tender either the Indian Agent on behalf of Principal / OEM or the Principal / OEM itself can bid, but both cannot bid simultaneously for same item / product in the same Tender. In case bids are received from both the Principal / OEM and the agent, bid received from the agent will be ignored.
D	If an agent submits Bid on behalf of the Principal / OEM, the same agent shall not submit bid on behalf of another Principal / OEM in the Tender, for the same Item / Product.
11	**Documentation:**
A	**Indigenous Purchase**
	Seller shall arrange to send to the consignee, Original Tax invoice (Buyer's copy and duplicate for Transporter), Commercial invoice in duplicate, consignee copy of LR & 2 sets each of Packing list, Test certificate, Guarantee / Warranty certificate, O & M manuals (where applicable), immediately on despatch of the goods. The distribution of such documents will be specified in the Purchase order. In case of labour / mixed basis jobs, material is issued free of cost. Necessary material reconciliation is to be done and Free Issue Material Statement (FIMS) is to be submitted with each bill.
B	**Foreign Purchase — Imports**
	Seller shall send **1** set of following documents, in English, within 7 days of B/L date / 1 day of AWB date by courier to the

	Purchaser 1. Express / Original 'Clean on board' Bill of Lading / AWB. 2. One set of Commercial Invoice, Packing list indicating container-wise Gross weight, Net weight, CBM volume, No. of packages with Dimensions of each package. 3. Original Certificate of Country of Origin issued by Chamber of Commerce. 4. One set of Original Test Certificates and O&M Manual where called for. 5. Fumigation / Phyto Sanitary Certificate wherever cargo is packed in wooden packing or packing of plant origin material is used. 6. Supplier should additionally forward 2 sets of original documents mentioned at point 1 to 5 along with original bill to Lading through any international courier service/registered airmail or AWB by captain's mail within three days of obtaining the same directly to the following: (i) AGM (M.S) Regional Operations Division BHEL 14th Floor Centre-1 World Trade Centre, Cuffe Parade Colaba, Mumbai 400 005 INDIA Email - msseabpl@bhel.in (In case of sea freight) msair@bhel.in (In case of air freight) (ii) DGM (FIN- FP) 4th Floor, Administrative Bldg. BHEL Bhopal - 462022 (India) E-mail : fin_fp@bhelbpl.co.in And confirm forwarding details to AGM (MM- FE), BHEL Bhopal at mmfe@bhelbpl.co.in 7. In case the Seller decides to negotiate all 3 originals of B/L / AWB along with all original documents through negotiating Bank, non-negotiable documents (NNDs) consisting of copy of B/L / AWB & documents mentioned at Sl. no. 11- B2 to B5 will be sent by e-mail to the Purchaser at his e-mail address given in the PO with one copy to be mailed at **mmfe@bhelbpl.co.in** & **msseabpl@bhel.in** (for sea shipment) or **msair@bhel.in** (for air shipment). Other documents, as required, will be separately indicated in the Purchase Order. Additional expenditure, if any, incurred by the Purchaser by way of detention / demurrage, resulting out of delay attributable to the Seller in providing Negotiable documents, will be recovered from the Seller. In case any discrepancy is raised by bankers / BHEL with respect to documents submitted, vendor to facilitate clearance of goods through Delivery Order.
C	**General**
	1. For Hazardous chemicals, the materials safety data sheet (MSDS) is to be submitted. 2. All certificates as called must be sent. BHEL may test any goods supplied and their decision is final irrespective of supplier's certificates. If test certificate and guarantee certificate are not received along with the document and stipulated in these specifications, BHEL reserves the right to get the material tested and recover the expenses from the supplier without awaiting supplier's confirmation
12	**Pricing Terms**
A	Prices once quoted shall remain firm within the validity or any extension thereof for placement of order, till complete execution of the order, without any escalation/increase for any reason, whatsoever, unless specifically provided for in the Enquiry & PO. In case of foreign vendors, the quoted price shall be taken as inclusive of Third Party Inspection and testing charges as called for in the NIT.
13	**Price Validity :**
A	Unless stated otherwise in the enquiry, offer shall be valid for a period of 90 days from the date of Techno- commercial (Part-I) bid opening date.
14	**Taxes & Duties - Indigenous Purchase**
	Vendor to ensure timely remittance of SGST, CGST , IGST as applicable in time as per law.
	Vendor to ensure compliance to filing of monthly GST sales return including BHELs supplies by 10th of next calendar month in the online GST portal wherever applicable.
	Vendors to declare filing of timely returns and GST remittance/likely remittance /ITC adjustment alongwith invoice.
	Vendor to submit invoices compliant with GST invoice Rules
	Vendors to comply with all statutory provisions as may be applicable at the time of despatch/sale. Any additional financial liability to BHEL on account of non-compliance by vendors shall be borne by them and shall be adjusted / recovered from the vendors. BHEL reserves the right to review the existing offers / contracts for any revision in terms, which may arise due to change in any statutory provisions to ensure that the benefit accrues to BHEL.
	Vendor to ensure TAX INVOICE submission along with consignment
	In respect of cases where the liability to discharge GST is on BHEL under reverse charge mechanism, vendors have to ensure timely submission of invoices and delivery of material / services to BHEL, so that there is no mismatch on both activities. In case there is any additional financial liability on BHEL on account of default on the part of the vendor on submission or delivery of material / services the same shall be passed on to them.

	In respect of free issue material by BHEL, vendors have to return the processed material within the time line as per the provisions of GST. In case of any additional tax liability on BHEL on account of non-compliance by the vendor, the additional financial implications on BHEL shall be passed on to the vendor
	Vendors to provide the applicable HSN / SAC codes as called for in the enquiry
	As per provisions of section 171 of the CGST Act 2017, bidders to pass on the anti-profiteering benefits accruing to them under GST regime to BHEL
15.	**Taxes & Duties - Foreign Purchase — Imports**
	The offered prices shall be inclusive of all the Taxes and duties as applicable in the country of bidder / country of dispatch for the quoted CFR / CIF price.
16	**Payment Terms-**
A	**Indigenous:** 100% payment in 90 days of receipt (45 days for MSE including NSIC/ Udyog Aadhar registered suppliers as per relevant act in force), subject to acceptance of material at BHEL, on direct presentation of the documents. In case of despatch of material to site directly, site certification for receipt of materials is required unless otherwise provided for in the PO. Any deviation from the above payment terms, if accepted (by BHEL), shall be loaded @ SBI base rate + 6% for the purpose of bid evaluation.
B	**Foreign:** 100% against irrevocable, unconfirmed LC, payable within 90 days of the Bill of Lading (B/L) date or Payment terms of CAD payable on 90th day of B/L / AWB. In case BHEL considers any deviation in payment terms i.e. early payment based on vendor's request, then bids shall be evaluated with loading of State bank of India Base rate plus 6%, for the credit period short of 90 days. The LC shall be established 2 months prior to shipment date, valid for period of 90 days, unless agreed otherwise.
C	Foreign vendors to submit declaration of **Permanent Establishment and Business Connection (PEBC**) for remittances purpose. Declaration to be submitted in formats either in Annexure A or B whichever is applicable as per their transaction entered into with BHEL. In the absence of certificates from the vendor, withholding tax at applicable rates along with surcharge and cess will be recovered at the time of remittance to the vendor.
D	Foreign vendors to submit **Tax Residency Certificate (TRC) & Form 10F** (for obtaining DTAA benefits) as per Annexure C in respect of services. The TRC (tax residency certificate) is to be issued by the authorities of the government of vendor's country. If the informative part of the format (other than residency) is not furnished by the authorities the same may be furnished by the vendor as a declaration.
17	**Inspection of Goods**
A	The Seller shall give adequate notice, of 1 week or as mutually agreed period, in writing to the Purchaser (in case Customer inspection is involved) or BHEL appointed TPIA about the date and place at which the goods will be ready for inspection/ testing, as provided for in the contract.
B	Purchaser or his authorized representative shall be entitled to carry out inspection of material and workmanship/Surveillance Audit at Seller's premises or at his sub-contractor's premises at all reasonable times during execution of contract; Such inspection, examination and testing, if made, shall not absolve the Seller from his obligations under the contract. Wherever required, BHEL may carry out testing at BHEL's testing Lab and in case of any rejection during such testing, replacement / rectification, as required, will have to be done by Supplier. If BHEL carries out any rectification of such rejected material, such cost will be recovered from Supplier's Bills. In case of Customer inspection as Supplier's Works, inspection clearance to be obtained from Customer and submitted to BHEL.
C	BHEL's representative from unit or Corporate Quality (CQ) is authorised to carry out audits along with TPIA at vendor's works before clearing the items for despatch.
D	All costs related to inspections and re-inspections shall be borne by the Seller. In case of inspection by BHEL and / or BHEL's customer, the cost of to & fro passage and Boarding & Lodging shall be borne by the Purchaser / Customer, unless otherwise specifically agreed. In case of foreign vendors, the cost of third party inspection, where called for, shall be deemed to be included in the quoted price. Seller shall be responsible to provide assistance such as labour, materials, electricity, fuels, stores, apparatus, instruments at his cost, as may be required and as may be reasonably demanded to carry out such tests effectively.
E	REJECTION: If any goods are rejected, BHEL shall be at liberty to take action as per following at the risk and cost of supplier: a) Allow the supplier, wherever mutually agreed, to rectify the rejected goods at BHEL's works within reasonable time as fixed by BHEL. Or b) Allow the supplier to make free replacement within a specified period. Rejected goods can be lifted by the

	supplier thereafter. Or c) In case payment has been done, allow supplier to refund equivalent value of rejected material by NEFT / RTGS or furnish Bank Guarantee for same amount before lifting the rejected goods. Fresh replacement shall be regulated as per terms and condition of the original Purchase Order. In case payment has not been done, allow the supplier, wherever mutually agreed, to rectify the rejected goods at supplier's works within reasonable time as fixed by BHEL. Or d) Take alternate procurement action from elsewhere and recover the difference in total cost to BHEL including services , if any, incurred by BHEL in this regard from the supplier. The supplier shall not be entitled to any gain on repurchase. Or e) Terminate the contract either in part or in whole at the discretion of BHEL and recover the loss, if any, from the supplier. Or f) Any goods rejected by BHEL must be removed by the supplier after making payment through NEFT / RTGS within 45 days from the date of intimation of rejection or 30 days after receipt of the intimation of rejection whichever is earlier. If vendor fails to lift or allow despatch of rejected material at his cost within 90 days from the intimation of rejection, his claim on rejected material shall cease.
18	**Guarantee / Warranty and corresponding Repairs / Replacement of Goods**
A	Manufacturer's works test/infection certificates shall be furnished along with the guarantee that material conforms strictly to the specification for general & special conditions as laid down in the purchase order. Goods shall comply with the specifications for material, workmanship and performance. The warranty shall be for a period of 12 months from the date of receipt. If the delivery is found non-compliant during the warranty period, leading to rejection, the Seller shall arrange free replacement / repair of goods, within one month from the date of intimation or any mutually agreed period. The rejected goods shall be taken away by the Seller at his cost and replaced on Delivered Duty Paid (DDP) (FOR - BHEL Stores/ designated destination basis) within such period. In the event of the Seller's failure to comply, Purchaser may take action as appropriate, including Repair / Replenish rejected goods & disposal of rejections, at the risk & cost of the Seller. In case the defects attributable to Seller are detected during processing of the goods at purchaser's / his subcontractor's works, the Seller shall be responsible for free replacement/ repair of the goods as required by the purchaser.
19	**Evaluation and Loading Criteria:**
	Evaluation of the tender shall be on the basis of delivered cost, i.e. 'total cost to BHEL' w.r.t the technical scope and commercial conditions finalized after techno-commercial clarifications (after considering, inter alia, Customs Duty and GST / Other taxes as applicable). Exchange rate (TT selling rate of State Bank of India) applicable on the date of Part-I bid opening shall be considered for evaluation of foreign bids. If the relevant day happens to be a bank holiday in India, then the FOREX rate as on the previous bank working day shall be taken for evaluation. Foreign suppliers shall ensure that the benefits as applicable under Comprehensive Economic Partnership Agreement (CEPA) with Government of India are disclosed in the bid & relevant documents such as Certificate of Country of Origin, issued by the appropriate authority in the country of Export, is provided by the vendor along with dispatch documents. Bids shall be evaluated with such applicable benefits. In the event of Seller failing to provide appropriate documents for Purchaser to avail disclosed concessional duty benefits in India, financial loss, so incurred, will be to the Seller's account.
20	**Variation of orders**
	No variation to the Purchase order is permitted unless authorised in writing and signed by or on behalf of purchase executive, BHEL Bhopal.
21	**Sub-contract**
	BHEL's order or part there off, if further to be subcontracted in exceptional circumstances the details of subcontracting and to whom to be subcontracted shall be furnished to BHEL and written permission shall be obtained from BHEL. However, it shall not absolve the supplier of the responsibility of fulfilling BHEL order requirements.
22	**Recovery / deductions of amount from supplier**
	a Any amount on account of recovery from consignor / supplier under any condition shall be liable to be adjusted against any amount payable to the consignor/supplier against bills. b For any deficiency in supplies where deduction is involved, an amount as decided by BHEL, shall be deducted from supplier's bills.
23	**Safety clause for purchase orders**
	The vendors shall maintain and ensure sufficient safety measures as required for inspections and test like HV test. Pneumatic test, Hydraulic test Spring test, Bend test, Material handling and safe working environment etc. to enable

	Inspection Agency for performing inspection. The vendor shall ensure that all the safety precautions specified in factories Act 1948 chapter-IV Section-21 to 41 are complied with respect to equipment's to be inspected. If any test equipment is found not complying with proper safety requirement, then the inspection agency may withhold inspection, till such time the desired safety requirements are met.
24	**Non-Disclosure Agreement**
	All Drawing and technical documents relating to the product or it's manufacture submitted by one party to the other, prior or subsequent to the formation of contract, shall remain property of the submitting party. Drawing, technical documents or other technical information received by one party, shall not without the consent of the other party, be used for any other purpose than that, for which they were provided. Such technical information shall not without the consent of the submitting party, otherwise be used or copied, reproduced, transmitted or communicated to a third party. Patterns supplied by BHEL will remain BHEL's property which shall be returned by the bidder on demand to BHEL. Bidder shall in no way share or use such intellectual property of BHEL to promote his own business with others. ***BHEL reserves the right to claim damages from the bidder, or take appropriate penal action as deemed fit against the bidder, for any infringement of the provisions contained herein.***
	DRAWINGS, PATTERNS & TOOLS: All drawings, patterns & tools supplied by BHEL or made at BHEL's expense are BHEL's property. These cannot be used or referred to any other party and must only be used in the execution of BHEL's orders. These should be preserved at the supplier's cost for a period of not less than 5 years. Patterns & tools should be returned to BHEL within 90 days of issue of the same.
25	**Settlement of Disputes & Arbitration**
A	All questions/interpretations regarding subject matter of the Contract shall be decided by the Purchaser on the request of the Seller and the decision of the Purchaser shall be final.
B	In case of dispute, steps shall be taken by the parties to the contract to settle the same through negotiations.
C	In case, dispute is not settled in negotiations, it shall be referred to Conciliator appointed by the competent authority of the Purchaser.
D	Except as provided elsewhere in this Contract, in case amicable settlement is not reached between the Parties, in respect of any dispute or difference; arising out of the formation, breach, termination, validity or execution of the Contract; or, the respective rights and liabilities of the Parties; or in relation to interpretation of any provision of the Contract; or, in any manner touching upon the Contract, then, either Party may, by a notice in writing to the other party refer such dispute or difference to the sole arbitration of an arbitrator appointed by Head of the BHEL Unit/Region/Division issuing the Contract. The Arbitrator shall pass a reasoned award and the award of the Arbitrator shall be final and binding upon the Parties. Subject as aforesaid, the provisions of Arbitration and Conciliation Act 1996 (India) or Statutory modifications or re-enactments thereof and the rules made thereunder and for the time being in force shall apply to the arbitration proceedings under this clause. The seat of arbitration shall be Bhopal. The cost of arbitration shall be borne as per award of the Arbitrator. Subject to the arbitration in terms of Clause above, the Courts at Bhopal shall have exclusive jurisdiction over any matter arising out of or in connection with this Contract. Notwithstanding the existence or any dispute or differences and /or reference for the arbitration, the Contractor shall proceed with and continue without hindrance the performance of its obligations under this Contract with due diligence and expedition in a professional manner except where the Contract has been terminated by either Party in terms of this Contract. **In case of Contract with Public Sector Enterprise (PSE) or Government Department, the following shall be applicable :** In the event of any dispute or difference relating to the interpretation and application of the provisions of the Contract, such dispute or difference shall be referred by either Party for arbitration to the sole arbitrator in the Department of Public Enterprises to be nominated by the Secretary to the Government of India in-charge of the Department of Public Enterprises. The Arbitration and Conciliation Act, 1996 shall not be applicable to arbitration under this clause. The award of the arbitrator shall be binding upon the Parties to the dispute, provided, however, any Party aggrieved by such award may make further reference for setting aside or revision of the award to the Law Secretary, Department of Legal Affairs, Ministry of Law and Justice, Government of India. Upon such reference the dispute shall be decided by the Law Secretary or the Special Secretary or Additional Secretary when so authorized by Law Secretary, whose decision shall bind the Parties hereto finally and conclusively. The Parties to the dispute will share equally the cost of arbitration as intimated by the Arbitrator.
E	The Seller shall continue to perform the contract, pending settlement of dispute(s).
26	**Applicable Laws and Jurisdiction of Courts**
	Indian laws both substantive and procedural, for the time being in force, including modifications thereto, shall govern the Contract including Arbitration proceedings. The competent Courts at Bhopal in the State of Madhya Pradesh, India

	shall have sole jurisdiction.
27	**RIGHT OF REJECTION /NON- PLACEMENT OF PO:** BHEL reserves the right to accept the offers in part or in full, or cancel the Tender enquiry without assigning any reason.
28	**Performance Bank Guarantee (PBG)/ Security Deposit (SD):**
A	Wherever PBG (covering equipment / system / work performance guarantee) **is** called for in the Notice Inviting Tender (NIT) deviation shall not be accepted.
B	Bank Guarantee wherever called for, shall be in the BHEL prescribed format. In case the order is to be placed in foreign currency, the BG must also be in Foreign currency, so specified by the Purchaser.
C	Wherever Security Deposit (covering contract performance) is called for in the NIT, deviation shall not be accepted.
D	Composite 'Contract Performance Bank Guarantee' of matching value/ validity, where both Security Deposit and Performance Bank Guarantee are required, shall not be construed as deviation.
E	Wherever the contract is for supply of Goods processed on labour basis from BHEL supplied materials, the materials shall be issued against a suitable Bank guarantee as specified in the Enquiry.
29	**Benefits earmarked for Purchase from Micro & Small Enterprises (MSEs) — Indigenous Purchase**
A	Tender documents shall be issued free of cost & no EMD wherever called for will be insisted upon. MSE bidders shall submit along with bid relevant documents w.r.t. their respective MSE status as per extant norms. Date to be reckoned for determining the deemed validity will be the last date of Technical bid submission. Non- submission of such document will lead to consideration of their bid, at par with other bidders and MSE status of such bidders shall be shifted to Non- MSE supplier till the supplier submit these documents.
B	In tender, participating MSEs quoting price within price band of L1+15% shall also be allowed to supply a portion of requirement by bringing down their price to L1 price in a situation where L1 price is from someone other than a MSE and such MSE shall be allowed to supply up to 20% of total tendered value. In case of more than one such MSE, the supply shall be shared proportionately. A quantum of 4% out of 20% quantity, so earmarked, will be reserved for MSE's owned by SC / ST entrepreneurs who submit their bid with relevant documents provided that in event of failure of such MSE(s) to participate in tender process or meet tender requirements and L1 price, 4% sub-target for procurement earmarked for MSE(s) owned by SC or ST entrepreneurs shall be met from other MSE(s). In case of indivisible tender the full quantity shall be awarded to L1.
C	If an enterprise falling under MSE category as defined in the MSMED Act 2006, graduates to a higher category from it's original category or beyond the purview of the Act, it shall continue to avail all non-tax benefits of it's original category notified by the Ministry of Micro, Small and Medium Enterprise for a period of three years from the date of such graduation to the higher category.
D	MSE suppliers can avail the intended benefits only if they submit along with the offer, attested copies of either EM II certificate having deemed validity (five years from the date of issue of acknowledgement in EM II) or valid NSIC certificate or EM II certificate along with attested copy of a CA certificate (As per BHEL Format, where deemed validity of EM II certificate of five years has expired) applicable for the relevant financial year (latest audited). Date to be reckoned for determining the deemed validity will be the date of bid opening (Part 1 in case of two part bid). Non submission of such documents will lead to consideration of their bid at par with other bidders. No benefits shall be applicable for this enquiry if any deficiency in the above required documents are not submitted before price bid opening. If the tender is to be submitted through e-procurement portal, then the above required documents are to be uploaded on the portal. Documents should be notarized or attested by a Gazetted officer
30	**Integrity Pact (IP) — Independent external monitors (IEM)** For tenders in which integrity pact is applicable, following points stand valid :
A	IP is a tool to ensure that activities and transactions between the company and its bidders/contractors are handled in a fair, transparent and corruption free manner. A panel of Independent External Monitors (IEMs) have been appointed to oversee implementation of IP in BHEL. The IP as enclosed with the tender is to be submitted (duly signed by authorized signatory who signs in the offer) along with techno commercial bid. Only those bidders who have entered into such an IP with BHEL would be competent to participate in the bidding. In other words, entering into this pact would be a preliminary qualification. Name : ---------- Address : ---------- } As indicated in NIT / enquiry E-mail : ----------

B	Please refer section 8 of the IP for roles and responsibilities of IEMs. In case of any complaint arising out of tendering process, the matter may be referred to the IEM mentioned in the tender. **NOTE :** No routine correspondence shall be addressed to the IEM (phone / post/e-mail) regarding the clarifications, time extensions or any other administrative queries, etc. on the tender issued. All such clarifications/ issues shall be addressed directly to the tender issuing (procurement) department. **For all clarifications/ issues related to the tender, Please contact:**

	(1)	(2)
Name		
Landline No.		
Mobile No.		
Email		
Deptt		
Address		
Fax		

31	**Fraud Prevention Policy** : The Bidder along with its associate/ collaborators/ sub-contractors/ sub-vendors/ consultants/ service providers shall strictly adhere to BHEL Fraud Prevention Policy displayed on BHEL website www.bhel.com and shall immediately bring to the notice of BHEL Management about any fraud or suspected fraud as soon as it comes to their notice.
32	**Integrity Commitment:** The offers of the bidders who are under suspension as also the offers of the bidders, who engage the services of the banned firms, shall be rejected. The list of banned firms is available on BHEL website www.bhel.com. Integrity commitment, performance of the contract and punitive action thereof :
A	**Commitment by BHEL :** BHEL commits to take all measures necessary to prevent corruption in connection with the tender process and execution of the contract. BHEL will during the tender process treat all bidder(s) in a transparent and fair manner, and with equity.
B	**Commitment by bidder / Supplier / Contractor :** - The bidder / supplier / contractor commit to take all measures to prevent corruption and will not directly or indirectly influence any decision or benefit which he is not legally entitled to nor will act or omit in any manner which tantamount to an offence punishable under any provision of the Indian Penal code, 1860 or any other law in force in India. - The bidder / supplier / contractor will, when presenting his bid, disclose any and all payments he has made, and is committed to or intends to make to agents, brokers or any other intermediaries in connection with the award of the contract and shall adhere to relevant guidelines issued from time to time by govt. of India / BHEL - The bidder / supplier / contractor will perform / execute the contract as per the contract terms & conditions and will not default without any reasonable cause, which causes loss of business / money / reputation to BHEL.
C	If any bidder / supplier / contractor during pre-tendering / tendering / post tendering / award / execution / post-execution stage indulges in mal-practices, cheating, bribery, fraud or / and other misconduct or formation of cartel so as to influence the bidding process or influence the price or acts or omits in any manner which tantamount to an offence punishable under any provision of the Indian Penal Code, 1860 or any other law in force in India, then action may be taken against such bidder / supplier / contractor as per the extant guidelines of the company available on www.bhel.com and / or under applicable legal provisions.

Annexure-1

INTEGRITY PACT

Between

Bharat Heavy Electricals Ltd. (BHEL), a company registered under the Companies Act 1956 and having its registered office at "BHEL House", Siri Fort, New Delhi - 110049 (India) hereinafter referred to as "The Principal", which expression unless repugnant to the context or meaning hereof shall include its successors or assigns of the ONE PART

and

_____, (description of the party along with address), hereinafter referred to as "The Bidder/ Contractor" which expression unless repugnant to the context or meaning hereof shall include its successors or assigns of the OTHER PART

Preamble

The Principal intends to award, under laid-down organizational procedures, contract/s for PILOT OPERATED MAIN STEAM SAFETY VALVE (hereinafter referred to as "Contract"). The Principal values full compliance with all relevant laws of the land, rules and regulations, and the principles of economic use of resources, and of fairness and transparency in its relations with its Bidder(s)/ Contractor(s).

In order to achieve these goals, the Principal will appoint panel of Independent External Monitor(s) (IEMs), who will monitor the tender process and the execution of the contract for compliance with the principles mentioned above.

Section 1- Commitments of the Principal

1.1 The Principal commits itself to take all measures necessary to prevent corruption and to observe the following principles: -

1.1.1 No employee of the Principal, personally or through family members, will in connection with the tender for, or the execution of a contract, demand, take a promise for or accept, for self or third person, any material or immaterial benefit which the person is not legally entitled to.

1.1.2 The Principal will, during the tender process treat all Bidder(s) with equity and reason. The Principal will in particular, before and during the tender process, provide to all Bidder(s) the same information and will not provide to any Bidder(s) confidential/ additional information through which the Bidder(s) could obtain an advantage in relation to the tender process or the contract execution.

1.1.3 The Principal will exclude from the process all known prejudiced persons.

1.2 If the Principal obtains information on the conduct of any of its employees which is a penal offence under the Indian Penal Code 1860 and Prevention of Corruption Act 1988 or any other statutory penal enactment, or if there be a substantive suspicion in this regard, the Principal will inform its Vigilance Office and in addition can initiate disciplinary actions.

Section 2 - Commitments of the Bidder(s)/ Contractor(s)

2.1 The Bidder(s)/ Contractor(s) commit himself to take all measures necessary to prevent corruption. The Bidder(s)/ Contractor(s) commits himself to observe the following principles during participation in the tender process and during the contract execution.

2.1.1 The Bidder(s)/ Contractor(s) will not, directly or through any other person or firm, offer, promise or give to the Principal or to any of the Principal's employees involved in the tender process or the execution of the contract or to any third person any material, immaterial or any other benefit which he/ she is not legally entitled to, in order to obtain in exchange any advantage of any kind whatsoever during the tender process or during the execution of the contract.

2.1.2 The Bidder(s)/ Contractor(s) will not enter with other Bidder(s) into any illegal or undisclosed agreement or understanding, whether formal or informal. This applies in particular to prices, specifications, certifications, subsidiary contracts, submission or non-submission of bids or any other actions to restrict competitiveness or to introduce cartelization in the bidding process.

2.1.3 The Bidder(s)/ Contractor(s) will not commit any penal offence under the relevant Indian Penal Code (IPC) and Prevention of Corruption Act; further the Bidder(s)/ Contractor(s) will not use improperly, for purposes of competition or personal gain, or pass on to others, any information or document provided by the Principal as part of the business relationship, regarding plans, technical proposals and business details, including information contained or transmitted electronically.

2.1.4 Foreign Bidder(s)/ Contractor(s) shall disclose the name and address of agents and representatives in India and Indian Bidder(s)/ Contractor(s) to disclose their foreign principals or associates. The Bidder(s)/ Contractor(s) will, when presenting his bid, disclose any and all payments he has made, and is committed to or intends to make to agents, brokers or any other intermediaries in connection with the award of the contract.

2.2 The Bidder(s)/ Contractor(s) will not instigate third persons to commit offences outlined above or be an accessory to such offences.

2.3 The Bidder(s)/ Contractor(s) shall not approach the Courts while representing the matters to IEMs and shall await their decision in the matter.

Section 3 - Disqualification from tender process and exclusion from future contracts

If the Bidder(s)/ Contractor(s), before award or during execution has committed a transgression through a violation of Section 2 above, or acts in any other manner such as to put his reliability or credibility in question, the Principal is entitled to disqualify the Bidder(s)/ Contractor(s) from the tender process , terminate the contract, if already awarded, exclude from future business dealings and/ or take action as per the separate "Guidelines on Banning of Business dealings with Suppliers/ Contractors", framed by the Principal.

Section 4 - Compensation for Damages

4.1 If the Principal has disqualified the Bidder (s) from the tender process before award / order acceptance according to Section 3, the Principal is entitled to demand and recover the damages equivalent to Earnest Money Deposit/ Bid Security.

4.2 If the Principal is entitled to terminate the Contract according to Section 3, or terminates the Contract in application of Section 3 above , the Bidder(s)/ Cotractor (s) transgression through a violation of Section 2 above shall be construed breach of contract and the Principal shall be-entitled to demand and recover from the Contractor an amount equal to 5% of the contract value or the amount equivalent to Security Deposit/ Performance Bank Guarantee , whichever is higher, as damages, in addition to and without prejudice to its right to demand and recover compensation for any other loss or damages specified elsewhere in the contract.

Section 5 - Previous Transgression

5.1 The Bidder declares that no previous transgressions occurred in the last 3 (three) years with any other company in any country conforming to the anti-corruption approach or with any other Public Sector Enterprise in India that could justify his exclusion from the tender process.

5.2 If the Bidder makes incorrect statement on this subject, he can be disqualified from the tender process or the contract, if already awarded, can be terminated for such reason or action can be taken as per the separate "Guidelines on Banning of Business dealings with Suppliers/ Contractors", framed by the Principal.

Section 6 - Equal treatment of all Bidder (s)/ Contractor (s) / Sub-contractor (s)

6.1 The Principal will enter into Integrity Pacts with identical conditions as this Integrity Pact with all Bidders and Contractors.

6.2 In case of Sub-contracting, the Principal Contractor shall take the responsibility of the adoption of Integrity Pact by the Sub-contractor(s) and ensure that all Sub-contractors also sign the Integrity Pact.

6.3 The Principal will disqualify from the tender process all Bidders who do not sign this Integrity Pact or violate its provisions.

Section 7 - Criminal Charges against violating Bidders/ Contractors /Subcontractors

If the Principal obtains knowledge of conduct of a Bidder, Contractor or Subcontractor, or of an employee or a representative or an associate of a Bidder, Contractor or Subcontractor which constitutes corruption, or if the Principal has substantive suspicion in this regard, the Principal will inform the Vigilance Office.

Section 8 -Independent External Monitor(s)

8.1 The Principal appoints competent and credible panel of Independent External Monitor (s) (IEMs) for this Integrity Pact. The task of the IEMs is to review independently and objectively, whether and to what extent the parties comply with the obligations under this Integrity Pact.

8.2 The IEMs are not subject to instructions by the representatives of the parties and performs his functions neutrally and independently. He reports to the CMD, BHEL.

8.3 The IEMs shall be provided access to all documents/ records pertaining to the Contract, for which a complaint or issue is raised before them as and when warranted. However, the documents/records/information having National Security implications and those documents which have been classified as Secret/Top Secret are not to be disclosed.

8.4 The Principal will provide to the IEMs sufficient information about all meetings among the parties related to the Contract provided such meetings could have an impact on the contractual relations between the Principal and the Contractor. The parties offer to the IEMs the option to participate in such meetings.

8.5 The advisory role of IEMs is envisaged as that of a friend, philosopher and guide. The advice of IEMs would not be legally binding and it is restricted to resolving issues raised by a Bidder regarding any aspect of the tender which allegedly restricts competition or bias towards some Bidders. At the same time, it must be understood that IEMs are not consultants to the Management. Their role is independent in nature and the advice once tendered would not be subject to review at the request of the organization.

8.6 For ensuring the desired transparency and objectivity in dealing with the complaints arising out of any tendering process or during execution of Contract, the matter should be examined by the full panel of IEMs jointly, who would look into the records, conduct an investigation, and submit their joint recommendations to the Management.

8.7 The IEMs would examine all complaints received by them and give their recommendations/ views to the CMD, BHEL at the earliest. They may also send their report directly to the CVO, in case of suspicion of serious irregularities requiring legal/ administrative action. Only in case of very serious issue having a specific, verifiable Vigilance angle, the matter should be reported directly to the Commission. IEMs will tender their advice on the complaints within 30 days.

8.8 The CMD, BHEL shall decide the compensation to be paid to the IEMs and its terms and conditions.

8.9 IEMs should examine the process integrity, they are not expected to concern themselves with fixing of responsibility of officers. Complaints alleging mala fide on the part of any officer of the Prinicpal should be looked into by the CVO of the Principal.

8.10 If the IEMs have reported to the CMD, BHEL, a substantiated suspicion of an offence under relevant Indian Penal Code / Prevention of Corruption Act, and the CMD, BHEL has not, within reasonable time, taken visible action to proceed against such offence or reported it to the Vigilance Office, the IEMs may also transmit this information directly to the Central Vigilance Commissioner, Government of India.

8.11 After award of work, the IEMs shall look into any issue relating to execution of Contract, if specifically raised before them. As an illustrative example, if a Contractor who has been awarded the Contract, during the execution of Contract, raises issue of delayed payment etc. before the IEMs, the same shall be examined by the panel of IEMs. Issues like warranty/ guarantee etc. shall be outside the purview of IEMs.

8.12 However, the IEMs may suggest systemic improvements to the management of the Principal, if considered necessary, to bring about transparency, equity and fairness in the system of procurement.

8.13 The word `Monitor' would include both singular and plural.

Section 9 - Pact Duration

9.1 This Integrity Pact shall be operative from the date this Integrity Pact is signed by both the parties till the final completion of contract for successful Bidder, and for all other Bidders 6 months after the Contract has been awarded. Any violation of the same would entail disqualification of the bidders and exclusion from future business dealings.

9.2 If any claim is made/ lodged during currency of this Integrity Pact, the same shall be binding and continue to be valid despite the lapse of this Pact as specified above, unless it is discharged/ determined by the CMD, BHEL.

Section 10 - Other Provisions

10.1 This Integrity Pact is subject to Indian Laws and exclusive jurisdiction shall be of the competent Courts as indicated in the Tender or Contract, as the case may be.

10.2 Changes and supplements as well as termination notices need to be made in writing.

10.3 If the Bidder(s)/ Contractor(s) is a partnership or a consortium or a joint venture, this Integrity Pact shall be signed by all partners of the partnership or joint venture or all consortium members.

10.4 Should one or several provisions of this Integrity Pact turn out to be invalid, the remainder of this Integrity Pact remains valid. In this case, the parties will strive to come to an agreement to their original intentions.

10.5 Only those bidders / contractors who have entered into this Integrity Pact with the Principal would be competent to participate in the bidding. In other words, entering into this Integrity Pact would be a preliminary qualification.

10.6 In the event of any dispute between the Principal and Bidder(s)/ Contractor(s) relating to the Contract, in case, both the parties are agreeable, they may try to settle dispute through Mediation before the panel of IEMs in a time bound manner. In case, the dispute remains unresolved even after mediation by the panel of IEMs, either party may take further action as the terms & conditions of the Contract. The fees/expenses on dispute resolution through mediation shall be shared by both the parties. Further, the mediation proceedings shall be confidential in nature and the parties shall keep confidential all matters relating to the mediation proceedings including any settlement agreement arrived at between the parties as outcome of mediation. Any views expressed, suggestions, admissions or proposals etc. made by either party in the course of mediation shall not be relied upon or introduced as evidence in any further arbitral or judicial proceedings, whether or not such proceedings relate to the dispute that is the subject of mediation proceedings. Neither of the parties shall present IEMs as witness in any Alternative Dispute Resolution or judicial proceedings in respect of the dispute that was subject of mediation.

23/01/2025

For & On behalf of the Principal
(Office Seal)

For & On behalf of the Bidder/ Contractor
(Office Seal)

Place Bhopal
Date 23/01/2025

Witness:
(Name & Address)
अरुण कुमार हरिप्रिया / Arun Kumar Haripriya
अपर महाप्रबंधक / Addl. General Manager
एम. टी. एक्स विभाग / MM-Thermal
बी.एच.ई.एल., भोपाल / B.H.E.L., BHOPAL

Witness:
(Name & Address)

Clause on IP in the tender

Integrity Pact (IP)

(a) IP is a tool to ensure that activities and transactions between the Company and its Bidders/ Contractors are handled in a fair, transparent and corruption free manner. Following Independent External Monitors (IEMs) on the present panel have been appointed by BHEL with the approval of CVC to oversee implementation of IP in BHEL.

SI	IEM	Email
1.	Shri Otem Dai, IAS (Retd.)	iem1@bhel.in
2.	Shri Bishwamitra Pandey, IRAS (Retd.)	iem2@bhel.in
3.	Shri Mukesh Mittal, IRS (Retd.)	iem3@bhel.in

(b) The IP as enclosed with the tender is to be submitted (duly signed by authorized signatory) along with techno-commercial bid (Part-I, in case of two/ three part bid). Only those bidders who have entered into such an IP with BHEL would be competent to participate in the bidding. In other words, entering into this Pact would be a preliminary qualification.

(c) Please refer Section-8 of IP for Role and Responsibilities of IEMs. In case of any complaint arising out of the tendering process, the matter may be referred to any of the above IEM(s). All correspondence with the IEMs shall be done through email only.

Note:

No routine correspondence shall be addressed to the IEM (phone/ post/ email) regarding the clarifications, time extensions or any other administrative queries, etc on the tender issued. All such clarification/ issues shall be addressed directly to the tender issuing (procurement) department's officials whose contact details are provided below:

Details of contact person(s):

(1)
Name: Rashmi Pratima Kujur
Deptt: MTX
Address: BHEL - Bhopal
Phone: (Landline/ Mobile)
0755-250-2401
Email: rashmiminz@bhel.in
Fax: _____

(2)
Name: Ajay Kumar
Deptt: MTX
Address: BHEL - MTX
Phone: (Landline/ Mobile)
0755-250-3207
Email: ajay-singh@bhel.in
Fax: _____