

VOLUME-IA PART- II CHAPTER-2

TECHNICAL SPECIFICATION & SCOPE OF WORK DETAILED

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Note: Bidder to refer BOQ for relevant scope of work of this tender

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2.2.1 ERECTION, ALIGNMENT AND WELDING OF REACTOR AND ITS SUPPORT ASSEMBLY

SI No	Description
1	Purpose
2	Scope
3	Reactor assembly (JAA) general introduction
4	Erection of reactor assembly
4.1	Support ring assembly
4.2	Reactor pressure vessel (RPV) erection
4.3	Thrust ring assembly
4.4	Erection of separating bellow
5	Reports and Records

1. Purpose:

The purpose of this procedure is to provide guidance to contractor to understand the scope & quantum of work and technical requirements to be followed during erection, alignment, welding and inspection of reactor and its supporting assembly.

2. Scope:

The scope of the contractor's work comprises but not limited to the following.

- Study of drawings, preparation of network schedules.
- Preparation and approval of QAP, erection, welding and inspection procedures, Preparation of erection schemes.
- Receipt of material from NPCIL store, transportation, storage.
- De-preservation & dimensional survey of equipment's.
- Handling, assembly, erection, alignment, welding and inspection.

3. Reactor assembly (JAA):

General introduction:

Reactor assembly consists of following.

- Support ring.
- Reactor pressure vessel (RPV)
- Thrust ring.
- Separating bellow.

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S No	Description of item	Weight in MT	Size in mm.
1	Support ring	21.0	Φ5350 * 250 thickness
2	Reactor pressure vessel (RPV)	317.0	Φ4570 * 11185 height
3	Thrust ring.	25.0	Φ5170 * 600 thickness
4	Separating bellow	2.1	Φ5700 * 300 thickness

Support ring (JAA00BQ801) acts as the seat for Reactor Pressure Vessel and limits the vessel movement in any direction and located at +17.100 mtr elevation of reactor core cavity. The support ring consists of a precision machined ring and parts that fasten it to support truss and RPV.

The support ring is step shaped with radial grooves for installing 30 keys for retaining the reactor vessel against turning on its axis and 30 locks retaining the ring against turning on its axis fixing it on the support truss. 30 strips, connected with the ring by 90 studs M56, retain the reactor vessel against vertical travel. Elevation of support ring is adjusted by use of pair wedges which helps in aligning/leveling the reactor Pressure Vessel.

Reactor pressure vessel (RPV) is made of high purity & low alloy steel of high strength cylindrical forging of thickness about 200 mm welded together. Inside of the Vessel is clad with Austenitic stainless steel of 7 mm to 15 mm thickness. Overall length of reactor assembly (RPV with upper unit) is 19m & dia of 4.5m. RPV is rigidly mounted on vessel supporting ring located in the reactor pit at an elevation of +17.350m. Further RPV has sliding support with a thrust truss at elevation of +22.35m. Main circulating pipelines DN 850 are welded to RPV nozzles at 8 locations. Further four nozzles are provided for connecting ECCS (Emergency Core Cooling System) piping of DN300 and one nozzle for housing various I&C equipments. Flange portion of pressure vessel is provided with double grooves for metallic circular gaskets and 54 studs of 170mm diameter are provided for connecting reactor cover.

Thrust ring (JAA00BQ802) is intended for fixing the reactor vessel relative to concrete cavity in the reactor vessel upper part and retention it against turning over and located at + 22 mtr elevation of reactor core cavity.

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The thrust ring consists of a ring itself and wedges, spacing it relative to the reactor vessel and thrust truss. The thrust ring is intended for preventing the reactor vessel from turning over.

Separating bellow: Separating bellow hermetically separates the upper and lower parts of reactor concrete pit during refueling when water is filled above the reactor. Bellows is a welded structure comprising of the bellows and two reducing rings. Upper ring of separating bellows is welded to the thrust truss, where as lower ring is welded to the reactor vessel. Provision of bellows allows thermal expansion of reactor vessel with hermetic separation of upper and lower cavity. For transportation and mounting of the separating bellows staggering ribs are provided which shall be cut off after mounting.

Ref. drawings:

1. R56.KK.1UJA.JAA.TM.MC.WD434 - Support ring. Mounting drawing.
2. R02.KK.3UJA.JAA.RP.MC.WD030 - Reactor Mounting Drawing.
3. R56.KK.3UJA.JAA.TM.MC.WD435- Thrust ring. Mounting drawing.
4. R02.KK.3UJA.JAA.RP.MC.WD020 - Thrust truss. Mounting Drawing.
5. R02.KK.3UJA.JAA.RP.MC.WD013 - Separating bellows. Mounting Drawing.

4. Erection of Reactor assembly:

A brief detail of work for main components is provided below for understanding the scope of work. However contractor has to execute the work by fulfilling all the requirements of working drawings\manufacturer's instructions for satisfactory completion of said work.

4.1 Support ring assembly:

Supporting ring assembly consists of support ring (1 nos), locks (30 nos), strips (30 nos), keys (30 nos), wedges (90 nos), studs (90 nos), inserts (60 nos), nuts (90 nos), washers (90 nos), screws (90 nos) etc.,

- a) Obtain as built details of embedded support truss.
- b) Marking of Reactor cavity axis over support truss, marking of locations of individual support beam assembly.

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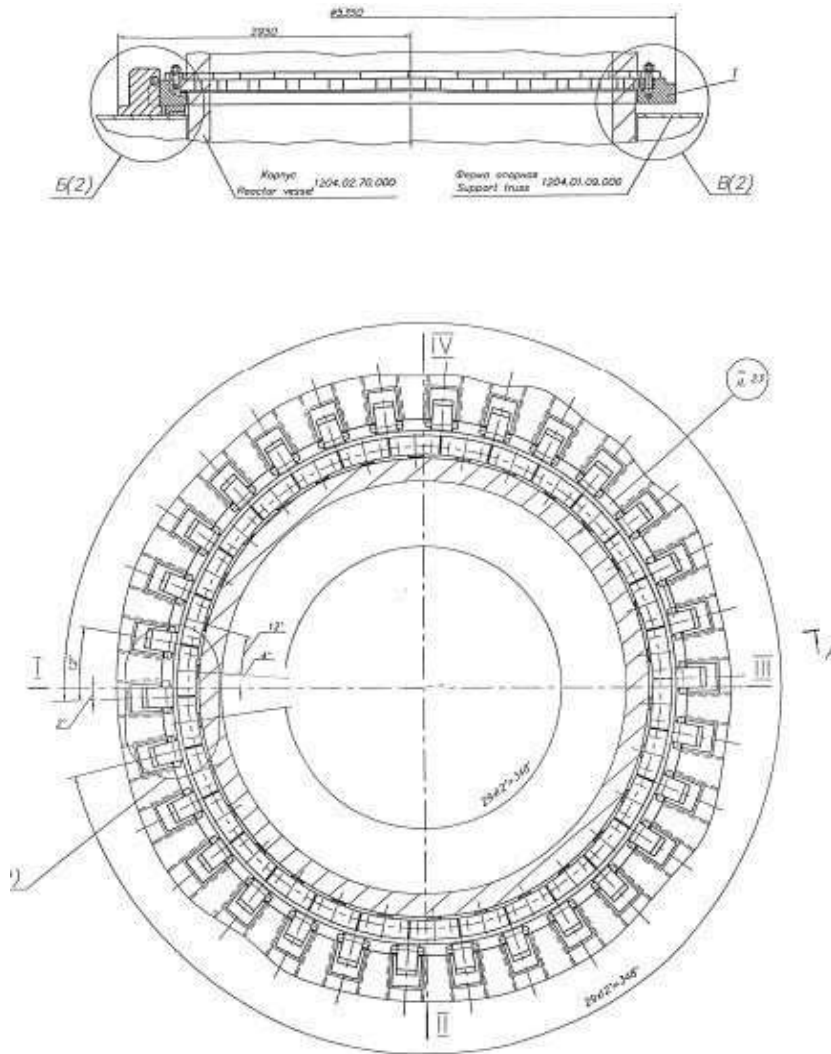
- c) De-preservation of support ring components, dimensional survey, with optical instruments for all the components/ relevant embedded parts.
- d) Providing precision optical alignment tools like Optical level with LC 0.01mm, theodolite, jig-transit, total station etc.,.
- e) Ensure clean room conditions of reactor support ring area as per Russian document Д44.
- f) Clean room enclosure shall be made at core cavity area with aluminum frames, PVC panel sheets, vinyl flooring sheets etc. the required clean room conditions shall be maintained inside the enclosure by continuous moping of the floors, providing air conditioning units, air curtain, vacuum cleaners. (Payment for providing air conditioners, air curtain, enclosures will be measured in respective BOQ item.)
- g) Shifting of support ring and its accessories to inside reactor building with the help of Heavy duty crawler crane/contractors tower crane.
- h) Heavy duty crane/Polar crane will be provided by NPCIL as free of cost for erection of support ring only. Contractor has to arrange the sling and de-shackle and other tools & tackles.
- i) Optical level readings shall be taken of support truss beam top surface at 30 locations all around the support truss.
- j) Analyze the surface level and flatness of seating area of support ring wedges, lock and perform rough grinding operation and recheck the readings for all the 30 locations.
- k) Contractor may consider developing in-situ surface grinding machine with required jigs and fixtures to perform large surface grinding work involved instead of manual grinding to reduce the time.
- l) Perform grinding operation, check the flatness of seating area (of supporting ring wedges, lock area) with the help of master level and repeat the grinding operation till flatness of 0.02 mm is achieved over entire seating area for all the wedges, locks.
- m) Perform blue matching of seating area of both wedges, lock area and ensure minimum even contact area as specified in the WD is established between wedge (lock) and support truss beam.
- n) Perform blue matching of seating area between the wedges and ensure minimum even contact area as specified in the WD is established between wedges.

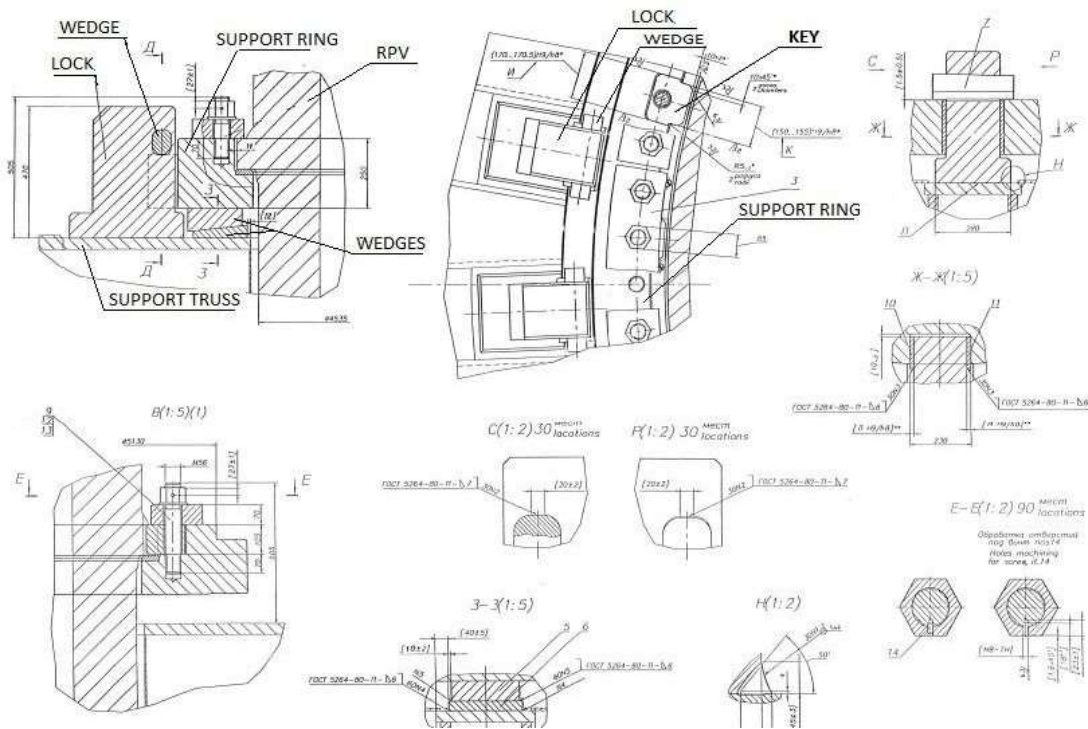
TECHNICAL CONDITIONS OF CONTRACT (TCC)

- o) Ensure maximum 0.1mm local clearance between wedges (top and bottom), as well as between bottom wedge and support truss beam top.
- p) The above steps to be repeated for all the 30 locations.
- q) Providing temporary supports, jigs and fixtures for supporting, alignment & adjustment of elevation of support ring. Ensure axis mismatch of Support ring with reactor cavity pit is within 1mm.
- r) Perform blue matching of seating area between the top wedge and support ring bottom area and ensure contact area specified in WD is established between wedges (30 nos) and support ring bottom.
- s) Alignment of wedges in order to achieve the designed elevation of support ring. The monitoring and control of support ring elevation is carried out by dial indicator set up fixed at 8 locations all around support ring.
Calculate/measure the wedge dimensions to meet the drawing requirements (approximate overlap area around min 75% between the wedges).
- t) Machine the contact surfaces of bottom & top wedges by milling & grinding operation.
- u) Assemble the wedges again, align support ring, blue match the wedge surfaces & ensure area of contact as per drawing.
- v) After final alignment of the wedges lock the bottom wedges with the support truss beam by means of tack welding (TIG).
- w) Inspect the top elevation of support ring (RPV seating area) after welding of bottom wedges with the help of dial indicator set up and optical reading and ensure the horizontality of top surface is within 0.1 mm.
- x) After ensuring the horizontality of top surface, weld the bottom wedges with the support truss beam (TIG process) to required fillet thickness at all 30 locations as per drawing.
- y) Perform blue matching of seating area between the lock and support truss beam top area and ensure minimum even contact is established between locks (30 no's) and support truss beam top area as specified in the drawing.
- z) Approximate blue matching area 34 sq.mtr at various locations of support ring for both units KK 3&4.

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Support Ring Assembly Schematic view:





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- gg) Erection and alignment of 60 no's of Inserts between lock and support ring on either side, and ensure summarized clearance between insert and lock/support ring as per drawing (appx. 0.07 mm). After ensuring clearance weld the insert with lock as per drawing requirement.
- hh) After completion of all the alignment requirements lock the nuts with studs by drilling & threading a hole through nut and stud and by inserting screws M8-6g*16 of 90 nos.
- ii) Various design clearances applicable at various locations of support ring needs to be ensured as per drawing requirements.
- jj) Re-preservation of weld joints and other areas, where found necessary, with OC-51 paint and varnish.
- kk) Preparation of reports and acceptance

4.2 Reactor Pressure vessel (RPV) Erection:

Reactor pressure vessel is a cylindrical Pressure vessel with dia 5mtr and length 11.5 mtrs.

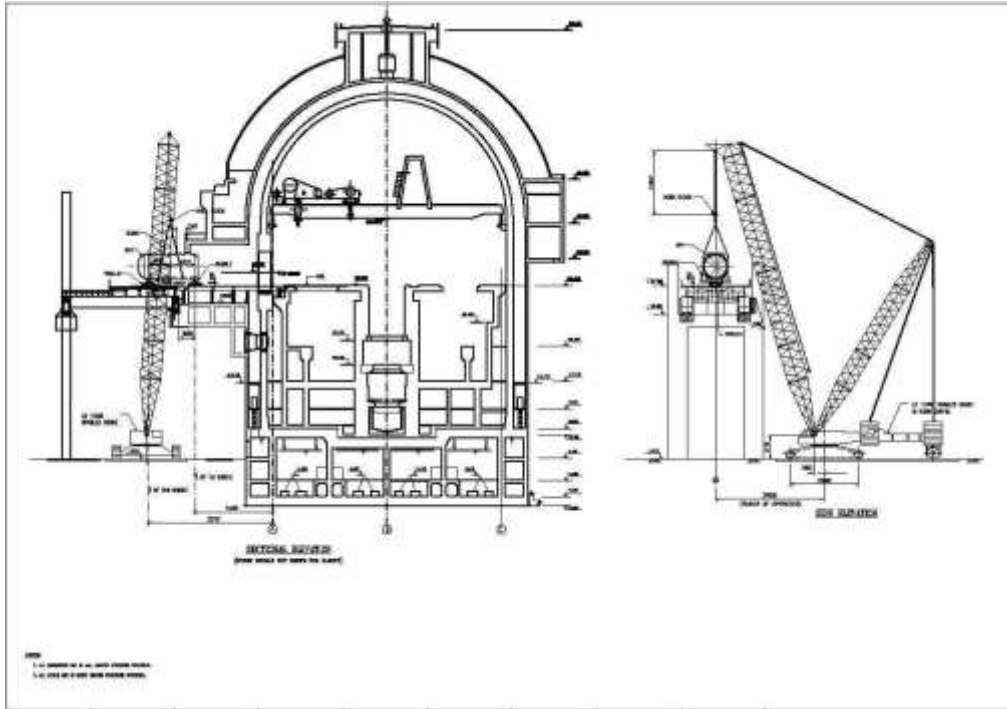
- a) Preparation of schemes for Reactor pressure vessel erection with detailed drawings considering the layout of the reactor building, transport portal, configuration of heavy duty crawler crane.
- b) Carryout ultrasonic examination of Reactor pressure vessel weld joint performed at factory five (5) joints (N1-N5) at CMM warehouse / crane pad outside reactor building before erection. This includes removal of paint at weld joint area by paint remover, cleaning with acetone, performing UT, temporary preservation with mineral oil, re- preservation with OC-51 paint after completion of UT.
- c) Receipt of Reactor pressure vessel from NPCIL (near reactor building), and preparation of IMIR.
- d) De-preservation of RPV, dimensional survey (including optical) for all the components.
- e) Heavy duty crane will be provided by NPCIL as free of cost for erection of RPV only. Contractor has to arrange the sling and de- shackle and other tools & tackles. All lifting tools and tackles should be load tested before lifting RPV.

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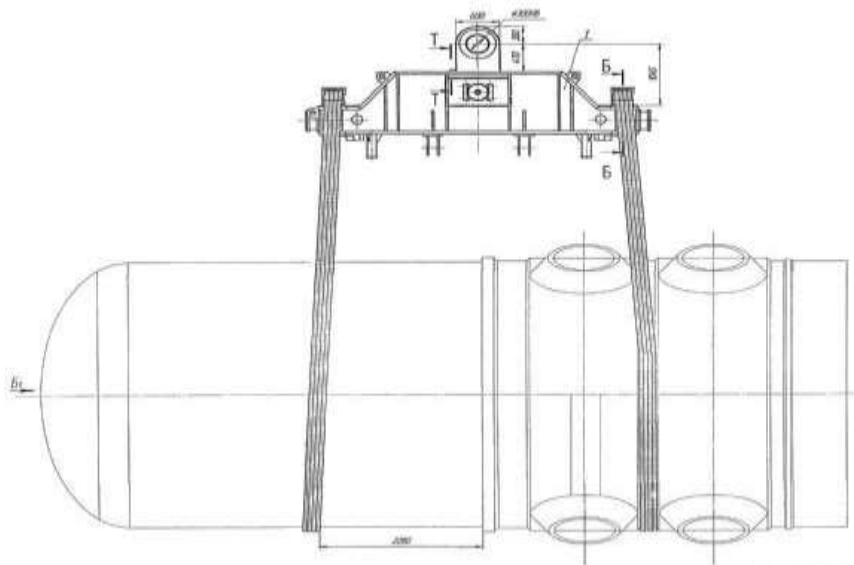
- f) Reactor pressure vessel lifting traverse needs to be assembled and commissioned and load tested before lifting RPV.
- g) RPV initial lifting from outside RB on to transport portal trolley shall be carried out by heavy duty crawler crane and further shifting to inside RB with the help of erection trolley and winch mechanism.
- h) RPV lifting traverse along with attachments shall be mounted on RPV and trail lifting shall be carried out.
- i) Placing RPV seating cradle, rest etc inside Reactor cavity, inspection well area.
- j) Lift Reactor pressure vessel horizontally with the help of polar crane, mounting traverse assembly and place on the RPV seating cradle & rest inside cavity.
- k) Remove the mounting traverse from RPV, change the configuration of mounting traverse for tilting the RPV from horizontal to vertical position. Also install Sleeves supplied by manufacturer over RPV flange threaded recess for fixing of mounting traverse.
- l) RPV mounting traverse shall be mounted on RPV flange surface and lifted with the help of polar crane, thereby making it vertical over cradle.
- m) Reactor pressure vessel shall be lifted vertically with the help of polar crane, mounting traverse assembly and placed on the RPV support ring inside cavity.
- n) Alignment check of RPV to be carried out over support ring using optical instruments. If required necessary, adjustment of supporting wedges may have to be carried out. Multiple lifting and placing over support ring with the help of polar crane may be required to achieve the RPV flange surface horizontality and flatness requirements as specified in the drawing.
- o) RPV sealing surface shall be protected by Rubber sheet of 10 mm thickness & CAF gasket in order to avoid damage to sealing area. The supply and erection of rubber sheet, CAF gasket is included in this item.
- p) After achieving required alignment parameters, RPV is locked with the help of support ring accessories.

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RPV Erection Scheme



Вариант 2 (120) Транспортировка корпуса реактора
в горизонтальном положении
Version 2 (120) Transportation of the reactor vessel
in horizontal position



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- q) After completion of erection of separating bellow, erection and welding of inter-gasket leakage collection system pipeline shall be taken up, the pipeline should be cold bent to required profile before fit-up as per drawing requirements.
- r) Re-preservation paint damaged areas shall be done with OC-51 paint.
- s) Carry out optical alignment and record the readings.

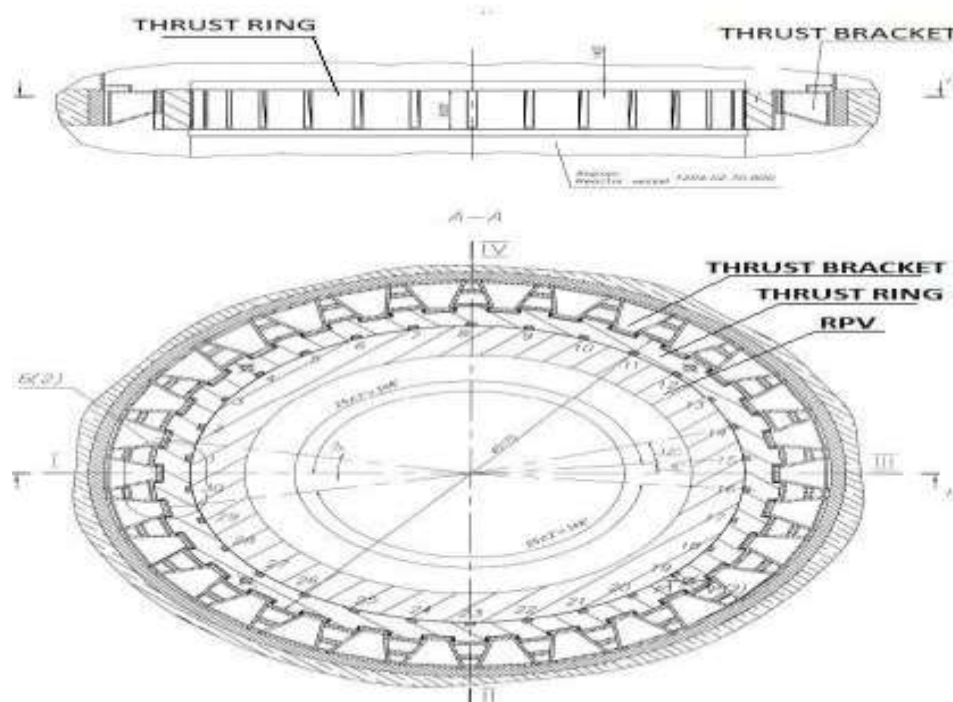
4.3 Thrust ring assembly:

Thrust ring assembly consists of thrust ring (1 nos), wedges (60 nos), spikes (60 nos), and screws (30 nos).

- a) Obtain as built details of embedded Thrust truss.
- b) Marking of Reactor cavity axis over thrust truss.
- c) De-preservation of thrust ring components, dimensional survey (optical) is carried out for all the components.
- d) Ensure clean room conditions of reactor thrust ring area as per document D44.
- e) Arranging scaffolding and erection platform all around the periphery of Reactor pressure vessel. Elevation of thrust ring assembly is +22.510 mtr.
- f) Shifting of thrust ring and its accessories from outside RB to erection trolley on transport portal with the help of heavy duty crawler crane/ contractor's tower crane and from transport portal to inside reactor building by means of erection trolley winch mechanism.
- g) Heavy duty crane/Polar crane will be provided by NPCIL as free of cost for erection of thrust ring only. Contractor has to arrange the sling and de-shackle and all other tools tackles. Arrange jigs and fixtures for adjustment of axis of thrust ring.
- h) Erection and alignment of thrust ring on to reactor pressure vessel thrust ring seating area with the help of polar crane, Ensure axis mismatch of thrust ring with reactor axis as per drawing. Also ensure difference of measurements of clearances between RPV and thrust ring in diametrically opposite points at minimum eight locations as per drawing.
- i) Erection, alignment and marking of wedges over RPV, thrust ring and smooth grinding/machining of wedges to match the profile curvature of RPV outer surface, thrust ring surface.

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Thrust ring assembly



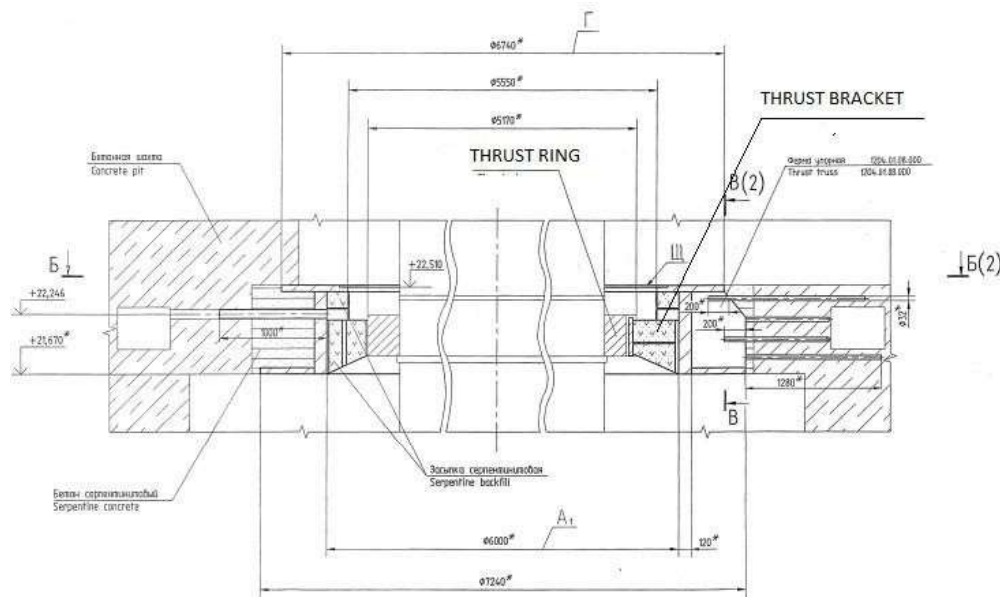
- j) Ensure clearance between the wedge surfaces to RPV outer surface is as per drawing (less than 0.1mm over the arc length of more than 40 mm).
- k) Carryout smooth grinding/machining of wedges till the above requirement is fulfilled.

Perform blue matching of seating area of Main wedge to thrust ring wedge seating area and ensure even contact is established between them as per drawing requirements.

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- Technical drawings of the "Spike" armor system, showing various components and their assembly:
- SPike**: The main armor component, shown in cross-section with dimensions $2-2\frac{1}{2} (1) 0.30$ and $2-2\frac{1}{2} (1) 0.30$.
 - THRUST RING**: A ring component shown in cross-section with dimensions $2-2\frac{1}{2} (1) 0.30$ and $2-2\frac{1}{2} (1) 0.30$.
 - THRUST BRACKET**: A bracket component shown in cross-section with dimensions $2-2\frac{1}{2} (1) 0.30$ and $2-2\frac{1}{2} (1) 0.30$.
 - ADDITIONAL WEDGE**: A wedge component shown in cross-section with dimensions $2-2\frac{1}{2} (1) 0.30$ and $2-2\frac{1}{2} (1) 0.30$.
 - MAIN WEDGE**: A wedge component shown in cross-section with dimensions $2-2\frac{1}{2} (1) 0.30$ and $2-2\frac{1}{2} (1) 0.30$.
 - SCREW**: A screw component shown in cross-section with dimensions $2-2\frac{1}{2} (1) 0.30$ and $2-2\frac{1}{2} (1) 0.30$.
- The drawings include various dimensions and material specifications, such as $2-2\frac{1}{2} (1) 0.30$ and $2-2\frac{1}{2} (1) 0.30$.

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Thrust ring



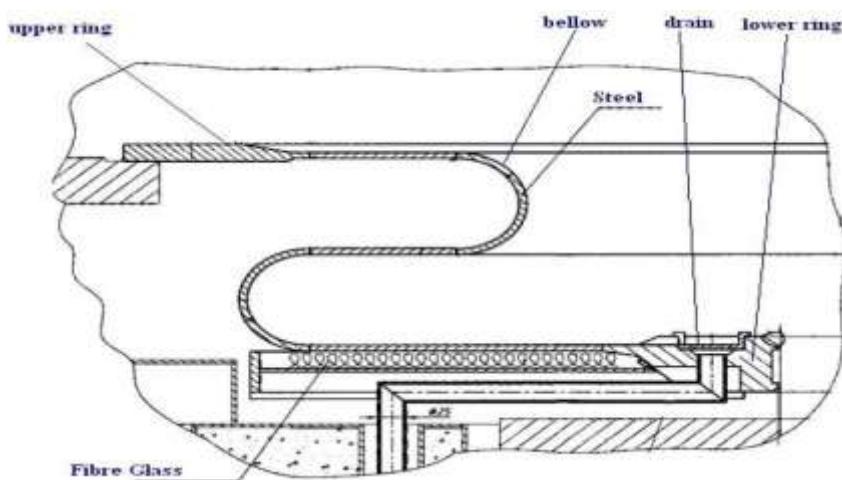
- s) After completion of welding of brackets with thrust truss, measure the clearances between bracket side faces (either side) and thrust ring and grind/machine the spikes (60 nos) over entire length in order to achieve a uniform gap of 0.2 mm after installation of spikes. Weld the spikes with bracket as per drawing requirement.
- t) Install and fit up vertical stiffener plates between bracket to bracket and also within bracket and weld these stiffener plates.
- u) Install and fit up horizontal stiffener plates between bracket to bracket and also within bracket and weld these stiffener plates. The top stiffener plates to be welded only after completion of filling of bracket cavities with serpentine concrete mixed with steel balls (filling with serpentine concrete dry mix, filling with CS steel balls will be measured in respective BOQ item). Air vent holes of dia 5 mm needs to be drilled at identified locations as per drawing.
- v) Install and fit up three vertical drain pipes between bracket to bracket locations as designated in the drawing at three locations 120 degrees apart and weld these pipes with horizontal plates.
- w) Install and fit up vertical shell segments (8 nos) over completed brackets and weld these shells with bracket top surfaces.
- x) Install and fit up horizontal sector segments (8 nos) over completed shell segments and thrust truss and weld these sectors with them.
- y) Install and fit up vertical shell segments (8 nos) over completed sector segments, thrust truss and weld these shells segments with them.

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- z) After completion of dry filling of serpentine pebble mixture inside cavities of thrust truss the filling points should be sealed with metal sheet by welding.
- aa) Various design clearances applicable at various locations of thrust ring needs to be ensured as per drawing requirements.
- bb) Re-preservation of weld joints and other damaged areas with OC-51 paint, varnish.
- cc) Preparation of reports and acceptance

4.4 Erection of Separating bellow

- a) Preparation of erection schemes of separating bellows with detailed drawings considering the layout of the reactor building, transport portal, configuration of crane.



- b) Receipt of separating bellows from CMM stores and preparation of IMIR.
- c) De-preservation & dimensional survey for all the components.
- d) Contractor has to arrange crane, slings and de-shackle and other tools & tackles. All lifting tools and tackles should be load tested before put in use.
- e) Initial lifting of separating bellows from outside RB on to transport portal trolley shall be carried out by contractor's crane and further shifting to inside RB with the help of erection trolley and winch mechanism.
- f) Lift the separating bellows with polar crane, place it over Thrust truss, and align the bellows as per drawing requirements, do the fit up of separating bellows with RPV, thrust truss.
- g) Perform the welding of the separating bellows with Both RPV, thrust truss.

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- h) Erect the separating bellows accessories (drain pipes, sieves etc.), align and weld the accessories with bellow.
- i) Approximate welding quantity envisaged for erection of equipments is provided below. The actual welding may vary on either side because of change of design or site conditions etc. The welding quantity is indicated only for the assessment of work.

The unit rate quoted by the bidder is inclusive of erection and welding of equipments. No separate payment for welding or increase in quantity of welding will be considered. The contractor needs to factor in the variations in the cost quoted for the item.

S No	Name of equipment	Weld Quantity in CC (aprx) for both
1	Support ring	115000
2	Thrust ring	81000
3	Separating bellow	17100

5. Reports and Records:

- i. Erection reports at all stages of work, as-built drawings, welding inspection reports and NDE reports shall be prepared as per the established work procedures and submitted for acceptance.

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2.2.2 TECHNICAL SPECIFICATION FOR ASSEMBLY, ERECTION, ALIGNMENT AND WELDING OF REACTOR INTERNALS

SI No	Description
1	Purpose
2	Scope
3	Reactor internals and upper unit: General introduction
4	Erection of reactor internals
5	Reports and Records

1. Purpose:

The purpose of this procedure is to provide guidance to contractor to understand the scope & quantum of work and technical requirements to be followed during assembly, trial assembly with RPV, erection, alignment, welding and inspection of reactor internals.

2. Scope:

The scope of the contractor's work comprises but not limited to the following.

- a) Study of drawings, preparation of network schedules.
- b) Preparation and approval of QAP, erection, welding and inspection procedures, Preparation of erection schemes considering the layout of the reactor building, transport portal, configuration of heavy duty crawler crane.
- c) Receipt of material from NPCIL/BHEL store, transportation, storage.
- d) De-preservation & dimensional survey of equipments
- e) Handling, assembly, trial assembly with RPV, erection, alignment, welding and inspection.

3. Reactor internals and upper unit: General introduction:

Reactor internals and upper unit consists of following components.

- a) Core barrel.
- b) Core baffle
- c) Protective tube unit (PTU).
- d) Upper unit
- e) Parts of main seal
- f) Reference specimens

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The weight and size of component given below in table;

S No	Description of item	Weight in MT	Size in mm.
1	Core barrel.	76	Φ3670*10845 height
2	Core baffle	36	Φ3500*4070 height
3	Protective tube unit (PTU)	69	Φ3640*7465 height
4	Upper unit (after assembly)	132	Φ4580*8290 height

Core barrel:

It is a cylindrical barrel made of austenitic stainless steel having dimensions 3670mm x 65mm (Dia X Thickness) & length 10845 mm and total weight is 75.2 MT. The core barrel is located inside the pressure vessel and it houses the core baffle and fuel in the core. Core barrel is to be inserted inside RPV with use of guiding slot and seated on RPV flange groove/ step cut at top of core barrel. Lower part of core barrel is fixed at 8 locations with pressure vessel with matching slot & key arrangements. The core barrel has holes at upper portions and at bottom for coolant inlet and outlets.

Core baffle:

It is made up of hollow ring of forging austenitic stainless steel having dimensions OD 3500 & length 4070mm and total weight is 35.1 MT. It consists of four rings fastened between themselves by studs, pins and welding. The core baffle rests on the grid of core barrel. The core baffle is assembled with core barrel at site.

Protective tube unit (PTU):

It is a prefabricated assembly consisting of slab, shell & guiding channels. It's having dimensions OD 3640 & length 7464mm and total weight is 68.2 MT. Guiding channels are provided for control & protection of control rods and in core instrument detectors. In reactor assembled condition, the PTU keeps fuel assembly in appropriate location. The PTU is located inside the reactor and rests with the help of its shoulders on core barrel flange face.

RPV Closure head (Upper unit):

RPV closure head is intended for sealing the reactor under all conditions of its operation and for arrangement of control & protection system drives and core instrumentation. Top head is a forged welded structure with Truncated Ellipsoid

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shape, of low alloy steel clad inside with Stainless Steel with a flange. On top head there are 121-nozzle arrangement for mounting control & protection system drives, 18 nozzles for core instrumentation & 1 nozzle for air vent and 1 nozzle as backup. The upper unit cross piece with a shackle for polar crane hook is provided at the top for handling purpose.

Parts of main Seal (Studs of RPV & Upper Unit):

The top head is connected with the RPV with the help of 54 studs. Sealing is provided with the help of 2 concentric metallic gaskets. Leak monitoring system tube is connected in the space between the two metallic gasket rings. All the 121-control rod drive mechanisms are mounted on the nozzle flanges of the reactor top head. Cooling duct arrangement for control rods forms the part of upper unit metal structure.

Reference specimens (JBA11-12BB701-712):

Reference specimens are intended for monitoring of alteration of mechanical properties of base metal and weld joints of reactor pressure vessel.

Specimens are located in tight containers, which are assembled into container assemblies and installed onto inner wall of the RPV, Upper plate of protective tube unit.

Ref. drawings:

1. R56.KK.3.UJA.JAC.TM.SB.WD217- Core Barrel assembly drawing.
2. R56.KK.3.UJA.JAC.TM.SB.WD228 - Core Baffle assembly drawing.
3. R56.KK.3.UJA.JAC.TM.SB.WD231 - Protective Tube Unit assembly drawing.
4. R56.KK.3.UJA.JAB.TM.SB.WD284 - Upper Unit assembly drawing.
5. R56.KK.1UJA.JAA.TM.SB.WD436 - Parts of main seal (RPV main stud , washer & Nut)
6. R56.KK.1UJA.JBA.TM.MC.WD967 - Reference specimens

4. Erection of Reactor internals:

A brief detail of work for main components is provided below for understanding the scope of work. However contractor has to execute the work by fulfilling all the requirements of working drawings\manufacturer's instructions for satisfactory completion of said work.

TECHNICAL CONDITIONS OF CONTRACT (TCC)

1. The work of transportation, assembly, trial assembly, erection shall be carried by using trained rigger, fitter and foreman with required skills & experience involved in erection of critical equipment. The work will be performed only by accepted skilled persons from start of work to completion of work in one unit.
2. De-preservation of Core barrel, core baffle, protective tube unit (PTU), Upper unit, parts of main seal, dimensional survey (including optical) for all the components. Main joint studs (M170*6- 54 nos) shall be preserved with special grease and covered with lint free cotton over thread areas and shall be stored in the containers supplied by manufacturer.
3. Heavy duty crane will be provided by NPCIL as free of cost for lifting and placement on trolley of Core barrel, core baffle, protective tube unit and upper unit. NPCIL issue universal traverse and mounting traverse for the purpose of handling, assembly and erection as supplied by the equipment manufacturer. Contractor has to arrange the sling and de-shackle and other tools & tackles. All lifting tools and tackles should be load tested before put in use.
4. Core barrel, core baffle, protective tube unit, Upper unit, initial lifting from outside RB on to transport portal trolley shall be carried out by heavy duty crawler crane and further shifting to inside RB with the help of erection trolley and winch mechanism.
5. Transport and position RPV seating cradle, rest were put in place inside Reactor cavity, inspection well area.

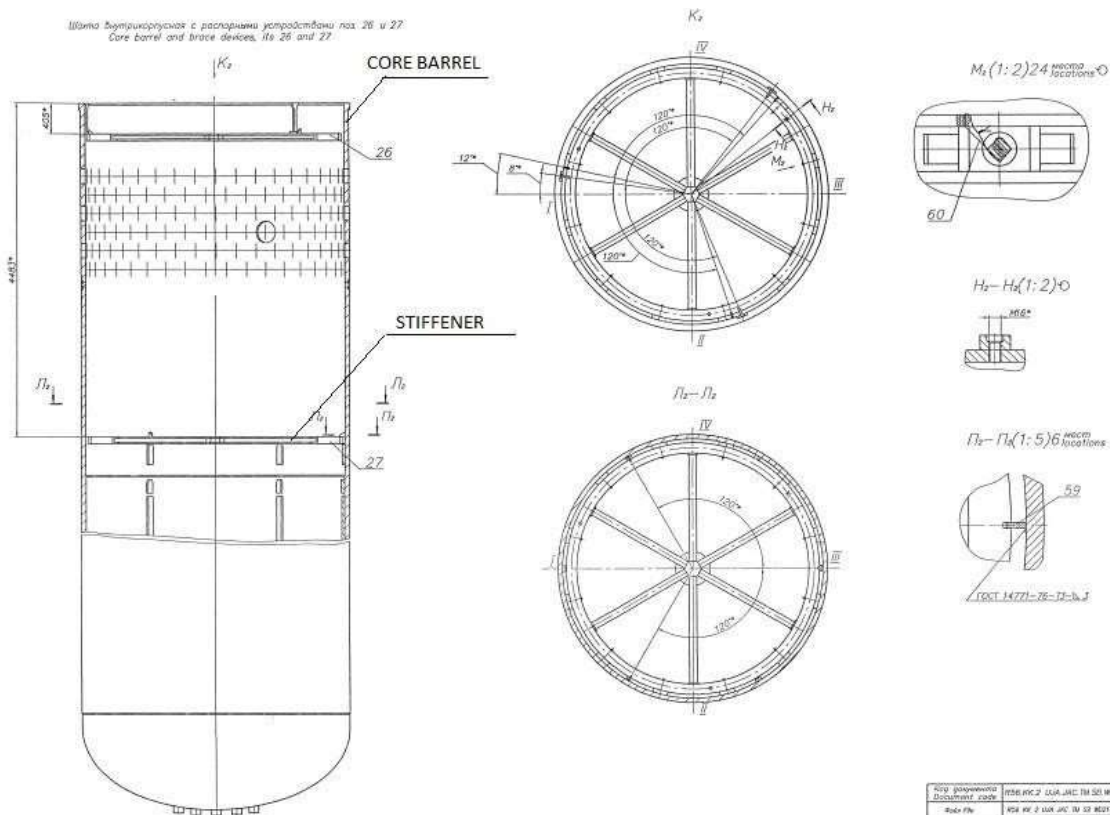
Core barrel assembly, trial assembly and erection:

6. Core barrel to be lifted horizontally with the help of polar crane, mounting traverse assembly and placed on the RPV seating cradle and rest placed inside cavity.
7. Removal of temporary structures by grinding inside core barrel, inspection and cleaning and depreservation.
8. Remove the mounting traverse from Core barrel. Mount the universal traverse on the face of the core barrel for tilting the Core barrel from horizontal to vertical position over cradle.
9. After making vertical, core barrel shall be lifted and placed inside inspection well pit by using polar crane & universal traverse. Check the clearances between core barrel and inspection pit to meet the requirements of the drawing.

TECHNICAL CONDITIONS OF CONTRACT (TCC)

10. Core barrel is having 6 set of keys for guiding core baffle and PTU inside, one set of the keys is not welded in factory and this slot is used for mounting sensors required for monitoring operating parameter during hydro test and hot run. After hot run the same shall be welded by the contractor.

Core barrel with internal bracing



11. Clearances between Core barrel assembly and embedded parts (6 nos) inside inspection pit needs to be checked. Based on the clearances available the required number of wedges and shim plates needs to be fastened to Embedded part with the help of bolts to ensure the required clearance of 1+1mm. Core barrel needs to be lifted and placed inside inspection pit multiple times to check these clearances. After installation of wedges and shim plates recheck the clearances. Further core barrel needs to be lifted and placed inside inspection pit multiple times during fixing of alignment guides of core barrel inside inspection well, CMS sensors fit-up & welding as per the requirement of the job.

-
- Technical drawing of a fuel support assembly. The main view is a longitudinal section of a fuel support (3.3) showing internal components like fuel support No. 2 (5, 6, 8, 12, 16, 18) and fuel support No. 3 (10, 12, 16, 18). Dimensions include diameters of 220* and 104*, a length of 10, and a 22* angle. A detail view shows a cross-section of a fuel support No. 2 (5, 6, 8, 12, 16, 18) with dimensions 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63, 64, 65, 66, 67, 68, 69, 70, 71, 72, 73, 74, 75, 76, 77, 78, 79, 80, 81, 82, 83, 84, 85, 86, 87, 88, 89, 90, 91, 92, 93, 94, 95, 96, 97, 98, 99, 100. The drawing is labeled "FUEL SUPPORT" and "10(1:2)".

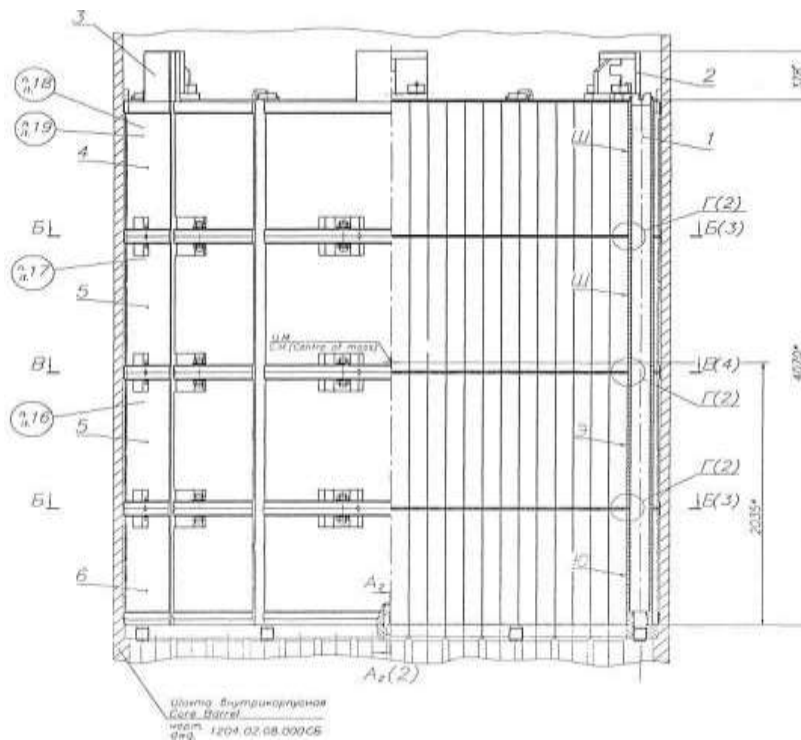
TECHNICAL CONDITIONS OF CONTRACT (TCC)

Core baffle assembly, trail assembly and erection:

Core baffle is supplied in two parts and same shall be assembled inside reactor building.

17. Provide proper working platform & walkways for assembly of core baffle.
18. By using universal traverse position upper part of core baffle over lower part.
Check verticality and alignment requirements.
19. Both lower and upper parts are connected with bolts and pins. On acceptance of assembly, carry out torque tightening of bolts using wrenches provided by the contractor as specified in manufacture drawings.

Core Baffle:



20. Carryout the welding and inspection of fasteners.
21. The baffle shall be lowered inside the core barrel using universal traverse.
Ensure no scratches on the inner surface of core barrel.

TECHNICAL CONDITIONS OF CONTRACT (TCC)

22. After lowering the baffles inside the barrel, check the clearance between barrel and baffle using feeler gauge with 0.2mm size.
23. The assembled and Fasten the core baffle with core barrel by using pipe studs of 6 nos.
24. Erection and fastening of six numbers limiters on core baffle.

Protective Tube Unit (PTU) assembly, trial assembly and erection:

25. PTU assembly will be lifted with the help of polar crane, mounting traverse assembly, and made vertical and placed inside inspection well cavity over temporary metal structures.
26. Lift the PTU from PTU transportation container with the help of universal traverse/ PTU lifting tool and place inside RPV.
27. Mount the PTU lifting tool with PTU assembly and lift with the help of polar crane and place inside PTU inspection pit. Check the clearances between PTU assembly and inspection pit to meet the requirements of the drawing.
28. While lifting the PTU assembly with PTU lifting tool check the horizontality/verticality of PTU to meet the drawing requirements when it is in hanging condition. Any deviation needs to be corrected by grinding the contact surfaces of PTU lifting tool and rechecking needs to be done till achieving drawing requirements.
29. Clearances between PTU assembly and embedded parts (6 nos) inside inspection pit needs to be checked. Based on the clearances available the required number of wedges and shim plates needs to be fastened to Embedded part with the help of bolts to ensure the required clearance of 1+1mm. PTU needs to be lifted and placed inside inspection pit multiple times to check these clearances. After installation of wedges and shim plates recheck the clearances. Further PTU needs to be lifted and placed inside inspection pit multiple times during fixing of alignment guides of PTU inside inspection well, CMS sensors fit-up & welding as per the requirement of the job.
30. After ensuring design clearances within the pits, horizontality, verticality of PTU while it is in hanging condition, lift the PTU with polar crane, PTU lifting device and place it inside RPV on top of core barrel.

31. Place the optical targets around six numbers on top of PTU at designed locations to check the alignment of PTU with upper unit nozzles after its installation.
32. PTU needs to be lifted and placed inside RPV multiple times to check clearances with upper unit guides (refer Upper unit alignment guides), during checking of coaxiality with upper unit, box-up of RPV, after removal of CMS sensors.

33. Ensure upper unit (UU) inspection well Embedded part (EP) readiness (horizontality of EP - 0.5mm). Grinding of Embedded part to be carried out to achieve the horizontality of 0.5mm.
34. RPV head will be lifted with the help of polar crane and placed inside upper unit inspection well area over temporary metal structures.
35. Removal of nitrogen preservation blanks from all the nozzles of upper unit (apprx 140 nos).

TECHNICAL CONDITIONS OF CONTRACT (TCC)

36. Mount the upper unit traverse over upper unit assembly with the help of six studs of 6 mtr length. Lift the upper unit with upper unit traverse and check horizontality of upper unit bottom sealing face and ensure the horizontality is within 1mm. Adjust the mounting studs to achieve the required horizontality.
37. While lifting the RPV head with polar crane check the horizontality/verticality of upper unit to meet the drawing requirements when it is in hanging condition. Any deviation needs to be corrected.
38. Install cover centering device (3 nos) over Reactor pressure vessel stud holes as per drawing requirement.
39. Lift the RPV head with polar crane and place it over reactor by guiding over cover centering device. Check the alignment between upper unit and RPV by mounting Main joint studs on a few stud locations. Align the upper unit and measure and record the clearances as per drawing.
40. Erection of RPV upper unit (head) alignment device [guides, brackets] (see tech specification erection, alignment and welding of reactor cavity equipments).
41. Place around seven numbers of optical targets on core barrel and on top of RPV head nozzles at designed locations to check the alignment of RPV head with PTU, core barrel.
42. Remove temporary lifting arrangements over RPV head and optically check the co-axiality of nozzles of upper unit cover, PTU, core barrel and confirm with manufacturer passport readings.
43. Lift the RPV head with polar crane from RPV and place it over UU inspection well EP.

Upper Unit (UU) assembly and erection:

44. The upper unit consists of following component which are supplied as separate parts and to be assembled at inside reactor building before erection.
 - a) RPV head (cover).
 - b) Drive cooling blocks,
 - c) Lower plate.
 - d) Upper plate.
 - e) Upper unit cross piece (used for lifting)

TECHNICAL CONDITIONS OF CONTRACT (TCC)

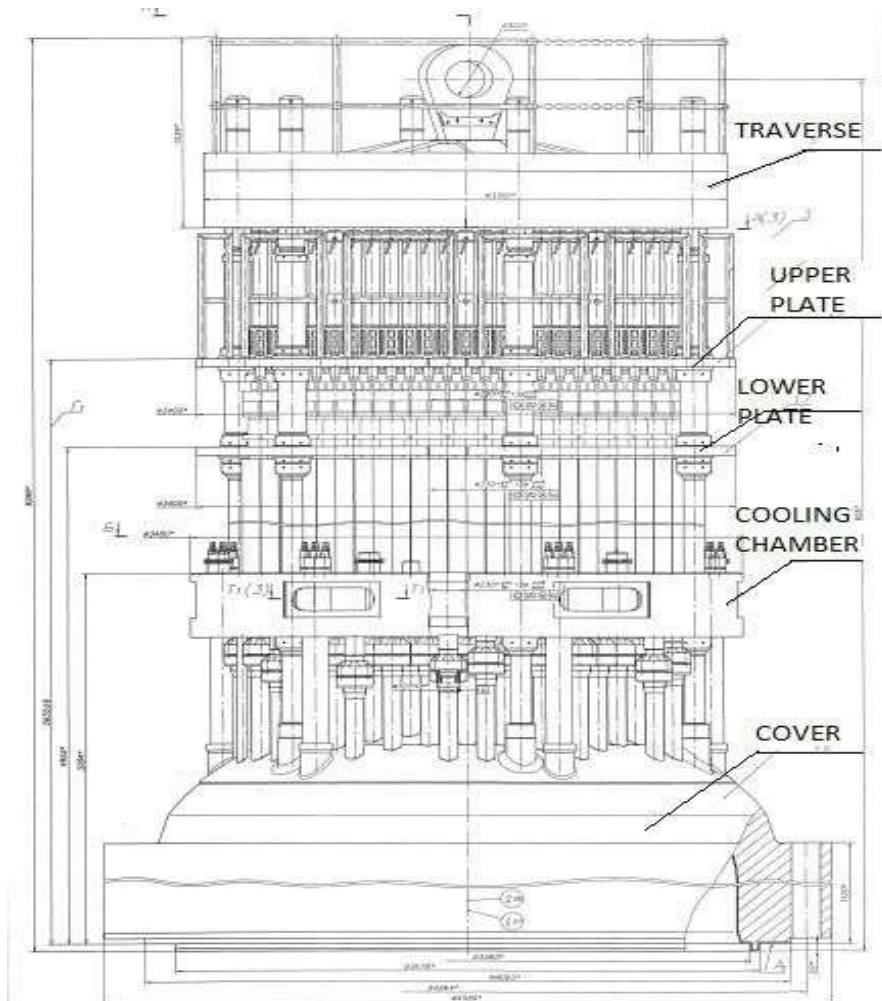
- 45. Assembly of above component shall be done as specified by the manufacturer drawings.
- 46. During assembly care shall be taken to maintain clean room condition in cavity.
- 47. Upper unit accessories (block of drive cooling, lower plate, upper plate and many smaller components etc.,. (around 80 number of items))

PTU:

- 48. Mount the PTU transportation platform over PTU residing inside RPV with the help of six numbers of studs.
- 49. Install the slider assembly over PTU transportation platform and fasten it with dowel, bolts and welding. During alignment the slider should freely slide inside guide (Upper unit alignment guide) attached to the RPV cavity. Check the free movement of slider by moving the PTU with PTU transportation platform multiple times.
- 50. Lift the PTU with the help of PTU transportation platform attached to the polar crane, place it inside PTU inspection pit concentric with pit opening. Align the PTU as per drawing requirement and carry out installation of guide alignment system of PTU inside inspection well cavity.
- 51. Assembled core barrel & core baffle shall be lifted using core barrel transportation device (issued as free issue) over core barrel residing inside RPV with the help of bolts (24 nos).
- 52. Install the bracket assembly over core barrel transportation device and fasten it with dowel, bolts and welding. During alignment the bracket should freely slide inside guide (Upper unit alignment guide) attached to the RPV cavity. Check the free movement of slider by moving the core barrel with core barrel transportation device multiple times.

TECHNICAL CONDITIONS OF CONTRACT (TCC)

View of assembled Upper Unit:



53. Lift the core barrel with the help of core barrel transportation device attached to the polar crane, place it inside core barrel inspection pit concentric with pit opening. Align the core barrel as per drawing requirement and installation of guide alignment system of core barrel inside inspection well cavity.

Work to be carried out after open loop flushing:

54. Provide assistance for installation of Commissioning monitoring sensors (CMS).
55. Removal of core baffle from core barrel with the help of universal traverse with attachment for performing Commissioning monitoring sensors (CMS) welding inside core barrel.

TECHNICAL CONDITIONS OF CONTRACT (TCC)

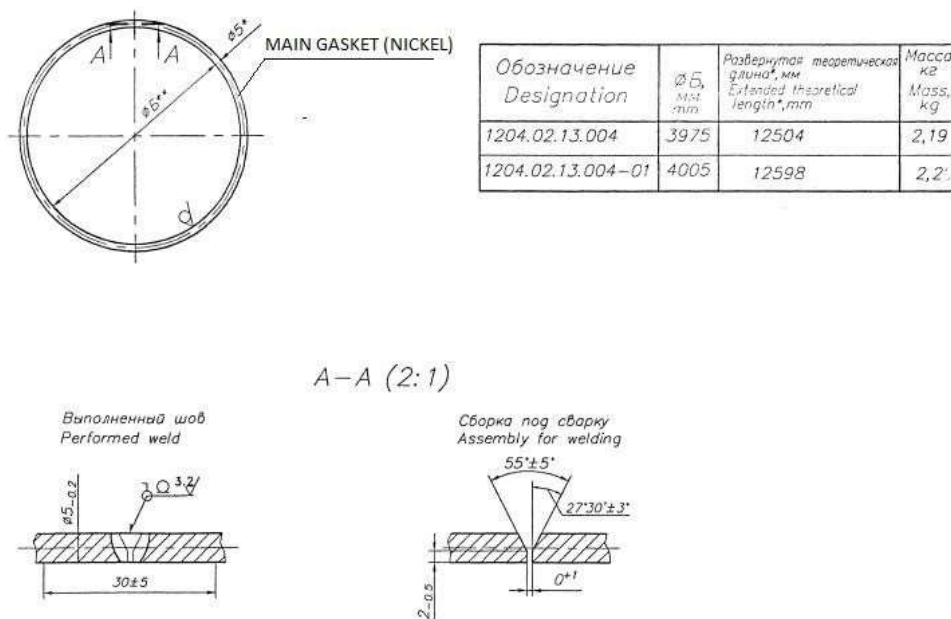
56. Erection and welding of CMS sensors both inside and outside (core barrel in hanging condition) core barrel (aprx 25 nos) shall be done in the inspection well pit. Approximate welding quantity envisaged for CMS sensors is 540 CC (cubic centimeter) for both units (3 & 4).
57. After completion of cleaning of the RPV post open loop flushing, lift the core barrel with core barrel transportation device attached to the polar crane and place it inside RPV.
58. Align the core barrel and take the measurements of clearances between core barrel key ways, Keys attached to RPV.
59. After ensuring design clearances between keys and key ways, do the fit up of cover plates covering the keyways and carryout the welding.
60. Installation of baffle inside core barrel with the help of universal traverse attached to polar crane.
61. Fasten the core baffle with core barrel by using pipe studs of 6 nos.
62. Erection and fastening of six numbers limiters on core baffle.
63. After completion of dummy fuel installation inside RPV (performed by NPCIL), installation of CMS sensors (aprx 10 nos) shall be done on top and outer surface of PTU.
64. PTU will be lifted with PTU lifting device attached to polar crane, and place it inside RPV on top of core barrel.
65. Perform the alignment of PTU as per drawing requirements.
66. After completion of hot run, CMS sensors shall be removed and Plugs shall be mounted on the sensor mounting area and welded on core barrel. Also one set of key and its accessories, three number of fuel supports shall be welded on core barrel and inspection shall be carried out.

Parts of main seal:

67. Take the as built dimensions of Reactor pressure vessel main sealing grooves (dia of grooves aprx 5.0 mm) for finalizing the dimension of nickel gaskets.
68. Carry out the trial welding of nickel gasket (dia of gasket 5 mm) for technology qualification. Arrange necessary jigs and fixtures for carrying out the qualification, for handling the round gaskets.

TECHNICAL CONDITIONS OF CONTRACT (TCC)

Nickel gasket welding:



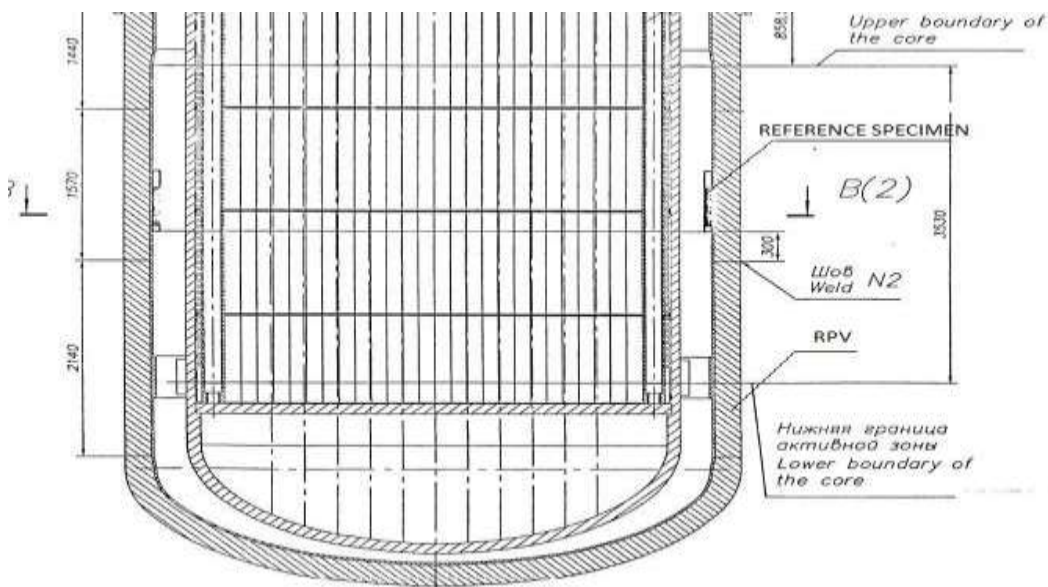
69. Stretching, straitening, cutting, edge preparation, fit up and welding of nickel gaskets based on as built dimensions of the RPV sealing grooves.
70. Make sure that no undulations were permitted while placing the gasket inside grooves. While performing final alignment of gaskets over grooves place the lead blocks over gasket.
71. Lift the upper unit from inspection pit with upper unit lifting traverse attached to polar crane and place it over reactor by guiding over upper unit guides.
72. After completion of upper unit alignment, mounting of Main joint studs will be taken up.
73. Lift each stud with the help of eye bolt, remove the cotton wrapping, clean the studs, inspect the studs, and apply the graphite based lubricant supplied by the manufacturer.
74. Place the studs one by one over RPV flange through upper unit flange, align and fasten the studs. Install the washers over the studs for all these 54 studs.
75. Release the Main joint for torque tightening of RPV main joint by multiple stud tensioner.
76. After completion of Main joint stud tightening, air vent elbow assembly, alignment, fit up and welding needs to be performed.
77. Re-preservation of damaged areas shall be done for upper unit with OC-51 paint.
78. Carry out optical alignment and record the readings.

TECHNICAL CONDITIONS OF CONTRACT (TCC)

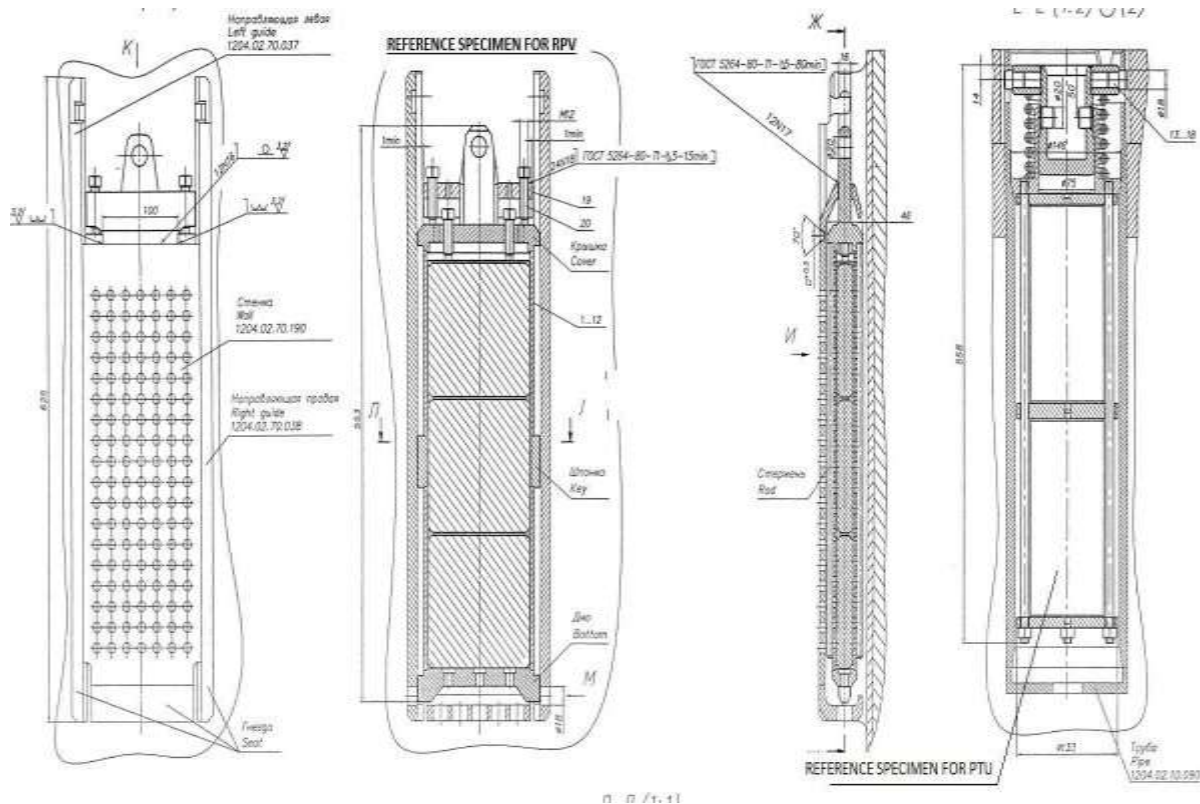
Reference specimen assemblies:

79. Reference specimens are located in container assemblies which houses number of individual specimens. Out of 18 container assemblies 12 container assemblies (each weighing 14 kgs) will be placed inside pockets available at reactor core belt area of RPV, other six container assemblies (each weighing 32 kgs) mounted on Protective tube unit.
80. For erection of these reference specimen assemblies all around staging (scaffolding & platform) needs to be provided and these assemblies' needs to be installed with very close tolerances. After completion of alignment of reference specimens welding of reference specimens housing with reactor vessel shall be performed. The reference specimens need to be erected before hot run.

Reference Specimens schematic sketch:



TECHNICAL CONDITIONS OF CONTRACT (TCC)



Approximate welding quantity envisaged for erection of equipments is provided below. The actual welding may vary on either side because of change of design or site conditions etc. The welding quantity is indicated only for the assessment of work. The unit rate quoted by the bidder is inclusive of erection and welding of equipments. No separate payment for welding or increase in quantity of welding will be considered. The contractor needs to factor in the variations in the cost quoted for the item.

S No	Name of equipment	Weld Quantity in CC (aprx)
1	Core barrel, core baffle, PTU	3900
2	Upper unit	1200
3	Reference specimens	900
4	CMS sensors	540

5. Reports and Records:

- i. Erection reports at all stages of work, as-built drawings, welding inspection reports and NDE reports shall be prepared as per the established work procedures and submitted for acceptance.

TECHNICAL CONDITIONS OF CONTRACT (TCC)

2.2.3 TECHNICAL SPECIFICATION FOR ERECTION, ALIGNMENT AND WELDING OF REACTOR CAVITY EQUIPMENTS

Sl No	Description
1.0	Purpose
2.0	Scope
3.0	Reactor cavity equipments
4.0	Erection of reactor cavity equipments
4.1	Alignment device for upper unit
4.2	Protective steel structure
4.3	Electrical equipment and heat control of reactor (CPSAR)
4.4	Thermal and biological shielding of nozzle area
4.5	Upper unit thermal insulation
4.6	Detection unit motion mechanism (JKT drives)
4.7	Device for removal of control and protection system
5.0	Reports and records

1. Purpose:

The purpose of this procedure is to provide guidance to contractor to understand the scope & quantum of work and technical requirements to be followed during assembly, erection, alignment, welding and inspection of reactor cavity equipment's.

2. Scope:

The scope of the contractor's work comprises but not limited to the following.

- a) Study of drawings, preparation of network schedules.
- b) Preparation and approval of QAP, erection, welding and inspection procedures, Preparation of erection schemes with detailed drawings considering the layout of the reactor building, transport portal, configuration of crane.
- c) Receipt of material from NPCIL/BHEL store, transportation, storage.
- d) De-preservation & dimensional survey of equipments
- e) Handling, assembly, trial erection, erection, alignment, welding and inspection.

TECHNICAL CONDITIONS OF CONTRACT (TCC)

3. Reactor cavity equipments:

The reactor cavity equipment consists of following components.

- a) Alignment guides for upper unit
- b) Protective steel structure
- c) Electrical equipment and Heat control of Reactor (CPSAR) drives
- d) Thermal insulation and Biological Shielding of RPV Nozzle Area
- e) Upper Unit Thermal Insulation
- f) Detection Unit Motion Mechanism (JKT drives)
- g) Device for removal of control and protection system (jib crane)

S No	Description of item	Weight in MT	Size in mm.
1	Alignment guides for upper unit	7	H-8300,W-
2	Protective steel structure	36	Φ7065,H-6265
3	Electrical equipment and Heat control of Reactor(CPSAR) drives	3	
4	Thermal insulation and Shielding of RPV Nozzle Area	24	
5	Upper Unit Thermal Insulation	12	Φ5780,H-2953
6	Detection Unit Motion Mechanism (JKT drives)	3.8	L-1476,W-1136,525-thickness.
7	Device for removal of control and protection system (jib crane)	9.8	H-11770

Ref. drawings:

1. R56.KK.UJA.FJA.TM.MC.WD354- Alignment device for Upper Unit, mounting Drawing.
2. R56.KK.3UJA.JAB.TM.SB.WD909 - Protective steel structure, assembly drawing.
3. R56.KK.3UJA.JAB.TM.SB.WD980 - Electrical equipment and heat control of the reactor, assembly drawing.
4. R56.KK.UJA.JAH.TM.SB.WD460 - Thermal and biological shieldings of nozzles area mounting drawing.
5. R56.KK.UJA.JAH.TM.SB.WD785 - Upper Unit Thermal insulation, mounting Drawing.
6. R02.KK.3UJA.JKT.RP.MC.WD051 - Detection Unit Motion Mechanism.

TECHNICAL CONDITIONS OF CONTRACT (TCC)

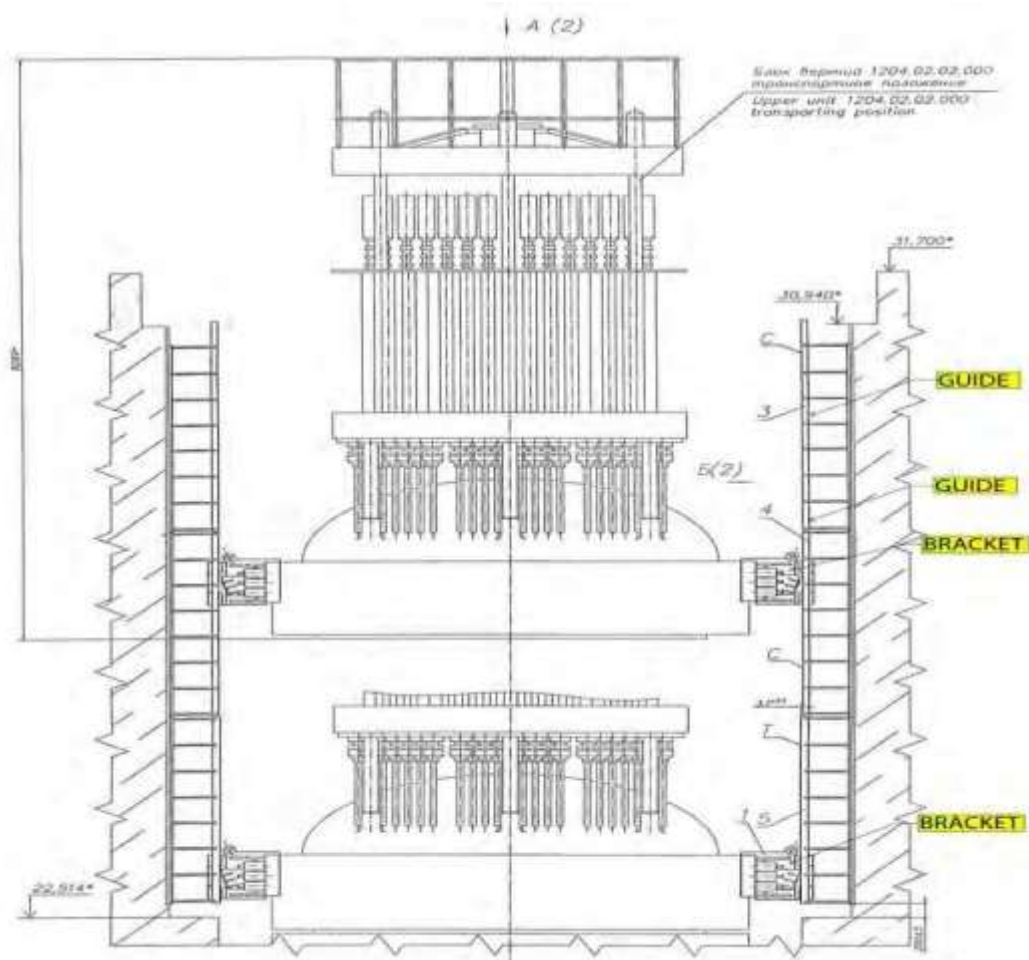
7. R134.KK.UJA.FJA.TM.OK.WD176 - Device for removal of control and protection system.(Jib CRANE).

4. Erection of Reactor cavity equipments:

A brief detail of work for main components is provided below for understanding the scope of work. However contractor has to execute the work by fulfilling all the requirements of working drawings\manufacturer's instructions for satisfactory completion of said work

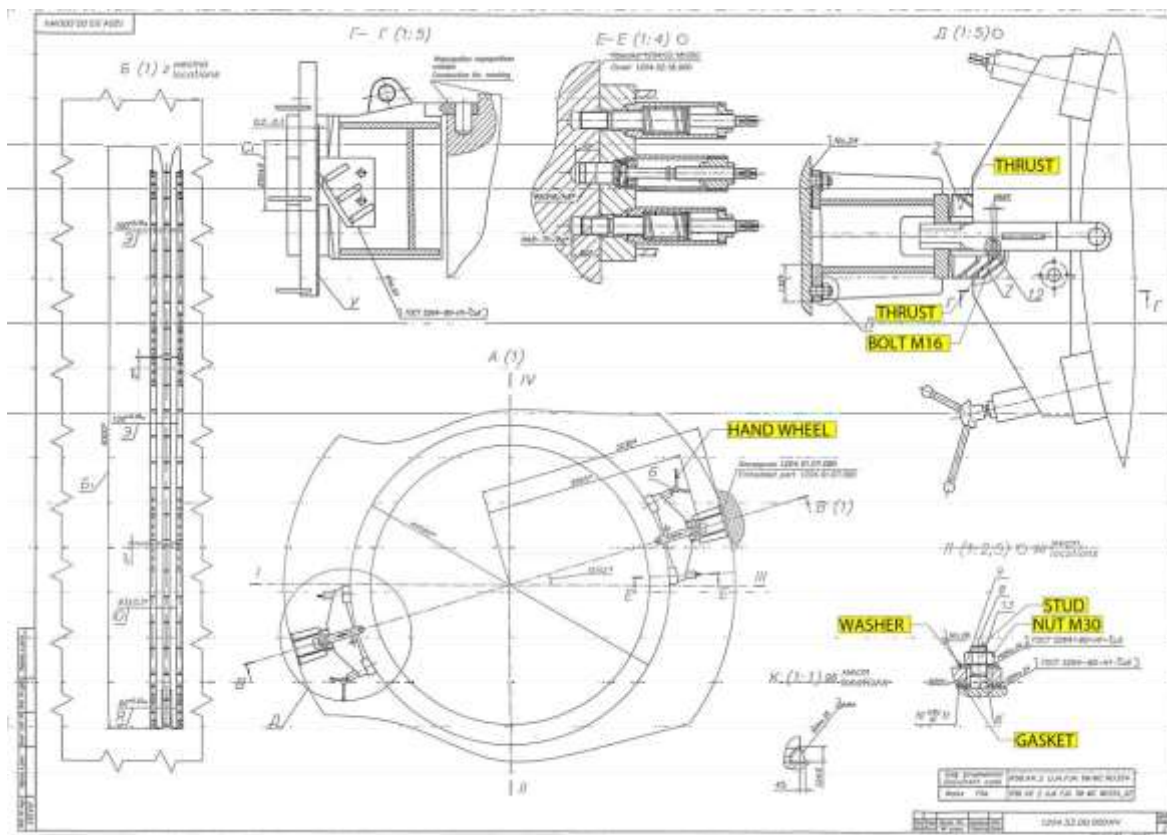
4.1 Alignment device for Upper unit:

Alignment device is intended for upper unit installation on reactor pressure vessel. It consists of two Upright guides and two removable brackets fastened to Reactor cover flange. Brackets are provided with thrust devices; thrusts shall be installed and welded after final installation of guides during mounting.



TECHNICAL CONDITIONS OF CONTRACT (TCC)

UPPER UNIT ALIGNMENT DEVICE (GUIDE)



- Install the brackets over aligned Upper unit (UU) flange and fasten with bolting assembly.
- Mark the guide seating area over EPs, Obtain as built dimensions of Embedded parts of reactor cavity at many locations along the entire length (8.5 mtrs) of the embedded parts. Based on these dimensions either machining of guides on seating area or insertion of shim plates between guides and embedded part shall be made to achieve drawing requirements.
- Fit up and welding of studs for mounting of UU guides. Installation of guides over studs, alignment, fixing of nuts.

TECHNICAL CONDITIONS OF CONTRACT (TCC)

- d) Ensure the clearance between bracket thrust and guide face should be within 0.2 - 0.3mm. To adjust the gap it is permitted to adjust the bolts of thrust.
- e) Carry out trial lifting and lowering of Upper unit multiple times and observe for smooth movement of UU bracket slider inside UU guides. Adjust the guides by loosening the nuts (on guides as well as on the bracket as required) for achieving the smooth movement. For carrying out adjustment of guides, upper unit needs to be handled multiple times between inspection well and RPV. The cost of handling Upper unit multiple times for achieving the required clearance and smooth movement is included in this item.
- f) After ensuring smooth movement of UU slider inside guides, weld the UU guides with embedded part. Carry out welding of nut to washer, washer to guide, nut to stud (96 nos)
- g) After obtaining the required clearance tack welding of thrust plate to brackets shall be performed. And after completion of hot run of Reactor system complete welding of thrust plate shall be performed.

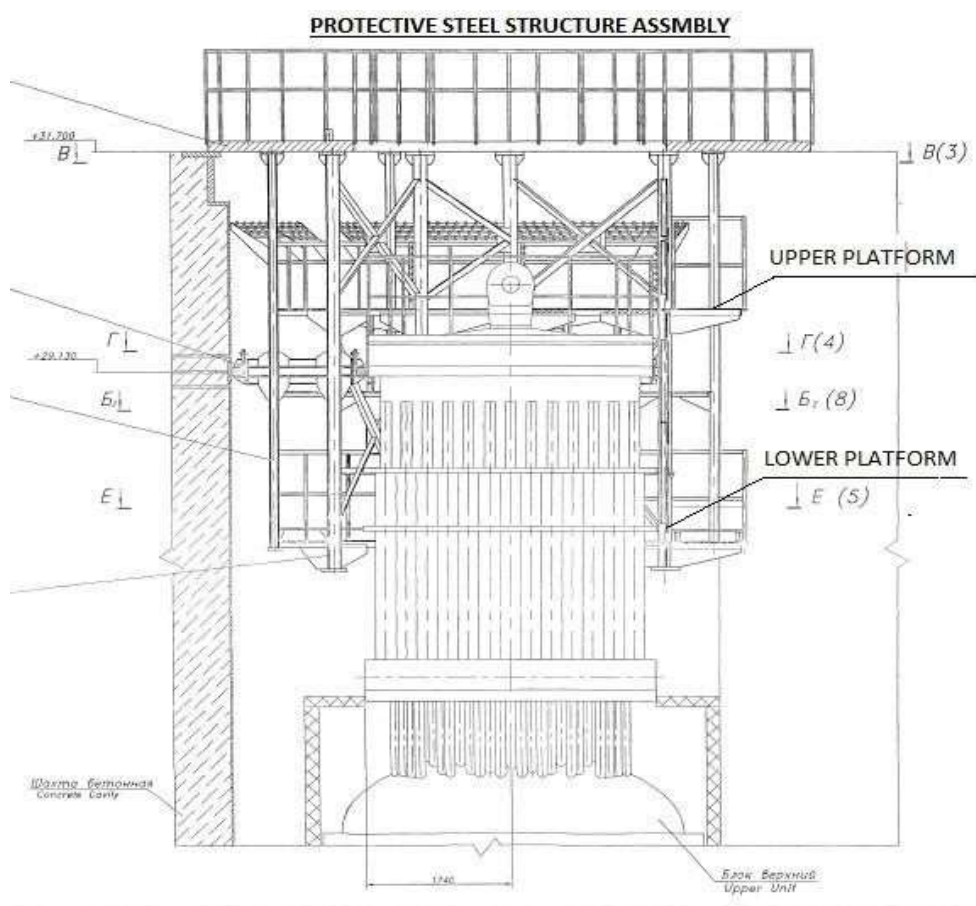
4.2 Protective steel structure:

- a) Protective steel structure of the reactor concrete cavity equipment designed for accommodation of electrical communication stubs, service platforms as well as devices/supports for isolating reactor upper unit from impact of seismic loads.
- b) Dimensions of protective structure: OD – 7.0 mtr, Height- 6.3 mtr, weight- 36 MT.
- c) Protective steel structure consists of many parts which shall be assembled and welded at site as per manufacturer's drawing. Main components of Protective steel structure consists of upper support plate, two service platforms and posts connecting the upper plate with the service platforms where the electrical communication stubs are arranged. The upper support plate is a thick wall circular ring fastened to the embedded parts of reactor cavity at +31.7 mtr elevation. The posts are fastened on this plate, both service platforms are suspended on these posts. The guards and the ladder are fastened on the upper plate and the service platform, which allows maintaining the protective steel structure, electrical equipment and heat control of reactor and upper unit.

TECHNICAL CONDITIONS OF CONTRACT (TCC)

- d) The assembly of all the above stated parts needs to be carried out both at in-situ at design location and +31.0 mtr elevation based on the erection feasibility and reduction of welding at design location. Contractor needs to carefully plan the assembly accordingly. Contractor needs to provide scaffolding and working platform all around cavity. During the installation of seismic supports over protective steel structures the gap between embedded parts on reactor cavity and seismic support, between upper unit traverse and seismic support needs to be maintained 0.5mm. It is permitted to grinding/machining of support blocks of seismic support to achieve the drawing requirement.

PROTECTIVE STEEL STRUCTURE ASSEMBLY

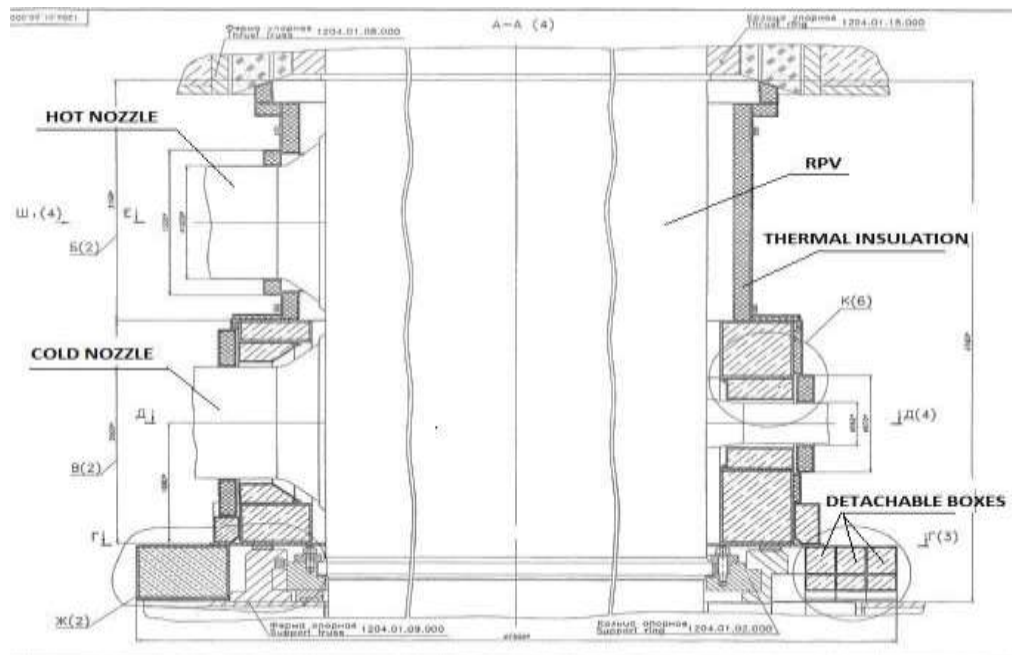


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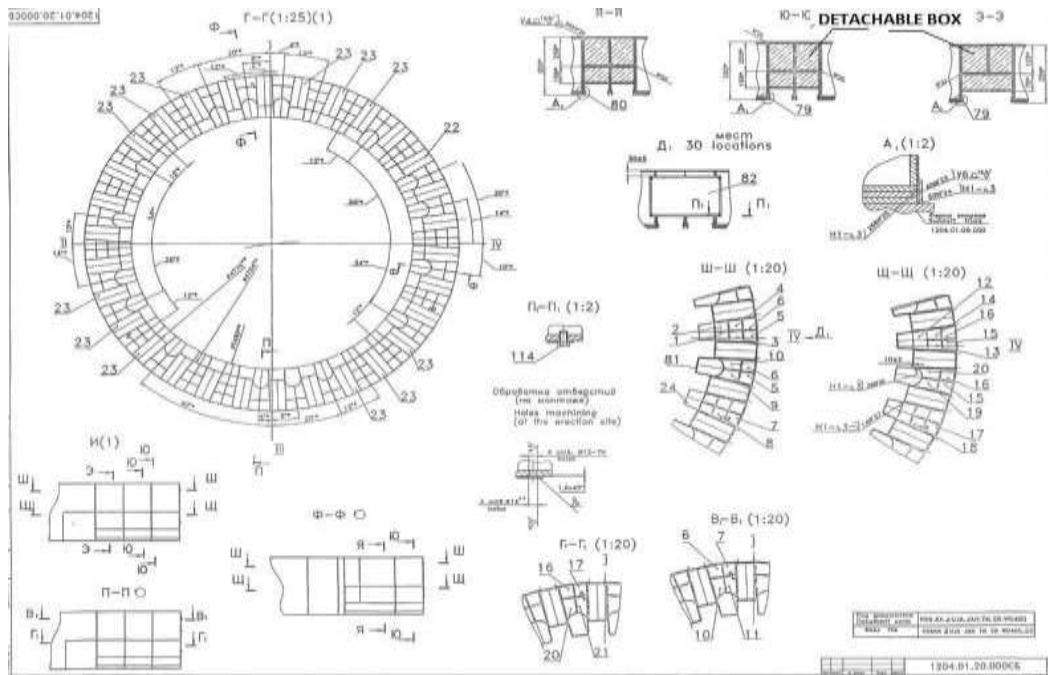
4.4 Thermal and Biological Shielding of Nozzle Area :

- a) Thermal and biological shielding of nozzle area is intended to decrease the heat loss from the reactor vessel in nozzle area and to shield & reduce the penetrating radiation from core and coolant.
- b) Thermal and biological shielding of nozzle area is a welded metal structure assembled of sections, made of carbon steel sheets. These sheets form cavities (boxes). Glass wool is laid for heat insulation inside the activities as well as special concrete for biological shielding. Weight of Thermal and biological shielding of nozzle area is 24000 kg per unit.
- c) Thermal and biological shielding of nozzle area consists of many segments installed over circumference of reactor (diameter 7300 mm, height-4675mm)

Thermal and biological shielding of nozzle area



TECHNICAL CONDITIONS OF CONTRACT (TCC)

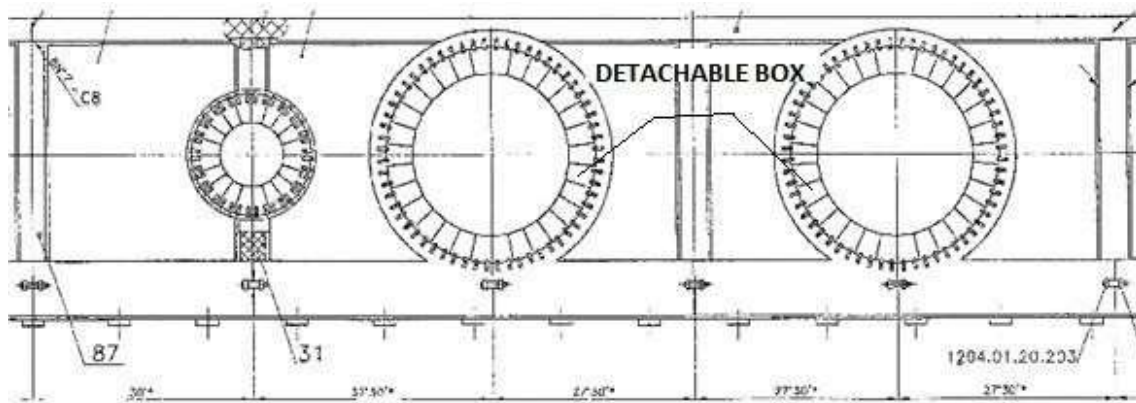


- d) Thermal and biological shielding of nozzle area consists of many blocks. Out of which some blocks will be placed on top of support ring area, other set of blocks all around RPV nozzle area.
- e) The material supplied consists of many detachable carbon steel box frames with top cover tack welded. Contractor needs to assemble these boxes after de-preservation, modification of boxes to match the profile of support truss supports, fill the boxes with concrete (measured in respective SOQR item) at specified location, place the cover after drying of concrete, fit up and welding of top cover, handling, transportation and erection of these boxes at designed location near support truss. For certain boxes concreting and welding needs to be done in-situ. For aligning these boxes at support ring location shims needs to be placed to achieve the required elevation.
- f) For blocks which are to be erected all around RPV nozzle area, pre-assembly, dimensional check for ensuring designed clearances, welding of stoppers and lock plates needs to be performed.

TECHNICAL CONDITIONS OF CONTRACT (TCC)

- g) In case of RPV hot leg nozzles pre fabricated thermal insulation blocks will be supplied. Contractor needs to carry out the assembly, erection, alignment and welding of these blocks. Design clearances between the thermal insulation blocks needs to be filled with loose insulation mattresses and cover sheets (CS sheets of 5 mm thick) needs to be fixed and welded with insulation blocks.

RPV nozzle:



- h) For thermal insulation blocks which are adjoining thrust truss bottom, local modification of blocks (3 nos) needs to be performed by cut opening the blocks to allow separating bellow drain pipes through them.

4.5 Upper Unit Thermal Insulation:

- a) Upper unit thermal insulation is intended for reducing the heat losses from the reactor, reducing the temperature load in the reactor concrete cavity, decreasing the heat and radioactive irradiation effect on construction concrete in the upper part of concrete cavity and operating personnel.
- b) The dimensional parameters of upper unit thermal insulation:

OD of thermal insulation : 4960 mm

ID of thermal insulation : 4620 mm

OD of biological shielding : 5780 mm

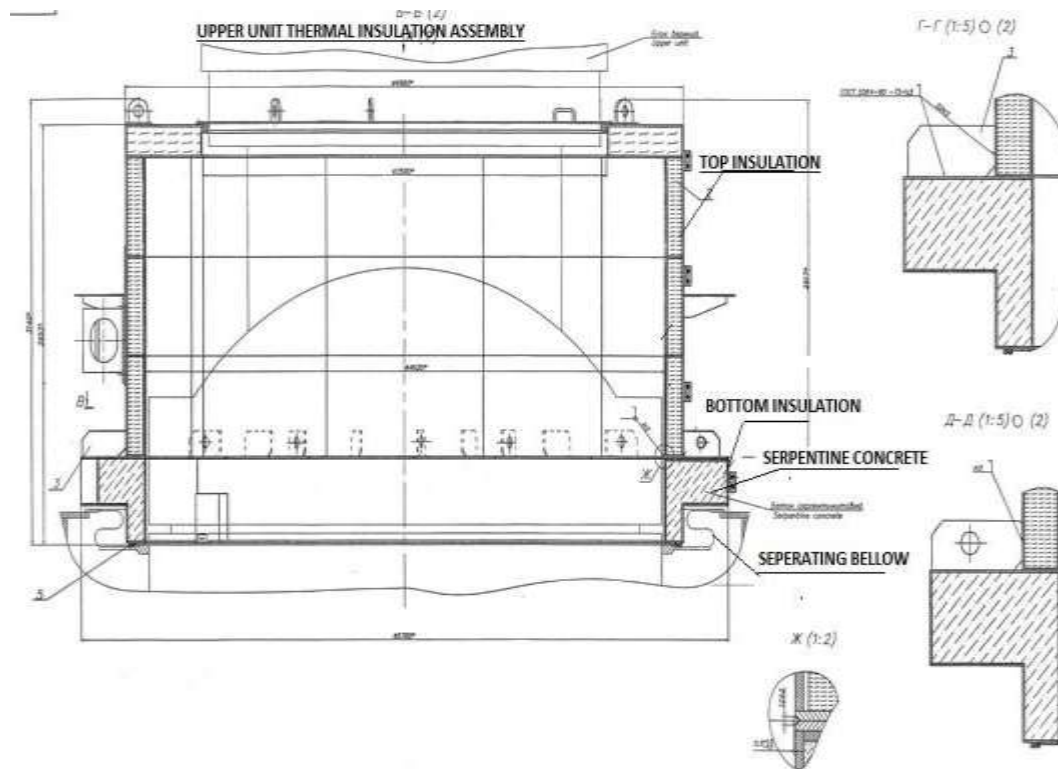
ID of biological shielding : 4620mm

TECHNICAL CONDITIONS OF CONTRACT (TCC)

Height : 3140mm

Total weight : 11450kg.

Upper unit Thermal Insulation:



- c) Upper Unit Thermal Insulation consists of pre fabricated thermal insulation blocks & pre fabricated biological shielding blocks.
- d) The material supplied for biological shielding consists of two halves of hollow circular pre fabricated blocks with top cover open for filling of serpentine concrete. Contractor needs to assemble these halves after de-preservation and trial erection needs to be done for checking any interference before filling of concrete. Perform necessary modifications for elimination of interference. Fill the assembly with serpentine concrete (measured in respective SOQR item) at specified location, place the cover after drying of concrete, fit up and welding of top cover.

TECHNICAL CONDITIONS OF CONTRACT (TCC)

- e) The material supplied for Thermal insulation consists of two halves of circular pre fabricated insulated blocks. Contractor needs to perform assembly of these halves after de-preservation, alignment, fit up and welding. Assemble the thermal insulation with biological shielding assembly, align, fit up and welding circumferentially (ID as well as OD sides).
- f) Place the stiffener plates between thermal insulation, biological shielding assemblies as per drawing, fit up and welding of these stiffener plates.
- g) Make ready the Universal traverse along with special attachment to lift the upper unit thermal insulation. Mount the universal traverse with attachment to upper unit thermal insulation lifting lugs. Place the sealing thermal insulation cords over separating bellow. Lift, shift and erect upper unit thermal insulation assembly over separating bellows at designed location. Align the upper unit thermal insulation concentrically with reactor, ensure there is no interference with inter-gasket leakage collection line & horizontality of upper unit thermal insulation as per drawing requirement.
- h) Install alignment brackets of thermal insulation, fasten with bolts, check for smooth movement of thermal insulation assembly over upper unit guides and perform welding of alignment brackets as per drawing requirement.
- i) Erection, fit up, modification and bolting of circular channels all around upper unit top thermal insulation, fill the channels with insulation material, cover plate fixing with bolts.

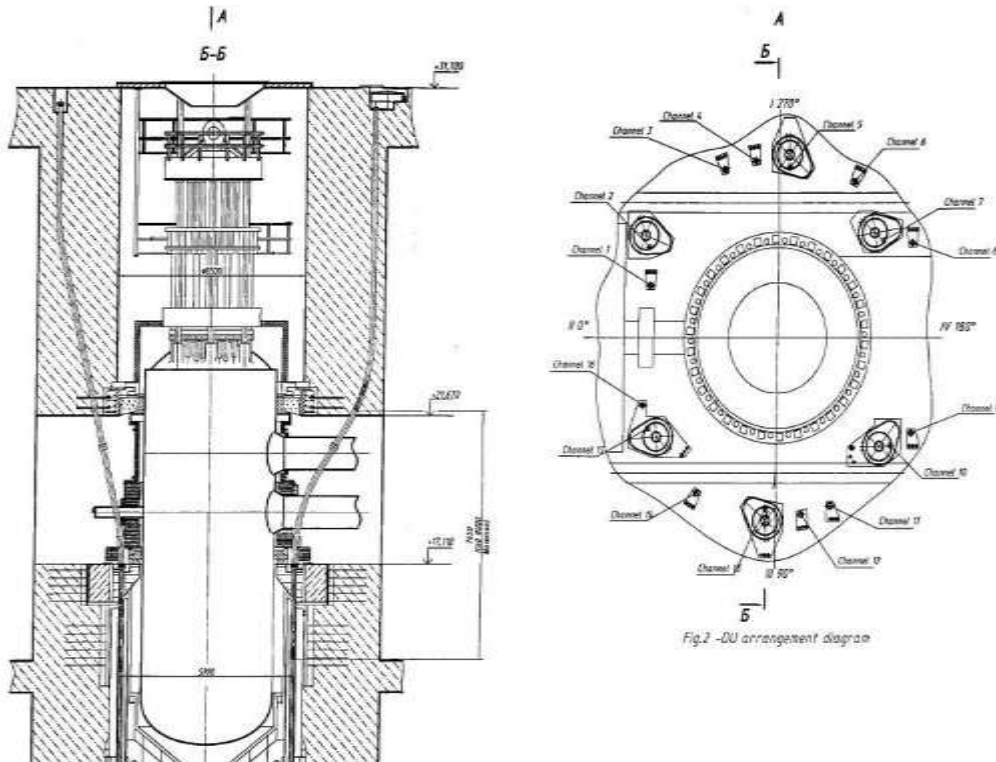
4.6 Detection Unit Motion Mechanism (JKT drives):

- a) Detection unit motion mechanism is intended for movement of detection units (DU) and their installation into assigned position in the measuring channels.
- b) DU displacement mechanism shall be installed and assembled in the reactor hall at the elevation +31.7mtr. Clean the internal cavities of DU channels and the embedded plates against contamination.
- c) Detection unit motion mechanism consists of six drive assemblies containing motor assembly, outer casing, and top cover. Prior to installation, the internal cavity of drives shall be air blown and tested with overpressure of air (nitrogen)- 0.1 ± 0.005 Mpa for tightness checking having sealed the body with blind cover.

TECHNICAL CONDITIONS OF CONTRACT (TCC)

- d) Install the drive assemblies over embedded parts and align the drive assembly as per drawing requirement. Carryout the modification of threaded holes for meeting the alignment requirements

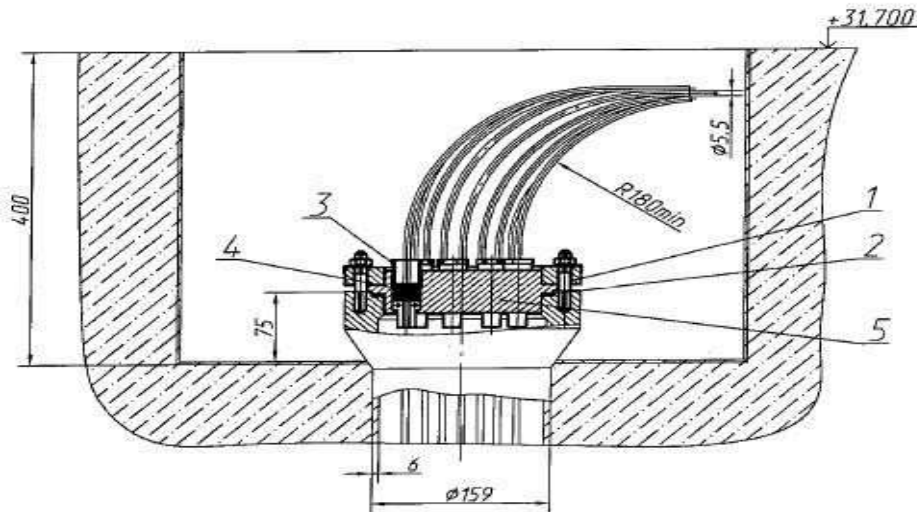
Detection unit motion mechanism drives:



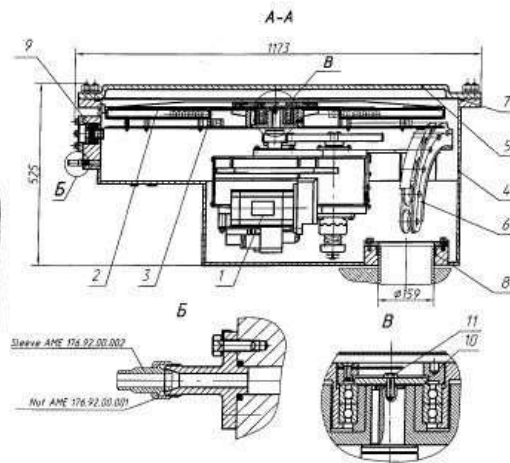
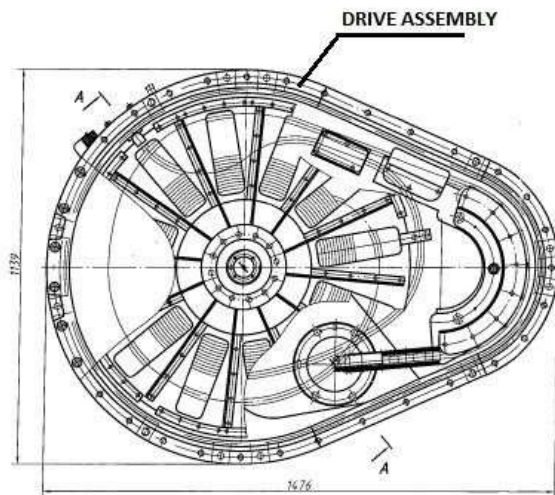
- e) Assemble the accessories of DU motion mechanism over the measuring channel flanges and seal the outer covers for avoiding foreign material entry inside the measuring channels.

TECHNICAL CONDITIONS OF CONTRACT (TCC)

Device for installation of detection units in channels 1,3,4,6,9,11,12,14 of actuating and operational range
(Mandatory)



Drive AME 176.01.00.000
(Mandatory)



1. Motor-reducer	5. Cover	9. Gasket
2. Fixed drum	6. Bracket	10. Washer
3. Movable drum	7. Seating	11. Bolt
4. Body	8. Ring	

TECHNICAL CONDITIONS OF CONTRACT (TCC)

4.7 Device for removal of control and protection system (jib crane):

- a) The device is intended for shifting the components of the drives of reactor control and protection system, studs of the reactor main joint, air vent elbow, air box for cooling of control and protection system drives as well as other equipment.
- b) The item is installed in one of two positions at +31.7mtr elevation, either on the embedded part located near the reactor or on the embedded part located near the upper unit inspection pit.
- c) The weight of the assembly is 8900 kg.
- d) The device consists of intermediate support (2 pcs), support with turning mechanism, post, arm, extension piece, maintenance platform, turn buckle, slings, control cabinet, handheld control panel. The item may be installed on either of the two places on two intermediate supports welded to the embedded parts.
- e) Intermediate supports shall be welded to the embedded plates located in reactor hall at +31.mtr elevation. Intermediate support is a welded plate of 1400mm diameter with twelve hole of M48.
- f) The device (post) is fixed to the intermediate support by means of studs, nuts and washer assembly.

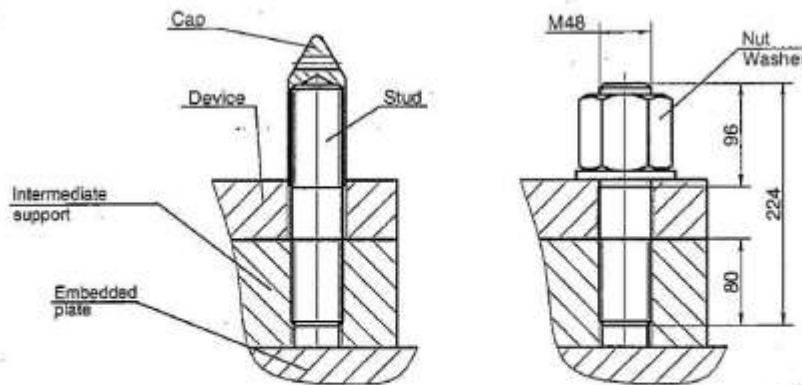


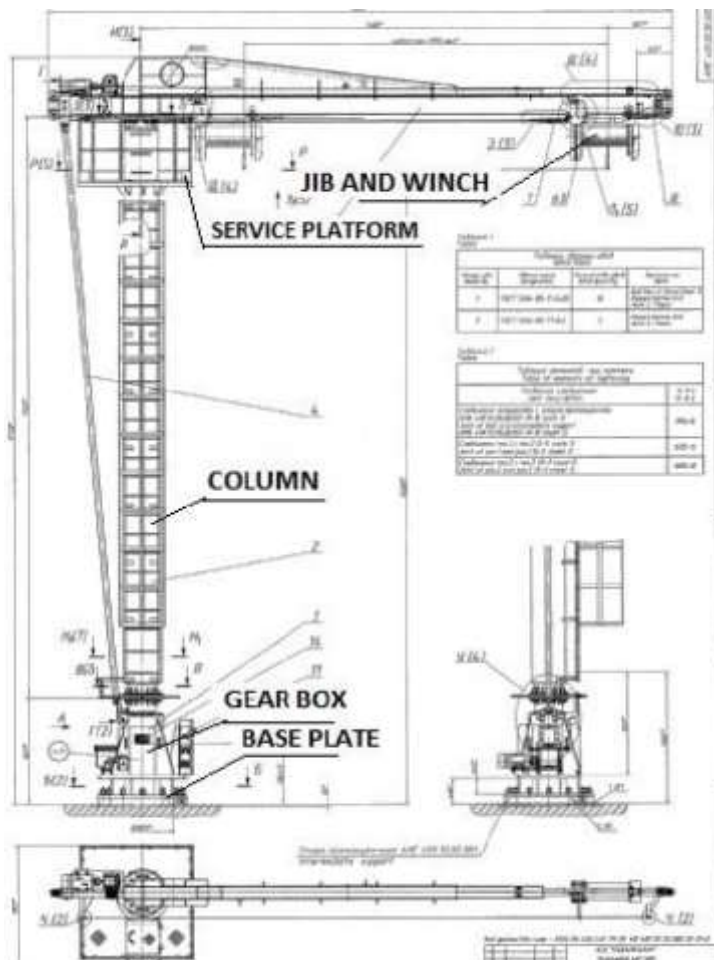
Fig.3

- Install the post (3) on the support with turning mechanism (2), fix them to each other

TECHNICAL CONDITIONS OF CONTRACT (TCC)

- g) Install the maintenance platform on the post and fix them to each other by means of bolts M16 and washers. Fix the extension piece onto the support with the turning mechanism by means of axle, nut M30 and washer. Install telfer, sling on the arm and provide tightening the sling with turn buckle and clamps of the sling. Install the arm with telfer and sling onto the assembled structure, fix them to each other by means of bolts M30, nuts and washers. Fix the extension piece to arm by means of axle, nut M30 and washer. Install the control cabinet on the wall of support and turning mechanism, control panel on the hooks located on the wall of the support with turning mechanism. Install electrical equipment in accordance with the requirements of wiring drawing.

Device for Incore Instrumentation Detection Withdrawal (jib crane)



TECHNICAL CONDITIONS OF CONTRACT (TCC)

- h) After complete assembly and commissioning load testing of device needs to be performed as per manufacturer instruction.

Approximate welding quantity envisaged for erection of reactor cavity equipments is provided below. The actual welding may vary on either side because of change of design or site conditions etc. The welding quantity is indicated only for the assessment of work. The unit rate quoted by the bidder is inclusive of erection and welding of equipments. No separate payment for welding or increase in quantity of welding will be considered. The contractor needs to factor in the variations in the cost quoted for the item.

S No	Name of equipment	Weld Quantity in CC (aprx)
1	Upper unit alignment device (guides)	6000
2	Protective steel structure	28000
3	Electrical equipment and heat control of reactor	2900
4	Thermal and biological shielding of nozzle area of reactor	36500
5	upper unit thermal insulation of reactor	11000
6	Device for removal of control and protection system of reactor	9800

5. Reports and Records:

- i. Erection reports at all stages of work, as-built drawings, welding inspection reports and NDE reports shall be prepared as per the established work procedures and submitted for acceptance.

TECHNICAL CONDITIONS OF CONTRACT (TCC)

2.2.4 TECHNICAL SPECIFICATION FOR ASSEMBLY, ERECTION, ALIGNMENT AND WELDING OF REACTOR INSPECTION WELL EQUIPMENTS

Sl No	Description
1	Purpose
2	Scope
3	Reactor inspection well equipments
4	Erection of reactor inspection well equipments
4.1	Guide alignment system of core barrel
4.2	Guide alignment system of protective tube unit (PTU)
4.3	Core barrel transportation device
4.4	PTU transportation platform
4.5	PTU spacer
4.6	PTU hatch
4.7	Racks for moving units & CPS drive extension shafts
4.8	Racks for pitch position indicator
4.9	Racks for electromagnet unit
4.10	Racks for drive housing
4.11	Platform for examination of upper unit
4.12	Air duct
5	Reports and records

1. Purpose:

The purpose of this procedure is to provide guidance to contractor to understand the scope & quantum of work and technical requirements to be followed during assembly, erection, alignment, welding and inspection of reactor inspection well equipments.

2. Scope

The scope of the contractor's work comprises but not limited to the following.

- Study of drawings, preparation of network schedules.
- Preparation and approval of QAP, erection, welding and inspection procedures, Preparation of erection schemes.
- Receipt of material from NPCIL/BHEL store, transportation, storage.
- De-preservation & dimensional survey of equipments

TECHNICAL CONDITIONS OF CONTRACT (TCC)

e) Handling, assembly, erection, alignment, welding and inspection.

3. Reactor inspection well equipments:

Reactor inspection well equipments consist of following.

- a) Guide alignment system of Core Barrel
- b) Guide alignment system of PTU(protective tube unit)
- c) Core Barrel transportation device
- d) PTU transportation platform
- e) PTU spacer
- f) PTU hatch
- g) Racks for electromagnet Unit
- h) Racks for drive Housing
- i) Racks for moving units & CPS drive extension shafts
- j) Racks for pitch position indicator
- k) Platform for examination of upper Unit
- l) Air duct
- m) Pulley Assembly
- n) Cone and cover centering block

S No	Description of item	Weight in MT	Size in mm.
1	Guide alignment system of Core Barrel	2.9	L-7120,W-400,
2	Guide alignment system of PTU (protective tube unit)	2.6	L-6450,W-400, thickness-432
3	Core Barrel transportation device	70	Φ4010*3450 height
4	PTU transportation platform	25	Φ3500*8650 height
5	PTU spacer	38	Φ3925*2830 height
6	PTU hatch	39	Φ4000*450
7	Racks for electromagnet Unit	9	L-3850,B-2608, H- 2608
8	Racks for drive Housing	7	L-3780,B-2652, H-1850
9	Racks for moving units & CPS drive extension shafts	9.5	L-2500,B-530, H-6315
10	Racks for pitch position indicator	2	L-3220,B-540, H-770
11	Platform for examination of upper Unit	7	L-6500,B-5400, H-6800
12	Air duct	0.34	

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Ref. drawings:

1. R02.KK.3UJA.FJB.RP.MC.WD003, R01.KK.1 UJA.FJB.TP.OK. WD015- Equipment of inspection wells stage I & II. & RPV internals inspection shafts, Mounting Drawing.
2. R56.KK.3UJA.FJB.TM.SB.WD613 - Core Barrel transportation device.
3. R56.KK.3UJA.FJB.TM.SB.WD639 - Erection of PTU transportation platform.
4. R56.KK.3UJA.FJB.TM.SB.WD634 - Erection of PTU spacer.
5. R56.KK.3UJA.FJB.TM.SB.WD635 - Erection PTU hatch.
6. R56.KK.3UJA.FJB.TM.SB.WD902 - Racks for electromagnet Unit.
7. R56.KK.3UJA.FJB.TM.SB.WD903- Racks for drive Housing.
8. R56.KK.3UJA.FJB.TM.SB.WD612 - Racks for moving units and CPS drive extension shafts
9. R56.KK.3UJA.FJB.TM.SB.WD1045 - Racks for pitch position indicator.
10. R56.KK.3UJA.FJB.TM.SB.WD636 - Platform for examination of upper Unit.
11. R56.KK.3UJA.JAB.TM.SB.WD1125 - device for cover centering.
12. R56.KK.3UJA.FJB.TM.SB.WD614 - Guide alignment system of PTU.
13. R56.KK.3UJA.FJB.TM.SB.WD618 - Guide alignment system of Core Barrel.
14. 1204.01.33.000CB - Air Duct assembly Drawing.

4. Erection of Reactor inspection well equipments:

A brief detail of work for main components is provided below. However contractor has to execute the work by fulfilling all the requirements of working drawings\manufacturer's instructions for satisfactory completion of said work.

4.1 Guide alignment system of core barrel:

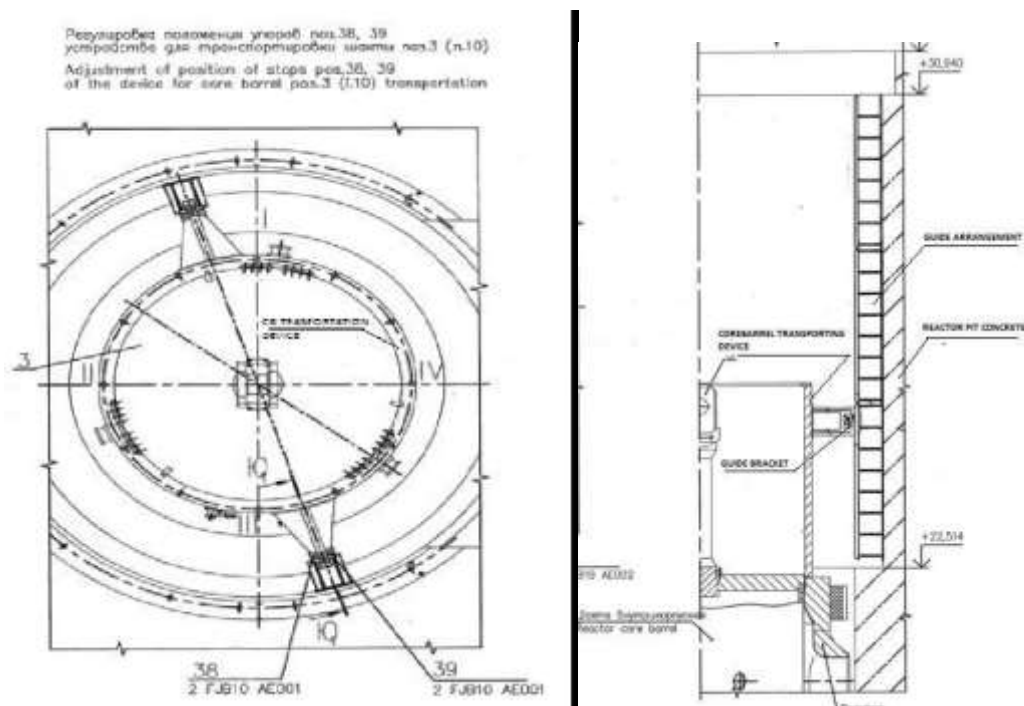
Alignment device is intended for guiding the core barrel smoothly inside RPV, core barrel inspection pit. It consists of two Upright guides and two brackets welded to core barrel transporting device. Brackets are provided with thrust devices; thrusts shall be installed and welded after final installation of guides during mounting.

- a) Guide alignment system consist of guide to be fixed to reactor cavity wall and bracket welded to the handling and transportation assembly of reactor internal and upper unit during erection and operation of unit.

TECHNICAL CONDITIONS OF CONTRACT (TCC)

- b) Alignment guide used for upper unit shall also to be used for core barrel and PTU alignment.
- c) Mount the core barrel transportation device over aligned core barrel inside RPV.
- d) Install and align the brackets over core barrel transportation device by smoothly guiding the bracket slider inside UU guide and fasten with bolting assembly.
- e) Ensure the clearance between bracket thrust and guide face should be within 1.5 mm. To adjust the gap it is permitted to adjust the bolts of thrust.
- f) Carry out trial lifting and lowering of core barrel multiple times and observe for smooth movement of core barrel bracket slider inside UU guides. If required adjust the bolts of brackets.
- g) After obtaining the required clearance doweling and tack welding of thrust plate to brackets shall be performed. Final full welding of thrust plate shall be performed only after completion of hot run of Reactor systems and clearance by Engineer. .
- h) Lift the core barrel with core barrel transportation device from RPV and install it over inspection well pit, align the core barrel as per drawing requirement.
- i) By keeping the core barrel in aligned condition inside inspection well pit, transfer the guide markings to the inspection well wall based on alignment brackets of core barrel transportation device. Mark the guide seating area over EPs, core barrel seating area over pit EP. Obtain as built dimensions of embedded parts of inspection well wall along the entire length (7.2 mtrs) of the embedded parts. Based on these dimensions either machining of seating area of guides or insertion of shim plates between guides and embedded part shall be made to achieve drawing requirements. Machining / shimming activities, as per requirement, are included in the scope & rate of this item.
- j) Fit up and welding of studs for mounting of core barrel guides. Installation of guides over studs, alignment, fixing of nuts.
- k) Carry out trial lifting and lowering of core barrel multiple times and observe for smooth movement of core barrel bracket slider inside Core barrel guides. Adjust the guides by loosening the nuts for achieving the smooth movement. For carrying out adjustment of guides, core barrel needs to be handled multiple times between inspection well and RPV. The cost of handling core barrel multiple times for achieving the required clearance and smooth movement is included in this item.

l) Ensure the clearance between bracket thrust and guide face should be within 1.5 mm.



4.2 GUIDE ALIGNMENT SYSTEM OF PROTECTIVE TUBE UNIT (PTU):

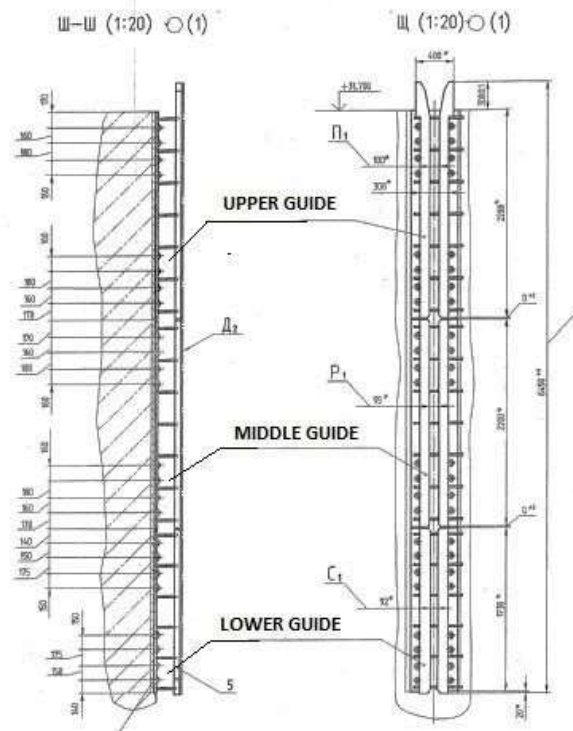
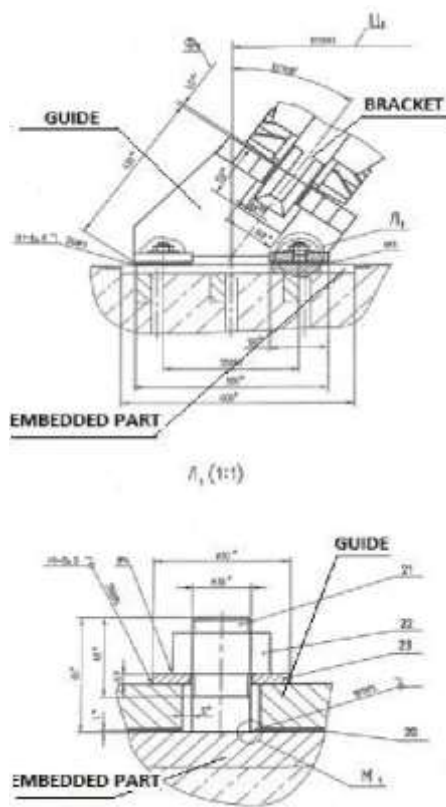
Alignment device is intended for guiding the protective tube unit smoothly inside RPV, PTU inspection pit. It consists of two Upright guides and two brackets (sliders) welded to PTU transportation platform. Brackets are provided with thrust devices; thrusts shall be installed and welded after final installation of guides during mounting. Weight of guide alignment system is 2568 kg

- Mount the PTU transportation platform over aligned PTU inside RPV.
- Install and align the brackets over PTU transportation platform by smoothly guiding the bracket slider inside UU guide and fasten with bolting assembly.
- Ensure the clearance between bracket thrust and guide face should be within 1.5 mm. To adjust the gap it is permitted to adjust the bolts of thrust.
- Carry out trial lifting and lowering of PTU multiple times and observe for smooth movement of PTU transportation platform bracket slider inside UU guides. If required adjust the bolts of brackets.
- After obtaining the required clearance tack welding of thrust plate to brackets shall be performed. Final welding of thrust plate shall be performed only after completion of hot run of Reactor systems and clearance from Engineer in charge.
- Lift the PTU with PTU transportation platform from RPV and install it over inspection well pit, align the PTU as per drawing requirement.

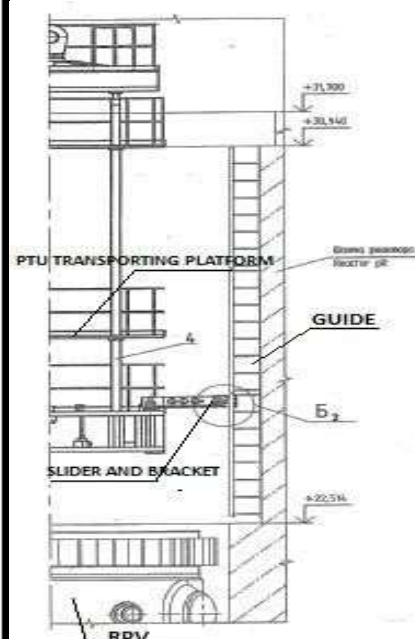
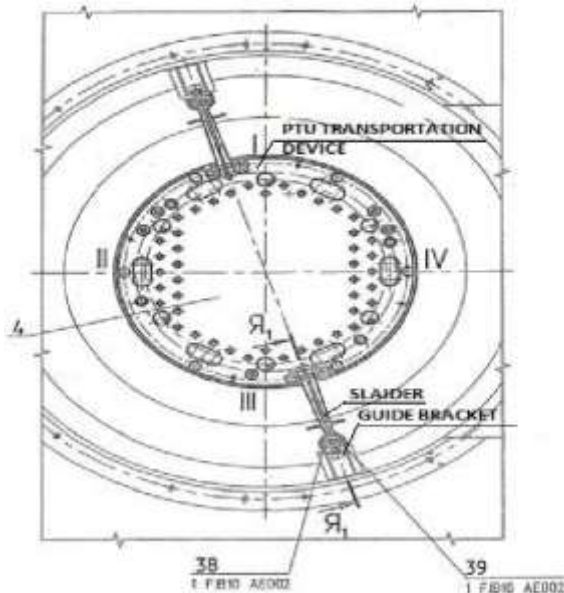
TECHNICAL CONDITIONS OF CONTRACT (TCC)

- g) By keeping the PTU in aligned condition inside inspection well pit, transfer the guide markings to the inspection well wall based on alignment brackets of PTU transportation platform. Mark the guide seating area over EPs of inspection well. Obtain as built dimensions of embedded parts of inspection well wall along the entire length (6.5 mtrs) of the embedded parts. Based on these dimensions either machining of guides on seating area or insertion of shim plates between guides and embedded part shall be made to achieve drawing requirements. . Machining / shimming activities, as per requirement, are included in the scope & rate of this item.
- h) Fit up and welding of studs for mounting of PTU guides. Installation of guides over studs, alignment, fixing of nuts.
- i) Carry out trial lifting and lowering of PTU multiple times and observe for smooth movement of PTU transportation platform bracket slider inside PTU guides. Adjust the guides by loosening the nuts for achieving the smooth movement. For carrying out adjustment of guides, PTU along with PTU transportation platform needs to be handled multiple times. The cost of handling PTU along with PTU transportation platform multiple times for achieving the required clearance and smooth movement is included in this item.
- j) Ensure the clearance between bracket thrust and guide face should be within 1.5 mm.
- k) After ensuring smooth movement of PTU transportation platform slider inside guides, clearance between brackets thrust and guide face, weld the PTU guides with embedded part. Carry out welding of nut to washer, washer to guide, nut to stud (96 nos).

TECHNICAL CONDITIONS OF CONTRACT (TCC)



Adjustment of position of stops pos.38, 39 of the platform for transportation of protective tube with pos.4 (1.50)



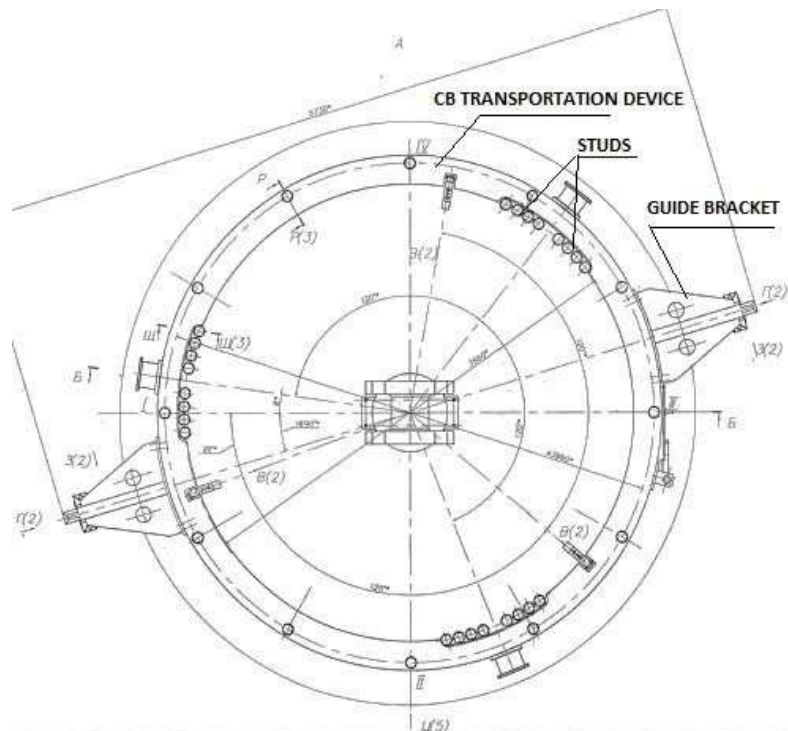
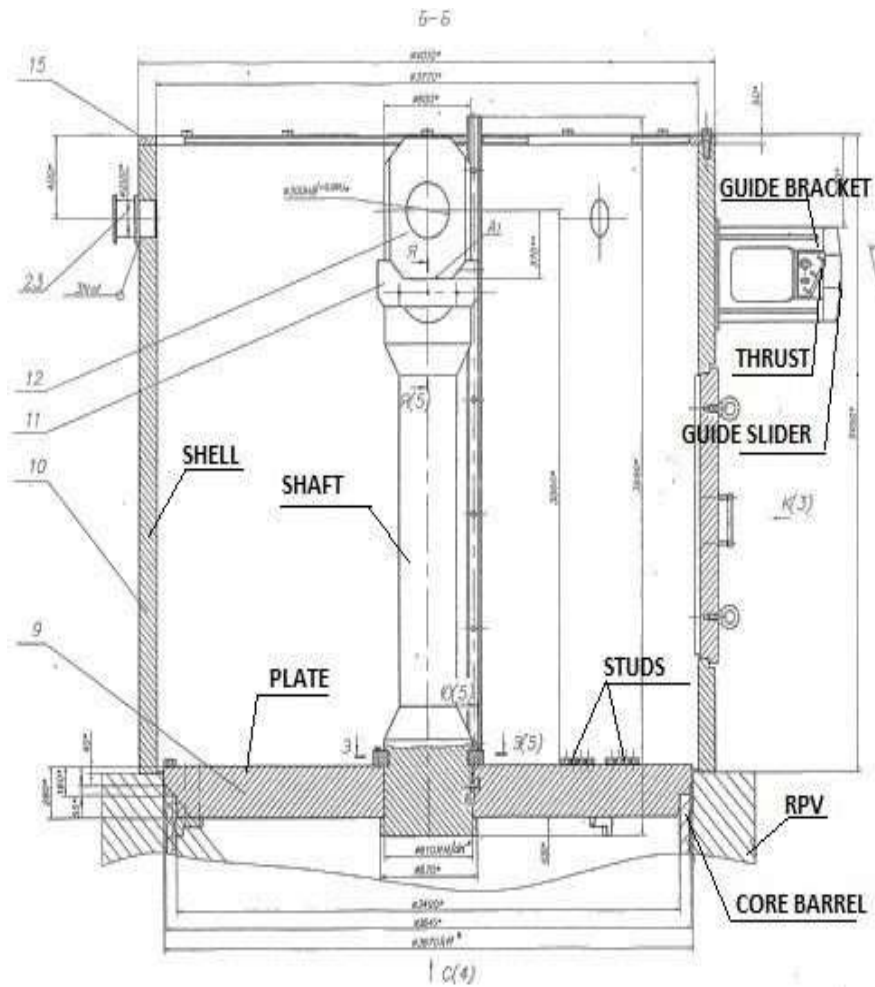
TECHNICAL CONDITIONS OF CONTRACT (TCC)

4.3 Core Barrel transportation device:

- a) Core Barrel transportation device is intended for handling, removal of core barrel from the reactor, its transportation and installation into core barrel inspection wells.
- b) Device consists of shell that serves for radiation protection during transportation of the reactor core barrel, plate with lug. The plate is intended for connection with reactor core barrel by means of 24 bolts. The lug is intended for connection of the device to polar crane jaw during the device transportation.
- c) Two brackets are fastened (by bolting, alignment with guides, doweling, welding) with the outside of the shell for alignment in the inspection wells as well as in the reactor concrete cavity. Three journals are fastened outside the shell for its transportation. Three guides are fastened on the shell internal surface by means bolting & welding.
- d) The guides together with three keys on the plate provide the device plate alignment relative to the core barrel during its removal/installation. Ring is fastened on the upper end face of the shell. The device plate sets against this ring during transportation of the shell together with the plate and the core barrel. Door is provided in the shell for access inside the device and for carrying out works with the equipment.
- e) The assembly of the above described individual components shall be done at site by following manufacturer's instructions. Weight of Core Barrel transportation device assembly is: 70 MT.

TECHNICAL CONDITIONS OF CONTRACT (TCC)

Core Barrel transportation device:



TECHNICAL CONDITIONS OF CONTRACT (TCC)

4.4 PTU transportation platform:

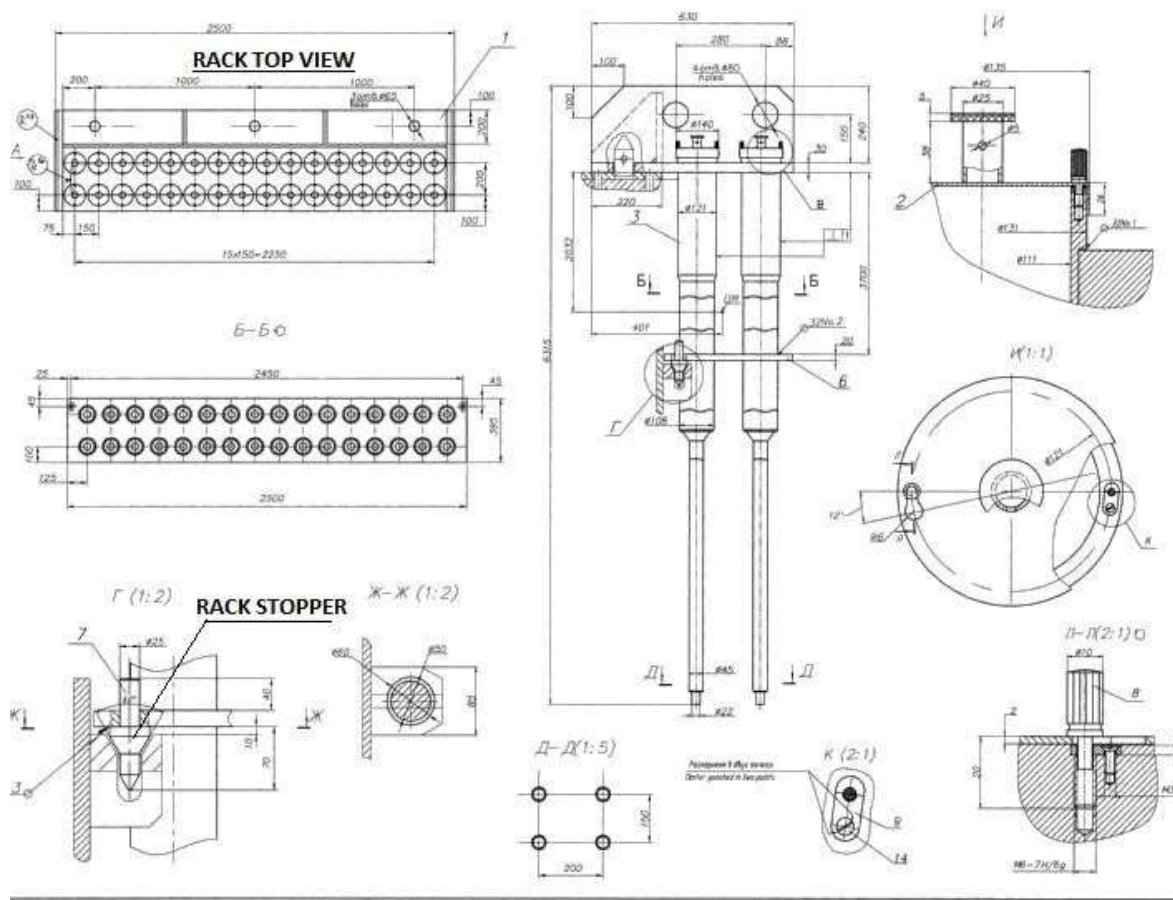
- a) PTU transportation platform is designed for handling, removal of the PTU from the reactor, for transportation and installation into the PTU inspection well.
- b) The PTU transportation platform assembly is a welded steel structure, made of four platforms which are connected with each other by means of eight posts. In the upper part the four posts end with M90*6 thread for connection with traverse of upper unit. The PTU shall be transported by means of PTU transportation platform attached to polar crane. Ladders between the platforms and manholes in the platforms are provided for the PTU maintenance. Three upper platforms are encircled with guards.
- c) In the lower platform there are holes for six grips with M80*6 thread to connect the platform with the PTU and there are four thrusts, entering the spacer groove, to fasten the platform against seismic impact. The thrusts are controlled from the second platform.
- d) Two bracket sliders were fastened (by bolting, alignment with guides, doweling, welding) on PTU transportation platform for alignment of the platform into the alignment system guides located in the PTU IW (inspection wells) and in the reactor concrete cavity.
- e) Six thrusts providing installation of the platform on the inspection well spacer. The sliders are fixed with locks in horizontal and vertical positions.
- f) When sliders and thrusts are removed the platform can travel inward the spacer and the inspection well up to the well bottom. 121 holes of 80mm diameter are made in platforms for inspection of CPS drives extension shafts, which are placed in the PTU. Weight of PTU transportation platform assembly is: 24 MT.
- g) The assembly of the above described individual components (ladders, bracket sliders etc.,) shall be done at site by following manufacturer's instructions.



TECHNICAL CONDITIONS OF CONTRACT (TCC)

4.7 Racks for moving units & CPS drive extension shafts:

The rack is designed for storage of the motion units and the extension shafts of CPS drives during reactor refueling and inspection.



- Handling, lifting, erection, alignment of Racks for moving units & CPS drive extension shafts over embedded part located near inspection well at +31.7 mtr.
- Enlarge the holes of the rack, if found necessary, for matching with the embedded part.
- Install the locator ring over EP for guiding the rack, align and weld the locator ring.

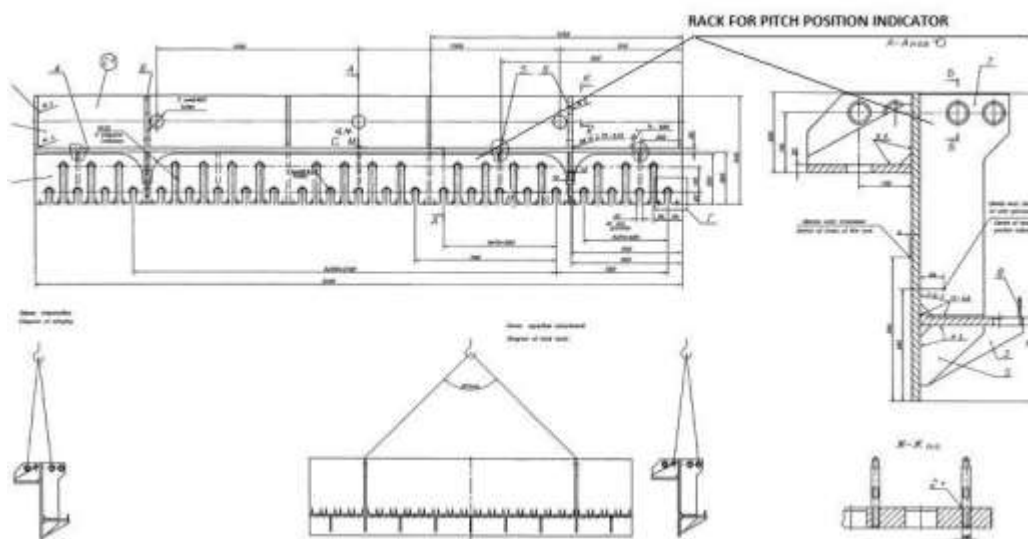
TECHNICAL CONDITIONS OF CONTRACT (TCC)

4.8 Racks for pitch position indicator:

Rack for pitch position indicators of CPS drives is intended for installation and storage of position indicators of CPS drives for the period of the upper unit mounting and dismounting. The rack is a welded steel structure that consists of a vertical slab welded to its support (to install the rack onto the embedded part) and a rack projection with slots (to install position indicators into them)

- Handling, lifting, erection, alignment of Racks (3 numbers) for pitch position indicators over embedded part located near inspection well at +31.7 mtr.
- Enlarge the holes of the rack, if found necessary, for matching with the embedded part.
- Aligning the racks, fastening the rack assembly with locking pins with the embedded part.
- d) Weight of Rack for pitch position indicator is: 700 Kg. Total weight of 3 racks (per unit) is: 2.1 MT

Racks for pitch position indicator:

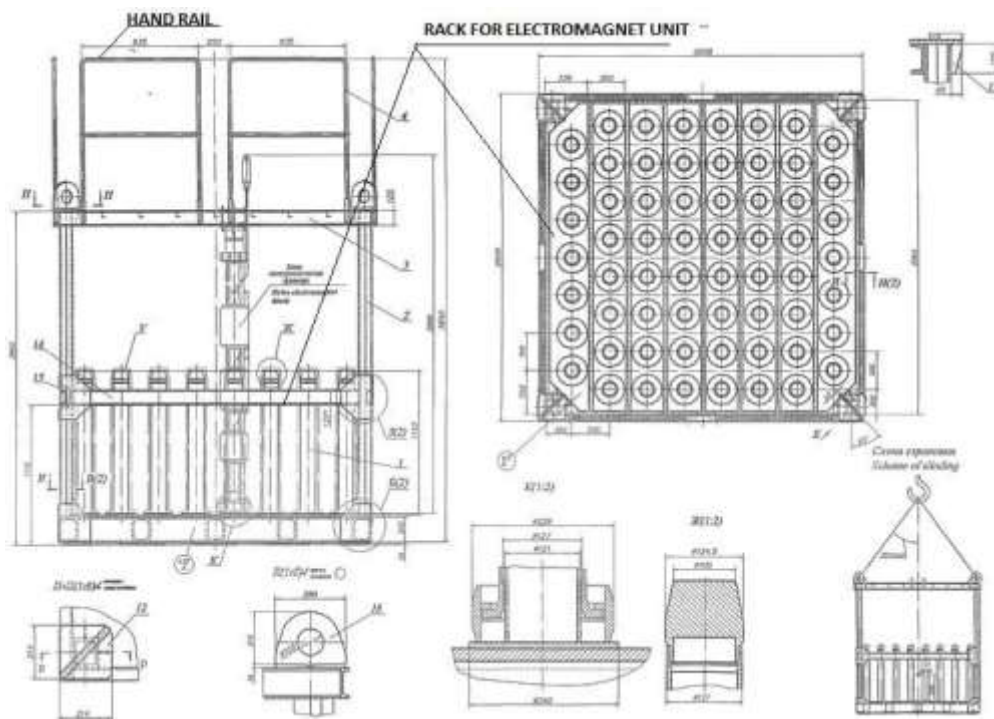


TECHNICAL CONDITIONS OF CONTRACT (TCC)

4.9 Racks for electromagnet Unit:

- The rack for electromagnet blocks of drive is intended for storage of the CPS drive of electromagnet blocks during inspection of the upper unit and CPS drives.
- Handling, lifting, erection, alignment of Racks (2 numbers) for electromagnet Units over the liner near inspection well at +31.7 mtr.
- Alignment of the racks, install the handrails over rack units.
- Weight of rack for electromagnet blocks of drive is: 4.53 MT. Total weight of 2 racks (per unit) is: 9.06 MT.

Racks for electromagnet Unit

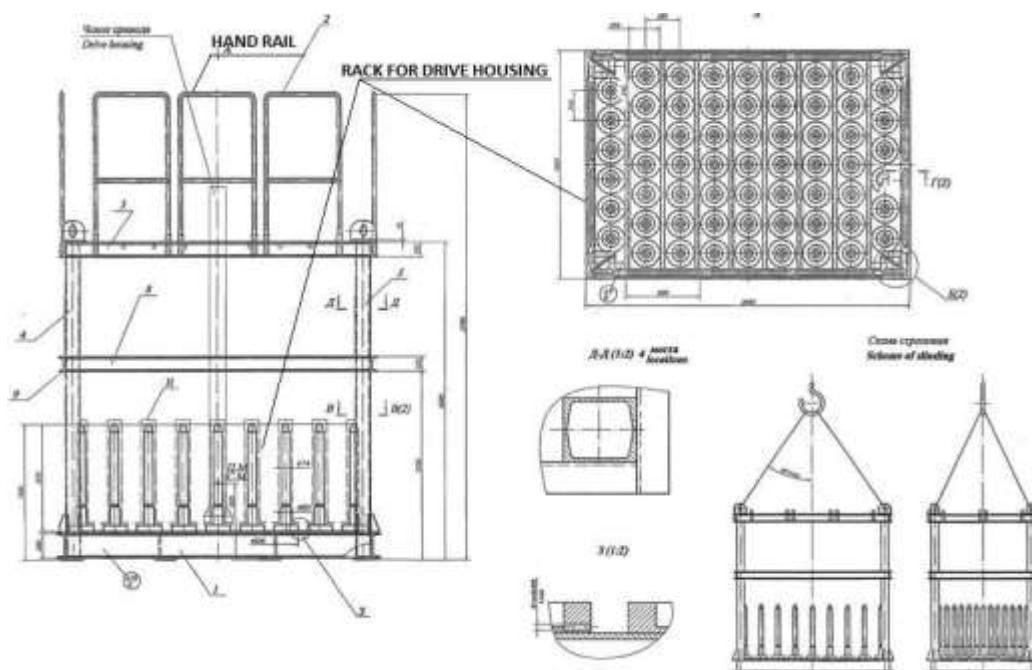


TECHNICAL CONDITIONS OF CONTRACT (TCC)

4.10 Racks for drive Housing:

- a) Rack for drive housing is intended for arrangement and transportation of drive housings.
- b) Handling, lifting, erection, alignment of Racks (2 numbers) for drive housing over the liner near inspection well at +31.7 mtr.
- c) Alignment of the racks, install the handrails over rack units.
- d) Weight of rack for electromagnet blocks of drive is: 3.35 MT. Total weight of 2 racks (per unit) is: 6.7 MT

Racks for drive Housing



4.11 Platform for examination of upper Unit:

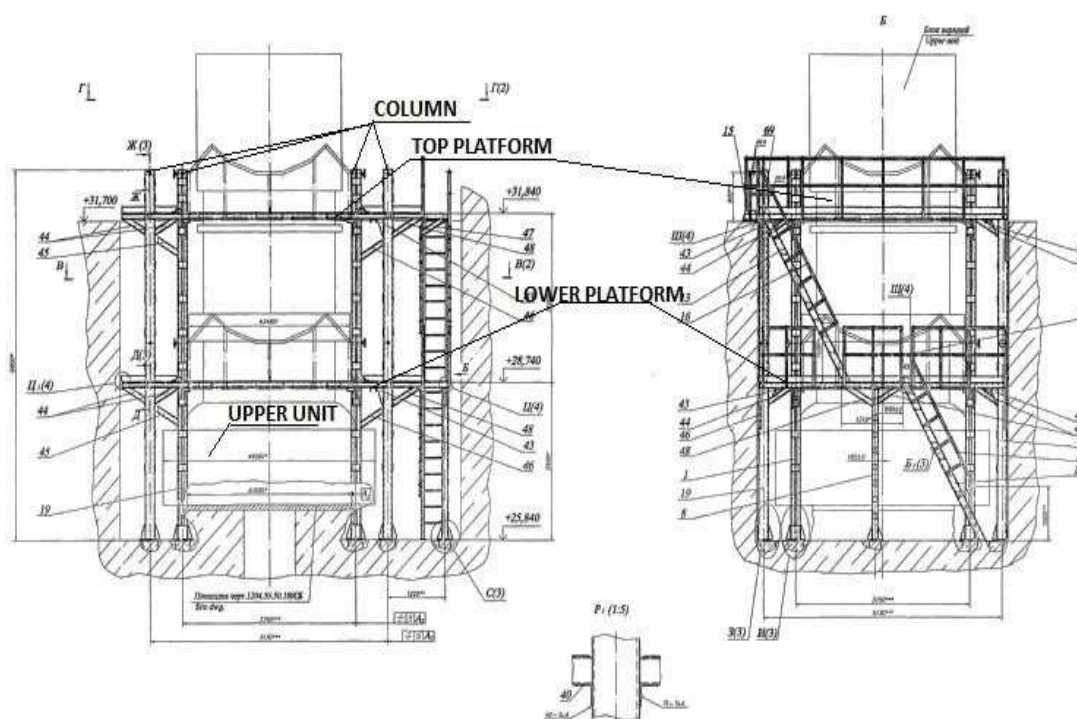
- a) Platform for examination of upper unit is designed to provide personnel access and equipment supply to the upper unit when inspecting at the installation place in the inspection well. Weight of platform for examination of upper unit : 6.88 MT
- b) It consists of many parts (aprx 300 nos) for which assembly and installation needs to be performed at site as per the assembly drawing. Mainly Columns of the platform shall be welded to embedded parts of inspection well pit. Two

TECHNICAL CONDITIONS OF CONTRACT (TCC)

service platforms (8 folding platforms) fastened to erected columns by means of journal assembly.

- c) The folding platforms functioning shall be checked after full assembly for opening and closing. Assemble the ladders and fasten it to platform by means of welding.

Platform for examination of upper unit:

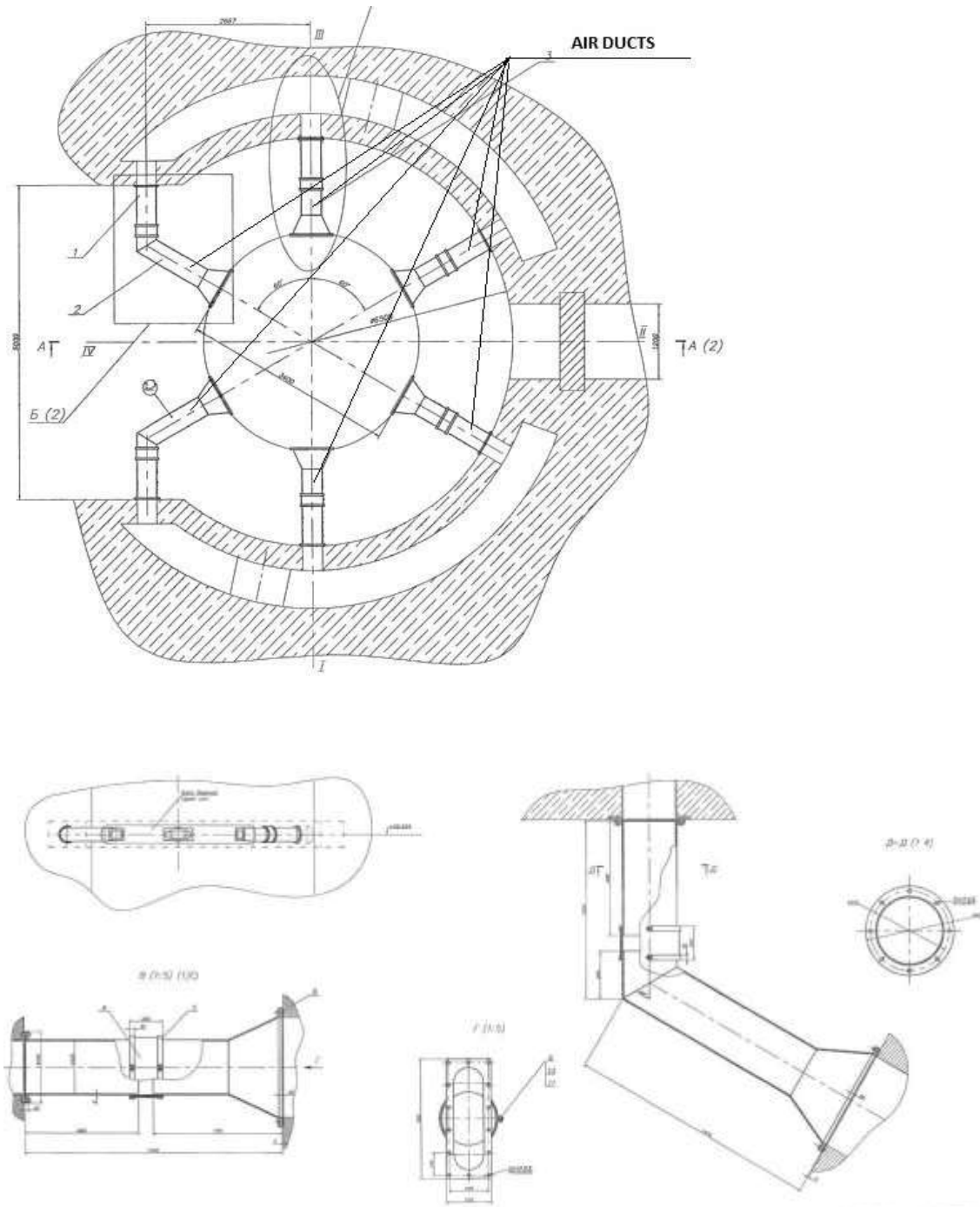


4.12 Air duct: air duct is a set of assembly units, parts, fastening elements intended for removal of air supplied for cooling down reactor upper unit.

- a) The air duct assembly consists of 4 rectilinear ducts, two angle ducts, six nozzles, six collars, twelve numbers of yokes, twelve numbers of flanges, paronite gaskets and fastening elements.
- b) The four rectilinear ducts were aligned axially with upper unit cooling chamber flanges & concrete cavity penetration flanges, two angle duct sections connected together by rubber collars fastened on the ducts by yokes. Ducts fastening to the upper unit shall be performed by bolts M16 with paronite gaskets, fastening to the concrete cavity shall be performed by bolts M16 with rubber gaskets.
- c) Such a structure is designed for compensation of upper unit temperature displacement relative to the concrete cavity.
- d) For aligning of ducts with concrete cavity minor modifications of ducts shall be performed.

TECHNICAL CONDITIONS OF CONTRACT (TCC)

Air duct:



TECHNICAL CONDITIONS OF CONTRACT (TCC)

Approximate welding quantity envisaged for erection of Reactor inspection well equipments is provided below. The actual welding may vary on either side because of change of design or site conditions etc. The welding quantity is indicated only for the assessment of work. The unit rate quoted by the bidder is inclusive of erection and welding of equipments. No separate payment for welding or increase in quantity of welding will be considered. The contractor needs to factor in the variations in the cost quoted for the item.

S No	Name of equipment	Weld Quantity in CC (aprx)
1	Erecting guide alignment system of core barrel of reactor	3600
2	Erecting guide alignment system of	3500
3	Core Barrel transportation device	1650
4	PTU transportation platform	200
5	Erecting Platform for examination of upper unit	6700

5. Reports and Records:

- i. Erection reports at all stages of work, as-built drawings, welding inspection reports and NDE reports shall be prepared as per the established work procedures and submitted for acceptance.

TECHNICAL CONDITIONS OF CONTRACT (TCC)

2.2.5 TECHNICAL SPECIFICATION FOR ASSEMBLY, ERECTION & WELDING OF STEAM GENERATOR AND ITS SUPPORTS (JEA)

Sl No	Description
1	Purpose
2	Scope
3	Erection of steam generator assembly (SG) : General introduction
4	Erection of steam generator support assembly
5	Erection of steam generator
6	Erection of steam generator accessories
7	Re-box up of primary, secondary collector covers and manholes by replacing nickel gaskets
8	Erection of steam generator header
9	Reports and Records

1. Purpose:

The purpose of this procedure is to provide guidance to contractor to understand the scope & quantum of work and technical requirements to be followed during erection, alignment, welding and inspection of steam generator and its support assembly.

2. Scope:

The scope of the contractor's work comprises but not limited to the following.

- Study of drawings, preparation of network schedules.
- Preparation and approval of QAP, erection, welding and inspection procedures, Preparation of erection schemes.
- Receipt of material from NPCIL/BHEL store, transportation, storage.
- De-preservation of steam generator support components, dimensional survey (optical) for all the components.
- Handling, pre-assembly, erection, alignment, welding and inspection.

3. Erection of Steam Generator assembly (SG):

General introduction:

The Steam generator is a heat-exchanging device of horizontal type with submerged heat exchanging tube surface. The SG is connected to the MCP pipelines and other systems including feed water and steam line systems. SG rest upon two movable supports and is fixed by eight hydraulic absorbers and fasteners.

TECHNICAL CONDITIONS OF CONTRACT (TCC)

S No	Description	Parameter
1	Design Pressure (shell side)	7.84 MPa
2	Design Pressure (tube side)	17.64 MPa
3	Design Temperature (shell side)	300 °C
4	Design Temperature (tube side)	350 °C
5	Size of SGs	Dia 5.50m and Length 14 m
6	Weight (without support)	310 M T
7	Weight (with supports & accessories)	425 MT

The steam generator assembly comprises of following components (per SG):

S No	Description of item	Quantity	Weight
1	Steam generator vessel	1	310 MT
2	Steam generator support assembly	2	60 MT
3	Steam header	1	7.2 MT
4	Single chamber surge tanks	10	150 Kg
5	Double chamber surge tanks	4	440 Kg
6	Hydraulic shock absorbers	8	14 MT

The nozzles are provided in the SG for piping connection for feed water, steam removal & condensate from PHRS, SG blow down and cool down system, SG drain system, blow down return system, nozzles for various sampling and I & C requirements.

4. Erection of Steam generator support assembly:

Steam generator support assembly consists of two sets of roller supports, foundation bed, Saddle supports, Shim plates, connecting tie rods, and couplings, cross beams, embedded components and fasteners. The steam Generator support is designed to take up the weight and vertical component of outside dynamic impacts. The sequence of erection is given below

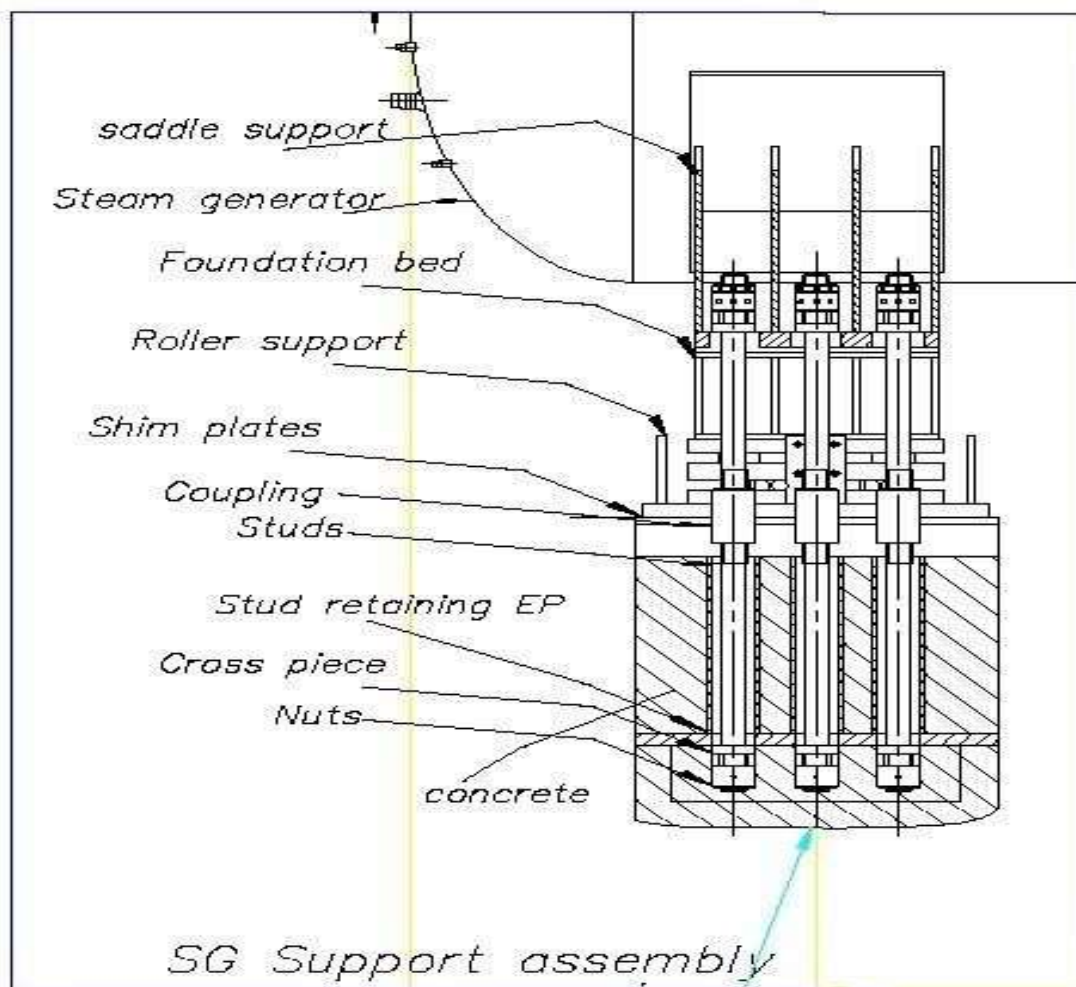
- Providing temporary Working platform / scaffoldings on both steam generator concrete pedestals all around the periphery.
- Survey and make as-built details of Steam generator embedded parts /components on civil concrete pedestal using optical instruments.
- Arrange suitable jigs and fixtures for lifting of steam generator support assembly for insertion of additional shim plates for elevation correction.
- The steam generator supports co-ordinate position and elevation is based on the as built co-ordinates of Reactor pressure vessel hot collector nozzle. For

TECHNICAL CONDITIONS OF CONTRACT (TCC)

adjustment of elevation of steam generator shim plates of thickness 40mm, 20mm, 10mm, and 4mm are provided.

- e) Check and record Design movement of roller supports in both longitudinal and transverse direction.
- f) The Steam generator support assembly has to be pre-assembled over specially designed and erected leveled platform outside reactor building.

STEAM GENERATOR SUPPORT ASSEMBLY



- g) Prepare Steam generator saddle supports profile template in order to match the steam generator seating profile, and carry out necessary corrections in the saddle support to match the profile of the corresponding steam generator by local grinding.

TECHNICAL CONDITIONS OF CONTRACT (TCC)

- h) Trial assembly of roller supports, foundation bed, saddle support, and steam generator template is to be carried out on a leveled platform and check for required dimensions in order to decide the required number and thickness of shim plates to be used for final erection.
- i) Survey Reactor pressure vessel nozzles, steam generator collector bottom elevations, trial assembly readings and analyze the shim plate's thickness required, mark the axis of steam generator supports on SG concrete pedestals.
- j) Erect and align Steam generator support assembly components (shim plates, roller supports, foundation bed, and saddle support) and measure elevation after each component installation.
- k) Adjust/ correct elevation and insert shim plates if required for achieving the designed elevation of steam generator.
- l) Weld steam generator support saddle with steam generator after final alignment of steam generator.
- m) Cut and remove SG saddle middle portion as per drawing requirement after completion of saddle welding and grinding and finishing of edges.
- n) Shift, Install and align steam generator support anchor studs (tie rods), cross piece, washer, nuts and stud retainer plate in the concrete pockets provided in the SG concrete pedestal.
- o) After completion of grouting/concreting of the pockets align the studs, ensure design clearances between stud to stud inside the coupling.
- p) Re-preservation of weld joints and other damaged areas with OC-51 paint.
- q) Preparation of reports and acceptance
- r) It is envisaged that SGs saddle can be welded to SG outside reactor building. Option of welding SG saddle support with steam generator shall be verified after considering as built details of support assembly, hatch openings, mounting traverse tilting provision etc.

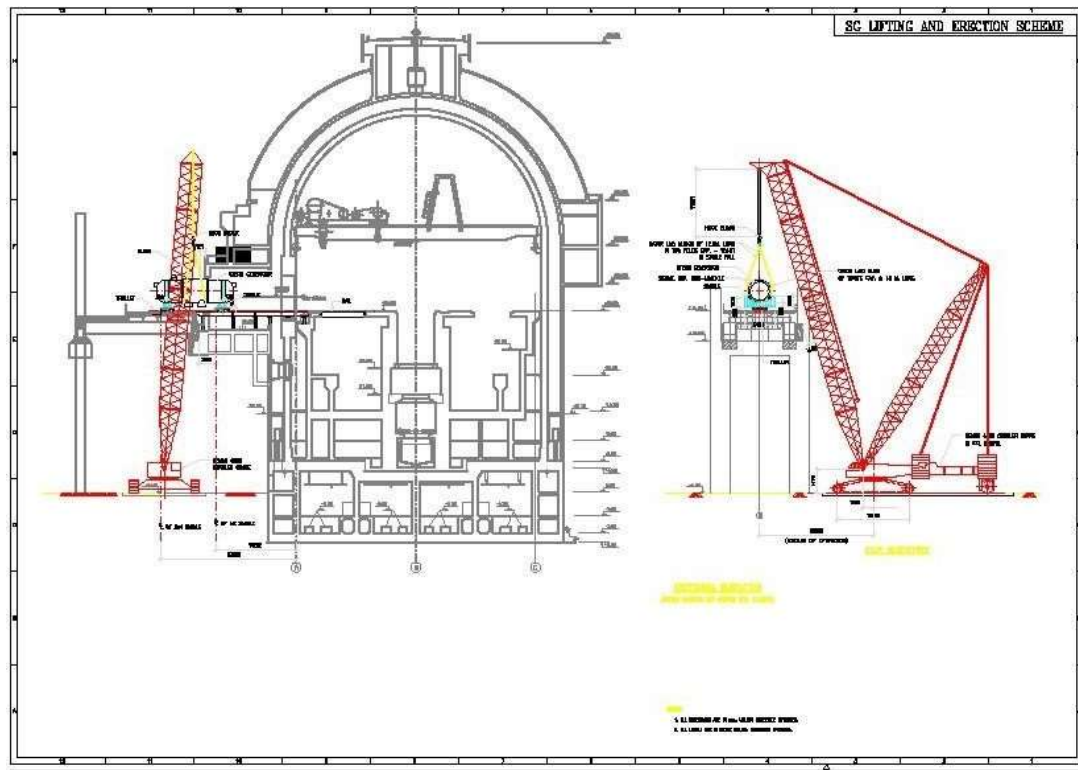
5. Erection of Steam generator:

The sequence of movement, lowering, erection, alignment, welding and inspection of SGs are elaborated below.

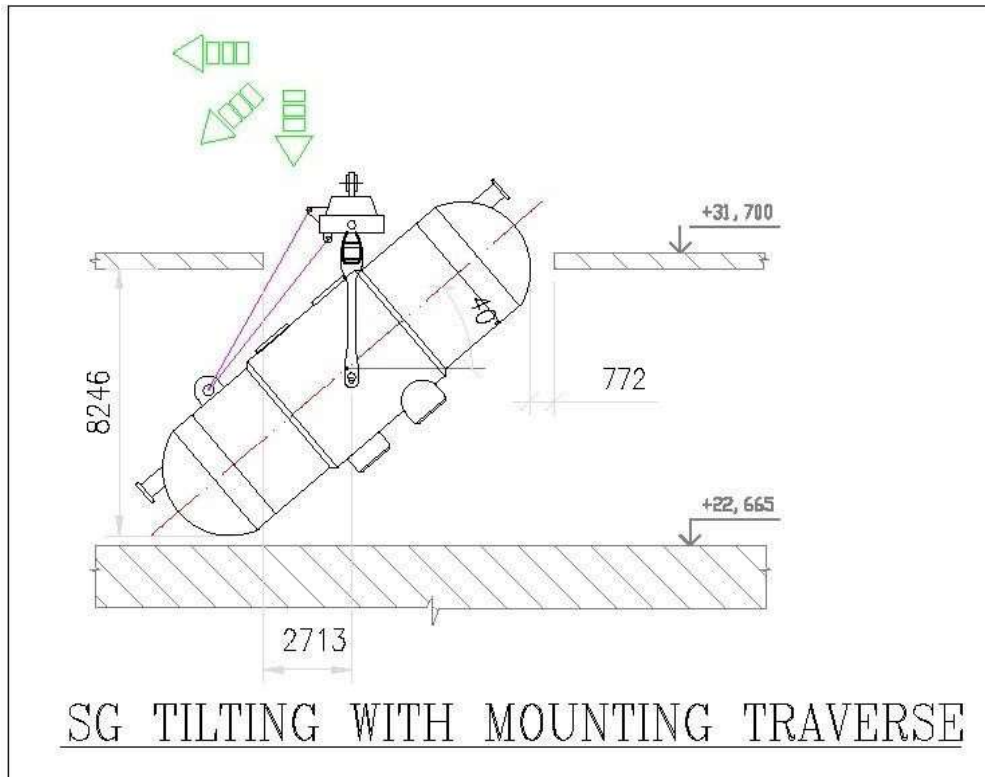
TECHNICAL CONDITIONS OF CONTRACT (TCC)

- a) Preparation of erection schemes of steam generator lifting using free issue heavy duty crane, movement using electrical winch arrangement provided by the contractor, erection with detailed drawings considering the layout of the reactor building, transport portal, configuration of heavy duty crawler crane.
- b) Ensure all higher dimension items (Pipelines, Valves of lower floors) needs to be lowered inside building (ALA area) before erection of steam generators.
- c) Steam generators lifting journals and brackets fit up and welding shall be completed in NPCIL store with detailed procedure, including providing staging, covered shed for welding.
- d) Steam generators lifting journals and brackets welding needs to be done with pre-heating and nitrogen preservation inside Steam generator. Sufficient care needs to be taken while carrying out welding.
- e) Removal of paint on steam generator & saddle support (de-preservation) for welding of saddle supports.
- f) Heavy duty crane will be provided by NPCIL as free of cost for erection. Contractor has to arrange the sling and de-shackle and other tools & tackles of adequate capacity & sizes for lifting outside the building. All lifting tools and tackles should be load tested before put in use.
- g) NPCIL will issue steam generator lifting traverse for handling, tilting and erection of SGs inside the reactor building. The same needs to be assembled and commissioned and load tested before lifting steam generator.
- h) Steam generator initial lifting from outside RB on to transport portal trolley shall be carried out by heavy duty crawler crane and further shifting to inside RB with the help of erection trolley and winch mechanism.

TECHNICAL CONDITIONS OF CONTRACT (TCC)



- i) Steam generator lifting traverse along with shackles shall be mounted on steam generator and trial lifting and tilting shall be carried out.
- j) Steam generator support assembly will be in assembled condition, and suitable jigs and fixtures arrangement to be made for lifting of support assembly for insertion of fine shim plates for fine adjustment of SG elevation.
- k) Steam generator will be lifted with the help of polar crane, tilted with the help of mounting traverse to clear SG hatch opening (SG hatch opening is smaller than length of SG) and placed on the steam generator support assembly.
- l) Alignment of steam generator will be carried out and fit up of Steam generator with saddle support is made and optical surveys for required parameters were taken. If required necessary grinding works will be carried out on saddle support.
- m) If required steam generator saddle support needs to be lifted for placement of fine shim plates for adjustment of height of SG.



- n) Take elevation readings of steam generator collector's bottom, centre line elevation of SG and carryout the welding of steam generator saddle to steam generator welding.
- o) After completion of SG erection and acceptance, cut and remove the steam generator lifting lugs & arms by grinding (gas cutting is not allowed) and smooth grinding.
- p) Re-preservation of weld joints and adjacent areas with OC-51 paint.
- q) Carry out optical alignment and record the readings.

6. Erection of Steam generator accessories:

Erection of Steam generator accessories consisting of single chamber and double chamber surge tanks, connected tubing and its supporting assembly, primary, secondary collector covers, man hole covers and connected studs, nuts, washers etc,. All these accessories are light weight items, and erection of each item takes place a different periods of erection works as per the erection sequence envisaged. The sequence of erection is elaborated below

TECHNICAL CONDITIONS OF CONTRACT (TCC)

- a) Making temporary working platform needs to be provided on both sides of steam generator for accessing surge tanks nozzles, collector covers etc,
- b) Remove temporary covers of Steam generator nozzles which are welded to base metal without damaging the base metal, Surveying of nozzles.
- c) De-preservation of surge tanks and other accessories as per manufacturer's recommendation. De-preservation of collector primary and secondary covers, secondary man hole covers, studs, nuts, washers, stud recess area of all the steam generator collectors, manholes etc,.
- d) Shifting of steam generator accessories inside reactor building. Ensure sufficient care to be taken while handling, shifting studs, and nuts by wrapping each stud with lint free cotton cloth in order to avoid damage to threads.
- e) Handling, lifting, Erection and alignment of Steam generator accessories. Nickel gaskets placement, Erection of collector/manhole covers, alignment, application of lubricants to stud assembly, fixing of studs, nuts, washers.

Details of Studs of Steam generator for KKNPP UNIT-3						
Sr. No	Equipment Details	Material	Size (Φxlength)	Apprx. Weight per stud(~Kg)	Qty/ Equipment	Total
	Steam Generator					
1	Stud M60(Flange joint of primary side)	38XH3MΦ A	Φ60x520	8	20x2=40	40x4=160
2	Stud M52(Flange of secondary side hatch)	38XH3MΦ A	Φ52x698	8	28x2=56	56x4=224
3	Stud M48 (Side manhole	38XH3MΦ A	Φ48x475	4	20x2=40	40x4=160

TECHNICAL CONDITIONS OF CONTRACT (TCC)

S No	Name of equipment	Weld Quantity in CC (aprx) for both
1	Steam generator support assembly.	260500
2	Steam generator	29500
3	Steam generator accessories	6500

7. Re-box up of primary, secondary collector covers and man holes by replacing nickel gaskets:

The scope of work envisaged only after completion of primary and secondary hydro test. The steam generators primary, secondary collector covers and man holes covers are to be opened and activities like internal inspection, cleaning of the internal surfaces of steam generator, removal and replacement of nickel gaskets, re-box up of primary, secondary collector covers and man holes covers etc are to be carried out by the contractor. The sequence of work is elaborated below.

- a) Temporary Working platform needs to be provided on both sides of steam generator for accessing collector covers.
- b) Removal of stud assembly, collector covers, manhole covers, nickel gasket etc,.
- c) Ensure sufficient care to be taken while handling, shifting, safekeeping of studs, and nuts by wrapping each stud with lint free cotton cloth in order to avoid damage to threads.
- d) Cleaning and safe keeping of collector primary and secondary covers, secondary man hole covers, studs, nuts, washers, stud recess area etc,.
- e) Foreign material removal, cleaning of internal surfaces of steam generator primary and secondary sides with the help of NPCIL approved cleaning agents by ensuring Confined space Safety guidelines.

TECHNICAL CONDITIONS OF CONTRACT (TCC)

- f) After completion of PSI inspection, Handling, lifting, re-erection and alignment of Steam generator collector, manhole covers, Nickel gaskets replacement, application of lubricants to stud assembly, fixing of studs, nuts, washers.
- g) Torque tightening/stud elongation of Primary, secondary collector covers, man hole covers by means of multiple stud tensioner (multiple stud tensioner will be issued as free issue)
- h) Preparation and submission of reports for acceptance.

8. Erection of Steam generator header:

The steam header assembly consists of header of size DN 630mm and connected with SG steam chamber with ten (10) bent tube-elbows of size 200 mm diameter. The Steam header assembly is located above the steam generator and welded with SGs steam outlet nozzles. The steam header will be issued along with SG, however erection and welding is considered part of piping. The weight of SG header will be measured in piping erection item.

The scope and sequence of erection works of SG header are detailed below.

- a) Removal of temporary covers of Steam generator nozzles which are welded to base metal without damaging the base metal.
- b) Survey and checking (Template matching) of steam header nozzles with as built details of steam generator nozzles.
- c) De-preservation of steam header nozzles as per manufacturer's recommendation. Steam header is factory preserved with special chemical, it needs to be de-preserved as per manufacturers instruction.
- d) Design and fabricate suitable jigs, fixtures suitable bracing mechanism to adjust the steam header nozzle positions with respect to steam generator for making fit-up of joint.
- e) Handling, lifting, Erection and alignment of Steam header with the help of crane.
- f) Providing backing ring, making fit up and welding of steam header with corresponding nozzles after achieving the alignment requirements.

TECHNICAL CONDITIONS OF CONTRACT (TCC)

- g) After completion of welding, cutting (by grinding) of temporary bracing members, grinding, final cleaning, inspection, touchup painting of weld joints and other damaged areas with OC-51 paint.
- h) Preparation of reports and acceptance.

9. Reports and Records:

- i. Erection reports at all stages of work, as-built drawings, welding inspection reports and NDE reports shall be prepared as per the established work procedures and submitted for acceptance.

TECHNICAL CONDITIONS OF CONTRACT (TCC)

2.2.6 TECHNICAL SPECIFICATION FOR ASSEMBLY, ERECTION, ALIGNMENT AND WELDING OF REACTOR COOLANT PUMP CASING AND SUPPORT ASSEMBLY (JEB)

SI No	Description
1.0	Purpose
2.0	Scope
3.0	Erection of reactor coolant pump assembly (JEB) : Introduction
4.0	Erection of reactor coolant pump casing assembly
4.1	Pre assembly of lower spacer to casing
4.2	RCP hydraulic casing erection inside reactor building
5.0	Reactor coolant pump accessories
6.0	Reports and Records

1. Purpose:

The purpose of this procedure is to provide guidance to contractor to understand the scope & quantum of work and technical requirements to be followed during assembly, erection, alignment, welding and inspection of Reactor coolant pump casing and its supporting assembly.

2. Scope:

The scope of the contractor's work comprises but not limited to the following.

- a) Study of drawings, preparation of network schedules.
- b) Preparation and approval of QAP, erection, welding and inspection procedures, Preparation of erection schemes.
- c) Receipt of material from NPCIL/BHEL store, transportation, storage.
- d) De-preservation of Reactor coolant pump components, dimensional survey (optical) for all the components.
- e) Handling, pre-assembly, erection, alignment, welding and inspection.

3. Erection of reactor coolant pump assembly (jeb):

Introduction:

Reactor Coolant Pump forms part of primary circuit, is provided for circulation of coolant and are four in number one for each loop.

TECHNICAL CONDITIONS OF CONTRACT (TCC)

S No	Description	Parameter
1	RCP discharge flow rate	22000 m ³ /h
2	Synchronous rotational speed	750/1000 rpm
3	RCP Weight with supports (Assembled)	144 MT
4	RCP casing assembly	57 MT
5	Rated power	7100/2800KW

The main support structure of the pump unit is the lower welded spacer resting on three support devices with roller support which allows the pump to move along embedded plates up to 80 mm, in case of thermal expansion of primary circuit pipelines. The lower welded spacer carries pump casing enclosed in insulated jacket. The upper spacer carries the drive electric motor, which is connected to the pump shaft by a torsion bar and flexible plate coupling.

To absorb seismic shock, if any, the pump is provided with two hydraulic shock absorber mounted on the electric motor casing and tie rod are provided for pump casing.

The RCP consists of components such as pump with shaft seal and bearings, welded /forged casing with guide vanes; electric motor; upper and lower spacer; support devices; couplings; independent circuit water system; radial axial bearing water-cooling system; electric motor oil system; intermediate circuit water system; instrumentation and automatics system.

The pump casing consist of guide vanes inside and has a pin for mounting the tie rod, which receives load in case of seismic effects .The blade system of the pump consist of centrifugal impeller and guide vanes. The impeller is aligned with shaft using centering cones. Two bearings support the pump shaft; the upper bearing is radial-axial bearing while the lower one is radial bearing. The bearing is cooled by water circulation using auxiliary impeller mounted on the shaft. Seals are provided to restrict leakage from bearing lubrication and cooling circuit. To prevent boron crystal deposition in the final stage of sealing assembly, distillate supply is provided to the cavity above the seal.

The solid-forged shaft has splines to fit the impeller, the axial bearing disk and the flange of flexible coupling.

TECHNICAL CONDITIONS OF CONTRACT (TCC)

A lock device in the form of cam ratchet and pawl mechanism eliminates the reverse rotation of the shaft with reverse coolant flow.

The pump shaft is coupled with the motor shaft by a torsion coupling, which accommodates possible misalignment of the shafts.

The pump uses an asynchronous two-speed electric motor (750-1000 rpm). The motor is vertical, with two guide bearings and a thrust bearing designed to receive the load generated by the weight of motor rotor and the flywheel mounted in the bottom part of motor shaft.

The instrumentation and diagnostic system is designed to provide monitoring of the operation of the pump and to ensure its reliable performance under various operating conditions.

Ref. drawings:

1. R95.KK.3 UJA31.JEB.MT.MC.WD001- GCNA-1 Casing with support, fastening & tools, Mounting Drawing.
2. R02.KK.3 UJA.JEB.RP.MC.WD036- Fasteners of reactor coolant pump set biological shielding ring, Mounting Drawing.
3. R02.KK.3 UJA.JEB.RP.MC.WD008 - Fasteners of reactor coolant pump set. Mounting Drawing.

4. Erection of reactor coolant pump casing assembly:

The reactor coolant pump casing assembly comprises of following main components (per RCP):

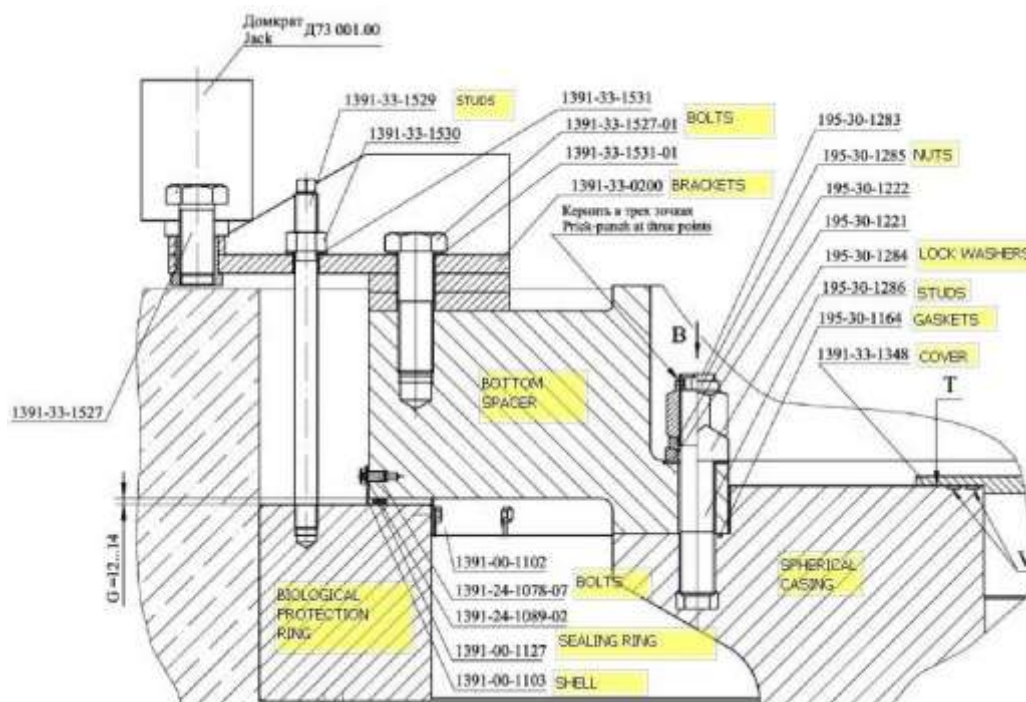
S No	Description of item	Quantity	Weight
1	RCP spherical housing	1	31 MT
2	bottom spacer	1	16 MT
3	biological protection ring	1	7 MT
4	supporting device roller supports	3	2.5 MT
5	supporting device adjusting mechanism	3	1 MT

Complete assembly and installation of RCP hydraulic casing shall be done as per manufacturer's mounting instruction. Brief sequence of erection activities is given below

TECHNICAL CONDITIONS OF CONTRACT (TCC)

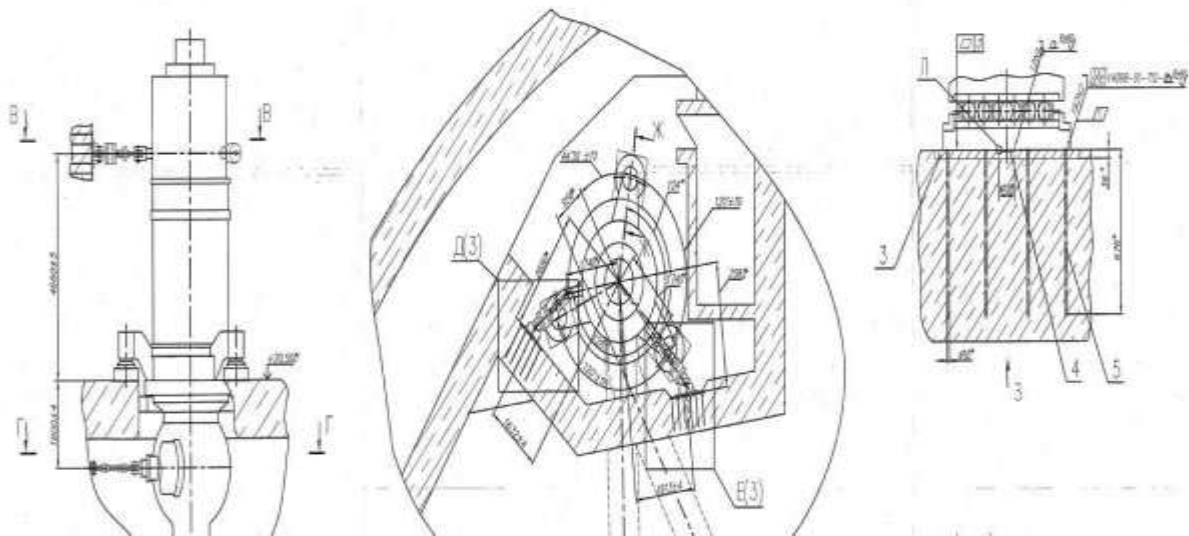
4.1 Pre assembly of lower spacer to casing:

- a) The assembly of RCP hydraulic spherical housing with bottom spacer is to be taken up outside reactor building/ contractor workshop under closed roof and dust controlled to be established by contractor.
- b) Assembly has to be carried out on specially designed temporary metal structures to withstand weight of RCP casing assembly, the measurement of which shall be paid in respective BOQ item. Sufficient protection packing shall be provided on supports in areas where pump casing will be seated.
- c) Reactor coolant pump hydraulic casing assembly will be done on temporary leveled metal structure designed for this purpose. Suitable jigs and fixtures arrangement will be made along with crane for assembly of pump casing.
- d) Providing temporary Working platform all around the periphery of reactor coolant pump casing assembly.
- e) Turn/rotate the spherical housing and place it on the temporary support designed for assembly of spherical housing with the help of contractors and NPCIL heavy duty crane. Avoid direct contact of lifting ropes with spherical housing.
- f) Install cover onto the main joint of the spherical housing for protection of main joint sealing face.
- g) Take the dimensions of gasket groove of spherical casing, Weld the gasket ends as per as built dimension of pump casing groove.
- h) Installation of Brackets onto bottom spacer and fix them with the help of bolts. Provision for insertion of shim plates of thickness up to 40 mm is allowed for adjustment of hydraulic casing height as per design requirement.



TECHNICAL CONDITIONS OF CONTRACT (TCC)

- i) Install shell (sealing cover) all around the circumference of bottom spacer with the help of bolts. Install sealing ring gasket onto cylindrical part of the spacer.
- j) Install bottom spacer together with sealing ring onto biological protection ring. Bring the biological protection ring closer to bottom spacer with the help of Stud assembly installed over brackets.
- k) Place gasket over spherical housing, Install bottom spacer along with biological protection ring onto spherical housing with the help of stud assembly.
- l) Tighten the nuts with the help of hydraulic torque wrench up to a torque of 2450 +50 N.m. ensure gap between the hydraulic casing and bottom spacer is less than 0.1mm.
- m) Install flange of drain line on to the spherical casing and fix it with bolts. Final installation of flange is only after welding of the drainage pipelines.
- n) Fasten the lock stud assembly onto supporting device.
- o) Cut by grinding & and flush grind the lifting hooks of spherical housing and perform visual and DPT examination of these places.



TECHNICAL CONDITIONS OF CONTRACT (TCC)

After completion of assembly the assembled hydraulic casing will be erected inside reactor building at RCP floor.

4.2 RCP hydraulic casing erection inside Reactor building:

- a) Ensure clean room conditions of reactor coolant pump area inside reactor building as per document Д44. All Embedded parts are inspected and accepted for equipment erection.
- b) Survey as built details of Reactor coolant pump embedded components. Ensure the horizontality of embedded plates in not more than 0.5mm. Also check & ensure clear opening for installation of biological protection ring at +20.0 mtr RCP floor.
- c) Perform blue matching of the reactor coolant pump supporting device with embedded part and ensure 60% of contact area. Perform grinding/machining of the embedded part to achieve the above requirement.
- d) Check and record Design movement of roller supports in both longitudinal and transverse direction.
- e) Erect roller supports onto embedded parts of RCP floor at + 20.0 mtr elevation.
- f) Assemble and adjust the supporting device as per drawing requirement.
- g) Erect Spherical housing assembly along with bottom spacer, biological protection ring on to RCP erection opening at RCP floor at +20.0 mtr elevation by loading the three brackets onto RCP floor.
- h) Assemble and commission the hydraulic jacks supplied by equipment manufacturer as per the instruction manual.
- i) Fix the three hydraulic jacks into brackets of bottom spacer for adjustment of height of spherical housing assembly.
- j) Adjust the spherical housing height with the help of hydraulic jacks for achieving the final position of spherical housing for welding with main coolant pipelines. Fix the spherical housing position at that elevation with puller bolts available on the brackets and remove the hydraulic jacks.
- k) While carrying out alignment of spherical housing ensure the root gap between spherical housing branch pipes (both suction and discharge) to Main coolant pipelines is 1.5 ± 0.5 mm, mis-alignment of weld edges between spherical housing branch pipes (both suction and discharge) to Main coolant pipelines is 1.5 ± 0.5 mm. Also ensure that horizontality of main sealing joint of spherical housing is less than 0.5 mm/m.

TECHNICAL CONDITIONS OF CONTRACT (TCC)

- l) Align the bottom spacer supporting device bracket openings with each roller support concentrically with the help of screw bolts provided, interconnect the bottom spacer with roller supports by means of lock stud. Ensure installation of roller support with screwed bolt relative to cylindrical part of bottom spacer bracket is 0.5mm. Unscrew the bolts.
- m) Assemble supporting device components like hemispheres, adjusting mechanism, keys, rings etc., as per manufacturers instruction manual.
- n) Using power nut driver supplied by manufacturer, tighten the adjusting mechanism's supporting screw to transfer the load of spherical housing assembly (along with bottom spacer, biological protection ring) from brackets (fixed on bottom spacer) to supporting device.
- o) Carryout the above exercise on all three supporting device uniformly so that horizontality of main sealing surface shall not change.
- p) Ensure the design clearances mentioned in the manufacturers drawings/manuals were achieved while carrying out above activities.
- q) Contractor shall design a structure which will be seated over the RCP casing for placing a load of 20 MT on top of spherical housing assembly uniformly in order to maintain horizontality of sealing surface during welding and heat treatment of main coolant pipelines with spherical housing.
- r) During and after completion of main coolant pipeline welding ensure that the horizontality of main joint sealing surface is maintained within 0.5mm/m, design clearances of supporting devices are maintained.
- s) Complete the supporting device assembly as per documentation.
- t) Install and weld the locking cleats for arresting roller support base movement.
- u) Remove Roller supports technological arresting bolts, install plugs with gaskets and lock washers as per design documentation.
- v) Adjust the gap between biological protection ring, bottom spacer by means of providing shim plates between brackets and the ring to achieve a gap of 12-14mm.
- w) Install sealing rings all around the bottom spacer, biological protection ring as detailed in the drawing by maintaining designed clearances.
- x) Apply graphite ГC-4 Gost 17022 thread surfaces of studs and nuts, mated surfaces of basic washers and bushes of the main joint at installation as per manufacturer's instruction.
- y) Re-preservation of weld joints and other damaged areas with OC-51 paint.
- z) Preparation of reports and acceptance.

TECHNICAL CONDITIONS OF CONTRACT (TCC)

Approximate welding quantity envisaged for erection of reactor coolant pump is 2800 CC (cubic centimeter) for both units (3 & 4). The actual welding may vary on either side because of change of design or site conditions etc. The welding quantity is indicated only for the assessment of work. The unit rate quoted by the bidder is inclusive of erection and welding of RCPs. No separate payment for welding or increase in quantity of welding will be considered. The contractor needs to factor in the variations in the cost quoted for the item.

On similar lines to the scope defined above, erection of RCP pump assembly (pullout assembly, motor, and other components) shall be carried out as per manufacturer's mounting instructions/ mounting drawings.

Note:

1. The removal part of RCP pump along with motor shall be assembled by NPCIL. The transportation and erection shall be performed by the contractor under the supervision of engineer's representative.
2. The entire work shall be performed by the qualified engineers/ supervisors and trained technicians and fitters of contractor.
5. Assembly, erection of Reactor coolant pump accessories such as service platform assembly, immovable support, independent circuit air separator, air separator for the radial axial bearing circuit, pressure head tank, IC cooler, additional cooler of seal unit, radial axial bearing cooler, tank assembly, air cooler etc.,.

The ancillary items are supplied along with RCP pump and these accessories are light weight items, and erection of each item takes place at different periods of erection works as per the erection sequence envisaged. The same shall be assembled as per the details and instructions provided by the manufacturer.

The general sequence of erection is elaborated below

- a) Temporary Working platform needs to be provided all around Reactor coolant pump for accessing various nozzles for erection of pump components.
- b) Remove temporary covers of Reactor coolant pump nozzles which are welded to base metal without damaging the base metal, Surveying of nozzles.
- c) De-preservation of accessories as per manufacturer's recommendation. De- preservation of covers, studs, nuts, washers, stud recess area of main joint sealing surface.

TECHNICAL CONDITIONS OF CONTRACT (TCC)

- d) Shifting of RCP accessories inside reactor building. Ensure sufficient care to be taken while handling, shifting studs, and nuts by wrapping each stud with lint free cotton cloth in order to avoid damage to threads.
- e) Handling, lifting, Erection and alignment of Reactor coolant pump accessories. Nickel/copper gaskets placement, Erection of flange covers, alignment, application of lubricants to stud assembly, fixing of studs, nuts, washers.
- f) Torque tightening/stud elongation of manhole covers by means of hydraulic torque wrenches/stud tensioner (Stud tensioner will be provided by NPCIL).
- g) Final cleaning, touchup painting of weld joints and other damaged areas with OC-51 paint.
- h) Preparation of reports and submission for acceptance
- i) Approximate welding quantity envisaged for erection of Reactor coolant pump accessories welding is 11000 CC (cubic centimeter) for both units (3 & 4). The actual welding may vary on either side because of change of design or site conditions etc. The welding quantity is indicated only for the assessment of work. The unit rate quoted by the bidder is inclusive of erection and welding of RCPs. No separate payment for welding or increase in quantity of welding will be considered. The contractor needs to factor in the variations in the cost quoted for the item.

6. Reports and Records:

- i. Erection reports at all stages of work, as-built drawings, welding inspection reports and NDE reports shall be prepared as per the established work procedures and submitted for acceptance.

TECHNICAL CONDITIONS OF CONTRACT (TCC)

2.2.7 TECHNICAL SPECIFICATION FOR ERECTION, ALIGNMENT AND WELDING OF PRESSURIZER AND ITS SUPPORT ASSEMBLY (JEF)

SI No	Description
1	Purpose
2	Scope
3	Pressurizer assembly(JEF) : General introduction
4	Erection of pressurizer assembly
5	Erection of pressurizer thrust ring assembly
6	Erection of pressurizer accessories
7	Reports and Records

1. Purpose:

The purpose of this procedure is to provide guidance to contractor to understand the scope & quantum of work and technical requirements to be followed during erection, alignment, welding and inspection.

2. Scope:

The scope of the contractor's work comprises but not limited to the following.

- Study of drawings, preparation of network schedules.
- Preparation and approval of QAP, erection, welding and inspection procedures, Preparation of erection schemes.
- Receipt of material from NPCIL store, transportation, storage.
- Handling, erection, alignment, welding and inspection.

3. Pressurizer assembly (JEF):

General introduction:

Pressurizer is connected to the primary circuit "hot" pipeline of loop no.3 and is intended to maintain the pressure of primary circuit within the limits assigned during the steady state condition and to restrict the pressure deviation under the reactor plant transient and emergency conditions, using electric heater or coolant injection from the primary "cold" pipeline of loop no. 4.

TECHNICAL CONDITIONS OF CONTRACT (TCC)

S No	Description	Parameter
1	Design Pressure	17.64 MPa
2	Design Temperature	350 °C
3	Hydro test pressure	24.05 MPa
4	Pressurizer volume	79 M3
5	Size	Diameter: 3.5 mtr Height : 15.0 mtr
6	Weight (without support)	186 M T
7	Number of heaters and capacity	28 nos, 90 KW each

The main parts of the pressurizer (PRZ) assembly are vessel, pressurizer support including thrust ring assembly, tubular electric heater units and surge tanks.

The PRZ vessel is of welded design consisting of four cylindrical forged shell made of steel. On the upper shell there are 10 pipe sleeves for connection to surge tank and one casing for resistance thermometer. The surge tanks are used to measure the PRZ water level by means of pressure difference transducer.

On second shell two straps with load carrying trunnions are welded. The trunnions are arranged on the both side of shell for lifting the pressurizer. On the third shell there are eight-pipe sleeve for connection to pressure difference transducer, three housing for resistance temperature transducer, a boss for measuring outer wall temperature and four claddings for welding the wave guides of the acoustic sensors.

Lower shell is having circular openings arranged in two tiers; each tier is having 14 circular openings for electric heater.

The pressurizer internal consists of spray device, supporting shell of the electric heater unit, thermal shield, platforms & stairs.

Ref. drawings:

1. R02.KK.3 UJA.JEF.RP.MC.WD028 - Pressurizer Fasteners, Mounting drawing.
2. R02.KK.3 UJA.JEF.RP.MC.WD027 - Pressurizer assembled - Mounting drawing.

TECHNICAL CONDITIONS OF CONTRACT (TCC)

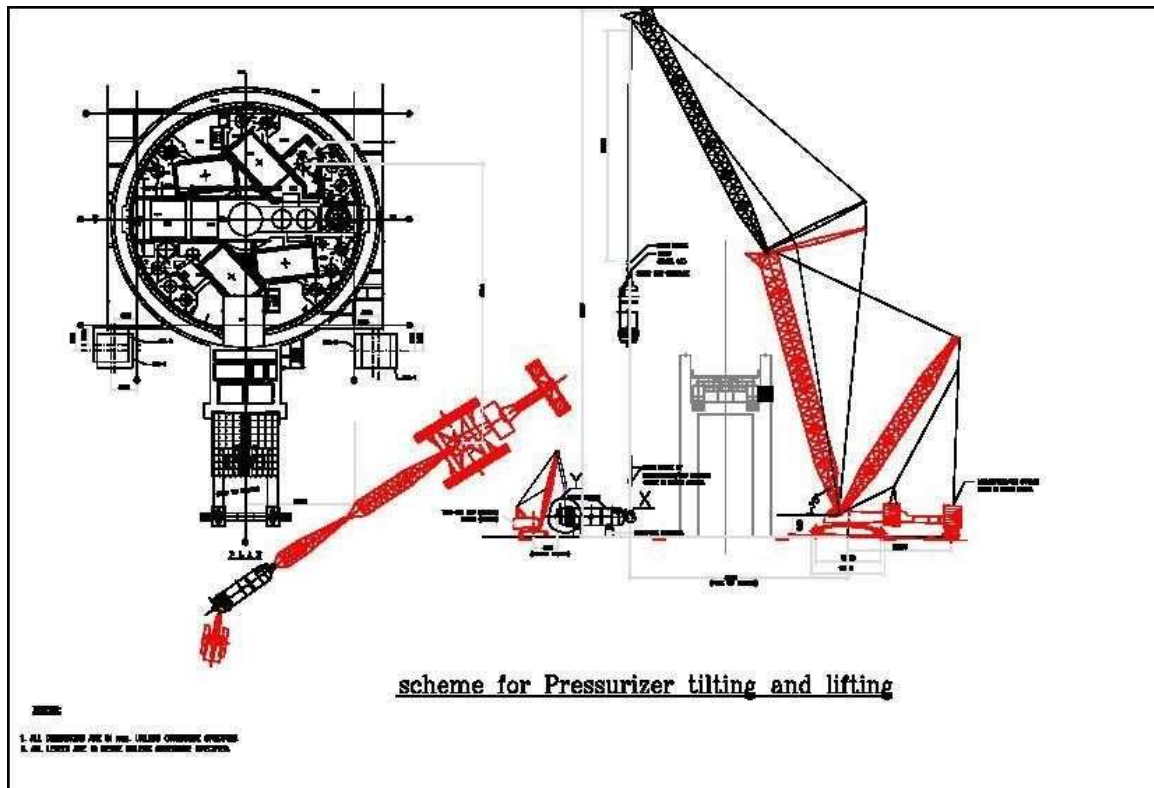
4. Erection of Pressurizer assembly:

Brief sequence of erection activities are given below

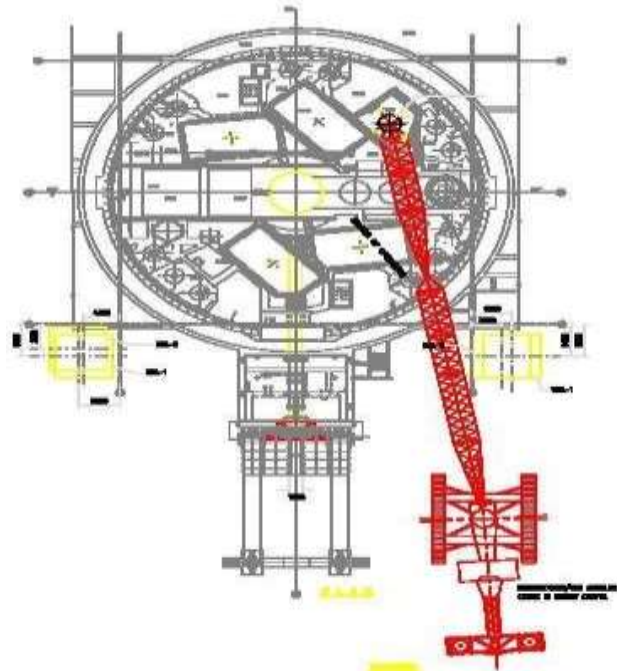
- a) Preparation of erection schemes of pressurizer erection with detailed drawings considering the layout of the reactor building, configuration of heavy duty crawler crane.
- b) Survey as built details of pressurizer embedded components and perform cleaning, axis marking on top of embedded part, mark the pressurizer shell seating area.
- c) De-preservation of pressurizer components, dimensional survey (optical) for all the components.
- d) Design and fabricate suitable jigs, fixtures, other mechanisms to make the fit-up of pressurizer with support shell concentrically and also to avoid distortion during welding of pressurizer with supporting shell.
- e) Make the fit up ensuring concentricity of both the components and sequential welding of pressurizer supporting shell to pressurizer should be carried out by controlling distortion.
- f) Perform site survey to check the available clearances with civil and other structures etc.
- g) Fixtures, locking arrangement for holding pressurizer during fitup and welding shall be made available.
- h) Fasten Pressurizer mounting cover with pressurizer manhole with the help of stud assembly.
- i) Heavy duty crane will be provided by NPCIL as free of cost for erection of Pressurizer only. Contractor has to arrange & provide the sling and de-shackle and all other tools & tackles.
- j) Contractor has to arrange suitable capacity crane for tailing the pressurizer while tilting the pressurizer from horizontal position to vertical position with heavy duty crawler crane.
- k) Pressurizer lifting & erection from outside RB on to embedded part shall be carried out by heavy duty crawler crane.
- l) Alignment of pressurizer to be carried out, fit up & tack welding of pressurizer with embedded part to be made, and optical surveys for required parameters are to be taken. If required necessary grinding work to be carried out on embedded part to ensure alignment requirements.
- m) Perform sequential welding of pressurizer shell with pressurizer EP to avoid distortion as well as to ensure verticality of pressurizer tank.

TECHNICAL CONDITIONS OF CONTRACT (TCC)

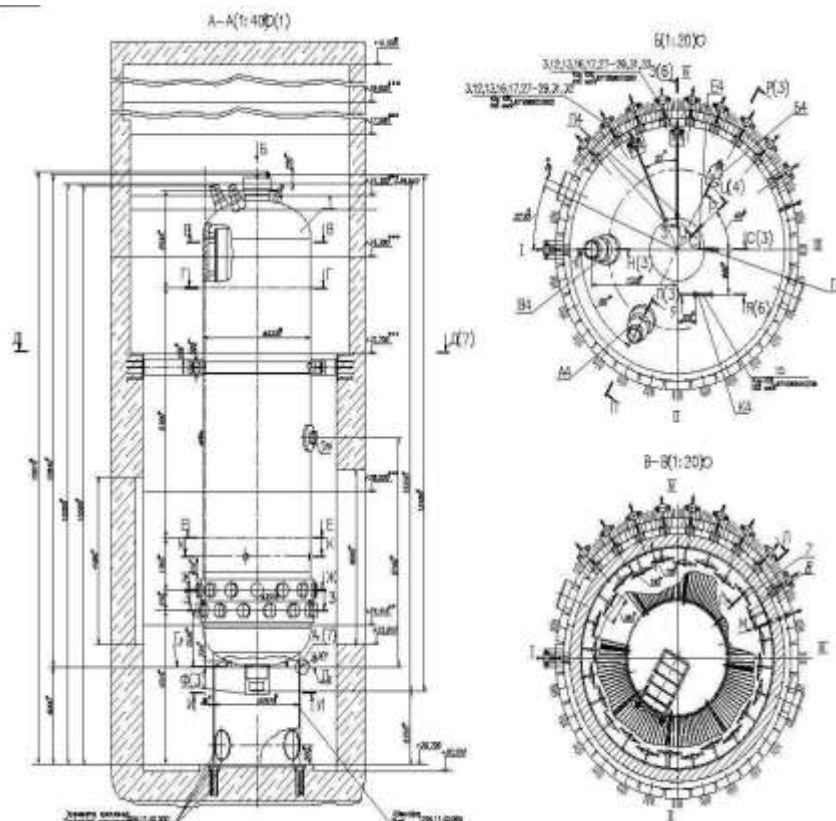
- n) Providing protective cover for pressurizer as lot of civil works, including wall grinding & painting, will be carried out in the vicinity with pressurizer in place. Cleaning of Pressurizer after civil works.
- o) Re-preservation of weld joints and other damaged areas with OC-51 paint.
- p) Carry out optical alignment and record the readings.



TECHNICAL CONDITIONS OF CONTRACT (TCC)



1. ALL DIMENSIONS ARE IN mm. UNLESS OTHERWISE SPECIFIED.
2. ALL LEVELS ARE IN METRE UNLESS OTHERWISE SPECIFIED.



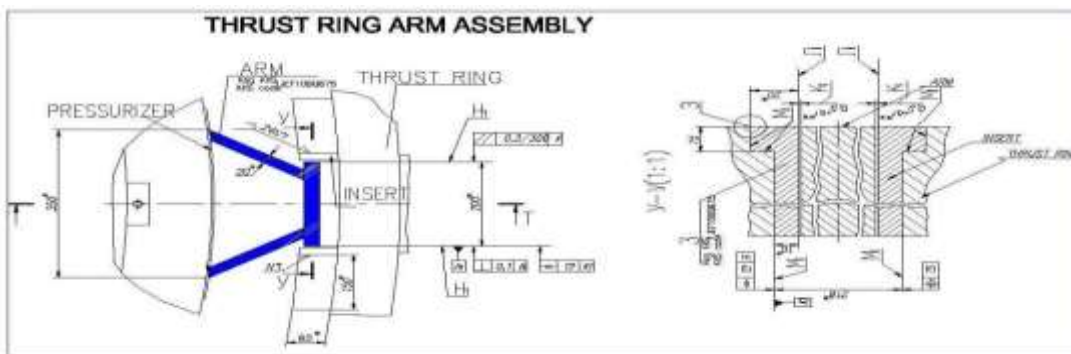
Section view of pressurizer erected insitu:

TECHNICAL CONDITIONS OF CONTRACT (TCC)

5. Erection of Pressurizer thrust ring assembly:

Pressurizer Thrust ring assembly consists of thrust ring (1 nos), arms (12 nos), inserts (24 nos), and interconnecting supports (box channels) between Embedded parts and thrust ring. Brief sequence of erection activities involved are given below.

- a) Temporary Working platform needs to be provided all around pressurizer for accessing thrust ring, embedded parts etc.
- b) Obtain as built details of embedded parts of Thrust ring support.
- c) Marking of Pressurizer axis over thrust ring. Marking of pressurizer thrust ring arms position over pressurizer.
- d) De-preservation of thrust ring components, dimensional survey (optical) is carried out for all the components.
- e) Ensure clean room conditions of pressurizer thrust ring area as per manufacturer document.
- f) Shifting of thrust ring and its accessories from RB outside to design location by means of NPCIL/contractor's crane.
- g) Heavy duty crane will be provided by NPCIL as free of cost for erection of thrust ring only. Contractor has to arrange the sling and de-shackle and all other tools & tackles.
- h) Arrange temporary supports, jigs and fixtures for adjustment of height, axis of thrust ring.
- i) Erection, alignment and welding of arms over pressurizer, and smooth grinding/machining of arms to match the profile curvature of pressurizer outer surface.
- j) Erection and alignment of thrust ring placed over temporary supports, Ensure axis mismatch of thrust ring with Pressurizer axis is within 2mm. Also ensure difference of measurements of clearances between pressurizer arms and thrust ring in diametrically opposite points, concentricity of thrust ring and pressurizer is meeting the drawing requirements. Adjust the thrust ring with the help of jigs and fixtures.
- k) Fabrication, erection, fit-up and tack welding of thrust ring supporting box channels based on site as-built measurements between embedded parts and thrust ring.



- l) Complete welding of thrust ring arms, box channels with thrust ring and embedded parts.
- m) Measure the as built dimensions of clearances between thrust ring and arms in circumferential direction for all the arms and machine the inserts based on these dimensions. Ensure clearance between the arm surfaces to insert surface is less than 0.5mm over the entire length of the insert.
- n) After ensuring the required clearances weld the insert with thrust ring at both top and bottom.
- o) Various design clearances applicable at various locations of thrust ring needs to be ensured as per drawing requirements
- p) Re-preservation of weld joints and other damaged areas with OC-51 paint.
- q) Preparation of reports and submission for acceptance

TECHNICAL CONDITIONS OF CONTRACT (TCC)

6. Erection of Pressurizer accessories:

Pressurizer accessories consisting of surge tanks (volume control tanks), Connected tubing and its supporting assembly, Manhole covers, connected studs, nuts, washers, RTDs, nickel gaskets etc,. All these accessories are light weight items, and erection of each item takes place at different periods of erection works as per the erection sequence envisaged. The sequence of erection is elaborated below

- a) Temporary Working platform needs to be provided all around Pressurizer for accessing surge tanks nozzles, man hole covers etc,
- b) Remove temporary covers of Pressurizer nozzles which are welded to base metal without damaging the base metal, Surveying of nozzles.
- c) De-preservation of surge tanks and other accessories as per manufacturer's recommendation. De-preservation of man hole covers, studs, nuts, washers, stud recess area of manhole.
- d) Shifting of Pressurizer accessories inside reactor building. Ensure sufficient care to be taken while handling, shifting studs, and nuts by wrapping each stud with lint free cotton cloth in order to avoid damage to threads.
- e) Handling, lifting, Erection and alignment of Pressurizer accessories. Nickel gaskets placement, Erection of manhole covers, alignment, application of lubricants to stud assembly, fixing of studs, nuts, washers.
- f) Torque tightening/stud elongation of manhole covers by means of hydraulic torque wrenches as per the designed sequence in a number of steps to achieve required stud elongation values as per drawing requirements and Measurement of stud elongation shall be taken with the help of dial gauges mounted on special fixture arranged by contractor.

- Details of accessories

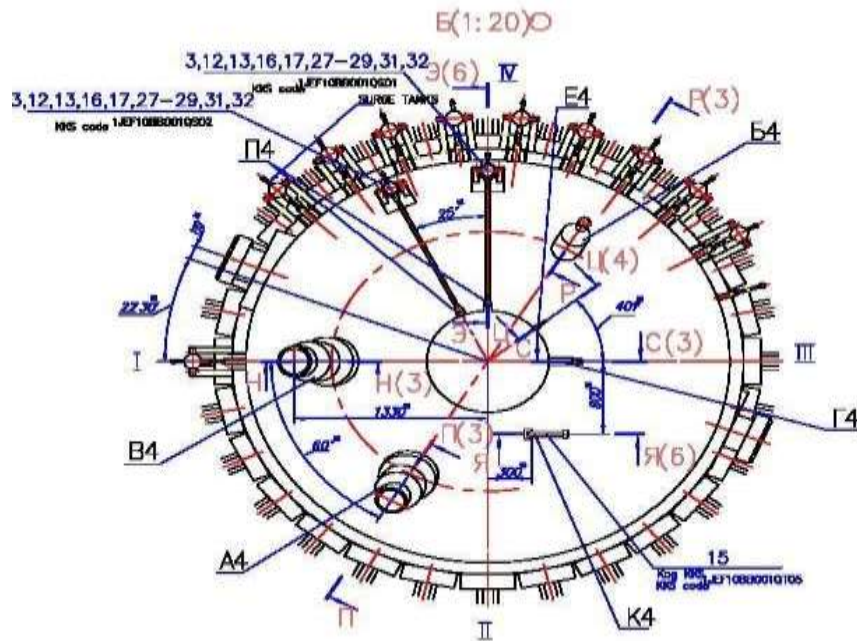
ERECTION OF PRESSURIZER ACCESSORIES								
SI No	System	Part Name/ Drawing Number	Material	Size	Unit Weight in Kg	Q-ty	Total Weight in Kgs	Weight in MT
1	JEF	TEMPERATURE SENSOR 1204.11.04.000	08X18H10T	N.A	3	4	12	0.012
2	JEF	SURGE TANK CON.PIPE1204.1 1.00.012	08X18H10T	Φ25* 2.5 * 873 MM	1.21	2	2.42	0.002

TECHNICAL CONDITIONS OF CONTRACT (TCC)

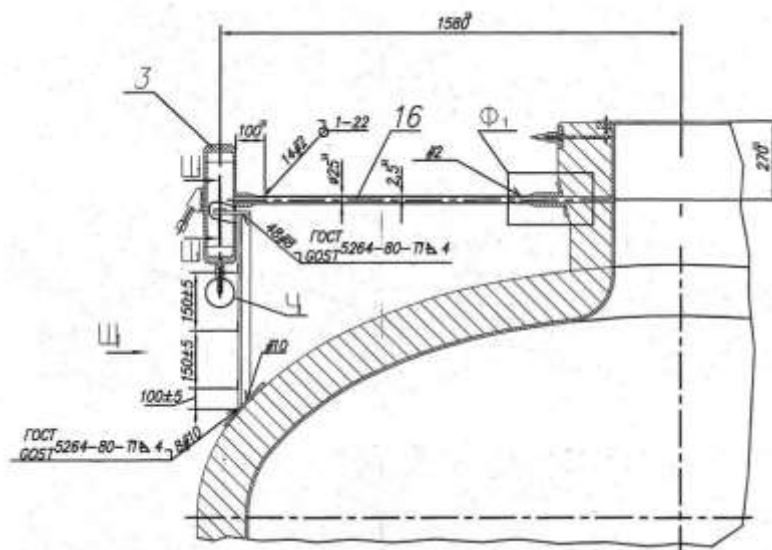
3	JEF	SURGE TANK 1204.11.05.000	08X18H10T	TANK	17	10	170	0.170
4	JEF	SURFACE RTD1204.11.00.0 11	08X18H10T	Φ 18*219L	0.7	3	2.1	0.002
5	JEF	SURGE TANK SUP.POST1204- 1.00.005/008	CM3CN3	PILLER&ANG LE 40*40*4 *480L	0.93	20	18.6	0.019
6	JEF	STRIP1204- 11.00.007	CM3CN4	200*30*4 MM	0.18	48	8.64	0.009
7	JEF	STRIP1204- 11.00.007	CM3CN5	200*30*4 MM	0.18	26	4.68	0.005
8	JEF	SURGE TANK SUP.POST	CM3CN3	PILLER & ANGLE 40*40*4 *480L	0.93	4	3.72	0.004
9	JEF	SURGE TANK BOLT TO NUT WELDING	N.A	N.A	N.A	24	0	0.000
10	JEF	PLATE 1204.11.00.001	08X18H10T	N.A	17	23	391	0.391

TECHNICAL CONDITIONS OF CONTRACT (TCC)

SURGE TANK WITH CONNECTED TUBING



SURGE TANK TYPICAL DRAWING



TECHNICAL CONDITIONS OF CONTRACT (TCC)

- g) Making fit up and welding of surge tanks along with supporting assembly with corresponding nozzles after achieving the alignment requirements. Tube bending needs to be performed as per site requirement. Ensure slope requirements as per drawing for surge tank tubing.
- h) Ensure confined space safety precautions compliance while working inside pressurizer. Arrangements for ensuring sufficient oxygen level, +24V power supply for lighting etc.,. needs to be provided.
- i) Erection of deflector plates inside pressurizer, erection of RTD casings inside pressurizer and welding with sleeve.
- j) Final cleaning, touchup painting of weld joints and other damaged areas with OC-51 paint.
- k) Preparation of reports and acceptance.

Approximate welding quantity envisaged for erection of pressurizer components is provided below. The actual welding may vary on either side because of change of design or site conditions etc. The welding quantity is indicated only for the assessment of work. The unit rate quoted by the bidder is inclusive of erection and welding. No separate payment for welding or increase in quantity of welding will be considered. The contractor needs to factor in the variations in the cost quoted for the item.

S No	Name of equipment	Weld Quantity in CC (aprx) for both units KK3&4
1	Pressurizer assembly.	28500
2	Pressurizer Thrust ring	13500
3	Pressurizer accessories	300

7. Reports and Records:

- i. Erection reports at all stages of work, as-built drawings, welding inspection reports and NDE reports shall be prepared as per the established work procedures and submitted for acceptance.

TECHNICAL CONDITIONS OF CONTRACT (TCC)

2.2.8 TECHNICAL SPECIFICATION FOR ASSEMBLY, ERECTION & WELDING OF EMERGENCY CORE COOLING SYSTEM (ECCS) TANKS OF STAGE 1 &2, QUICK BORON INJECTION SYSTEM TANKS (QBIS)

SI No	Description
1	Purpose
2	Scope
3	Erection, welding and inspection of tanks
3.1	ECCS stage 1 tanks : General details
3.2	ECCS stage 2 tanks : General details
3.3	QBIS tanks : General details
3.4	Design parameter of tanks
4	Erection of tanks
5	Erection of tank accessories
6	Reports and Records

1. Purpose:

The purpose of this procedure is to provide guidance to contractor to understand the scope & quantum of work and technical requirements to be followed during erection, alignment, welding and inspection of ECCS and QBIS tanks.

2. Scope:

The scope of the contractor's work comprises but not limited to the following.

- a) Study of drawings, preparation of network & schedules.
- b) Preparation and approval of QAP, erection, welding and inspection procedures, Preparation of erection schemes.
- c) Receipt of material from BHEL/NPCIL store, transportation, storage ancillary materials of equipment.
- d) Handling using NPCIL crane, erection and alignment.
- e) Welding of equipment with base frame / EPs, ancillaries and inspection.
- f) Erection, welding and inspection of ancillary material supplied

TECHNICAL CONDITIONS OF CONTRACT (TCC)

3. Erection, welding, inspection of tanks:

3.1 General details of ECCS stage-1:

First stage Hydro accumulator tanks (Emergency core cooling system (ECCS)) are high- pressure thick walled vertical cylindrical vessel having dished ends and are installed vertically. Nitrogen gas is supplied to tank from the high pressure Nitrogen supply system under pressure 5.89Mpa through the sleeve DN 20 on the upper end.

On lower end there is nozzle DN 300 intended for supply of water into the reactor. The nozzle is connected to the ECCS pipeline through the reducer of DN 300. There are several sleeves for connection to instrumentation lines.

3.2 General details of of ECCS stage-2:

2nd stage hydro accumulator tanks (core additional passive flooding accumulators) are located at elevation +31.7 m in UJA building inside the hermetic part, and are made up of stainless steel vertical cylindrical vessel having dished ends and are installed vertically. On lower end there are four nozzles intended for supply of the boric acid solution into the reactor through throttling orifices to allow different flow rates with respect to time. There are several sleeves for connection to instrumentation lines.

3.3 General details of QBIS tanks:

Quick boron injection system (QBIS) is designed for bringing the reactor core to the sub- critical state by supplying concentrated solution of boric acid into the primary circuit under ATWS scenario. QBIS tank is high-pressure thick walled vertical cylindrical vessel having elliptical heads and are installed vertically.

There are several sleeves for connection to instrumentation lines. The transport lifting lugs (3nos) are provided for tank on the tank top. Surge tanks (2pcs) along with connected tubing, are to be installed on the upper part. On the lower part, unit of thermal electric heater is to be installed.

The tank is installed vertically with the help of the supporting shell onto the foundation Embedded part. To prevent the tank displacement under action of seismic loads the supporting shell is uniformly welded to the embedded ring.

TECHNICAL CONDITIONS OF CONTRACT (TCC)

3.4 Design parameter of tanks:

S No	Description	ECCS Stage-1	ECCS Stage-2	QBIS
1	Design Pressure	6.37 MPa	3 MPa	17.64 MPa
2	Design wall	90 °C	235 °C	350 °C
3	Tank volume	60 m3	120 m3	7.8 m3
4	Tank weight	79 MT	78 MT	28.1 MT
5	No. of tank per unit	4 Nos.	8 Nos	4 Nos.
6	Size of ECCS stage-1	Dia: 3.20m	Dia: 4.30m	Dia: 2.50 m

The tank are installed vertically with the help of the supporting shell which is welded / bolted to the foundation ring (EPs).

The transport lifting journals are provided for tank turning over and transfer during mounting. Surge tanks (3pcs) along with connected tubing, are to be installed on the upper part. On the lower part, unit of thermal electric heater is to be installed

Ref- Fig-1, 2 General view of ECCS stage-1 tank handling and erection scheme.

Ref- Fig- 3, 4 General view of ECCS stage-2 tank handling and erection scheme.

Ref- Fig-5, 6, 7 General view of QBIS tank handling and erection scheme.

Ref. drawings:

- a) R02.KK.3.UJA.JNG.RP.MC.WD007- The emergency core cooling system accumulator (1ST STAGE) - Mounting drawing.
- b) R02.KK.3 UJA.JNG.RP.MC.WD039 - Core additional passive flooding accumulator, Mounting Drawing.
- c) R02.KK.3 UJA.JNG.RP.MC.WD010 Core additional passive flooding accumulator fasteners, Mounting Drawing.
- d) R02.KK.3UJA.JDJ.RP.MC.WD022- Quick boron injection system tank, Mounting drawing.

TECHNICAL CONDITIONS OF CONTRACT (TCC)

4. Erection of tanks:

Typical sequence of erection activities of hydro accumulators / QBIS tank is given below

- a) Preparation of erection schemes of hydro accumulator/QBIS tanks with detailed drawings considering the layout of the reactor building, configuration of heavy duty crawler crane.
- b) Survey as-built details of hydro accumulator/QBIS tank embedded components and carryout cleaning and axis marking on embedded components.
- c) Hydro accumulator/ QBIS tanks will be shifted from CMM stores to area near RB by NPCIL. Contractor has to arrange transport to shift other accessories.
- d) De-preservation and dimensional survey of hydro accumulator/QBIS tanks, supports, studs, nuts, washers etc.,.
- e) Perform site survey to check the available clearances with polar crane brackets, IC wall liner etc.
- f) Suitable jigs and fixtures arrangement to be made for pulling the hydro accumulator towards Inner containment side during erection to clear the polar crane brackets and also to guide the tank to design position and For QBIS tanks for pulling the tank towards cavity.
- g) Heavy duty crane will be provided by NPCIL as free of cost for erection. Contractor has to provide the crane of suitable capacity for tilting, slings and de- shackles and other tools & tackles. All slings and other shackles shall be load tested and should have valid test certificates.
- h) 2nd stage hydro accumulator cylindrical support shall be shifted near reactor building. Handling, lifting and erection on top of embedded part will be done by using NPCIL supplied heavy duty crawler crane.
- i) Hydro accumulators will be shifted near reactor building in horizontal condition. Lifting slings shall be mounted on accumulator, Bring the accumulator from horizontal position to vertical position using NPCIL supplied heavy duty crawler crane and contractors supplied crane.
- j) Alignment of support will be carried out and fastening of Hydro accumulator with embedded EP support is made with the help of stud assembly and torque tightening with hydraulic torque wrenches. Optical survey for required parameters needs to be taken. If required necessary grinding works will be carried out on EP support to achieve alignment requirements. After

TECHNICAL CONDITIONS OF CONTRACT (TCC)

completion of erection welding of cylindrical support with Embedded part , seal welding of all nuts with Support will be made as per drawing requirements

- k) Hydro accumulators/QBIS tank will be lifted with the help of heavy duty crawler crane and erected on the embedded part by slowly guiding the tank on to EP by ensuring sufficient clearance with polar crane brackets.
- l) Alignment of Hydro accumulators/QBIS tanks to be carried out and fit up & tack welding of Hydro accumulator with embedded EP support is to be made and optical surveys for required parameters to be taken. If required, necessary grinding works will be carried out on EP support to achieve alignment requirements.
- m) Carryout welding of Hydro accumulator/QBIS skirt with embedded EP support by following proper welding sequence.
- n) Re-preservation of weld joints and other damaged areas with OC-51 paint.
- o) Carry out optical alignment and record the readings.
- p) Preparation and submission of reports to BHEL & NPCIL.

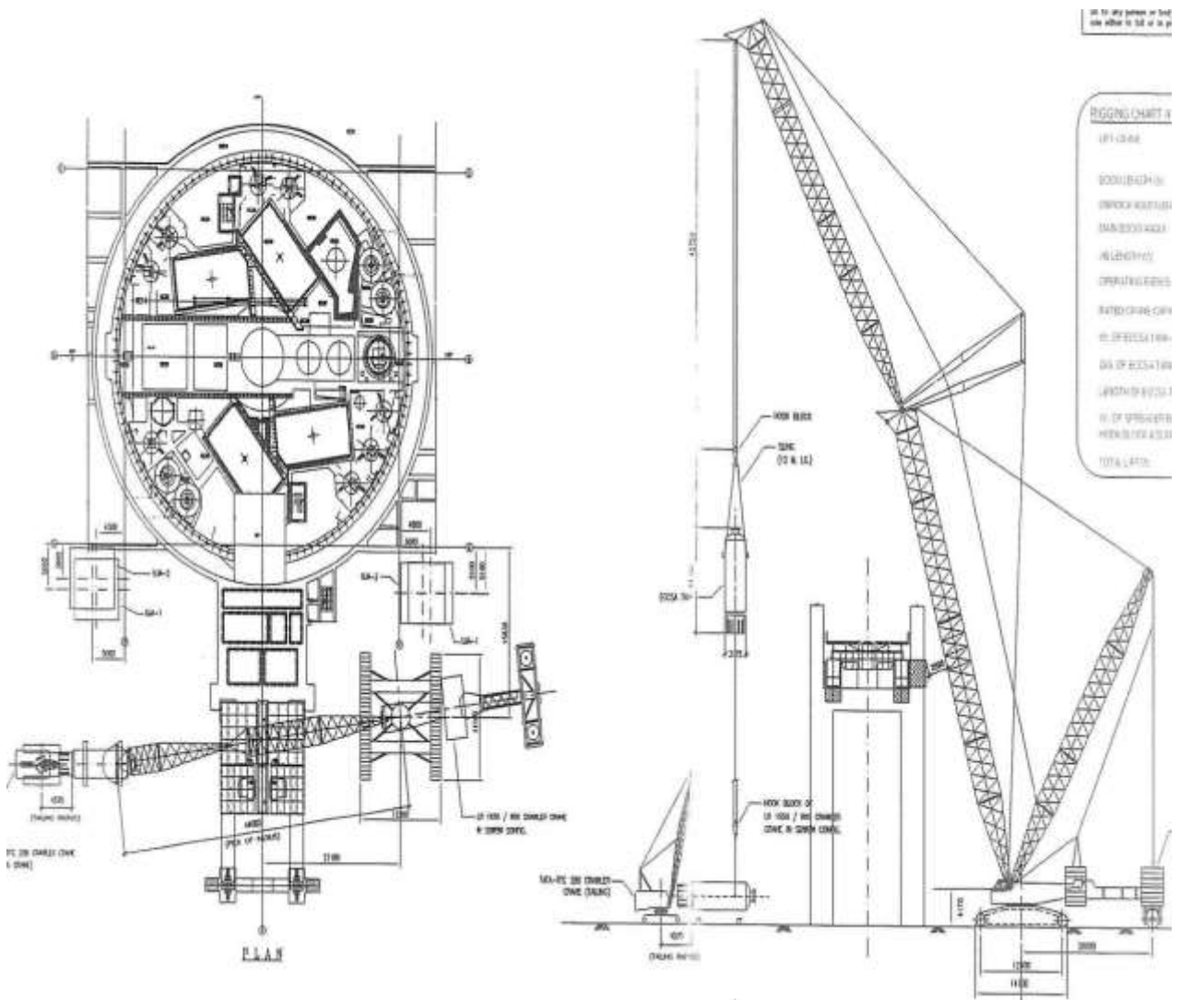


Fig-1: SCHEME FOR HANDLING AND ERECTION OF ECCS STAGE TANKS-1

TECHNICAL CONDITIONS OF CONTRACT (TCC)

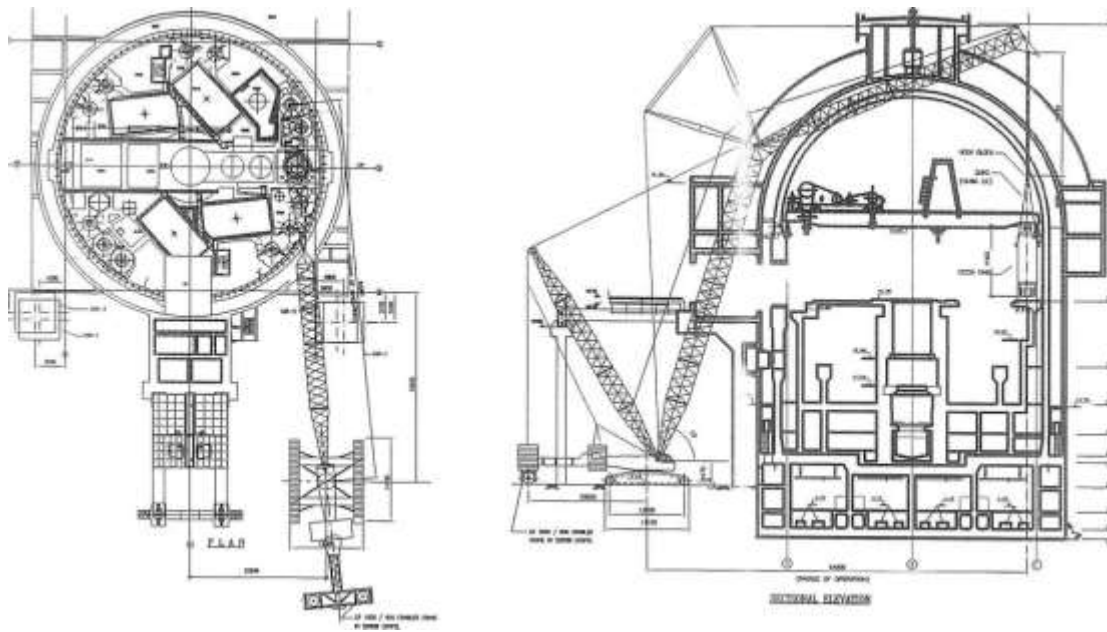


Fig-2: SCHEME FOR HANDLING AND ERECTION OF ECCS STAGE TANKS-1

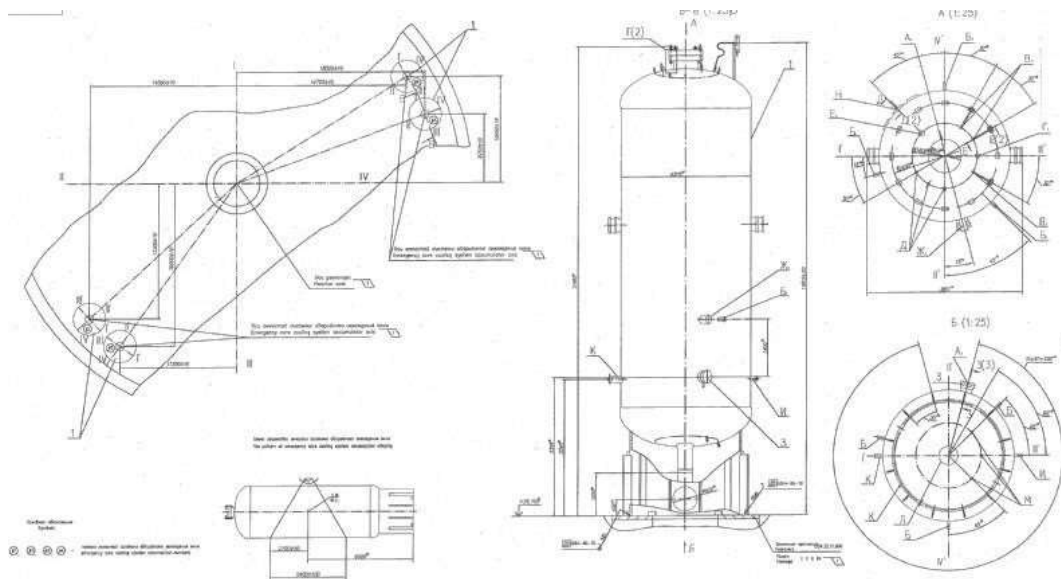


Fig-3: 2nd Stage ECCS accumulators support assembly:

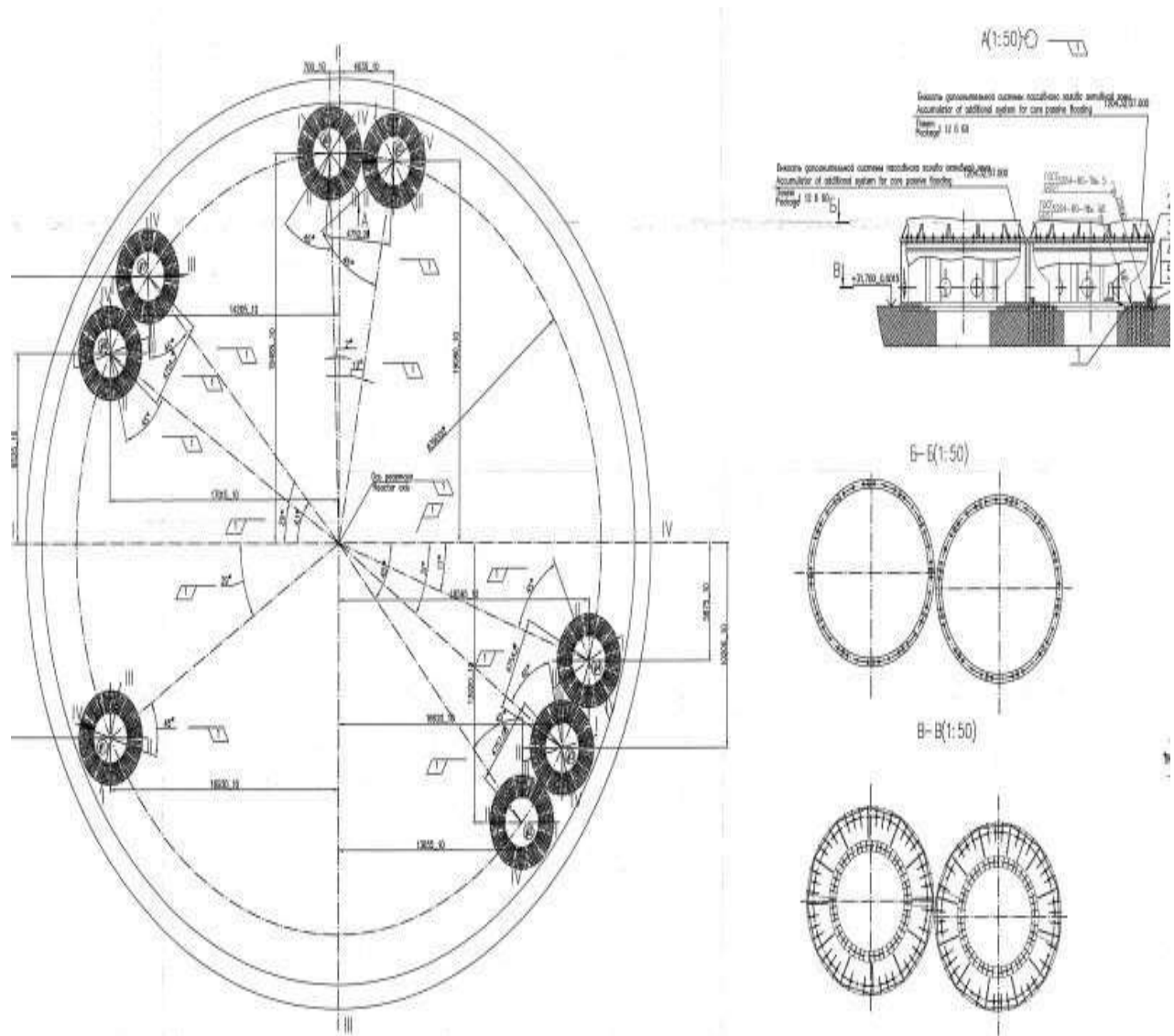


Fig-4: SCHEME FOR HANDLING AND ERECTION OF ECCS STAGE TANKS-2

TECHNICAL CONDITIONS OF CONTRACT (TCC)

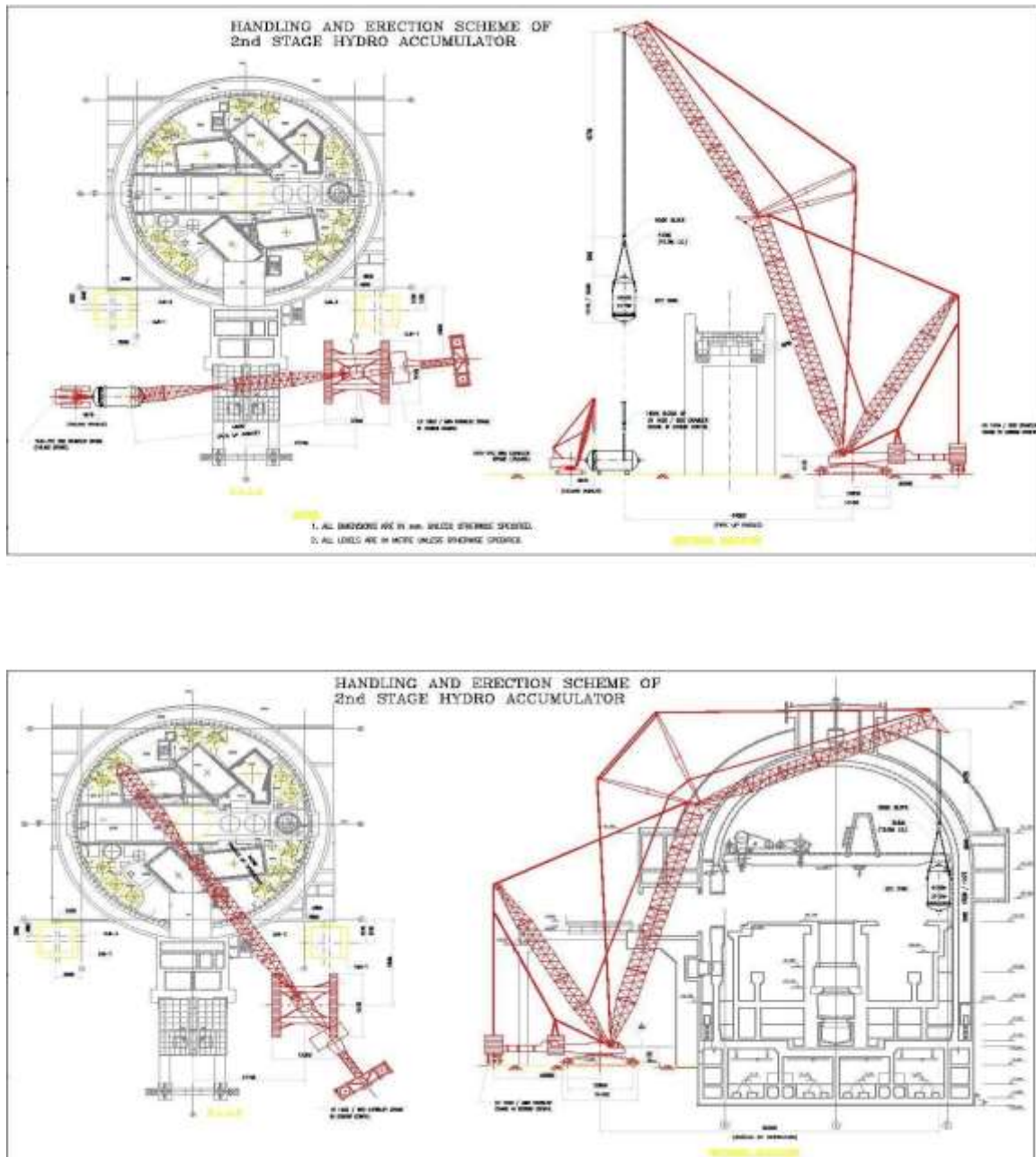


Fig-5: SCHEME FOR HANDLING AND ERECTION OF JDJ TANKS

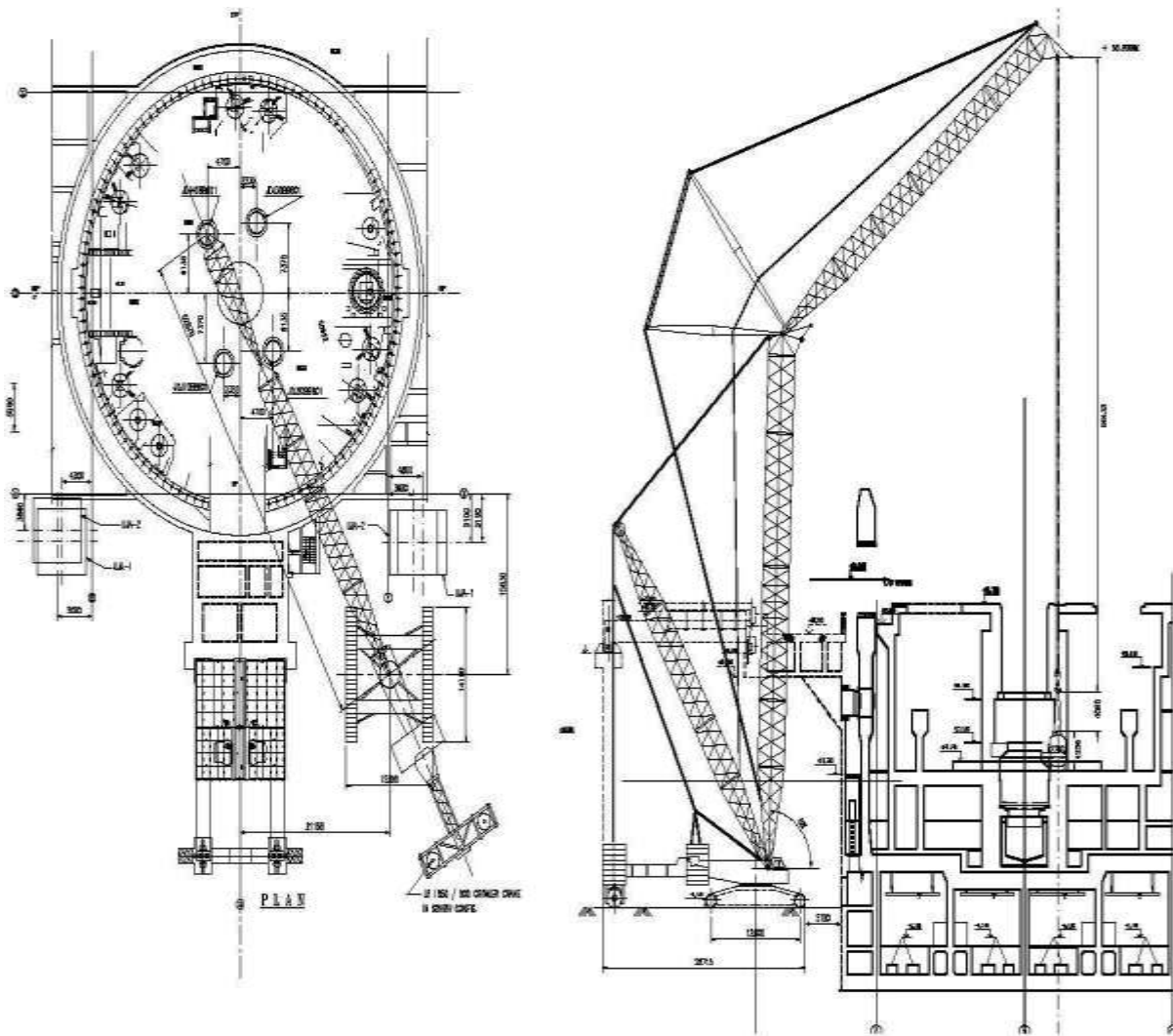


Fig-6: SCHEME FOR HANDLING AND ERECTION OF JDJ TANKS

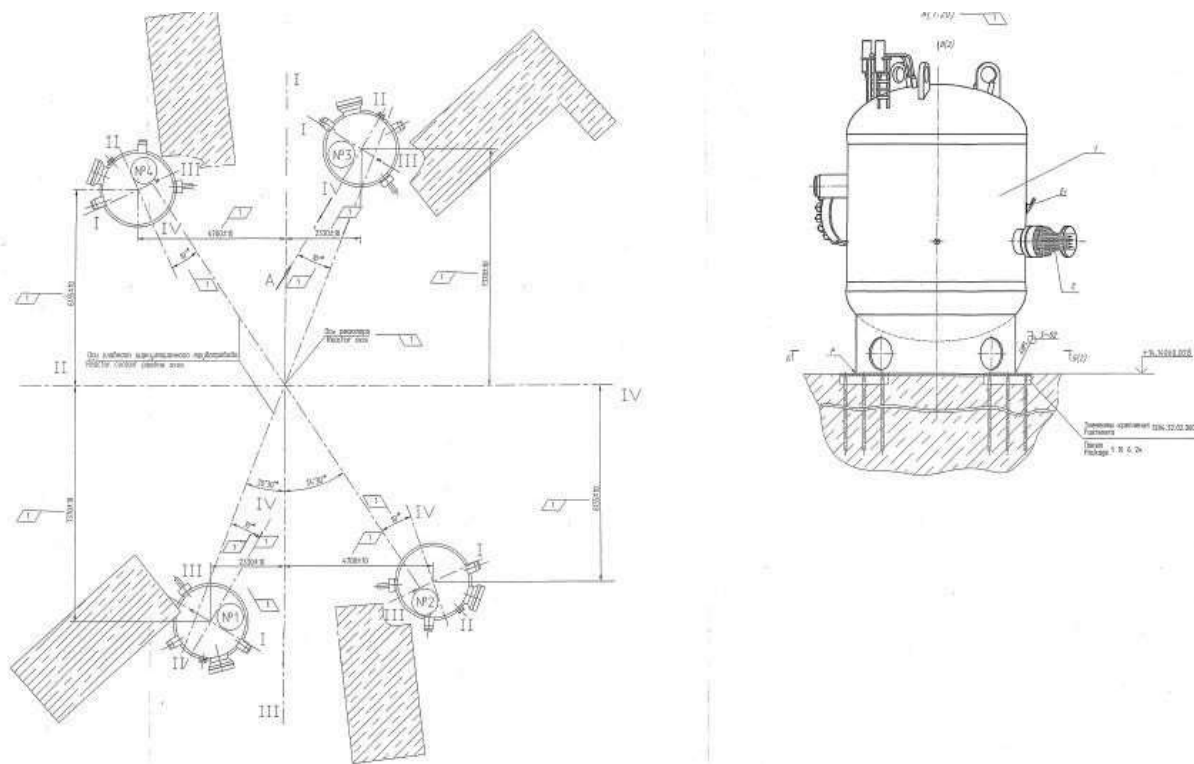


Fig-7: QBIS TANKS

5. Erection of tanks accessories:

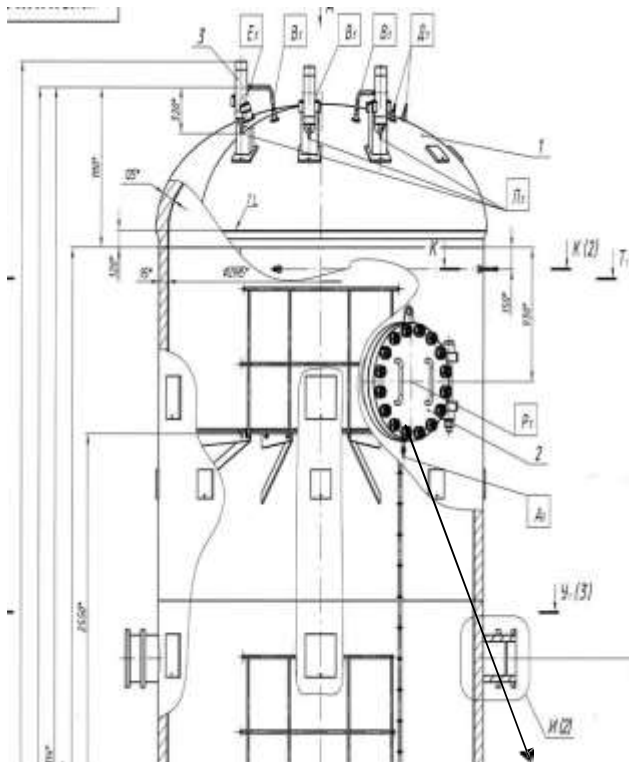
Erection of hydro accumulator/QBIS tank accessories consisting of surge tanks (volume control tanks), Connected tubing and its supporting assembly, Manhole covers, connected studs, nuts, washers, heater studs, nuts, washers, RTDs, nickel gaskets etc,. All these accessories are light weight items, and erection of each item takes place at different periods of erection works as per the erection sequence envisaged. Brief sequence of erection is elaborated below.

- Temporary Working platform needs to be provided all around hydro accumulators for accessing surge tanks nozzles, man hole covers etc,
- Remove temporary covers of ECCS tank/QBIS tank nozzles which are welded to base metal without damaging the base metal, Surveying of nozzles.
- De-preservation of surge tanks and other accessories as per manufacturer's recommendation. De-preservation of man hole covers, studs, nuts, washers, stud recess area of manhole.
- Shifting of hydro accumulator accessories inside reactor building. Ensure sufficient care to be taken while handling, shifting studs, and nuts by wrapping each stud with lint free cotton cloth in order to avoid damage to threads.
- List of typical accessories

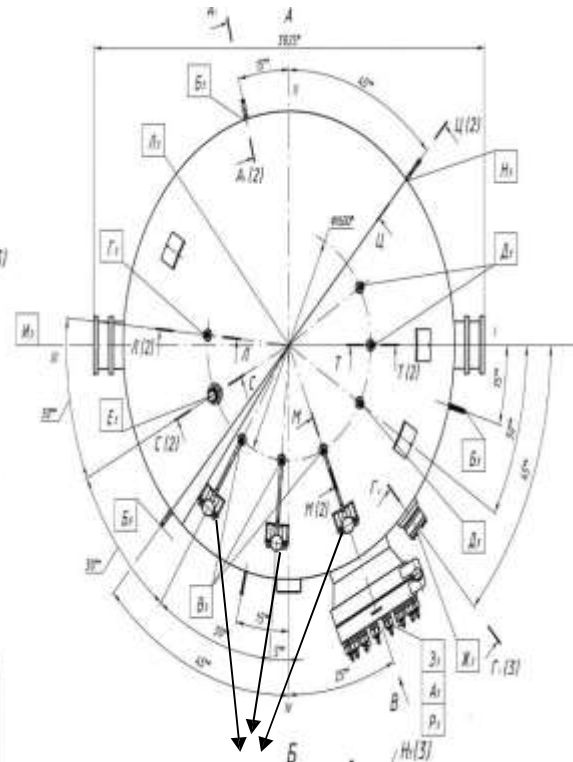
TECHNICAL CONDITIONS OF CONTRACT (TCC)

SI No	DESCRIPTION	UNIT	QUANTITY	UNIT WEIGHT (KG)	TOTAL WEIGHT (KG)	TOTAL WEIGHT (MT)
1	VOLUME CONTROL TANK	NOS	3	17	51	0.051
2	PIPE	NOS	3	3.6	10.8	0.011
3	U-SHAPED STEEL	NOS	3	0.65	1.95	0.002
4	U-SHAPED STEEL	NOS	3	16.1	48.3	0.048
5	U-SHAPED STEEL	NOS	3	0.65	1.95	0.002
6	CAN FOR RESISTANCE HEAT CONVERTER	NOS	1	0.39	0.39	0.0004
7	STUD M36, ASSY	NOS	12	2.1	25.2	0.02520
8	NUT M36	NOS	12	0.48	5.76	0.00576
9	WASHER M36	NOS	12	0.11	1.32	0.00132
10	STUD M48	NOS	16	4.9	78.4	0.07840
11	NUT M48	NOS	16	1.2	19.2	0.01920
12	WASHER M48	NOS	16	0.6	9.6	0.00960
13	NUT M48	NOS	16	1.2	19.2	0.01920
14	NIPPLE	NOS	2	0.07	0.14	0.00014
15	COUPLING NUT	NOS	2	0.09	0.18	0.00018
16	PULLER BOLT	NOS	3	0.25	0.75	0.00075
17	GASKET	NOS	1	0.24	0.24	0.00024
18	GASKET	NOS	2	0.3	0.6	0.00060
19	GASKET	NOS	2	0.32	0.64	0.00064
20	BOLT M12-6GX40.48 TOCT 7798-70	NOS	6	0	0	0.00000
21	NUT M12-6H.5 TOCT 5915- 70	NOS	6	0	0	0.00000
22	WASHER 12	NOS	12	0	0	0.00000
23	FILLING OF THROUGHT BRAIDING GRADE ATN 6X6 TOCT 5152-84	KG	0.4	1	0.4	0.00040
	Total weight of accessories per tank, MT					0.276
	Total weight of accessories per unit, MT					1.104

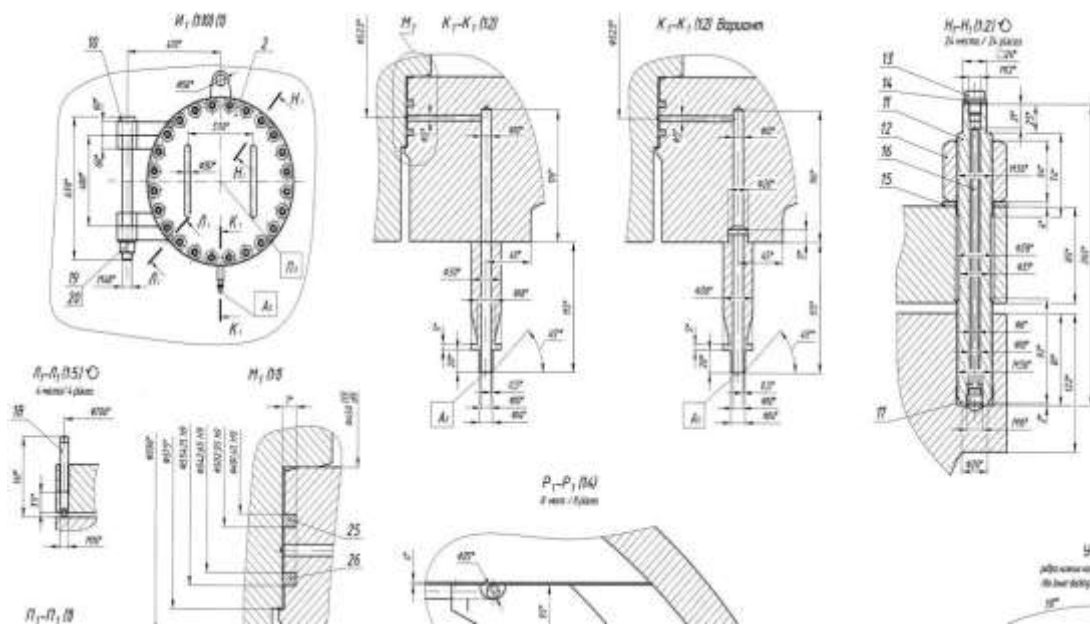
TECHNICAL CONDITIONS OF CONTRACT (TCC)



Man hole covers

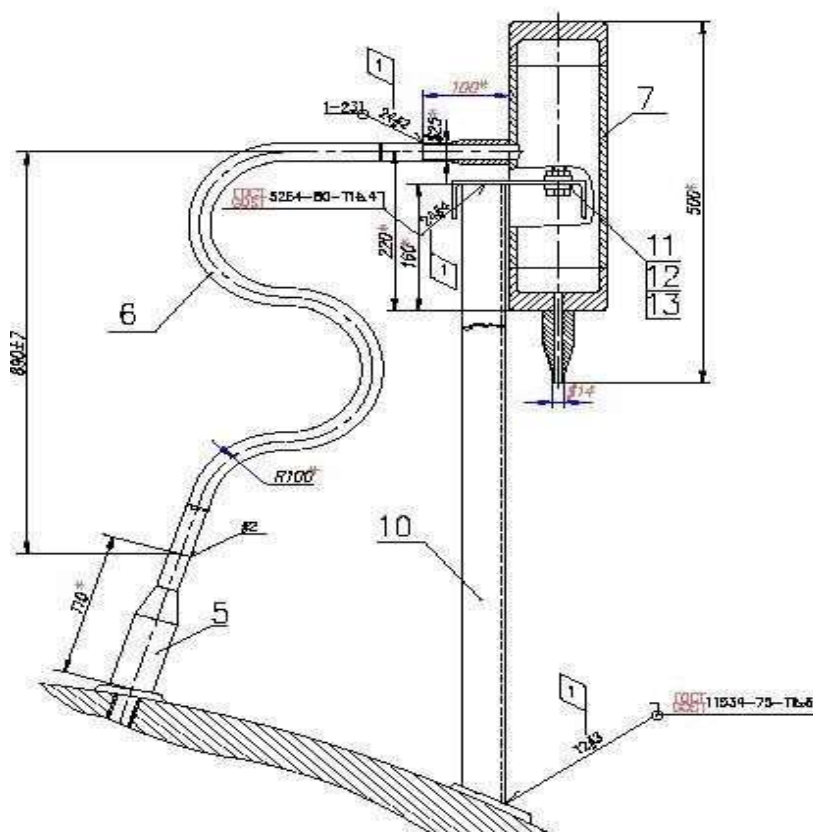


Surge tanks



TECHNICAL CONDITIONS OF CONTRACT (TCC)

- f) Handling, lifting, Erection and alignment of hydro accumulator accessories. Nickel gaskets placement, Erection of manhole covers, alignment, application of lubricants to stud assembly, fixing of studs, nuts, washers.
- g) Utmost care shall be taken while placing the gaskets and arrest the gaskets in the designed location\groove in order to avoid slipping of the gasket out of groove while tightening the studs.
- h) Before closing the manhole covers thoroughness of inter-gasket leak off nozzle shall be performed with the help of compressed air and after ensuring thoroughness manhole shall be closed.
- i) Ensure through cleanliness, foreign material exclusion guidelines shall be followed while carrying out erection work, before box-up of hydro accumulator tanks.
- j) Torque tightening/stud elongation of manhole covers by means of hydraulic torque wrenches by following sequence provided in the working document by minimum 4 number of passes. Measurement of stud elongation shall be taken with the help of dial gauges mounted on special fixture arranged by contractor.
- k) Making fit up and welding of surge tanks along with supporting assembly with corresponding nozzles after achieving the alignment requirements. Tube bending needs to be performed to as per site requirement. Ensure slope requirements as per drawing for surge tank tubing.
- l) Final cleaning, touchup painting of weld joints and other damaged areas with OC-51 paint.
- m) Preparation of reports and acceptance



Approximate welding quantity envisaged for erection of ECCS stage 1 &2, QBIS tanks for both units (3 & 4) is provided below. The actual welding may vary on either side because of change of design or site conditions etc. The welding quantity is indicated only for the assessment of work. The unit rate quoted by the bidder is inclusive of erection and welding. No separate payment for welding or increase in quantity of welding will be considered. The contractor needs to factor in the variations in the cost quoted for the item.

TECHNICAL CONDITIONS OF CONTRACT (TCC)

S No	Description	ECCS Stage-1	ECCS Stage-2	QBIS
1	Equipment Welding	44500 CC	42000 CC	21100 CC
2	Equipment Accessories welding	320 CC	340 CC	220

6. Reports and Records:

- i. Erection reports at all stages of work, as-built drawings, welding inspection reports and NDE reports shall be prepared as per the established work procedures and submitted for acceptance.

TECHNICAL CONDITIONS OF CONTRACT (TCC)

2.2.9 TECHNICAL SPECIFICATION FOR ASSEMBLY, ERECTION, ALIGNMENT AND WELDING OF PHRS SYSTEM COMPONENTS (JNB 50-80)

Sl No	Description
1	Purpose
2	Scope
3	Passive heat removal system : General introduction
4	Erection of Passive heat removal system
4.1	Assembly & erection of passive heat removal system heat exchanger shell(casing) and its accessories
4.2	Assembly, erection & alignment of Passive heat removal system heat exchanger and its accessories
4.3	Assembly and erection of inlet dampers, expansion duct, reducing duct, top and bottom duct, regulating device, electro magnets, outlet dampers, shell members, transition members, compensator group, sealing gland etc
4.4	Assembly and erection of round duct including KLB pipeline support assembly
5	Reports and Records

1. Purpose:

The purpose of this procedure is to provide guidance to contractor to understand the scope & quantum of work and technical requirements to be followed during assembly, erection, alignment, welding and inspection of Passive heat removal system (PHRS) components.

2. Scope:

The scope of the contractor's work comprises but not limited to the following.

- Study of drawings, preparation of network schedules.
- Preparation and approval of QAP, erection, welding and inspection procedures, Preparation of erection schemes.
- Receipt of material from NPCIL/BHEL store, transportation, storage.
- De-preservation of PHRS components, dimensional survey for all the components.
- Handling, assembly, erection, alignment, welding and inspection.

TECHNICAL CONDITIONS OF CONTRACT (TCC)

3. Passive Heat Removal System (PHRS) General introduction:

Passive Heat Removal System (PHRS) (JNB50-80) is designed for prolonged residual heat removal from the reactor core during beyond Design basis accidents with station blackout (loss of all alternate current Power supply sources).

PHRS system is located in UJC building. Its Heat exchangers (HX) base is at 43.9 meter elevation. System has four independent loops. Each loop has 3 HXs. Each circuit includes three heat exchangers, steam-condensate pipe-lines with valves, vent and drain lines, supply and discharge air ducts, inlet and out let air dampers and regulating devices. Steam supply pipeline (200mm) from each SG steam line goes to the header (200mm), delivering steam through individual pipelines (150mm) to three heat exchanging modules. Condensate from each heat exchanger goes back through pipelines (100mm) to steam generator Vent lines are given (20mm NB) for removal of air from the systems during initial filling and hydro tests. Steam cooling in the heat exchangers is realized by atmospheric air. Cooling air is taken from atmosphere. Air passes through protecting grills and enters a circular corridor, located around containment below the inlet of the HXs. When the inlet and out let dampers of this HXs open, the atmospheric air would come in contact with the hot tubes inside the HX casing. As the temperature of the air rises it would move up through the HX to the outlet duct and will exit through a common opening at the top of the UJC building to atmosphere. Thus a constant air flow is established. This will continue as long as the Dampers are open and there is enough heat energy to create a substantial temperature rise in the air inside the HX.

Ref. drawings:

1.	R01.KK.3.UJA.JNB.RP.MC.WD055 - Passive heat removal (HEAT EXCHANGER),Mounting drawing. system
2.	R140 KK UJA JNB RP KC WD001 - HEAT EXCHANGER.
3.	ЧГС 110.00.00.000СБ - Shell of heat- exchange module.
4.	ЧГС 111.00.00.000СБ - Passive heat removal system air ducts.

TECHNICAL CONDITIONS OF CONTRACT (TCC)

4. Erection of Passive Heat Removal System:

A brief detail of work for main components is provided below. However contractor has to execute the work by fulfilling all the requirements of working drawings\manufacturer's instructions for satisfactory completion of said work.

4.1 Assembly & erection of Passive heat removal system heat exchanger shell (casing) and its accessories:

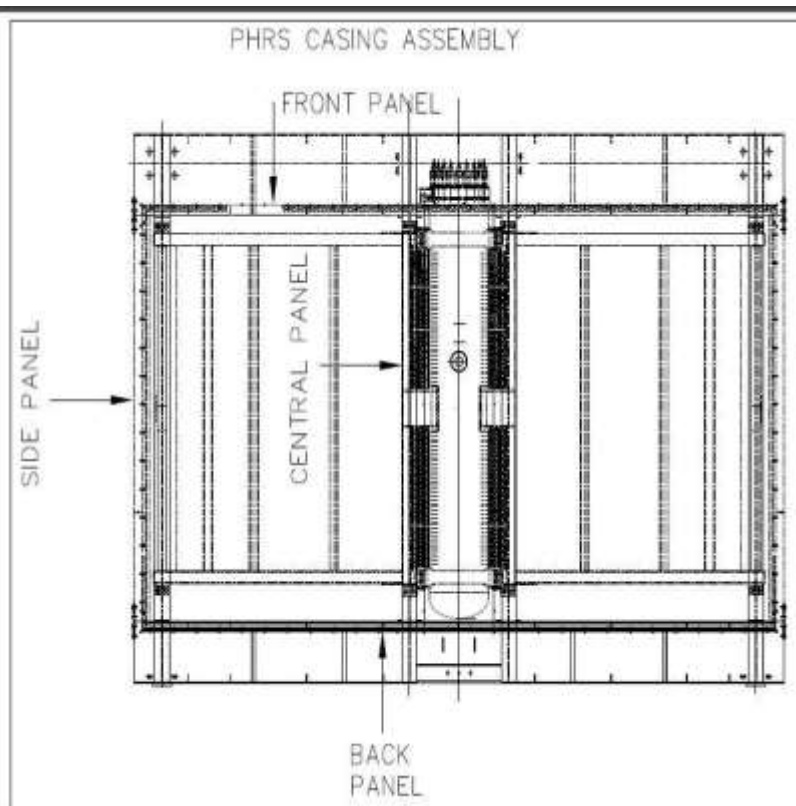
Passive heat removal system heat exchanger shell (casing) assembly consists of beams, front panel, back panel, side panels, central panel, dome covers, crossbar etc.,.

- a) PHRS HX casing has to be assembled on the ground, over specially designed and erected leveled platform\concrete blocks outside reactor building before lifting for erection at location. Leveled platforms should cater parallel assembly of minimum three heat exchanger casings.
- b) PHRS casing beam erection on temporary supports: Place casing beams (4 nos) over leveled platform and align the beams as per drawing requirements. Place cross bar along with pin on stool between central beams at its location and check design gaps between various members and ensure the design requirements. Lock the beams with temporary clamps.
- c) Casing back and side panel erection on temporary supports: Place of back panel over the beams at its location and ensure that the erected beam end should touch the end plate of back panel. Weld back panel with beam (vertical joint between back panel and beam) over the approximately length of 600mm which will not be accessible after erection of side panel. Place one number of side panel with inserted sealing cord over temporary stools, align with back panel and fasten it with the help of end plates & bolt assembly.
- d) PHRS heat exchanger trial assembly on casing beams: Place heat exchanger on to the casing beam assembly, align it with respective match marks keeping thrust gap between PHRS thrust pads and beams equal on either side of HX tube sheet collector. The thrust gap between PHRS thrust pads and beams should be $3 \pm 0.5\text{mm}$. It is permitted to grind the thrust plates or place & weld the shim plates in order to achieve the designed clearances.
- e) After completion of HX alignment over casing beams mark the HX guide plate position over casing side beams (on both sides), also mark the position of 8 no of brackets position on HX with reference to stud holes in the casing beams

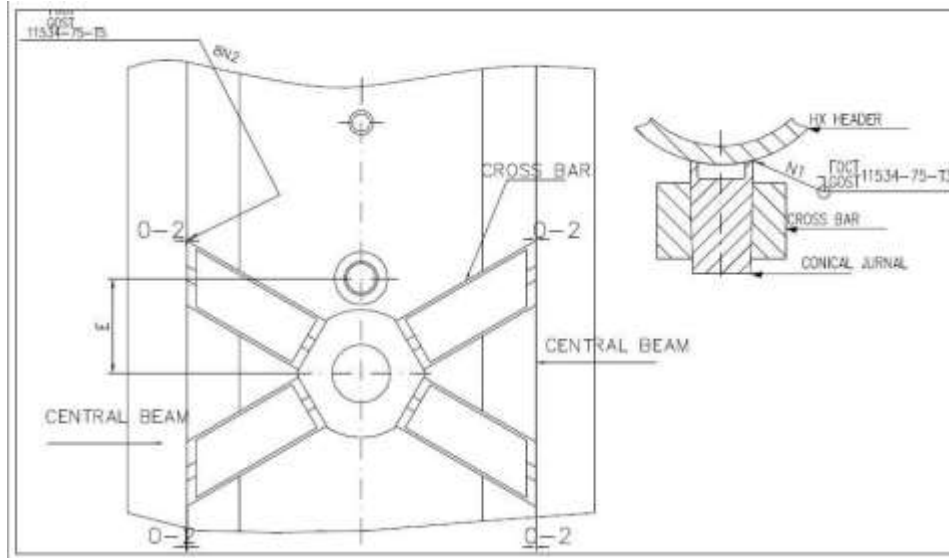
TECHNICAL CONDITIONS OF CONTRACT (TCC)

by ensuring design clearances. After removal of HX from casing do the Fit up and welding of the guide plate on top of side beams, fit up and welding of brackets with HX.

- f) After completion of HX alignment over casing beams mark the HX guide plate position over casing side beams (on both sides). Remove Hx from casing. After removal of HX from casing do the Fit up and weld the guide plate on top of side beams.
- g) Cross bar and conical journal fit—up and welding: Place the cross bar on to the casing beam assembly from the bottom and mark the position of cross bar, conical journal over beams, HX tube sheet collector by ensuring the design dimensions and weld them as per drawing requirements.



TECHNICAL CONDITIONS OF CONTRACT (TCC)



- h) Assembly of central panel: Mark the location of cross bar and conical journal over central panel and cut the location of central panel to accommodate the cross bar and journal. Make the fit up of central panel with central beams after ensuring alignment requirements and carryout the welding. Weld back panel with central panel from inner side of central panel. Grind & remove transport lugs from central panel after welding.
- i) PHRS casing front and side panel erection on temporary supports: Place second side panel with inserted sealing cord over temporary stools, align with back panel and fasten it with the help of end plates & bolt assembly. Place the front panel onto casing beams by pulling the front panel onto projection of Hx tube sheet collectors and fasten it with side panels, beam assembly. If required perform modification of openings of the front cover to accommodate the collector projections. Fasten the front panel collector covers with front panel.
- j) Weld panels with beams after checking all geometric dimensions.

4.2 Assembly, erection & alignment of Passive heat removal system heat exchanger and its accessories:

Trial assembly of PHRS heat exchanger along with casing is already covered in above section. The requirements of erection of HX assembly provided below for indicative purpose to assess the scope of work. Contractor has to plan the assembly and erection work by following manufacturer's recommendation.

- a) PHRS HX has to be assembled along with casing as detailed in the above section over specially designed and erected leveled platform\concrete blocks outside

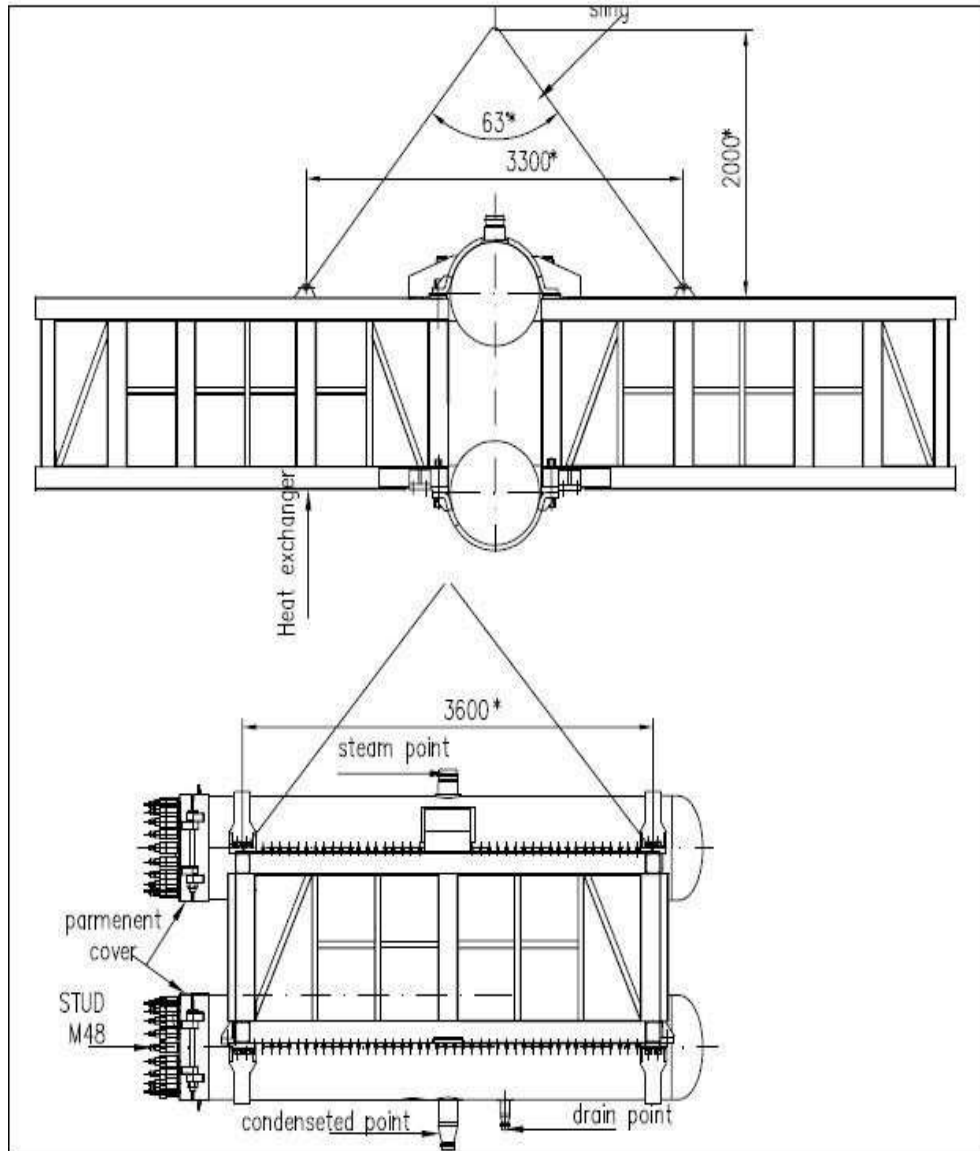
TECHNICAL CONDITIONS OF CONTRACT (TCC)

reactor building. Leveled platforms should cater parallel assembly of three heat exchanger casings.

- b) Temporary Working platform needs to be provided on both sides of OC wall, Territory dome wall.
- c) De-preservation of PHRS Hx and its accessories, dimensional survey for all the components.
- d) Obtain as built details (elevation, horizontality, dimensional details) of all PHRS embedded components (CO/1 to CO/6).
- e) Perform cleaning, minor grinding operations on top of embedded parts to achieve the required flatness requirements on seating area of HX.
- f) Mark the PHRS Hx casing seating area over the embedded parts. Measure the dimensional details (fastening holes relative dimensions) of embedded parts and check with the dimensions of assembled casing load bearing area. If required enlarge the dimensions of HX casing to match with the embedded parts.
- g) Machining of mounting plates of thickness 40mm (which are to be welded at the location of CO/4, CO/5, and CO/6 (brackets) on the bottom of heat exchanger shell module) to match the profiles of Hx casing, brackets seating area.
- h) Place the machined mounting plates on brackets CO/4, CO/5 & CO/6. Surface gap between EP bracket and mounting plate should not be more than 0.5 mm (0.5 mm feeler gauge not to pass). It is permitted to grind the mounting plates in order to achieve the same.
- i) Lower the components which are to be lowered before PHRS Hx erection (expansions duct, inlet damper etc.,) on to floor at +36.0 mtr elevation.
- j) Heavy duty crane will be provided by NPCIL as free of cost for erection of PHRS Hx. Contractor has to arrange the sling and de-shackle and other tools & tackles. The details of items for which heavy duty crane will be provided by NPCIL is given in scope of work chapter, for all the other items contractor has to arrange the crane by himself.
- k) Arrange suitable jigs and fixtures including hydraulic jacks for lifting PHRS casing along with Hx to carry out minor grinding works over mounting plates and also welding of mounting plates with casing after final alignment.
- l) PHRS heat exchanger along with casing assembly will be lifted and placed on the Support brackets on top of mounting plates with the help of heavy duty crane.
- m) While placing the PHRS Hx along with casing ensure that load transferring beams of casing should be in line with PHRS support brackets rib centerline. Align the PHRS Hx as per working document requirements.

TECHNICAL CONDITIONS OF CONTRACT (TCC)

- n) Check various clearances between mounting plates, Hx casing, between HX casing and support brackets. Also check the alignment of bolt holes of PHRS support brackets and Hx casing for fastening of bolts. Perform the required corrections to achieve drawing requirements.



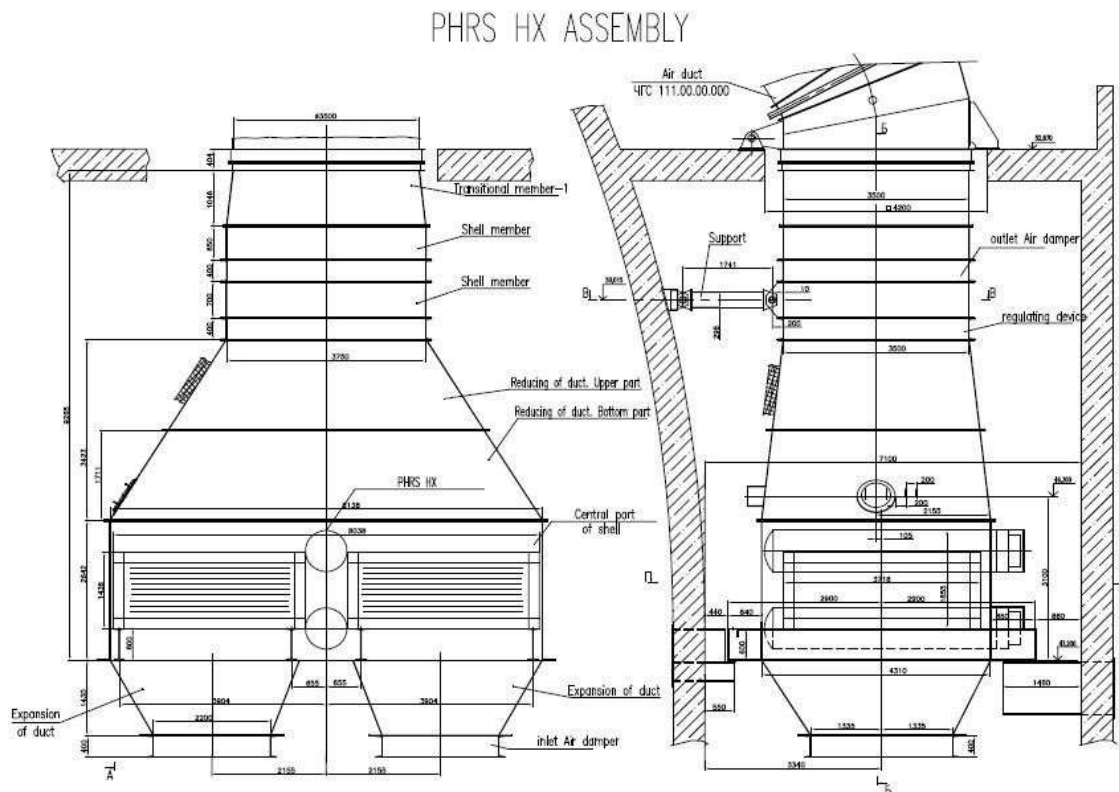
- o) After ensuring alignment lift the PHRS casing along with Hx with the help of hydraulic jacks and do the fit up and welding of Mounting plates with casing. After completion of welding replace the Hx assembly on to supporting brackets.
- p) Fasten the PHRS Hx assembly with the bracket support assembly by means of bolts. Tighten the bolts with the help of torque wrenches to the value specified in the drawing. Do the fit up of lock plates to arrest the movement of Hx casing and perform the welding.

1. *Journal of the American Medical Association*, 1997; 277: 1001-1005.

1. *Journal of the American Medical Association*, 1997; 278: 1039-1044.

TECHNICAL CONDITIONS OF CONTRACT (TCC)

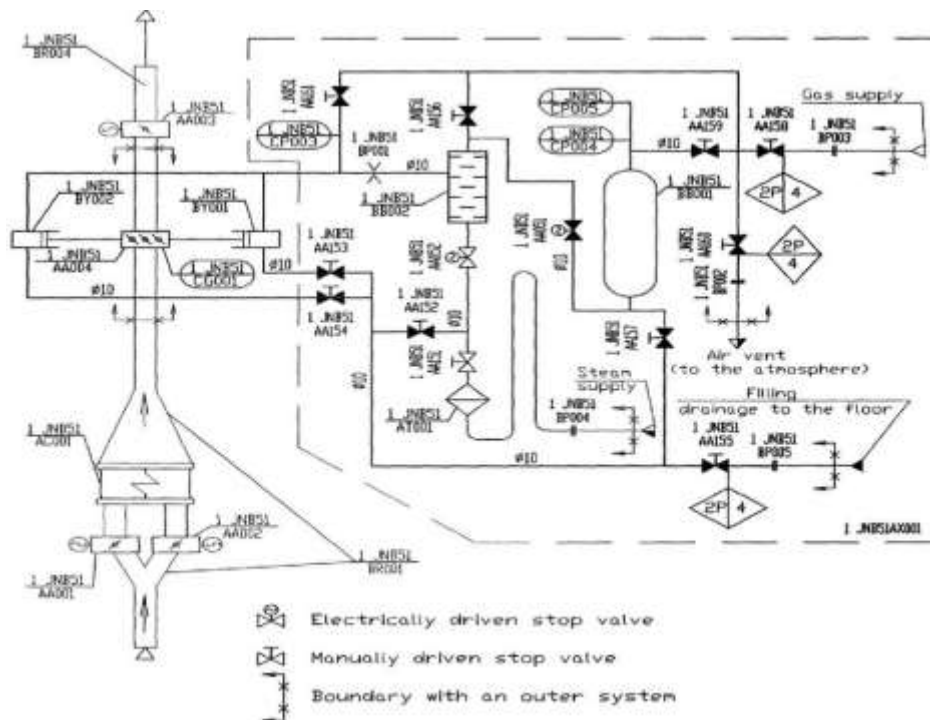
- e) Handling, lifting and placement of expansion duct, inlet dampers, electro magnets with contractor's crane, and placement on floor before erection of PHRS casing.
- f) During erection of PHRS components after installation of every component Protective covers (Made of carbon steel structural members and sheet) shall be placed over top portion to avoid falling of civil debris. Since civil and mechanical erection works will go simultaneously utmost care needs to be taken to protect the erected equipments.



- g) Fix the sealing cord over both expansion ducts and lift and assemble the expansion ducts with PHRS shell casing. Fasten the expansion ducts with the help of bolting assembly.
- h) Fix the sealing cord over both Inlet dampers (air slide) and lift and assemble the Inlet dampers with PHRS expansion ducts. Fasten the Inlet dampers with expansion ducts with the help of bolting assembly. After completion of erection check the clearance between damper leaf and damper seating area on air slide. Adjust the dampers to achieve the required drawing clearance of 0.5mm.
- i) Electromagnets needs to be installed on to inlet dampers and fastened with the help of bolting assembly. The installation needs to be carried out at later stages of PHRS erection.

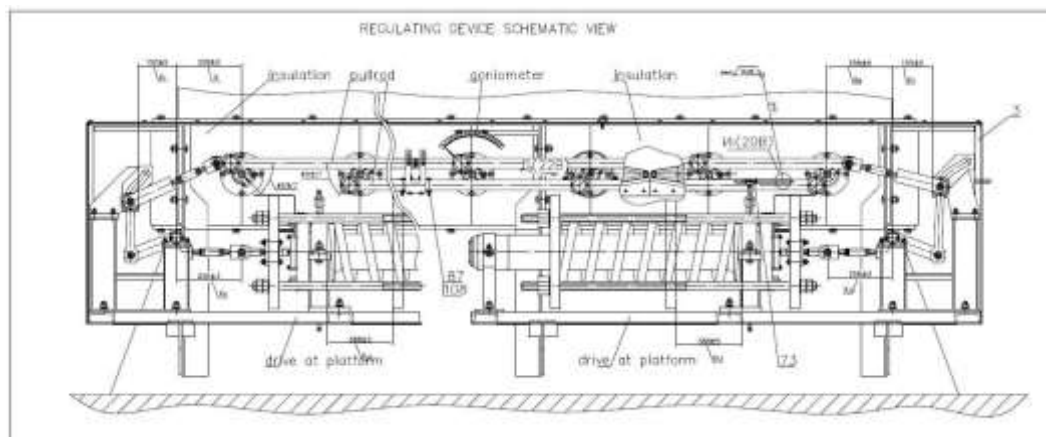
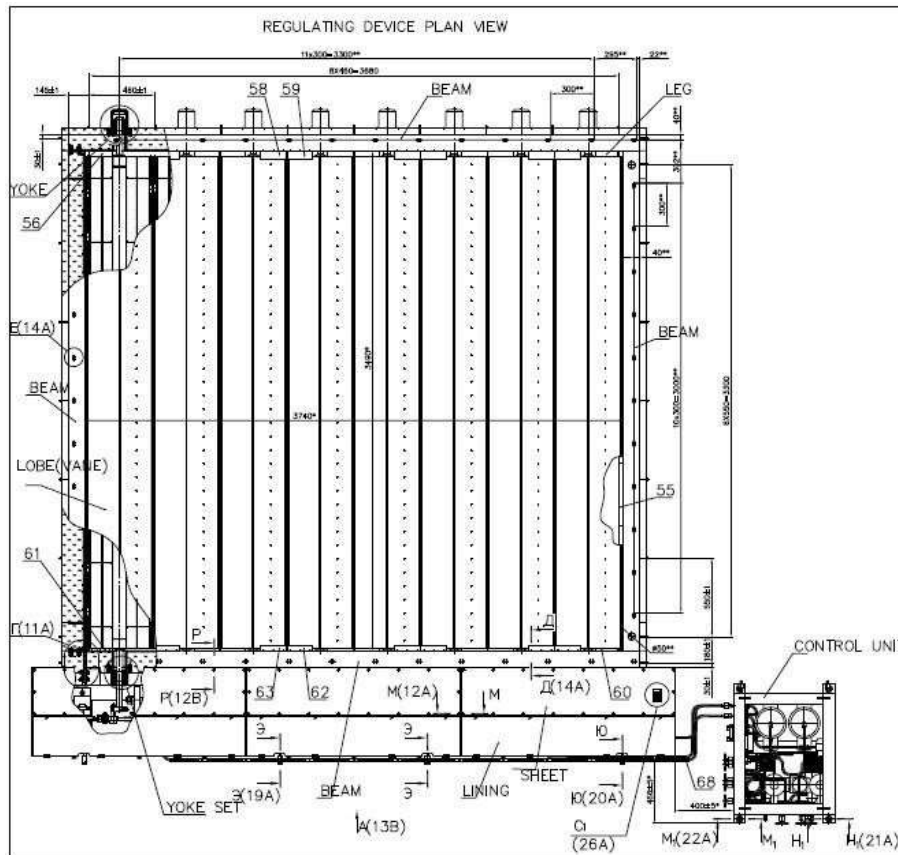
TECHNICAL CONDITIONS OF CONTRACT (TCC)

- j) Handling, lifting and placement of reducing duct parts with contractor's crane on top of PHRS shell casing.
- k) Fix the sealing cord over reducing duct parts (top and bottom) and assemble with PHRS shell casing. Fasten the reducing duct parts with the help of bolting assembly.
- l) Regulating device Erection: The regulating device is intended for air flow control through PHRS Heat-exchanger in operation mode. Regulating dampers are present in Between heat exchanger and upper air damper. There are 8 vanes across the width of the HX which when closed would obstruct the flow of air. The opening and closing of these dampers are based on rise and fall of SG pressure. The regulating device consists of gate with rotating drives, two passive drives, transmission gear, control unit, tubes etc.



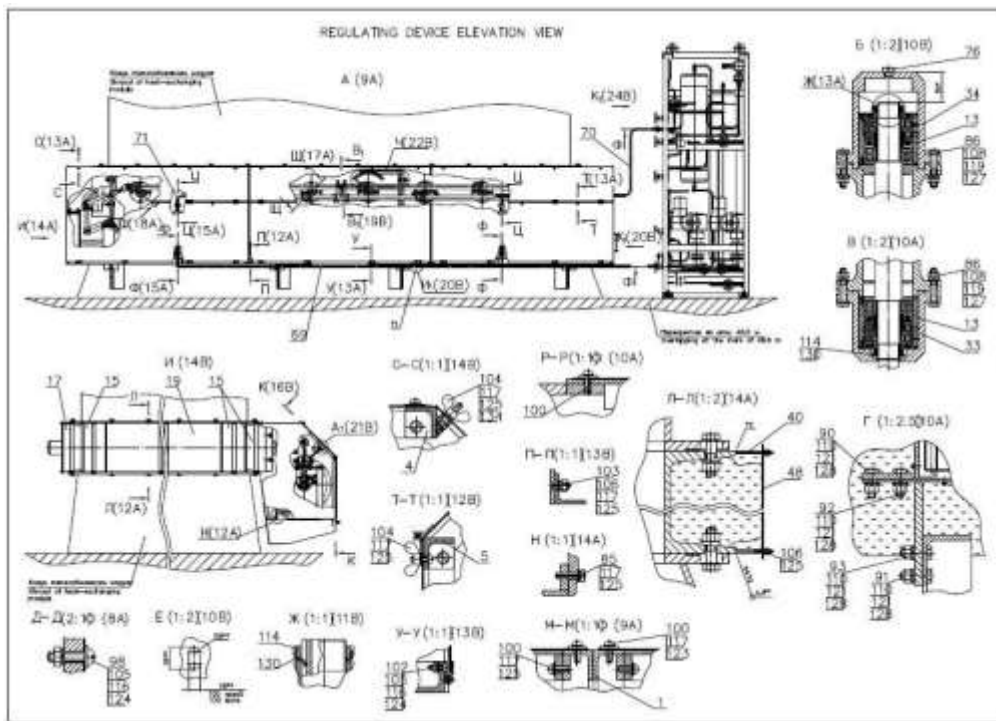
TECHNICAL CONDITIONS OF CONTRACT (TCC)

- m) The gate is a main element of the regulating devices. It is a frame horizontally positioned in the air duct (between the heat exchanging module shroud and upper air shutter) with eight rotary vanes, which can revolve in the opposite direction at the angle from 0 to 90 degrees. The vanes are controlled through the transmission gear with passive drives.



- n) The drive is a mechanism with a movable spring loaded rod. The leak tightness of which with the casing is provided by a bellow unit. The transmission gear transforms linear motion of drive rods into rotary motion of gate vanes. The inner cavity of the drive is connected to the secondary circuit and also connected to gas tank of the control unit.

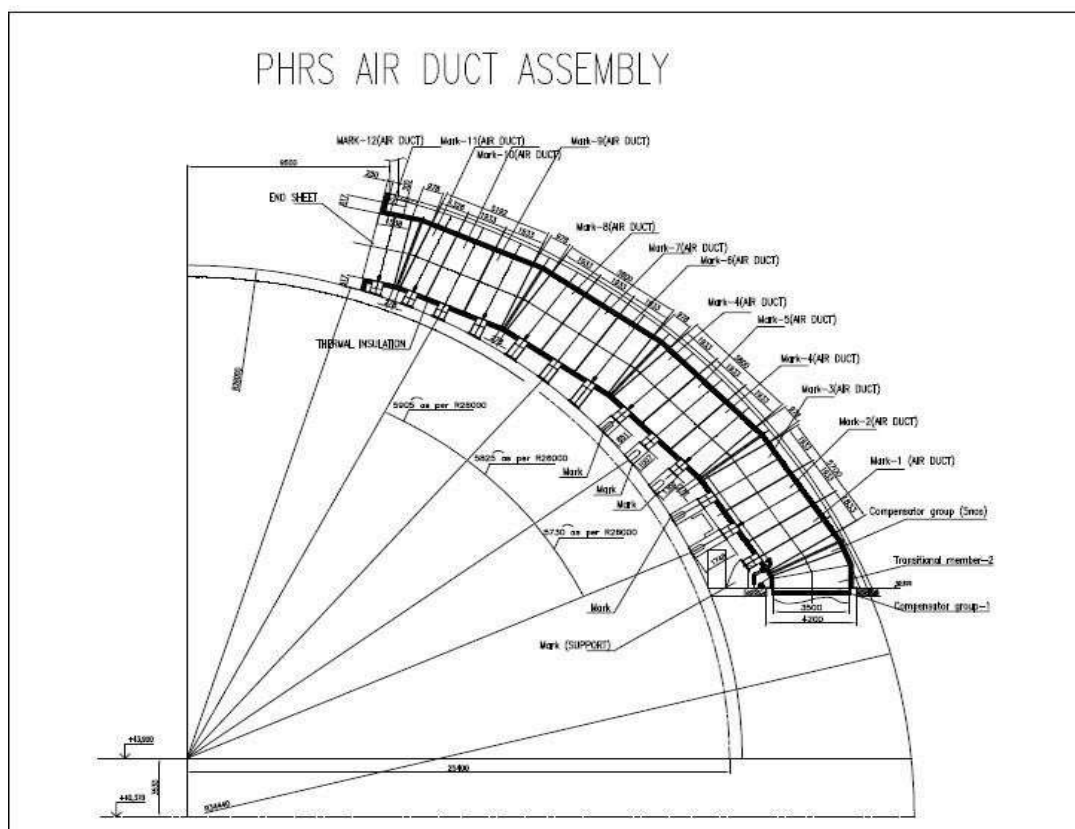
TECHNICAL CONDITIONS OF CONTRACT (TCC)



- The pre-assembly of all the components of regulating device shall be performed as per manufacturers instruction at ground and perform operability check of the drives with nitrogen gas. Disconnect the control unit from the regulating device and handling, shifting of regulating device and control unit to +50.mtr elevation of UJC building.
 - Erection, alignment of regulating device along with control unit with PHRS heat exchanger assembly including connected tubing.
 - Pre-compression of the springs of the regulating device to the required value mentioned in the manufacturers documents by using tool supplied by the manufacturer and adjust the regulating device.
 - Hydraulic testing of the regulating device assembly along control unit shall be performed to the required value of 13 Mpa.
 - Thermal insulation of the regulating device casing shall be performed with the supplied insulation mattresses as per manufacturer's instruction.
- o) Handling, lifting and placement of regulating device with contractor's crane on top of PHRS top part of reducing duct.
- p) Fix the sealing cord over reducing duct top part and assemble with PHRS regulating device. Fasten the reducing top duct along with regulating device with the help of bolting assembly.

TECHNICAL CONDITIONS OF CONTRACT (TCC)

- q) Use compression set supplied by manufacturer for tightening of drive springs inside regulating device.
- r) Handling, lifting and placement of control block with contractor's crane near regulative device mounting on platform.
- s) Lay the interconnecting tubing between control block and regulating drive.
- t) Handling, lifting and placement of Shell member along with supporting member with contractor's crane on top of PHRS regulating device.
- u) Fix the sealing cord over regulating device mating parts and assemble with PHRS shell member. Fasten the shell member along with regulating device with the help of bolting assembly.
- v) Fit up and welding of shell member support with Outer containment embedded part.
- w) Assemble outlet damper assembly outside reactor building.
- x) Fix the sealing cord over both outlet dampers (air slide) and lift and assemble the outlet dampers with PHRS shell member. Fasten the outlet dampers with shell member with the help of bolting assembly. After completion of erection check the clearance between damper leaf and damper seating area on air slide. Adjust the dampers to achieve the required drawing clearance of 2.0 mm.
- y) Electromagnets needs to be installed on to outlet dampers and fastened with the help of bolting assembly. The installation needs to be carried out at later stages of PHRS erection.
- z) Handling, lifting and placement of 2nd Shell member with contractor's crane on top of outlet damper.
- aa) Fix the sealing cord over 2nd shell member and assemble with PHRS outlet damper. Fasten the shell member along with outlet damper with the help of bolting assembly.
- bb) Handling, lifting and placement of PHRS transition member-1 with contractor's crane on top of 2nd Shell member.
- cc) Fix the sealing cord over 2nd shell member and assemble with PHRS transition member-1. Fasten the shell member along with transition member-1 with the help of bolting assembly.



TECHNICAL CONDITIONS OF CONTRACT (TCC)

- g) Compensator group assembly consists of upper member, lower member, transitional member and sealing cord. The lower member is assembled with transition member-1, upper member is assembled with transition member-2 (which is to be erected on top of floor at +52.87 mtr elevation). The transitional member along with sealing cord interconnects the lower and upper members of compensator group by means of bolting assembly. Align the compensator group assembly after finalizing the position of PHRS duct transition member-2.
- h) Handling, lifting and placement of PHRS transition member-2 with contractor's crane on top of embedded parts at +52.87 mtr elevation.
- i) Perform Alignment of PHRS transition member-2 along with supports, and weld the supports with embedded parts provided at +52.87 mtr elevation. Finalize the alignment of compensator group.
- j) Obtain the as built details of embedded parts of OC wall for holding PHRS air duct supports.
- k) PHRS air duct assembly consists of thirteen number of round duct parts along with its supports, five flexible compensator groups, end sheet. The air ducts, compensator groups are interconnected by bolting assembly. PHRS air duct assembly runs from + 52.870 mtr to +69 mtr on top of Outer containment. To provide flexibility to the air duct assembly after every three air ducts one flexible compensator group is provided. Every individual duct part is having support base which needs to be welded to embedded part on reactor building outer containment. Air duct integral support is assembled with support base for each air duct.
- l) Contractor needs to study and plan for preassembly of air ducts on the ground along with thermal insulation and perform lifting and erection of the duct assemblies to reduce the work at higher elevation.
- m) Based on the as built details of embedded parts of PHRS air ducts on top of outer containment wall, the modification of PHRS air ducts supports needs to be carried out on the ground.
- n) Survey the embedded parts given on secondary containment for welding of duct supports. Contractor shall ensure the profile of secondary containment & the duct supports are compatible, both in terms of curvature as well as vertical /horizontal distances between the EPs on containment & support members on the ducts. Any correction required is to be carried out by the contractor. This correction, if required, also is in the scope of the erection item and no additional payment will be given for the same.

TECHNICAL CONDITIONS OF CONTRACT (TCC)

- o) PHRS air duct houses KLB 50-80 pipelines inside the ducts. The KLB 50-80 pipelines spools are joined by flange joints. The supports for KLB 50-80 pipelines are mounted inside air ducts.
- p) Handling, lifting and placement of PHRS air ducts on top of reactor building outer containment Embedded parts Using NPCIL crane.
- q) Perform Alignment of PHRS air ducts along with supports, compensator groups and weld the duct supports with embedded parts. Finalize the alignment of compensator group. Fasten the individual air ducts, air duct to compensator group, compensator group to transition member-2 with the help of bolting assembly.
- r) The contractor needs to study the erection methodology based on the civil erection schedule of tertiary dome concreting and based on that they can plan the erection of air ducts.
- s) After completion erection of ducts weld the end sheet with embedded part, air duct.

Approximate welding quantity envisaged for erection of PHRS equipments is provided below. The actual welding may vary on either side because of change of design or site conditions etc. The welding quantity is indicated only for the assessment of work. The unit rate quoted by the bidder is inclusive of erection and welding of equipments. No separate payment for welding or increase in quantity of welding will be considered. The contractor needs to factor in the variations in the cost quoted for the item.

Weld quantity details of PHRS components

S No	Name of equipment	Weld Quantity in CC (aprx) for both units KK3&4
1	PHRS shell casing assembly	103000
2	PHRS Hx	3490
3	Assembly and erection of Inlet dampers, expansion duct, reducing duct, top and bottom duct, regulating device, electro magnets, outlet dampers, shell members, transition members, compensator group, sealing gland	15600
4	PHRS round air duct assembly	37000

TECHNICAL CONDITIONS OF CONTRACT (TCC)

5. Reports and Records:

- i. Erection reports at all stages of work, as-built drawings, welding inspection reports and NDE reports shall be prepared as per the established work procedures and submitted for acceptance.

TECHNICAL CONDITIONS OF CONTRACT (TCC)

2.2.10 TECHNICAL SPECIFICATION FOR ERECTION OF TUBULAR ELECTRIC HEATER UNITS

SI No	Description
1	Purpose
2	Scope
3	Tubular electric heater units (TEH) : General introduction
4	Erection of thermal electric heater (TEH units)
5	Reports and Records

1. Purpose:

The purpose of this procedure is to provide guidance to contractor to understand the scope & quantum of work and technical requirements to be followed during erection, alignment, torque tightening and inspection of Electrical heaters of pressurizer, emergency core cooling system tanks, quick boron injection system tanks

2. Scope:

The scope of the contractor's work comprises but not limited to the following.

- a) Study of drawings, preparation of network schedules.
- b) Preparation and approval of QAP, erection and inspection procedures, Preparation of erection schemes.
- c) Receipt of material from BHEL/NPCIL store, transportation, storage.
- d) Handling, erection, alignment, torque tightening and inspection.
- e) Providing, torque wrenches, measuring instruments & tools including consumables required for the work.

3. Tubular electric heater units (TEH):

General introduction:

Tubular electric heater units of equipments (pressurizer, quick boron injection system tanks, and Emergency core cooling system) are designed for maintaining required coolant temperature inside the vessel to meet the process requirements.

TECHNICAL CONDITIONS OF CONTRACT (TCC)

S No	Description of item	Nos of heaters per equipment	Weight in KG (each)
1	Pressurizer – (90 KW each)	28	154
2	Emergency core cooling system Tank	1	200
3	Quick boron injection system	1	200

Ref. drawings:

1. R56.KK.UJA.JEF.TM.SB.WD1122 – Thermal electric heaters of pressurizer.
2. R02.KK.3UJA.JEF.RP.MC.WD027 - Pressurizer assembled - Mounting drawing.

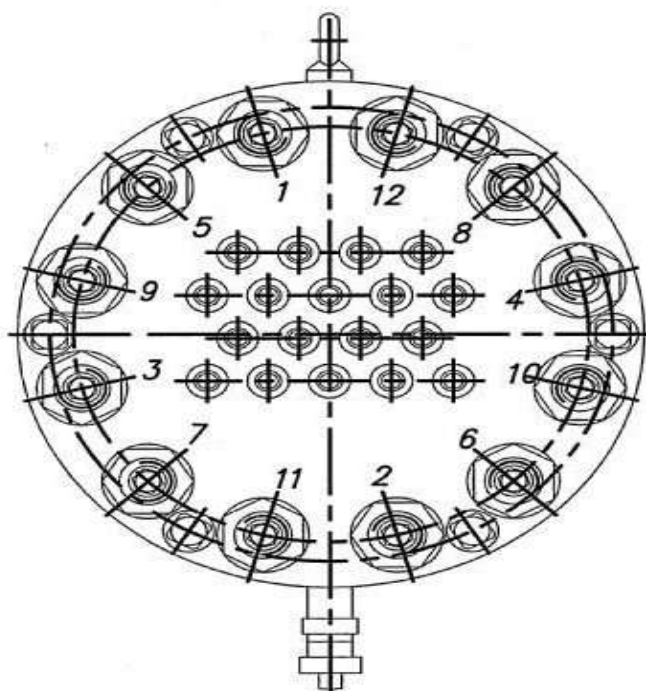
4. Erection of Thermal electric heaters (TEH units):

A brief detail of work is provided below, however the contractor has to execute the work by fulfilling the requirements specified in working drawings \ manufacturer's instructions for satisfactory completion of said work.

- a) Providing temporary Working platform for accessing Equipment heater location
- b) Removal of temporary covers of heater flanges and cleaning and de-preservation of flanges, guides provided inside the equipment, checking clearances & spacing of flanges for erection of heaters.
- c) Parameters of Electrical heaters

S No	Parameter of heater	Rated value
1	Rated power of TEH unit of pressure compensator,	90±6.8
2	Rated voltage of power line, V	380+38
3	Current frequency, HZ	47-53
4	Number of TEH in a unit, pcs	9
5	Rated power of each TEH, KW	10

View of Heater



TECHNICAL CONDITIONS OF CONTRACT (TCC)

- d) Heaters erection shall be carried out only after completion of flushing of the connected systems.
- e) De-preservation, dimensional survey of heaters, measuring electrical parameters of heaters (insulation resistance, etc,.), ensuring nozzle throughness of inter gasket leak monitoring.
- f) Fabrication of protective cage for lifting / shifting and transportation of heater units to erection location.
- g) Handling, shifting of TEH heaters in protective covers to designed location.
- h) Nickel gasket placing, Erection, ensure heater support rollers are guided in internal guides provided inside tanks, alignment, application of lubricants to stud assembly, fixing of studs, nuts, washers.
- i) Torque tightening of heaters using hydraulic torque wrench as per the designed sequence in a number of steps to achieve required stud elongation values as per drawing requirements and Measurement of stud elongation shall be taken with the help of dial gauges mounted on special fixture arranged by contractor.
- j) Provide the Temporary Protective structural covers to all the heaters to cover the heaters leads protruding outside to avoid the damage.
- k) Removal of staging, Preparation of reports and submission for acceptance
- l) Return of wooden scrap to Stores and material accounting.

5. Reports and Records:

- i. Erection reports at all stages of work, as-built drawings shall be prepared as per the established work procedures and submitted for acceptance.

TECHNICAL CONDITIONS OF CONTRACT (TCC)

2.2.11 TECHNICAL SPECIFICATION FOR ASSEMBLY, TESTING AND ERECTION OF HYDRAULIC SHOCK ABSORBERS

Sl No	Description
1	Purpose
2	Scope
3	Hydraulic shock absorber assembly : General introduction
4	Erection of hydraulic shock absorber assembly
4.1	Hydraulic shock absorber along with supporting brackets
4.2	Installation of position indicators for hydraulic shock absorber of various
4.3	Erection of oil tanks and connected tubing, level indicators for hydraulic shock absorber of various types
5	Reports and Records

2.2.11.1 Purpose:

The purpose of this procedure is to provide guidance to contractor to understand the scope & quantum of work and technical requirements to be followed during assembly, erection, alignment, welding and inspection of hydraulic shock absorbers with supporting brackets.

2.2.11.2 Scope:

The scope of the contractor's work comprises but not limited to the following.

- a) Study of drawings, preparation of network schedules.
- b) Preparation and approval of QAP, erection, welding and inspection procedures, Preparation of erection schemes.
- c) Receipt of shock absorber assembly from CMM stores, shifting to site, storage and preparation of IMIR and dimensional survey of individual components.
- d) De-preservation of shock absorbers and its accessories as per manufacturer's recommendation.
- e) Handling, erection, alignment, welding and inspection.
- f) Checking of design movement.

TECHNICAL CONDITIONS OF CONTRACT (TCC)

2.2.11.3 Hydraulic shock absorber assembly: General introduction:

The Hydraulic shock absorbers are provided to take up external dynamic loads acting upon the equipments/pipelines. The shock absorbers are fastened to equipments/pipelines on one side and to the embedded parts/metal structures on the other side.

Shock absorber assembly consists of supporting arms, brackets, fixing axles, shock absorber, shock absorber oil tank, connected tubing, oil level indicator, connected support structures etc.,.

Ref. drawings:

1. Mounting drawing: R02.KK.3 UJA.J.RP.KC.WD002

4. Erection of Hydraulic shock absorber assembly:

A brief detail of work for main components is provided below for understanding the scope of work. However contractor has to execute the work by fulfilling all the requirements of working drawings\manufacturer's instructions for satisfactory completion of said work.

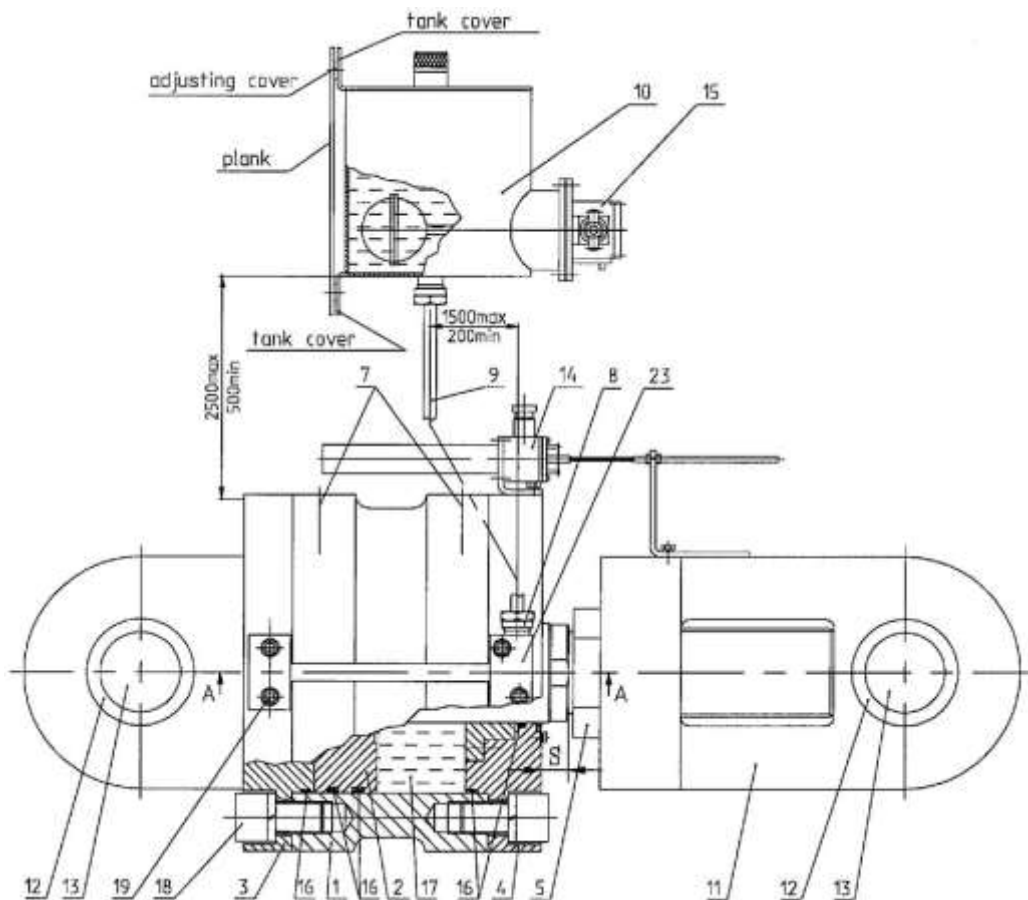
4.1 Hydraulic shock absorber along with supporting brackets:

- a) Provide Temporary Working platform for preliminary adjustment & for erection and alignment of shock absorbers.
- b) Arrange suitable jigs, fixtures for testing of shock absorber design movement, check the design movement of hydraulic shock absorber piston before erection.
- c) Cleaning, removal of paint in both equipment\pipeline shock absorber seating area, embedded part for fit up of shock absorber brackets.
- d) Handling, lifting, erection of shock absorber arms/brackets over equipment/pipelines and embedded parts\support structures, survey, make the fit up and tack welding and completion of welding. In case of pipelines the supporting brackets shall be fastened to pipelines by means of clamping arrangement.
- e) Check the dimension between eye to eye of the brackets and pre-set the hydraulic shock absorber piston position based on working documents, as built data (bracket eye to eye distance) And Lock the piston as per manufacture document .
- f) Handling, lifting, Erection and alignment of shock absorber over brackets and fix with the axle pins. Ensure alignment requirements and oil vent holes location

g) Fabricate and install Protection covers for hydraulic shock absorbers to avoid damage to position indicator assembly.

h) Final cleaning, touchup painting of weld joints and other damaged areas with OC-51 paint.

g) Welding of tubing will be measured in respective item



Approximate welding quantity envisaged for erection of equipments is provided below. The actual welding may vary on either side because of change of design or site conditions etc. The welding quantity is indicated only for the assessment of work. The unit rate quoted by the bidder is inclusive of erection and welding of equipments. No separate payment for welding or increase in quantity of welding will be considered. The contractor needs to factor in the variations in the cost quoted for the item.

TECHNICAL CONDITIONS OF CONTRACT (TCC)

Details of equipment, number of shock absorber and quantity of welding involved:

S No	Name of equipment	No per equipment	Total number per unit	Weld Quantity in CC (aprx) for both units KK3&4
1	Hydraulic shock absorbers (R-450) of Steam generators (64 nos)	8	32	5840000
2	Hydraulic shock absorbers (R-300) of Reactor coolant pumps (16 nos)	2	8	15600
3	Hydraulic shock absorbers (R-100) of Pressurizer pipelines (28 nos)	14	14	21500
4	Hydraulic shock absorbers (R-50) of Pressurizer pipelines (8 nos)	4	4	4800
5	Hydraulic shock absorbers (R-100) of ECCS pipelines (6 nos)	3	3	3600
6	Hydraulic shock absorbers (R-50) of ECCS pipelines (12 nos)	6	6	5000
7	Hydraulic shock absorbers (R-50) of JDJ pipelines (32 nos)	16	16	6000

Note:

- The above quantity is tentative based on KK Unit-1&2.
- During detailed design, there can change in type, size and number of absorbers.

TECHNICAL CONDITIONS OF CONTRACT (TCC)

4.2 Installation of position indicators for hydraulic shock absorbers of various types (R-450,R-300,R-100,R-50):

The device is intended for measuring linear displacement of the shaft which connects the hydraulic shock absorber with the equipment or pipelines. The device is placed directly on the hydraulic shock absorber. The range of transducer measurement is 0 – 100mm, weight of each LVDT is 6 kgs.

SCOPE OF WORKS:

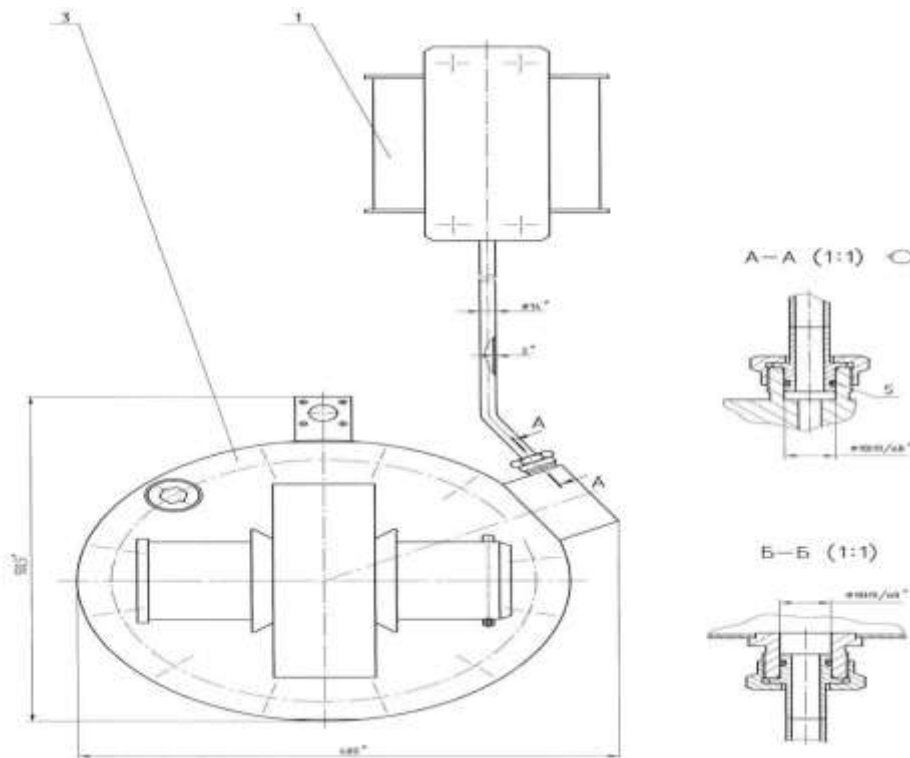
- a) Providing temporary Working platform\scaffoldings on both sides of shock absorbers for accessing the shock absorbers.
- b) Obtain as built details of shock absorbers.
- c) Check and record Design movement of position indicators.
- d) Shifting of position indicators (LVDTs) to the respective shock absorber location.
- e) Ensure that the shock absorber cylinder and arm are in aligned condition for fixing the position indicators, adjust the arm in order to achieve the same.
- f) Calculate the pre-set condition of the position indicators based on the position of the shock absorber piston and adjust the position indicator accordingly.
- g) Fasten the position indicator on the cylinder body of the shock absorber on the screwed holes provided on the cylinder cover.
- h) Drilling and tapping of additional holes shall be done as per the requirement for fixing of LVDT.
- i) Fasten the Arm which supports the extension rod of the piston of the LVDT, to the lug of the shock absorbers. Ensure smooth movement of extension rod inside the arm. Grind and enlarge the arm in order to achieve the smooth movement.
- j) Ensure linear alignment of both the cylinder, adjustable arm perfectly and lock them with check nuts as per design requirements. After installation check the functionality of position indicator linear movement and ensure smooth movement of extended portion of piston inside the angle bracket provided on the adjustable arm. Adjust the angle bracket for smooth movement of piston by providing shims if required. After final alignment lock the nuts by the tying the steel wire through the holes provided in the nuts. This activity will be carried out at later stages of project work just before commissioning works to avoid any damage to position indicator assembly as it encases very sensitive electronic instruments.
- k) The screws shall be tightened in control method by using torque wrench. After completion of tightening of bolts, bolts shall be locked by wire.
- l) Preparation of reports and submission to BHEL & NPCIL for acceptance.

Table 1 Demographic characteristics of study population

- e) Mark the location of Hydraulic shock absorber oil tank location and fix the oil tank along with supporting structure to Embedded part/metal structure by ensuring design requirements.
- f) As built survey of oil tank and shock absorber for selecting optimum route for connected tubing in order to follow slope and dimensional requirement of WD(minimum horizontal, vertical dimensions as specified).
- g) Bending of tube to the required profile as per the dimensions taken with the help of tube bending machine.
- h) Welding of end fittings and tube to tube (if required) to be performed on joints.
- i) Perform non destructive examination like Dye penetrant test, Radiography test etc as per the requirement of working documentation.
- j) Flushing of the oil tank and tube, up to shock absorber cylinder nipple without connecting the tube to the cylinder, Install oil tank filter.

TECHNICAL CONDITIONS OF CONTRACT (TCC)

- k) Handling, erection and alignment of level indicator of oil tank at its designated position as per working document. Check the functionality of level indicator, fix the oil level indicator. Assisting in oil filling of shock absorber cylinder and reserve oil filling in oil tank.
- l) Fill the oil tank up to required level with the supplied oil by properly venting the shock absorber. Ensure sufficient oil quantity by oil level indicator reading. This activity will be carried out at later stages of project work to avoid any oil spill over/ to keep sufficient reserves of oil just before commissioning works.
- m) Preparation of reports and submission to BHEL & NPCIL.



5. Reports and Records:

- i. Erection reports at all stages of work, as-built drawings, welding inspection reports and NDE reports shall be prepared as per the established work procedures and submitted for acceptance.

TECHNICAL CONDITIONS OF CONTRACT (TCC)

2.2.12 TECHNICAL SPECIFICATION FOR ASSEMBLY, WELDING, MODIFICATION AND ERECTION OF DETACHABLE THERMAL INSULATION BLOCKS (DTIB)

SI No	Description
1	Purpose
2	Scope
3	Detachable thermal insulation blocks (DTIB) : General introduction
4	Preparatory work
4.1	Erection of quick release detachable thermal insulation blocks (DTIB)
4.2	Modification of DTIB insulation blocks to suit to site requirements
4.3	Removal and re-installation of DTIB blocks
5	Reports and Records
	Annexure 1 : NPCIL Free issue equipment & tool list

2.2.12.1 Purpose:

The purpose of this procedure is to provide guidance to contractor to understand the scope & quantum of work and technical requirements to be followed during assembly, erection, alignment, welding and inspection of detachable thermal insulation blocks (DTIB).

2.2.12.2 Scope:

The scope of the contractor's work comprises but not limited to the following.

- a) Study of drawings, preparation of network schedules.
- b) Preparation and approval of QAP, erection, welding and inspection procedures.
- c) Receipt of material from NPCIL/BHEL store, transportation, storage.
- d) Receipt of modular thermal insulation blocks of various sizes and shapes and its accessories from NPCIL stores, handling, transportation, rigging, uncrating, shifting to contractors stores/site, temporary storage and preparation of IMIR.
- e) Handling, assembly, erection, alignment, checking interference, welding and inspection.
- f) Handling, assembly, modification based on site condition, reassembly, erection, alignment, welding and inspection.

TECHNICAL CONDITIONS OF CONTRACT (TCC)

2.2.12.3 Detachable thermal insulation blocks (DTIB):

General introduction:

Detachable thermal insulation blocks consists of a set of rigid frame elements (modules) made of corrosion resistant stainless steel sheets of austenitic class having thickness 0.5 and 1mm and embossed stainless steel foil having 0.1mm on contact surface with the equipment/ pipeline, and these modules are filled with stitched mats made of super fine glass fiber without fiber fabric lining are used as thermal insulating material. Thermal insulating material is fixed and sealed inside a module by means of special pins with clips. To facilitate erection works external surface of each module is provided with handles and these modules are installed on the equipment and pipelines of NSSS and fastened to each other by means of special quick removable locks. Weight of one module of thermal insulation does not exceed 40 kg.

In general the work comprises of executing the handling, transportation, shifting to location, assembly over pipeline & equipment, checking of connection & gaps and erection of thermal insulation blocks, which involves familiarization with the specialized tools available for erection/modification works (spot welding machines, sheet bender, impact drilling machine). These tools are in addition to the tools and tackles supplied by the contractor.

Prior to thermal insulation erection an inspection is to be performed to check any interference between heat insulated equipment/pipelines and the nearest building structure/steel structure, equipment and pipeline. When any interference is detected the decision on modification of thermal insulation modules is made with the assistance of the RF thermal Insulation specialist.

The detachable insulation blocks are to be erected over the NSSS equipment and pipelines are given below:

1. Steam Generator (SGs).
2. Main Circulation Pipeline (MCP).
3. Pressurizer (Prz) and its connecting pipelines.
4. Quick Boran Injection sytem (QBIS) tank and its pipe lines.
5. ECSS stage-1 tanks and its pipeline upto first isolation valve from reactor.

TECHNICAL CONDITIONS OF CONTRACT (TCC)

4. Preparatory work:

- a) Covered temporary storage and staking of the DTIB blocks without any damage at outside reactor building roof floor.
- b) Set up temporary fabrication cum machine room with required work benches and power connections as per manufacturer recommendations for pre fabrication of DTIB insulation blocks.
- c) Supply and commissioning machineries & tools issued by the engineer as per Annexure-1.
- d) The contractor shall assess the requirement of number of tools / equipment based on erection schedule and provide hand tools, equipment as per the work requirement.
- e) Training of welding machine operator for spot welding machines, other tools supplied by insulation manufacturer & other persons working in DTIB insulation blocks erection work. Assistance will be provided by Russian specialists in handling the tools during initial period.
- f) Ensure completion of all works (Inspection, painting etc.,) on equipments/pipelines which are to be DTIB insulated, and obtain clearance from NPCIL for carrying out DTIB insulation over individual equipment/piping system.
- g) Providing temporary Working platform on equipments/pipelines all around the periphery for access for thermal insulation erection.
- h) Obtain/measure as built details, field / site measurements of erected equipment and piping and check for clearances of equipment/piping with surrounding equipment/structures/pipelines/cable metal structures etc to ensure sufficient erection clearances for DTIB installation.
- i) De-preservation of DTIB blocks, accessories.
- j) Surface cleaning of equipment and pipelines for installation of DTIB insulation blocks.

4.1 Erection of Quick release detachable thermal insulation blocks (DTIB)

- a) Handling, shifting the DTIB insulation blocks to fabrication room, pre fixing of quick release fasteners (locks) at design locations with the help of spot welding machines.
- b) Handling, shifting, trial assembly of DTIB insulation blocks over equipment/pipeline over nozzle, support, sensor locations for checking of design clearances as per drawing.

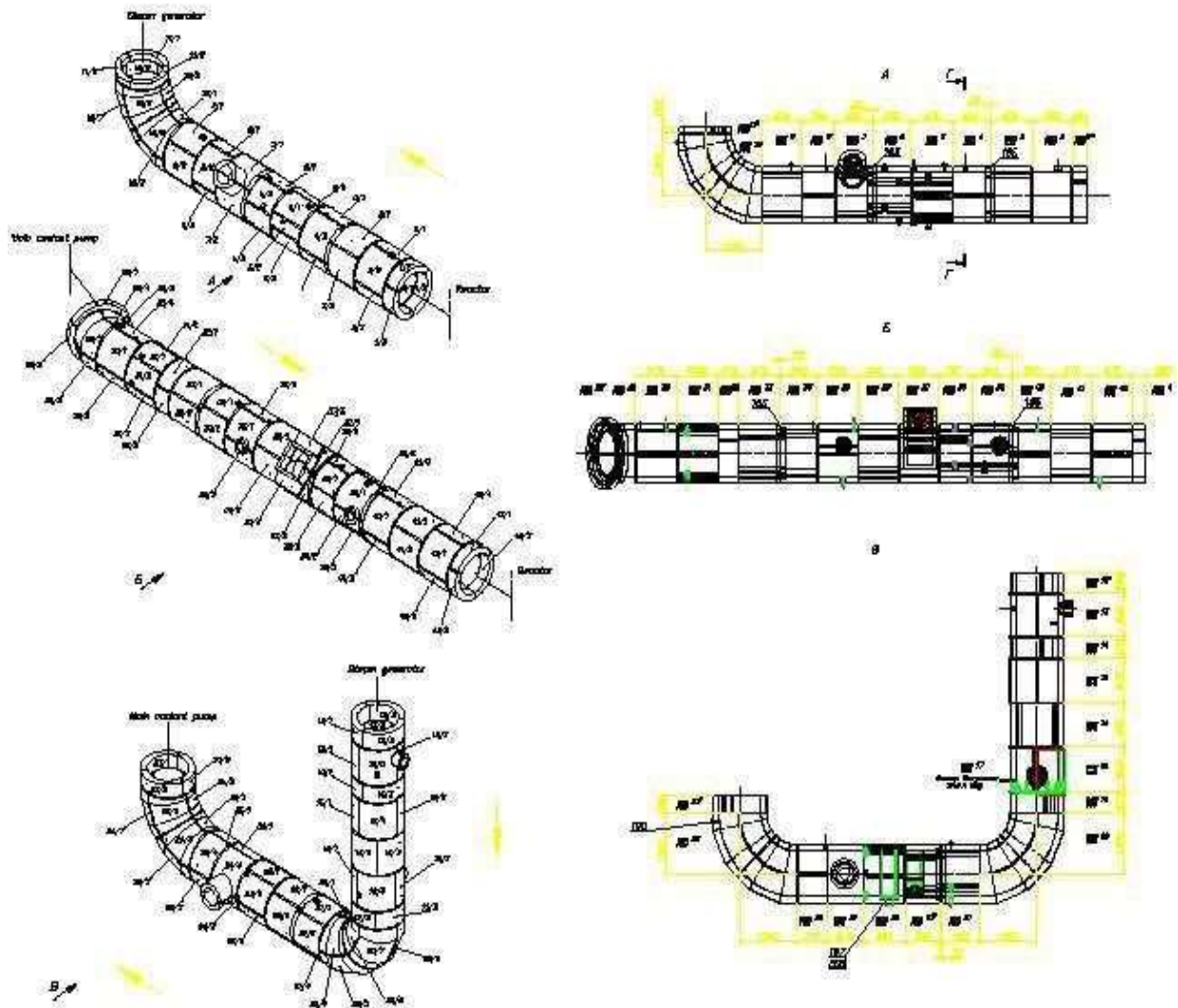
TECHNICAL CONDITIONS OF CONTRACT (TCC)

- c) Preparation of drawing/template for nozzle, support, sensor locations, marking profiles on insulation blocks, cut /enlarge provision for piping nozzle, support, sensor openings as per as built data of equipments/pipelines.
- d) Handling, shifting, erection of DTIB supporting/shroud rings over equipment/pipelines.
- e) Handling, shifting, installation of DTIB insulation blocks over equipment/pipeline row by row separately. Ensure identification labels of the blocks are visible and stability of the blocks during erection to avoid any mechanical damage of the blocks. Ensure erection of blocks as per sequence provided in the drawings, Alignment of blocks.
- f) DTIB blocks are designed in such a way that each row of blocks overlaps the next row in order to provide leak tight installation. Sequence of installation/removal of DTIB insulation blocks planned by taking into account of these overlaps.
- g) After completion of alignment of DTIB blocks, perform welding of additional locks with DTIB blocks by using spot welding machines.
- h) Interconnect the DTIB insulation blocks both circumferentially, longitudinally with quick release fasteners (locks) and adjust the clearances/gaps between the blocks with the help of quick release fasteners to meet the drawing requirements.
- i) In certain cases modification of insulation blocks needs to be performed because of fouling with other equipments/ pipeline/structure/cable tray etc., (Measured and paid in respective item number of BOQ). After completion of modification of these thermal insulation blocks erection shall be performed.
- j) Identification and measurement of Interference either because of fouling with other equipments/pipeline/structure/cable tray or because of profile mismatch.
- k) Fabrication, stitching and installation of required size ceramic wool mattresses wrapped in silica cloth in nozzle locations, designed openings.
- l) Pre-fabrication & installation of cover sheets with spot welding machines at all nozzle locations, designed openings to protect the erected mattresses from damage, dirt etc.,.
- m) Finally assembled thermal insulation shall be inspected to ensure Modules shall have no visible damages, dents, tears, weld failures etc. Damaged modules are subject to repair and replacement.

- n) Minimum distance between thermal insulation and adjacent equipment, pipelines, operating platforms, stairs, ducts etc to be not less than 100 mm to ensure the modules integrity during the process of thermal expansion of thermal insulated equipment and pipelines.
- o) Inspection of all design clearances as per drawings and technical specifications.
- p) Preparation of reports and as built drawings for every equipment and pipelines for NPCIL acceptance
- q) Measurement unit for erection of DTIB insulation blocks is square meter area of insulation blocks erected.
- r) DTIB insulation blocks typical sketches for steam generator is provided as sketch-1, for main coolant pipeline as sketch-2 and pressurizer in sketch-3.

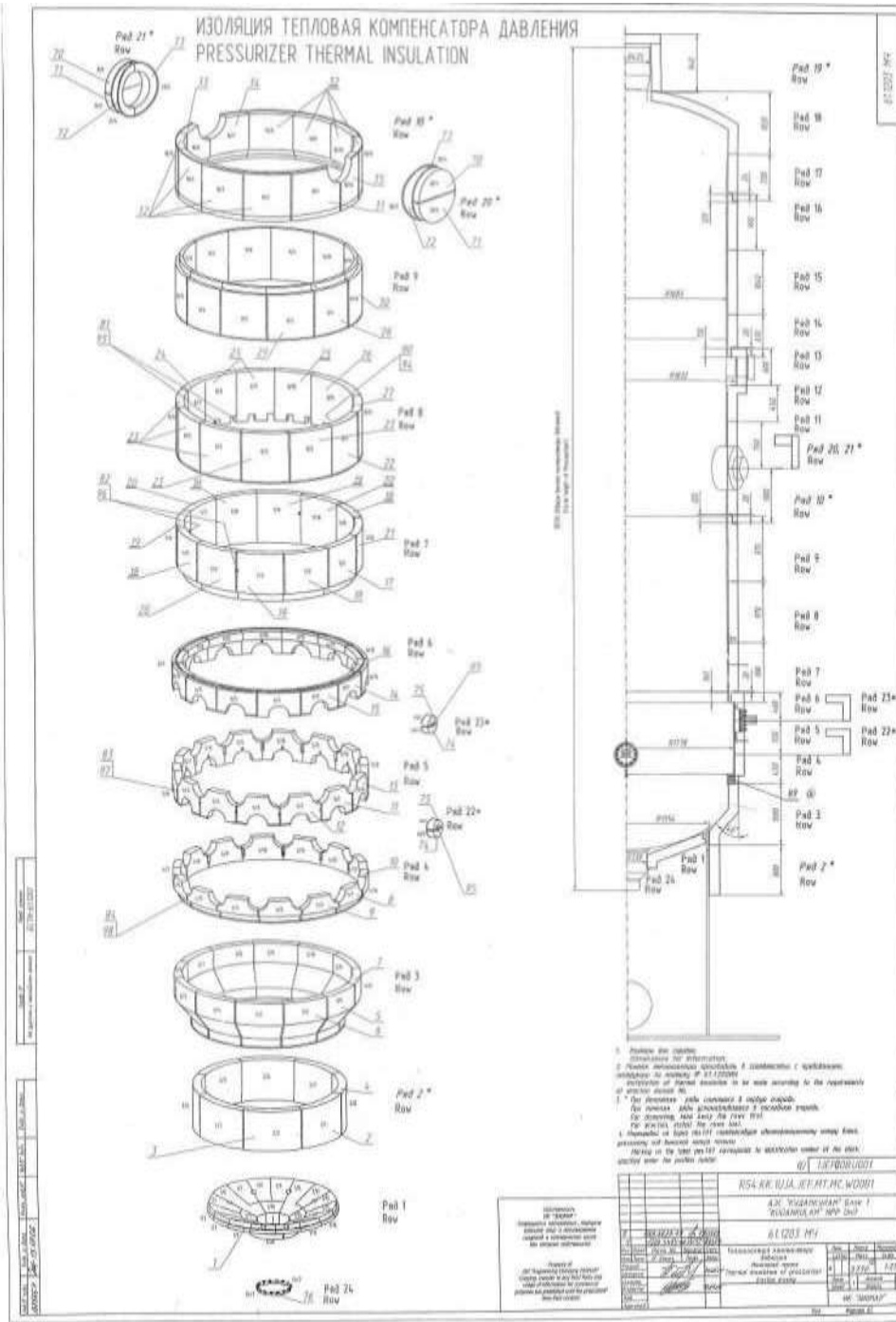
Technical drawing of a steam generator, cylindrical part, showing exploded view and assembly details. The drawing includes a main assembly view at the bottom left and several exploded views of the cylindrical shell segments at the top. The segments are labeled with part numbers and dimensions. The main assembly view shows the cylindrical shell with various fittings, including a pressure gauge, a safety valve, and a drain valve. The exploded views show the segments being joined to form the cylindrical shell. The drawing includes a title block at the top right with the text "STEAM GENERATOR, cylindrical part". The drawing is a technical drawing of a steam generator, cylindrical part, showing exploded view and assembly details. The drawing includes a main assembly view at the bottom left and several exploded views of the cylindrical shell segments at the top. The segments are labeled with part numbers and dimensions. The main assembly view shows the cylindrical shell with various fittings, including a pressure gauge, a safety valve, and a drain valve. The exploded views show the segments being joined to form the cylindrical shell. The drawing includes a title block at the top right with the text "STEAM GENERATOR, cylindrical part".

Main coolant pipeline thermal insulation typical sketch



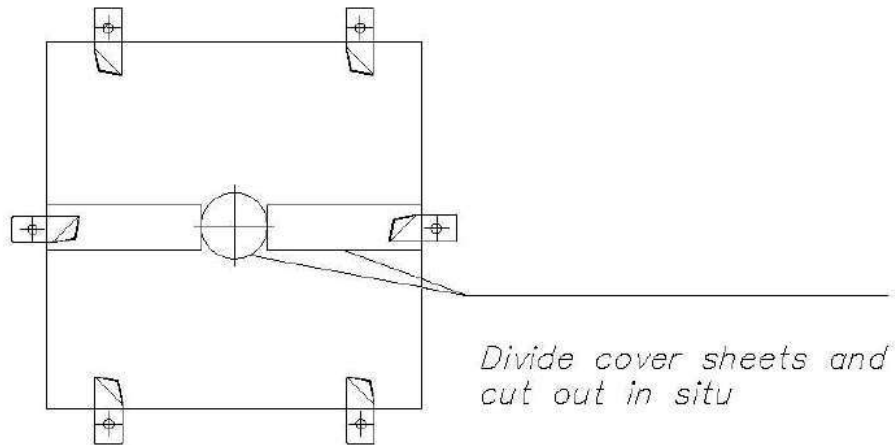
TECHNICAL CONDITIONS OF CONTRACT (TCC)

Pressurizer insulation typical sketch

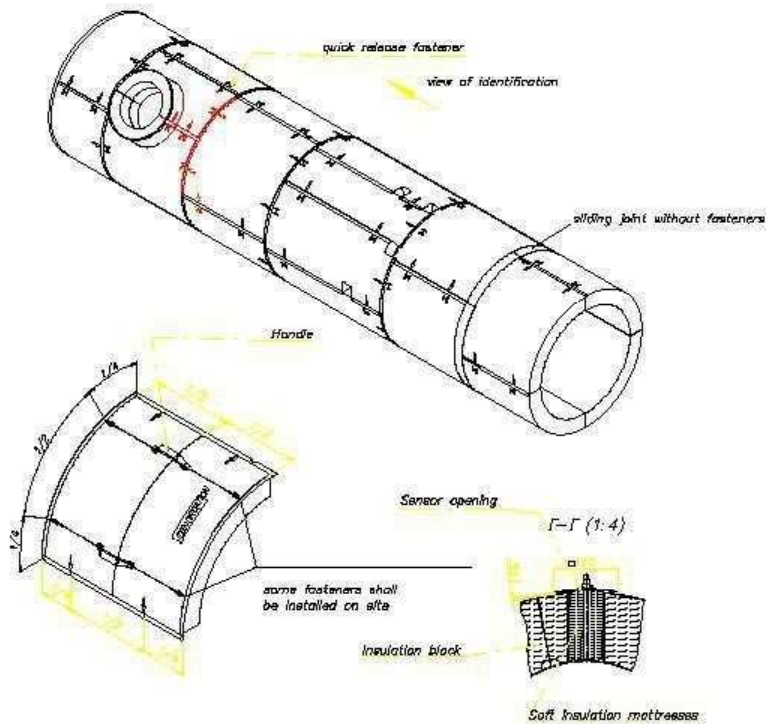


TECHNICAL CONDITIONS OF CONTRACT (TCC)

Principle of cover sheets installation



Principle arrangement of fasteners, handles and identification labels



TECHNICAL CONDITIONS OF CONTRACT (TCC)

4.2 Modification of DTIB insulation blocks to suit to site requirements:

Prior to thermal insulation erection an inspection is to be performed to detect any interference between heat insulated equipment/pipelines and the nearest building structure/steel structure, equipment and pipeline. When any interference is detected the decision on modification of thermal insulation modules is made with the assistance of the RF thermal Insulation specialist.

The modification of thermal insulation may also arise if the Inside profile of thermal insulating modules doesn't match with the equipment/pipeline outside profile. Interference drawing as well as modification drawing needs to be prepared for approval from NPCIL for taking up modification works.

The modification works needs to be carried out with the assistance of/under the supervision of Insulation manufacturer's representative.

- a) Identification and measurement of Interference either because of fouling with other equipments/pipeline/structure/cable tray or because of profile mismatch.
- b) Prepare drawing for interference and propose possible solution (modification drawing) to eliminate mismatch/interference and submit for approval. After getting the approval for the modification drawing the modification work can be taken up.
- c) Shift the DTIB modular insulation blocks to fabrication room after getting clearance for modification of Individual Insulation modules from NPCIL.
- d) Marking of the blocks, preparation of templates (if required) to be carried out as per the approved drawings.
- e) In general the modification involves marking of the DTIB blocks with marker and cutting the outer layer of the SS sheet of the module with the help of appropriate tools, removing the Insulation material or placing additional insulation material as per the requirement and restoring the shape required as per approved drawing by using spot welding machine.
- f) In certain cases thermal insulations blocks rigid frames also needs to be fabricated as per the requirement by using Stainless steel sheets.
- g) Thermal insulating material is placed and sealed inside a DTIB module by means of special pins with clips and density of Thermal insulating material is to be ensured as per the requirements of manufacturer's

TECHNICAL CONDITIONS OF CONTRACT (TCC)

documentation or as per the advice of Russian manufacturing representative on a case to case basis.

- h) Re-install the modified thermal insulation block to check for the correctness/elimination of interference, if required perform the required corrections.
- i) Preparation of reports and as built drawings for modified block for NPCIL acceptance
- j) Measurement unit for insulation modification is Square inch of area of insulation block modified.

4.3 Removal and re-installation of DTIB blocks:

For carrying out pre service inspection (PSI) of weld joints of equipments/pipelines after primary hydrotest and hot run DTIB thermal insulation blocks needs to be removed. After completion of inspection these thermal insulation blocks needs to be assembled/erected again on equipments/pipelines.

- a) Providing temporary Working platform on equipments/pipelines all around the periphery to access the DTIB insulation blocks.
- b) Removal of Installed DTIB thermal insulation blocks, soft insulation mattresses, cover sheets from equipment/pipelines for pre service inspection (PSI) activities, segregation, properly marking the blocks and loose mattresses and cover plates for easy identification, handling, shifting to designated safe location and stacking properly.
- c) Cleaning of removed insulation blocks, sending to fabrication shop for attending any minor repair if any.
- d) After completion of PSI and getting clearance for erection, cleaning the equipments/pipelines for re-erection of DTIB insulation blocks.
- e) Shifting the DTIB insulation blocks back to erection location, erection, alignment, fixing of quick release fasteners.
- f) Cleaning the nozzle locations, shock absorber supports openings, sensor openings, dimensional measurement of openings, lagging of hot insulation mattresses.
- g) Check for designed clearances, final alignment, installation of removed hot installation mattresses, and installation of cover sheets with fasteners.

TECHNICAL CONDITIONS OF CONTRACT (TCC)

Install additional spot welding studs for installation of cover sheets for adjusting any mismatch due to re-erection of blocks.

- h) Visual inspection, Inspection of all design clearances as per drawings and technical specifications.
- i) Cleaning of the installed blocks, preparation and submission of reports.
- j) Measurement of unit for erection of DTIB insulation blocks is square meter area of insulation blocks erected.

5. Reports and Records:

- i. Erection reports at all stages of work, as-built drawings, welding inspection reports and NDE reports shall be prepared as per the established work procedures and submitted for acceptance.

Annexure-1

NPCIL FREE ISSUE EQUIPMENT & TOOL LIST

S No	Description	QTY
1	Portable spot welding machine for welding of SS sheets ("DALEX VARIOSPOT 3.2" Welding machine with tongs A-3112 and Impulse F 103)	1set
2	Portable spot welding machine for welding of Studs for fastening("LBS-090" welding machine with a gun Impulse F 104, Alu-Pinpuller LBS 75/PKM-1B welding machine for pin welding with a gun PHM-1A)	5set
3	Bender TFS,10/25	1piece
4	Plate cutter S 160E machine	2piece

TECHNICAL CONDITIONS OF CONTRACT (TCC)

2.2.13 TECHNICAL SPECIFICATION FOR MAIN COOLANT PIPELINE (MCP) ERECTION, WELDING, HEAT TREATMENT AND INSPECTION.

SI No	Description
1	Purpose
2	General description and layout
3	Scope
4	Infra-structure and storage facility
5	Procedures
6	Certification of Welding Personnel and Training
7	Heat load analysis and finalization of specialized sub-contractor
8	Welding Technology qualification
9	Technical Requirements of pre & post heating and Post weld heat treatment of weld joints
9.1	Induction heating
9.2	Resistance heating system
10	Main coolant pipeline erection
11	Welding of main coolant piping
12	Hot radiography
13	Supply, erection, commissioning and operation of electrical panels
14	Reports and Records
	List of Annexure
	Annexure-1 to Technical specification of MCP erection, welding and heat treatment (Figures, tables and sketches)
	Annexure-2 to Technical specification of MCP erection, welding and heat treatment (Sample flow chart indicating activities involved for fit-up, welding and NDT works)

TECHNICAL CONDITIONS OF CONTRACT (TCC)

1. Purpose:

The specification provides guidance to the contractor regarding general technical details of Main Circulation Pipe line (MCP), transportation to location, erection of pipeline on temporary supports, alignment, welding, heat treatment using induction and resistance methods and performing non destructive examination of weld joints.

It is the responsibility of contractor to understand the scope work to be performed such as type of material to be welded, design, validation and supply of heat treatment equipment (resistance heating) including providing un-interrupted power supply during welding, heat treatment, arrangements for control of distortion & movement of pipeline, welding, Non destructive examination including hot radiography arrangements. Supply & providing Induction heating machine along with accessories shall be in the scope of BHEL.

2. General description and layout:

The Main Coolant Pipeline (MCP) is welded to reactor pressure vessel (RPV), steam generator (SGs) and reactor coolant pump (RCPs) with four separate support less loops. The piping is used to circulate the primary coolant thereby removing heat from reactor & transport the same to steam generator. Pipeline is made from low alloy steel having OD 990 mm and 70 mm wall thickness, clad inside with austenitic stainless steel. The pipes are supplied as pre fabricated piping spools. In one loop 4 spools of pipe to be erected and welded to connecting equipments of NSSS and each loop will have 7 weld joints and there are four loops which will have 16 spools weighting about 265 MT with total 28 field weld joints per unit. The MCP has connection to many process piping systems and also many small nozzles for online monitoring of Process parameters in addition to the equipment of NSSS. The MCP are to be erected inside the containment of reactor building and design parameters are given below:

S No	Description of parameter	Value / Remarks
1	Design pressure	17.64 Mpa
2	Design temperature	350 C

TECHNICAL CONDITIONS OF CONTRACT (TCC)

3	Hydro test pressure	24.5 Mpa
4	Material of MCP	10ГH2MΦA (low alloy)
5	Material of RPV	15X2HMΦA-A (low alloy)
6	Material of SGs	10ГH2MΦA-A (low alloy)
7	Material of RCPs	06X12H3Д (low alloy)

Each pipe spool will have additional length of about 200mm to 250mm for field adjustment, which shall be measured, cut & removed before making weld edge preparation for welding. The Fig-1, 2 and 3 provide the sectional elevation, 3D view and plan view of MCP welded with NSSS equipments. Table-1 provides the details of MCP such as length and weight of each spool including weld joint numbers. The technical parameters and chemical composition of base metal and weld metal for Main coolant pipelines, Reactor pressure vessel, Reactor coolant pump, and steam generator are provided in Table-2 for the purpose of general understanding & for designing heat treatment equipments.

Note: All figures, tables, sketches of this specification are given in Annexure-1.

3. Scope of works:

The scope of the contractor's work comprises but not limited to the following.

- Preparation of schedule for technology qualification, schedule for erection, welding, heat treatment of MCP including NDE.
- Preparation and submission of procedures of erection, welding, heat treatment and NDE methodology and procedures including Job Hazard analysis.
- Finalization of heat treatment agency, heat load analysis, arranging & qualification of welding & heat treatment machineries, standby power supply system, software for monitoring and control.
- Construction of closed shop for training of welders, storage of MCP material.
- Development of induction heating/resistance heating systems for pre heating and PWHT of MCP pipe joints and performing heat treatment of weld joints.

TECHNICAL CONDITIONS OF CONTRACT (TCC)

- f) Erection, commissioning and operation of electrical panels including automatic change over network panels, connecting system for welding and heat treatment of MCP.
Note: Auto change over panel and Power cables shall be provided by BHEL at free of cost
- g) Training of experienced welders in high thickness pipe and plate including supply of welding consumables. High thickness pipe and plate shall be provided by BHEL/NPCIL for training of welders.
- h) Supply of inspection equipment & consumables, tools & tackles, welding consumables such as argon gas, grinding consumables etc..
- i) Engaging qualified engineers, supervisors, fitters, erection crews and training & assessment before deploying at actual work.
- j) Qualification of 4 Nos of welding technology for different material and weld joints. (SCH-B, Item-1.1,1.2)
- k) Handling, erection of MCP pipe spools over temporary supports, alignment, providing special tools, guiding arrangement such as Hillman rollers, hydraulic adjustment mechanism for carrying out alignment, fit up of MCP spools, cutting, beveling, edge preparation of MCP spools using contractor supplied low clearance split type beveling machine. Alignment and fit up of MCP pipe spools. (SCH-B, Item-1.3)
- l) Welding of MCP joints, monitoring and control of distortion & movements of MCP, NSSS equipments including providing tools & instruments. (SCH-B, Item-1.4).
- m) Supply & Providing heat treatment equipment such as flexible heating coils, chilled water cooled arrangements like tanks if required, piping, insulation, pump & valves, DG sets for providing un-interrupted power supply
- n) Supply & providing heat treatment monitoring and control systems of required accuracy class such as PID controllers, recorders, software based data logging system with laptops, thermo couples & compensating cables for heat treatment.
- o) Providing NDE testing machineries including hot radiography arrangements, consumables, NDT qualified engineers & supervisors for round the clock shift work.

4. Infra structure and storage facility:

The following infra structure and storage facilities shall be made available by the contractor for MCP work:

- a) Electrode storage facility with temperature & humidity controlled arrangement.
- b) Covered welder training shop with power supply and weld fume extraction facilities.
- c) Covered shed for machineries & DGs and electrical panels to prevent exposure to rain, dust and costal climate.
- d) Covered shed for assembly, commissioning and testing of Heat treatment equipment.

TECHNICAL CONDITIONS OF CONTRACT (TCC)

5. Procedures:

It is envisaged that the contractor shall prepare the following procedures for MCP erection, welding & heat treatment works. These procedures will be approved by Russian designers and takes considerable amount of time for approval process.

- a) Quality Assurance Plan (QAP).
- b) Procedure for training & qualification of workers such as welders, pipe fitters, riggers, heat treatment operators.
- c) Procedure for testing & calibration of welding & heat treatment equipment, tools & tackles.
- d) Methodology for handling and lowering of main coolant pipelines.
- e) Procedure for erection and alignment of main coolant piping.
- f) Welding technology and heat treatment procedure for RPV and MCP welding joint using induction heating method with flexible coils.
- g) Welding technology and heat treatment procedure for SGs and MCP welding joint using induction heating method with flexible coils.
- h) Welding technology and heat treatment procedure for MCP and MCP welding joint using resistance heating method for horizontal weld joint (2G).
- i) Welding technology and heat treatment procedure for MCP and MCP welding joint using resistance heating method for vertical weld joint (5G).
- j) Procedure for welding of main coolant piping including distortion control and weld repair procedures.
- k) Procedure for NDE such as Visual inspection, dye penetrant inspection, radiography, ultrasonic and hot radiographic inspection.
- l) Procedure for control and movement of manpower and material inside MCP welding area.
- m) Procedure for handling emergency during welding and heat treatment work.

6. Certification of Welding Personnel and Training :

Construction schedule of main coolant pipeline welding & heat treatment requires round the clock work (3 shifts) for an approximate period of nine months per unit. Around 40 numbers of welders are required to be qualified.

The MCP work involves welding of high wall thickness pipe and dissimilar cladding in extremely congested, confined and narrow area. Entry to weld cladding location is only through small passage of equipment manhole. Welder having good health with due certification only can perform such work. The contractor shall screen the welder for following conditions

TECHNICAL CONDITIONS OF CONTRACT (TCC)

- a) Having experience of minimum 5 years in pipe welding relevant process in critical welding preferably with heavy wall thickness involved in Refineries, Fertilizers, and Power plants and IBR System with reputed customers.

(Or)

3 years direct exposure in critical welding (Nuclear piping) of NPC/BARC projects in pipe / Equipment welding in relevant process preferably with heavy wall thickness including cladding.

- b) Welder's practical and theoretical knowledge shall be assessed before putting them in training.

- c) Welder shall have welded in 50mm thickness & above pipe or plate.

Welder selected based on above conditions / parameters shall undergo training in high wall thickness pipe. Welding electrodes required for qualification welders shall be supplied by the contractor. Minimum two samples shall be welded to assess their skills before engaging them in actual technology qualification work. Contractor shall consider these costs while quoting for technology qualification of MCP. Only after satisfactory performance of trial welding, welders are allowed to work on Russian materials for welder qualification.

- d) Welders shall be qualified in 990 mm OD, 70mm thick welding specimen pipe in overhead position (5G) for a minimum length of the inspection zone of the weld joint of 200mm.

7. Heat load analysis and finalization of specialized sub-contractor:

Contractor shall finalize agency specialized in heat load calculation using analysis softwares (Ansys or other thermal analysis softwares) for development of heat treatment methodologies. The agency engaged should have done heat treatment of welding of high walled thickness pipes or vessels in the last ten years. The specialized heat treatment agency approval shall be obtained from NPCIL.

8. Welding Technology qualification:

S No	Description	Pipe joint No.
1	MCP Technology certification -01	Pipe to Pipe joints N3 & N7 (5G)
2	MCP Technology certification -02	RCP to Pipe joints N4 (2G)
3	MCP Technology certification -03	RPV to Pipe joints N5 and N6 (5G)
4	MCP Technology certification -04	SG to Pipe joints N1 and N2 (2G)
5	Production Control (Test) welds Joint Certification for RPV, SG and RCP weld.	This is to be done prior to welding or during welding of MCP

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Welding technology processes development, validation and certifications have to be undertaken before start of actual job, as follows.

Technology qualification and subsequent welding and heat treatment of main coolant pipeline work involve development of technologies for which specialist agencies will have to be deployed. Contractor needs to factor in the resources and time required for carrying out these activities meeting the technical requirements. Brief requirements are provided below for general understanding of bidders.

a. Formation of committee:

The entire works of Main coolant piping is to be carried out under the guidance of a committee (called a “commission”) consisting concerned responsible and authorized functionaries drawn from the NPCIL & BHEL, designer of system and contractor. The Committee is responsible and authorized to ensure that the complete work of MCP is undertaken and validated during the whole process of implementation in complete compliance with the regulatory norms, specified requirements and nuclear industry practices. The process of validation of the critical and important work is undertaken in the various technology certification processes as well as in the site erection / welding /heat treatment activities.

b. Certification of Inspection Personnel:

The certification committee will ensure the following requirements and their availability with respect to the certification of non-destructive testing personnel as given in chapter 4 of Russian code (PNAEG-07-10-89).

The certification of NDT and Quality control personnel shall be done to test their theoretical knowledge and practical skill for the specific inspection method applicable to them.

The non-destructive testing personnel to be assessed by the committee shall have previous certification in their respective NDT field certified by various National and International organizations like ISNT/ASNT/BARC etc.

The committee on assessment shall issue the authorization of inspection method and period of validity to the inspection personnel who have undergone the assessment process successfully.

c. Conducting Technology Certification:

The technology certification process needs to be reviewed, concurred and all the stages witnessed by a team of Russian Specialists, representing various Russian design as well as manufacturing organization.

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Qualification of the welding, NDT and heat treatment equipment and processes identified for use in the technology certification and main production works is also envisaged during the above certification process in accordance with Russian standards and normative documents.

- i. Technology certification shall be conducted only with NPCIL (Russian) supplied specimen and welding consumables.
- ii. The different essential variables involved in qualification of welding procedure for MCP are shown in TABLE-5.
- iii. During Technology certification, all welding parameters shall be recorded.
- iv. After conducting all technology certification tests, the specimen shall be tested for NDT and destructive testing.
- v. For preheating, inter pass heating, thermal recovery, post weld heat treatment requirements for both technology qualification and production welds are detailed in the subsequent paragraphs.
- vi. Contractor shall quote his rates for technology qualification based on induction heating system and resistance heating system considering huge costs involved in heat treatment.

d. NDT Requirements:

The welded specimen shall undergo the following Non-destructive testing during Technology certification. Sequence of NDT's are explained in sample flow chart provided in Annexure-2.

- Visual including measurement control for each layer
- Penetrant examination
- Radiographic examination / hot radiography
- Ultrasonic examination

e. Destructive testing:

Destructive test requirements for different Technology Certification for various specimen preparations are shown in Table-6. Ferrite content test for cladding needs to be performed for all joints. Specimen locations for destructive testing are provided in Figure-4. Preparation of specimen for all destructive tests, as per relevant Russian standards and sketches, is also in the scope of contractor, rate for which shall be included in the item rate quoted for technology qualification.

Destructive test specimens has to be tested separately to qualify the additional technical requirement of production control weld joint (PKSS) as per the Russian requirement.

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Tensile Test (Longitudinal) at 20deg	Tensile test at (Longitudinal) 350deg	Impact test At minus10°C	IGC
539Mpa (Minimum)	490 Mpa (Minimum)	49 Joules	As per Gost - 6032

All test details are to be documented in the Technology Certification Documentation.

In addition to the above mandatory tests, additional tests are also shall be carried out viz. chemical analysis of base metal, weld metal and clad metal to cross verify composition of base and filler materials by the contractors at his own cost to ensure compliance to the requirements specified by PNAEG-007-010-89 and PNAEG-007-002-86. The details of tests to be carried out for technology certification are given in Table-7.

In case of clubbing of technology qualification and production control test weld qualification, the destructive testing will also be clubbed.

9. Technical Requirements of pre & post heating and Post weld heat treatment of weld joints: The pre heat and post weld heat treatment requirements needs to be fulfilled by resistance and induction heating for various MCP weld joints for conducting technology qualification as well as for performing actual welding operation.

- Contractor shall arrange required number of diesel generators (approximate 500 KVA capacity –02 numbers) for providing uninterrupted power supply while carrying out full welding and heat treatment of weld joints. He shall consider all consumables, fuels, spares required for full period of main coolant pipeline welding completion (approximate period 9 months per unit apart from technology qualification period) in his quoted rate for heat treatment.

Preheating and PWHT of MCP weld joints:-

Please see the Table- 3 & 8 for information on temperatures to be maintained for pre-heating during the welding process as well as post weld heat treatment of N1, N2, N5 and N6 weld joints and relevant technology qualification.

For welding of joint nos. N1, N2, N5 and N6 induction heating process it to be adopted for the equipment nozzles and the pipe weld joint area. Induction heating is dealt in a more elaborative way below to give fair idea to contractor regarding scope of work.

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The preheat and post weld heat treatment for other joint nos.N3, N4, N7 and relevant technology qualification are to be done by resistance heating. Contractor needs to develop custom made resistance heating system along with fixtures to fulfill the technical requirements.

9.1 Induction heating system:

Supply of required Induction heating equipments along with accessories will be supplied by BHEL free of cost. However the following are in the scope of contractor

- i. Establishing induction heating cycle for suiting it for MCP welding related works.
- ii. Mock up of the Induction heating system
- iii. Contractor shall supply Latest configuration laptops (core i7/i5 8th gen or higher) with data acquisition software for continuous monitoring of temperature profiles of heat treated joint.

Note: contractor shall handover temperature chart printouts of all the MCP joints along with complete heat treatment data (data logger software with laptop systems) to BHEL/NPCIL.

9.1.1 Mock-up of the Induction Heating System

A Mock-up casting, simulating RPV nozzle, SG nozzle fabricated for development and testing of induction heating system in the shop will be issued as a free issue material by NPCIL at KKNPP. Nozzle casting and pipe combination needs to be supported on support structure with axis of pipe horizontally. Both pieces need to be supported to give free access for mounting the inductor coil on OD. Transportation of the mockup pieces to the place of development of heating system, and back to KKNPP, is in the scope of the contractor.

All modules of induction heating system such as inverter, converter panels, data acquisition system, logger, cooling system for coil, thermocouple fixing etc. are to be checked for functionality before start of heating the job.

9.2 Resistance heating system:

Resistance heating system envisaged generally consists of power control modules, PID controllers, different configurations of heating elements/ heating pads with high alumina insulation beads to suit to job profile, temperature recorders, K-type thermocouples, compensating cables, etc.,.

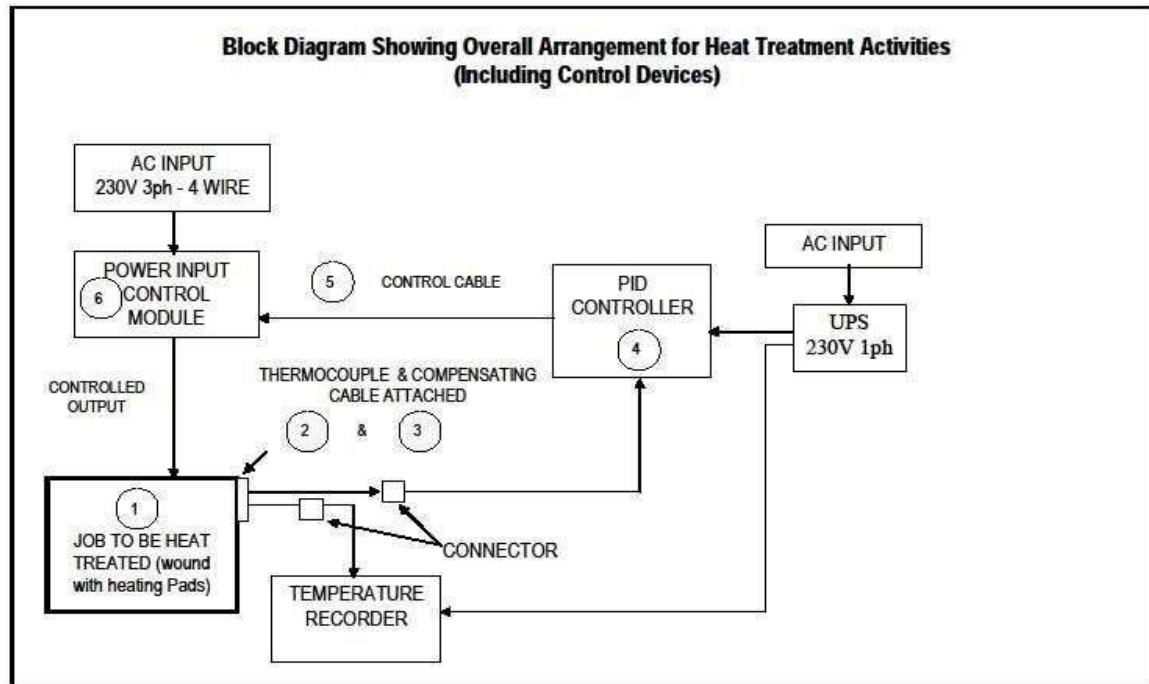
The layout Equipment placed should correspond to the requirements of rules on electrical installations and safety. Back up equipment should be placed nearby for the prompt replacement in case of failure of the main equipment.

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Brief tentative requirement of resistance heating system envisaged is provided below for understanding purpose. The number and capacity of such systems required will be based on the calculation performed on analysis software's simulating actual equipment parameters. Tentative power requirement for single joint during PWHT is around 110KW. Contractor shall arrange sufficient number of resistance heating systems to take up 4 joints of MCP welding simultaneously taking in to account additional spare machines required.

- a) Power control module: one for every 3 heaters and at least one standby unit with the following specifications:
 - i. Input voltage- 3 Φ , 50Hz, 4 Wire, 230V
 - ii. Number of output channels – 3
 - iii. Current -30Amps
 - iv. Output Power-3 X 10KW = 30KW Nominal
- b) PID controller with 6 control loops of make YOKOGAWA CX2000 or equivalent with measurement accuracy- ± 0.15 % of reading $+0.7^{\circ}\text{C}$ and operating condition of 5 to 40°C temperature and 20 to 80 % relative humidity.
- c) Twelve (12)-channel temperature recorders of make YOKOGAWA - MR 2000 or equivalent with the measurement accuracy - ± 0.3 % of reading $+0.6^{\circ}\text{C}$ and operating condition of 5 to 40°C temperature and 20 to 80 % relative humidity.
- d) Mineral Insulated K type thermocouple with 2mtr long for placing outside and 3mtr long for placing inside of joint and required length of compensating cables.
- e) Heating elements with high alumina insulation beads, Wrap around pads-5KW as emergency stand by.
- f) Fixtures for holding heating pads

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Performance of resistance heating system needs to be validated on a mock up at manufacturers place as well as at site to ascertain the parameters. The mock up test needs to be carried out on nozzle casting/ MCP specimens supplied by NPCIL to check the performance of the resistance heating system. The mock up piece will be issued to the contractor at site and handling/ transportation of these mock up pieces to the manufacturer's shop for qualifying heating system is in the scope of the contractor. Multiple trials may have to be undertaken simulating the actual size and site conditions. Based on the test results clearance will be given for taking up technology certification.

After completion of heat treatment of all MCP weld joints of both units resistance heating equipment supplied by the contract shall be taken back by the contractor except records of heat treatment carried out, heat treatment chart data, data acquisition software's along with computer system

10. Main coolant pipeline erection

A brief detail of work is provided below for understanding the scope of work. However contractor has to execute the work by fulfilling all the requirements of working drawings/manufacturer's instructions for satisfactory completion of said work.

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- a) Preparation of procedures for erection, welding, heat treatment, NDE related procedures of main coolant pipeline and get it approved by RF designers after review by NPCIL before start of actual site work.
- b) Preparation of erection schemes of Main coolant pipeline lifting and erection with detailed drawings considering the layout of the reactor building, transport portal, configuration of heavy duty crawler crane/polar crane.
- c) Receipt of Main coolant pipeline spools from NPCIL stores, and preparation of IMIR.
- d) De-preservation of Main coolant pipelines and complete dimensional survey (including optical survey) of pipe line spools for various parameters needs to be performed.
- e) Heavy duty crane/Polar crane will be provided by NPCIL as free of cost for erection. Contractor has to arrange the sling and de-shackle and other tools & tackles.
- f) Main coolant pipelines shifting from outside RB to transport portal trolley is envisaged with the help of heavy duty crawler crane, from trolley to inside the reactor building with the help of erection trolley, from reactor building +31.0 mtr elevation to erection location by polar crane/contractors winches. Please refer figures 7.1, 7.2, 7.3.
- g) Shifting of Main coolant pipelines on temporary metal structure supports designed for MCP pipelines. Ensure temporary metal structure layout should allow placement of low clearance cutting and beveling machine for adjustment of MCP pipeline length. MCP pipelines shall be supported by hillmen rollers in order to allow thermal expansion or contraction of pipelines during welding and heat treatment.
- h) During handling and lowering of MCP pipelines ensure no damage to pipeline beveled edges, nozzles etc by covering with protective covers.
- i) Temporary supports for pipe spools erection shall be selected in such a way that the accessibility for laying, aligning & measuring excess length, slope, free movement of the pipe expansion during welding and heat treatment is ensured. Indicative sketches are shown in figures 8.1,8.2 for general information
- j) Temporary metal structures also should be made for placement of induction heating machines, chillers and related equipments etc,. The location of temporary structures should take care of already erected equipment. The measurement for these temporary metal structures will be done in respective BOQ item.
- k) Suitable jigs, fixtures, rollers, dial indicators needs to be arranged for thermal movement of pipelines during welding and heat treatment, also for monitoring and controlling pipe movement in horizontal direction in order to control the weld sequence to arrest or reduce the break of axis of weld joint.
- l) Supply & Prepare fixtures for holding optical targets to find out exact as built coordinates and elevation of nozzles of RPV, SG, RCPs

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- m) Establish as built coordinates and elevation of Reactor pressure vessel nozzles, steam generator nozzles, reactor coolant pump nozzles with the help of Optical survey in order to calculate the excess length of MCP pipeline spools to be trimmed.
- n) Arrange/supply low clearance pipe cutting and beveling machine which can handle pipe of size OD 1000*70 mm thickness and also able to make edge preparation of J-groove (sample sketch shown in figure 9). The machine should be capable of parting, counter boring and edge preparation to required profile based on the edge configuration.
- o) Assemble and commission of beveling machine and perform cutting and edge preparation of required J-groove on weld test specimen.
- p) Calculate the excess length of each pipe spool considering the shrinkage allowance during welding, as built details of equipment nozzles and perform cutting and edge preparation of pipe spools.
- q) Make the fit up of pipelines with corresponding equipment nozzles with the help of jigs and fixtures (External pipe clamps for fit up). Clit welding on base material is not permitted. Make sure sufficient clearances exist for placing and holding preheating/PWHT induction heating coils/resistance pads. Fit up of pipeline spools with corresponding equipment nozzles/pipe end shall be done preferably with the help of hydraulically controlled tie rods/jacks in order to allow fine adjustment of pipelines and also to protect the beveled edges during handling.
- r) Make arrangements for continuous monitoring of pipeline movement during welding/heat treatment with the help of dial indicators/optical readings. Continuously record readings manually after completion of each pass of welding. Also provide provision for adjusting the support height during welding of vertical pipes to aid the shrinkage of pipelines.
- s) Also monitor top flange surfaces of Reactor pressure vessel, Reactor coolant pump casings with dial gauges, while carrying out welding and heat treatment of main coolant pipelines. 20MT load shall be placed on top of reactor coolant pump casing during welding & PWHT of N7, N4 joints.
- t) After completion of welding of main coolant pipelines as per technical requirements, flush grind the weld joints and apply preservative over weld joints.
- u) Cleaning of the pipelines both externally and internally.
- v) Carry out optical survey and record the readings.
- w) Shift and erect all equipments related to pre-heating/PWHT of MCP like inverters, converters, chillers, heating pads, flexible inductors, fume extractors, welding generators and all such tools/tackles/equipments required for welding& heat treatment works at pre- decided locations.

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11. Welding of main coolant piping :

a) Provision of ventilation outside and inside pipe units and equipments.

Arranging fume extractors, packaged air conditioners with flexible ducts, cooling pads, thermal & breathing suits for welders while carrying out cladding operations inside pipelines.

b) Clean room conditions shall be maintained inside working area.

Maintenance of clean room condition:

The various aspects in maintaining the clean room condition inside the reactor building during the alignment, fit-up, welding, cladding and other tests are briefly explained below for general information of bidder:

Requirements for working area of level – I:

- The area shall be closed and the boundaries of the working area shall be designated physically.
- A supervisor shall be engaged in the area, who shall keep records of tools and fixtures brought to the area as well as of the personnel who work in this area.
- The tools and fixtures shall be cleaned before they are brought to the area.
- The personnel should wear the coveralls, hats and safety helmets, gloves made of unrolled fabric, clean footwear or casks for footwear.
- Admittance is allowed only for the personnel appointed for erection work in this area.
- Smoking and ingestion are not permitted inside the area.
- The floors shall be permanently maintained clean and wet cleaning shall be performed three times a day. It is necessary to use vacuum cleaner or vacuum pumps for dust removal. If there is any pollution it shall be immediately removed.
- Combination of welding and construction/erection work inside the MCP welding area is not allowed.
- Construction safety work permit should be obtained from concerned Engineer in charge before starting the work.
- A separate register shall be maintained for the control of personnel entering inside the MCP working area (i.e. area under clean room condition).
- Adequate firefighting equipment shall be installed in the clean room condition.
- Sufficient number of fume extractors shall be arranged by the contractor for removal of gases and welding aerosols during welding operation.

- I. All activities including fit-up, welding and NDT works and their stages involved shall be as per sample Flowchart / Annexure as detailed below:

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SL.NO	JOINT NUMBER	Description	FLOWCHART
1	N5 & N6	RPV Nozzle to MCP	ANNEXURE- 2

- II. While performing welding of main coolant piping welding sequence should be chosen in such a way that to reduce distortion (both weld sequence within a joint, as well as welding sequence of the piping loop).
- III. Following brief steps to be carried out during welding are given for information.
- A. Welding of Main coolant pipeline from RPV to SGs:
1. Check the alignment of SGs and record reading.
 2. Weld edge for joint N5 shall be prepared by cutting extra length of pipe using cutting/beveling machine.
 3. Shrinkage value found during technology qualification, trial test shall be provided extra. Pre-position of equipment according to shrinkage value found during trial test shall be followed.
 4. During welding of joint N5, the other end of the pipe is aligned and kept free from movement.
 5. During fit up of N1, MCP pipe shall be maintained horizontal without slope.
 6. SGs movement in horizontal and vertical direction using its roller shall be studied and recorded, fixture arrangement shall be made to move the same if required during fit up of joint N1.
 7. Weld joint no N1.
 8. During welding, shrinkage will be towards SG in upward direction. Final slope after welding from SG towards RPV shall not exceed 4mm.
- B. Welding of pipe from RCP to RPV:
1. Carryout cutting of extra length and prepare the bevel edges as per WD requirement by considering excess length and shrinkage of pipes during welding. During welding, pipe shall be allowed to move by shrinkage value.
 2. Carryout fit up of joint No. N6 and weld. During welding, pipe shall be allowed to move towards RPV by shrinkage value. While doing fitup of N6 the RCP should be moved away from RPV using roller supports in such a way to allow thermal expansion of pipe during welding and heat treatment.

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3. Carryout fit up & welding of joint No N7 . While carrying out welding of joint N7, a weight of 20 MT shall be arranged and placed safely on top of RCP casing through temporary structures.
4. While carrying out N7 joint welding the required movement of the casing during welding with MCP is assured when the lubrication is applied to the embedded components for supports during erection. Contractor shall arrange required lubrication (graphite powder)

C. Welding of pipe from SGs to RCP:

1. Carryout alignment of SGs and RCP, exact orientation and horizontal length of pipe shall be worked out.
2. Prepare weld edge for Joint No.N3 by cutting extra length of pipe.
3. Shrinkage value shall be kept extra during edge preparation.
4. Pipe trimming and edge preparation can be done in floor at El.+ 14.000mtr. A mockup for welder movement from N4 ends to the inside of joint N3 shall be conducted. This is performed by assembling of both spools 1 & 2 together with temporary fit up. After successful completion of mockup, these spools are lifted to position and aligned with N4 & N2 using fit up clamp.
5. Carryout fitup of weld joint N3 by using fitup clamps. Also to maintain root gap SS sheet of 1 mm thick shall be place between edges.
6. Carryout fit-up of Joint No.N2 and Joint No.N4 and weld both joints simultaneously.
7. Pipes will be moved by shrinkage value. Orientation of pipe shall be watched and recorded carefully during welding.
8. During welding of N2 & N4, pipe will be moved by shrinkage allowance upward.
9. Carryout fit-up and welding of Joint No.N3.

D. Overall Welding and Cladding sequence with respect to RPV:

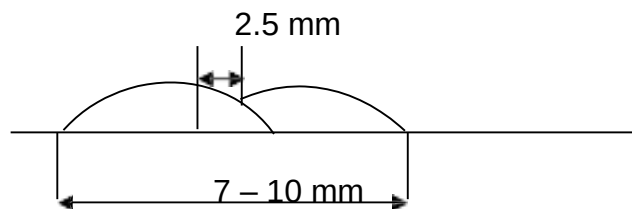
1. All the joints in the Loop No.1 & 3 shall be welded simultaneously as per the sequence explained above. e.g. Weld the joint no. N 5 of Loop No.1 simultaneously with joint no. N 5 of Loop No.3.
2. Every layer welding will be commenced only after ensuring the completing of previous layer on both joints (Ex. Joint No.5 of loop 1 and loop 3).
3. Similarly welding of Loop No.2 & 4 shall be carried simultaneously.

E. Cladding works:

Cladding of MCP weld joints consists of two types. One is Separative cladding (dissimilar welding) and other protective cladding (SS). Cladding needs to be carried out inside of MCP weld joints, which will be access through manholes of equipments.

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1. Welding of separative and protective claddings shall be done in separate ring beads, with each bead width being not more than 3 electrode diameters. Making cross beads (across weld edges) is not allowed.
2. Separative cladding shall be welded at minimal values of welding current. Bead shall overlap austenite-pearlite boundary in pipe steel not less than 2.5mm on both sides.
3. Separative cladding shall completely overlap base pearlite steel by at least 2.5mm in height.



4. Due to the restricted size of MCP Pipe (850 mm ID), any operation to be carried out shall be ensured for accessibility with respect to safety.
5. For cladding works, the welder shall be equipped with protective appliances to safe guard himself from heat, suffocation, and electrical hazards. Contractor shall arrange sufficient number of protective appliances (cooling pads, thermal & breathing suits for welders etc,) for carrying out welding operations in parallel to meet the schedule.
6. Ensure the completion of welding from outside with necessary NDT.
7. Carryout separative cladding from inside, with SMAW process as shown in the working document.
8. The separative cladding should be built up without interruptions.
9. Visually examine the cladding layer for undulation in between beads and fill up the same.
10. Grind the cladded portion to obtain uniform polished surface using hand grinder.
11. After completion of seperative cladding, carryout PT.
12. Carryout protective cladding
13. Multi layers shall be employed to achieve the thickness by ensuring each layer clearance by visual examination.
14. Prior to depositing the next bead, the revealed defects (cracks, chipped areas, cuts) shall be removed.
15. The final layer of protective cladding shall be ground smooth and checked for visual and PT.
16. Inter pass temperature shall be maintained maximum of 100 degrees C.

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17. Area adjoining at least 200mm on both sides shall be protected against molten metal splash during cladding work and main welding.

IV. DISTORTION CONTROL:

1. Measurement of Shrinkage during Welding: Expected shrinkage shall be established during trial test / technology certification test welding with heavy wall pipe of 70mm thick for a length of 250 / 450mm on both side of the joint.
 2. Monitoring distortion during welding: For distortion control, requirements given in the working documentation are to be met. All possible directions X, Y and Z plane of the pipeline and equipments will be monitored and recorded by measuring the deflection of the dial gauges attached in various locations.
 3. During welding, the deflections shall be continuously monitored and recorded at least in the following stages:
 - a. After 4 layers up to 10mm
 - b. After welding up to 10th layers
 - c. After 100% Welding
 - d. After Completion of Cladding
 - e. After PWHT
 4. In case of any abnormal distortion noticed during welding, welding shall be stopped and needs to be corrected by following appropriate welding sequence after taking concurrence from NPCIL.
12. Hot radiography:
- a) A special requirement of not to allow dropping of temperature below 150 degree at specified location (around joint) while carrying out welding of Reactor nozzle with MCP pipe till the completion of intermediate tempering of RPV nozzle shall be fulfilled as per technical requirement. In order to fulfill this requirement and also to ensure sound joint, radiography of weld joints shall be performed in hot condition of weld joint.
 - b) For carrying out radiography inspection during hot condition of weld joint a special hollow fixture shall be made of stainless steel with a provision to cool the fixture through compressed air from inside. Contractor needs to develop, supply, fabricate, test and qualify this fixture for carrying out hot radiography before start of technology qualification. Contractor shall also arrange air compressor of suitable capacity for cooling the hot RT fixture.
 - c) The Hot RT technique and the fixtures had to ensure not to damage the source, provide access inside the equipment, pipeline in hot condition near the joint. All necessary

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arrangements shall be made to prevent any damage to heating elements, radiography source as well as prevent any possible burn injury to the personnel carrying out RT. Many trials shall be performed through a process of evolution to arrive at the finally acceptable fixture and technique yielding the requisite result.

- d) Hot radiography process shall be adopted at specified stages of 50% thickness of the joint, and on full thickness of the joint in hot condition and prior to the thermal recovery process.
- e) The developed hot radiography fixture in principle shall consists of two hollow circular halves and connected by hinge and clamping arrangement. The finishing of the fixture shall be ensured smooth. i.e. undulations, spatters and localized projections shall not be allowed which may interfere with actual film interpretation. Ensure leak tightness of the fixture outside, before put into service. Refer figure 10 for typical scheme of Hot radiography fixture.
- f) Spacing studs shall be used in between the fixture and OD of the pipe to maintain the distance from the radiography film to the surface of the welded joint facing the film shall be minimum and shall never exceed 150mm.
- g) After installation of fixture, air from compressor or cylinder shall pass through the box in order to minimize the temperature of box, which will protect the film cassette from direct heat.
- h) Reference RT films shall be taken for the fixtures alone. This can be used as base reference during interpretation of RT films taken on the weld joints. Proper identification – segment numbers shall be made on the fixtures, so that correlation can be made with the film segments and fixture segments during interpretation. This will facilitate identification of details on the joint from the details on the fixtures.

Note: the radiography taken by the contractor with the help of hot radiography fixture also will be measured as normal radiography only. Contractor needs to load all his costs for development and performing hot radiography accordingly.

13. Reports and Records:

- i. Erection reports at all stages of work, as-built drawings, welding inspection reports and NDE reports shall be prepared as per the established work procedures and submitted for acceptance.
- ii. Contractor shall handover complete heat treatment data (temperature chart printouts of all the MCP joints, heat treatment data with data logger software system) to NPCIL.

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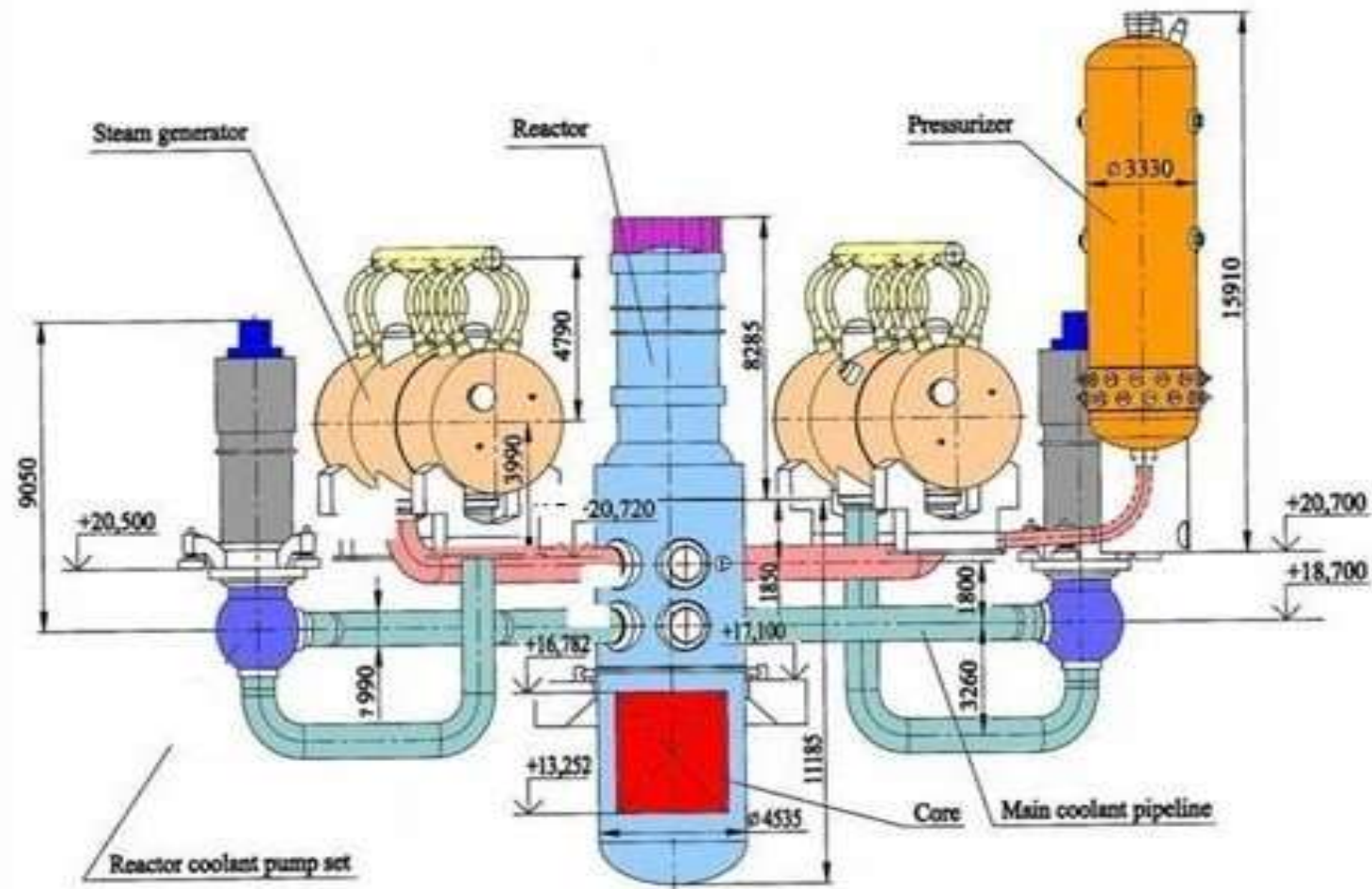


Fig-1: SCHEMATIC VIEW SHOWING ELEVATIONS AND CONNECTION OF MCP

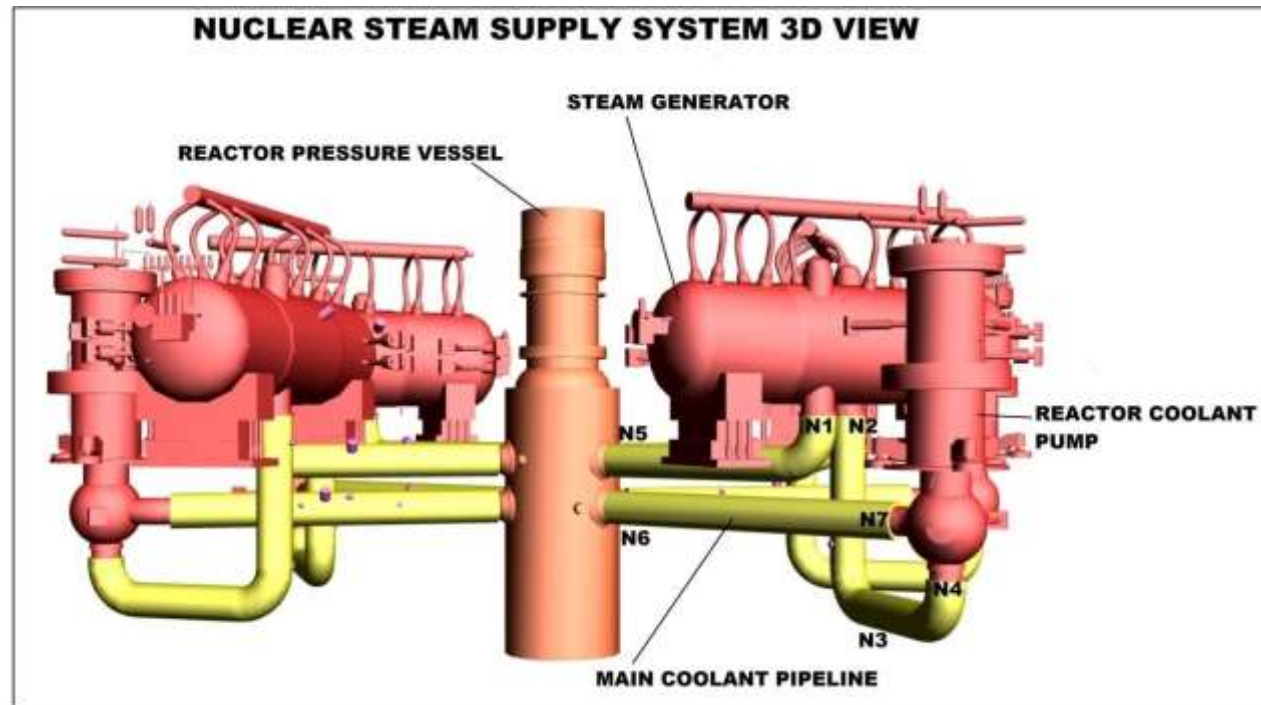


Fig-2: 3D VIEW OF REACTOR, SGs, MCPs AND WELD JOINT NUMBERS

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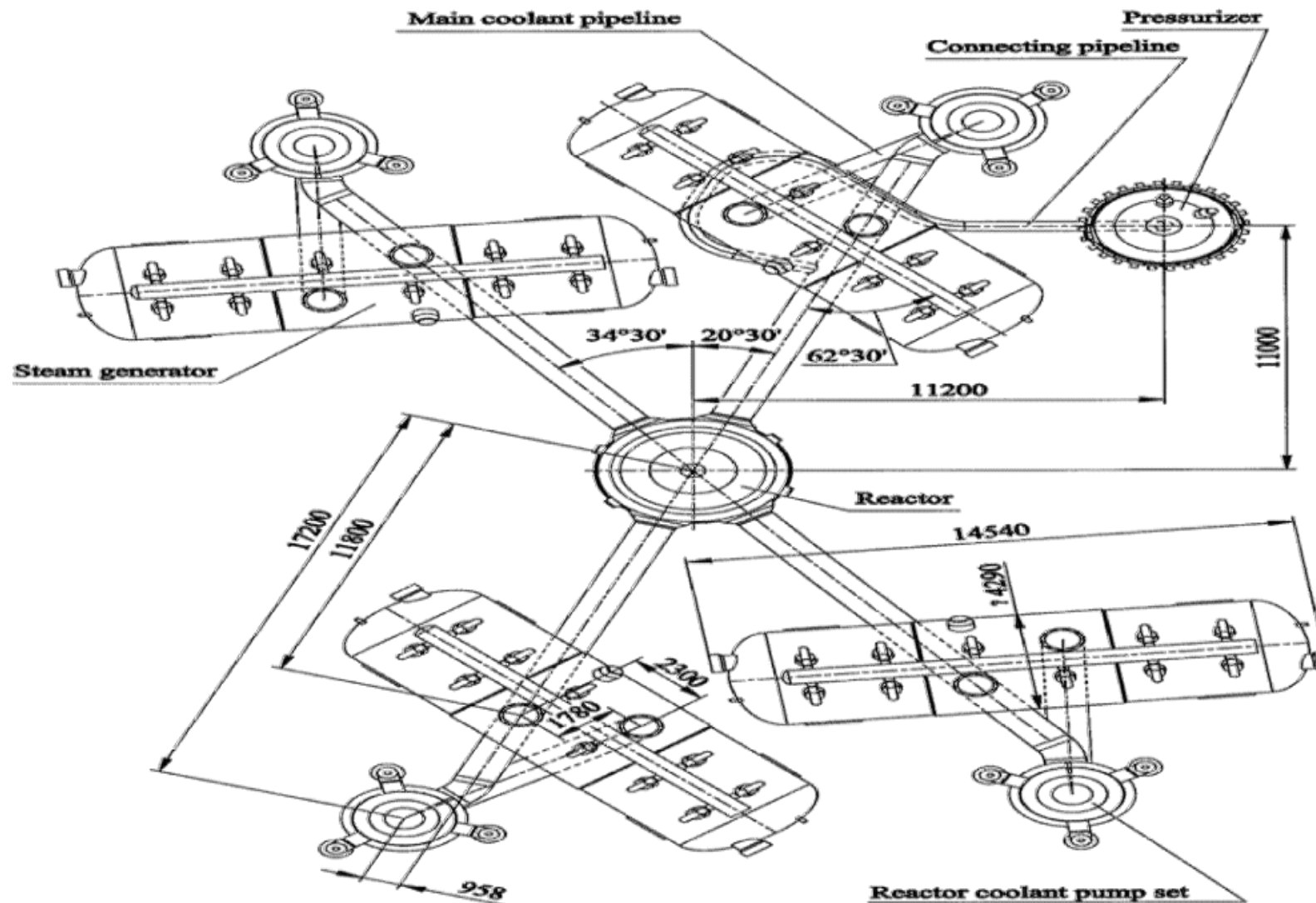


Fig-3: MAIN COOLANT PIPELINE ARRANGEMENT PLAN VIEW

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Table-1: Details of Main coolant pipeline spools for one loop:

SL.NO	KKSCODE	END CONNECTION	QTY	LENGTH	WEIGHT IN KG	Weld No
1	JEC11BR001	RPV to SG	1	9370/9170*	18100	RPV to MCP - N5 MCP to SG - N1.
2	JEC12BR001	SG to RCP pump casing - spool 1	1	7055/6855*	13700	SG to MCP- N2. MCP to MCP- N3.
3	JEC12BR002	SG to RCP pump casing - spool 2	1	5703/5503*	12050	MCP to MCP-N3. MCP to RCP- N4.
4	JEC13BR001	RCP casing to RPV	1	12215/12015*	19620	RCP-to MCP N7. MCP -to RPV N6.

Note: * - Excess length provided in the pipe spool for site adjustment.

Total weight of Main coolant pipelines for one unit is apprx 265MT.

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Table-2 : Chemical composition of material (2.1)

The technical parameters and chemical composition of base metal and weld metal for Main coolant pipelines, Reactor pressure vessel, Reactor coolant pump, steam generator are provided below for the purpose of general understanding & for designing heat treatment equipments

Sl no	Base Metal	C	Si	Mn	Cr	Nicke l	M o	Cu	S	P	As	Co	Ti	An ti- mo ny	P+ Sn+ Sb	Vana- dium
1	15X2HMΦA- A (RPV- Material)	0.13 - 0.18	0.17 -0. 37	0. 3-0. 6	1.8 -2. 3	1.0 -1.5	0. 5 0.7	0. 08	0. 012	0.01 0	0.0 10	0.0 30	0. 0 0 5	0.0 05	0.0 15	0.10 - 0.12
2	10ГН2МΦА (SG and MCP)	0.08 - 0.12	0.17 -0.37	0.7 -0.9	0.3	1.7 - 2.0	0. 4 - 0. 7	0. 3	0. 02	0.02	---	---	-- -	---	---	0.04
3	06X12H3Д (RCP- Material)	0.06	0.30	0.6	12 - 13. 5	2.8 - 3.2	---	0. 8 - 1.1	0. 025	0. 025	---	---	-- -	---	---	---

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Table-2 : Mechanical properties- Base Metals (2.2)

Sl. No.	Base metal	Mechanical Properties at Test Temperature									
		20 deg					350 deg				Critical Brittleness Temp(Tko) *
		UTS (Mpa)	Yield Strength (Mpa)	Elongation (%)	Reduction Area (%)	Impact strength J/cm2	UTS (Mpa)	Yield Strength (Mpa)	Elongation (%)	Reduction Area (%)	
1	15X2HMΦA-A (RPV-Material)	608	490	15	55	-----	539	441	14	50	Minus 25
2	10ГН2МΦА (SG and Coolant Pipe)	539-637	343-490	16	55	-----	490	295	14	50	Minus 10
3	06X12H3Д (RCP-Material)	590	490	14	35	155 (KCV)	540	440	10	30	-----

TECHNICAL CONDITIONS OF CONTRACT (TCC)

Table-3: Details of NSSS equipment weld joint number, welding process, pre heating & PWHT and NDE

S No	Joint No/ Qty	Joint description	Base metal	Filler metal	Welding process	Pre-Heat	Thermal recovery	PWHT (Tempering)	NDT
						Interpass			
1	N- 1 (4 nos)	RPV Outlet – SG Inlet collector	10GH2MΦA – 10GH2MΦA-III	1)Cb08g2s 2)PT-30	1)GTAW- Root-10mm 2)Smaw-Fill pass-50mm	220-270°C	150-250 12 Hrs	620-660°C 08 Hrs	VT, PT, RT&UT
						120-270°C			
2	N-2 (4 nos)	SG Outlet Collector-Spool with elbow	10GH2MΦA – 10GH2MΦA-III	1)Cb08g2s 2)PT-30	1)GTAW- Root-10mm 2)Smaw-Fill pass-50mm	220-270°C	150-250 12 Hrs	620-660°C 08 Hrs	VT, PT, RT&UT
						120-270°C			
3	N-3 (4 nos)	Spool with elbow – RCP inlet spool	10GH2MΦA	1)Cb08g2s 2)PT-30	1)GTAW- Root-10mm 2)Smaw-Fill pass-50mm	220-270°C	150-250 12 Hrs	640-660°C 08 Hrs	VT, PT, RT&UT
						120-270°C			
4	N-4 (4 nos)	At RCP Suction	10GH2MΦA	1)Cb08g2s 2)PT-30	1)GTAW- Root-10mm 2)Smaw-Fill pass-50mm	200-250°C	150-250 12 Hrs	Int.Tempering 610-630°C(5Hrs)	VT, PT, RT&UT
						100-		Final	

TECHNICAL CONDITIONS OF CONTRACT (TCC)

S No	Joint No/	Joint descriptio	Base metal	Filler metal	Welding process	Pre-Heat	Thermal recovery	PWHT	NDT
						250°C		Tempering 625-650°C(8Hrs)	
5	N-5 (4 nos)	At RPV Outlet	15X2HMΦA-10GH2MΦA	1)Cb08g2s 2)PT-30	1)Gtaw- Root-10mm 2)Smaw-Fill pass-50mm	220-270°C	NA	Int.Tempering 620-660°C (3Hrs)	VT, PT, RT&UT
						150-270°C		Final Tempering 620-660°C (7Hrs)	
6	N-6 (4 nos)	At RPV inlet	15X2HMΦA-10GH2MΦA	1)Cb08g2s 2)PT-30	1)Gtaw- Root-10mm 2)Smaw-Fill pass-50mm	220-270°C	NA	Int.Tempering 620-660°C (3Hrs)	VT, PT, RT&UT
						150-270°C		Final Tempering 620-660°C (7Hrs)	
7	N-7 (4 nos)	At RCP Discharge	10GH2MΦA	1)Cb08g2s 2)PT-30	1)GTAW- Root-10mm 2)SMAW-Fill	200-250°C	150-250 12 Hrs	Int.Tempering 610-630°C(5Hrs)	VT, PT, RT&UT

TECHNICAL CONDITIONS OF CONTRACT (TCC)

S No	Joint No/	Joint description	Base metal	Filler metal	Welding process pass-50mm	Pre-Heat	Thermal recovery	PWHT	NDT
						100-250°C		Final Tempering 625-650°C(8Hrs)	

Table-4: CLADDING DETAILS

S.No	Joint No/Qty	Joint description	Base metal	Filler metal	Welding process	PWHT	NDT	Remarks
1	N- 1 (4 nos)	RPV Outlet – SG Inlet collector	10GH2MΦ A – 10GH2MΦ A- III	1) uL-25/1 2)EA-898/21b	Smaw 1)2-5mm(Dissimilar cladding) 2)10mm (SS Cladding)		#VT, PT, UT	
2	N-2 (4 nos)	SG Outlet Collector-Spool with elbow	10GH2MΦ A – 10GH2MΦ A- III	1) uL-25/1 2)EA-898/21b	Smaw 1)2-5mm(Dissimilar cladding) 2)10mm (SS Cladding)		#VT, PT, UT	

TECHNICAL CONDITIONS OF CONTRACT (TCC)

Sl.no	Joint No/Qty	Joint description	Base metal	Filler metal	Welding process	PWHT	NDT	Remarks
3	N-3 (4 nos)	Spool with elbow – RCP inlet spool	10GH2MΦ A	1) uL-25/1 2)EA-898/21b	Smaw 1)2-5mm(Dissimilar cladding) 2)10mm (SS Cladding)		#VT, PT, UT	
4	N-4 (4 nos)	At RCP Suction	10GH2MΦ A	1) uL-25/1 2)EA-898/21b	Smaw 1)2-5mm(Dissimilar cladding) 2)10mm (SS Cladding)	Tempering 650 deg	#VT, PT, UT	
5	N-5 (4 nos)	At RPV Outlet	15X2HMΦ A- 10GH2MΦ A	1) uL-25/1 2)EA-898/21b	Smaw 1)2-5mm(Dissimilar cladding) 2)10mm (SS Cladding)		#VT, PT, UT	

TECHNICAL CONDITIONS OF CONTRACT (TCC)

Sl.no	Joint No/Qty	Joint description	Base metal	Filler metal	Welding process	PWHT	NDT	Remarks
6	N-6 (4 nos)	At RPV inlet	15X2HMΦ A- 10GH2MΦ A	1) uL-25/1 2)EA-898/21b	Smaw 1)2-5mm(Dissimilar cladding) 2)10mm (SS Cladding)		#VT, PT, UT	
7	N-7 (4 nos)	At RCP Discharge	10GH2MΦ A	1) uL-25/1 2)EA-898/21b	Smaw 1)2-5mm(Dissimilar cladding)2)10mm (SS Cladding)	Tempering 650 deg	#VT, PT, UT	

#- PT Shall be carried out in multiple stages

One- On prepared Surfaces, before Cladding starts

Further on completion of each layer (As per technical requirements of the drawing/QAP)

TECHNICAL CONDITIONS OF CONTRACT (TCC)

Table-5 : Essential variables involved in qualification of welding procedure

Sl. No	Description	WPS Number			
		MCP-001	MCP-002	MCP-003	MCP- 004
1	Applicable for Joint No	N3 & N7	N4	N5 & N6	N1, N2
2	Weld category	II	I	I	I
3	Base material	10GH2MΦA WITH 10GH2MΦA	10GH2MΦA WITH 10GH2MΦA	15X2HMΦA-A WITH 10GH2MΦA	10GH2MΦA WITH 10GH2MΦA
4	Group No as per RF code	3	3	3	3
5	Thickness	70mm	70mm	70mm	70mm
6	Diameter	ID 850mm	ID 850mm	ID 850mm	ID 850mm
7	Welding process	GTAW+SMAW W	GTAW+SMAW	GTAW+SMAW	GTAW+SMAW
8	Groove Design	Sketch A	Sketch B	Sketch C	Sketch D

TECHNICAL CONDITIONS OF CONTRACT (TCC)

Sl. No	Description	WPS Number			
		MCP-001	MCP-002	MCP-003	MCP- 004
9	Filler material				
	a) Filler wire 8-10 MM thick. (Root & up to 4 th layer)	CB-08Г2C	CB-08Г2C	CB-08Г2C	CB-08Г2C
	b) Covered Electrode Upto 61 mm thick (5 th to 19 th)	ИТ30	ИТ30	ИТ30	ИТ30
	c) Separative cladding 3mm Thick (20 th layer)	ЦЛ 25/1	ЦЛ 25/1	ЦЛ 25/1	ЦЛ 25/1
	d) Protective cladding 9 mm thick (21 st to 24 th layer)	ЭА-898/21b	ЭА-898/21b	ЭА-898/21b	ЭА-898/21b
10	For GTAW process	Root (1-4 layers) is welded without pre-heating			

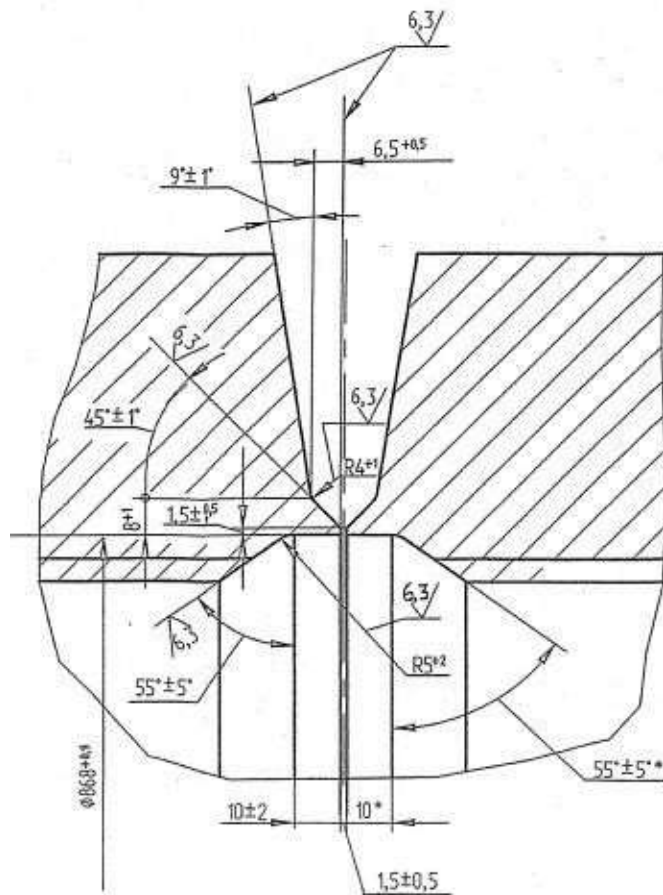
TECHNICAL CONDITIONS OF CONTRACT (TCC)

Sl. No	Description	WPS Number			
		MCP-001	MCP-002	MCP-003	MCP- 004
11	For SMAW process from 5 th layer Preheating temperature ⁰ C	220 ⁰ C to 270 ⁰ C	200 ⁰ C to 250 ⁰ C	220 ⁰ C to 270 ⁰ C	220 ⁰ C to 270 ⁰ C
12	Temperature range during welding	120 to 270 ⁰ C	100 to 250 ⁰ C	150 to 270 ⁰ C	120 to 270 ⁰ C
13	Thermal recovery / PWHT	Refer later sections			

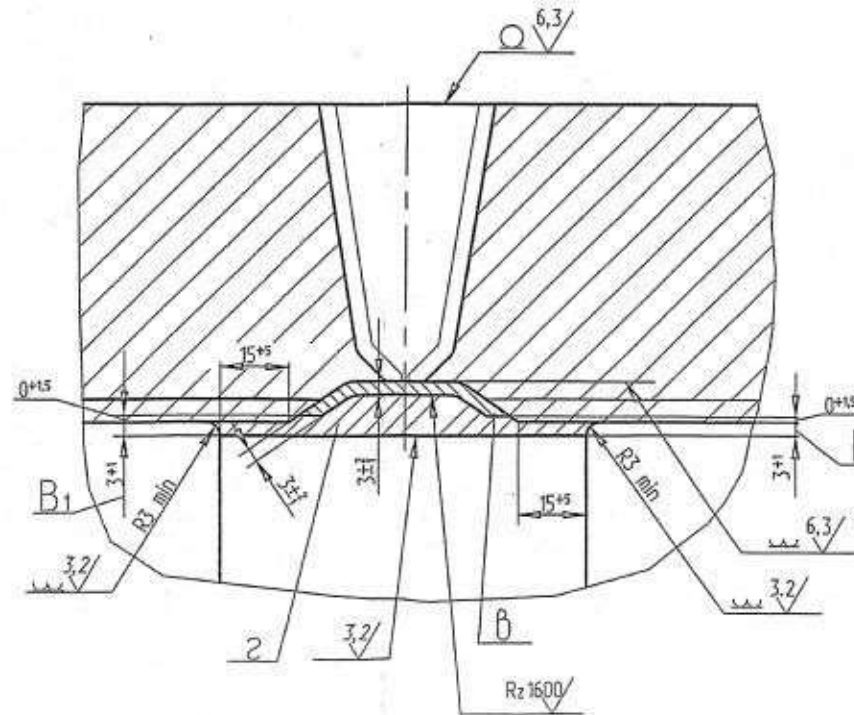
TECHNICAL CONDITIONS OF CONTRACT (TCC)

SKETCH-A

Fit-up for welding

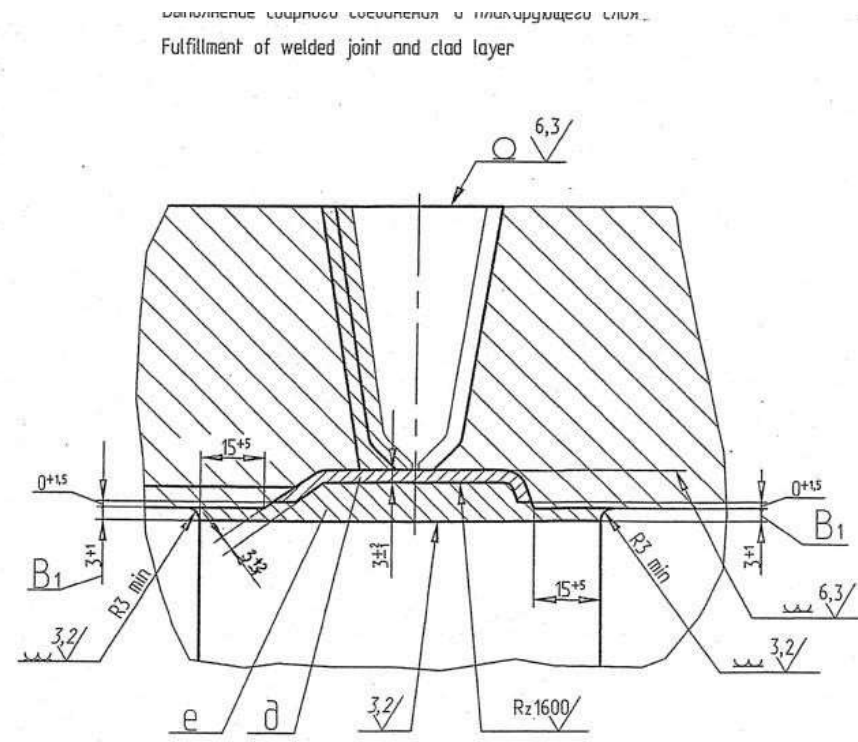
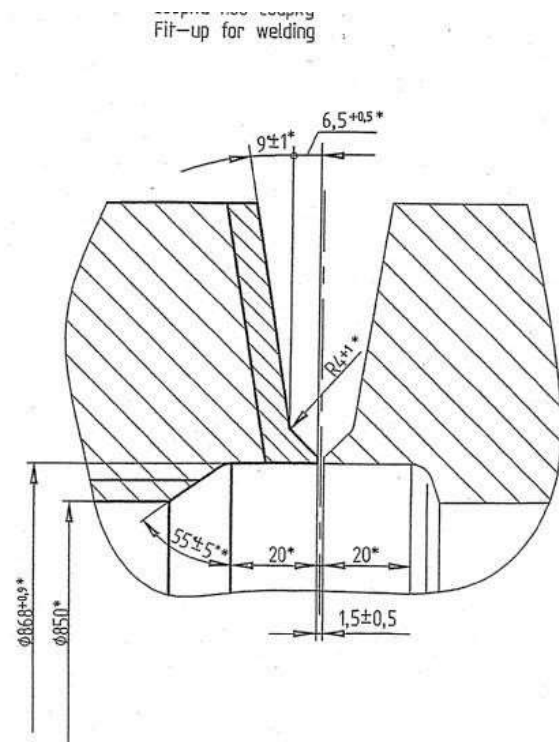


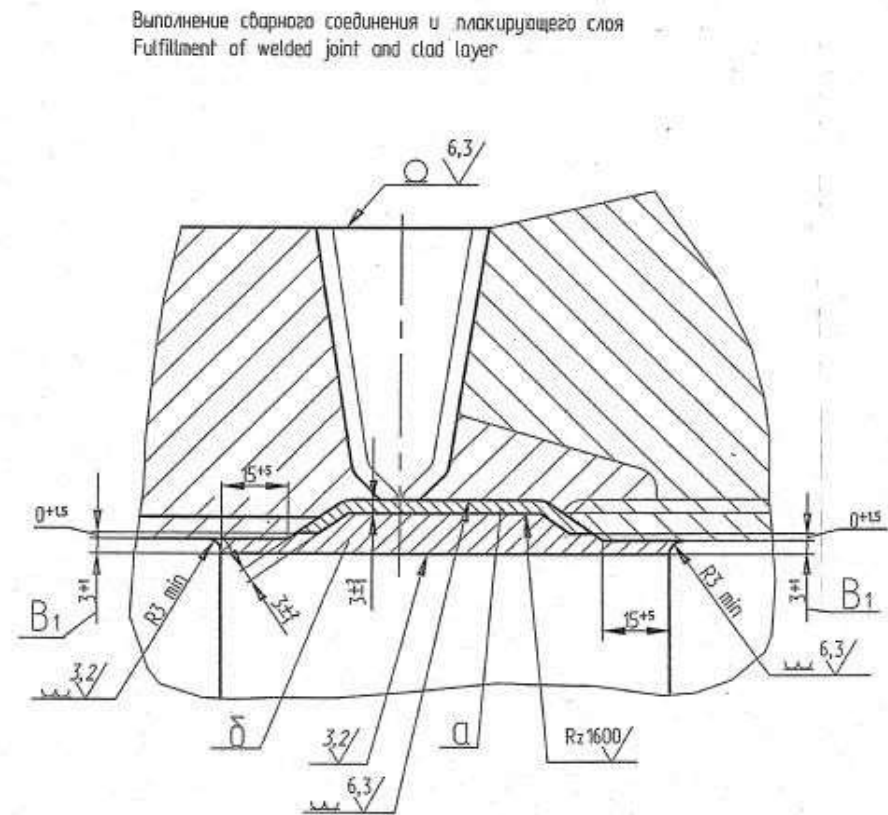
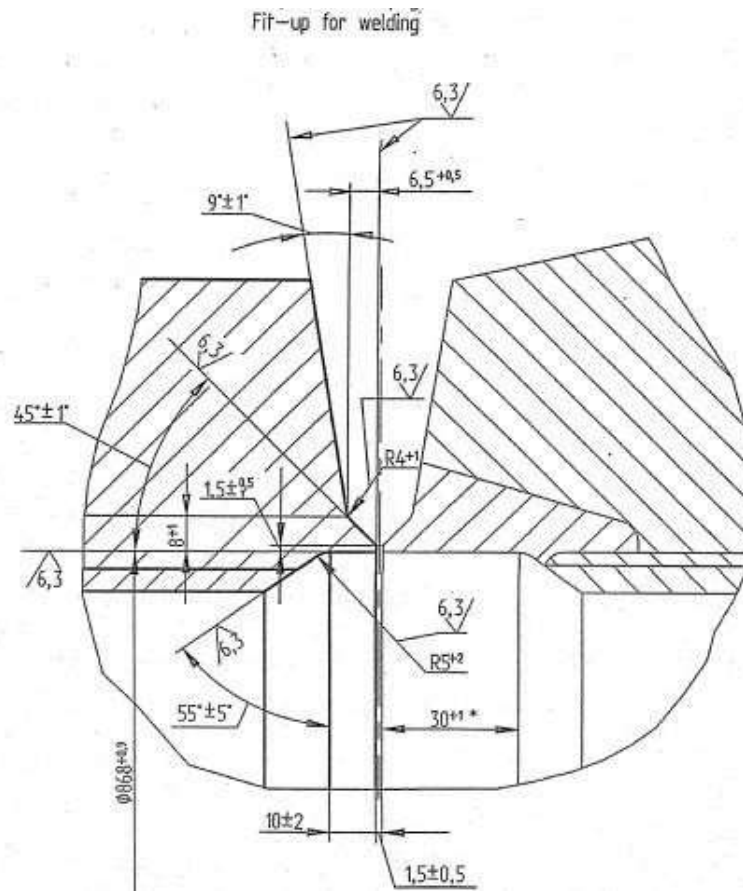
Выполнение сварного соединения и лакирующего слоя
Fulfillment of welded joint and clad layer



TECHNICAL CONDITIONS OF CONTRACT (TCC)

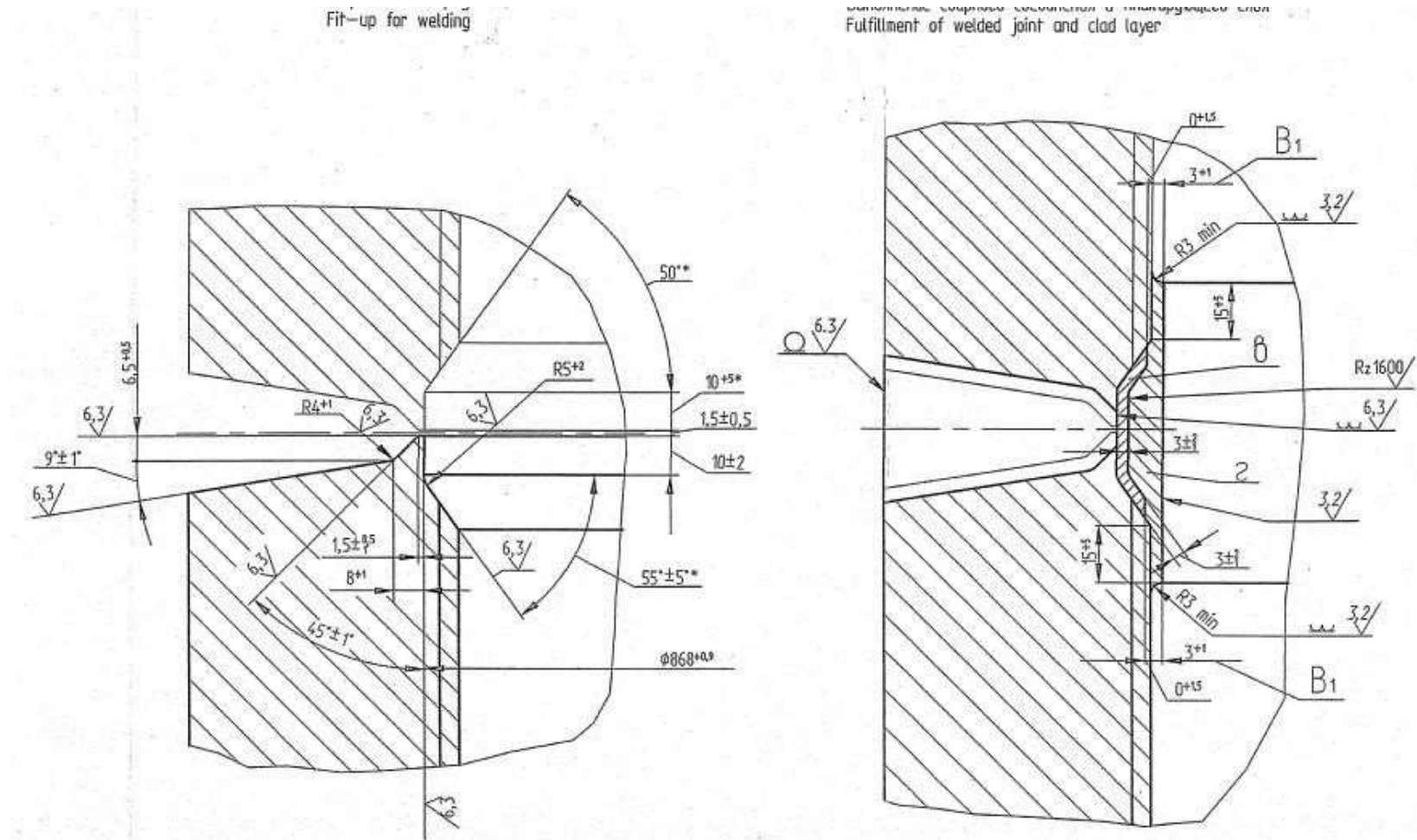
SKETCH-B





TECHNICAL CONDITIONS OF CONTRACT (TCC)

SKETCH-D



TECHNICAL CONDITIONS OF CONTRACT (TCC)

Table-6 : Destructive test requirements for different Technology Certification

Sl. No	Test Description	WPS No./ Technology certification No.		
		MCP001 & 004	MCP002	MCP003
1	Tensile test of specimen at room temperature	✓	✓	✓
2	Tensile test of specimen at elevated (350 ⁰ C) temperature .	✓	✓	✓
3	Static Bend test for main welding.	✓	✓	✓
4	Metalography test for cladding (Protective)	✓	✓	✓
5	Bend test for cladding (Type- A & Type –B)	✓	✓	✓

TECHNICAL CONDITIONS OF CONTRACT (TCC)

Table-7 : MCP TECHNOLOGY CERTIFICATION - JOINT TEST DETAILS

Sl.no	Name of Test	No of samples	Size of Specimens	Specimen location on test weld	Test as per Std	Acceptance value as per PNAEG-7-10-89	Purpose of Test	Remarks
1	Chemical analysis on weld metal	--	Spectrometry sample only	As per PM-10 Operation-291	As per PM-10 Operation-102	TU-108-1197-83 From base metal Mfg std	To determine chemical composition on weld joint	
2	Tensile test at room temp(Mpa)	02	20mm dia 250mm long	As per appd. program	Gost-6996 Drg-24 Type-xiv Table-10	* 1) 539-637 2) 608 3) 590	Tensile test on weld joint at 20 deg	*1) 10ГН2МΦА 2) 15Х2НМΦА 3) 06Х12Н3 Д
3	Tensile test at elevated temp(Mpa)	02	20mm dia 250mm long	As per appd. program	Do	*1) 539 2) 490 3) 540	Tensile test on weld joint at 350 deg	-Do-
4	Static bend test (Root bend)	02	280x60 x40	As per appd. program	Gost-6996 Drg-40 Type-xxvii Table-14	Bend specimen to 40 deg Max 5mm long crack allowed	To find crack at Root side when weld joint is stretched	---
5	Static	02	280x60	As per	Do	Do	-Do- but at face	---

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	bend test (Face bend)		x40	appd. program			side	
6	Impact test(Ducti le to brittle Transition s temp) J/cm2	12	55x10x 10	As per appd. program	Gost-6996 Drg-6 Type-ix Table-4/13	*1)49 J/cm2 at Minus 10 deg 2)49 J/cm2 at Minus 25 deg 3)155J/cm2 at 20 deg (As per PNAEG-7- 002-86)	To find required notch toughness at Minus temp	*1) 10ГН2МΦА 2) 15Х2НМΦА 3) 06Х12Н3 Д
7	Test for resistance to formation of hot cracks	--	As per appd. program	As per appd. program	As per appd. program	As per appd. program	To confirm weld integrity	Done on cladding only
8	Corrosion test	--	As per appd. program	As per appd. program	As per appd. program	As per appd. program	To confirm weld integrity	For N4&N7 only
9	IGC Test	2	80x20x 5	As per appd. program	Gost-6032 AM Method	As per appd. program	To confirm absence of grain boundary corrosion	Done on ss cladding only
10	Metallogr aphic analysis	2	As per appd. program	As per appd. program	As per appd. program	2.5mm for cat-1 joint 3mm for cat-2 joint As per Table-19	To confirm absence of weld defect on etched Macrographs	-----

TECHNICAL CONDITIONS OF CONTRACT (TCC)

TABLE-8: HEATING REQUIREMENTS FOR RPV NOZZLE TO MCP AND SG NOZZLE TO MCP ARE GIVEN BELOW

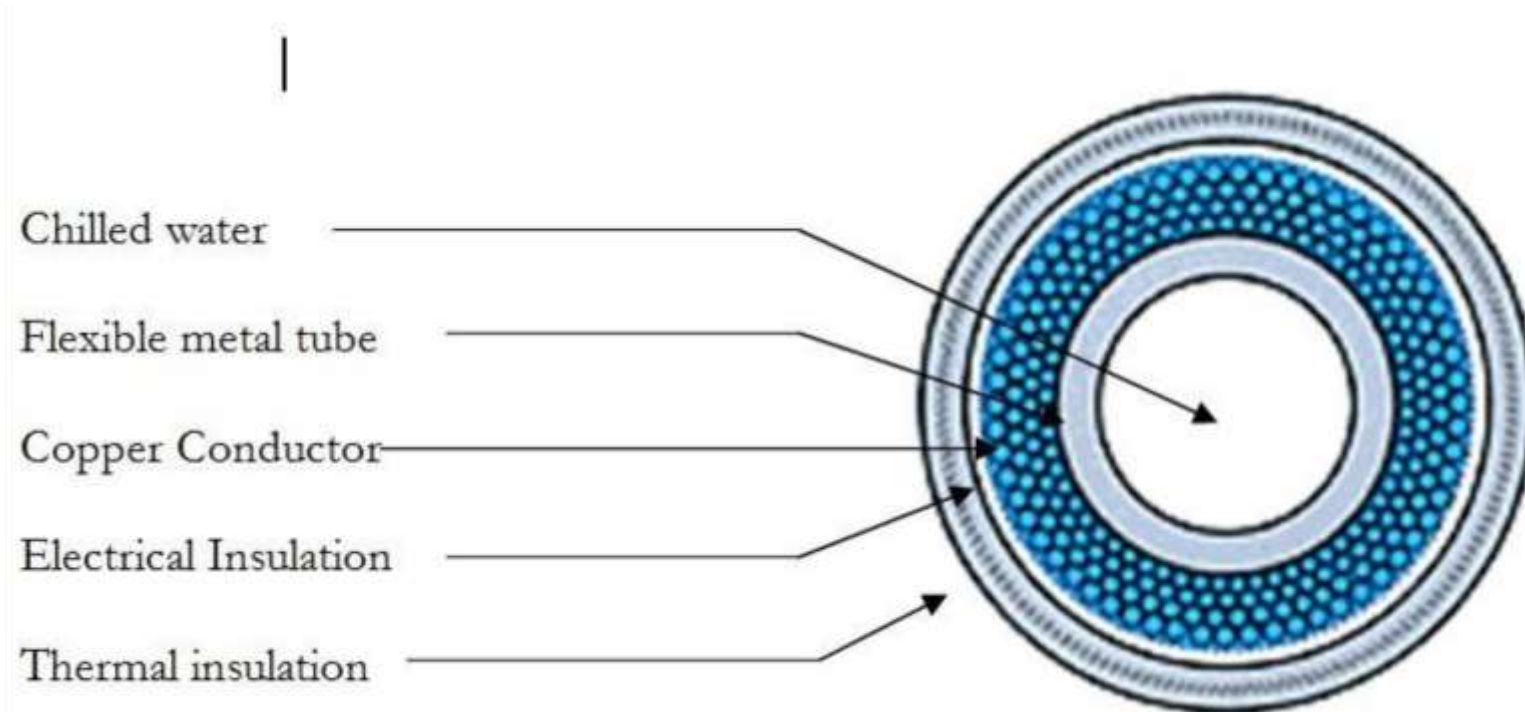
Sl. No.	Parameter	RPV nozzle to Pipe N5,N6,Technology qualification-3)	SG Collector to pipe (N1,N2,Technology qualification-4)
1	Preheat temp deg. C	220 to 270 deg C	220 to 270 deg C
2	Inter pass temperature	150 to 270 deg C	120 to 270 deg C
3	Thermal recovery	Not Applicable	150 to 250 deg C for 12 hours
4	Intermediate tempering	620-660 deg C for 3 hours soaking with controlled cooling upto 300 degC	Not Applicable
5	Final Tempering	620-660 deg C for 7 hours soaking with controlled cooling upto 300 degC	620-660 deg C for 8 hours
6	Limiting values:	Temp. not to exceed 350 deg C at a distance of 250mm from weld center on the Nozzle Temperature not to exceed 230 deg C on ID side of the nozzle at distance of 70mm from RPV ID	Temperature not to exceed 500 deg C on the collector factory weld joint

Note : At no point of time temperature shall fall below 150 deg C.

During PWHT temperature shall not go less than 600 deg C at two thermocouple locations cumulative for more than 10 minutes.

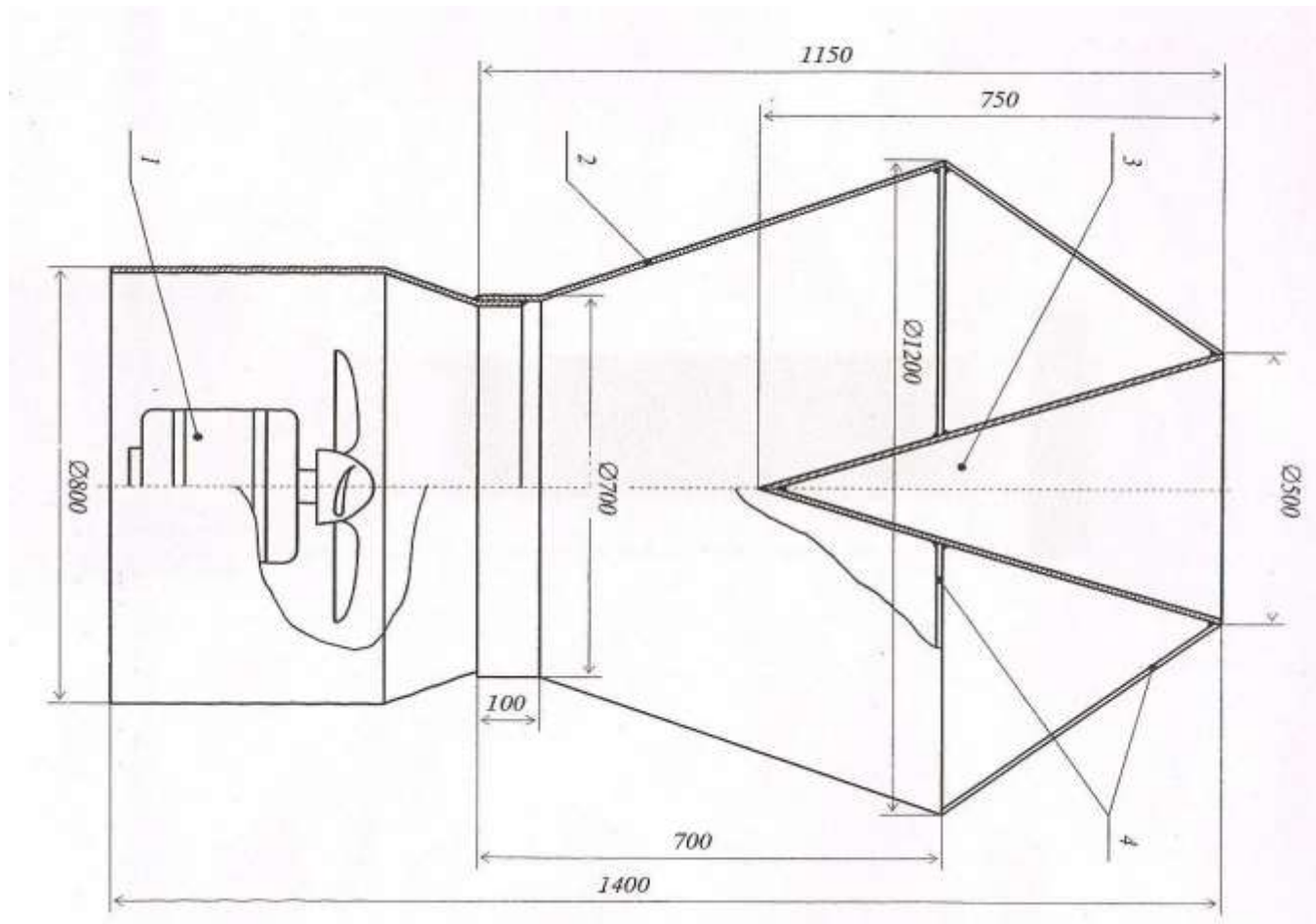
TECHNICAL CONDITIONS OF CONTRACT (TCC)

Figure-5: Flexile inductor coil cross section:



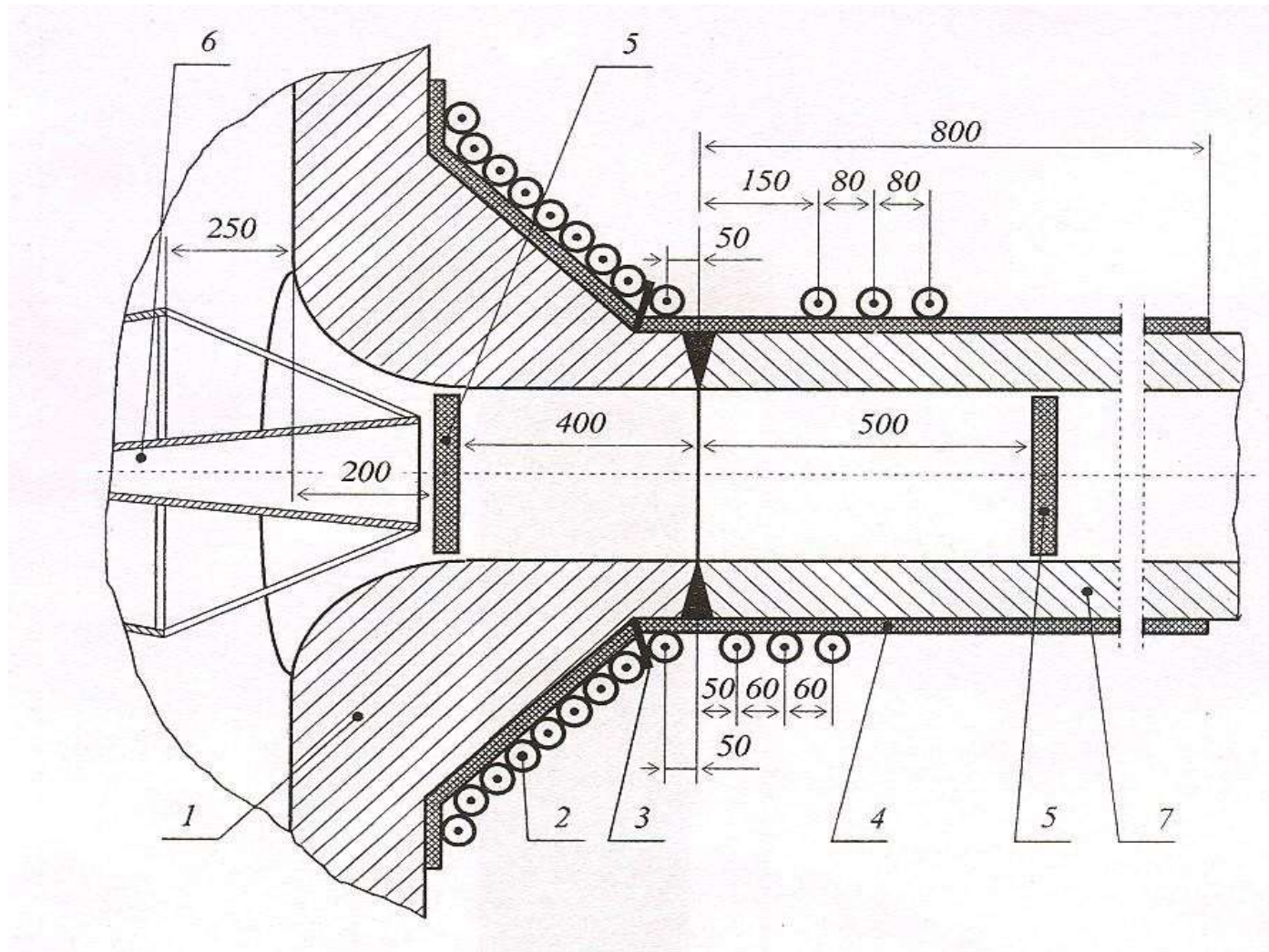
TECHNICAL CONDITIONS OF CONTRACT (TCC)

Figure-6.1 : Axial fan envisaged for RPV cooling with diffuser



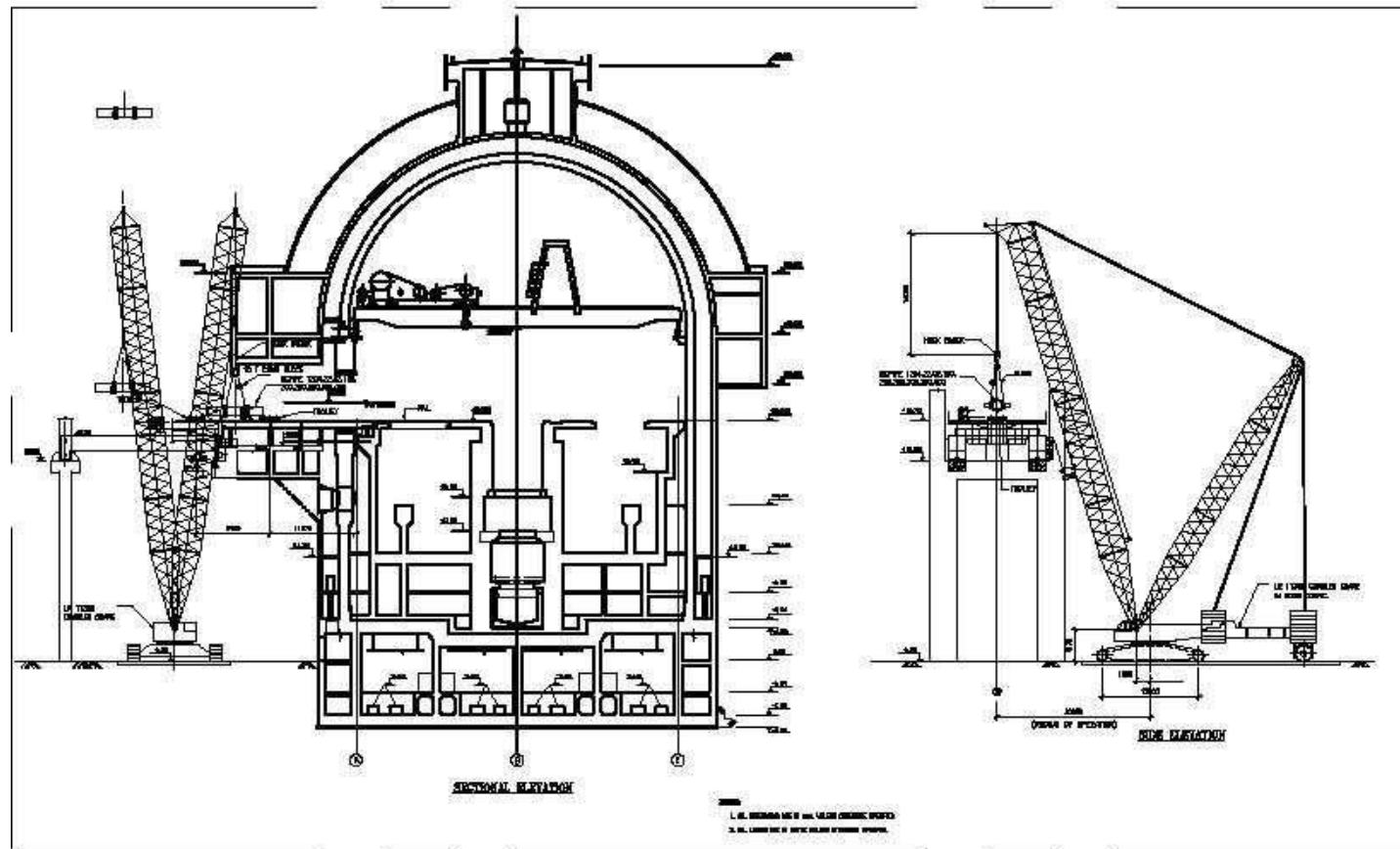
TECHNICAL CONDITIONS OF CONTRACT (TCC)

Figure-6.2 : Diffuser placement at RPV nozzle for cooling



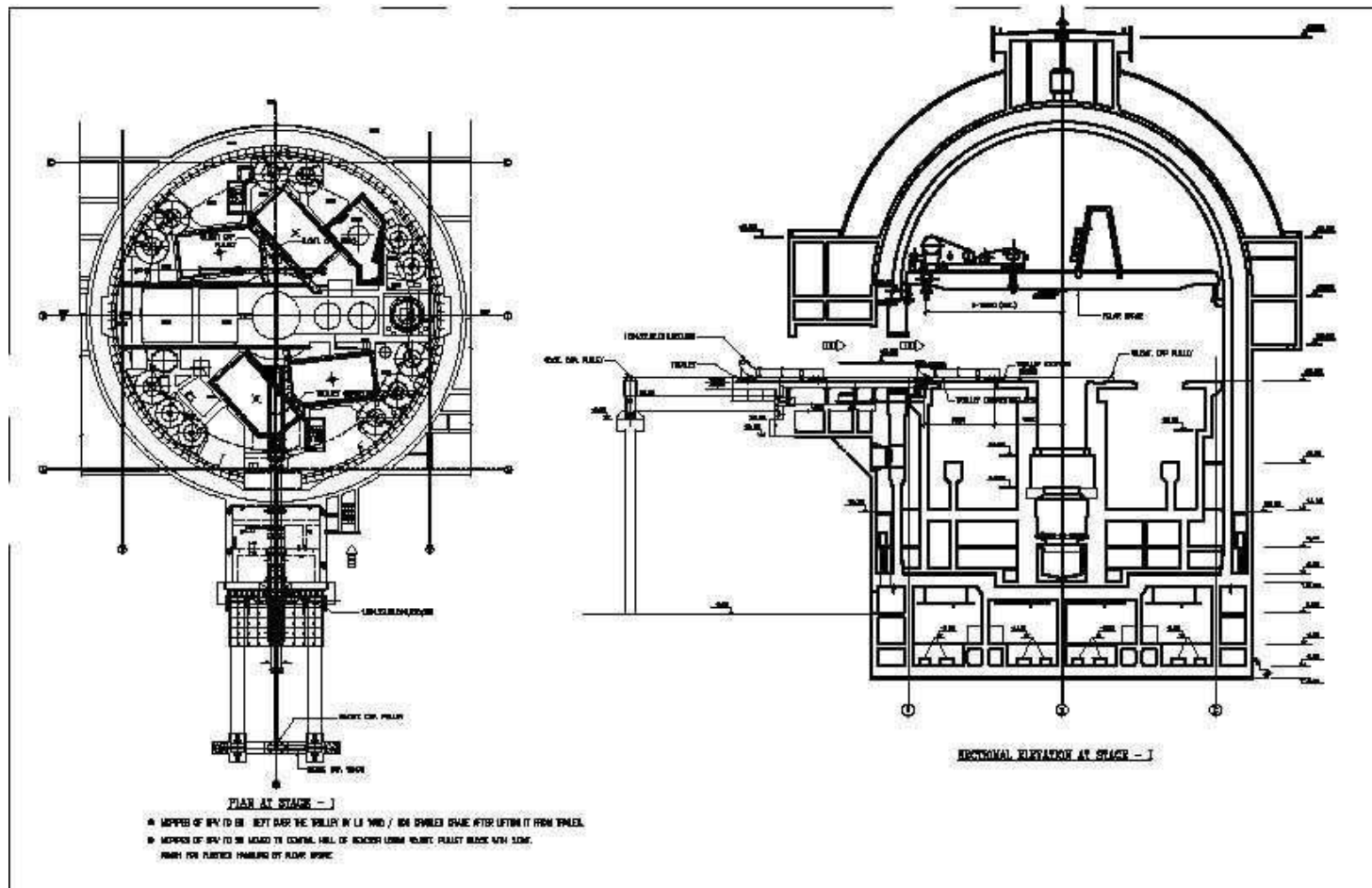
TECHNICAL CONDITIONS OF CONTRACT (TCC)

Figure-7.1 : MCP handling scheme:



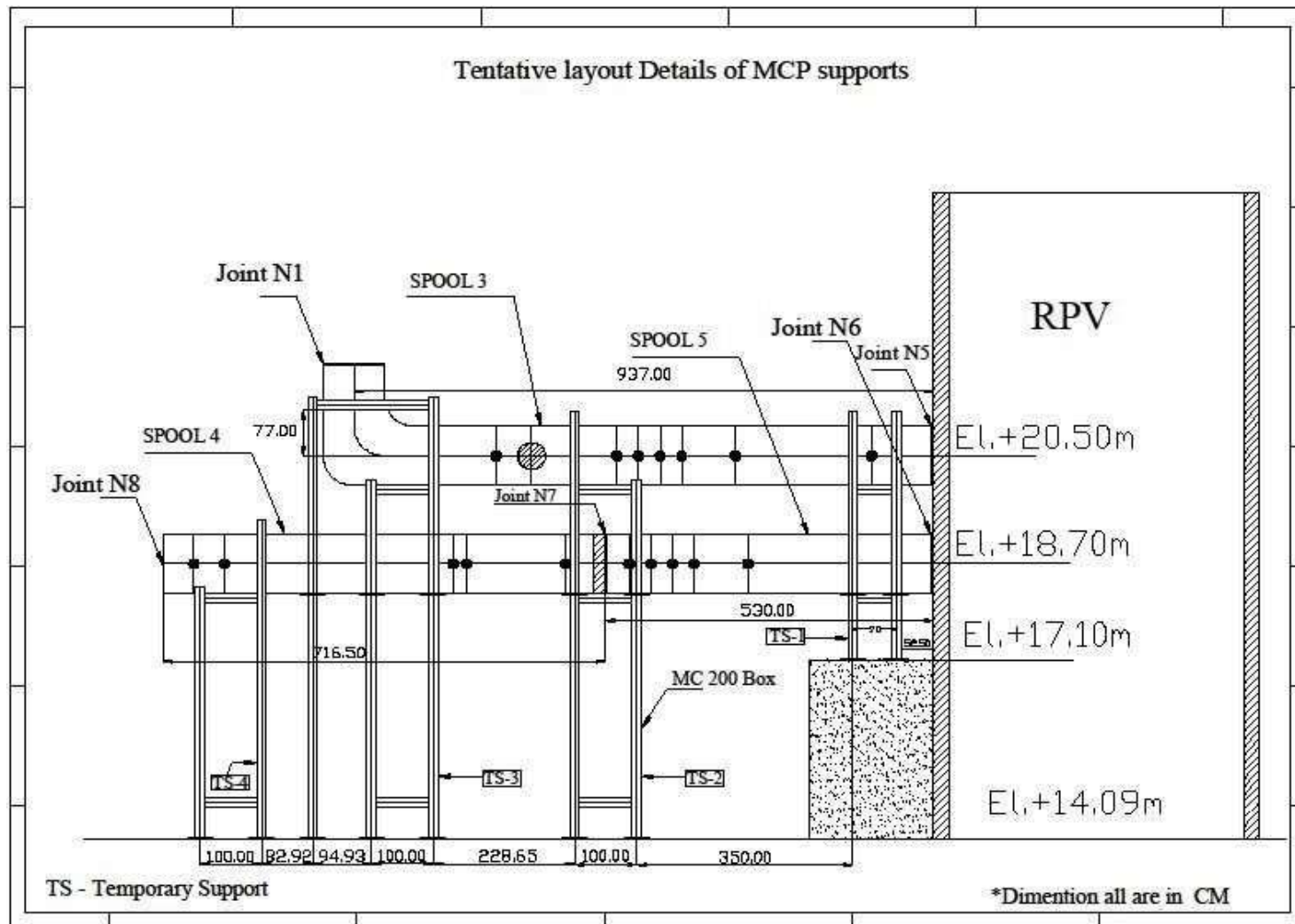
TECHNICAL CONDITIONS OF CONTRACT (TCC)

Figure-7.2 : MCP handling scheme:



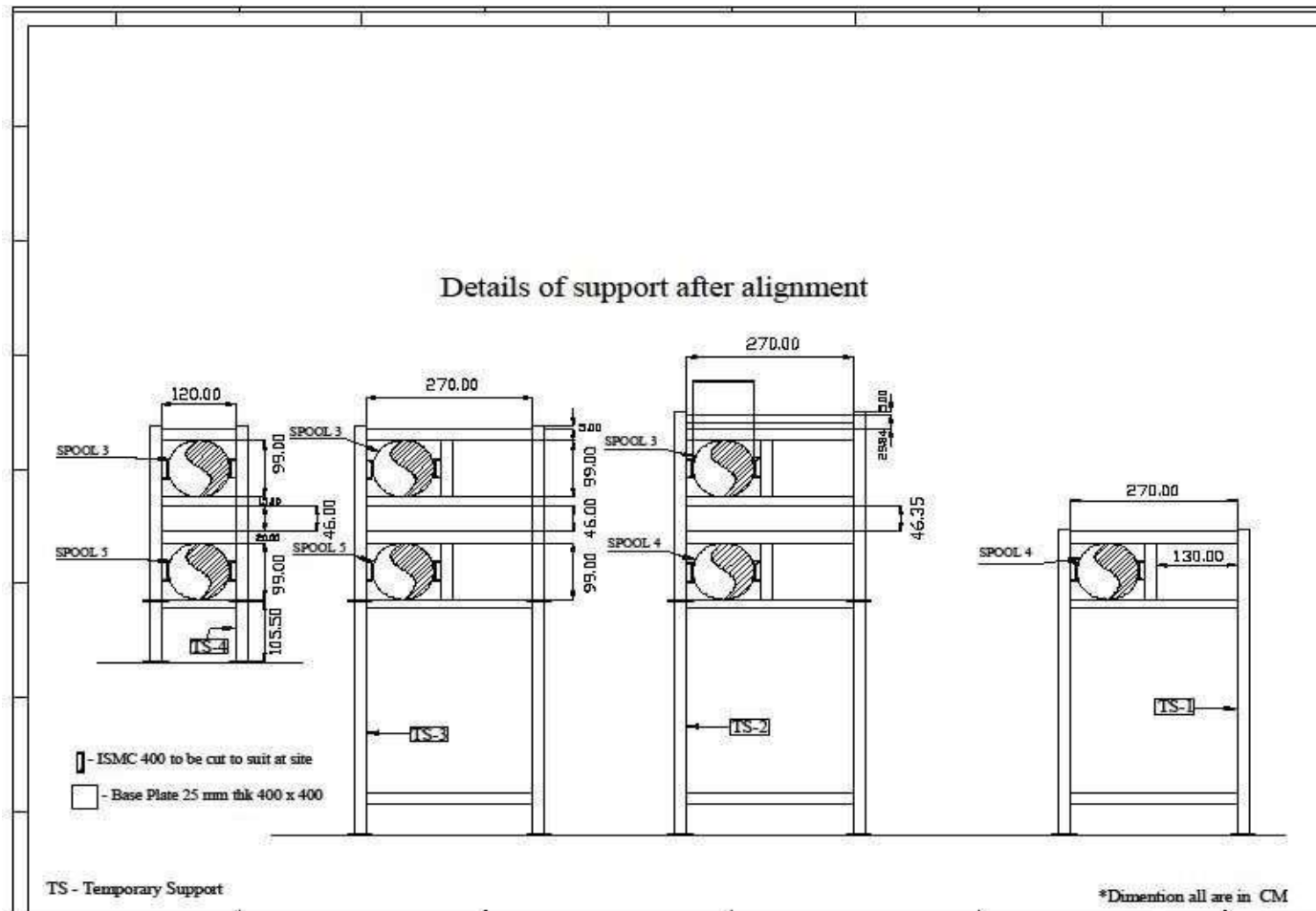
TECHNICAL CONDITIONS OF CONTRACT (TCC)

Figure-8.1 : Schematic layout of MCP supports



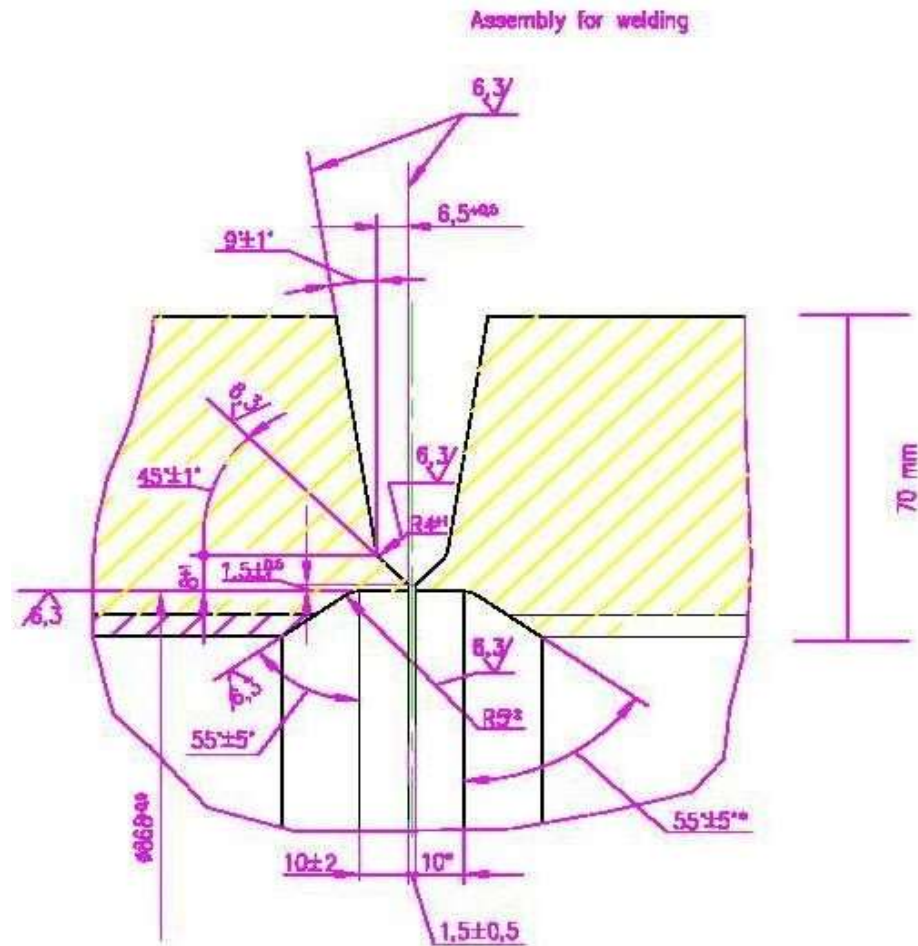
TECHNICAL CONDITIONS OF CONTRACT (TCC)

Figure-8.2 : Schematic layout of MCP supports



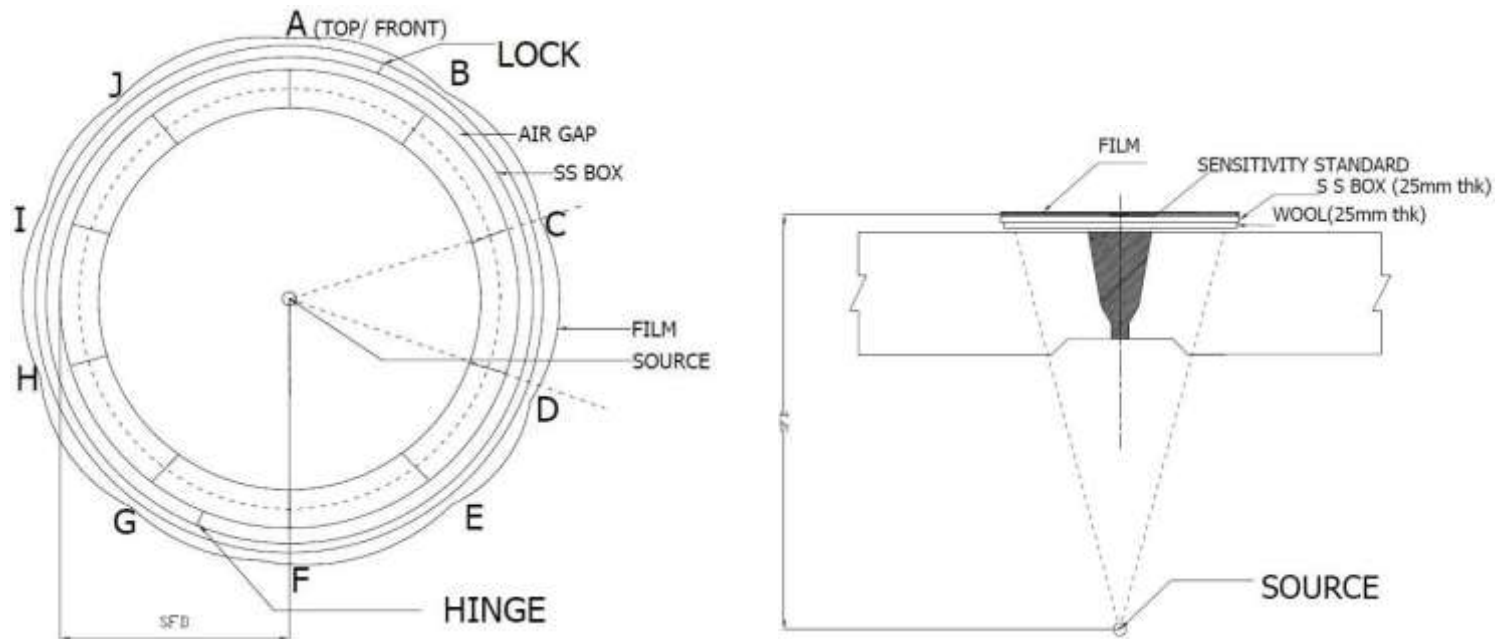
TECHNICAL CONDITIONS OF CONTRACT (TCC)

Figure-9 : J-groove configuration of MCP pipe spool



TECHNICAL CONDITIONS OF CONTRACT (TCC)

Figure-10.1 : Hot radiography fixtures

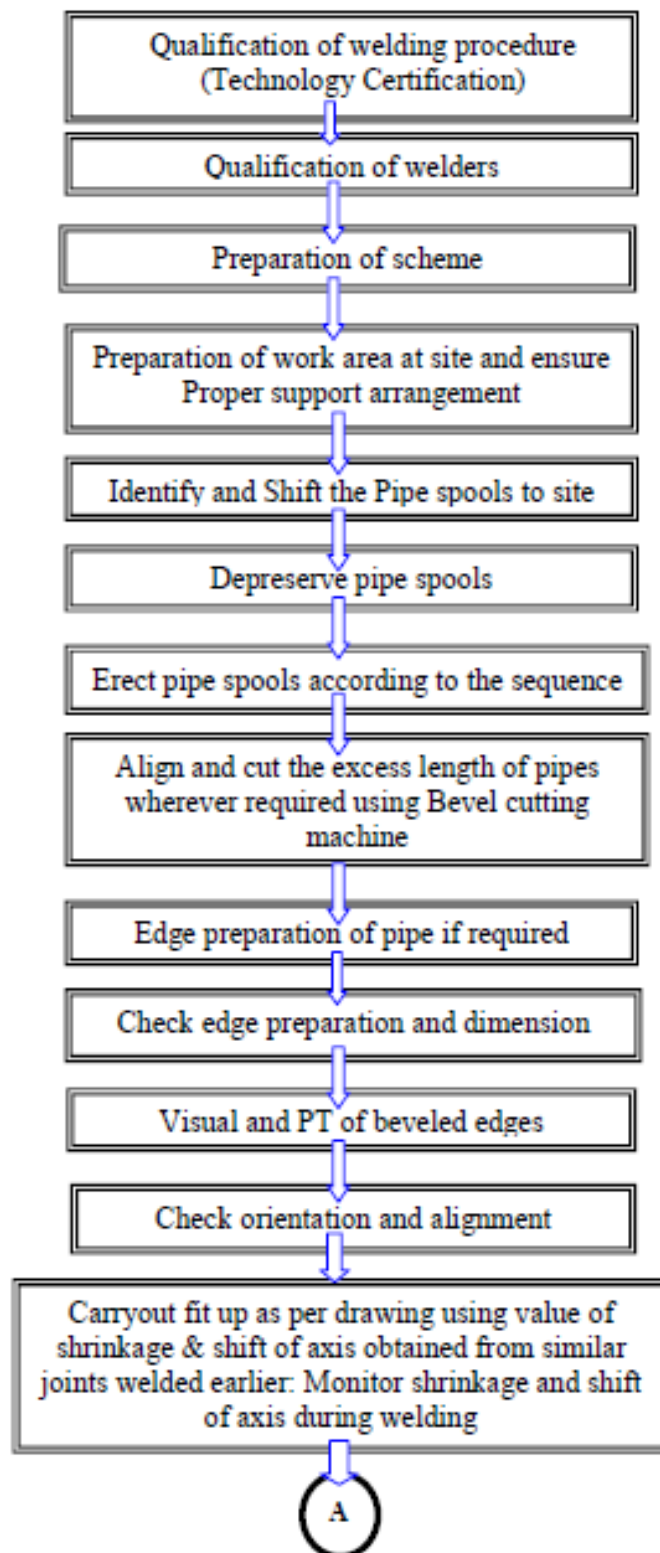


TECHNICAL CONDITIONS OF CONTRACT (TCC)

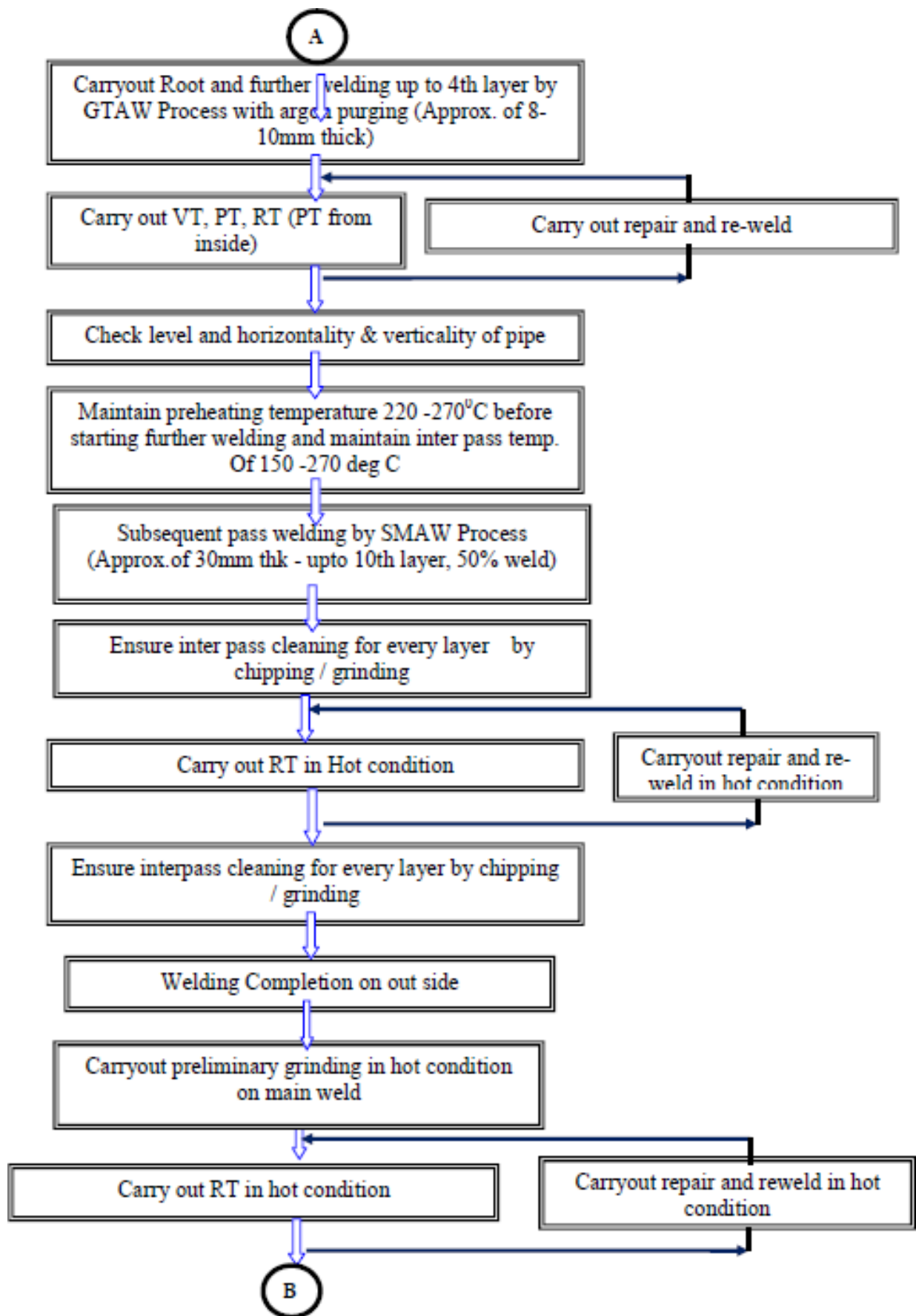
ANNEXURE- 2

TYPICAL SAMPLE FLOW CHART FOR WELDING OF MAIN COOLANT PIPELINE

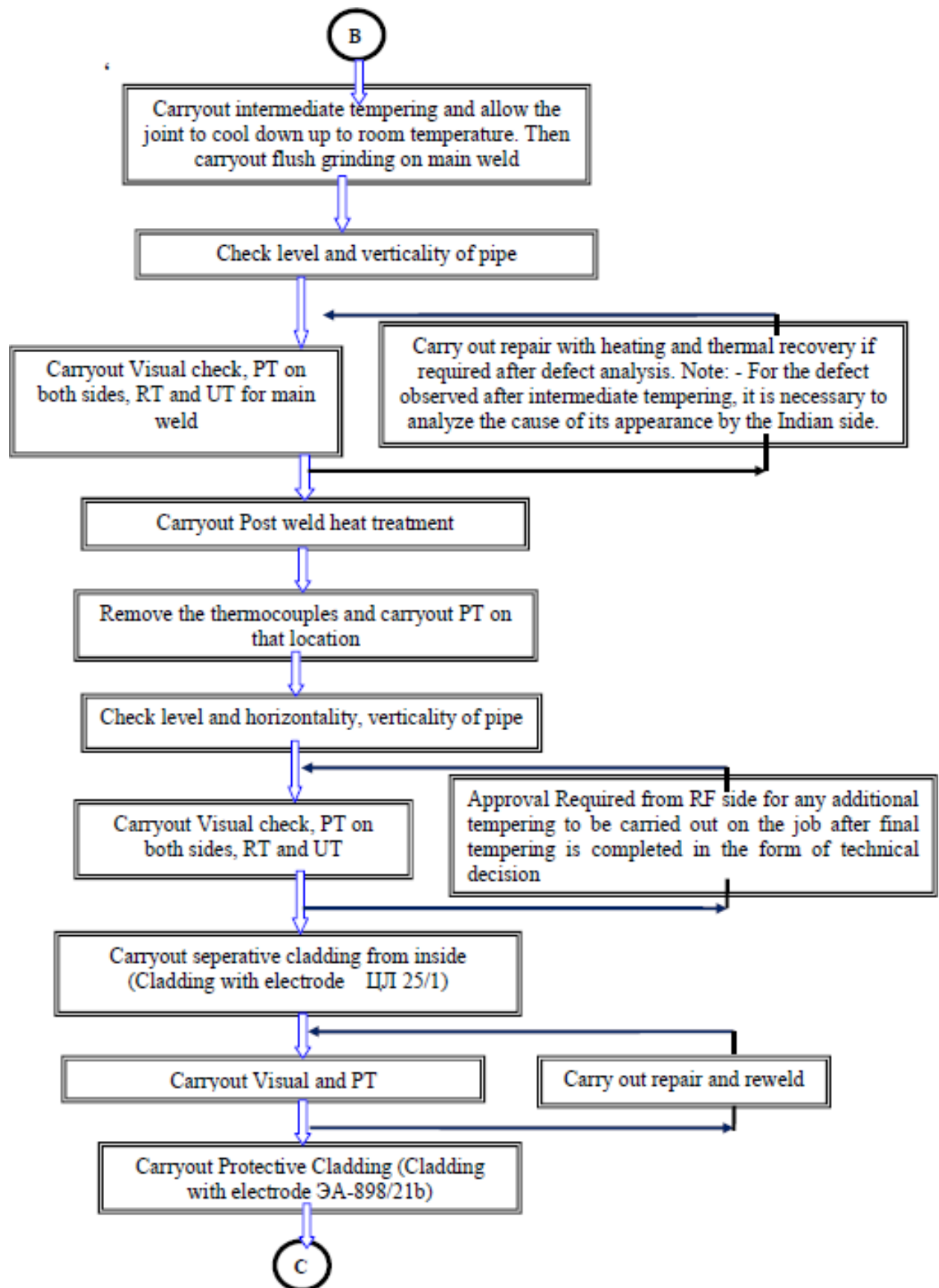
PRODUCTION WELD JOINT NOS. N5 & N6 OF MAIN COOLANT PIPING



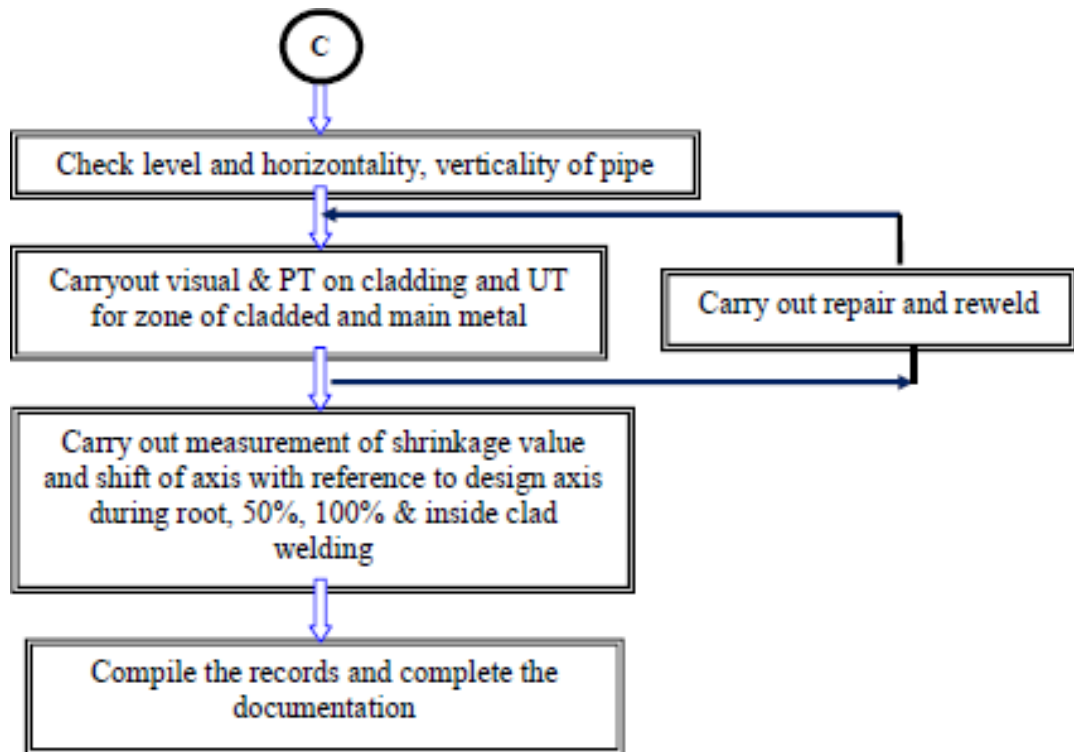
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TECHNICAL CONDITIONS OF CONTRACT (TCC)



TECHNICAL CONDITIONS OF CONTRACT (TCC)



TECHNICAL CONDITIONS OF CONTRACT (TCC)

2.2.14 TECHNICAL SPECIFICATION FOR ERECTION, ALIGNMENT, FIT UP AND WELDING OF STATIC EQUIPMENT IN REACTOR AND REACTOR AUXILIARY BUILDING

Sr No	Description
1	Purpose
2	Scope of work
3	Erection of Static Equipment
3.1	Tolerance & Finishes
3.2.1	Erection of Hydrogen Recombiner:
3.2.2	Erection of Sump filter:
4	Erection of JMJ louvers (Relief devices):
5	Erection of JMP louvers (Relief devices):
6	Reports and Records

1. Purpose:

Purpose of this specification is to provide guidance to contractor to understand the scope, quantum of work and technical requirements to be followed during erection, alignment, welding and inspection of static equipment.

2. Scope of work:

The contractor scope of work involves but not limited to the following.

- i. Study of drawings, preparation of network schedules.
- ii. Preparation and approval of QAP, erection, welding and inspection procedures.
- iii. Receipt of material from BHEL/NPCIL store, transportation, storage
- iv. Receipt of material, handling & preparation of IMIR ,
- v. Survey of EPs & marking, orientation and elevations of equipment.
- vi. Handling, shifting, lowering, assembly, erection, alignment, fit up, welding of equipment to the base plate / embedded part equipment as per the requirement given in the working drawing.
- vii. Surveying relief devices embedded parts and make ready the EP for positioning of relief devices (de-preservation, checking the level, verticality, marking on embedded parts, and checking of approach to the location) JMJ 18 Nos.

TECHNICAL CONDITIONS OF CONTRACT (TCC)

- viii. Arrange suitable jigs and fixtures for lifting and holding of relief devices in position. Arrange temporary metal structures for hoisting the relief devices to design position.
- ix. De-preservation of relief devices & its accessories, dimensional survey for all the components.
- x. Shifting of relief devices to designed location with the help of contractor crane /polar crane from RB 0 mtr elevations to +14.0 mtr elevation inside UJA.
- xi. Safely store the relief device near to erection opening. It is prohibited to open the relief device leafs, take it out from the frame, step on the leafs etc.,. proper care needs to be taken while storing not to damage the rubber sealing of relief devices
- xii. Preparation of as built drawings and reports and submission for acceptance.

3. Erection of Static Equipment:

- i. Static equipment includes tanks, filters, heat exchangers etc. All these equipments are covered in various buildings covered under this contract at various locations and different elevations. Material of construction of the equipment is carbon steel or stainless steel.
- ii. Check list of all the activities involved in the erection including pre-erection checks shall be made in consent with the Engineer, filling the check list before proceeding or erection after joint survey.
- iii. Survey shall be made for shifting, handling and erection, it shall be ensured that necessary embedded parts are available for handling of equipments for erection. In case there are no embedded parts anchor plates with fasteners shall be erected for handling of equipment in concurrence with BHEL & NPCIL.
- iv. Dismantling and re-assembling the accessories are included in the scope of work if required. In case of any damage or missing occurred in accessories which in custody of contractor, the same shall be arranged by contractor at his own risk and cost.
- v. De-preservation of equipments such as removal of peel able protective coating, removal of grease/oil applied on equipments using high quality Kerosene, other liquid as required.

TECHNICAL CONDITIONS OF CONTRACT (TCC)

- vi. Arrangement of temporary fixtures required for shifting and erection of equipment.
- vii. Erection of scaffolding and disassembling after completing the work is included in the scope of work.
- viii. In case of equipment to be fastened to the embedded part / base frame, cleanliness of fasteners shall be checked, and any damage in threads shall be corrected before proceeding.
- ix. Equipments to be erected on the metal platform, in which there may be requirement for providing additional members or modifying the existing members. The same shall be carried out and is included in the scope of work. Measurement and payment for such work will be made in the relevant BOQ item.
- x. Handling, shifting, positioning of stationary equipment over the foundation, alignment for coordinate and elevation. The same shall be measured and ensured using surveying instruments such as water level, total station, auto level, optical instruments etc.
- xi. Check the nozzle orientation, co-ordinate, horizontality, verticality, elevation for equipment level, tightening of equipment foundation bolts, nuts, washers to required torque using calibrated torque wrench etc.
- xii. Alignment shall be verified for acceptable limit as specified for the particular equipment by the system Engineer.
- xiii. In case the equipment shall be welded to the embedded part, welding shall be carried out by qualified welder as per the approved WPS/PQR. For detailed requirements of welding, technical specification for welding may be referred. Welding shall be performed only after obtaining the acceptance of the alignment.
- xiv. Terminal points / nozzles on the equipments shall be kept closed & equipment must be preserved preventing dust entry till the terminals are released for connected activity.
- xv. All tools and tackles, hydra, truck necessary for safe handling & transportation of the equipment shall be in scope of the contractor. NPCIL will not issue crane for handling and erection.
- xvi. Disassembling of all temporary arrangement, cleaning the area, touch up painting and depositing back the packing material to Engineers stores.

TECHNICAL CONDITIONS OF CONTRACT (TCC)

3.1 Tolerance & Finishes:

Dimensional tolerance for alignment of static Equipment shall be specified in the drawing or manufacture instruction. Unless otherwise specified, the following tolerances shall be followed during erection.

a) Installation of Tanks: -

- Verticality deviation of installed tank is not to exceed 2.5 mm per each meter of tank height (from tank centerline)
- Out let pipe (Gravity flow) shall have slope 1:100

b) Installation of Filters: -

- Verticality deviation of filter body shall be maintained at 2 mm per one meter of the filter height
- Deviation from horizontal drain facilities and from distribution devices shall be 2 mm per 1 meter but not exceed 5 mm for the whole length of the filter (In the direction of the drain)

3.2 Special Equipment:

Based on the efforts required few separate BOQ items have been provided, work involved and sequence of activities of such equipment are as given below.

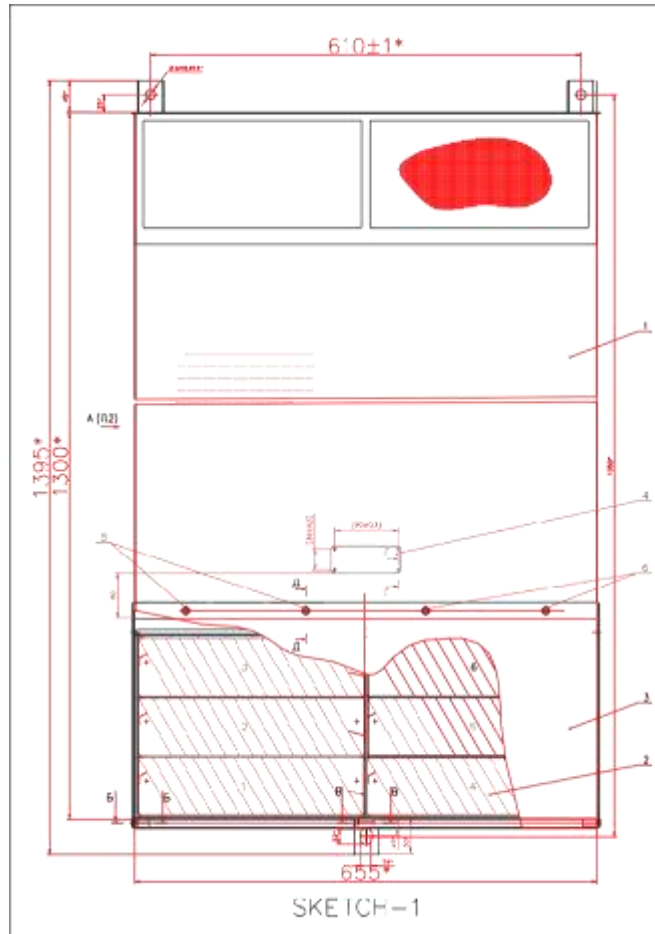
3.2.1 Erection of Hydrogen Recombiner:

- i. Hydrogen recombiners (JMT) stainless steel rectangular boxes provided with recombining agents. These are to be erected inside reactor building at different floors, elevations and locations including dome portion.
- ii. Recombineres are needed to be erected using existing metal structure or using anchor fasteners or shall be erected on the new metal structure. Scope includes erection of the new metal structure also. Payment for erected metal platform or anchor fasteners will be paid in the relevant BOQ item.
- iii. Recombineres are very light members whose weight ranges from 25 to 50Kg, whereas they needed to be erected at higher elevations where huge scaffolding erection, efforts are required. Considering these factors, a separate BOQ item has been provided for Hydrogen recombiner.
- iv. Recombineres are provided with inlet and outlet ports as per process requirements. While erection the inlet ports needed to be blanked with temporary arrangements. And these arrangements needed to be removed

TECHNICAL CONDITIONS OF CONTRACT (TCC)

only after obtaining the clearance from Engineer. Scope includes the temporary arrangement also

- v. Typical arrangement of the recombiners is shown in the sketh-1 below.



3.2.2 Erection of Sump filter:

- i. Sump filter is a modular filter which is to be erected in sump at 1.7m elevation of reactor building. This filter is an assembly of frame work with filtering modules which are to be assembled with the embedded parts.
- ii. Sump filter will be supplied in disassembled condition in loose / separate parts such as stainless steel frames of various sections, filtering modules approx. 120nos, supporting slotted plates, fasteners etc (these numbers are subjected to change based on the working drawings issued at the time of execution).

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- iii. All these members are needed to be shifted from contractor fabrication shop to the reactor building at +31.700m elevation floor and from +31.700m elevation floor, these items are to be shifted to sump location at 1.7m elevation.
- iv. Before proceeding for the assembly of the filtering modules stainless steel structural part shall be erected and welded for supporting the filter assembly. Erection and welding of the stainless steel structure is also included in the scope of work. Whereas the Payment for such stainless steel structure will be measured in the relevant BOQ item.
- v. Filter frames shall be assembled with the structural support by welding and fastening. Filter module supporting sheets shall be erected and fastened with the frame work.
- vi. Assembling of the filter module with the supporting sheet using mechanical fasteners in a proper sequence and a zero gap shall be ensured between the plate and the filter module.
- vii. Once all the modules are erected, cover sheets shall be assembled with the frame.
- viii. As stated above this filter is to be erected at the bottom most elevation of the reactor building i.e. cavity sump. This area is prone for collection of drain water / flushing water. In view of this there may be hindrance to the job, bidder shall consider all these factor before submitting the offer.

4. Erection of JMJ louvers (Relief devices):

Relief devices are intended for protection of structural elements of accident localization zone (ALA) against over-pressurization and will open when a pressure differential of over 10 KPa exist between ALA and outside ALA of reactor building.

Relief device consists of Outer frame, rotating leaves, supports and adjustment mechanism of relief device actuation force. Relief devices are installed both in horizontal and vertical direction.

- i. Issue of relief devices & its accessories from CMM stores, shifting to site and preparation of IMIR.
- ii. Providing temporary Working platform\scaffoldings on both sides of relief device at various locations\elevations for accessing the embedded part for erection of relief devices.
- iii. Obtain as built details of Relief device embedded components.

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- iv. Surveying relief devices embedded parts and make ready the EP for positioning of relief devices (de-preservation, checking the level, verticality, marking on embedded parts, and checking of approach to the location) JMJ 18 Nos.
- v. Arrange suitable jigs and fixtures for lifting and holding of relief devices in position. Arrange temporary metal structures for hoisting the relief devices to design position.
- vi. De-preservation of relief devices & its accessories, dimensional survey for all the components.
- vii. Shifting of relief devices to designed location with the help of contractor crane / polar crane from RB 0 mtr elevations to +14.0 mtr elevation inside UJA.
- viii. Safely store the relief device near to erection opening. It is prohibited to open the relief device leafs, take it out from the frame, step on the leafs etc., proper care needs to be taken while storing not to damage the rubber sealing of relief devices.

TABLE-1

S. NO	KKSCODE	DESCRIPTION	ELEVATION (M)	UNIT	Q-ty	TOTAL WEIGHT (KG)	FORCE (N)
1	1JMJ10AA00 4	RELIEF DEVICES PYB 10/2000X1500	20.45 to 41.5	set	1	1010	304 ⁺¹⁰ → °
2	1JMJ10AA01 8	RELIEF DEVICES PYT 10/2000X1500	20.45 to 41.5	set	1	800	308 ⁺¹⁰ → °
3	1JMJ10AA00 5	RELIEF DEVICES PYB 10/2000X1500	20.45 to 41.5	set	1	1010	304 ⁺¹⁰ → °
4	1JMJ10AA00 6	RELIEF DEVICES PYB 10/2000X1500	20.45 to 41.5	set	1	1010	304 ⁺¹⁰ → °
5	1JMJ10AA00 7	RELIEF DEVICES PYB 10/2000X1500	20.45 to 41.5	set	1	1010	304 ⁺¹⁰ → °
6	1JMJ10AA00 8	RELIEF DEVICES PYB 10/2000X1500	20.45 to 41.5	set	1	1010	304 ⁺¹⁰ → °
7	1JMJ10AA00 9	RELIEF DEVICES PYB 10/2000X1500	20.45 to 41.5	set	1	1010	304 ⁺¹⁰ → °
8	1JMJ10AA01 0	RELIEF DEVICES PYB 10/2000X1500	20.45 to 41.5	set	1	1010	304 ⁺¹⁰ → °
9	1JMJ10AA01 1	RELIEF DEVICES PYB 10/2000X1500	20.45 to 41.5	set	1	1010	304 ⁺¹⁰ → °
10	1JMJ10AA01 2	RELIEF DEVICES PYB 10/2000X1500	20.45 to 41.5	set	1	1010	304 ⁺¹⁰ → °
11	1JMJ10AA01	RELIEF DEVICES	20.45 to	set	1	1010	304 ⁺¹⁰ → °

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S. NO	KKSCODE	DESCRIPTION	ELEVATION (M)	UNIT	Q-ty	TOTAL WEIGHT (KG)	FORCE (N)
	3	PYB 10/2000X1500	41.5				°
12	1JMJJ10AA00 3	RELIEF DEVICES PYB 10/2000X3000	20.45 to 41.5	set	1	1530	625 ⁻¹⁰ → °
13	1JMJJ10AA01 6	RELIEF DEVICES PYT 10/2000X3000	20.45 to 41.5	set	1	1350	629 ⁻¹⁰ → °
14	1JMJJ10AA01 7	RELIEF DEVICES PYT 10/2000X3000	20.45 to 41.5	set	1	1350	629 ⁻¹⁰ → °
15	1JMJJ10AA01 4	RELIEF DEVICES PYB 10/1000X2500	20.45 to 41.5	set	1	920	517 ⁻¹⁰ → °
16	1JMJJ10AA01 5	RELIEF DEVICES PYB 10/1000X2500	20.45 to 41.5	set	1	920	517 ⁻¹⁰ → °
17	1JMJJ10AA00 1	RELIEF DEVICES PYB 10/2200X3650	20.45 to 41.5	set	1	1900	758 ⁻¹⁰ → °
18	1JMJJ10AA00 2	RELIEF DEVICES PYB 10/2200X3650	20.45 to 41.5	set	1	1900	758 ⁻¹⁰ → °
TOTAL per UNIT (MT)						20800 kg	

- ix. Erection of relief devices on Embedded Part and alignment as per drawing requirement, and checking of verticality & horizontality and lock the relief devices with L-clamp and giving temporary supports, fine adjustment with shim plates, tack weld with EP.
- x. After final alignment measure the initial verticality & horizontality readings and record in register.
- xi. Sequential welding of relief devices with EP by monitoring and controlling distortion.
- xii. Final measurement of verticality & horizontality readings and record in register.
- xiii. Grinding of weld spatters & final cleaning, painting & removal of temporary supports.

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- xiv. Checking of relief device door freeness, lubrication & checking of door opening and closing, Check for proper sealing of the relief device doors with outer frame and perform corrections if any for ensuring proper sealing of relief device doors with outer frame.
- xv. Perform functional and acceptance tests of relief device as per ЮПА 006.01.00.000 PЭ (operating manual of relief device).
- xvi. Inspection of the relief devices actuation force shall be performed by means of a dynamometer (range should be 0-1000N) for each leaf.
- xvii. Apply required force as mentioned in the operating manual ЮПА 006.01.00.000 PЭ through dynamometer for each relief device. The force should be applied at designated location mentioned in the drawing.
- xviii. Inspection results shall be considered positive, if the minimum angular displacement of relief device leafs occurs at application of force within the limits of values given in above table-1
- xix. If the test results are not satisfactory, then do the necessary corrections as per ЮПА 006.01.00.000 PЭ (operating manual of relief device).
- xx. After completion of tests reports needs to be prepared and submitted to NPCIL.
- xxi. Final cleaning and painting of the relief device doors and frames.
- xxii. Approximate welding quantity envisaged for erection of relief devices is 10000 CC (cubic centimeter) for both units (3 & 4). The actual welding may vary on either side because of change of design or site conditions etc. Any variation in welding quantity than specified above will not be paid. The contractor needs to factor in the variations in the cost quoted for the item.

5. Erection of JMP louvers (Relief devices):

5.1.1 General introduction JMP relief devices are intended for protection of structural elements inside steam chambers (of UJE building) against over pressurization and will open when a pressure differential of over 30 KPa exist between steam chamber and outside steam chamber.

Relief device consists of outer frame, rotating leaves, supports with bearing units, ribs, gusset plates, side frames etc., the relief devices are installed in horizontal direction.

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Ref. drawings:

R4.KK.3.UJE.JMP30.SR.OK.WD001 - Relief device mounting drawing.

5.1.2 Detailed scope of work:

- i. Issue of relief devices & its accessories from CMM stores, shifting to site and preparation of IMIR.
- ii. Providing temporary Working platform\scaffoldings on both sides of relief device at various locations\elevations for accessing the embedded part for erection of relief devices.
- iii. Obtain as built details of Relief device embedded components.
- iv. Surveying relief devices embedded parts and make ready the EP for positioning of relief devices (de-preservation, checking the level, horizontality, marking on embedded parts, and checking of approach to the location) JMP 14 Nos.
- v. Arrange suitable jigs and fixtures for lifting and holding of relief devices in position. Arrange temporary metal structures for hoisting the relief devices to design position.
- vi. De-preservation of relief devices & its accessories, dimensional survey for all the components.
- vii. Shifting of relief devices to designed location with the help of contractor crane from outside RB to +26.20 mtr elevation inside UJE.
- viii. Erection of JMP relief devices on Embedded Part and alignment as per drawing requirement ,and checking of horizontality and lock the relief devices with L-clamp and giving temporary supports, fine adjustment with shim plates ,tack weld with EP.
- ix. Perform minor grinding operation on top of embedded part to achieve the required flatness requirements.
- x. Perform fit up and welding of relief devices accessories (wall supports, partitions, weld strip, gusset plates, side frame, rest support, ribs etc.,) with relief device & with the embedded part of the erection opening as per drawing requirements. Accessories come in many parts which shall be assembled and welded.
- xi. Perform fastening of partition walls to the concrete wall with the help of anchor bolts.
- xii. After completion of alignment & welding of relief device accessories remove the locking ring of relief device bearing support.
- xiii. After final alignment measure the horizontality readings and record in register.

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- xiv. Grinding of weld spatters & final cleaning, painting & removal of temporary supports.
- xv. Checking of relief device door freeness, lubrication & checking of door opening and closing, Check for proper sealing of the relief device doors with outer frame.
- xvi. Perform functional and acceptance tests of relief device as per operating manual of relief device.
- xvii. Place the Required number of counter weights as per manufactures instruction at designated location on top of relief device leaves by using the fixture provided and check with dynamometer (to be arranged by the contractor) the force required to open the relief device leafs.
- xviii. Observe for smooth operation of support bearings during functional testing of relief devices.
- xix. If the test results are not satisfactory, then do the necessary corrections as per operating manual of relief device.
- xx. After completion of tests positively reports needs to be prepared and submitted to BHEL & NPCIL.
- xxi. Final cleaning and painting of the relief device doors and frames.
- xxii. Approximate welding quantity envisaged for erection of relief devices is 48000 CC (cubic centimeter) for both units (3 & 4). The actual welding may vary on either side because of change of design or site conditions etc. Any variation in welding quantity from mentioned above will not be paid. The contractor needs to factor in the variations in the cost quoted for the item.
- xxiii. All the above details are given for information and general understanding of the bidder for quoting. Separate procedures are to be established by the contractor, and to be approved by NPCIL, before taking up respective activities at site.

6. Records and Reports:

- i. Reports for the executed work shall be prepared and submitted for acceptance after completion of work.

TECHNICAL CONDITIONS OF CONTRACT (TCC)

2.2.15 TECHNICAL SPECIFICATION FOR HANDLING, ASSEMBLY, WELDING, ERECTION, TESTING AND COMMISSIONING OF TRANSPORT AIR LOCK

Sr No	Description
1	Purpose
2	Scope
3	Construction details of TAL
3.1	General Description
3.2	Pre-assembly and welding at crane pad
4	Handling. Shifting, erection, alignment, welding
4.1	Erection of temporary trolley
4.2	Erection of TAL components
4.3	Wedge Erection
4.4	Erection of Rail and bridge assembly
4.5	Erection of Inner gate
4.6	Erection of Bellow compensator and thermal insulation
4.7	Erection of accessories
4.8	Hydraulic and Pneumatic tubing
4.9	Electrical panel erection and cabling
4.10.	Commissioning and testing
5	Reports and Records

1. Purpose

Purpose of this specification is to provide guidance to contractor to understand the scope, quantum of work and technical requirements to be followed during handling, transportation, shifting, assembly, fit up, welding, inspection, erection, site welding, testing and commissioning of transport air lock (TAL) which is located at +28.510 M elevation at UJG.

2. Scope:

The scope of the contractor's work comprises but not limited to the following.

- i. Study of drawings, preparation of network schedules.
- ii. Preparation and approval of QAP, erection, welding and inspection procedures.
- iii. Receipt of material from NPCIL store, transportation, handling & preparation of IMIR.
- iv. Handling, shifting to crane pad near reactor building, checks the ovality, pre-assembly of transport air lock components, using contractor's crane in the crane pad area.

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- v. Fit up, welding of pre-assembled sections, inspection & other NDEs.
- vi. Cleaning Inner Conatinment (IC) & Outer Conatinment (OC) walls and embedded parts, survey using optical instruments, comparing the readings with the post concrete report.
- vii. Handling, lifting & placing of assembled & welded part of TAL and other parts in sequential manner on temporary trolley & supports using NPCIL crane at UJG.
- viii. Shifting of assembly to the desired location using temporary trolley, erection and alignment of assemblies in design position.
- ix. Final alignment of the lock components using pair of wedge assembly on either side of the embedded part on the IC wall, fit up, welding of wedges in erected position & inspection
- x. Handling, lifting and erection of hydraulic system components, laying and terminating hydraulic tubing as per drawing.
- xi. Carrying out welding and necessary NDEs as per the working drawings / manufacturer document.
- xii. Carrying out electrical wiring termination using the wiring drawing submitted.
- xiii. Commissioning the transport air lock as per the requirement specified in the working drawing / manufacturer instruction.

3. Constructional details of TAL.

3.1 General Description :

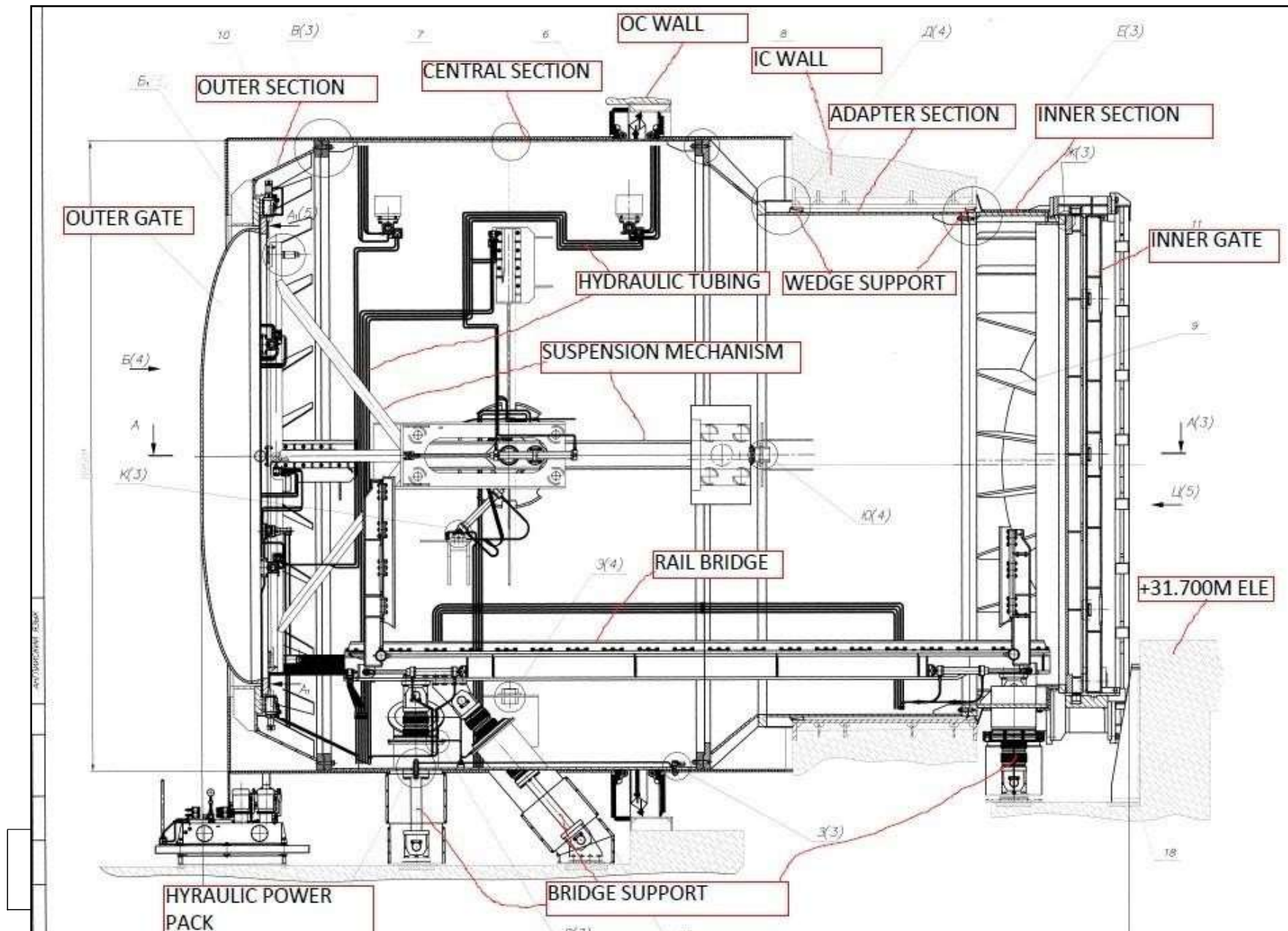
Main parts and technical parameter of the TAL is below in table

SR NO	DESCRIPTION	Weight Per Unit (Kg)	Approx Qty of Welding (Cubic Centimeter)
1	CENTRAL SECTION	52466	65950
2	ADAPTOR SECTION	39836	
3	INNER SECTION	22600	
4	OUTER SECTION	27800	
5	INNER GATE	51000	
6	OUTER GATE	42200	
7	RAIL TRACK	26000	
8	HYDRAULIC SYSTEM	3412	
9	PROTECTIVE SHELL	761.5	
10	PROTECTIVE CONE	461	
11	WEDGES KIT	1540	
12	SEPARATION DEVICE	6120	
13	ELECTRICAL EQUIPMENT OF MATERIAL LOCK	2000	

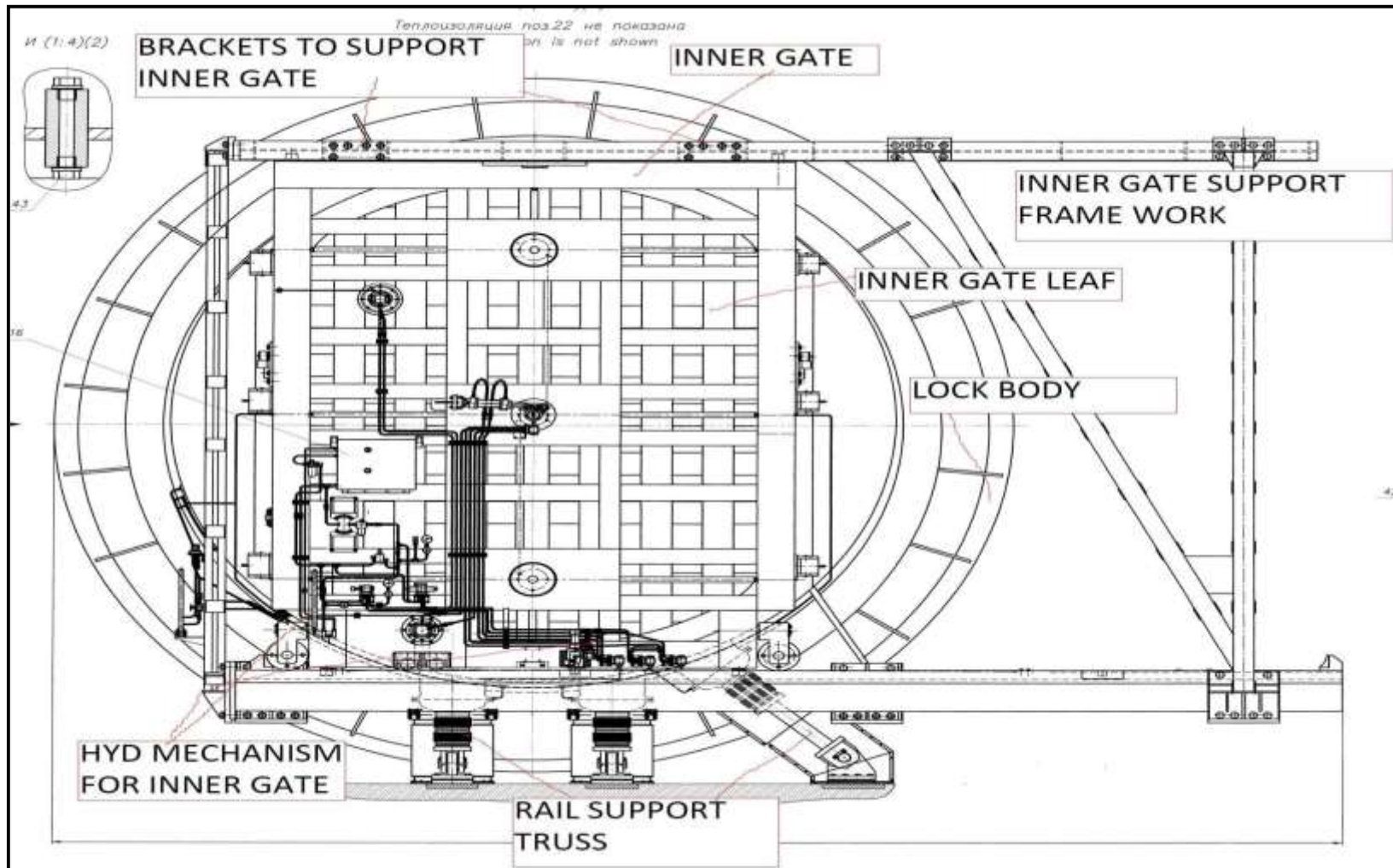
TECHNICAL CONDITIONS OF CONTRACT (TCC)

- i. Transport air lock (TAL) is a cylindrical hollow equipment is used as a passage to transport heavy equipments from/to reactor Building without communicating the reactor environment to outside atmosphere.
- ii. TAL mainly consists of :
 - a) Body (Comprising)
 1. Central Section.
 2. Outer Section(with outer gate)
 3. Inner section
 4. Adapter Section.
 - b) Inner gate
 - c) Rail bridge
 - d) Hydraulic mechanism (For operation of the doors and bridge)
 - e) Hydrulic power pack and tubing
 - f) Air compressor unit with tubing.
 - g) Electrical Panels
- iii. TAL inner/adaptor section assembly is fixed to inner containment (IC wall) embedded part through pair of wedges and acts as a cantilever structure.
- iv. Fixing of lock body with the IC wall embedded part is made by using 60 pairs of wedge assemblies, on either side of the IC wall i.e. towards reactor side and away from reactor.
- v. Central section is cylindrical barrel which is fastened welded to the adapter section.
- vi. Outer door, which swings up/down, is operated by an hydraulic operated suspension mechanism. Outer door is supplied in integral with outer section. Outer section is fastened and welded to the cylindrical section.
- vii. TAL houses rail track bridge inside with two lifting type bridges on either side i.e. inner gate or outer gate side. These bridges will connect with the rail outside the lock when respective gate is opened.
- viii. General arrangement drawing of the transport air lock as shown in the sketch below.

TECHNICAL CONDITIONS OF CONTRACT (TCC)



TECHNICAL CONDITIONS OF CONTRACT (TCC)

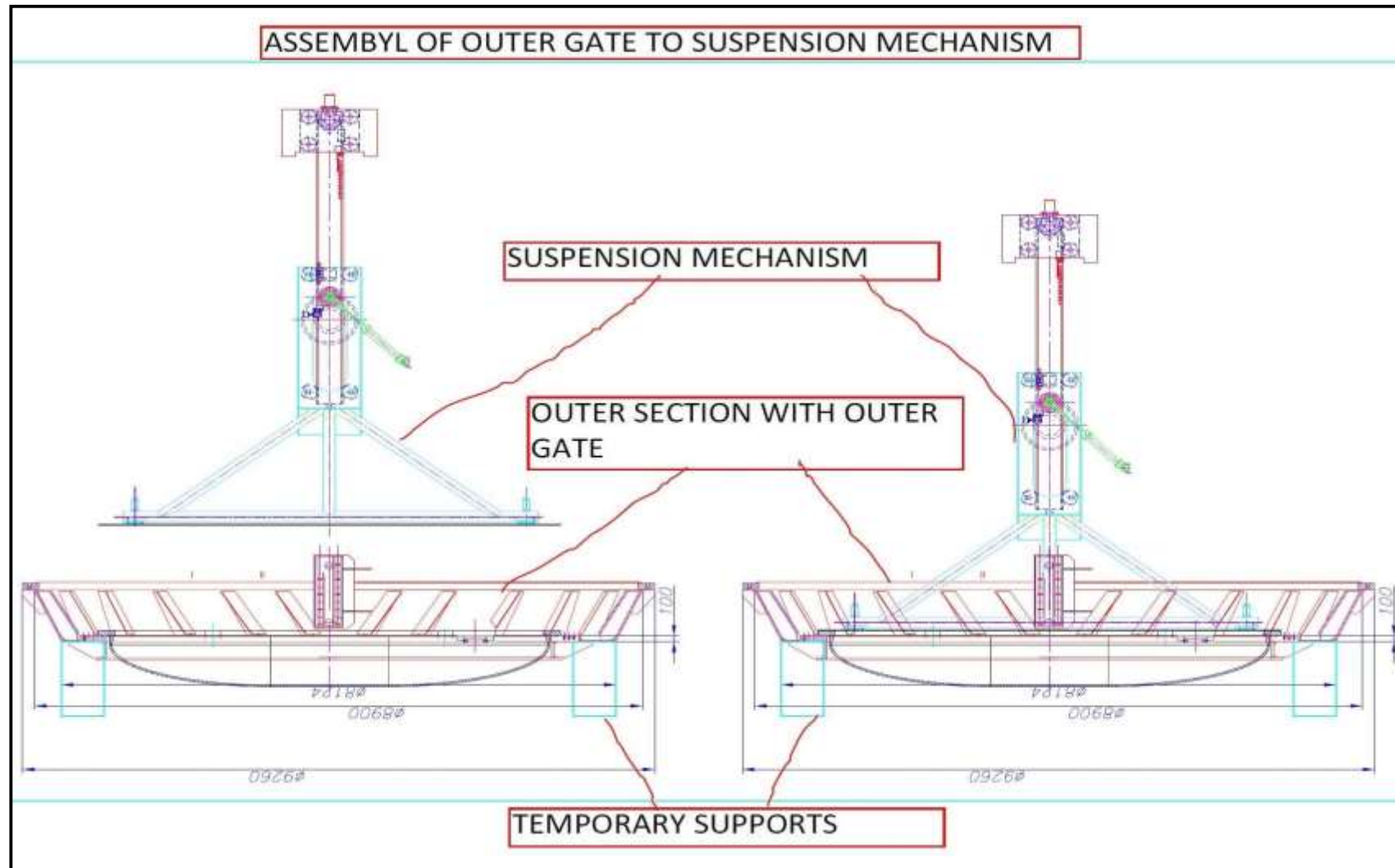


TECHNICAL CONDITIONS OF CONTRACT (TCC)

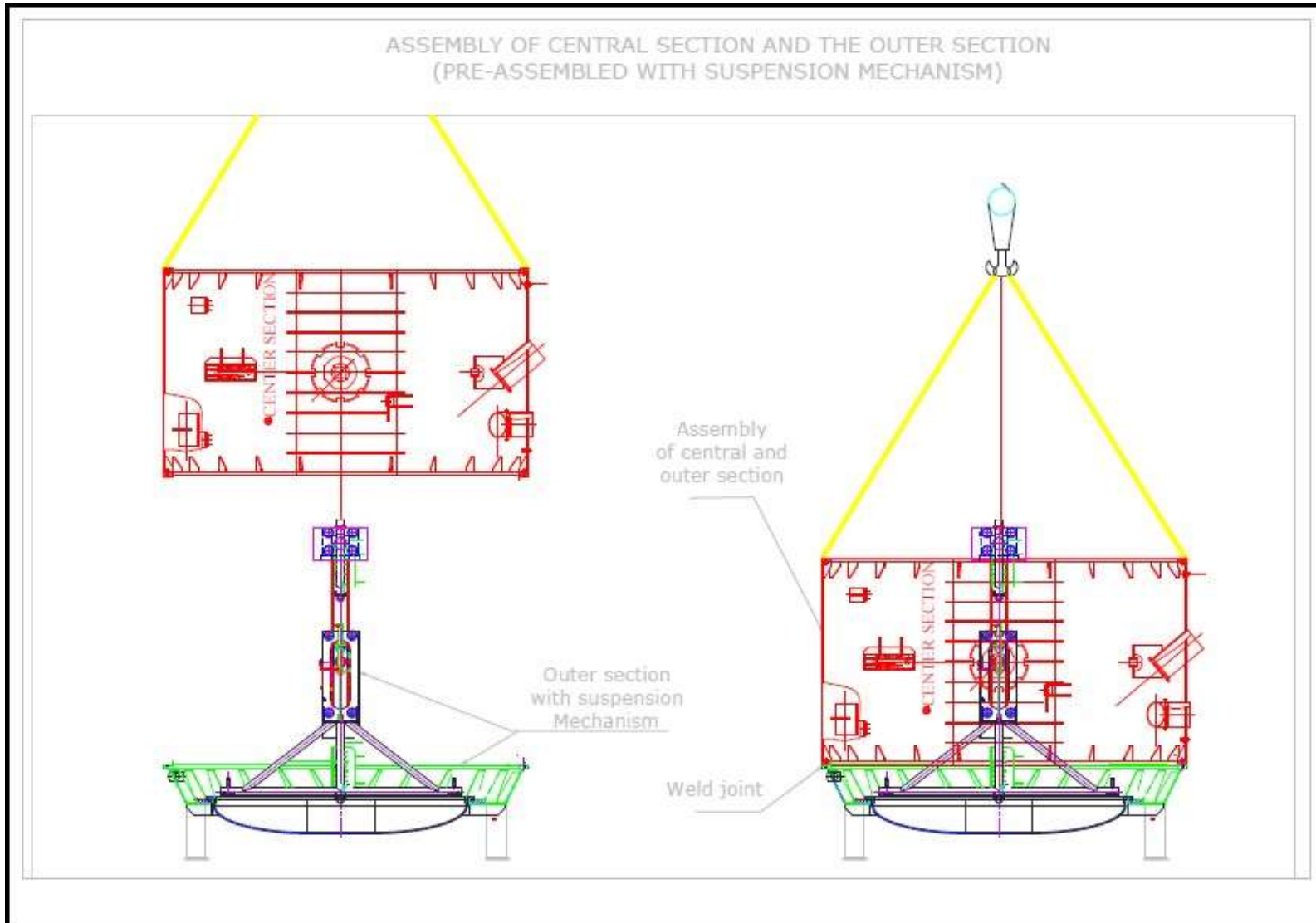
3.2 Pre-Assembly and welding at crane pad:

- i. Prior to erection of the TAL components, pre-assembly of the main components shall be taken up. Sequence of the pre-assembly is as given below.
- ii. Arrangement of temporary supports for placing carrying out and placing the assemblies.
- iii. Assembly of Inner section to Adapter section , fastening, welding using GTAW / SMAW process and inspection.
- iv. Assembly of suspension mechanism components , such as counter weight beam, bearings and hydraulic cylinders.
- v. During assembly of components , healthiness of the bearings, hydraulic cylinders etc shall be ensured and preservation condition shall be checked and shall be restored if required.
- vi. Assembly of suspension mechanism with the outer gate. (Note: Outer gate is pre-assembled to the outer section and will be in locked condition.)
- vii. Assembly of Outer section assembly with the central section , fastening, welding using
- viii. GTAW / SMAW process and inspection.
- ix. Schematic activities of the pre-assembly are as shown below.

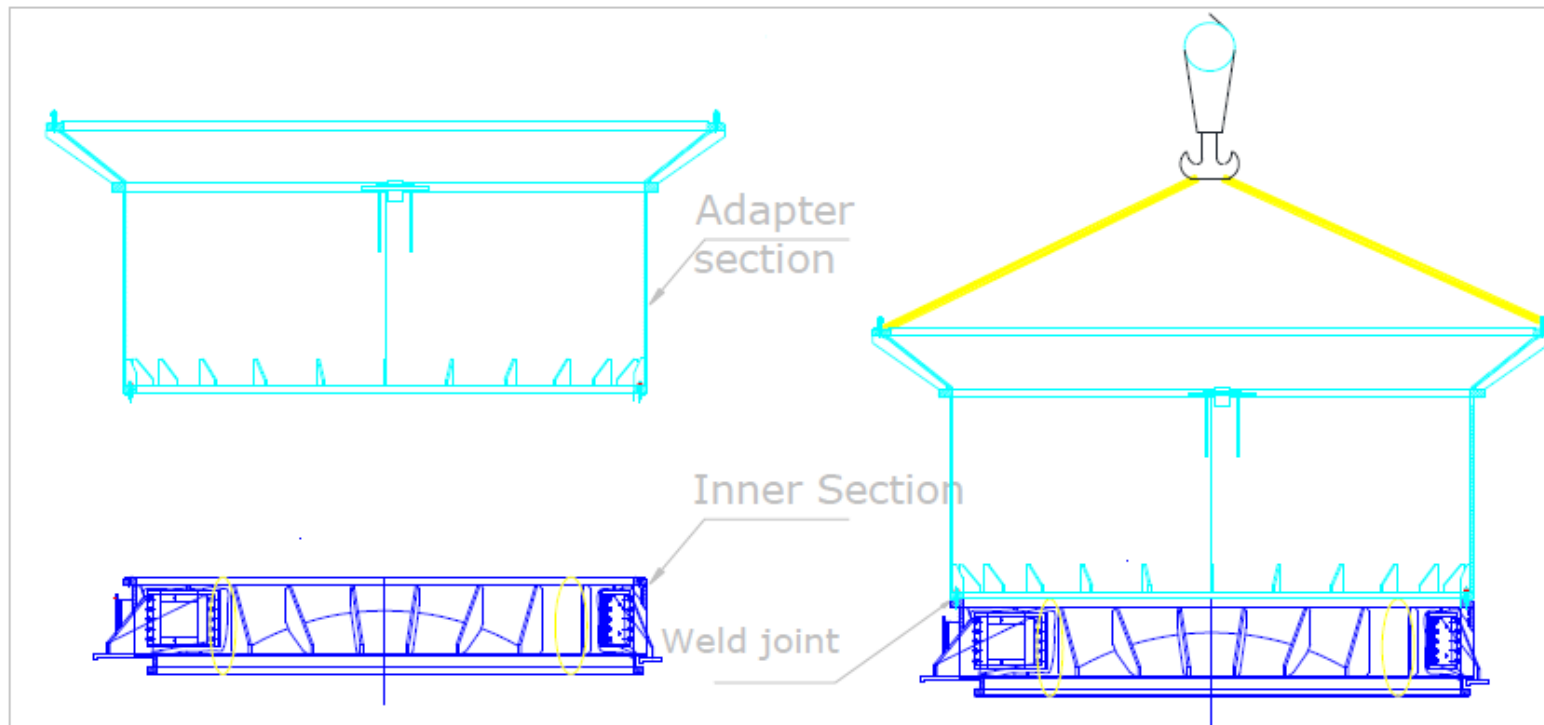
TECHNICAL CONDITIONS OF CONTRACT (TCC)



TECHNICAL CONDITIONS OF CONTRACT (TCC)



ASSEMBLY OF INNER SECTION WITH THE ADAPTER SECTION

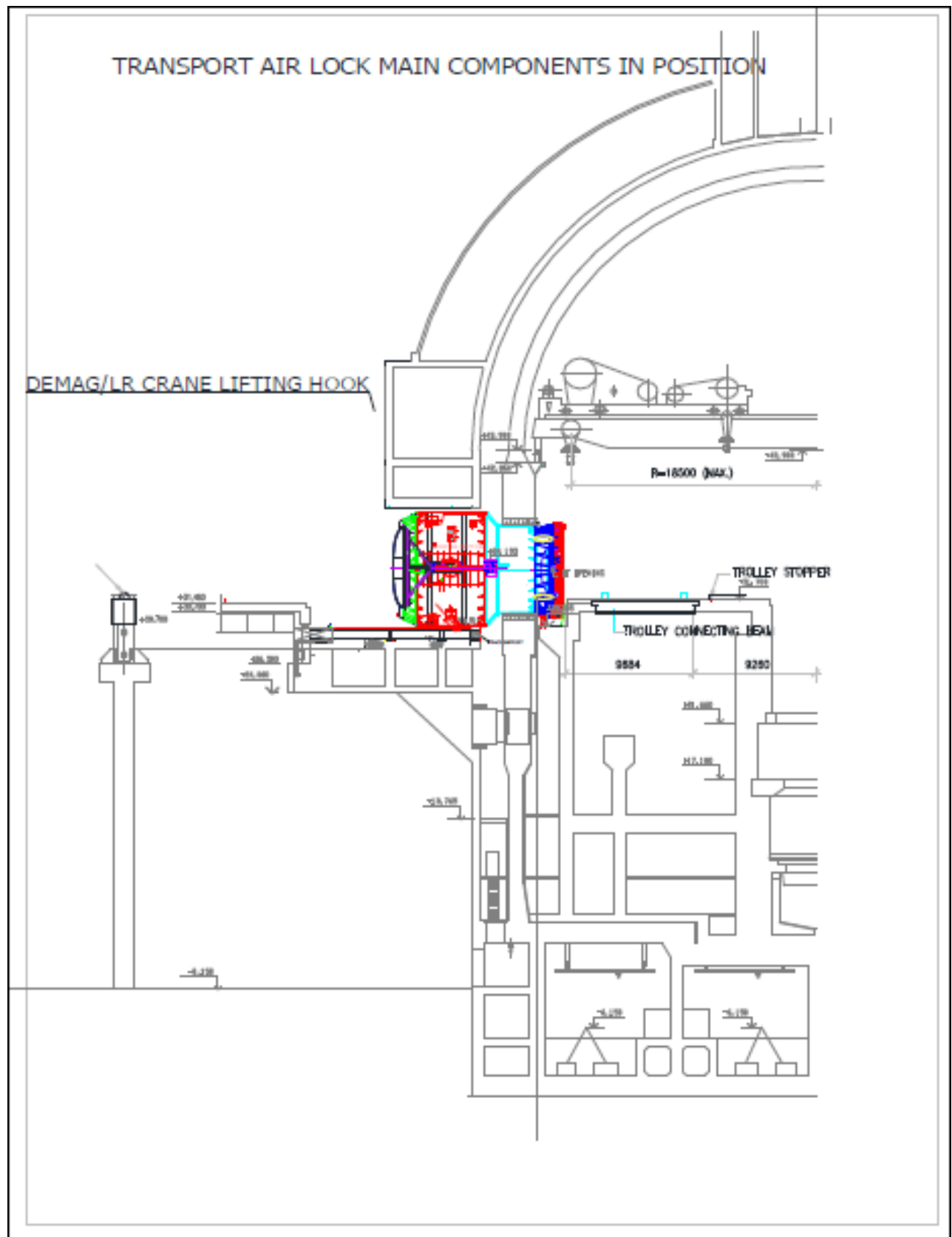


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TECHNICAL CONDITIONS OF CONTRACT (TCC)

4.2 Erection TAL components:

- i. Cleaning of embedded parts , survey, record the dimensions in the wedge seating areas.
- ii. Handling, tilting and placing of the inner section and adapter section assembly, on the temporary trolley using NPCIL heavy duty crane. Arrangement of tailing crane for tilting the TAL components is under the scope of contract.
- iii. Shifting the assembly towards inner containment with the help of winch arrangement.
- iv. Alignment of the assembly w.r.t inner containment embedded part for concentricity , measure the gap between the IC wall EP and the lock inner section and record the same.
- v. Handling, tilting and placing of central section and outer section assembly on temporary trolley, shift the assembly towards adapter using winch arrangement.
- vi. Scope includes providing scaffolding / temporary platform around the lock body for performing the alignment, welding and inspection.
- vii. Assembling, alignment, fitup and welding of adapter section to central section at location.
- viii. On completion of welding, final alignment of the assembly w.r.t inner containment wall embedded part. Measure the gap between the inner section and the embedded part.
- ix. A schematic diagram of handling and erection of the assemblies is shown in the sketches given below, However detailed erection methodology and schemes shall be submitted by the contractor along with the work procedures.

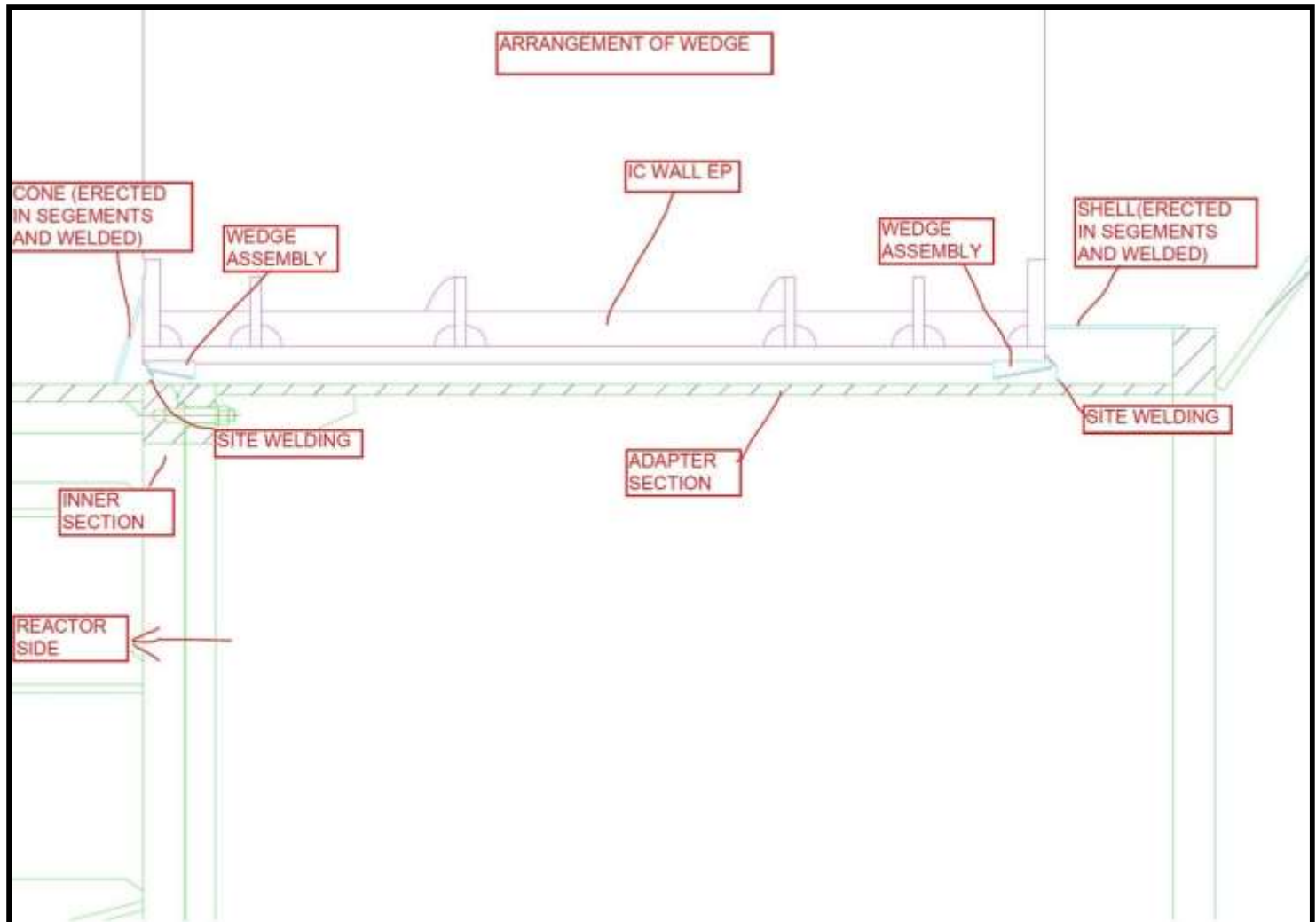


TECHNICAL CONDITIONS OF CONTRACT (TCC)

4.3 Wedge Erection:

- i. Lock body assembly is fastened to inner containment embedded part with wedge arrangement on either side of the embedded part.
- ii. Temporary access platform shall be made in the annular space for accessing the area for assembly of wedges.
- iii. Based on the gap between the inner containment wall embedded part, the percentage area of contact shall be seen and it shall fulfill the readings given in the working drawing. This work includes machining the wedges to meet the requirement of contact specified in WD.
- iv. There are 24 such pairs on either side of the embedded part.
- v. Erection of wedges, alignment, parallel check the alignment of the lock body, on completion of alignment, welding of the wedges shall be carried out.
- vi. Erection of protective cone from reactor side and protective shell from outer side around the wedges. These cone and shell are supplied in sectors; these sectors are to be assembled in location and are to be welded in segments at site.
- vii. On completion of the welding of cone and shell, pneumatic testing shall be carried out for the cone and shell area.
- viii. The detailed arrangement of the wedge assembly is as shown below in the drawing.

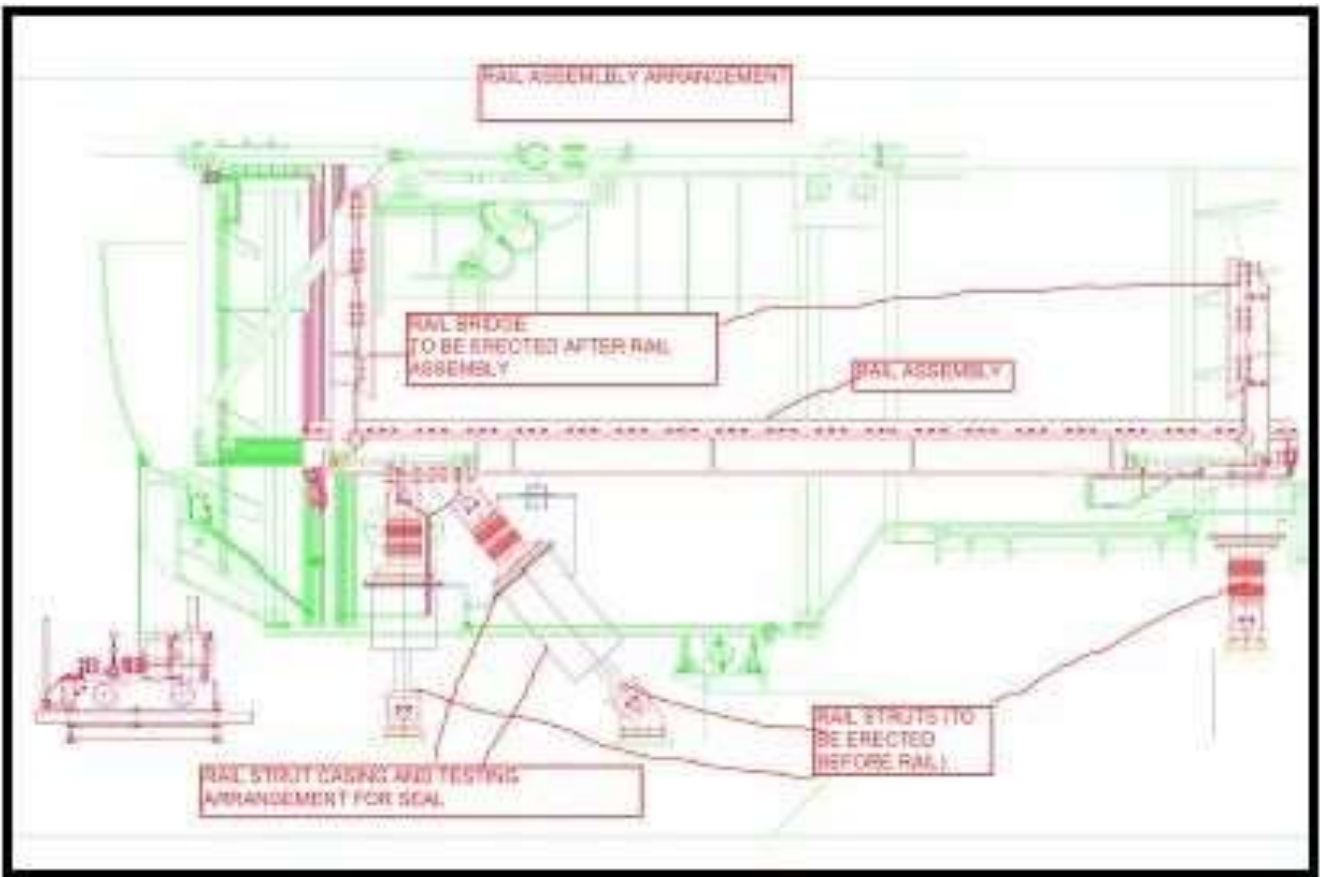
TECHNICAL CONDITIONS OF CONTRACT (TCC)



TECHNICAL CONDITIONS OF CONTRACT (TCC)

4.4 Erection of Rail and bridge Assembly:

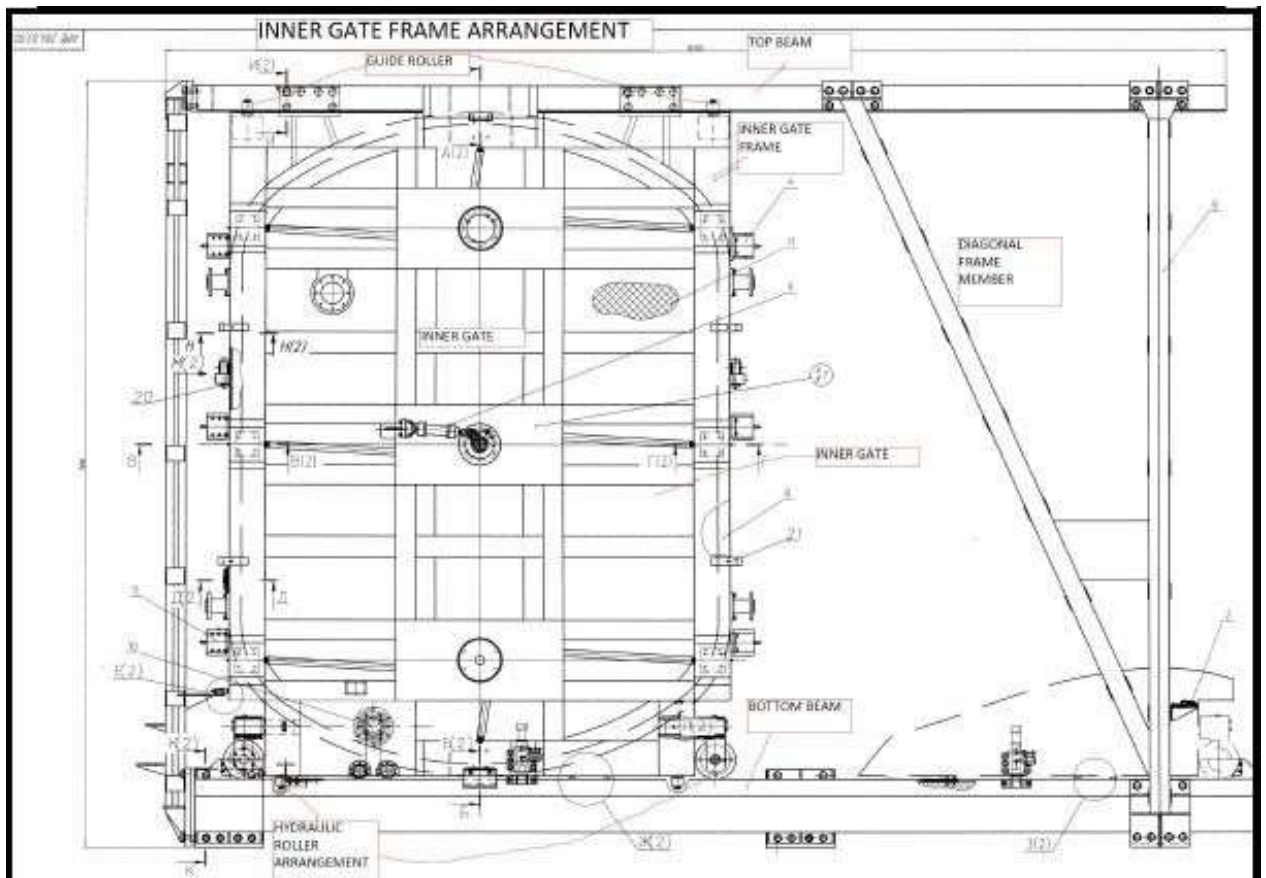
- i. After successful completion of the lock barrel components, erection of rail assembly shall be taken up.
- ii. Prior to shifting of rail to the location, supporting truss of the rail shall be shifted to the location and shall be placed in the desired position, fixing of these truss to the concrete by embedded part or by the anchor plate.
- iii. Handling, lifting and shifting of the rail to the location, shifting & erection of the rail bridges i.e. one towards the reactor where the inner gate slides and other bridge away from reactor where outer gate moves.
- iv. Final alignment of the rail with the axis of the already erected rail at +31.70m elevation floor of reactor building. Horizontality of the rail shall be achieved as per requirements specified in the working drawing / manufacturer instruction.
- v. Fixing of rail with the supporting trusses, carrying out welding of the truss with the embedded part/ anchor plate, after welding and inspection, truss covers shall be erected to seal the lock environment with the atmosphere.



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4.5 Erection of Inner gate:

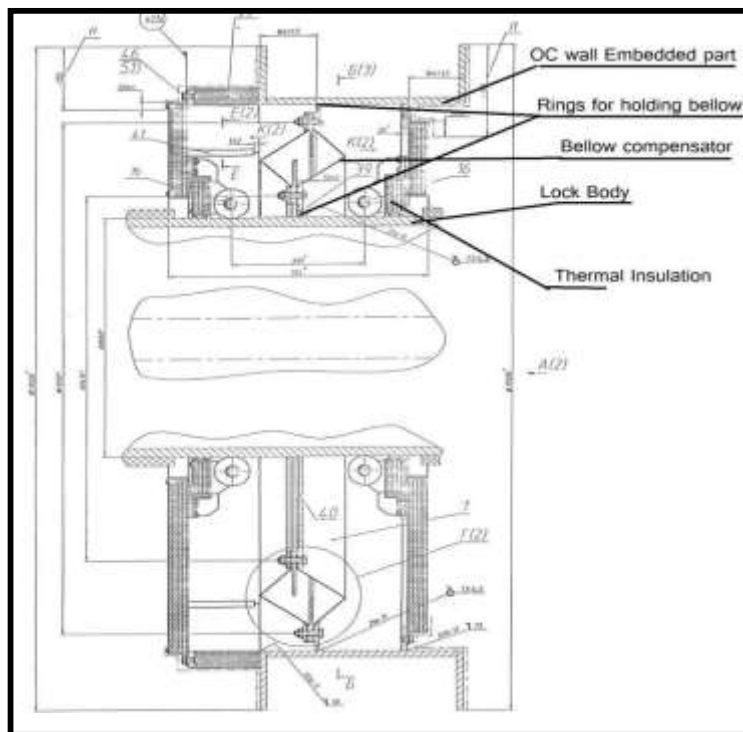
- i. Arrangement of the inner gate is shown in the below sketch.
- ii. Inner gate is a rectangular frame section with solid leaf, integral with the locking mechanism. Inner gate is provided with the hydraulic roller mechanism.
- iii. Measure the field measurement of the inner section brackets, compare with the dimensions of the matching holes of frame, any discrepancies shall be brought to the notice of NPCIL.
- iv. Handling, erection of supporting frame work of inner gate, all frames are be assembled except top ones, the top beam shall be erected after erection of inner gate assembly.
- v. Handling and assembling of inner gate assembly, placing the top beam and fastening, locking of inner gate with temporary arrangement till the works on supporting frames are completed.
- vi. As the inner gate rolls over the frame, any slope on the gate will hamper it's proper functioning. Due to this maintaining the horizontality of the frame is very crucial. Since the frame is mounted on the inner section, orientation of the inner section also is important.
- vii. On completion of the inner gate frame work, temporary locks shall be released and free movement of the gate shall be ensured.



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4.6 Erection of Bellow compensator and thermal insulation:

- i. For isolating the annulus space environment with the outside atmosphere an arrangement is provided by providing bellow compensator.
- ii. Bellow compensator of silicon fabric is provided between central section and the outer containment embedded part.
- iii. Two metal retainer rings are provided, one on the outer containment embedded part and one ring on the body of central section and same shall be welded to EP and body of central section.
- iv. Arrangement of bellow compensator ring is as shown below.
- v. Bellow compensator ring is rubber fabric supplied in the required profile with ends in open condition.
- vi. Thermal insulation is supplied in prefabricated blocks enclosed in metal sheet. These blocks are to be erected at site by welding and mechanical fastening.



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4.7 Erection of accessories:

Accessories of TAL include

- i. Hydraulic power pack.
 - ii. Pneumatic control panel with compressor.
 - iii. Sleeves of struts of rail.
 - iv. Nozzles over the inner section.
-
- i. During assembly and erection of TAL, there may be requirement for dismantling of some projected items from the lock body to avoid interference during erection and to prevent any damage. Quoted rate shall include all these dis-assembly and re-assembly works also.
 - ii. Hydraulic power pack is used for operation inner & outer gate and lock, rail bridges and it is connected with all these components by tubings. The tubes are partially assembled in each TAL section. The tubing end connection shall be done after erection of each assembly.
 - iii. Erection and welding of sleeves on the inner section and the central section which provide provision for passing supporting struts.
 - iv. Fixing of supporting struts, fit up and welding of supporting struts to the embedded parts.
 - v. Erection of rail support strut covers, fastening with the lock body.
 - vi. Lifting, handling and erection of hydraulic power pack unit and air compressor housing cabinet.

4.8 Hydraulic and Pneumatic tubing:

- i. Air lock parts are operated by means of hydraulic mechanism including power pack, hydraulic cylinders, tubing & control valves.
- ii. All the sealing areas such as sealing between the outer section and the outer gate, inner section and inner gate, openings on the inner section, openings on the central section etc are provided with tubing circuits, with a dedicated air compressor and control valves, for pneumatic testing of individual.
- iii. Hydraulic power pack and air compressor unit shall be shifted and erected in the desired location as per the working drawings.
- iv. All the tubing terminals shall be identified, carry out flushing with oil free compressed air, termination of tubing as per the hydraulic circuit and the pneumatic circuit given in working drawing.

TECHNICAL CONDITIONS OF CONTRACT (TCC)

- v. Termination of hydraulic circuit tubing with the hydraulic power pack and the pneumatic tubing with the air compressor unit.

4.9 Electrical panel erection and cabling:

- i. TAL consists of electrical control panels (main control panel & local control panels) near outer gate, inner gate both outside and inside the lock. Electrical cables from these panel are to be laid to the main control panel erected in the rooms located at higher elevation i.e.+42.00m elevation. Laying and termination of work is included in the scope of contractor with in the quoted rate.
- ii. For scope of work involved in erection of panels and electrical cabling refer technical specification for protective rolling gate.

4.10 Commissioning & Testing:

- i. Preparation of detailed work procedure and QAP for commissioning activities and submission for approval from NPCIL.
- ii. Preparation of detailed check list for the electrical items and the mechanical items and the same shall be included in the procedure.
- iii. Check for continuity of the cables and IR values of the electrical items included in the system, and other control points shall be fulfilled, viz., mentioned in the check list.
- iv. Checking the thoroughness of the hydraulic tubing, pneumatic tubing any defects found shall be addressed and rectified as per the instruction of Engineer.
- v. After establishing the power supply, local operation of the hydraulic power pack for smooth functioning, similarly air compressor unit shall be checked for operation, all the parameters during operation shall be recorded as per the procedure established and shall be cross checked with the manufacturer instruction.
- vi. Flushing of Hydraulic lines by operating the hydraulic power pack and the venting of individual hydraulic circuits of mechanisms which and terminating the hydraulic tubing with hydraulic cylinders of outer gate swigging mechanism, locking mechanism, bridge operation mechanism, inner gate operating & locking mechanism etc.
- vii. Operation of the all the individual system shall be checked and discrepancies any shall be attended as per the procedure.
- viii. Check the operability of the outer gate including the locking mechanism, operability of the inner gate with the locking mechanism.

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ix. Testing of pneumatic seals :

- a) All the doors and the hatches are provided with the seals (two parallel seals) with provision for testing pneumatically. Sealing areas such as outer gage, inner gate, hatch covers etc. are provided with double sealing arrangement with provision for pressurizing the inter seal cavity.
- b) For testing the healthiness of the seals, compressor unit will be supplied along with the TAL. Check for thoroughness of the air lines connecting to the seal test ports, with a compressed air, any chocking observed shall be cleared and rectified. Any rectification shall be carried out in concurrence with the NPCIL.
- c) Air line termination shall be carried out after air flushing, after termination testing of the seals independently shall be carried out using the compressor unit supplied along with the TAL.

5. Reports and Records:

- i. All the stage of the work shall be properly documented and reports shall be prepared in the form of as built information, weld inspection reports, testing report, commissioning report etc.

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2.2.16 TECHNICAL SPECIFICATION FOR HANDLING AND ERECTION OF FUEL POOL EQUIPMENT AND ERECTION TROLLEY IN REACTOR BUILDING

SR NO	DESCRIPTION
1	Purpose
2	Scope
3	General Description
3.1	Erection of fuel Pool rack , rack support, shock absorber and sluice gate
3.1.1	Erection of fuel Pool rack & rack support
3.1.2	Erection of Universal Seat and Shock absorber:
3.1.3	Erection of sluice gate
3.2	Erection of refueling machine
3.2.1	Erection of Rail
3.2.2	Erection of Bridge
3.2.3	Erection of Trolley and Rotating platform
3.2.4	Erection of Working mast and TV mast
3.2.5	Erection of accessories
3.3	Erection & commissioning of transportation trolley and Rail
3.3.1	Erection of Rail
3.3.2	Erection of Trolley and accessories
4	Reports and Records

1. Purpose:

Purpose of this specification is to provide guidance to contractor to understand the scope, quantum of work and technical requirements to be followed during handling and erection of the fuel pool equipment viz. Fuel pool rack supports, fuel pool racks, shock absorber, refueling machine, sluice gates, skip transfer trolley, rails for trolley and the refueling machine, commissioning of skip transfer trolley with temporary power supply.

2. Scope:

The scope of the contractor's work comprises but not limited to the following.

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- a) Study of drawings, preparation of network schedules.
- b) Preparation and approval of QAP, erection, welding and inspection procedures, Preparation of erection schemes.
- c) Receipt of material from NPCIL/BHEL store, transportation, storage, preparation of IMIR and submission for acceptance.
- d) De-preservation of racks , which includes removal of heavy amount of grease applied over the surface of the racks.
- e) Handling, erection , alignment and welding of the fuel pool supports over the embedded parts in the fuel pool.
- f) Handling and erection of the fuel pool racks over the rack supports, alignment, fit-up and welding of the rack thrust guide angles locks and inspection.
- g) Handling and erection of the shock absorber in the cask area of the fuel pool, this includes pre assembly of the shock absorber also.
- h) Survey of embedded parts, cleaning, grinding, erection, alignment of rail and welding.
- i) Handling, assembly and erection of the re-fueling machine including all the accessories.
- j) Handling and erection of the sluice valve of the fuel pool and erection of the equipment and structures in the vertical stand.
- k) Erection of the skip transfer trolley with rail and commissioning of the trolley with the temporary power supply.
- l) Preparation of reports and submission for acceptance in the relevant formats as per the approved procedures.

3. General Description:

- i. Reactor building houses spent fuel pool for storing the spent fuel and receiving the fresh fuel. Fuel pool consists of three sections viz. I section, L-section and cask pool.
- ii. Fuel pool is provided with the racks in I section and L section, Racks are supported by rack supports, rack supports are fixed with embedded parts.
- iii. Cask section is provided with the shock absorber assembly at the floor elevation, fixed to embedded part by means of welding.
- iv. Loading and unloading of fuel assemblies will be carried out by means of refueling machine, which shall be erected at +31.700m elevation over rail.
- v. Skip transfer trolley shall be erected at +31.700m elevation for movement of equipment inside and outside the reactor building.

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- vi. Fuel pool starts from +12.43m elevation to +31.7m elevation and is filled with borated water during operation.
- vii. Transfer of fuel will be carried under the water; this will be done with the help of refueling machine. Refueling machine is located on +31.7m elevation, mounted on the rail along the direction of fuel pool to reactor.
- viii. Refueling machine can travel in Cartesian directions and can access all the racks inside the fuel pool and all the points inside the reactor pressure vessel.
- ix. Refueling machine (RFM) is mounted on the rail, and the rail in-turn mounted on the embedded parts on +31.7m elevation.
- x. During normal operation of reactor, there required an isolation between the cavity and the fuel pool to prevent the entry of water in the fuel pool to the cavity area. And during shut down time, cavity area and the fuel pool are integrated and filled with water till elevation +31.000m. This isolation is achieved by providing the sluice gate (2nos between the cavity and the fuel pool) and sluice gate 1 nos between the cask pit and the fuel pool.
- xi. For handling equipment to and from the reactor building, there is trolley at elevation +31.700m elevation. This trolley is electrical operated trolley mounted on rails.

The detailed technical specification of the equipments covered under this section is explained in three sections, viz.,

- a) Erection of fuel Pool rack, rack support, shock absorber and sluice gate.
- b) Erection of Refueling machine and its accessories.
- c) Erection of skip transfer trolley.

3.1 Erection of fuel Pool rack , rack support, shock absorber and sluice gate:

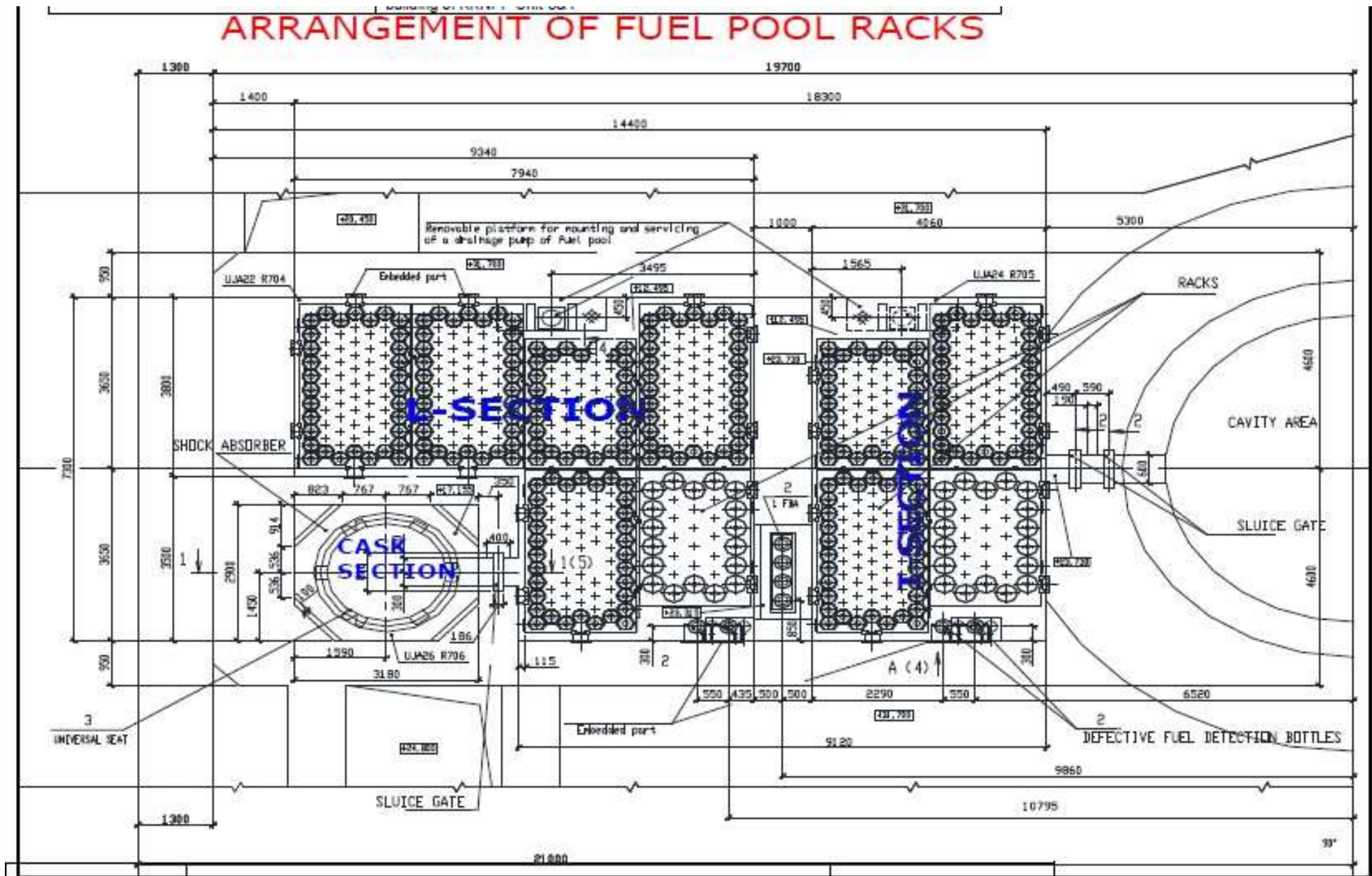
3.1.1 Erection of fuel Pool rack & rack support:

- i. Rack support is a frame work supporting the fuel pool racks, which will seat on the embedded parts inside the fuel pool at elevation +12.495m
- ii. Prior to erection, survey shall be made on the embedded parts for flatness, elevation and location. This shall be made using optical survey instruments such as auto level, total station and master level, etc.,
- iii. The readings shall be compared with the erection reports submitted by other agencies If any deviation found the same shall be brought to the notice of BHEL & NPCIL for deciding the corrective action.
- iv. Horizontality of the seating area of the rack shall be within 1mm until unless it is specified.

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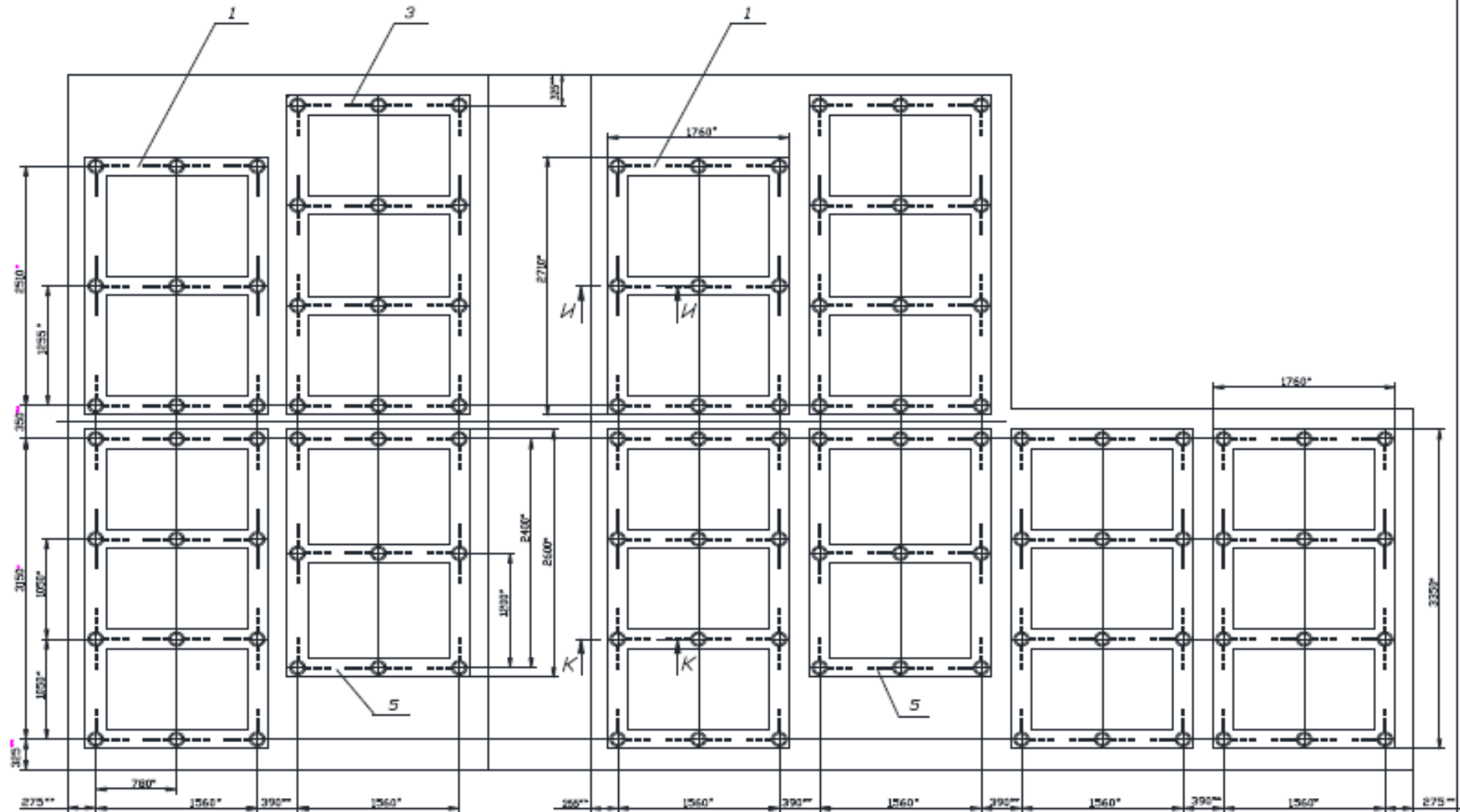
- v. After completion of survey, the readings shall be plotted to the as built drawings, which shall be used while erecting the rack supports.
- vi. Handling, transportation and shifting of rack supports to the location.
- vii. Polar crane will be provided by NPCIL for handling of rack supports inside the reactor building for erection, alignment and other works.
- viii. Rack supports shall be erected in position as per the sequence, alignment shall be done as per the working drawings.
- ix. Since the embedded structure supporting the rack supports is a welded structure there is an every possibility for undulation in the seating area of the rack support. If any gap is observed under the seating area and the rack support legs, shim plates shall be provided.
- x. On acceptance of erection and alignment of supports, welding shall be carried out using GTAW process.
- xi. Rack supports are provided with screw type sleeves on the top face for supporting the racks.
- xii. Elevation of these sleeves can be adjusted by screwing and unscrewing. Using this facility top face of all the sleeves of rack supports shall be brought to the same level. Carry out optical survey.
- xiii. Since rack supports are not accessible after erection of racks, all the works related to supports shall be finished in all respects before proceeding for erection of racks. As built details shall be submitted for acceptance and clearance shall be obtained for erection of racks.

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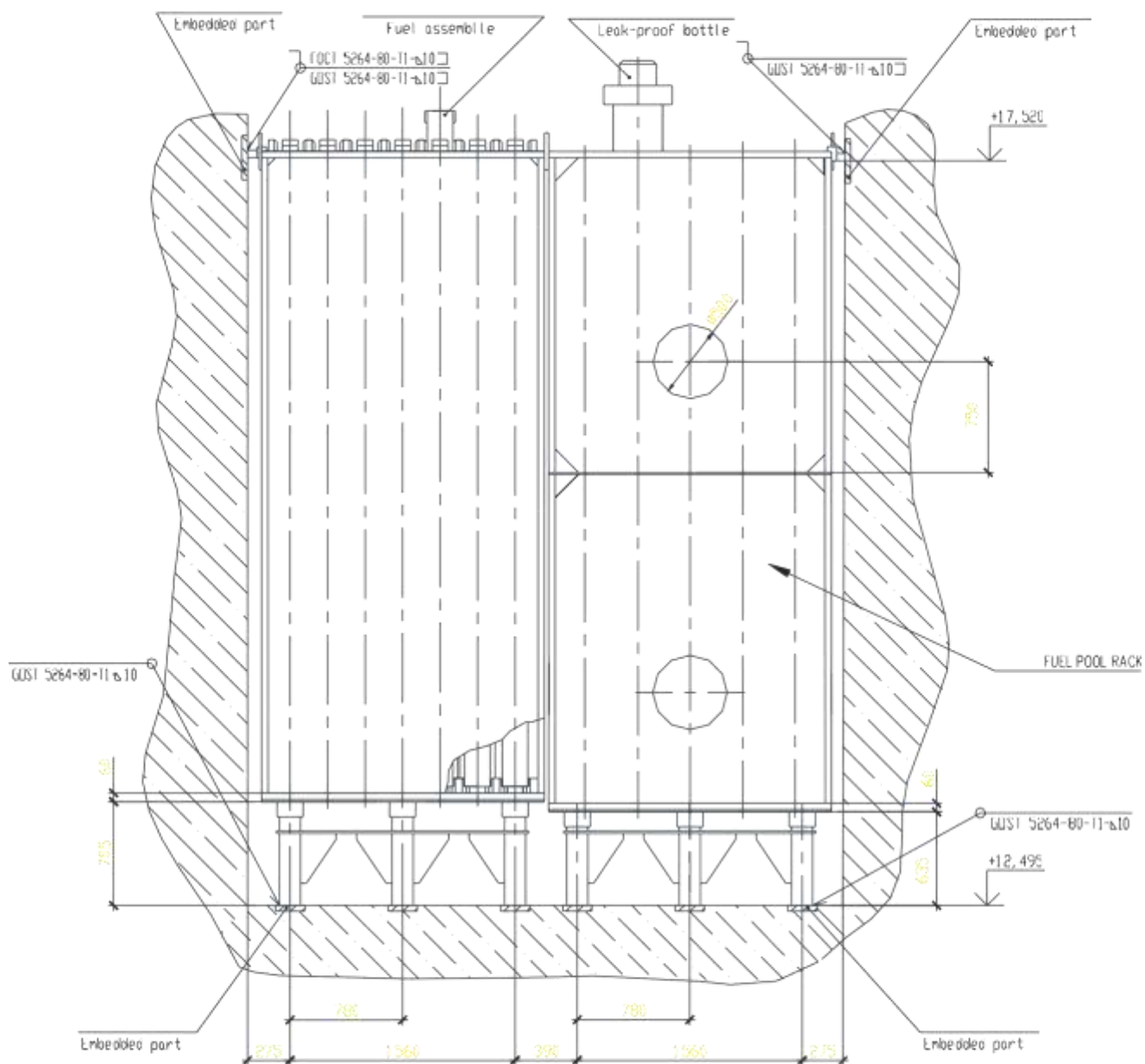
TECHNICAL CONDITIONS OF CONTRACT (TCC)

ARRANGEMENT OF RACK SUPPORT



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SECTIONAL VIEW OF RACK AND RACK SUPPORT



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- xiv. De-preservation of Racks:
 - a. Racks are used for storing the spent fuel and this component erection and preservation is considered as a critical, hence corrosion and contamination are not permitted.
 - b. The grease applied over the racks shall be removed and cleaned with acetone, before transporting to the Reactor building for erection. The removal of grease and subsequent passivation if required shall be done in a closed dust free facility.
- xv. Rack shall be shifted to +31.700 m floor, and shall be lowered to position using polar crane. Before lowering the rack into position, place soft material such as lead / clay to ensure the surface contact between the support and rack.
- xvi. Racks are provided with a hollow sleeve in the bottom for engaging over the screw arrangement provided on the support. During erection, support screw shall enter into the rack sleeve.
- xvii. On completion of lowering of rack over support, check the horizontality of the racks at four corners. Lift the rack and check the surface contact between the rack and the supports from the impression on the soft material for all the position of the sleeves. It shall be ensured that all the sleeves shall have uniform contact with the rack. In case of any unevenness, threaded sleeve shall be adjusted to ensure the horizontality within 1mm of the racks.
- xviii. For attaining this alignment, multiple handling of these racks may be required. Bidder shall consider this factor during submission quote. No additional payment will be made for repeated handling for alignment.
- xix. The gaps between the adjacent racks shall be within the acceptable limits as specified in the drawing. The same shall be achieved by inserting guides.
- xx. Final survey of all the racks shall be made for checking horizontality, elevation and clearances. On acceptance of erection, the guide shall be welded.
- xxi. The gap between the guide plates is very important dimension to be maintained. i.e. within 3mm.
- xxii. Final as built shall be prepared and submit for acceptance.
- xxiii. All dimensions quoted above are for preliminary information to the bidder. Actual dimensions mentions in the approved drawings shall be met during erection.

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xxiv. Post Erection cleaning:

- a. On completion of erection and welding works, final cleaning shall be taken on all the racks and clearance shall be obtained before handing over to NPCIL. The rate quoted shall be inclusive of these cleaning works. Such cleaning may require lifting of racks from the position, cleaning the surface of the racks thoroughly using detergent and water jet etc.
- b. Placing back the racks in the desired position after cleaning, preparation of reports and submission for acceptance.
- c. Cleaning of the racks shall be carried out after fill test.

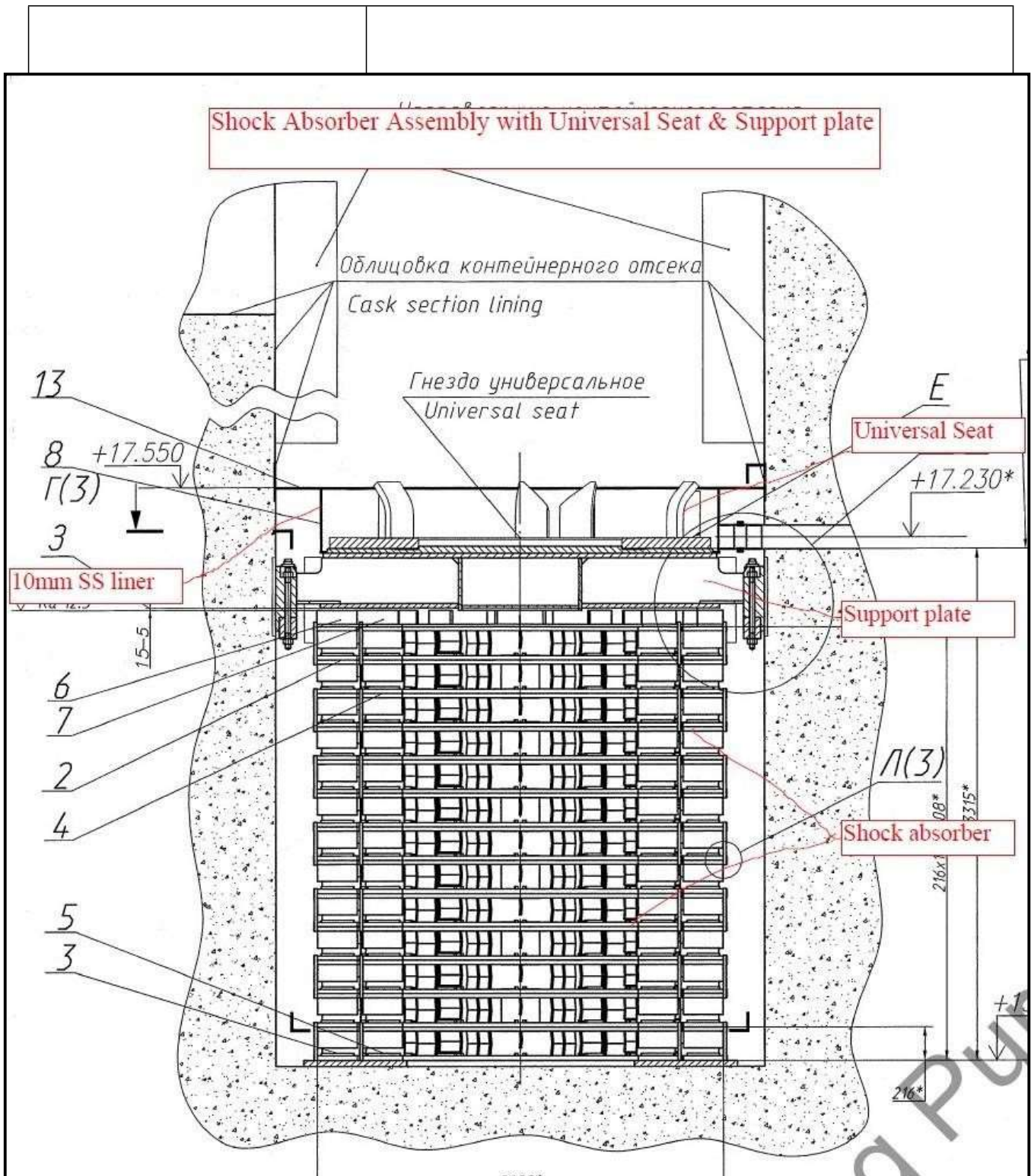
3.1.2 Erection of Universal Seat and Shock absorber:

- i. Shock-absorber of the spent fuel pool cask section is intended for reduction of loads on the transport jacket, transfer package with spent nuclear fuel and on structural units of the spent fuel pool to allowable values in case of failure of handling mechanism.
- ii. An assembly drawing of the shock absorber with universal seat is given below. The main parts of shock absorber consist of shock absorber assembly, support & universal seat.
- iii. The shock-absorber is a multi-layer structure consisting of inside and outside dampers installed onto the carbon steel ring embedded part.
- iv. Support plate assembly is a welded structure including the upper plate and the lower plate connected to each other by means of ribs and a ring. An adjustment plate made of stainless steel is put on the upper plate and welded to it.
- v. Support plate also consists of bushings having threaded holes M48 at the upper end and coaxial guides with cylindrical holes of Dia 40mm at the lower end at the ends of the ribs.
- vi. Universal seat is a welded structure, which is seated on the support plate and is welded to support plate.
- vii. Prior to start of any erection work, survey of embedded parts i.e. Bottom embedded part and the vertical embedded parts using total station and any other instrument with required accuracy and least count. Elevation, horizontality and verticality shall be measured, if these values are beyond the acceptable limits, the same shall be machined locally to achieve the required values. flatness of the embedded parts shall be 0.5mm until unless it is specified in the drawing.

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- viii. Bottom embedded parts are carbon steel member. After complete survey the same shall be painted with OC51-03 paint.
- ix. Once the embedded parts as built is accepted, assembly of the inner sections and the outer sections shall be made outside the reactor building and stitch welding between the sections shall be performed as per the requirements.
- x. After completion of welding and inspection, the shock absorber assembly shall be lifted & shifted to RB, and placed on the bottom embedded part. Align the shock absorber assembly for verticality and horizontality, welding using SMAW process and inspection.
- xi. Handling, shifting, lowering of support over the shock absorber, alignment of support, locking the support with temporary jack bolts.
- xii. Mark guide plate positions on the vertical embedded parts, handling, shifting, and erection of support plate guide plates in position, fit up and alignment of guide plates. Based on the site condition, this work includes machining of guide plates / providing addition shim for maintaining the necessary clearance between the guide plates and support.
- xiii. Release of temporary jack bolts of support plate, lifting out from position and carrying out welding of guide plates over the embedded parts and inspection.
- xiv. Based on the position of the guide plate the gap between the support plate bottom and the shock absorber top shall be measured. The gap shall be as per the measurement provided in the working drawing. It shall be around 15mm until unless it is specified in the drawing.
- xv. If the gap is less than the required, the ribs on the shock absorber shall be grounded. Scope includes the grinding work also.
- xvi. Handling, shifting and erection of universal seat over the support plate.
- xvii. Alignment of universal seat with the match marking provided on support plate, fit up and welding of universal seat with the support plate.
- xviii. Erection of 10mm stainless steel liner around the universal seat. Welding of liner with the support and the wall vertical embedded parts, inspection and NDEs shall be carried.
- xix. Leak tightness of the shock absorber compartment shall be carried by provision made on the liner. Upon completion of the tightness test, welding & inspection of the plug shall be carried out as per requirement.
- xx. This work also includes erection of other accessories such as bellow & pipe spools.

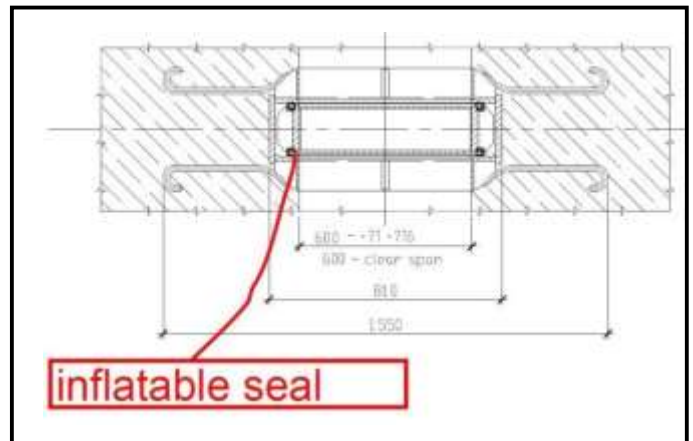
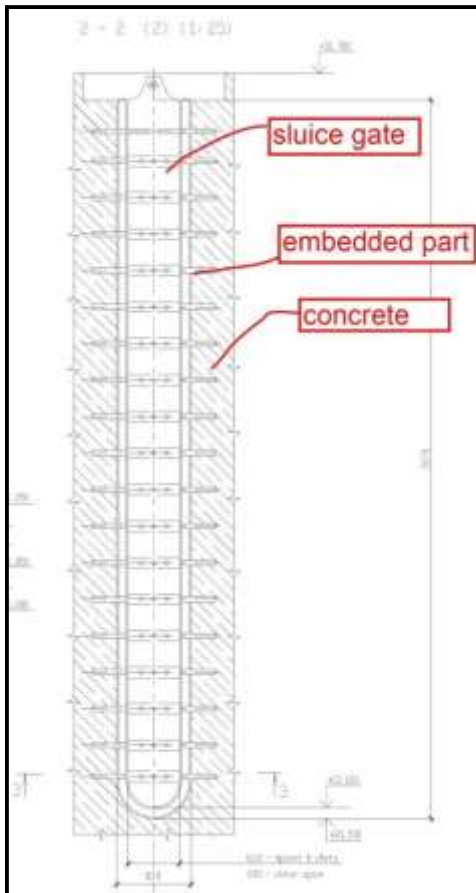
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3.1.3 Erection of sluice gate:

- a) Sluice gate is a vertical gate, with inflatable seal around the circumference; there are total 3 nos of sluice gate. 2nos between the fuel pool & cavity and 1 nos between cask room & fuel pool.
- b) General arrangement of the sluice gate is as given below.



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- c) Cutting of temporary locks of the embedded part and cleaning the embedded part thoroughly using acetone.
- d) Survey of embedded part for verticality, parallelism etc and the check the readings with the post pour report.
- e) Any deviations observed shall be records and necessary corrective actions shall be taken with concurrence of BHEL& NPCIL.
- f) Handling and shifting of sluice gate to the location and lowering the gate without seal into the embedded part and check for seal clearances and compare with the requirements specified in the working drawing.
- g) Lifting the gate from the position and assembly of inflatable seal (1nos on either side) to the groove of gate using adhesive supplied by the manufacturer and leave for sufficient time for dwelling of adhesive.
- h) Assembly of pneumatic panel over the gate that connects the tube from the panel to the seal.
- i) Handling and erection of gate with seal.
- j) Pressurizing the seal using compressed air through pneumatic control panel to a pressure of as mentioned in the working drawing and check for leak tightness. Any leak at connections observed shall be attended and re-test shall be conducted for satisfactory results.

3.2 Erection of refueling machine:

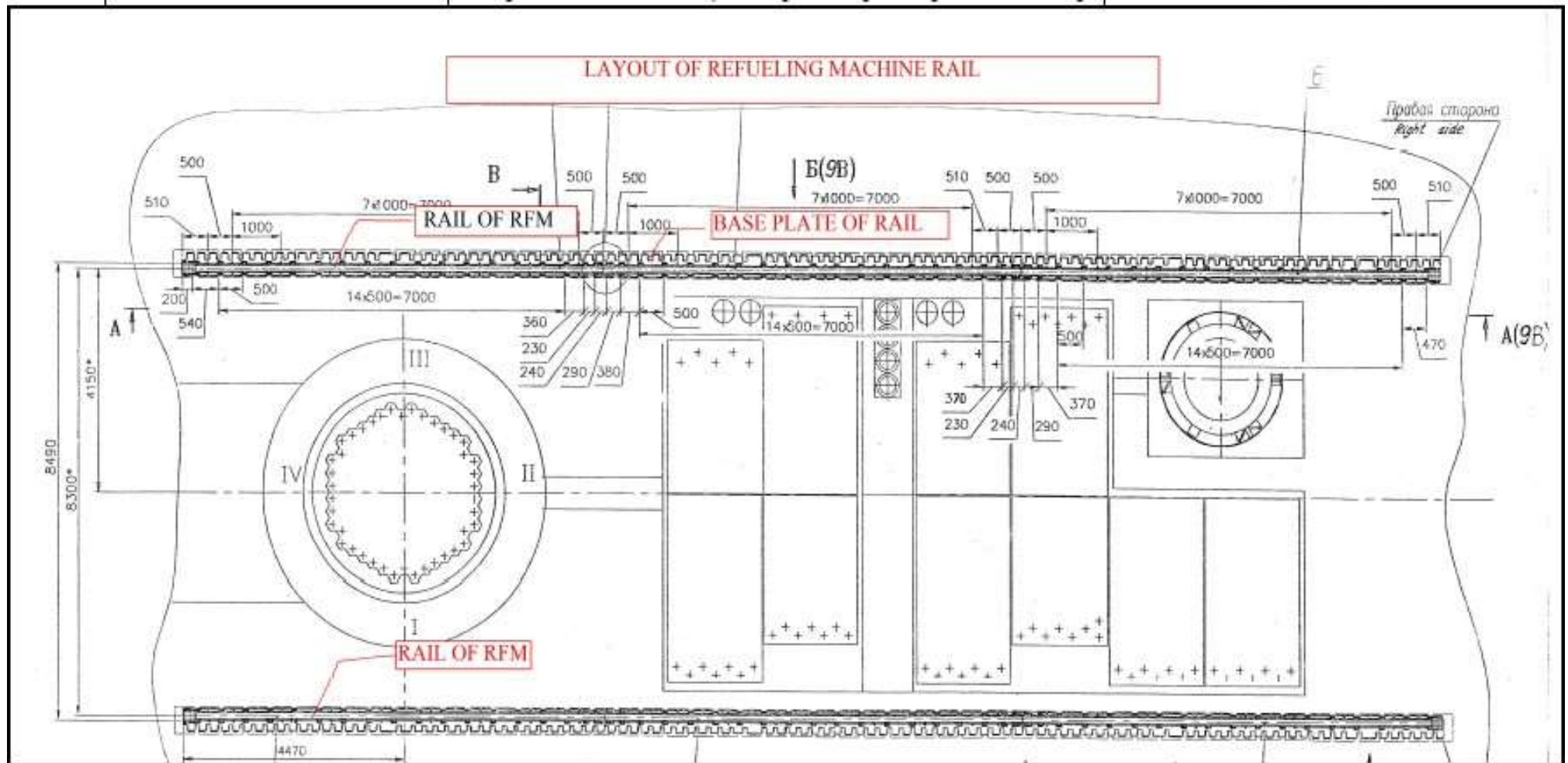
- i. Refueling Machine (RFM) is used for handling fuel assemblies from the reactor to fuel pool and vice versa.
- ii. RFM moves on rails which are erected in 0-180 direction, at elevation +31.7000m and will move in Cartesian directions for handling the fuel and can reach any position of rack in the fuel pool.
- iii. Erection of RFM consists assembly and erection of following,
 - a) Erection of rail
 - b) Erection of Bridge beams.
 - c) Erection of Trolley with rotating platform
 - d) Erection of main mast and drive assembly.
 - e) Erection of TV mast.
 - f) Erection of electrical, control panels on the bridge.
 - g) Erection of electrical and control panels in the RFM control room.
 - h) Erection of ancillaries such as cable chain, limit switches, mechanical locks, encoders etc.

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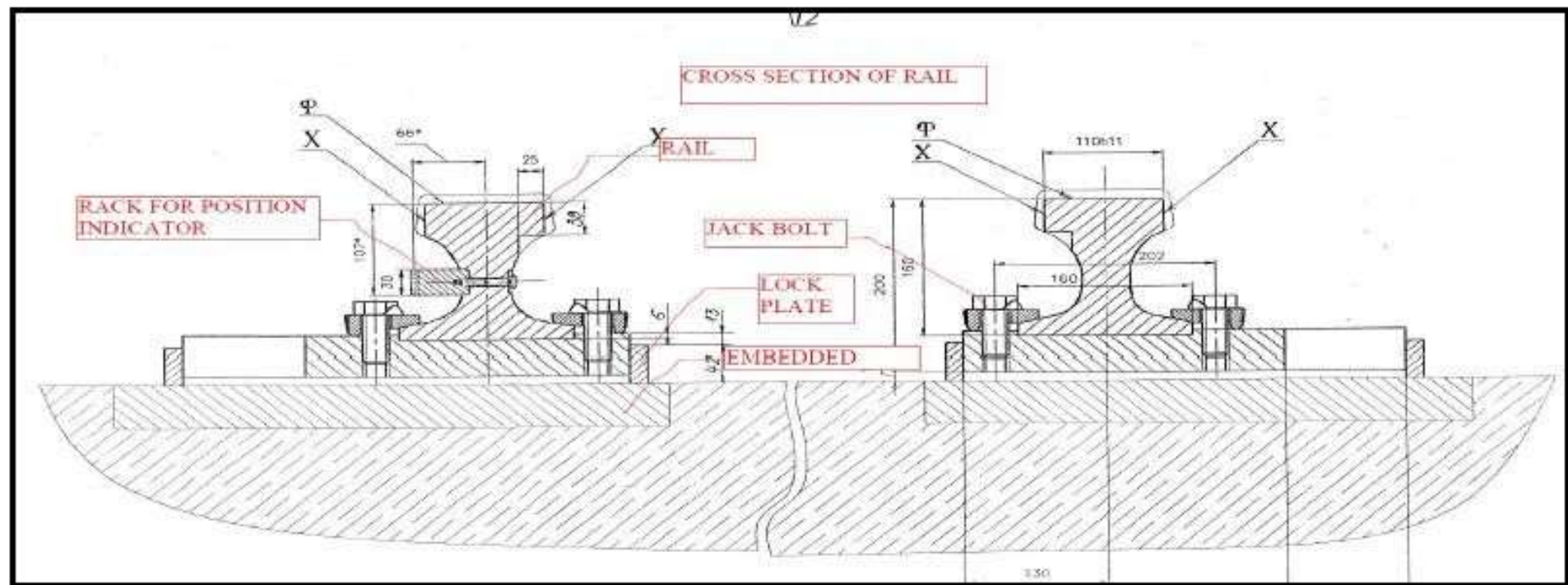
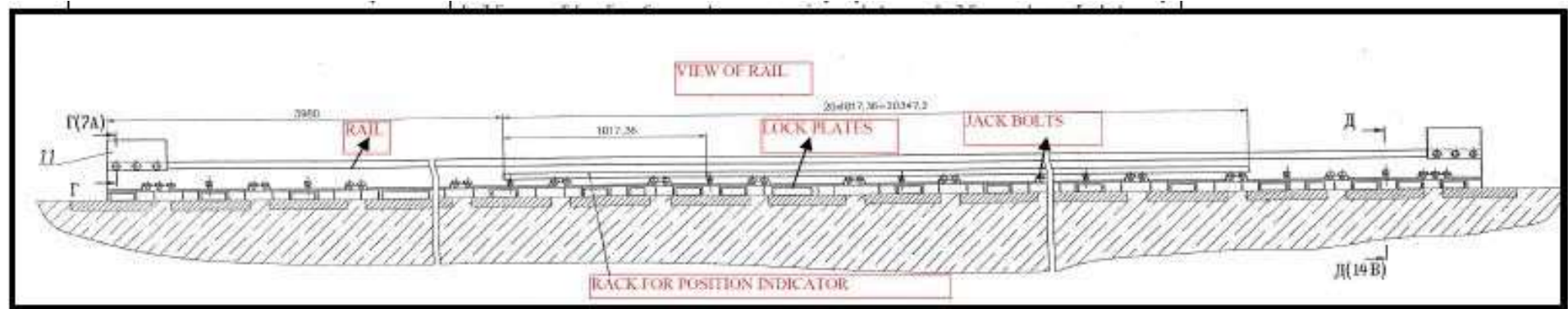
3.2.1 Erection of Rail:

- i. Prior to erection of rail, survey of rail embedded parts shall be made using total station and other optical survey instruments.
- ii. Compare the readings with the post pour report of these embedded parts for elevation & horizontality readings.
- iii. Rail assembly is supplied in three segments on either side of the fuel pool.
- iv. Each rail segment is supplied in assembled form with the base plate by means of fasteners.
- v. Base plates are provided with jack screws at different locations throughout the length of the rail. These jack screws are used to adjust the elevation of the rail.
- vi. All the rail segments shall be placed in position and alignment shall be made as per the requirements given in the respective working drawings. Some of the requirements are as given below,
 - a) Surface differential of the abutting rail ends in the horizontal and vertical ends shall not exceed 0.15mm..
 - b) Non linearity of the rail along the length and along the sides shall not exceed 0.5mm over the length of 4meter. This shall be checked and ensured using auto level & jig transit.
 - c) The clearances between the rails shall not exceed 0.3mm.
 - d) Surfaces of the rails shall lie in same plane; non flatness shall not exceed 0.8mm over the length of 9meter.
- vii. On completion of erection & alignment and acceptance of the rail fit up and welding of lock plates shall be performed. Lock plates are provided on the side ways of the base plate.
- viii. NDEs shall be carried out
- ix. On completion of erection & acceptance of rail, rack installation on side face of rail shall be carried out. This rack is used for monitoring the position of the RFM & hence this is one of the most important parts of RFM.
- x. During the erection of rack, pitch and non linearity of the rack shall be checked and ensured. Linearity deviation shall not be exceed 0.1mm throughout the length of 1meter, teeth pitch at the connection end shall not exceed +/- 0.04mm.
- xi. Non parallelism of the rack with respect to the surface shall not exceed 0.2mm.
- xii. On completion of all the activities & inspection etc, as built and reports shall be submitted for acceptance and clearance shall be obtained for erection of RFM.

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3.2.2 Erection of Bridge:

- i. Handling & shifting of bridge inside reactor building, place the bridge parts on the rail and both parts shall be coupled and fastened. During erection care shall be taken for aligning the wheels of the bridge with rail.
- ii. During coupling of bridge assembly, temporary support shall be made for retaining two halves of the bridge in horizontal position; scope also includes arranging temporary supports & any such arrangements required.
- iii. Bridge assembly shall be fixed using dowel blocks provided over the mating flanges.
- iv. Fastening of bridge shall be done to required torque using hydraulic torque wrench. Arrangement of such tools and torque wrenches shall be made by contractor.

3.2.3 Erection of Trolley and Rotating platform :

- i. Trolley is mounted on the bridge assembly, where trolley moves in the transverse direction to the direction of Bridge movement. Rail arrangement has been provided on the bridge assembly for movement of trolley. Rail assembly over the bridge for trolley may be supplied in pre-assembled form, in case supplied in loose condition; scope includes assembly of rail over the bridge assembly for the trolley.
- ii. Survey of the trolley rail shall be made for horizontality and parallelism and cross checked with the manufacturer documentation.
- iii. Trolley is supplied in pre assembled form, where as other mechanisms such as rotating platform, working mast, TV mast, electrical panel, guards etc are supplied as separate parts. These parts are to be assembled at site.
- iv. A temporary support shall be fabricated and placed on +31.7m operating floor to assemble the trolley and the rotating platform. Bidder shall consider supply and fabrication of the temporary platform in the quoted rate.
- v. Shifting the trolley assembly to +31.7m floor and placing the trolley on the temporary support.
- vi. Handling and shifting the rotating platform to the location, placing this below the trolley assembly, assembling the rotating platform with the trolley using fasteners to required torque.
- vii. Handling and assembly of drive mechanism for rotary platform over the trolley.
- viii. Trolley is provided with seismic brackets with guide roller assembly (stoppers) to retain in position during emergencies. These brackets with complete wheel

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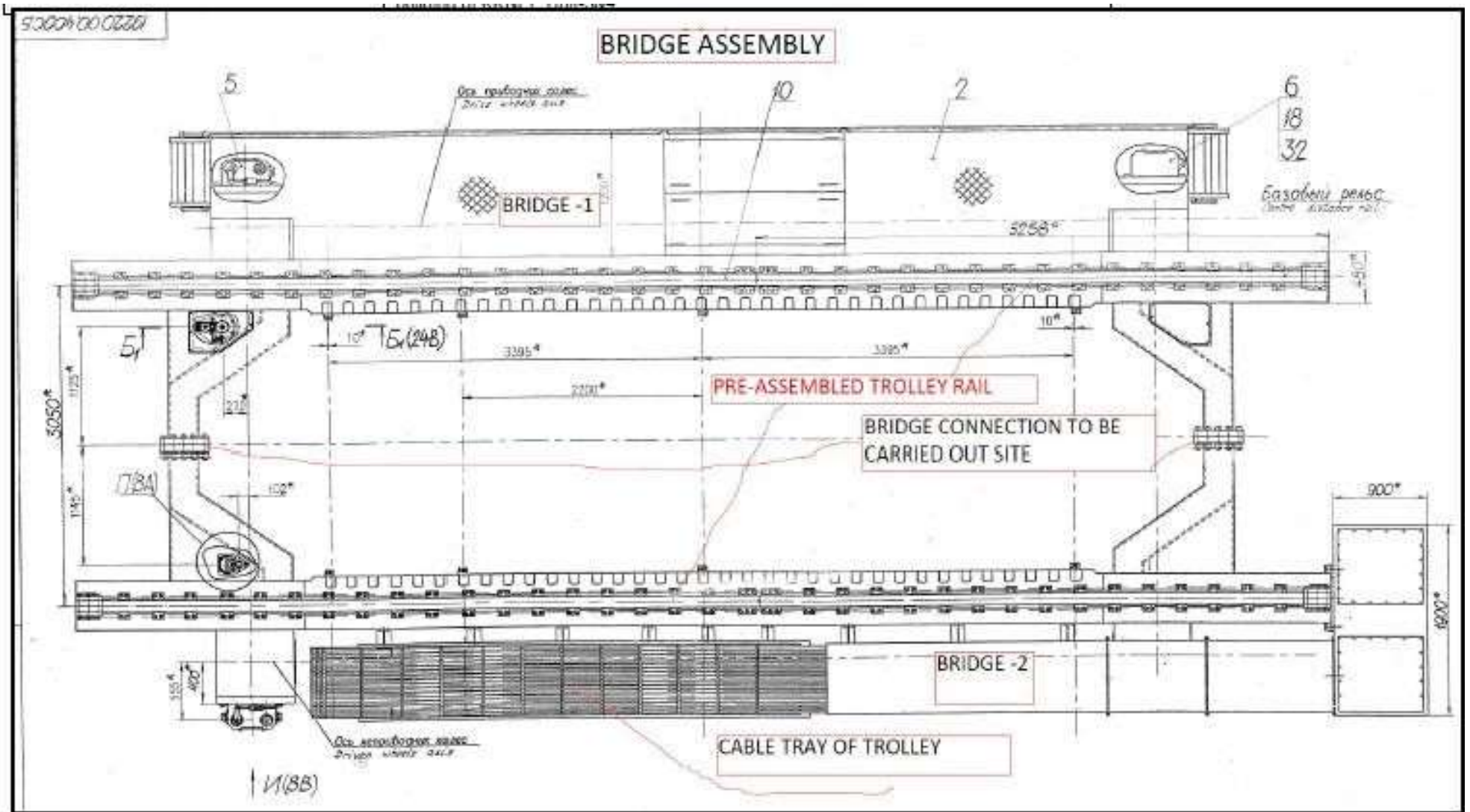
assembly are needed to be dismantled before taking up erection works from any one side of the trolley.

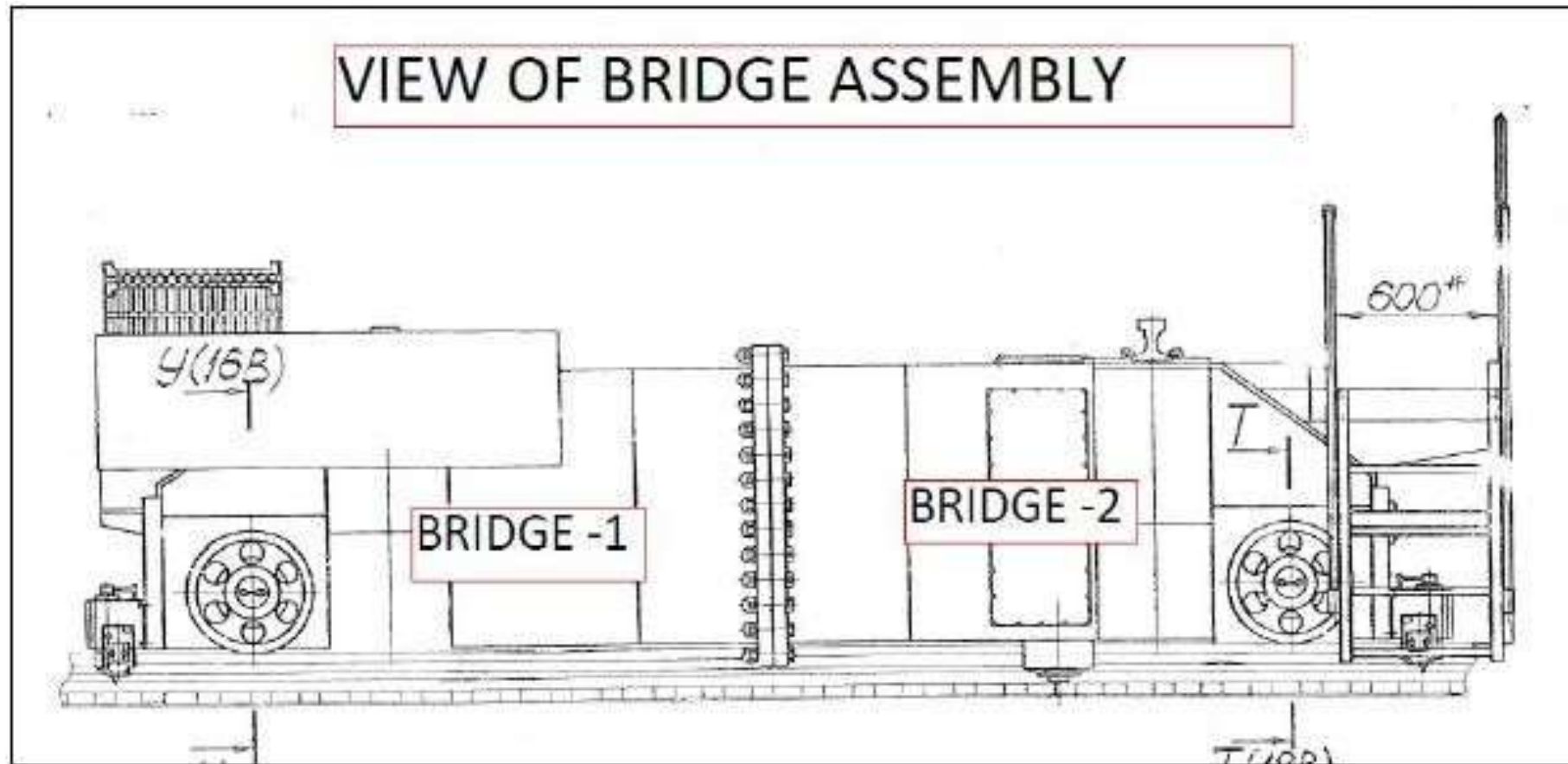
- ix. Placing the trolley assembly over the rails on the bridge. Assembling back the wheel assembly with seismic bracket to position.

3.2.4 Erection of Working mast and TV mast:

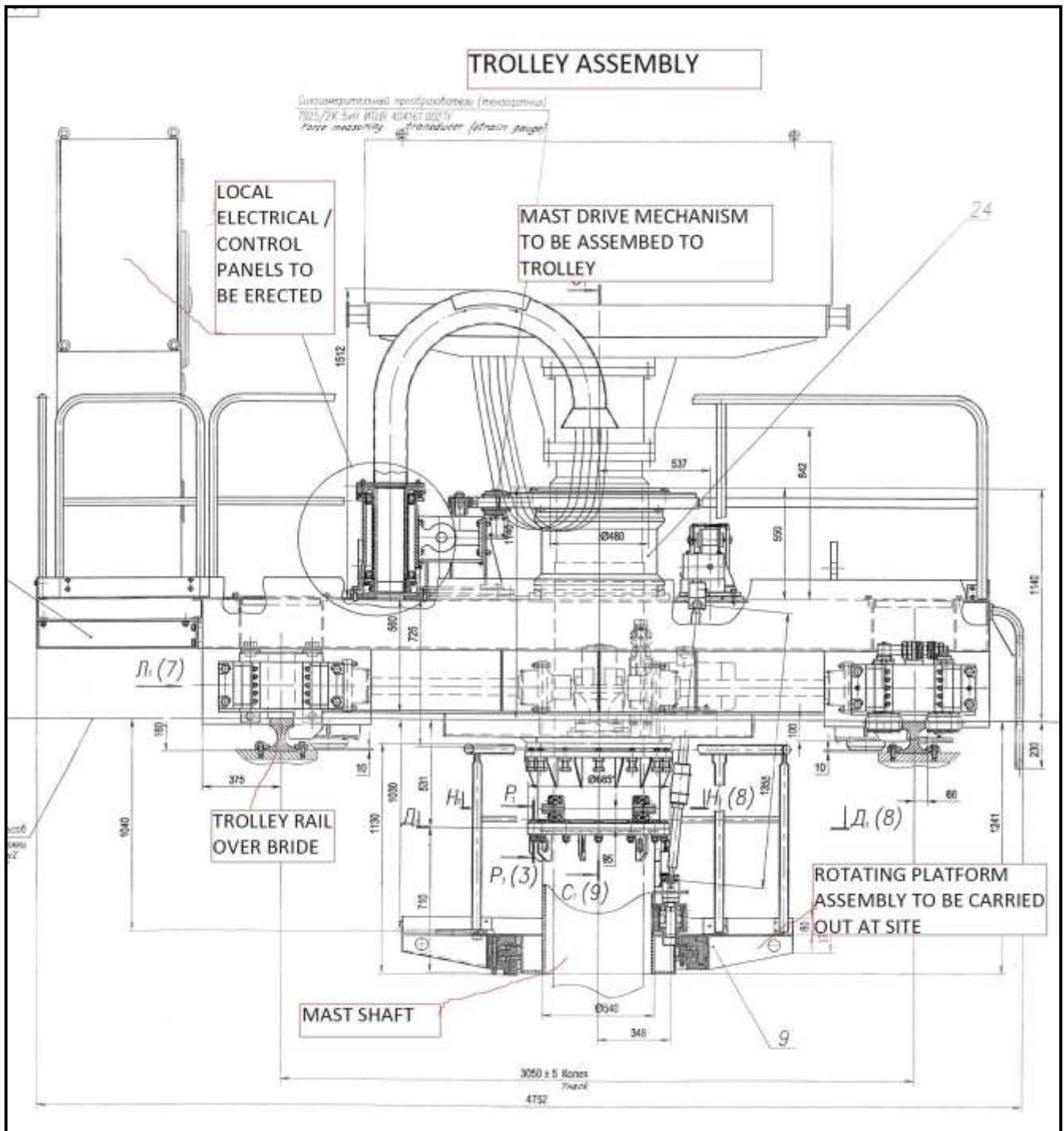
- i. Working mast is a tubular and a telescopic member which houses cluster mechanism which is used to handle the fuel bundle during loading and unloading. This working mast is a pre assembled item which is to be directly erected on the trolley.
- ii. TV mast is also a tubular and telescopic member which also moves in parallel with working mast, which is used to monitor the activity. TV mast is also a preassembled item which is to be erected on the trolley.
- iii. Shifting and erection of working mast in desired position with the help of key, which fixed to mast before erection locking as per drawing.
- iv. Handling and erection of drive mechanism of working mast, assembling the drive mechanism with the working mast engaging the drive rope of the working mast with the mechanism. Working mast travel mechanism is 2.67MT, and working mast is 3.7MT of 10m in length and Dia 413mm.
- v. Handling and erection of camera mechanism, which is to assembled with the provision made on the trolley. Once the camera mechanism is placed in position, the same shall be fastened in to trolley with required torque.
- vi. This work also includes handling and assembly of accessories of the main mast such as tubing, engaging the drive ropes of mast with the drive mechanism, cable termination of TV mast camera to the mast junction box.
- vii. All these members are very sensitive in nature; at most precautions shall be taken during handling of these items.

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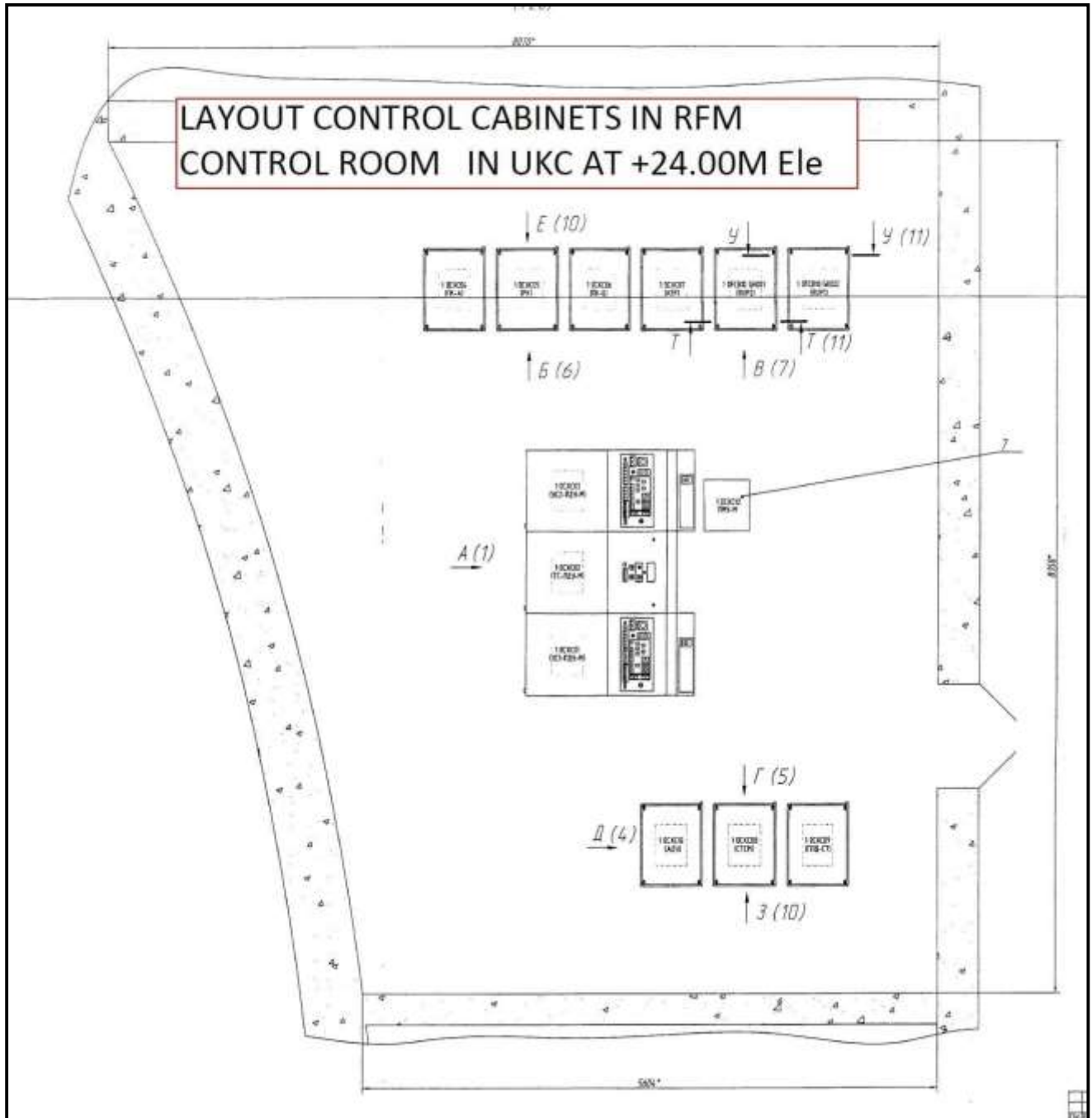


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3.2.5 Erection of accessories:

- i. RFM Accessories include cabinet (local and control room), cable travelling tray of the refueling machine bridge, trolley cable travelling tray, guards, seismic locks, limit switches with actuators etc.
- ii. Handling, shifting and erection of electrical / instrumentation cabinet over erected trolley and fastening of the cabinet with the trolley to required torque. One cabinet is located on the trolley and the other panel is located at +31.700m elevation on east of RFM.
- iii. Handling and shifting of electrical & control panels of RFM inside RFM control room in UKC at approx 24.000m elevation. Typical layout of the panels is shown in the sketch given below.
- iv. Cable chain of trolley and bridge assembly will be supplied separately. Handling and erection of cable and fastening of cable chain of trolley.
- v. Handling, erection of cable chain of bridge assembly along with the support rollers and guide angles. Guide angles shall be welded to the embedded parts over +31.700m elevation.
- vi. Deployment of qualified electrician / wire men for carrying out wiring of RFM from local panels to the control room panels.
- vii. Handling, shifting and carrying out cable laying and termination as per working drawing. For detailed scope of work involved in cabling refer Technical specification for protective rolling gate.
- viii. Handling and assembly of seismic locks to the bridge assembly and trolley. (2nos each for bridge and trolley)
- ix. Handling and assembly of encoders, limit switches with brackets and actuator blocks.

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3.3 Erection & commissioning of transportation trolley and Rail:

- i. Skip transfer trolley is used to transport the material from outside the reactor building to inside reactor building and vice versa.
- ii. In order to avoid any delay in shifting material to reactor building , trolley shall be erected immediately after the erection of transport air lock.
- iii. Material over the trolley will be loaded using trestle crane and other outside crane.
- iv. Trolley moves on the rail which is fastened to the embedded parts on +31.7m elevation, portion of rail on the transport air lock & balance portion of the rail mounted on the trestle beam.

3.3.1 Erection of Rail:

- i. Rails are supplied in segments, and are supplied in assembled condition with the shoes.
- ii. Near the rolling gate rail segment is supplied as a hinged assembly, where rail can be lifted when the gate in closed position. Scope includes erection of this assembly with all the accessories.
- iii. Prior to erection of the rail segments, complete survey of the platform and the embedded parts shall be made where rail is seated. And the obtained readings shall be compared with the post pour readings, any deviations observed shall be brought to the notice of BHEL& NPCIL, and necessary corrective actions shall be taken with concurrence from NPCIL.
- iv. Rails shall be shifted and placed in the designed position and alignment shall be made. Unless specified following are the tolerances to be considered during erection of the rail
 - Gaps between the adjacent rails shall not exceed 1mm.
 - Irregularity of the surfaces of the abutting edges of the rail shall not exceed 0.5mm.
 - Deviation from the horizontal line of the rail common surface shall not exceed 1mm.
 - Slope of the rail surface shall not exceed 1mm per 1meter length.
- v. In achieving the above tolerances there may requirement for erection of shim plates between the rail shoes and the base structure or embedded part.
- vi. Handling, erection & Alignment of the rail and fitup of rail with the embedded parts.

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- vii. Survey and prepare the alignment report for acceptance before proceeding for welding, carrying out welding using SMAW and carrying out inspection as per working drawing.

3.3.2 Erection of Trolley and accessories:

- i. Handling and erection of trolley assembly over the rail, assembly of seismic brackets to the trolley.
- ii. Free movement of the trolley shall be checked by pushing and pulling the trolley manually.
- iii. Checking the functionality of lock assembly manually, to ensure the stopping of trolley in desired position with the help of brake and locking mechanism.
- iv. Handling, Shifting and erection of power supply panels and local control panels.
- v. Carrying out electrical wiring from the local control panel to the main supply panel, trolley to the local control panel after erection of trolley.
- vi. For specification and requirements of cabling and commissioning of the trolley refer technical specification for protective rolling gate.

4. Reports and Records:

- i. Necessary erection reports, as built drawings shall be prepared as per the established work procedures.
- ii. All stages erection reports with as built shall be submitted to manufacturer representative for obtaining the clearance for proceeding for next stage of work. To avoid any kind of delay in succeeding activities, all the reports shall be prepared in parallel to the work.
- iii. Welding inspection reports and NDE reports shall be prepared and submitted for acceptance.
- iv. All commissioning reports with check lists as per the approved procedures shall be prepared and submitted for acceptance.

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2.2.17 TECHNICAL SPECIFICATION FOR HANDLING, ASSEMBLY, WELDING, ERECTION, TESTING AND COMMISSIONING OF PROTECTIVE ROLLING GATE

Sr No	Description
1	Purpose
2	Scope
3	Scope of work in detail
3.1	General Information
3.2	Pre-erection activities
3.3	Erection of Rail
3.4	Assembly & erection of protective rolling gate
3.5	Electrical works
3.6	Commissioning of gates
4	Reports and Records

1. Purpose:

Purpose of this specification is to provide guidance to contractor to understand the scope, quantum of work and technical requirements to be followed during handling, transportation, assembly of the rollers with the leafs (gate) at ground and handling, assistance during filling of concrete in leafs, erection, fit up, alignment, welding, inspection and commissioning of protective rolling gate at reactor building portal (UJG).

2. Brief Scope of Work:

The scope of the contractor's work comprises but not limited to the following.

- i. Study of drawings, preparation of network schedules.
- ii. Preparation and approval of QAP, erection, welding and inspection procedures.
- iii. Handling, transportation, uncrating, preparation of IMIR (incoming material inspection report), de-preservation, storage of received components, preparation of IMIR.
- iv. Shifting the Rolling gate leafs to the crane pad area, releasing for concreting, closing the holes provided for the concreting by welding.
- v. Arranging scaffoldings, survey of embedded parts, checking the horizontality and the verticality of the embedded parts, any deviation found shall be rectified.
- vi. Handling and erection of bottom rails for supporting the rolling gate.
- vii. Assemble the wheels of the gate using the fasteners, lifting the gate using NPCIL crane erection in position, locking the gate using temporary supports.

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- viii. Erection of guides, fit up, welding and inspection.
- ix. Releasing the temporary supports, locks provided for the gate.
- x. Commissioning the gate as per the working drawings / manufacturer instructions.
- xi. Preparation of the reports and submission for acceptance.

3. Scope of work in detail:

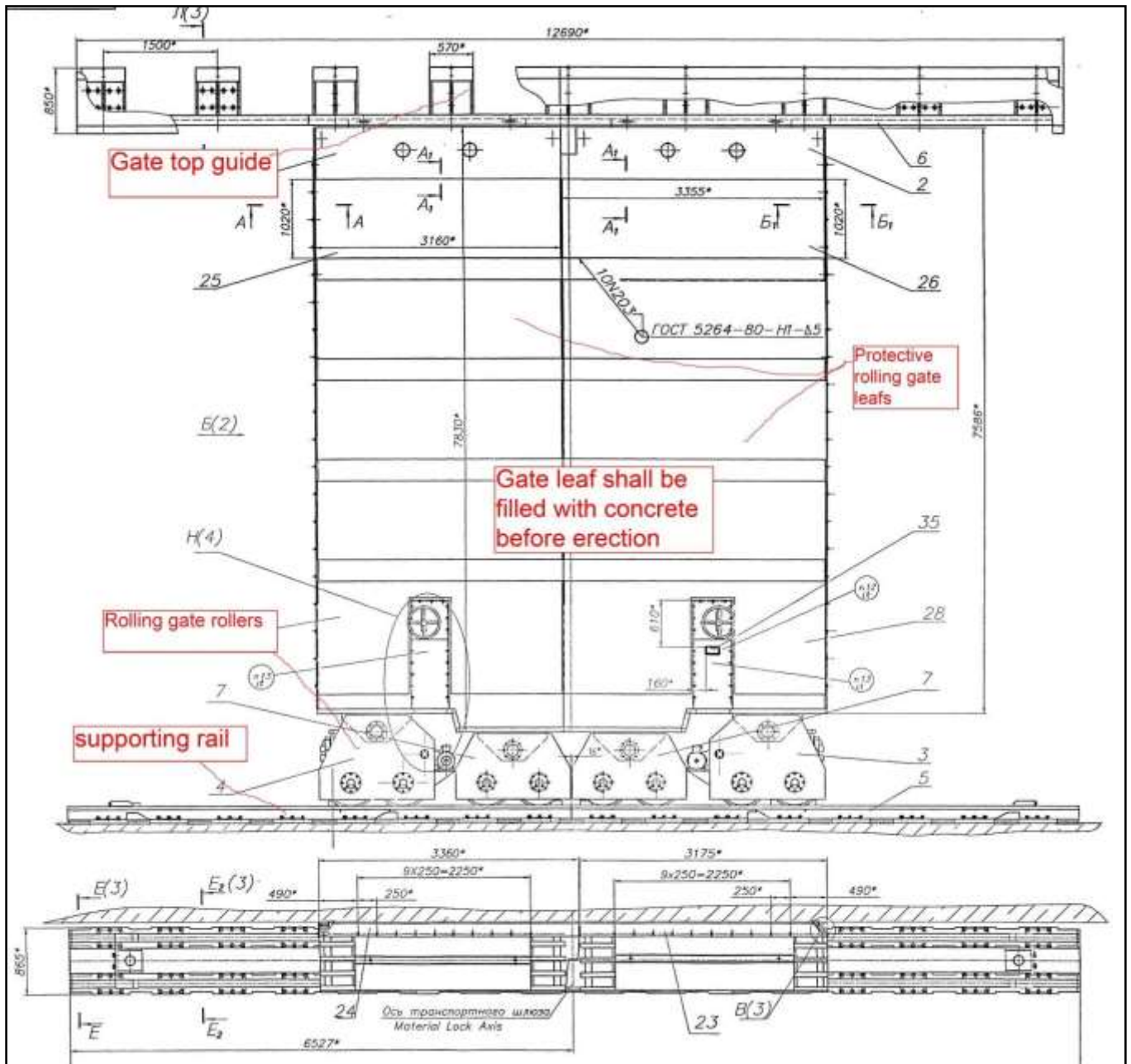
3.1 General information:

- i. Protective rolling gate consists of two leafs of rolling type on either side.
These leafs are provided with pair of wheels with electrical motors.
- ii. Pair of rails are provided beneath the leafs for supporting the gate and for guiding the gate during rolling, the top portion is provided with guided. Top guide is fixed to the embedded parts on the wall.
- iii. Bottom rail is supported by embedded parts mounted on the floor at (+) 29.3m elevation of UJG.
- iv. The technical parameter and details of rolling gate is given in table.

S No	Description	Weight in Kgs	Remarks
1	Gate leaf without concrete (2nos)	34000	
2	Gate leaf with concrete	16000	
3	Rail weight	7080	
4	Drive carriage (2x4233)	8466	
5	Guide	5047	
6	Carriage	3480	

- v. Construction details of the gate are given in the sketch below.

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3.2 Pre-Erection activities:

- i. Install scaffolding for survey of EPs and erection & welding of rolling gate, scaffolding erection shall be carried out higher elevation above the portal platform at +31.7m elevation.
- ii. All workers shall examine and certified for working at height. Barricading the work spot and providing screen for preventing falling of objects from height.
- iii. Protective rolling gate is supported by rail and the guide which in turn rail is supported by embedded part in floor at +29.300m elevation and guide is supported by embedded part in wall.
- iv. Survey of the embedded parts for horizontality and the verticality of both rail embedded parts on floor and the guide embedded parts on the wall and the same shall be compared with the post pour readings.
- v. In case any deviation observed in the embedded parts, the same shall be brought to the notice of the BHEL & NPCIL and the corrective action shall be taken. Scope includes correction of embedded parts by grinding.
- vi. Gate leafs are supported by guides and roller arrangement at the top. These guides are connected to the embedded parts in the wall by connecting legs. Due to deviation in the embedded part levels, these connecting legs are needed to be modified to maintain the parallelism between the guide and the bottom rail. Scope of includes such modification of the connecting legs.

3.3 Erection of Rail:

- i. Cleaning the rail seating area, marking the location as per the survey marks.
- ii. Rail assembly i.e. two rails in parallel in pre-assembled form Lifting and placing of rail tracks on the embedded parts. Aligning the rail tracks. For maintaining in parallel with the wall. Providing necessary shim plates for maintaining the elevation of the rail.
- iii. Fit up and welding of rail in the finalized location, carrying of required NDEs. At most care shall be taken during welding of the rail in order to maintain the horizontality specified in the working drawing.

3.4 Assembly & Erection of protective rolling gate:

- i. Gate Leaves are metal box-type structures and shall be filled with heavy concrete at crane pad outside reactor building at ground floor. Each leaf shall be assembled with two carriages (wheel drives), one of which is provided with electromechanical drive and manual leaf displacement drive.

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- ii. On drive of carriages is located stopping mechanism, designated for prevention of gate leaf displacement at specific dynamic loads.
- iii. Leaf upper part is held by way of roller movable supports, travelling along guide, fastened on portal building structure.
- iv. Structurally the guide is made out of three parts - one part is stationary and two - detachable.
- v. Placing the leaves (gate) in horizontal position in the crane pad area and releasing the gate for concreting. Concrete will be supplied and filed by NPCIL. However, contractor shall provide manpower for assistance as required.
- vi. On completion of curing time, carryout fit up and welding of liner plate at opening provided for concrete filling and the holes provided for venting during the concreting.
- vii. Lifting and assembly of the roller assembly with the gate. (Note: This option is left to the contractor, that the assembly of the rollers can be done at location also or on the ground) And the same process shall be repeated for the second leaf also.
- viii. NPCIL heavy duty crane will be issued as free issue for erection and during lifting and making vertical, contractor has to provide crane for tailing.
- ix. Erection of gate on the rail. Arresting the gate with temporary locks, aligning the gate for verticality. Approximate weight of each gate after concreting is 80MT.
- x. Lifting the second leaf and placing on the rail as similar to the first one. Keep the two gates in closed position, align the gates, and maintain the verticality.
- xi. Measuring the field distance from the wall embedded parts to the centre of guide rollers on the top of rolling gate.
- xii. Comparing the length of the guide members supplied with the measurement obtained, in case any differences, necessary corrective action shall be taken to accommodate the guides in position. Such corrective action shall be carried out in concurrence with BHEL & NPCIL.
- xiii. The scope also includes modification of the guide members by adding the sufficient thickness plate (shim plate) of various thicknesses, trimming of excess length of the guide members.
- xiv. Once modification of the guides are done, guides shall be assembled with the gate leaves, fit up with the embedded part and welding shall be carried between the embedded part and the guide plate.

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- xv. During erection of the guide plate care shall be taken for maintaining the even gap on either side of the gate and the guide member.
- xvi. On completion of inspection remove all temporary arrangements and attachments and the movement of the gate shall be checked manually.
- xvii. Painting site welded portion with OC51-03 paint.

3.5 Electrical Works:

- i. Handling and erection of electrical panels at control located at UJG. These panels erection also includes erection of the support structure of the panels.
- ii. Electrical panel includes main receiving panel and local control panel for operation.
- iii. After completion of erection of panels, Wiring shall be carried out as per the wiring drawing issued, from the main panel to the local control panel and further from the local control panel to the gate motors with proper grouping, tagging etc. qualified electrician shall be employed for carrying out the wiring works.
- iv. Wire work requires consumables such as cleaning agents, cable ties, identification
- v. Also commissioning of the gate shall be carried using the temporary power supply. Supply point will be provided by NPCIL, extension from the point to required location shall be arranged by the contractor for commissioning of the gate.
- vi. Material receipt at site, safe unloading at site and safe storage at site, etc. as per the specific requirements covered in manufacturer documentation / applicable procedure.
- vii. IR value and continuity of the cables being / to be laid shall be checked before laying and be recorded in a proper register (hard & soft copy) with date, cable type, size along with details of equipment used for measurement of cabling works and the same shall be produced for any verification by the Corporation. Acceptability of the above values measured shall be checked and verified prior to cabling works and in case of any non- conformance of the above, the same shall be brought to the notice of EIC.
- viii. The length of the cables laid, in general, shall be sufficient enough between the panel and load ends such that, sufficient extra length is available at both ends of the cable for taking up the cable termination works without generating any stress on the cable / cable termination as well as to take care of any exigency / re-termination works that might have to be taken up in future.

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- ix. The scope of cabling includes supply and installation of cable ties as stipulated in the technical specifications, cable tags made from anodized Aluminum sheet, with identification numbers punched, as mentioned in technical specifications of cabling works. The same shall be attached to the cables by G.I. binding wire / Scrap copper wire.
- x. In case of cables of smaller cross section, particularly for control cables, Contractor shall make conscious efforts to explore the possibility of laying the cables in “bunched groups” in a given tray, in order to optimize / utilize the space more effectively without overcrowding the trays.
- xi. LT/C & I cables shall be clamped with the trays at standard intervals, but at not more than 5 m intervals, and to be bonded together every 0.5 / 1 m band unless specified otherwise in the relevant clause(s) of technical specification / tender document / Cabling guidelines issued to the Contractor. Nylon / plastic ties as specified in the cabling guideline document shall be used, as specified and as recommended by Engineer – in – charge. For LT cables of higher cross section ($> 16 \text{ sq. mm}$), GI or AL. clamping with cable trays along with cable ties at every 0.5 m may be required to hold the cables firmly with the cable trays. For LT cables of lower cross section ($< 16 \text{ sq. mm}$) and for control cables, the cables shall be bonded together at every 0.5 m. The gap thus decided between the cables laid shall be sufficient enough to hold the cables together firmly.
- xii. In case of any cables to be terminated by other agencies, in particular for Instrumentation cables, the scope of cable laying includes lifting / dressing of the laid cables right up to the Panel / JB / TB level with suitable permanent marking with paint, over and above the cable tags to be provided as per standard cabling guidelines and technical specifications. In any case, the cables shall not be thrown indiscriminately on floor in such cases which would make it difficult later to trace / identify the required cable by other agencies.
- xiii. After laying of the cables and above mentioned dressing of the cables, IR and continuity of the cables, as well as cable screen (for screened cables) shall be checked and recorded in hard and soft copy register prior to releasing the same for cable termination. In case the cables are to be terminated by other contractor / agencies, then, IR & Continuity of the cables shall be verified in the presence of representative of other agencies for handing over of the cables for cable termination.

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3.6 Commissioning of gates:

- i. Preparation of various check lists for commissioning for mechanical, electrical and instrumentation etc.
- ii. Visual inspection of transport portal protective sliding door shall be done. If any damage, it shall be rectified with the help of concerned agencies.
- iii. Ensure that electric motor is grounded through earthing.
- iv. Check for power and instrumentation cable continuity and termination for junction boxes, control panel and control cabinet as per design drawings.
- v. Ensure oil filled in Gear boxes in left side and right side doors, grease applied for driving chains for both doors, no foreign material on rail top and sides, check the movement of the left side door in both directions, any abnormal noise and ensure smooth movement of the left side/ right side doors.
- vi. Electrical panel energization as per the approved check list and with proper precautions.
- vii. Electrical operation of doors Keep the left side door at intermediate position, Manual doubling to be released in case manual doubling appears. position by operating manually.
- viii. Operate the doors for open direction by pressing "Open"
- ix. Press button from control panel and give stop command by pressing STOP button from control panel and ensure door movement is stopped.
- x. Check the door is moving in open direction. (If it is not moving in open direction, change the phase of electrical supply in motor terminal box and repeat the test again).
- xi. Emergency stop testing of protective sliding doors shall also be tested.

4. Reports and Records

- i. Welding inspection reports, as built drawings, erection reports shall be prepared as per the approved formats.
- ii. Reports for cable laying shall be carried out separately.
- iii. All the pre-commissioning hand over checks carried out and the test performed shall be recorded as per the approved procedure for the commissioning.

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2.2.18 TECHNICAL SPECIFICATION FOR HANDLING, ERECTION, WELDING AND INSPECTION OF CARBON STEEL AND STAINLESS STEEL PIPING

Sr No	Description
1	Purpose
2	Scope
3	General description and detailed scope of work
3.1	Joint Numbering
3.2	Material of construction of piping
3.3	Pipe size
3.4	Erection of small bore piping
3.5	Erection of big bore piping
3.6	cutting and J-groove machining using beveling machine
3.7	Erection of carbon steel and stainless steel pipelines
3.7.1	Erection
3.8	Fit up
3.9	Purging
3.10.	Welding
3.11	preparation of CRR
3.12	Hydro-test / Leak test
3.13	Foreign material Exclusion
3.14	Facilities to be provided during welding
4	Reports and Records

1. Purpose:

Purpose of this specification is to provide guidance to contractor to understand the scope, quantum of work and technical requirements to be followed during handling, erection & fit up , welding, inspection, preparation CRR (circuit release report) and Hydro / Pneumatic testing of carbons steel and stainless steel piping of various systems covered in the contract.

2. Scope :

The scope of the contractor's work comprises but not limited to the following.

- Study of drawings, preparation of network schedules.
- Preparation and approval of QAP, erection, welding and inspection procedures.
- Receipt of material from NPCIL/BHEL store, transportation, storage, handling, identification of pipe spools.& preparation of IMIR and de-preservation

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- iv. Marking of joint numbers in the isometric drawings, identifying the field joints and shop joints.
- v. Pre-fabrication of small bore pipe spools as per joint marking involving marking, cutting, edge preparation, cleaning, fit up, welding and inspection based on the joint identified.
- vi. Cutting and edge preparation in big bore field joints after removal of excess length.
- vii. Shifting, handling, cleaning, erection of pipe spools to the location, as per the working drawings, alignment, fit up, welding and inspection.
- viii. Erection of supports, valves and other connected elements of process systems as per technical specification and working drawings.
- ix. Preparation of circuit release report (CRR) and submission for acceptance.
- x. Carrying out hydro test / pneumatic testing of the pipelines.
- xi. Post hydro test cleaning including draining and drying of pipelines.
- xii. Preparation of reports and records.

3. General description and detailed scope of work:

- i. The term piping includes pipelines, pipe fittings like bends, elbows, tees, flanges, reducers, on line pipe instruments etc. Piping is broadly classified as follows
 - a) Small bore piping of all sizes below 100 NB (size is less than or equal to 80NB)
 - b) Big bore piping of all sizes 100NB and above. Big bore piping further classified based on the thickness. (Refer BOQ for detailed classification of piping based on thickness).
- ii. Small bore pipe shall be supplied in standard length as pipe and pipe fittings separately i.e. pipe in standard lengths and the bends, elbows, tees, flanges, reducers etc.
- iii. Big bore pipe shall be supplied in pre-fabricated spools, such as pipe welded with elbow, spool welded with tees etc, and normally supplied with weld edge prepared condition. If any block is supplied without welding edge, edge preparation shall be carried out by the contractor, and payment for such work will be done in the respective BOQ item.
- iv. Piping erection and welding works shall be carried out in compliance with various RF (Russian) standards.
- v. For carrying out piping erection, piping isometric drawings provided shall be followed. In case isometric drawings are not provided for any system,

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contractor scope includes preparation of isometric drawings based on orthographic (plan & section) drawing provided with in the quoted rates.

- vi. Erection of small bore piping has to be carried out with field routing as per site conditions. Erection of such systems shall be taken up with concurrence of Engineer. Field survey shall be made prior to preparation of isometrics and the same shall be submitted for acceptance of BHEL & NPCIL before start of work.

3.1 Joint Numbering:

- i. Weld joint numbering shall be done using the piping isometrics with proper system, joint numbering shall be decided in consultation with Engineer.
- ii. Numbering system to be followed is elaborated below:

First level.

- shall include Shop joints identified as symbol (S),
- Field welds identified as symbol (F),
- Modification joints if any identified as symbol (M).

Second level:

- Butt weld as C.
- Fillet weld as F.
- Nozzle weld as N.

Numbering system shall be done as per line number wise of respective systems working drawing.

3.2 Material of construction of piping:

- i. Stainless steel (RF steel grade 08X18H10T & 12X18H10T).
- ii. Carbon steel (Various grades of RF material such as Steel 20, Steel 16GS etc)
- iii. Cladded piping. (Carbon steel cladded with stainless inside).

3.3 Pipe Size:

The pipe dimension shall be as per Russian standards. The sizes will not match with Indian and American standard. Hence, the Nominal pipe sizes with matching outer diameter and welding unit in INCH DIA considered for measurement are given below in table-1

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Table-1			
PIPE NOMINAL BORE WITH INCH DIA			
SR NO	PIPE NOMINAL BORE	OUTER DIA	INCH DIA
1	10	14	0.5
2	15	18	
3	20	25, 28	1
4	25	32	
5	32	38	1.5
6	40	42	
7	50	57	2
8	65	76	2.5
9	80	89	3
10	100	108	4
11	125	133	5
12	150	159	6
13	200	220	8
14	250	273	10
15	300	325	12
16	350	370	14
17	400	426	16
18	500	530	20
19	600	630	24
20	800	840	32
20	1000	1020	40

3.4 Erection of small bore pipeline:

- i. The pipe line and pipe fitting are supplied separately. Pipe fitting and valves will be supplied in edge prepared condition where as pipe will be supplied in plain end. It is the responsibility of contractor to review the field routing and shall carryout cutting, edge preparation and welding.
- ii. In general small bore piping work shall start only after big bore piping are erected except certain system where it is unavoidable.
- iii. Small bore pipe edge also may be done using beveling machine as specified in working drawings.

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- iv. Support shall be erected after finalization of pipeline routing.
- v. Care shall be taken to prevent wastage of pipe as per approved drawings & wastage of pipe fitting is strictly prohibited.

3.5 Erection of Big bore piping:

- i. Big bore pipe shall be supplied in pre-fabricated spools and edge prepared condition along with edge prepared pipe fitting and valves.
- ii. The pipe spools issued will have field cutting margin at direction change / hook up joints. Contractor shall cut the excess length as per field measurement with bevel cutting machine.

3.6 Cutting and J-Groove machining using Beveling machine pipeline:

- i. Most of the piping covered in this contract shall have J-groove edge and few cases V- groove.
- ii. In case any pipe spool which are supplied without edge preparation, weld edge for such spools shall be prepared as per the requirements given in the working drawing / applicable standards / technical specification.
- iii. Some of the hook up joints in the big bore pipe spools weld edge preparation is needed to be carried out in-situ to suit the site condition.
- iv. Pipe fittings such as throttling orifice, flow restricting orifice and other components in big bore will be installed after successful flushing operation. After flushing these elements are to be installed by cutting of the main line and edge preparation at site.
- v. Cutting and edge preparation of such big bore pipe spools shall be carried out using beveling machine only. It is not permitted to carry out cutting, edge preparation of big bore pipe spools using normal grinding machine.
- vi. Pipe beveling machine mobilized by the contractor shall be capable of cutting and edge preparation for the diameters range of 100NB to 600NB.
- vii. Maximum thickness of the pipelines varies up to 40mm.
- viii. Contractor shall provide different size of beveling machines, necessary machining tools, tackles and other accessories for beveling. Also necessary cooling, cleaning consumables such as cooling oils, water, air supply in case of pneumatic operated beveling machines shall be provided with manpower.
- ix. Arrangement of template for guiding the tool to get the required edge profile shall be provided.

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- x. The contractor shall conduct demo/mock up to qualify beveling machine, arrangement required and qualify operator including template before taking up the actual work.
- xi. Providing & erection of scaffolding for safe reach and carrying out beveling operation.
- xii. Setting of beveling machine on pipe is a very skilled work, any deviation in setting the machine will lead to damage the parallelity of the pipe weld edge. Hence only qualified and experienced operator shall be engaged for operating the machine.
- xiii. In case of connection welding with equipment or other edge prepared components, the contractor shall verify the ID of the existing pipe before taking up edge preparation. In some cases ID pipe shall be machined / bored to required length in order to match the diameter as mentioned in the standard.
- xiv. Machined profile shall be checked for correctness using template.
- xv. Cleaning the area after machining, shifting all the scrap outside the working area.
- xvi. Typical profile of the V-groove and J-groove are as given below.

Joint Number	Weld Joint Designation	Abutting Tubes or Fittings		Groove of Pipeline Fittings
		External Diameter of Pipes, mm	Wall Thickness of Pipes, mm	
Joints of Fittings of Steels of Grade 08X18H10T and 12X18H1				
01	1-23 (C-23)	14 through 57	2 through 3	12.5 ✓ (✓) 35° ± 2° 1.5 ± 0.5 1.05 S A
02	1-25-1 (C-42)	76 through 325	4,5 through 12	12.5 ✓ (✓) 3 ± 0.3 20° ± 2° R1 ± 0.3 0.5 max 6.3 10° ± 2° S A l φ

3.7 Erection of Carbon steel and Stainless steel pipelines:

- i. Handling, transportation of pipe material from the NPCIL/BHEL stores to the contractor store for segregation, identification, comparing with the bill of material mentioned in the working drawing, check for completeness of the piping material supplied.
- ii. Avoid direct contact between stainless steel and carbon steel material.

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- iii. Separate tools shall be identified with colour coding for working with stainless steel pipe components.
- iv. Prior to shifting and erection, pipelines shall be mechanically cleaned thoroughly, from outside and inside, using wire brush & cotton waste. Pipe shall be free from any kind of foreign material and preservatives.
- v. Mechanically cleaned pipelines shall be cleaned using oil free compressed air from inside.
- vi. Cleaned pipe end shall be covered with plastic end caps at shop as well as at site.
- vii. In case of carbon steel pipe lines, pipes shall be shifted only after grit blasting, primer application and final paint leaving the weld joint area for welding.
- viii. Painting of weld joint area shall be done at the site after completion all NDEs stipulated. Payment for grit blasting, primer application and painting will be done in the respective BOQ item.

3.7.1 Erection:

- i. Erection shall be taken up system wise to meet the target agreed and specified by BHEL & NPCIL.
- ii. Prior to erection of pipelines, reference co-ordinate shall be transferred to the working area / nearby structure so that once pipe is erected correctness can be checked with respect to the reference co-ordinate.
- iii. In general piping erection shall start from equipment nozzle / hermetic penetration to prevent transfer loading to equipment.
- iv. As most of the piping are stainless steel sequence of pipe welding shall be done considering purging weld joint.
- v. Offset of pipeline at equipment / flanges after welding is not permitted.
- vi. Unless otherwise it is specified in the drawing all the drain lines shall be routed up to the nearest drains collection point. Routing of such line shall be done with prior approval from the Engineer.
- vii. Temporary supports erected during erection of pipelines shall be cut and removed after erection of permanent supports. Material required for such temporary supports shall be arranged by contractor himself.

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3.8 Fit up:

- i. Fit up shall be carried out as per the specification, working drawings and applicable codes and standards using standard pipe clamps/fixtures. No direct welding of the weld cleats is permitted for making fit up.
- ii. Root gap shall be maintained as per the applicable standards and working drawings.
- iii. No tack welding is permitted on the weld edge during fit up stage.
- iv. Pipeline ovality shall be checked before proceeding for fit up. Mismatch is not allowed during fit-up. If any such mismatch it shall be within the permissible values.
- v. Special clamps, jigs or fixtures required for carrying out fit up of piping shall be arranged by contractor.
- vi. Application of mechanical loads for alignment and Fit up of pipelines is not permitted. Pipelines shall be tension free while carrying out fit up and alignment.
- vii. Weld edge shall be properly cleaned using acetone.

3.9 Purging:

- i. Stainless steel piping needs argon purging during welding irrespective type of welding such as GTAW.
- ii. Nozzle purging with argon needed for both carbon steel and stainless steel welding while using GTAW process.
- iii. Purity of argon shall not be less than 99.98%.
- iv. Purging dams shall be used for purging during welding of stainless steel pipelines. Purging dams used shall be of removable type, proper purging dam register shall be maintained for ensuring the removal for dam.
- v. Using of masking tape for fixing of soluble purging dam is not permitted. Only soluble gum shall be used for fixing the purging dam or purging tube etc.
- vi. In case of unavoidable situation, hookup joints and closing joints, soluble type purging dams may be used.
- vii. Inflatable type purging dams may be used for purging big bore pipelines. Implementing of such dams will reduce the usage of masking tape, rubber dams which are vulnerable for damage.
- viii. During course of time after erection of few piping systems, carrying out the Argon cylinders to the location will be difficult, in view of this contractor shall arrange small size cylinders which can be carried to site easily .

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3.10 Welding:

- i. All welding shall be carried out as per the approved welding procedure and qualified welders. Most of the piping welding shall be done using Russian material including welding consumable (electrode / filler wire), hence contractor shall provide adequate training to welder before permitting for qualification.
- ii. Welding shall be carried out only by qualified welder, tack welding of fit up shall also be done by using qualified welder.
- iii. Welding covered in this contract shall be carried out using 3 phase welding generator only. No rectifier type single phase welding machine shall be employed for welding operation. Approval from NPCIL shall be obtained for use of rectifier.
- iv. All qualified Welders shall be provided with the proper apron for easy identification & shall carry qualification card always.
- v. No weld joint shall not be left with root pass, immediately after root pass subsequent pass shall be completed.
- vi. Root weld inspection windows (at least two numbers) shall be left for checking the root welding. The windows shall be closed only after inspection and clearance of weld root.
- vii. During stainless steel welding operation HF unit is mandatory for GTAW process. No SS welding with GTAW is permitted without HF unit.
- viii. Welding electrodes shall be always stored in mother oven and intermediate oven and transported in the portable oven at site.
- ix. Welding filler wire shall be brought in closed container.
- x. Proper identification technique (colour coding) shall be employed for easy identification of filler wire for carbon steel, stainless steel and dissimilar filler wire.
- xi. Welding stubs shall be collected and stored and shall be taken out from site on day to day basis. Engineer may verify at contractor shop.
- xii. On completion of welding, weld joint information along with the welder number shall be engraved near the weld joint area.
- xiii. Purging arrangements made shall be removed and pipe shall be thoroughly checked for any left out foreign material inside the pipe.
- xiv. Open pipe ends after welding shall be closed immediately and after day to day activities.

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3.11 Preparation of CRR: Following activities are involved.

- i. Study of flow sheets, identification of hydro test loops, marking and submission for acceptance to NPCIL. (Note: One system may have more than one working document, one working document may have many numbers of loops, each loop shall have separate CRR)
- ii. Identified loops shall be marked in the flow sheet with test pressure, test medium, leak search pressure and test duration etc.
- iii. Preparation of as-built drawing of testing loop (consisting many lines), verification of pipe line at field for weld joint, support & valve location, clearances, removal of temporary support & attachments and making ready for testing.
- iv. Compiling all the reports, loop wise such as liner erection report, weld joint history sheet, support erection report, valve erection reports, list of terminal points, list of exemption if any etc.
- v. Submitting the CRR (compiled reports, hydro test circuit) to BHEL/NPCIL (Various departments such as User section, Field engineer, QA section etc) for acceptance.
- vi. Even though no physical work is involved in CRR preparation, this is a very important activity and CRR is a pre-requisite for hydro test of the loop

3.12 Hydro-test / Leak test:

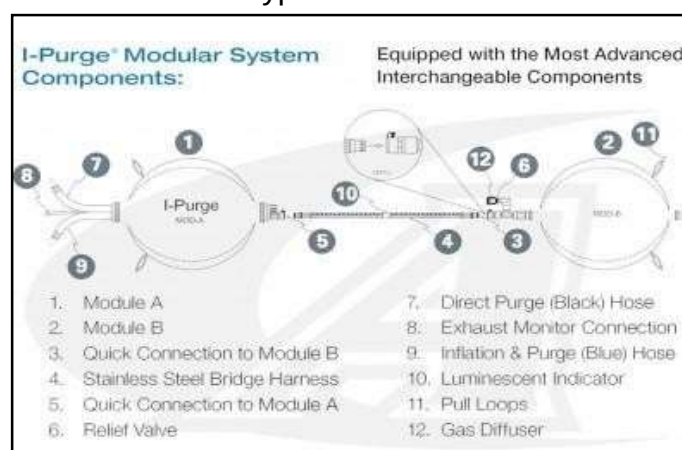
- i. Hydro test shall be carried out only after obtaining the approval of CRR.
- ii. Test may be carried out for single loop or clubbing of loops of same pressure requirement.
- iii. DM water required for carrying out hydro test shall be provided by NPCIL.
- iv. Hydro test shall be carried out as per the approved hydro test procedure.
- v. Before carrying out hydro test proper vent and drain points shall be identified. If required new temporary vent shall be made with the approval of engineer and to be welded after hydro test.
- vi. Vent shall be kept open during filling and draining of the circuit to vent the air out from the circuit.
- vii. Minimum two pressure gauges and one pressure relief valve (PRV) shall be used for hydro test.
- viii. Pressure gauge shall be calibrated before test is commenced. Validity period of the pressure gauge calibration will vary and shall be as per the codal requirements. PRV shall be calibrated for 10% more than hydro test pressure.

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- ix. Medium of testing shall be as per the working drawings, in case of pneumatic testing medium of testing shall be followed as per the working drawings.
- x. Gross leak test using pneumatic testing at lower pressure shall be done to ensure the tightness of system and also to check the healthiness of various components and pressure boundary. In general large loops shall be invariably tested at lower pressure using pneumatic test before filling water.
- xi. Pressurization shall be carried out using electric operated pumps/ manual operated pumps / air compressor /nitrogen cylinder etc.
- xii. Hydro test pumps shall have Maximum pressure: 25MPa, 380V, pressure gauge mount with spare connection, SRV, NRV etc. Sufficient length of hose also shall be arranged.
- xiii. Hose arrangement shall be made to collect the water from vent line to nearest drainage. Spillage of water is not permitted. Draining shall be done at lowest point and water shall be drained to nearest sump /pit.

3.13 Foreign Materials Exclusion (FME):

- i. During execution of piping, equipment erection, valves, fittings, orifice etc utmost care shall be taken to prevent foreign material inside these items.
- ii. Contractor shall train all workers to prevent stacking / placing of hand tools, welding consumables, PPEs inside pipeline during erection and welding.
- iii. Any such items found during further course of inspection, it is duty and responsibility of the contractor to remove such material from the location by any possible method. Efforts required for such works will not attract any kind of payment.
- iv. Dam register shall be maintained for all the dams such soluble dams, rubber dams etc. It shall be ensured whether all the dams are properly removed.
- v. Also latest tools such as inflatable dams for pipe welding shall be considered in place of conventional dams. Typical sketch of inflatable dams are as given below.



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- vi. Contractor shall arrange boroscope of minimum 30m length for carrying out inspection inside pipe on regular intervals during execution within the quoted rate.
- vii. The video boroscope shall be mandatorily used Where ever pipe changes its direction, Whenever valve erection is being done, Whenever piping is terminating with equipment
- viii. Following is the typical sketch of boroscope .



- ix. Following are the specifications boroscope.
 - a) Flexible, fiberglass core, 30m waterproof camera probe (spool assembly).
 - b) 25mm camera head (60° FOV, long depth of field) with built-in bright 12 LEDs for illuminating the problem areas
 - c) Wireless handset/transmitter with brightness and power controls.
 - d) Color LCD TFT with minimum 640 x 480 VGA pixel resolutions.

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- e) Rugged oil/chemical resistant and water/drop proof housing (IP67).
- f) SD memory card included to store >15,000 images.
- g) Video recording with Voice annotation.
- h) AV output for viewing images and video directly on a monitor.
- i) Video and images can be transferred to a PC via the SD card (included) or USB output
- j) Complete with Video Scope, wireless handset, 25mm camera probe, SD card, 3.7V rechargeable battery, patch cable, AC adapter (110-240V, four plugs), USB and AV cables, and hard carrying case

3.14 Facility to be provided during welding:

- i. Hand lamps used for inspection shall be powered from 24 V DC power supply.
- ii. Welder working in confined area shall be provided specially designed breather apparatus with filter.
- iii. In general fume extractor shall be provided with sufficient number to facilitate smoke free atmosphere.
- iv. All welders shall be provided with heat resistant silicon fabric to prevent fall of hot molten metal during welding.

4. Reports and Records:

- i. Necessary reports such as erection reports, welding reports, inspection reports, line history sheets, line erection reports, circuit release reports etc shall be maintained as per the approved quality plan and the work procedure.

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2.2.19 TECHNICAL SPECIFICATION FOR HANDLING, TESTING, ERECTION OF VALVES

Sr No	Description
1	Purpose
2	Scope of work
3	General Description
3.1	Spares and accessories
3.2	preservation of hand wheel
3.3	Establishing Valve testing facility and Testing of valves:
3.3.2	Specification for valve testing machine of Type-1
3.3.3	Type-2 4 Station test bench to test 1/2" to 4" dia valves:
3.3.4	Testing of valves
3.4	Vent plug welding
3.5	Base plate welding
3.6	Protection of valve
3.7	Erection of valves
3.8	Check valves
3.9	Pneumatic operate valves
3.10.	Special valves:
3.10.1	FSIV(fast steam isolation valve)
3.10.2	Pulse safety device
4	Reports and Records:

1. Purpose:

Purpose of this specification is to provide guidance to contractor to understand the scope, quantum of work and technical requirements to be followed during handling, storage, testing and erection of valves covered under this contract.

2. Scope of work:

The scope of the contractor's work comprises but not limited to the following.

- i. Study of drawings, preparation of network schedules.
- ii. Preparation and approval of QAP, erection, welding and inspection procedures, Preparation of erection schemes.
- iii. Receipt of material from NPCIL/BHEL store, transportation, storage.
- iv. De-preservation of valves, welding of vent plug and base plate for supports as per drawings.
- v. Shifting and testing of valves at valve testing facility.

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- vi. Shifting the valves to the required location, erection and fit-up of valves as per drawings.
- vii. Inspection and preparation of reports.

3. General Description :

- i. Various types of valves are mounted in the process systems piping such as Stop valves, check valves, control valves, throttle valves, safety relief valves, special valves such as pulse safety devices, fast steam isolation valves etc.
- ii. Valves are operated by electrical actuators, manual operated valves, pulse safety valves, pneumatic operated valves, and solenoid operated valves, etc.
- iii. Valve size ranges from 10NB to 600NB diameter and weight of valve is 0.5Kg to 6000kg.
- iv. These valves need to be erected in various buildings, location, orientations and elevations.
- v. The material of construction of the valve is of carbon steel or stainless steel.
- vi. Valves are required to be erected in horizontal pipeline, vertical pipelines or in any other orientation as per the requirement specified in the drawings.
- vii. For general scope of work regarding material receipt, preservation, de-preservation, storage etc, refer general technical specification.

3.1 Spares and accessories:

Usually valves will be supplied along with spares, accessories and a few electrical/instrumentation items. Contractor shall draw only the material required for erection. Any spares/ accessories/electrical /instrumentation items which are included in the main package of the valve shall be identified, recorded & returned to BHEL/NPCIL stores immediately after receipt of material before finalizing the IMIR.

3.2 Preserving hand wheels:

Both electrical and manual operated valves are provided with hand wheels for manual operation. These hand wheels are to be removed and preserved by the contractor to avoid damage during erection and till commissioning as instructed by the engineer. The contractor's procedure shall address this aspect, including safe storage of hand wheels with proper identification for easy retrievability. Contractor's rate shall include this activity also.

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3.3 Testing of valves:

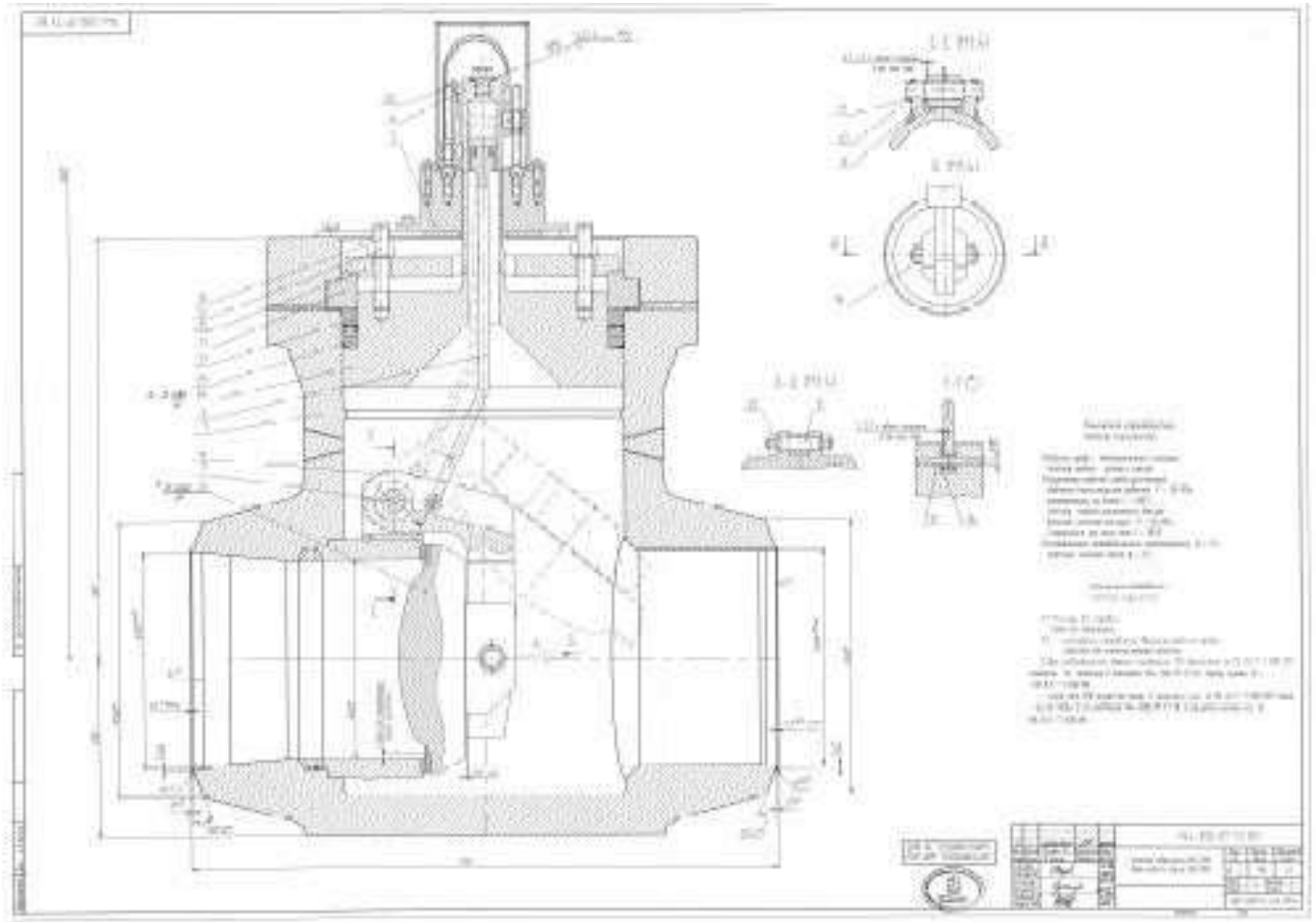
- i. Valve testing facility (VTF) shall be setup by BHEL or the facility provided by the NPCIL.
- ii. For operation of valves testing machines, qualified & trained operators for round the clock operation as per agreed schedule shall be deployed including skilled and unskilled workers for handling at VTF.
- iii. Valves shall be tested well in advance before proceeding for erection at site.
- iv. Scope includes arrangement of calibrated pressure gauge of different range with least count and range shall be as per approved procedure / standards including regular calibration.
- v. Shifting of valves from the BHEL/NPCIL storage yard to the valve testing facility, configuring the machine to the required configuration by changing the sealing arrangements, pressure settings etc as per the valve testing machine manufacturer instruction, mounting the valves on the rig.
- vi. DM water required for testing of valves will be issued on free issue basis. However, NPCIL will provide the DM water at one point, collection and transportation to the required location shall be carried out by the contractor.
- vii. Valves shall be tested using medium as specified in drawings and manufacturer instruction.
- viii. The rate of pressurization, dwell time & rate of de-pressurization shall be maintained as per approved procedures.
- ix. Recording the readings through computer interface, generating the report, demounting the valve from the test rig.
- x. Valves to be tested may be of manual, electrical, pneumatic operated. It is the responsibility of contractor to make arrangement for opening and closing using electrical / pneumatic and also operate with trained & skilled persons. Air compressor and electrical power connection will be arranged if the VTF is located in BHEL/NPCIL facility.
- xi. Scope also includes testing, adjustment and calibration of the safety relief valves.
- xii. Tested valve shall be cleaned thoroughly from oil, grease, dirt & foreign material and ends shall be covered with the end caps as supplied. Shifting back the valves to the storage yard / erection site based on the requirement.
- xiii. Scope also includes arrangement of all the necessary manpower for operating the machines, setting of valve testing machines, generating the reports through computer interface etc. throughout the contract period.

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3.4 Vent plug welding:

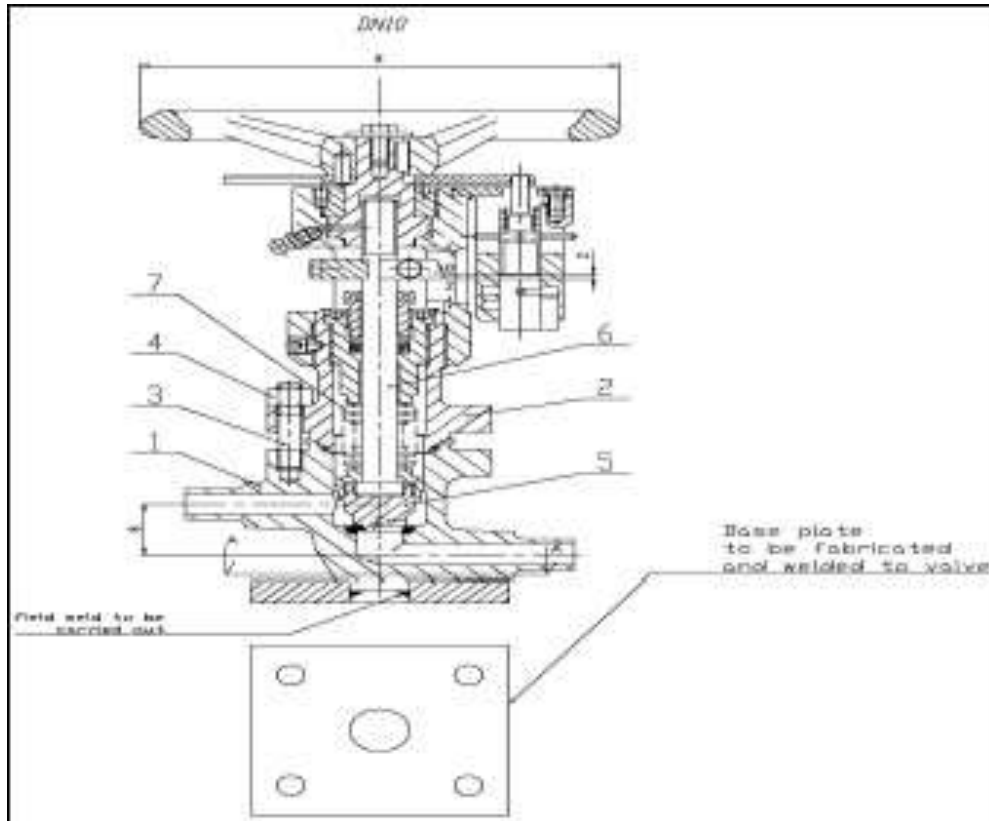
- i. Valves (both gate and check valves) are provided with vent plug which is used for venting during testing of valves at manufacturer's shop. These vent plugs are fastened to the valve body by threading and supplied in fastened condition with gasket provided.
- ii. This vent plug shall be welded at contractor shop before the valve is shifted to erection location. And the welded vent plug shall be inspected as per the manufacturer instruction.
- iii. Before proceeding for welding, vent plug shall be unscrewed, and the area shall be free from oil, grease, moisture or water and shall be fastened back to normal condition with gasket in position and shall proceed for welding.
- iv. Welding and inspection of the vent plugs will be measured and paid in the in the relevant BOQ item.
- v. Vent plug indication is shown below in typical sketch.





3.5 Base plate welding:

- i. Small bore valves are provided with base projection but without base plate.
- ii. To facilitate the valve with supporting arrangement, base plates are to be welded at site. Base plate shall be same as the material of construction of the valve. i.e., stainless steel valves shall be provided with the SS plate and CS valves with the CS base plates.
- iii. Activities include taking the measurements, marking, cutting, drilling, grinding, fit up, welding and inspection etc. Fabrication of the base plate will be measured in the relevant BOQ item.
- iv. Typical arrangement of the base plate to be attached to the base of the valve is as shown in the above sketch.
- v. Care shall be taken during welding of the base plate with the valve bottom. Any excess heat may cause damage to the seat of the valve.



3.6 Protection of valve:

- i. All the valve actuators, solenoids, pneumatic cylinders etc shall be protected from physical damage, water, fire etc.
- ii. To do so all these items shall be protected using protective covering with rubber fabric with silicon coat of required thickness.
- iii. For detailed scope for protection of valves refer general technical specification.

3.7 Erection of valves:

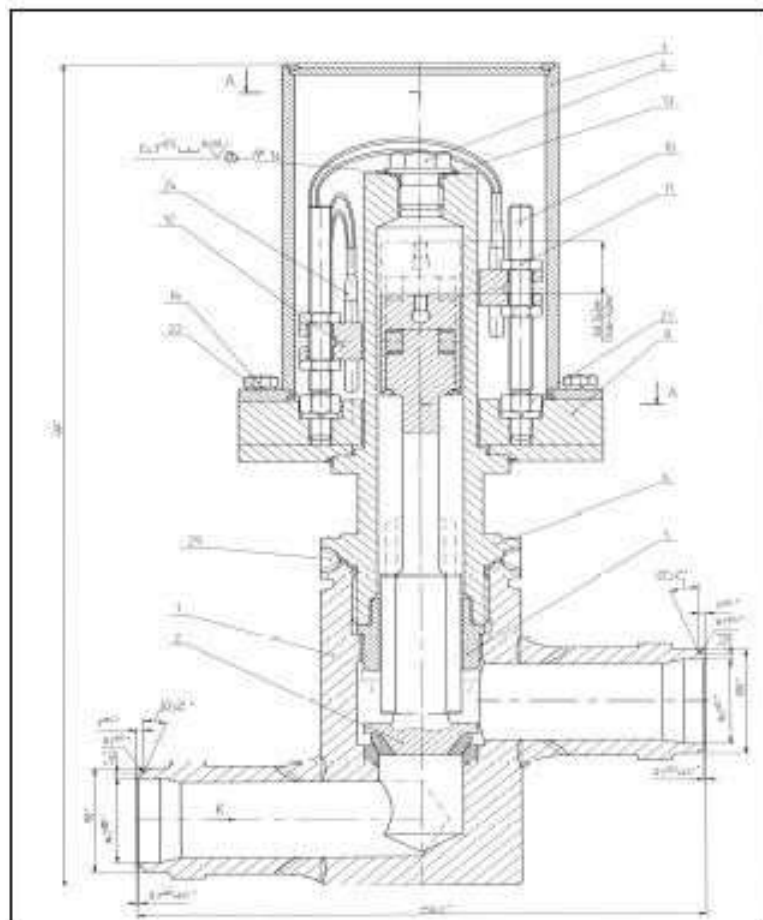
- i. Handling and shifting of the valves from BHEL/NPCIL warehouse to the respective location.
- ii. Heavy, big bore valves shall be handled carefully. Slings of these valves shall be done as per the manufacturer instruction.
- iii. During shifting & erection valve ends shall be covered with plastic end caps. These caps shall be removed only just before fit up.
- iv. Valve may require to be erected in any orientation, elevation, in vertical/ horizontal pipelines. In case of big bore electrical operated valves, during shifting of valve to the location, there may be requirement to dismantle the electrical actuators for safe shifting of the valves. Contractor's Scope includes dismantling and reassembling of such actuators from the valves.

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- v. While erection of the electrical operated valve, there may be a requirement for changing the orientation of the actuator. Scope includes changing of the actuator orientation to suit to site condition.
- vi. Jig & fixtures required for handling of valves shall be arranged by the contractor within the quoted rate and the same shall be dismantled and removed once its function is fulfilled.
- vii. Before fit-up of the valve, ensured that the preservatives are removed and cleaned.
- viii. In addition to the above scope of work, there are additional requirements based type of valves, such requirements are compiled and given below.

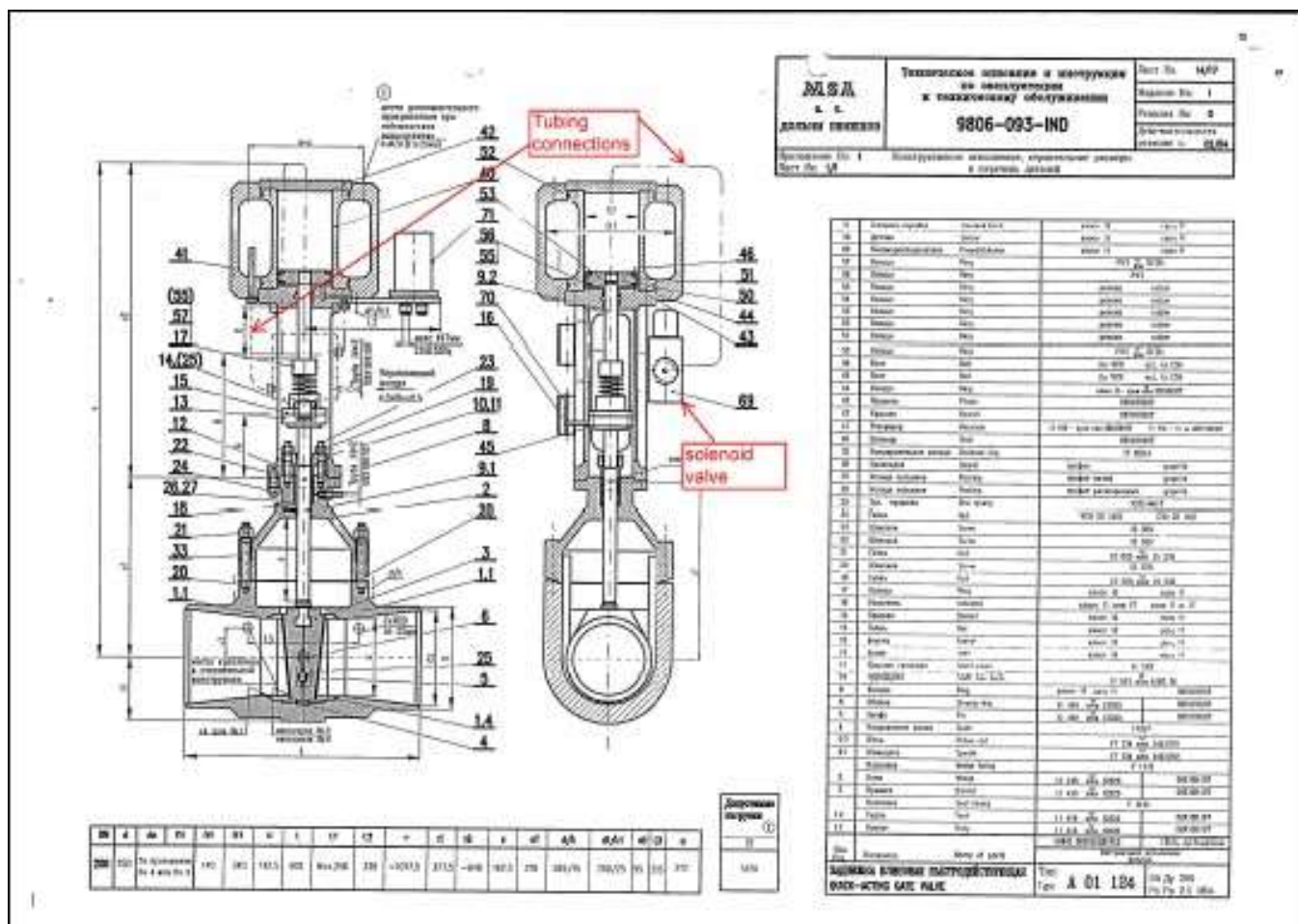
3.8 Check valves :

- i. Check valves also known as non return valves are direction oriented, i.e. these valves are to be erected as per the direction of the flow, If flow direction mark is missing and same shall be bought to the notice of BHEL/NPCIL.
- ii. Some of the check valve is provided with the position indicators. Contractor shall ensure healthiness of these position indicators before proceeding for fit up. Any deviation or deficiency found during the inspection stage, the same shall be reported to BHEL/NPCIL and shall be rectified as per the instruction of BHEL/NPCIL.
- iii. Typical sketch of the check valve is as shown below



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3.9 Pneumatic operate valves:



- Typical arrangement of pneumatic operated valves is as shown in the sketch above.
- All the containment isolation valves, quick boron injection system valves are provided with pneumatic operated actuators.
- These pneumatic operated valves typically consist of a pneumatic cylinder (double acting or single acting based on the function) and a piston connected to the valve stem. This piston is operated by means of solenoid valves.
- Connections from the solenoid valves to the cylinder are done using a tubing network.
- All these valves are needed to be erected along with the piping and may not be required to be operated till commissioning.
- To prevent any kind of damage to these valves, scope includes dismantling all these solenoids, connecting tubing work along with solenoid valve, preserving these items with proper identification and coding. For carrying out this job, qualified pipe fitter shall be involved in study of tube connections between the solenoid and the cylinder.
- After dismantling the solenoid valves, the cylinder ports shall be closed using temporary threaded plugs.
- For carrying out hydro testing of circuits/ containment testing etc., these valves are to be operated without power supply. Temporary arrangements with nitrogen cylinders

TECHNICAL CONDITIONS OF CONTRACT (TCC)

and tubing shall be made for such temporary operation. Providing such temporary arrangements also is in the scope of contractor without any extra payment.

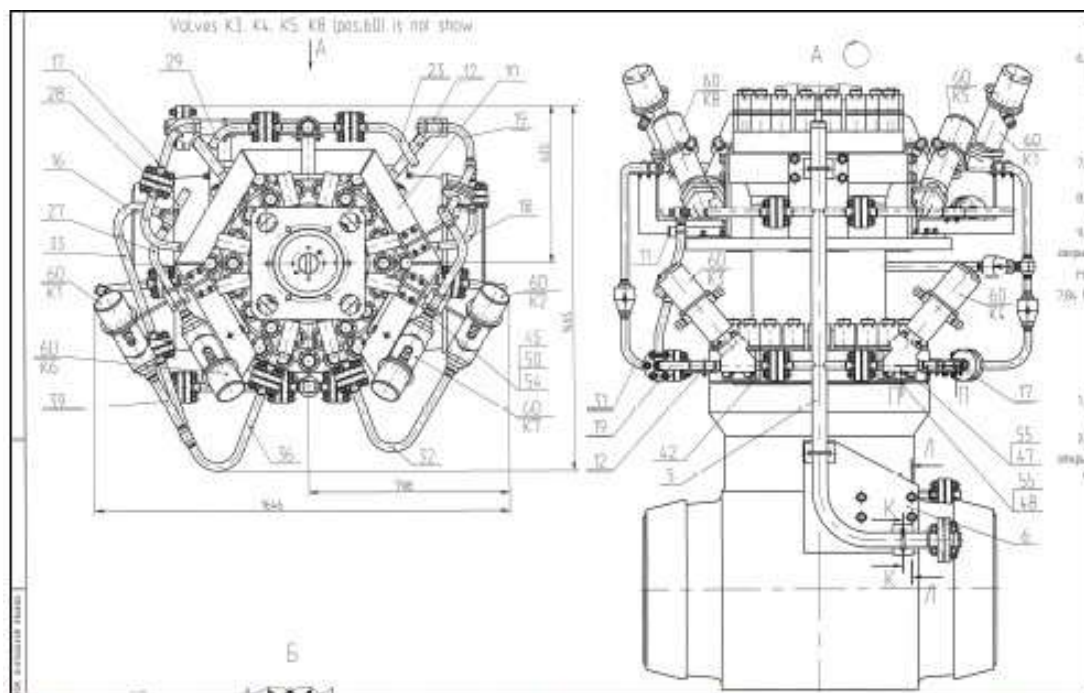
- ix. Re-fixing the solenoid valves and the connecting tubing shall be done as per the instruction of the engineer. Re-fixing of solenoid shall be carried out as per the original installation. Scope includes dismantling and re-fixing of these assemblies.

3.10 Special valves:

- i. Based on the mode of operation and construction of the valves , some of the valves are categorized as special valves such as Fast steam isolation valves (FSIV), Pulse safety device of steam line (SGPSD), pressurizer system emergency core cooling system stage-1 and fuel pool cooling system etc.
- ii. Even though their purpose of operation is to act as stop valve or safety relief valve their mode of operation and construction are completely different.
- iii. As mentioned above there are mainly two types of special valves such as fast steam isolation valve and pulse safety device.

3.10.1 FSIV(fast steam isolation valve):

- i. As name indicates the main purpose of this valve is to ensure fast closing and opening as per the process requirement. Total weight of each assembly is around 6MT.
- ii. The valves consist of valve body with actuator and interconnecting pipelines with series of solenoid operating valves and set of orifices.
- iii. These valves will be supplied in assembled condition i.e. with complete interconnecting lines, valves and orifices. The arrangement of the FSIV is as shown.



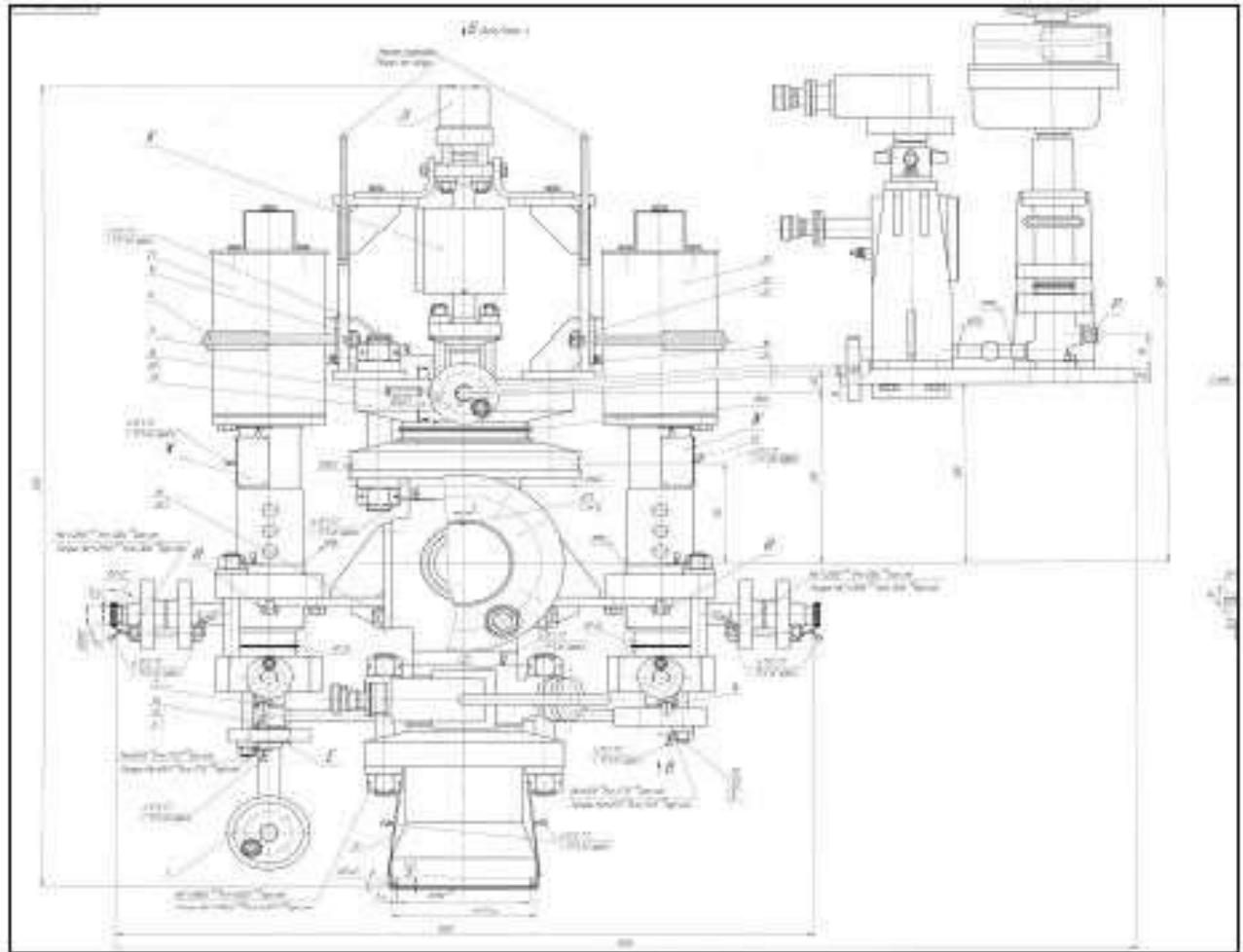
TECHNICAL CONDITIONS OF CONTRACT (TCC)

- iv. These valves are to be erected at +12.00m elevation inside UJE (steam chamber building). For shifting to the respective location, these valves are to be lifted top of the respective rooms of UJE before lowering to the required locations.
- v. All interconnecting piping and some of the accessories are to be removed before shifting the valves to location to facilitate easy handling as well as to avoid damage. Scope includes match marking of these interconnecting pipelines, dismantling the pipelines, safe guarding the check valves, orifices and gaskets.
- vi. Shifting the dismantled items to the contractor store, with proper identification marking.
- vii. Shifting the valve to the required location, erection and fit up, welding and inspection of valve.
- viii. Re-assembling and the connecting pipelines of FSIV.
- ix. Re-assembling of connecting pipelines as per the match markings made during the disassembly. Care shall be taken in placing the gaskets; no bending / tensioning of pipelines is permitted during re -assembling work.
- x. During re-assembly of the connecting lines, checking has to be carried out to ensure thoroughness of connecting piping, intactness of the gaskets, placement of orifice, orifice orientation etc.
- xi. Any interference of the adjacent metal structure with the interconnecting pipelines during assembly needs a modification in the structure. Scope includes modification of such structure.
- xii. Such modification of metal structure will be measured and paid in the relevant BOQ item.

3.10.2 Pulse safety device:

- i. Pulse safety device (PSD) is a safety valve for over pressure protection and is operated by means of solenoid as well as system pressure.
- ii. It mainly consists of main valve and one or two nos of pilot valves. Pilot valves will operate the main valve and pilot valves are operated by means of system pressure and solenoids.
- iii. Typical construction of pressurizer PSD is as shown below:

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- iv. Connection between the main valve and the pilot valves are made by means of flanged connections with metal gasket. PSD is supplied in single assembly.
 - v. Some of these connections may need to be dismantled during erection, for fit up with main pipes and pilot pipes.
 - vi. During dismantling of pipelines care shall be taken that the sealing lip of these connections, which are very thin and prone to damage. Utmost care shall be taken to prevent damage to the lip of the sealing element.
 - vii. Also the gaskets supplied along with the valve are very unique, shall be preserved carefully during installation of the valve.
4. Reports and Records:
- i. Erection report, as built information shall be reported in the prescribed format in quality assurance plan.
 - ii. Cleanliness report, de-preservation report, IMIR etc shall be prepared and submitted as per the prescribed format in quality assurance plan.

TECHNICAL CONDITIONS OF CONTRACT (TCC)

2.2.20 TECHNICAL SPECIFICATION FOR ERECTION, ALIGNMENT, FIT UP AND WELDING OF ORIFICE IN REACTOR AND REACTOR AUXILIARY BUILDING

Sr No	Description
1	Introduction
2	Scope
3	Information and Sequence of activities
3.1	General Description
3.2	Flow measuring orifice
3.3	Throttling orifice
3.4	Flow throttling orifice
3.5	Handling & Erection
4	Reports and Records

1. Purpose:

Purpose of this specification is to provide guidance to contractor to understand the scope, quantum of work and technical requirements to be followed during handling, erection & fit up of the flow measuring orifice, throttling orifice & flow restricting orifice etc. to be erected in various systems under this contract.

2. Scope:

- i. Study of drawings, preparation of network schedules.
- ii. Preparation and approval of QAP, erection, welding and inspection procedures.
- iii. Receipt of material from BHEL/NPCIL store, transportation, storage
- iv. Receipt of material, handling & preparation of IMIR
- v. De-preservation of orifices and checking the throughness of the orifice.
- vi. Shifting, cleaning, erection and welding of orifice after flushing of completed system piping as per the location indicated in the working drawings.
- vii. Inspection and carrying out other NDEs.
- viii. Preparation of reports and submission for acceptance.

TECHNICAL CONDITIONS OF CONTRACT (TCC)

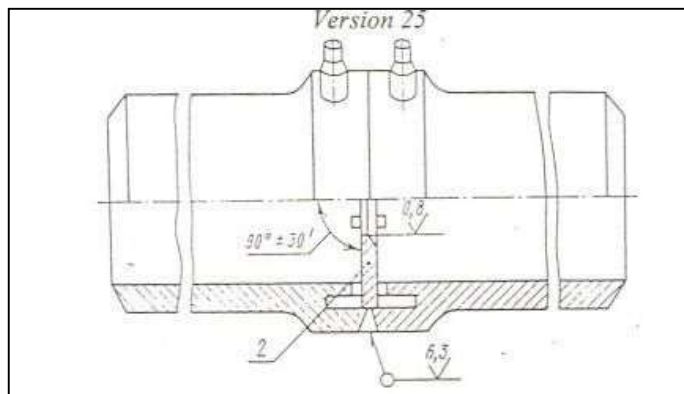
3. Information and Sequence of activities:

3.1 General Description:

- i. Piping systems inside Reactor building and Reactor auxiliary buildings consists of various type of orifices of different configurations in the measuring / throttling /limiting the flow.
- ii. These flow measuring orifices sizes ranges from 15NB to 500NB, and material of construction shall be of carbon steel and stainless steel.
- iii. Orifices will be supplied in machined and pre-assembled condition.
- iv. Orifices shall be erected on the piping systems in various floor & building at various elevations.
- v. Detailed functions, scope of work in erection of these orifices are explained in the later sections.

3.2 Flow measuring orifice.

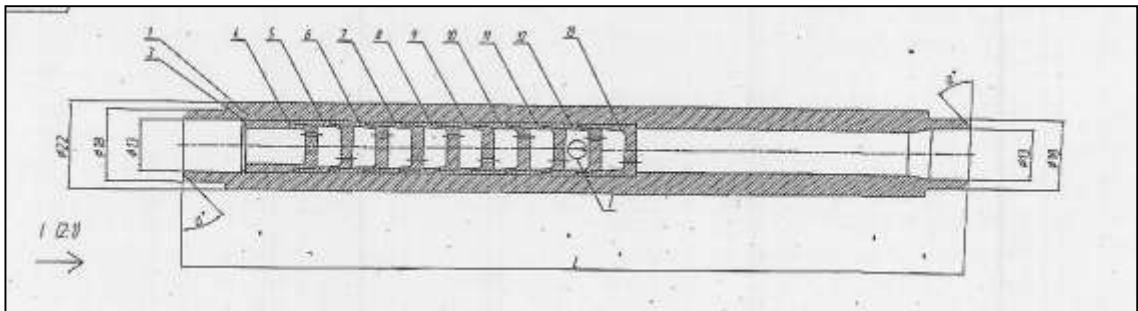
- i. Flow measuring orifice is used for measuring the flow in the main pipelines. As shown in the construction there will be a narrow opening for fluid to flow through the measuring tube. In this instrument two or more tubing connections will be taken from the orifice and connected to the respective instrument.
- ii. For connection of tube, orientation of the nozzle of the flow orifice is very important and shall be ensured before releasing the orifice for welding.
- iii. Since this device operates on the principle of venturi, direction of the orifice is very important, correctness of the direction of orifice shall be ensured before proceeding for welding.
- iv. Construction details of the orifice given below



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3.3 Throttling orifice:

- i. Throttling orifices are the devices used to restrict the flow and pressure from the system.
- ii. These are erected in transition between the high pressure and low pressure lines for great pressure drops.
- iii. Typical construction of the throttling orifices shown in the below sketch.
- iv. In throttling devices depending upon the pressure drop there will be number of stages. Number of stages will increase with the increase in the pressure drop.
- v. Each stage of throttling orifice consists of small pin hole, whose diameter will depend upon the required pressure drop.
- vi. These holes in each stage will have greater possibility of chocking with any kind of foreign material due to its size.
- vii. At most care shall be taken to prevent the chocking of the orifice.
- viii. Also direction of the orifice to be erected shall be as per the marking punched on the orifice. This direction shall be matched with the flow direction.

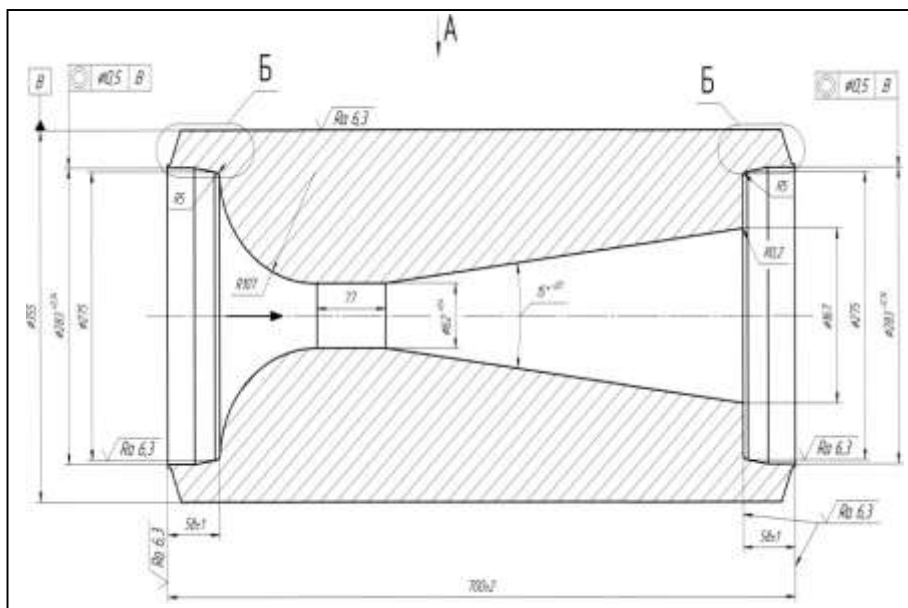
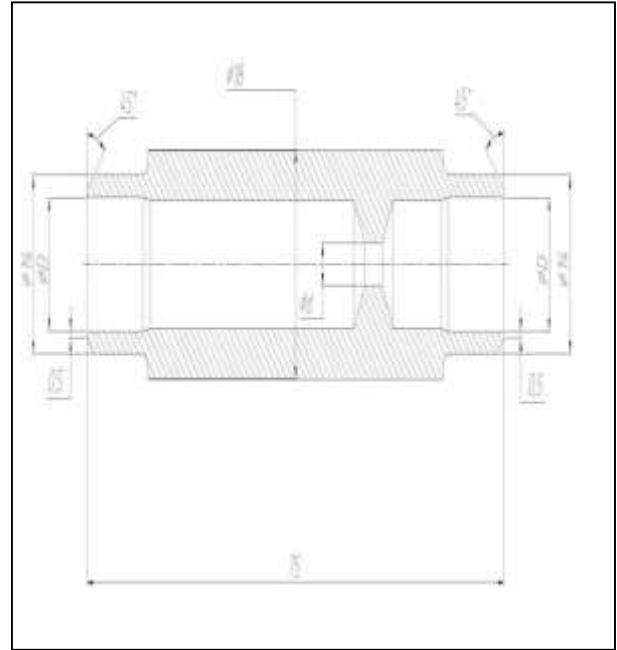
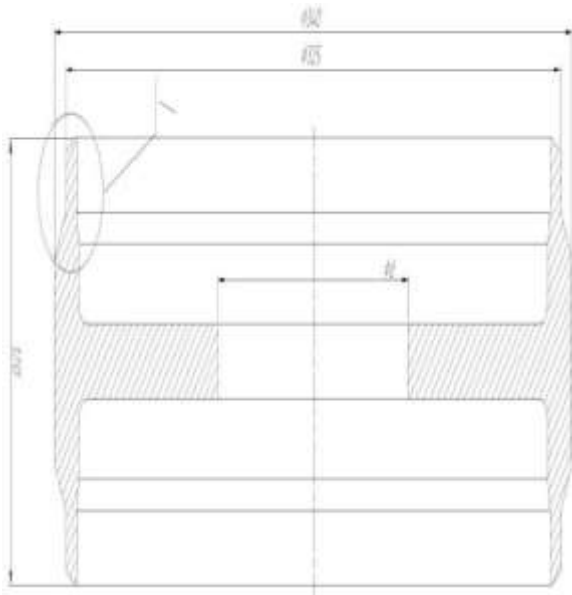


Throttling orifice

3.4 Flow throttling orifice.

- i. As name indicates this is the orifice which is used to control the flow in the system.
- ii. This device is used to supply flow at constant value, and this is a machined component or a welded component.
- iii. Typical construction of the flow throttling orifice shown in the below sketch.
- iv. Flow throttling orifice may be provided with an arrow mark to match with the flow direction.

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TECHNICAL CONDITIONS OF CONTRACT (TCC)

3.5 Handling and Erection:

- i. Handling, shifting the orifices to the desired location.
- ii. Narrow openings in the orifice are prone to choke with any foreign material in the pipeline. In view of this all these orifices shall be erected after completion of all physical works, including flushing of the systems
- iii. After completion of flushing activities in the respective system, clearance shall be obtained to erect the orifice from BHEL/NPCIL and proceed for erection of Orifice.
- iv. Position of orifice shall be marked on the pipe line which is already erected, cutting and edge preparation shall be carried out as per the marking.
- v. After cutting and before edge preparation a dam or stopper of suitable material shall be placed inside the pipe line to prevent the ingress of the grinding dust into the pipelines. Such entry of grinding dust will cause choking of these orifices.
- vi. After edge preparation, thorough cleaning of the pipe shall be carried out with industrial vacuum cleaners, to be arranged by contractor. Wherever direct visual inspection is not possible, pipes shall be inspected using video boroscope of max 30meter length, to ensure there is no foreign material inside the pipe line. Contactor shall arrange such boroscope also.
- vii. Before proceeding for fit up of the orifice with the pipeline, thoroughness of the orifice shall be ensured. This shall be carried out by using high pressure compressed air / water etc. based on the type of orifice. If any problem encountered in thoroughness of the orifice the same shall be brought to the notice of BHEL/NPCIL before proceeding for further action.
- viii. If thoroughness of the orifice is found satisfactory, orifice shall be fit-up with the pipeline, strictly as per the direction of flow marked on the orifice. Care shall be taken to ensure the arrow is matching the process flow direction. Non availability of flow direction in orifice if any shall be cleared before fit up.
- ix. In case of flow measuring orifice, the orientation of the nozzle is also important, and shall be ensured as per drawings/relevant document.
- x. Welding will be measured and paid in the relevant BOQ item.
- xi. The contractor also shall be responsible for cutting & removal and re-erection & welding of orifice in pipeline as instructed by the engineer. Payment of the same shall be made in respective BOQ items.

TECHNICAL CONDITIONS OF CONTRACT (TCC)

4. Reports:

- i. Reports shall be prepared and submitted for accepted as per the format prescribed.
- ii. As built drawing with detailed dimensions and the orientation shall be marked and submitted to BHEL/NPCIL for acceptance.

TECHNICAL CONDITIONS OF CONTRACT (TCC)

2.2.21 TECHNICAL SPECIFICATION FOR HANDLING, MARKING, CUTTING, FABRICATION, ERECTION, WELDING AND INSPECTION OF PIPE SUPPORTS.

Sr No	Description
1	Purpose
2	Scope
3	Scope of work in detail
3.1	General Information and Requirements
3.2	Simple Sliding Support
3.3	Sliding Guide supports / Guide supports
3.4	Fixed supports
3.5	Hanger supports
3.6	Spring Hanger Supports:
3.6.1	Spring assemblies
3.7	Shock absorber Supports (Other than for NSSS)
3.8	Viscous elastic Damper
4	Reports and Records

1. Purpose:

This section will give detailed technical specification, general information and broad sequence of activities involved in handling, fabrication, erection of pipe supports of various types and sizes in the process systems covered this contract in various locations, elevations and buildings.

2. Brief Scope of work:

- i. Receipt of pipe support material from BHEL/NPCIL stores along with system pipeline, handling, transportation, uncrating, preparation of IMIR.
- ii. De-preservation, segregating the pipe support members support wise (body of supports, spring assemblies, saddles, guides , hanger rods etc) and identifying all the members support wise.
- iii. Study of pipe support drawing, prefabrication of structural members which involves marking, cutting, grinding, grit blasting & inorganic zinc silicate primer application to required 75 microns DFT.

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- iv. Shifting the pre-fabricated support members to the required location, erection, fit up, welding, and inspection of pipe supports and visco-elastic dampers.
- v. Carrying out other applicable NDEs, preparation of reports and submission for acceptance.

3. Scope of work in Detail.

3.1 General Information and Requirements:

- i. Piping material is made of carbon and stainless steel in these buildings, spread at various floors/rooms.
- ii. Efforts shall be made to erect the permanent support before erection of piping. Piping erection on temporary supports shall be permitted by Engineer only for those locations where permanent supports cannot be erected in advance. There will not be any extra payment for temporary supports provided for piping. Temporary supports shall be removed by the contractor at his cost immediately after erection of permanent support.
- iii. Erection of pipe supports shall be carried out as per the working documents for pipeline of 100 NB and above and small bore pipe 80 NB & below, the support location shall be decided jointly based on field routing of piping and support type shall be selected from standard support album unless otherwise specified in the drawing.
- iv. Various types of pipe supports to be erected are given below.
 - a. Sliding supports
 - b. Sliding guide supports
 - c. guide supports
 - d. Simple Hanger
 - e. Spring Hanger
 - f. Simple shock absorber support.
 - g. Visco elastic damper
- v. Detailed requirement of the pipe supports are explained in the later sections of this specification.
- vi. Supporting structure of the support is mounted on the wall either by welding on embedded part or welding on anchor plate fixed by anchor bolt.
- vii. Location of the supports is provided in the piping isometric Drawings. Any deviation from the designed location as given in the drawings is not permitted until unless an approval is obtained from BHEL/NPCIL.

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- viii. Support material supplied will be in loose condition such as body of support, support clamp, clamp fasteners, shim plates, guide plates, hanger rod, spring assembly, supporting structure etc. These individual items are to be assembled at shop before shifting to site. The rate quoted by the contractor shall include involvement manpower & time accordingly.
- ix. Structural steel member such as channels, angles, plate, and beams of various sizes and thickness for the pipe support will be issued as free issue. In case of shortage / missing of support members, contractor shall supply as per approved Indian equivalent material. Payment of such item will be made in relevant BOQ item.
- x. Erection of scaffolding at required locations and elevations of various buildings covered under this tender.
- xi. Site survey shall be made for the location of the support based on the isometric drawings of pipelines and marking shall be made.
- xii. Detailed support fabrication drawings shall be provided by NPCIL for big bore pipe support i.e. Dia greater than 100NB and above. Whereas for small bore piping (80 NB & below) support fabrication drawings shall be made by the contractor based on the field dimensions and the standard album for small bore pipe supports. Following points shall be considered during developing the drawings for supports,
 - Nearest embedded part shall be considered on priority.
 - Nearest metal structure or structure of any big bore pipe support shall be considered.
 - If no metal structure or EP is available, then use of anchor fasteners shall be considered.
- xiii. To the extent possible plan shall be made to pre-fabricate the support structure in fabrication shop and only final fit up and welding shall be planned at location.
- xiv. Grit blasting of fabricated support structure & support members to required roughness as per SA 2-1/2, and application of zinc based primer over the grit blasted surface to required 70 microns DFT. Support primer painting is part of support item. For detailed specification of the grit blasting and primer application refer the technical specification for painting.
- xv. Stainless shim plates shall be provided between the body of supports and stainless steel pipelines. Shim plate will be supplied along with the body of supports.

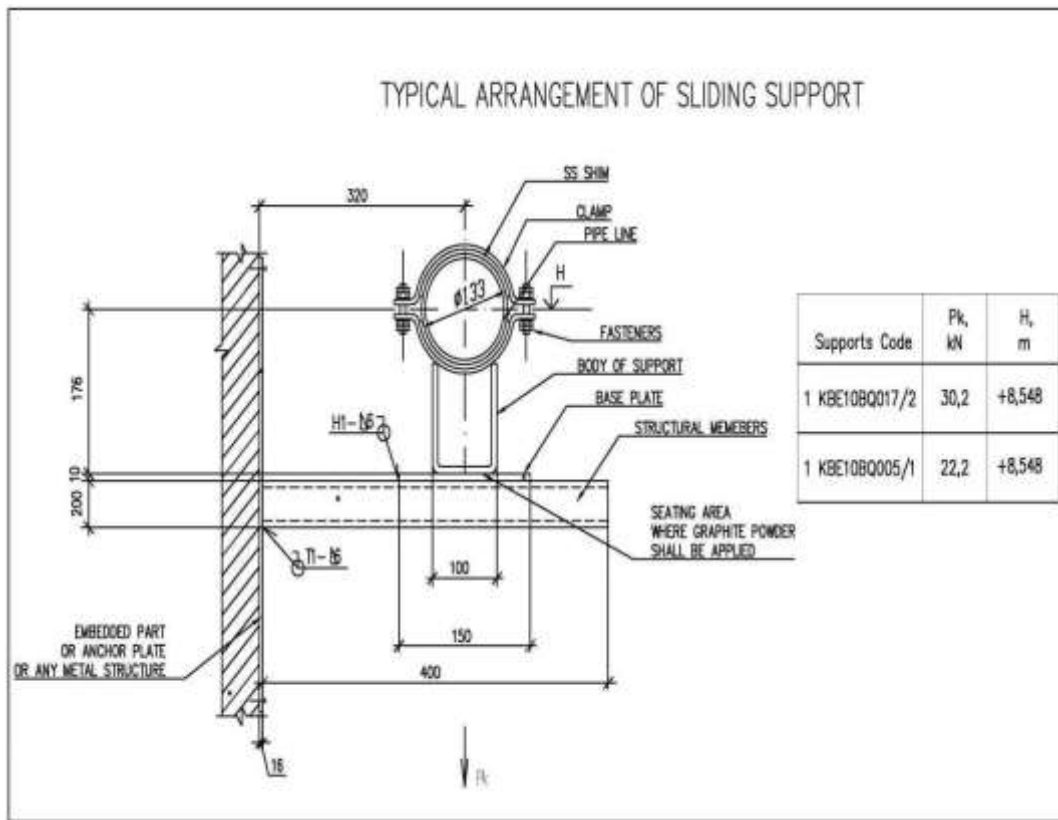
TECHNICAL CONDITIONS OF CONTRACT (TCC)

- xvi. The contact surfaces shall be applied with graphite powder for sliding supports & guide supports. Supply and application of graphite powder is also under the scope of contractor within the quoted rate.
- xvii. Welding of the support members as per the applicable and approved procedures.
- xviii. After completion of erection of support, as built shall be prepared and submitted with all the dimensions, elevation, physical dimensions irrespective of size of the support or pipelines. Also as built shall include the supporting anchor / embedded part details etc.
- xix. If the support is erected using any anchor bolts, fixing of anchor is included in the scope of the contractor. Fixing of anchor is measured in separate BOQ item.
- xx. Completed supports shall be applied with touch up primer where ever welding is performed. Scope includes Supply of primer and its application.

3.2 Simple Sliding Support:

- i. Typical construction of the simple sliding support is as shown below.
- ii. This is a dead weight support, simply resting on the support structure.
- iii. Care shall be taken during erection of sliding supports; there shall not be any gap between the resting plate and the body of support base.
- iv. Once erection is complete, graphite powder shall be applied between the contact surfaces. Supply of graphite powder is in the scope of contractor.
- v. Body of support is supplied meeting specific requirements as per working drawings and are designated with typical Russian standards, Contractor shall take utmost care during erection of the body of support so that to prevent wrong selection and erection of body of support.
- vi. Care shall be taken during welding of saddle to the pipeline not to damage the pipe line. Repair, required if any on this count, shall be at the risk and cost of contractor.

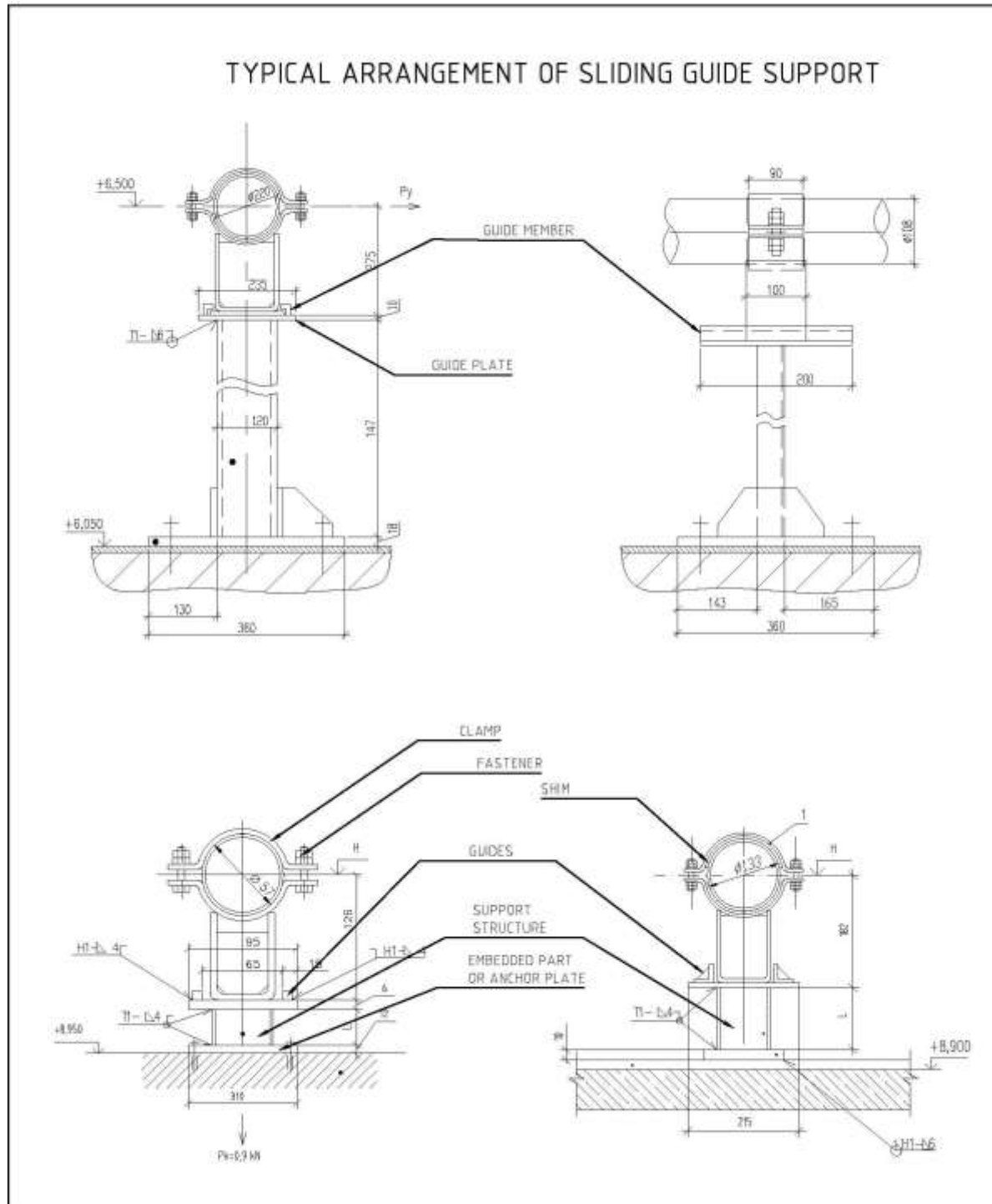
TECHNICAL CONDITIONS OF CONTRACT (TCC)



3.3 Sliding Guide supports / Guide supports:

- i. The main parts of the guide supports are body of supports whose details are explained above and , supporting structure. In addition , these supports have an additional member called a guide plate.
- ii. These guide plates will be resting on the supporting structure by welding and body of support is rested on the guide plate, within the guide.
- iii. Note that in some occasions the guides will be supplied in loose condition, which shall be welded to the plate. These factors shall be considered during quoting the rate.
- iv. In general, horizontal pipe lines will be provided with the single guide plate, where as vertical pipe line will be provided with the double guide plate.
- v. Typical construction of the guide and the sliding guide supports are as given below.
- vi. As explained earlier these are guiding members and hence there shall be free movement between the body of support and the guide plates. No gap shall be available between the resting surfaces and graphite powder shall be applied in mating areas.
- vii. Clearances shall be maintained as per drawing, between the guides and the body of support.

viii. Various types of guide plates will be supplied in one system, correct type of guide plate shall be installed in the specified location.

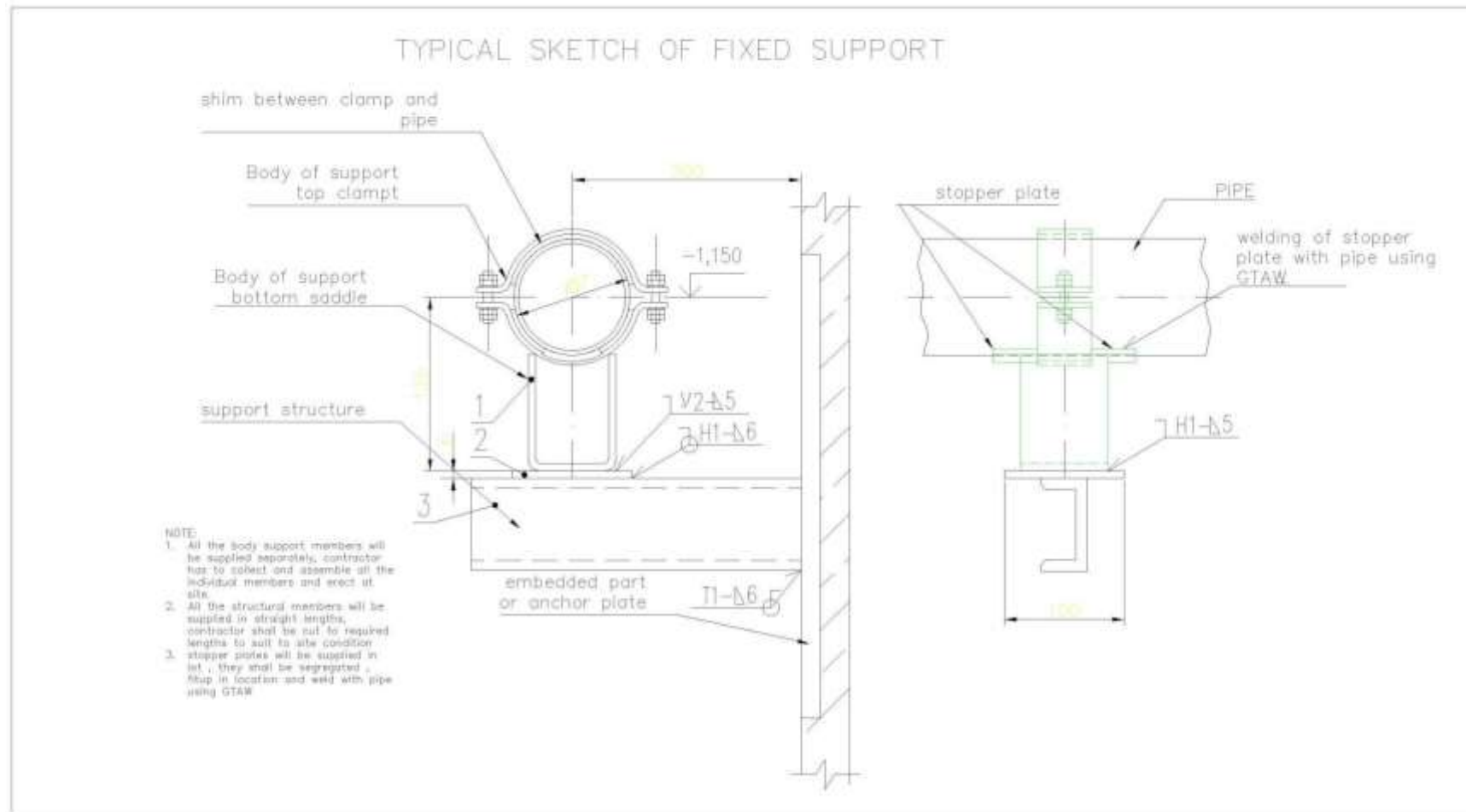


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3.4 Fixed supports:

- i. As name indicates, fixed supports are not intended to move from the desired location.
- ii. Support erection shall be done as explained above, except that the body of support movement will be restricted in all directions by welding to pipelines and the structure.
- iii. In this case the body of support mounted on the pipe will be directly welded on the resting plate. In addition to this one / two stopper plates will be welded on the pipe surface adjacent to the support bottom clamp on either side of the support to restrict relative movement of the pipe making the support fixed.
- iv. Material of stopper plates is similar to the pipe parent material. These stopper plates shall be welded to the pipe surface using GTAW process. Any repair/ additional weld joint required shall be carried out by the contractor at his own cost.. These factors shall be considered while submitting the quote.
- v. In case of small bore supports, body of supports will be directly welded to the pipe, without any clamps. This welding has to be carried out using GTAW process taking care not to damage the pipe. Any repair/additional joint due to this repair will be at the cost of contractor.
- vi. Typical construction of the fixed support is as given below.
- vii. In addition to the above mentioned scope of work, any other details and the requirements given in the working drawing shall be also included in the scope of work for successful completion of the work.

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3.5 Hanger supports:

- i. Hanger supports may be provided on the vertical run or horizontal run of pipes.
- ii. Hanger supports can be single rod hanger type or double rod type.
- iii. As bought out in earlier points, all the parts of the hanger will be supplied in loose conditions, i.e. lugs , rods (will be supplied in straight lengths), turn buckles, support clamps , fastening clamps, fasteners etc.
- iv. All the components shall be segregated support wise, identification marking shall be made by tagging or punching. Once identified and marked care shall be taken not to interchange the items.
- v. Rods shall be cut and ground as per the field measurement; all the clamps and the eyes shall be segregated, eyes shall be welded to the rods and shall be assembled at site with the clamp and the supporting member. The supporting member may be embedded part or a metal structure.
- vi. Joint between the rods and the eyes involves good quantum of welding. Welding will not be measured separately. Quoted rate shall include all these efforts/factors..
- vii. Rod sizes may vary from 8 mm to 40mm dia, the same in case of the eyes also.
- viii. In case of erection of hanger supports in location, utmost care shall be taken to ensure tightness of hangers. The complete weight of the pipe shall be transferred to the hanger. If any support is found in loose condition, it shall be rectified by the contractor without any additional cost implication.
- ix. The hanger support erection shall be planned and sequenced to ensure loading of all hangers. One type of hanger supports are provided with the turn buckles. Care shall be taken to ensure use of correct turnbuckle for the particular support., All threaded areas shall be protected before taking up fabrication, grit blasting etc, to avoid any damage.
- x. Hanger supports are also provided with the dowel pins with the locking rings for assembling the pipe saddle with the hanger members. These components shall be handled carefully. All such items shall be preserved with approved preservatives (grease/oil etc) to avoid rusting.
- xi. Unhindered operation of hanger support shall be ensured during erection. Typical sketches of the hanger supports are as given below.
- xii. In addition to the above mentioned scope of work, any other details and the requirements given in the working drawing shall also included in the scope of work for successful completion of the work.

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TECHNICAL CONDITIONS OF CONTRACT (TCC)

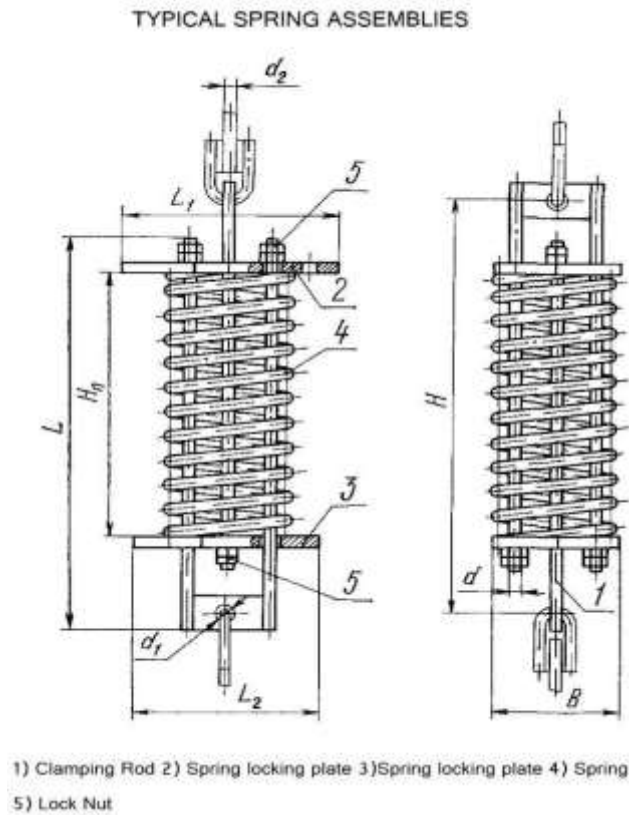
3.6 Spring Hanger Supports:

- i. Spring hanger supports may be mounted on vertical and horizontal pipe runs.
- ii. Similar to the simple hanger supports the main components of the spring hanger supports are Body of supports / clamps, supporting beam, hanger rods, eyes/lugs, shims etc. apart from spring assembly.
- iii. As brought out earlier all these components will be supplied in loose condition i.e. clamps, shims, rods, lugs, spring, spring plates, spring assembly rods, fasteners etc. All these components shall be identified & segregated support wise before proceeding for fabrication.
- iv. Similar to hanger supports as per the field measurements, rods are to be cut and ground to the required length and assembling the lugs / eyes with the rods and welding shall be performed.
- v. Similar to the other supports, these spring hanging supports also may be supported from the embedded part or anchor plate mounted using anchor bolts or nearest metal structure.

3.6.1 Spring assemblies:

- i. Spring assemblies are identified by separate and unique Russian standard. They are classified based on the stiffness, compression and free height of the spring. Hence springs are not interchangeable.
- ii. First activity shall be segregation of all the parts of the spring assembly support wise, assemble the spring with the spring plates and the rods using fasteners.

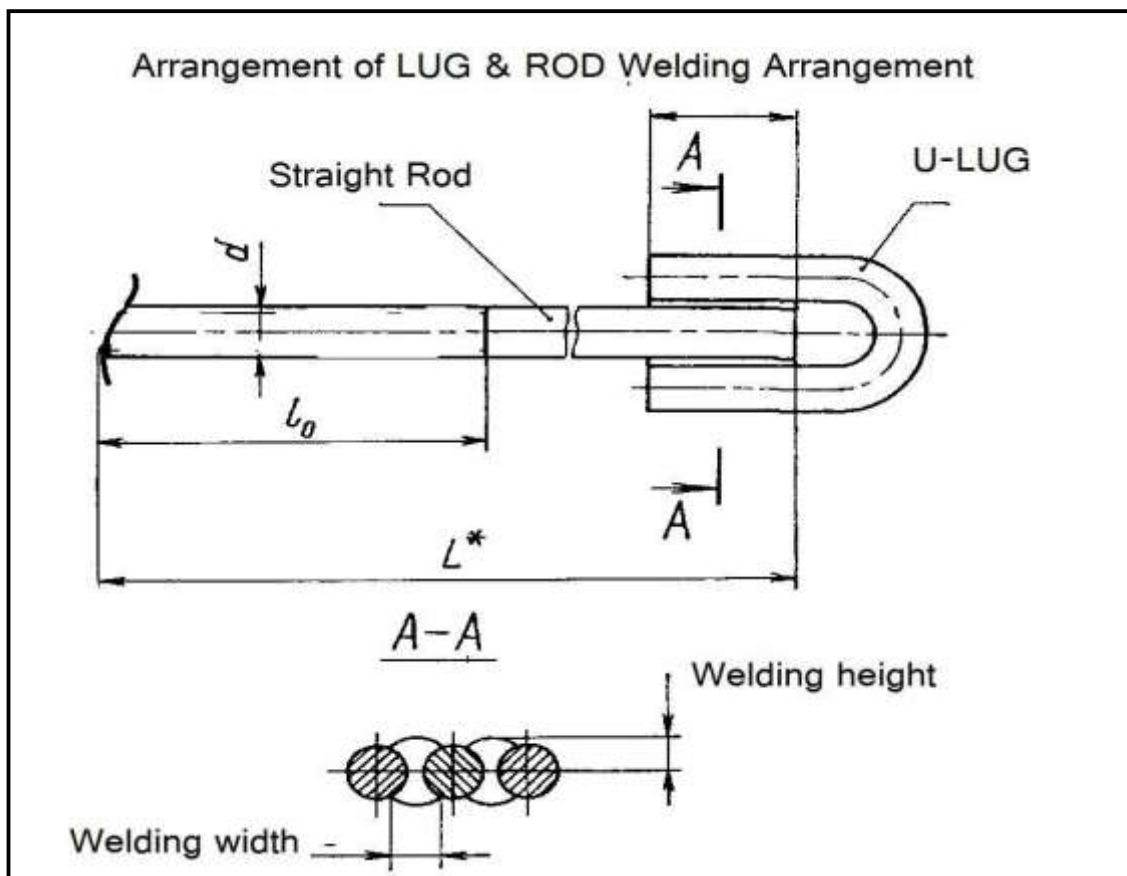
TECHNICAL CONDITIONS OF CONTRACT (TCC)



- iii. All these spring hanger supports are provided with a requirement of spring heights to be maintained during the erection condition and during operation condition.
- iv. Spring is supplied in free state. Before proceeding for assembly of components, spring dimensions such as free height & wire diameter shall be checked and ensure whether the spring being erected is as per the requirement or not.
- v. Since the quantity of the spring hanger supports are very huge for carrying out pre-compression and locking the spring there shall be a jig / fixture fabricated, so that before taking the spring assembly to the location spring shall be set and locked to the required dimension.
- vi. Spring shall be assembled and dimensions shall be set as per approved drawings before erection. i.e. dimension H or Hn in the above sketch
Once the spring assembly is set and locked, it can be erected in position and welded.
- vii. Lock of the spring shall be released after getting clearance from Engineer.
Spring height shall be re adjusted, if found to vary after releasing of locking. Spring assemblies may be provided below the pipe saddle or above the pipe saddle as shown in the sketch.

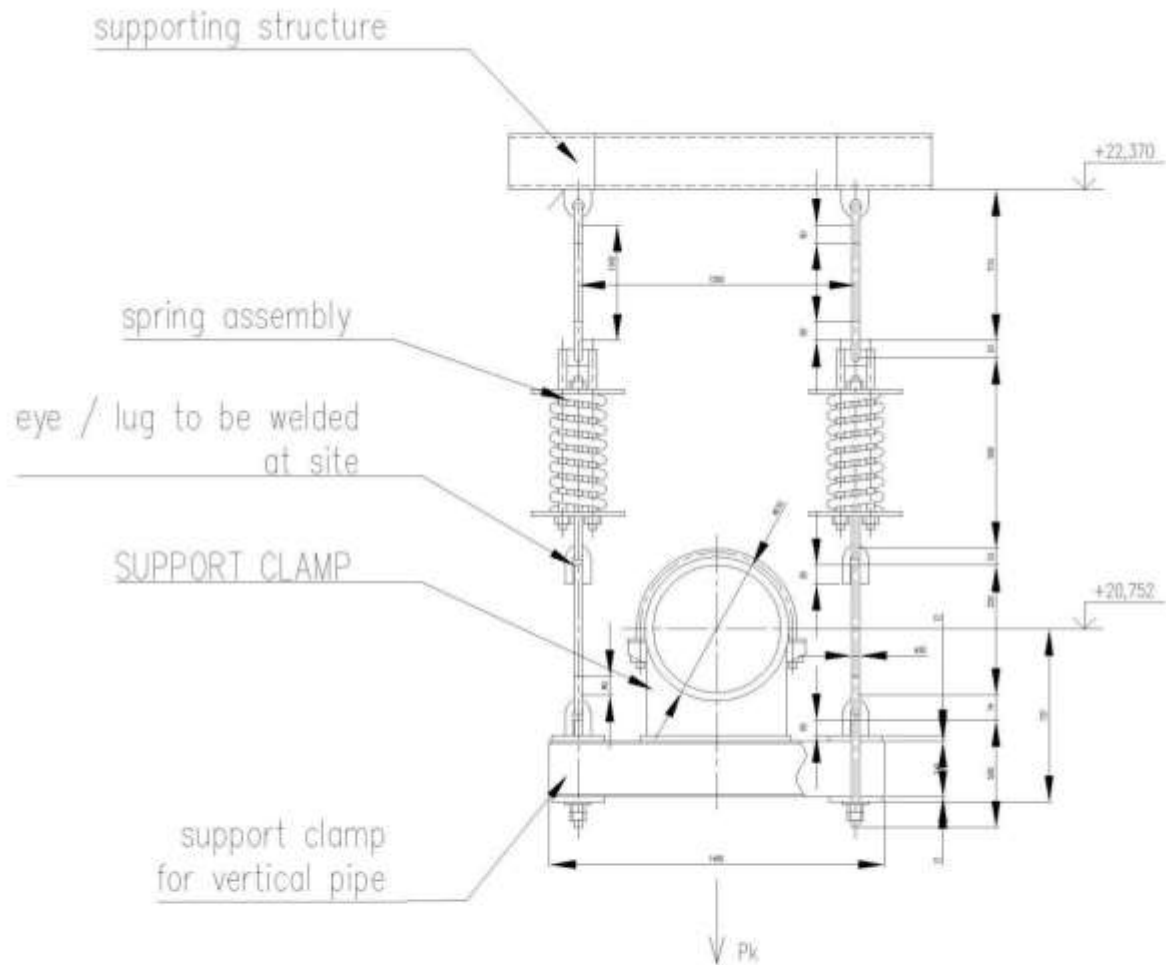
TECHNICAL CONDITIONS OF CONTRACT (TCC)

- viii. Spring assemblies provided on the vertical pipe will be provided with a stopper plates for taking the load of the pipe, these plates are to be welded to the pipe using GTAW process. Stopper plates will be supplied on free issue basis.
- ix. The manpower involvement & other requirements of the job shall be kept in mind while quoting the rates.
- x. Arrangement of typical spring support assembly on horizontal and vertical pipelines is as given below.



TECHNICAL CONDITIONS OF CONTRACT (TCC)

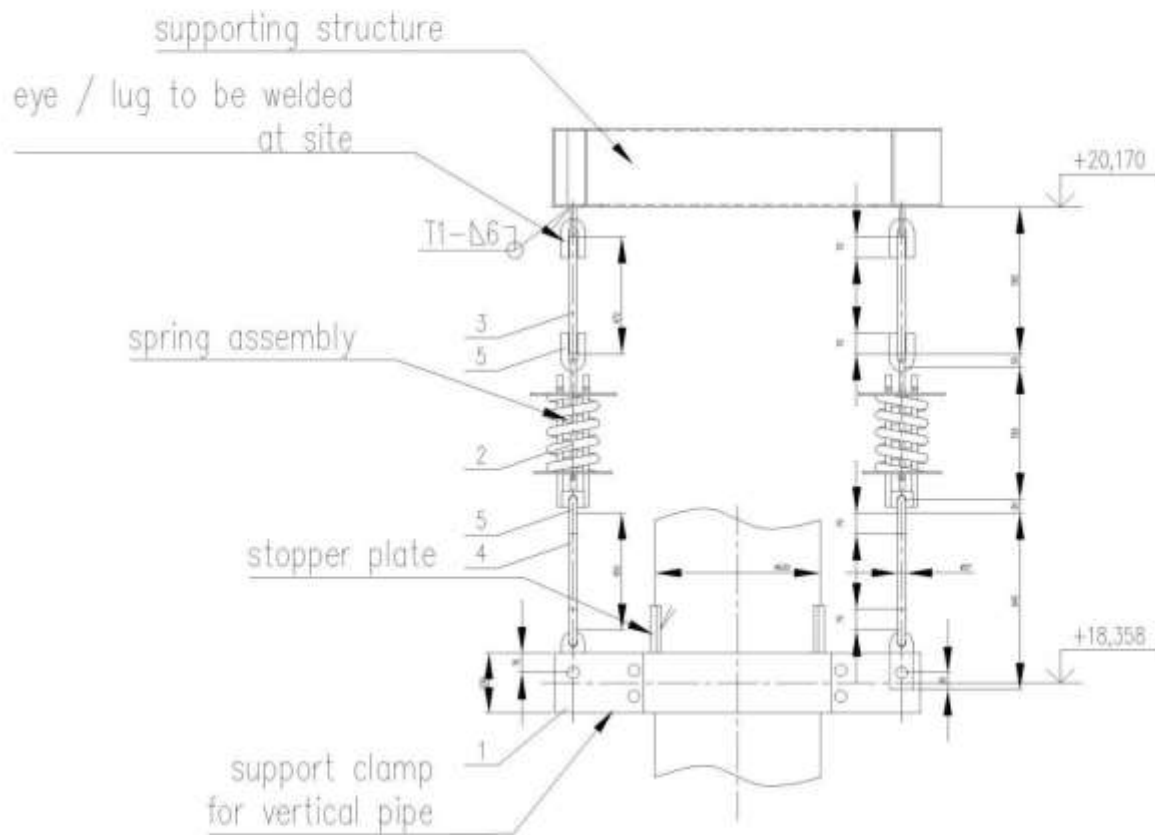
SPRING HANGER IN HORIZONTAL LINE



Name	Unit	Characteristic of the spring								Load on bearing structure $F_{structure}$ (N)
		Table data			When installing		Under operating conditions			
		Permissible operating load F_{max} (N)	Deflection at force F_{max} (mm)	Spring height in free state H_0 (mm)	Spring height H_{max} (mm)	Load on the spring F_{max} (N)	Spring height H_{max} (mm)	Load on the spring F_{max} (N)	Spring height H_{max} (mm)	
1.18438000/1	4	40,00	70	289	244	35,25	245	25,25	130	

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SPRING HANGER IN VERTICAL LINE



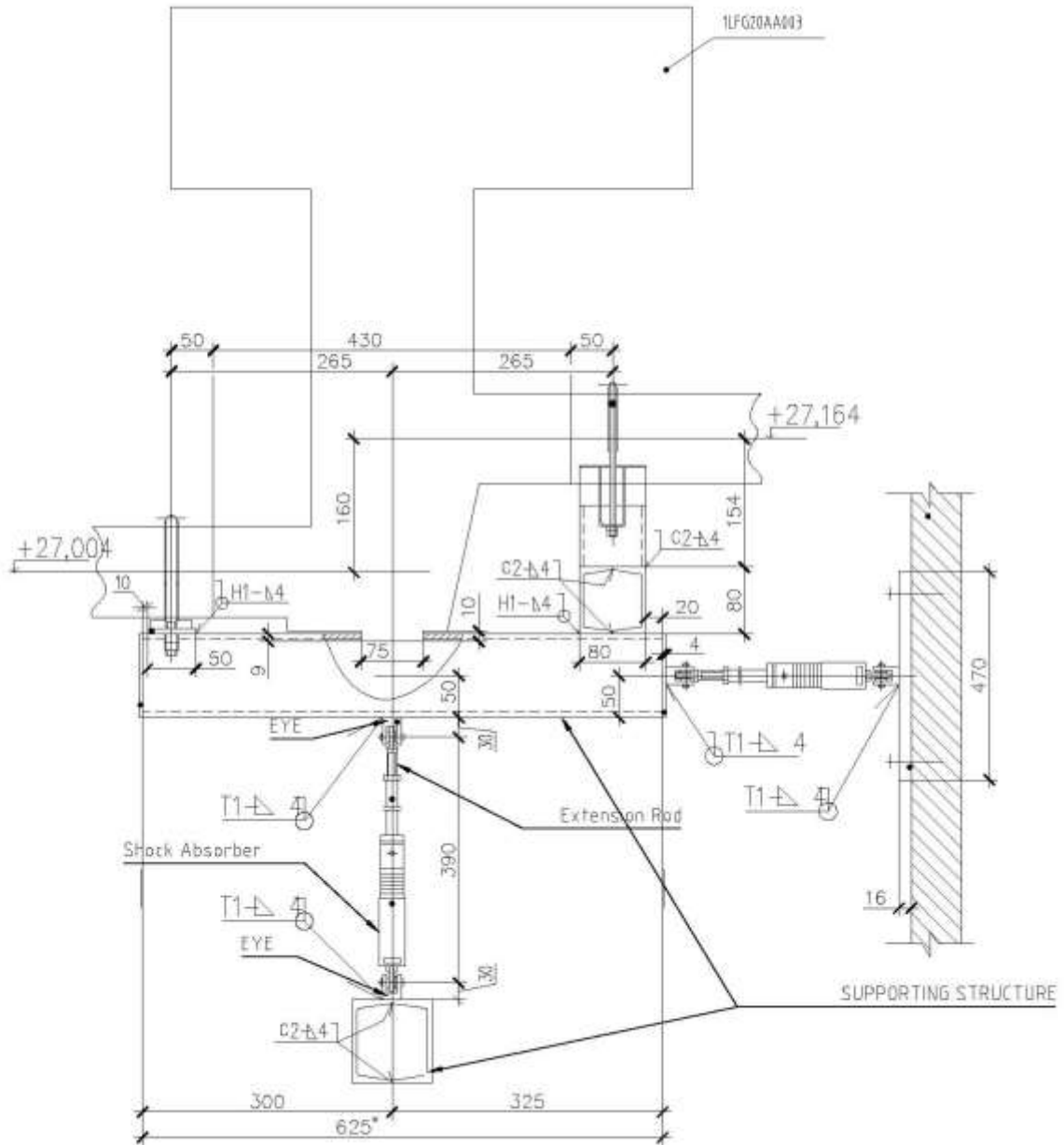
Name	Item	Characteristics of the spring								Load on loading structure F _{max} (kN)
		Static data			Mass installing		Under operating conditions			
		Permissible operating load F _{max} (kN)	Deflection at 20°C Δ (mm)	Spring height in free state H ₀ (mm)	Spring height H (mm)	Load on the spring F _{max} (kN)	Spring height H (mm)	Load on the spring F _{max} (kN)	Spring height H (mm)	
1184986000/1	3	32,60	10	217	238	27,38	238	26,70	238	26

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3.7 Shock absorber Supports : (Other than for NSSS):

- i. Some of the piping systems are provided with the shock absorber type pipe supports.
- ii. Typical arrangement of such support is as shown in the sketch below.
- iii. Mainly this kind of support consists of Body of support, structural members and a member called shock absorber.
- iv. All these members are supplied separately and shall be segregated support wise before taking up erection.
- v. Orientation of the support shall be marked properly at site while laying out to meet the angular orientation requirement as per drawings. The dimensions eye to eye shall be maintained as per the drawing. Before taking up erection of these supports proper planning is required in marking and cutting of the structural members, dimensions between the eyes shall be maintained perfect, so that the provided shock absorber will seat in the position without any alteration or modification.
- vi. Support structure shall be mounted taking support from metal platform or concrete wall as shown in drawing.
- vii. One support may contain more than one number of shock absorbers.
- viii. Dimensional requirements of all the shock absorbers shall be fulfilled.
- ix. Any deviation in the dimensions shall need approval from Engineer.
- x. Typical arrangement of the shock absorber support is as shown in the figure below.
- xi. In addition to the above mentioned scope of work, any other details and the requirements given in the working drawing shall also included in the scope of work for successful completion of the work.

TYPICAL ARRANGEMENT OF SHOCK ABSORBER SUPPORT



TECHNICAL CONDITIONS OF CONTRACT (TCC)

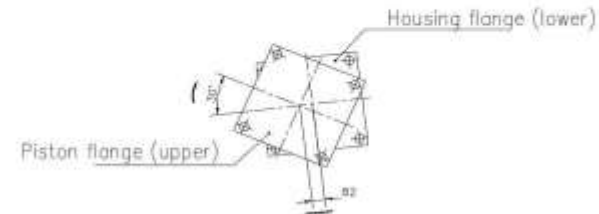
3.8 Viscous elastic Damper:

- i. Typical arrangement of the viscous elastic damper support is as shown in the sketch.
- ii. The main purpose of this damper is to isolate the vibrations to and from the system to the civil structure and vice versa.
- iii. The main components of this support are, viscous elastic damper, supporting structure, top and bottom flange &, fasteners.
- iv. These dampers may be provided separately on the pipe line or assembled along with the spring hanging support. If the damper is assembled with the spring hanging support, each item will be measured in the respective BOQ item, i.e. spring hanger will be measured in the support item and the damper will be measured in the damper BOQ item.
- v. There is wide range of dampers whose weight varies from 20kg to 1000kg approx.
- vi. Utmost care shall be taken during handling these dampers, as these dampers contain a viscous fluid. Any mishandling, damage and loss of viscous fluid during handling, transportation and erection shall be arranged by the contractor at his risk and cost.
- vii. The rubber covering provided on the damper is very delicate and care shall be taken during handling of the dampers to ensure this does not get damaged. Suitable protection shall be provided after erection.
- viii. Dampers are mounted in vertical condition irrespective of the direction/ orientation of pipes.
- ix. Structural members for this damper are pre-formed box type members, supplied in free lengths; these shall be cut to the suit to site condition and erected. In some cases members are fabricated out of plates of various thicknesses.
- x. Field measurements shall be taken with respect to the drawings.
- xi. Proper planning is required for shifting, handling and erection of dampers.
- xii. The main requirements for erection of the dampers are location, height of the damper, and orientation of the flange. Any deviation in all the above readings is not permitted.
- xiii. Damper will be supplied in locked condition for transportation purpose; this lock shall not be removed till the damper is shifted to the location, and is to be removed only just before installation.

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- xiv. There are two mating flanges of the damper, one flange is to fasten with the flange on the member from civil structure and other to fasten with flange on the member coming from pipe.
- xv. Before erection of the damper, damper shall be unlocked with the transport locking arrangement, and damper flanges shall be preset to the readings provided in the drawings i.e. orientation and the height of the damper, once it is ensured damper shall be locked using in-situ locking arrangement.
- xvi. Supporting members shall be erected in position in line with the body of support mounted on the pipe.
- xvii. Orientation of the mating flanges shall be adjusted at par with the orientation of the damper, and fit up shall be made.
- xviii. Damper shall be placed in location and check whether the mating flanges are matching with the flanges of the damper, if not corrections shall be made before taking up welding of flanges & associated members.
Damper shall be removed from location during the welding operation.
- xix. Re-erect the damper in the location; fasten the flanges as per the requirement.
- xx. Multiple handling of damper may be required during the erection & alignment process. Rate quoted shall be inclusive of all such multiple handling.
- xxi. In addition to the above mentioned scope of work, any other details and the requirements given in the working drawing shall is also included in the scope of work for successful completion of the work.

TYPICAL ARRANGEMENT OF VISCO ELASTIC DAMPER



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4. Reports and Records:

- i. All the information of the fabricated and erected support shall be made in to as built with detailed bill of material and shall be submitted for acceptance of BHEL & NPCIL.

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2.2.22 TECHNICAL SPECIFICATION FOR SUPPLY AND APPLICATION OF EPOXY PAINT INCLUDING GRIT BLASTING AND PRIMER APPLICATION.

Sr No	Description
1	Purpose
2	Scope
3	General information and scope of work in detail.
3.1	General:
3.2	Grit Blasting & Primer application:
3.3	Epoxy Paint Application
3.4	Application of high temperature paint (OC51-03):
3.5	Inspection, Qualification:
4	Reports and records

1. Purpose:

Purpose of this specification is to provide guidance to contractor to understand the scope, quantum of work and technical requirements to be followed during supply and application of zinc silicate primer, supply & application of epoxy paint and high temperature radiation resistant paint on pipeline supports, metal structures & equipment. The work also includes providing facilities for supply and carrying out grit blasting.

2. Scope:

The contractor scope work involves but not limited to the following.

- i. Study of drawings, Preparation and approval of QAP, erection, procedures.
- ii. Supply of zinc silicate primer of NPCIL approved brand.
- iii. Supply of Apcodur 641 or Apcodur 641CS of Asian paints or protecto mastic of Berger paints or any other equivalent paint.
- iv. Supply of high temperature radiation resistance paint OC51-03 and application of KO921 varnish.
- v. Receipt of material, transportation, inspection and storage.
- vi. Establishing grit blasting facility, grit blasting and application of zinc silicate primer to as specified in drawings. Unless otherwise specified the thickness of primer coating (DFT) shall be 60 to 70microns.
- vii. Application of epoxy paint and high temperature radiation resistance paint with varnish as per the requirement over pipe supports, metal structure and various equipment to required thickness.

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viii. Preparation of reports and submission for acceptance.

3. General information and scope of work in detail.

3.1 General:

- i. All the carbon steel pipelines, metal structures, pipe supports and other miscellaneous structures inside Nuclear Island buildings are needed to be painted.
- ii. Preparation of work procedure & quality plans and submission for review and approval from BHEL & NPCIL.
- iii. Painting systems needed to be followed shall be of NPCIL approved. Any other equivalent may be proposed from the end of contractor.
- iv. All the PIPE/STRUCTURES shall be grit blasted, primer applied before shifting to the site.
- v. Final paint may be applied (Leaving the weld area) on the members before shifting to the site as instructed by the engineer.
- vi. Erection of scaffoldings and temporary platforms for painting in location.
- vii. Scope includes supply, storage of paint, including cleaning aids like kerosene, acetone, cotton waste etc and submission of test reports, preparation of IMIR for BHEL & NPCIL acceptance.
- viii. Set up painting facilities at site complete with all necessary equipment such as compressor for grit blasting, primer application & paint application, air less paint equipment etc.
- ix. Qualification of grit blasters and painter shall be carried out as per the approved procedures.

3.2 Grit Blasting & Primer application:

- i. Piping and the pipe support material supplied on free issue basis by NPCIL will be supplied in the preservative applied condition. This paint shall be removed using grit blasting process.
- ii. Contractor supplied material shall be grit blasted and primer applied after fabrication and before proceeding for erection.

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- iii. Mill scale, rust, rust scale and foreign matter shall be removed fully to ensure that a clean and dry surface is obtained
- iv. The surfaces shall be blast cleaned using one of the abrasives like chilled cast iron or malleable iron and steel at compressed air pressure of 7kg/cm² at a appropriate distance and angle depending of nozzle size maintaining constant velocity and pressure.
- v. Unless otherwise specified, surface preparation shall be carried out for surface roughness of Sa 2-1/2.
- vi. Surface roughness measuring Tools like presso film with micrometer / roughness comparator shall be arranged by contractor.
- vii. Blasted surface shall be cleaned thoroughly using compressed air.
- viii. Painting of primer & epoxy shall not be permitted during rainy / wet condition. Primer shall be applied in the conditions specified by the paint manufacturer.
- ix. The first coat of primer must be applied by airless spray/ air assisted conventional spray on dry surface. This should be done immediately and in any case within 4 hours of cleaning of surface.
- x. Carryout primer wet and dry film thickness for acceptance.
- xi. Adequate number of instruments (Elcometer) for measuring WFT & DFT shall be arranged by the contractor.

3.3 Epoxy Paint Application:

- i. Supply specification of the paint is given in the end of the specification for various paints.
- ii. Mixing of the paint shall be carried out as per the manufacturer data sheet / instruction, using only compatible thinner.
- iii. Paint may be applied using Brush, air spray or airless spray techniques. The same shall be brought in the work procedure.
- iv. The painter shall be trained to measured each paint coating WFT corresponding to the specified DFT. Standardize the paint application technique to achieve the desired WFT and same shall be ensured in the qualification trial.
- v. The subsequent coat of paint shall not be applied as recommended by the paint manufacturer.
- vi. In case the drying time is abnormally higher than time specified by the manufacturer, the painting system and paint shall be reviewed for acceptance.

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- vii. No paint shall be force dried under conditions which will cause chalking, wrinkling, blistering formation of pores, or detrimentally affect the conditions of the paint.
- viii. Any repair observed during inspection shall be attended by the contractor as per the procedure. Such repairs are not eligible for payment.

3.4 Application of high temperature paint (OC51-03):

- i. OC51-03 paint is a Russian make paint for high temperature and radiation resistant.
- ii. Detailed specification of the paint shall be submitted for acceptance before placing of order by contractor to paint supplier.
- iii. OC-51-03 is a self priming paint which shall be applied after grit blasting.
- iv. OC-51-03 is a organic silicate paint which shall be prepare be mixing base and hardener (tetrabutoxytitanium or poly butyl titanate) dissolved in compatible toluene.
- v. Mixing shall be done as per the manufacturer instruction and the data sheet.
- vi. Paint may be applied using brush, air spray or airless spray.
- vii. First layer applied shall be dried up for 40 minutes , the second one for 7 hours after first layer.
- viii. Paint shall be applied to the required thickness as specified in the working drawings and other specifications.
- ix. This paint shall be applied to the structures and equipment which are specified in the working drawings / Engineer.

3.5 Inspection, Qualification:

- i. The grit blaster and painter engaged in work shall be assessed for skill and persons who have adequate technique only will be qualified.
- ii. During qualification of procedure the following test will be performed.
 - Wet film thickness (WFT).
 - Dry film thickness (DFT).
 - Peel off test.
 - Pull test.
- iii. During application only WFT and DFT will be done and based on DFT the work will be accepted.

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- iv. All material such as grit, primer, paint shall be checked for manufacturer test certificate (MTC) and date of manufacturing and expiry date. No material will be accepted without MTC.

4. Reports and records:

- i. The work of grit blasting and primer application is part of fabrication / supply & fabrication of metal structure / pipe support. No separate payment is envisaged for the same.
- ii. Painting shall be measured and paid as per respective BOQ item.
- iii. Records shall be made in the formats specified in the detailed quality plan.

2.2.23 TECHNICAL SPECIFICATION FOR SUPPLY AND APPLICATION OF HOT INSULATION USING CERAMIC BLANKET (FIXED & REMOVABLE) ON PIPING SYSTEMS AND EQUIPMENT

Sr No	Description
1	Purpose
2	Scope
3	General Information
4	Design Basis
5	Supply
6	Requirements of Ancillaries
6.1	Piping ancillaries
6.2	Equipment ancillaries
7	stitching
8	Application procedure
8.1	Surface preparation
8.2	Application of aluminum foil
8.3	Application of Insulation piping & equipment
8.4	Application of Multi Layer Insulation
8.5	Application of Insulation on equipment
8.6	Application of Insulation on Piping Passing Through Wall/Slab
8.7	Application of insulation on PHRS ducts
9	Removable Insulation
10	Cleaning Requirement Of Building/ Rooms After Application Of Insulation And Health & Safety
11	Mode of Measurement
12	Examination And Testing
13	Reports and Records

1. Purpose:

Purpose of this specification is to provide guidance to contractor to understand the scope, quantum of work and technical requirements involved in the supply and application of hot insulation & cladding over the process system piping and equipment covered under this contract.

2. Scope:

The scope of the contractor's work comprises but not limited to the following.

- i. Study of drawings, preparation of network schedules.
- ii. Preparation and approval of QAP, erection, welding and inspection procedures.
- iii. Supply, transportation, storage of ceramic fiber blanket of density 96 Kg/cum, glass cloth of 0.5 to 0.6 mm thickness of 600GSM, aluminum foil of 0.1 mm thick.

TECHNICAL CONDITIONS OF CONTRACT (TCC)

- iv. Supply, transportation, storage of stainless steel cladding sheets of 0.7mm thick conforming to ASTM SA 240, TP 304 mirror finish No 4 grade, stainless steel mesh of SS 304 and SS ancillaries for the systems inside reactor building and annular space.
- v. Supply, transportation, storage of aluminum cladding sheets of 0.8 mm thick and as per IS737, 19000H2 ancillaries for process systems of reactor safety & auxiliary buildings covered under this contract.
- vi. Handling, marking, cutting of mats & ceramic glass cloth to required lengths of required thickness and pre-forming of mats.
- vii. Cleaning of stainless steel pipe surface using acetone & application of aluminum foil on the stainless steel pipelines including cleaning of CS pipes.
- viii. Application of Hot insulation for CS and SS piping, piping elements, rotary and static equipments with fixed & removable type insulation in single & multilayer as per technical specification and working documents.
- ix. Marking, cutting and application of stainless steel wire mesh over the ceramic mats applied over the pipe lines. SS wire mesh application shall be applied over the systems inside reactor building.
- x. Marking, cutting, forming, fabrication of Aluminum cladding for systems outside reactor building, Stainless steel cladding, SS wire mesh for systems inside Reactor building.
- xi. Erection of Cladding over the insulation, fastening the cladding sheets using the fasteners and as per the details given in the working drawing. And application of sealant over the joints of cladding.
- xii. Cleaning the work area from the insulation material and other waste generated through this work.

3. General information :

Hot insulation of piping system under this contract is grouped in two groups.

a) Insulation of piping and equipment inside reactor building (group-1):

The insulation consists of following element:

- Aluminum foils wrapping on SS pipe lines.
- Ceramic insulation wrapped in glass cloth of various thickness as indicated in drawing.

- SS wire mesh
- SS cladding

b) Insulation of piping and equipment inside other than reactor building (group-2):

- Aluminum foils only on SS pipe lines.
- Ceramic insulation of thickness as indicated in drawing.
- Aluminum cladding

Application of thermal insulation shall be carried out after completion of the hydro test.

4. Design Basis:

- i. Hot insulation should be provided for external surfaces of equipment, pipes, valves and supports with following coolant temperature:
 - Above plus 45 deg C located in the full accessible and control accessible attended rooms.
 - Above plus 60 deg C located in unattended rooms.
- ii. For Indoor facilities when ambient temperature is plus 25 deg C, temperature on surface of insulation should not exceed the following.
 - Plus 45 deg C for facilities located in the permanently attended rooms,
 - Plus 60 deg C for facilities located in the periodically attended rooms,
- iii. For outdoors facilities within the service areas, the temperature on the surface of insulation should not exceed:
 - Plus 55 deg C for the covering metallic layers
 - Plus 60 deg C for other kinds of covering layers

5. Supply

- i. Supply of raw material: Supply of material includes ceramic insulation mats as per the specification mentioned below, fastening elements, supporting elements, sealing elements etc.
- ii. Supply of ceramic insulation mats:

For thermal insulation of stationary equipments, SS and CS piping sewn mats made of superfine basalt fiber/ ceramic fiber blanket wrapped in glass fabric confirming to the properties mentioned in Tables 1 shall be used.

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Table 1

Thermal Insulating material for Vibrating equipment, Valves, Tank, manhole, flanged joints and weld joints (selected) where removable type insulation is proposed		
Sl No	Parameters for thermal insulating material	Value for Ceramic Fiber blankets
1	Density of article, Kg/cum, (average)	96
2	Compaction factor during erection	1.2
3	Heat conductivity, W/(m deg C) at (22±5) deg C not greater than	0.04
4	Calculated head conductivity in the structure, W/m deg C	$\lambda_k = (0.035 + 0.00017 \cdot t_m)^*$
5	Sorption humidity, % not greater than	0.5
6	Radiation tolerance (cumulative irradiation dose), Mrads, not less than	100
7	Content of water soluble chlorides (by mass) % not greater than	0.03
8	Content of free alkalis reduced to caustic soda (by mass) % not greater than	0.02
9	Content of non fibrous impurities	0 (Particles having the same composition as the fiber are not considered as impurities)
10	Average diameter of fiber (micro meter) not greater than	3.0
11	Application for temperature not greater than deg C	600
	* $T_m = (t_w + 45)/2$ - average temperature of thermal insulating layer deg C, where t_w - coolant temperature deg C	

Note:

- 1) For thermal insulation for equipment, pipeline with coolant temperatures above 250°C (indicative only), multiple layer thermal insulating structure required and also outer layer seams must overlap the inner seams. However, thickness of insulation is indicated in insulation WDs and the same has to be followed.
- 2) Single layer of insulation thickness is limited to maximum of 50 mm only. Each layer of insulation shall be wrapped in glass cloth & stitched.
- 3) CS pipe and supports shall be painted before application of insulation.
- 4) The contractor shall qualify the insulation material for parameters specified in table above.

iii. Supply of cladding:

- 1) Stainless steel cladding sheets of 0.7mm thick conforming to SA 240, TP 304 mirror finish No 4 grade.
- 2) Supply Aluminum cladding sheets of 0.8 mm thick conforming to IS737-
- 3) 2008, 19000H2 grade and ancillaries for reactor auxiliary buildings covered under this contract.
- 4) Supply of Aluminum foil 0.1mm thick for required width and length conforming to IS737-2008.

iv. Supply of ancillaries:

- 1) Insulation ancillaries include Shelf supports, ring supports, clamping rings, yokes, pin bushings, clamping wire rings, wire suspensions and bracing wires, SS wire meshes, metal shroud etc.
- 2) Scope includes supply of these ancillaries, in case required shape is not readily available in the market, the same shall be fabricated.
- 3) Material of construction of the ancillaries shall be of carbon steel or stainless steel based on the material of pipe line and equipment.

6. Requirements of ancillaries:

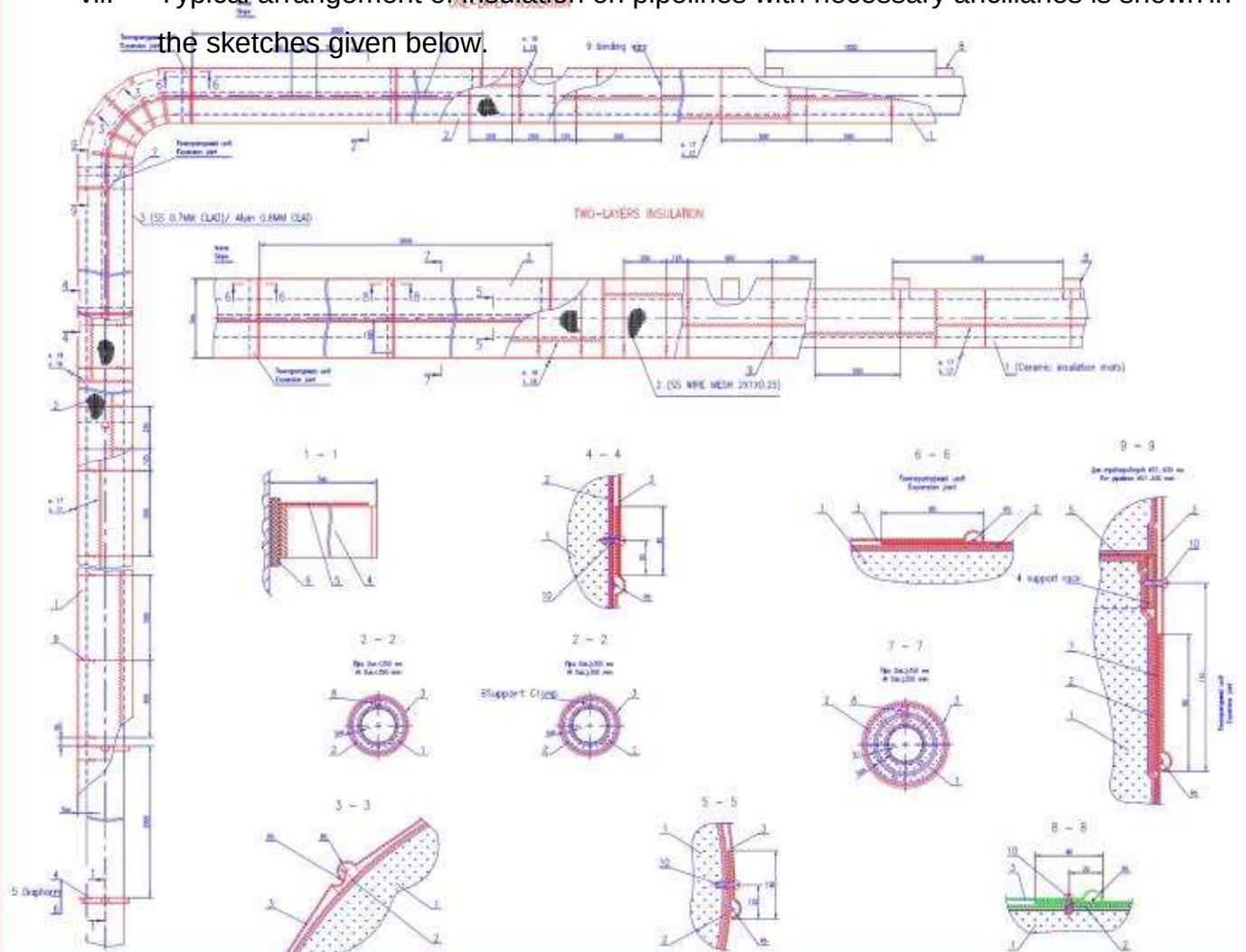
6.1 Piping ancillaries:

- i. Thermal insulating structures must rule out deformation and sliding down of thermal insulating layer throughout service life.
- ii. Shelf supports, ring supports, clamping rings, yokes, pin bushings, clamping wire rings, wire suspensions and bracing wires, wire meshes, metal shroud are used as support devices, reinforcing details and fasteners of the thermal insulating layer and thermal insulating structure. Typical arrangement of insulation on piping is shown below.

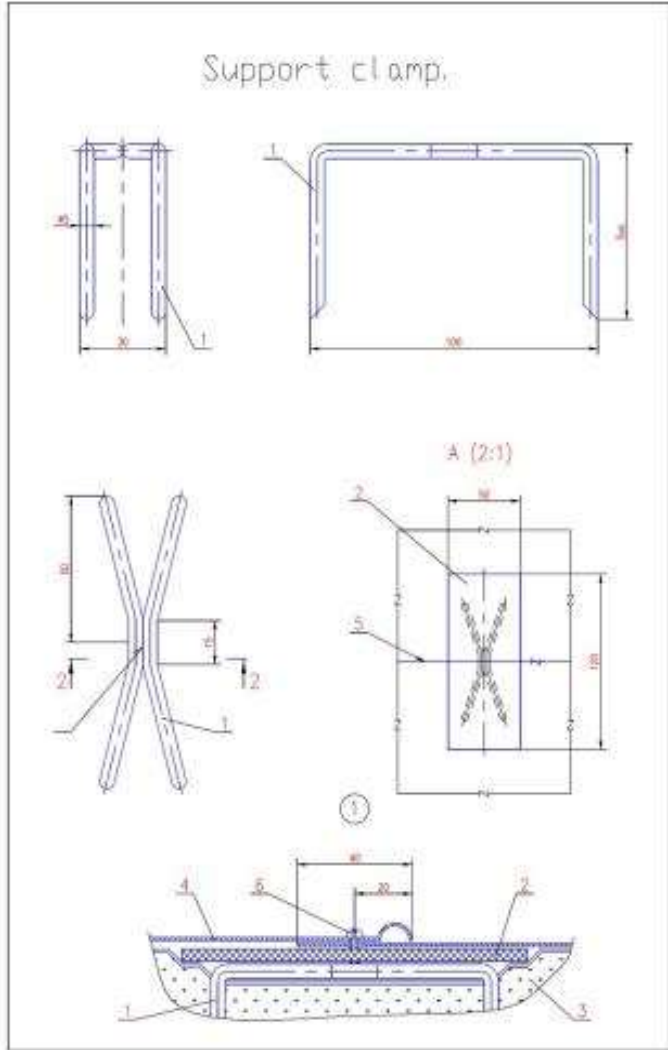
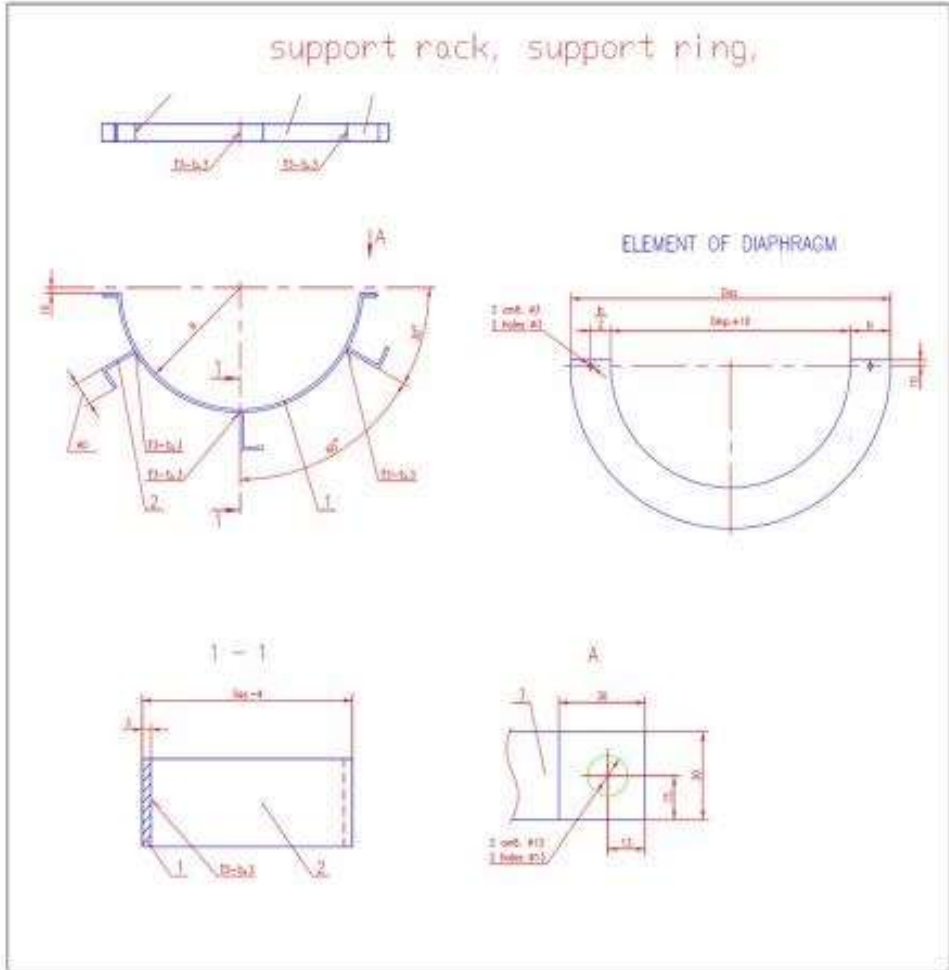
TECHNICAL CONDITIONS OF CONTRACT (TCC)

- iii. Support devices (shelf supports with metal sheet diaphragms on them) should be designed through 2000mm / suitable pitches on vertical sections of pipe lines with diameter of 57 mm and larger when insulation is 40 mm and larger and on vertical equipment.
- iv. Support devices (ring support) should be designed through 2000mm / suitable pitches on horizontal sections of pipe lines with diameter 630mm and larger when insulation is 80 mm and larger and on vertical equipment.
- v. Support devices should be designed through 1000mm suitable pitches on horizontal sections of pipe lines with diameter of 108 mm and larger; support yokes one in section if outer diameter of thermal insulation is 350 mm and less, three in section if outer diameter of thermal insulation is greater than 350mm. It is not allowed to install support yokes in place where ring supports are installed.
- vi. In order to preclude occurrence of direct thermal bridges, the space fillers (made of thermal insulating card board/ ceramic paper) are installed between the surface and shelf supports and ring supports as well as between support yoke and covering layer of thermal insulating structure.

- vii. Typical arrangement of insulation on pipelines with necessary ancillaries is shown in the sketches given below.



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6.2 Equipment ancillaries:

- i. Thermal insulation is fixed on equipment with outer diameter of housing of 1200 mm and larger by wire pins with diameter of 5mm or as specified in drawing.
- ii. Pin for fixing thermal insulation on equipment;
 - Inserted in yoke or bushing welded to housing of equipment.
 - Pins are welded to the frame made of metal tapes or stripes, which are welded to shelf supports or ring support and fastened by clamping rings installed between shelf supports along the length and vertical extent of equipments each 1000 mm,
 - Pins may be permitted to be welded directly to housing of equipment, if it is specified by equipment supplier / specification.
 - Frame made of metal tapes or strips is mounted after installation of equipment in the designed position.

Fixing of such fastening of pins over the surface of equipment is included in the scope of work.

- iii. Pins for fastening of thermal insulation on cylindrical part of equipment are located;
 - on vertical equipments horizontally through 500 mm pitches, vertically through 250 mm pitches
 - on horizontal equipments horizontally through 250 mm pitches, vertically through 500 mm pitch.
- iv. Pins are located on top bottom of vertical equipments and bottoms of horizontal equipments in concentric circles through 500 mm pitches circularly; pins are located on lower bottoms of vertical equipments in concentric circles through 250 mm pitches circularly.
- v. Pins are located on top bottoms of vertical equipments and bottoms of horizontal equipments with radial distance 500 mm between concentric circles, on lower bottom of vertical equipments pins are located with radial distance 330 mm between concentric circles.
- vi. Thermal insulation is fastened on equipment and pipe lines with outer diameter less than 1200 mm by bracing wires.
- vii. Bracing wires are woven with wire of diameter 1.2 ... 2 mm up to thickness of insulation. For single layer insulation, the bracing wires are woven of four wires, for double layer insulation of six wires.
- viii. Bracing wires are fastened to surface of equipment with ring made of wires 2 mm in diameter.

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- ix. Wire rings are installed on cylindrical parts of equipment at 500mm pitches along the length and vertical extent of equipment as well as along both parts of shelf supports and ring supports.
- x. Wire rings are installed on bottoms of equipments in the shape of concentric circles through a distance of 500 mm between them.
- xi. Wire rings on cylindrical parts of vertical equipment to be fixed in the required position are interlace with wire strings with diameter of 2 mm, which are located through 1000 mm pitch along the circle.
- xii. Wire strings on bottoms of horizontal equipments are installed through 500mm pitch along the circle and are fastened to rings supports. Wire strings on bottoms of vertical equipment are installed through 1000mm pitch along the circle, not less than three of them evenly located along circle and are fastened to shelf support.
- xiii. Support devices, reinforcing elements and fasteners of thermal insulating structure should be designed of steel, grade of which corresponds with the insulated surface, with which they contact.
- xiv. Support devices, reinforcing elements and fasteners of thermal insulating structure made of carbon steel are subject to corrosion protection.

Note: All supporting devices, reinforcing elements and fasteners of thermal insulating structure to be used on stainless steel piping and equipment shall be made from stainless steel material confirming to ASTM A240 Type 304.

All supporting devices, reinforcing elements and fasteners of thermal insulating structure to be used on carbon steel piping and equipment shall be made from carbon steel material confirming to IS 2062 with epoxy primer & paint of NPCIL approved brand.

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7. Stitching of ceramic fiber mats:

- i. The insulation supplied for various thicknesses shall be wrapped around layer wise using glass cloth and to be stitched at end also stitching in lengthwise in between as given in table.
- ii. As sewing material for thermal insulation articles (sewn mats) the glass threads, silica threads or roving are used.
- iii. Wrapping fabric used on thermal insulation articles must not have coarse defects (be cut or frayed).
- iv. Articles must be needled by threads or roving lengthwise.
- v. Sewing parameters are provided by performance by sewing machine as given below in table.

Parameters	value
1. Number of stitches on article; • 500 mm wide , pcs , not less than • 1000mm wide, pcs, not less than	3 6
2. Pitch of stitch, mm , not greater than	120
3. Space from edge of article to stitch, mm	40

8. APPLICATION PROCEDURE:

Some important features of application procedure for insulation and other related items outlined in this specification are for guidance of the contractor. Detailed procedure for each type of job along with proposed quality plan shall be prepared by the contractor based on information provided on each working drawings and shall be submitted for approval. The above documents require acceptance/ approval of the Engineer before commencement of any insulation work. The Contractor shall submit installation procedures for each type of insulation for acceptance by the Engineer-in-charge and carry out work as per drawings.

8.1 Surface Preparation:

- a) The term “cleaning” used in the specification means that the surfaces to insulated shall be made free of all loose scale rust, grease, dust, oil or any other foreign matter. The surfaces thus cleaned shall be thoroughly dried before proceeding with any insulation work. All material and tools required for cleaning shall be arranged by CONTRACTOR within the quoted rate of insulation work.
- b) For cleaning of stainless steel surfaces using acetone or any other equivalent. All cleaning agents shall be subject to the prior approval of Engineer.

- c) For cleaning carbon steel surfaces DM water shall be used (DM water shall be issued as free issue).

8.2 Application of aluminum foil:

Aluminum foil of 0.1mm thick shall be applied over the cleaned surface of stainless steel pipes and fittings before proceeding for insulation. The aluminum foil shall be fixed with the aluminum adhesive tape or any other alternative with prior approval from engineer.

8.3 Application of Insulation piping & equipment:

a) Application of single layer insulation:

- Cleaning of surface of piping as described above and acceptance by Engineer.
- Supply and of 10 SWG CS / SS (1.2mm to 2mm) bracing wires around the surface of the surface at 250-350mm mm center to center and drawing CS painted 20 SWG loops from the 10 SWG wires at 300mm distance for holding the blanket insulation. In case pins are installed than same is not required.
- Supply, fabrication and fixing CS / SS spacer ring fabricated out of flat 25x3 confirming to IS 2062 / SS 304. The CS fabricated spacer shall be grid blasted and applied one coat of zinc anode 304 primer and one coat of paint. The spacer shall be fixed with L type lugs. Asbestos mill board shall be used between pipe/equipment and lugs of spacer ring to avoid heat conduction.
- The ceramic fibre blanket wrapped around by using glass fibre cloth at shop shall be applied on piping, valves, equipment etc., including supports. The single layer permitted is only 50mm thickness and less.
- Ceramic fibre blanket wrapping shall be carried out in a such way that no gap between the joints of blanket.
- The blankets shall be impaled over the 20 SWG GI / SS wires and extra length of wire loops shall be bent and inserted into the insulation.
- After installation the thermal insulating articles must adjoin tightly to the insulated surface and be compacted down to the designed thickness.
- Wires projected from insulation (by 50 mm) are to be bent at the level of the surface of thermal insulating layer and are to be deepened into the thermal insulating layer so that they would not project out of the exterior of insulation.
- Laying insulation wrapped around by silica fabric or glass fabric, joints between mats to be sewn together with glass threads with diameter of 0.6-0.8 mm.

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- When pinning the fibre articles to surfaces, the rings made of wire with diameter of 2 mm or shrouds made of tapes 0.7 .. 0.8 x 20 mm are to be additionally installed along the exterior of insulation and tied to pins as specified in the working drawings.
- b) Outer protective cover (cladding).
- Marking, cutting and pre-fabricating of aluminum / SS cladding / SS wire mesh at contractor shop, Handling and shifting of the pre-fabricated cladding to the site as per the requirement on day to day basis. Material shall not dumped at work location at once.
 - Wrapping the SS wire mesh (for SS piping inside reactor building & annular space) and fixing using SS wire of 20 SWG.
 - Wrapping of Aluminum / stainless steel cladding over the surface, fastening cladding with pan head self-tapping size No. 8, length 12 to 18mm. Spacing of aluminum / SS screws shall be suitable for close fit up, but not over a pitch distance of 100-150 mm. Joints of the cladding shall be overlapped up to 30 – 50 mm.
 - Vapor barrier or sealing compound shall be applied all around joints of the cladding sheet.

8.4 Application of Multi Layer Insulation:

- The sequence specified for single layer shall be followed in general in addition, on multi layers insulation both longitudinal and circumferential joints of outer layer shall be staggered with respect to those of inner layer.
- The number of CS / SS loop wire shall be selected for multilayer. The first (interior) thermal insulating layer is to be fastened by tying of two-four bracing wires; the second (exterior) thermal insulating layer is to be fastened by tying of four-six bracing wires. Ends of bracing wires are to be twisted and deepened into the thermal insulating layer.
- The spacer ring size shall be selected for thickness of insulation.
- Steel band made of SS of size 12mm x 0.5mm thick shall be used to secure the insulation.
- Each layer of ceramic fiber blanket shall be wrapped around by using glass fiber cloth at shop.

8.5 Application of Insulation on equipment:

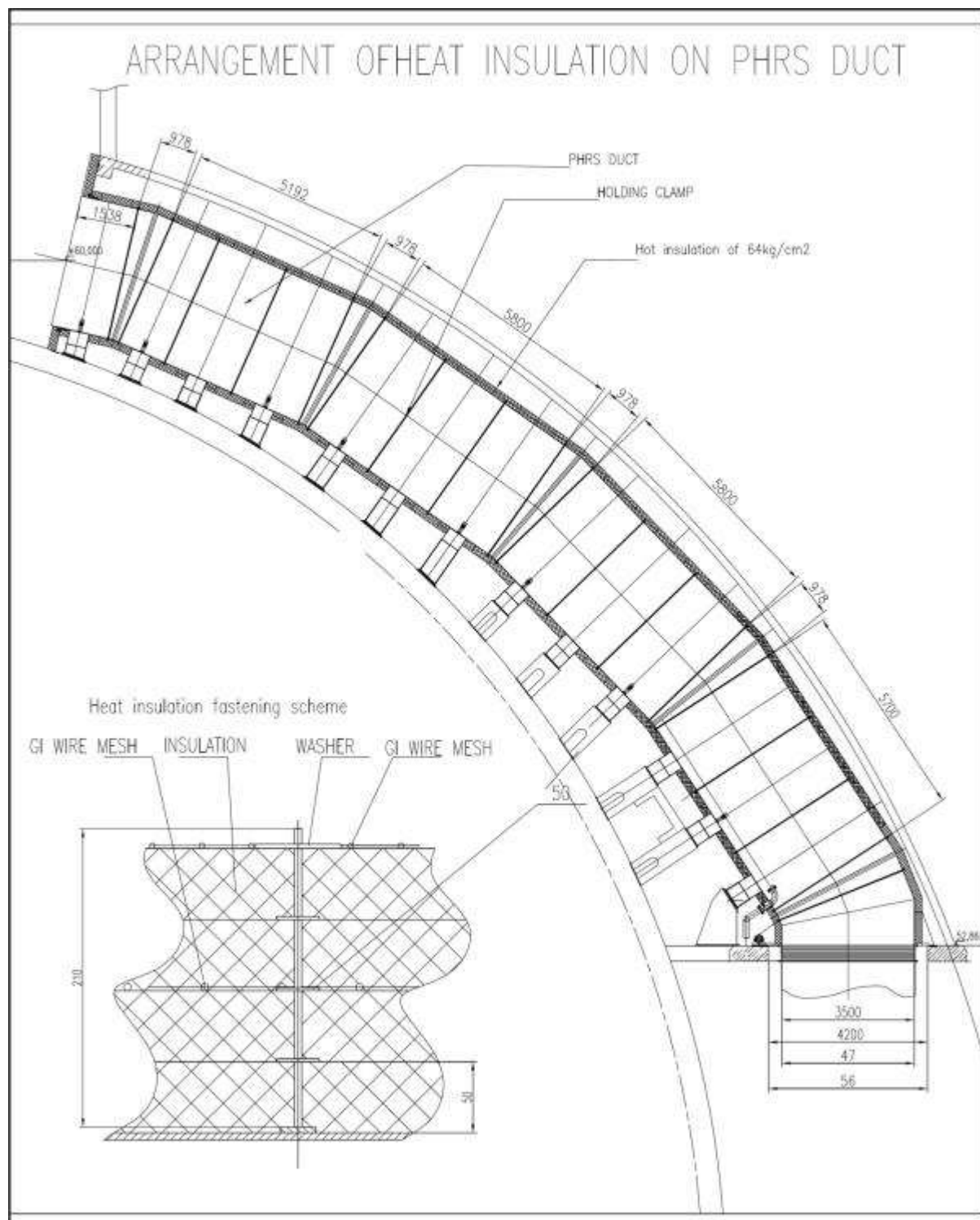
- a) No aluminum foil to be installed on equipment.
- b) Prior to application of insulation over the equipment, dowel for holding insulation in position and retainer rings (support rings) shall be welding over the body of the equipment.
- c) Scope of work includes welding of these dowel pins and support rings.
- d) On completion of the supporting arrangement , application of single layer and multilayer insulation with cladding for all equipment shall be done as described as explained above for piping.

8.6 Application of Insulation on Piping Passing Through Wall/Slab Opening:

- a) Wall opening required 50mm more from the insulation thickness all around. The same will be covered with flashings.
- b) Self-tapping ½" x No. 8 aluminum screws shall be utilized for holding the cladding
- c) sheet in position at a pitch distance of 150 mm.

8.7 Application of insulation on PHRS ducts:

- a) PHRS ducts are of dia approx 3.5m, shall be erected at +54.000 to +68.00 m elevation.
- b) Hot insulation of the duct shall be carried out prior to erection of these ducts.
- c) No cladding is provided over insulation of these ducts.
- d) General arrangement of the insulation is shown in the sketch below.
- e) Insulation in the transition area of individual ducts shall be carried out at the location.
- f) Galvanized wire mesh of dia 1.6mm and 2.0mm shall be provided after 2nd layer of insulation and 4th layer of insulation.



9. Removable Insulation:

- i. Equipment and component such as pumps, valves, orifices and areas which are subjected to regular inspection as part of in-service inspection (ISI) are to be insulated using a removable type thermal insulation for both carbon steel and stainless steel piping and equipment.
- ii. Before proceeding for insulation, development drawing of the outer counter of the component shall be made and pre-fabrication of cladding shall be made to suit the counter in multiple pieces which shall be attached to one another using the latches.
- iii. Fixing of latches can be made using fastening screws or spot welding method.
- iv. Detailed methodology for development of removable type insulation considering the latest practice available in use, shall be made and submitted to BHEL & NPCIL for approval.

10. Cleaning Requirement Of Building/ Rooms After Application Of Insulation And Health & Safety:

- i. During insulation and after completing insulation, the insulation debris, loose parts shall be collected in metal container on day to day basis and accumulated debris, metal scrape shall be shifted to dumping yard on weekly basis leaving work place.
- ii. Loose particle shall be cleaned by means of Vacuum Cleaner on daily basis.
- iii. Identified, separate and trained manpower shall be engaged in cleaning work.
- iv. Lapses in cleaning of work place will result in stoppage of work and holding deduction of payments due to the contractor.
- v. All staff and working personnel shall be provided with health protective gear such as mask, hand gloves etc.,
- vi. Persons employed in insulation work shall be qualified, skilled, and trained.
- vii. Personnel protective equipment and gears shall be used.

11. Mode of Measurement:

The unit of measurement for hot insulation is in square meter. It will be measured over the outer diameter of the pipe line / fitting / valves & equipment.

Note: No standard guide lines will be followed for measurement.

12. Examination And Testing:

- a) Material required for thermal insulation, including jacketing, insulation supporting devices and other finishing materials shall be new and subjected to the approval of the Purchaser.

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- b) Insulation material received at the plant site shall be stored in batches properly identified. The Quality Plan (QAP) for material shall be submitted for approval of Purchaser prior to commencement of work. All test certificates providing the proof of meeting technical requirements shall be provided for each batch as per approved QAP. Purchaser has the right to ask for additional testing at no extra cost in order to satisfy himself, that the insulating materials fully meet the technical requirements of the specification.
- c) The application of the insulation and finishing of the insulation work shall be of first class workmanship subject to the approval of the Purchaser.
- d) Thermal conductivity test of ceramic fiber blanket shall be carried out at NPCIL approved reputed Institute such as IIT Chennai, CBR Rookie and other Govt. approved laboratories only.
- e) The balance test as specified in QAPs, Indian and Russian standards shall be conducted at approved reputed test labs. Bidder will carry out all testing and inspection within the quoted rate of insulation. No separate payment will be made to the contractor on this account.
- f) The Contractor shall test at no extra cost the samples as per the above specification and prove that the materials being used is meet all requirements of this specification.
- g) Insulation material shall be tested for Gamma radiation to a dose of 100M RADS according to USP XXI 1985 and BP11-1988 at radiation plant for sterilization of medical product (board of radiation and isotope technology department of Atomic Energy) or at reputed lab as approved by NPCIL. Post irradiation examination shall also include visual examination and condition for usability of insulation.

13. Reports and Records:

- i. Reports shall be prepared as per the requirements and the formats mentioned in the QAP and the working drawings.
- ii. Erection reports and as built information shall be prepared and submitted for acceptance of the Engineer.

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2.2.24 TECHNICAL SPECIFICATION FOR COLD INSULATION FOR EQUIPMENTS AND PIPELINES

SR NO	DESCRIPTION
1	Purpose
2	Scope
3	Applicable codes & Standards
4	Design Requirement
5	Insulation material
5.1	Cold Insulating Layer
5.2	Covering Layer (Cladding)
5.3	Ancillary materials
6	Insulation Thickness
6.1	Pipe Insulation for Chilled Water System (water temperature 6 °C to 12 °C)
6.2	For HVAC ducts
7	Application of Insulation
7.1	Application of Insulation over the Pipes and fittings
7.2	Application of cold Insulation over the HVAC ducts and fittings
8	Application of covering layer (cladding)
9	Measurement of Insulation
10	Examination and testing
11	Submission of Technical Documents

1. PURPOSE:

Purpose of this specification is to provide guidance to contractor to understand the scope, quantum of work and technical requirements to be followed during raw material, fabrication, installation and performance guarantee of Elastomeric closed cell Nitrile / EPDM foam Rubber Insulation for cold insulation of ventilation ducts & chilled water equipment & piping/ equipment, and valves in various systems of KKNPP 3&4.

2. SCOPE:

The scope of the contractor's work comprises but not limited to the following.

- i. Study of drawings, preparation of network schedules.
- ii. Preparation and approval of QAP, erection and inspection procedures.

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- iii. Procurement of elastomeric foam - Nitrile rubber / EPDM insulation, conducting tests to meet technical requirements, supply to site, providing temporary storage, handling, transportation to site.
- iv. Supply, fabrication and erection of non metallic cladding (jacketing) sheet as per the technical specification.
- v. Supply and fixing ancillaries such as aluminium self adhesive tape, sealant, cleaning agents, non metallic screws etc. for completing the work.
- vi. Cleaning of ducting, pipes and fittings dampers/ valves, equipment, associated specialties, hangers and supports.
- vii. Preparation and submission of reports concerning the quality assurance, progress and completion of work.
- viii. Preparation of as built diagram of insulation with bill of material and preparation & submission of Construction Completion Certificate (CCC).

3. APPLICABLE CODES & STANDARDS:

The manufacture and performance of thermal/ acoustic insulation material shall comply with all currently applicable safety codes and standards including those specified below. Nothing in this specification shall be construed to relieve ventilation contractor and insulation vendor of his responsibility. In particular, the insulation and application shall conform to the latest editions of all applicable codes/ standards including the following;

TECHNICAL CONDITIONS OF CONTRACT (TCC)

Codes	Title
EN14304	Thermal insulation products for building equipment and industrial installations - Factory made flexible elastomeric foam (FEF) products
ASTM C534-02	Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form
ASTM C177 - 13	Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus
ASTM C518 -17	Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus
ASTM C 1338	Standard Test Method for Determining Fungi Resistance of Insulation Materials and Facings
ASTM D1667	Standard Specification for Flexible Cellular Materials—Vinyl Chloride Polymers and Copolymers (Closed-Cell Foam)
ASTM C 1534	Specification for Flexible Polymeric Foam Sheet Insulation Used as a Thermal and Sound Adsorbing Liner for Duct Systems
ASTM E 96	Standard Test Methods for Water Vapor Transmission of Materials
ASTM C692	Standard Test Method for Evaluating the Influence of Thermal Insulations on External Stress Corrosion Cracking Tendency of Austenitic Stainless Steel
ASTM C871– 95	Standard Test Methods for Chemical Analysis of Thermal Insulation Materials for Leachable Chloride, Fluoride, Silicate, and Sodium Ions
ASTM C1071 - 16	Standard Specification for Fibrous Glass Duct Lining Insulation (Thermal and Sound Absorbing Material)

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ASTM C795 – 08 (2013)	Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel
BS EN 12667:2001	Thermal performance of building materials and products. Determination of thermal resistance by means of guarded hot plate and heat flow meter methods. Products of high and medium thermal resistance properties
BS EN 13469:2012	Standard Test Method for Evaluating the Influence of Thermal Insulations on External Stress Corrosion Cracking Tendency of Austenitic Stainless Steel
US EPA Method 5021a	United state environmental protection agency – method a - volatile organic compounds in various sample matrices using equilibrium headspace analysis
BS 476 Part 6	Fire Tests on Building Materials and Structures, Method of test for fire propagation for products
BS 476 Part 7	Fire Tests on Building Materials and Structures, Method for the Classification of the Surface Spread of Flames of Products.
ISO4892-2 Method A	Methods of exposure to laboratory light sources - Part 2: Xenon-arc lamps
ISO 846 Method A & Method C	Determining the deterioration of plastics due to the action of fungi, bacteria and soil organisms.

In the event of any conflict between the provisions of this specification & the standards referred, the decision of the engineer shall be final.

4. DESIGN REQUIREMENTS:

Material and components used for thermal insulation layer must retain thermal, physical characteristics, and structure during the operation process and must meet the following requirements

- a) Capacity to function at the required temperature.
- b) Low thermal conductivity.
- c) Low water vapour permeability.
- d) Long life of insulating properties.

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- e) Good mechanical strength (compressive strength), light weight, flexibility and resistant against tearing and should have property of easy to wrap over duct and pipe and other complex structures.
- f) Non-corrosive, vermin/ rodent proof, water repellent.
- g) Fire retardant/ self-extinguishing.
- h) Suitability in radiation field.
- i) It should not emit during operating process any hazardous, fire risk & explosive gaseous substance gaseous substance with objectionable odour in quantities exceeding the limiting concentration
- j) It should be bio-stable & don't emit during operating process any pathogenic bacteria, virus & fungi.
- k) It should be resistant to degradation.
- l) It should be UV resistant for indoor & outdoor facilities.
- m) It should be easy to install & repair.

5. INSULATION MATERIAL:

General cold insulating structure can consist of the following components:

- Cold insulating layer.
- Steam insulating layer – in case of open cell insulation material (for cold insulation to prevent condensation of air)
- Covering layer – protective cladding for preventing mechanical damage and for providing UV resistance.
- Ancillaries - Reinforcing details, fasteners, adhesive tapes, glues for fixing of insulation and cladding over the surface to be insulated.

5.1 Cold Insulating Layer:

Following are the principle insulation (cold) materials with elastomeric Nitrile/ EPDM rubber for different area of application;

- a) Elastomeric Closed Cell Nitrile foam Rubber/ EPDM rubber insulation is shall be used as a basic thermal insulation structure in case of cold insulation of chilled water piping & equipment.

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- b) Elastomeric Closed Cell Class O Nitrile Rubber/ EPDM sheets with built-in antimicrobial and anti-fungal properties shall be used for duct work insulation.

The closed cell of elastomeric Nitrile/ EPDM foam rubber insulation eliminates the requirements of additional steam insulation layer in cold insulation structure which is required for preventing the wetting of the insulation structure if the surface condensation takes place. The basic properties of cold and acoustic insulation material shall be meeting the parameters as given in Table-1:

Table-1: Basic parameters of cold and acoustic insulation material:

Sl. No.	Parameter	Chilled water Pipe, Equipment	Cold insulation Air ducts.	Remarks
1.	Basic Material	Closed Cell Nitrile Rubber/ EPDM Insulation Class 'O' Fire category	Closed Cell Nitrile Rubber/ EPDM Insulation Class 'O' Fire category	
2.	Density (kg/m ³) Maximum	45-75	45-75	
3.	Maximum Thermal conductivity (W/m-K)	0.04 W/M-K at 22±5 deg C	0.04 W/M-K at 22±5 deg C	
4.	Sorption humidity % not by volume	0.5%	0.5-%	
5.	Water vapour diffusion (μ) Min.	7000	10,000	
6.	Contents of water-soluble chlorides (by mass), % not more than	0.03	0.03	
7.	Contents of free alkalis reduced to caustic soda (by mass), %, not more	0.02	0.02	

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	than			
8.	Fire Performance	Class-I	Class-I	
9.	Flame propagation BS 476 Part 7 BS 476 Part 6;	Total Index Performance (I) ≤ 12 Sub Index (i_1) ≤ 6	Total Index Performance (I) ≤ 12 Sub Index (i_1) ≤ 6	
10.	Anti Microbial Properties/ resistance to Fungi	-	Resistance for Fungi & bacteria as per DIN EN ISO 846 method A&C/ ASTM C-1338	
11.	Radiation Tolerance **	Shall not damage when exposed to 20 MRad	Shall not damage when exposed to 20 MRad	
12.	Insulation make	Armaflex, K-flex, Aeroflex or equivalent		

Note:- Fire performance test & anti microbial properties as per relevant standards shall be conducted and qualified for one sample of each manufacturer.

Radiation test shall be conducted for one sample of material for each manufacturer. The material after subjecting the radiation test shall be subjected to visual examination, and there shall not be any physical damage in terms of appearance, decolouration, development of cracks, shrinkage/ swell in the volume.

5.2 Covering Layer (Cladding):

Covering material shall provide mechanical resistance against impact loading/ tear resistance. A 3 layered non-metallic cladding having aluminium as an intermediate layer and UV protection shall be used as the cladding material.

The basic properties of cladding material shall be as per Table-2:

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Table-2: Basic properties of covering layer;

Sl. No	Description	Properties
1	Basic material	3 layered non-metallic cladding having aluminium as an intermediate layer with metallic finish or equivalent material
2	Thickness	300 to 350 Micron thickness minimum
3	UV resistance	Yes as per ISO 4892-2 Method A/ASTM G154
4	Fire performance	Class 1 as per BS 476 Part 7 Class 'O' Fire category as per 1991 Building Regulations (England & Wales) and the Building Standards
5	Resistance to mechanical impact	> 200 N as per ASTM D 4833-07.
6	Tensile strength	> 50 MPa as per ISO 527-1:1996 & ISO 527-3:1995
7	Elongation	>50 % as per ISO 527-1:1996 & ISO 527-3:1995.
8	Radiation Tolerance	Not less than 20 Mrad
9	Cladding make	Arma-Check Silver, K flex Al-Clad or equivalent

Note: a) The UV, radiation tolerance and fire performance of cladding shall be done for one sample for each manufacture.

5.3 Ancillary materials:

a) Specification for Adhesive :-

Adhesive shall be used for bonding the seams securely together. Special Rubber based contact Adhesive free from benzene; specially formulated for the Duct/ Piping insulation application and supplied by insulation manufacturer shall be used. The basic properties of adhesive shall be;

The adhesive material shall be compatible with the insulation as well as the primer/ finished paint applied over the duct/ pipeline and shall not cause any corrosion, damage to the base material.

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- The adhesive shall have excellent bonding to porous and non porous surfaces. It is recommended to use the adhesive as specified by the insulation material manufacturer for ensuring compatibility with the material.
- Adhesive shall be in compliance with Indian Green Building requirement.
- The adhesive material shall be as recommended by the insulation manufacturer.

The technical properties of adhesive used shall meet the technical requirements

Table-3: Technical Details of adhesive material

SI No.	Properties	Description/ Range
1	Material	Rubber based contact adhesive in blend of solvents meet the requirements of MIL-A-24179A Amend-2, Type II, Class 1
2	Form	Liquid
3	Temperature Range	-25°C to +90°C
4	Drying Time	7-8 minutes
5	Viscosity @ 30°C	3500 - 4000 cps
6	Specific Gravity	0.89 - 0.92 g/cc
7	Flash Point	The adhesive shall have a flash point below minus 3.9 °C

Note: One sample test certificate for one manufacturer shall be submitted at the time of approval of material.

b) Silver aluminum based tape with self-adhesive:

Silver aluminium based tape of minimum width 50 mm with self-adhesive ability to ensure 100% leak-proof joints. The tape shall be with a pre coated layer of solvent based adhesive which is non-hazardous in nature.

c) Fasteners:

The joints of the cladding sheet shall be secured with plastic rivets in the overlap area, installed every 200 mm along the material length.

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6. INSULATION THICKNESS:

The basis for selection of insulation thicknesses of various operating temperatures and piping and equipment are given in the following table. Insulation thickness can be modified subject to approval of NPCIL. In general the thickness of insulation shall be followed as indicated below;

6.1 Pipe Insulation for Chilled Water System (water temperature 6 °C to 12 °C)

Pipe Size*(Nominal Diameter)	Insulation thickness (mm)
25 mm & below	32 mm
25 mm to 65 mm	38 mm
80 mm-160mm	44 mm
Above 160mm	50 mm
Pumps	50 mm thick

For Valves, bends, valves the same thickness shall be used as for the connected pipe sizes.

*Thickness of insulation is tentative and shall be followed in case of missing details in WDs. Final decision regarding required thickness of insulation is taken by EIC & that should be binding to the contractor.

6.2 For HVAC ducts:

Duct type	Insulation thickness (mm)
Duct handling conditioned air running in Non AC areas	32 mm
Duct handling conditioned air Running in AC areas	32 mm

*Thickness of insulation is tentative only. Final decision regarding required thickness of insulation is taken by EIC & that should be binding to the contractor.

7. APPLICATION OF INSULATION:

Some important features of application procedure for insulation and other related items outlined in this specification are for the guidance of the Contractor. Detailed method statement for each type of job along with proposed Quality Plan shall be prepared by the contractor before executing

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the work at site. The insulation persons must have undergone training and the skill shall be evaluated by conducting mock-up test over the piping and fittings as agreed by engineer. Ensure proper tools, templates, instruments for measurements as recommended by insulation manufacturer are available before taking up the insulation work. It is not permitted to use makeshift tools for cutting and trimming of insulation. The ancillaries, adhesive used for fixing of insulation shall be of insulation manufacturer recommended make.

7.1 Application of Insulation over the Pipes and fittings:

Chilled water piping and accessory insulation application shall be as follows:

- a) Before applying insulation, all pipes shall be brushed and cleaned. All Pipe surfaces shall be free from dirt, dust, mortar, grease, oil, etc.
- b) Ensure that the hydro testing of piping network is completed and primer application is completed and are released for taking up insulation work.
- c) Insulating material in tube form shall be sleeved on the pipes.
- d) On erected piping, slit open tube of the insulating material (slit with tool recommended by manufacturer) and shall be placed over the pipe and adhesive shall be applied as suggested by the manufacturer.
- e) Wherever flat sheets are used for insulation it shall be cut out in correct dimension considering the outer diameter (OD) of the insulated pipe thickness. All longitudinal and transverse joints shall be sealed with application of sealant as per manufacturer recommendations.
- f) The insulation shall be placed continuously over the entire run of piping, fittings and valves and no gaps are allowed.
- g) Adhesive shall be applied on both surfaces of the insulation seam joint.
- h) The pipe bends and fittings shall be insulated first before carrying out the insulation of straight length of piping.
- i) On large radius bends, the insulation can be sleeved up and around the fitting. Always fix the seam on the centre of the pipe work and not along the "throat" or on the back off the bend. Once the seam is secure, the adhesive joint can be turned away from view.
- j) Care shall be taken up while fixing insulation on the bends, to avoid compression/tension on glued seam joint.
- k) For large bore welded bends that are segmented, the shape of the welded segments can be chalked and transferred by insulation sheet be

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placed onto the fitting using the correct thickness of insulation. The chalked outline can be used as a template and transferred to metal or the boxes. Always keep to the correct dimensions.

- l) All valves, fittings, joints, strainers, etc. in chilled water piping shall be insulated to the same thickness as specified for the main run of piping and application shall be same as above. Valves bonnet, yokes and spindles shall be insulated in such a manner as not to cause damage to insulation when the valve is in operation.
- m) Ensure all exposed metal of the fittings is insulated to prevent condensation/ formation. In areas and locations that have exposed electrical equipment nearby, it is advised that the Valve Handle itself is also insulated with removable insulation fabrications.
- n) All the transverse and seam joints shall be covered with the adhesive seam tape of size as recommended by the manufacturer.

7.2 Application of cold Insulation over the HVAC ducts and fittings:

The thickness of the insulation shall be as shown on drawing or identified in the schedule of quantity.

External thermal insulation shall be provided with insulation as follow:

- a) Prior to carrying out insulation work, duct surfaces shall be cleaned to remove all grease, oil, dirt, etc.
- b) Measurement of surface dimensions shall be taken properly to cut closed cell elastomeric rubbers sheets to size with sufficient allowance in dimension.
- c) For rectangular/ square ducts, install the insulation material to the top surface of the ductwork.
- d) After installing the insulation material to the top sections, proceed to install the insulation on the other sides.
- e) Finally install the insulation material sheet to the bottoms of the ductwork.
- f) For circular/ spiral ducts, the insulation shall be wrapped tightly, and the seam/transverse joints shall be joined with adhesive glue.
- g) After completing all sides, install bracket covers around all 4 sides.
- h) Material shall be fitted under compression and no stretching of material should be allowed.
- i) A thin film of adhesive shall be applied on the back of the insulating material sheet and then on to the metal surface. When adhesive is tack

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dry, insulating material sheet shall be placed in position and pressed firmly to achieve a good bond.

- j) All longitudinal and transverse joints shall be sealed with adhesive tape of minimum 40 mm width.
- k) The adhesive tape shall be strictly as recommended per manufacturer.

8. APPLICATION OF COVERING LAYER (CLADDING):

After completion of installation of thermal insulation, three layered non-metallic cladding having aluminium as an intermediate layer and UV protection shall be installed over the insulation. The cladding shall be adjoin tightly and free of gaps to the thermal insulating layer, be free of visual defects (dents, cracks, signs of corrosion).

- a. Covering layer is assembled of individual components made in workshop. Dimensions of components are determined by assembly conditions.
- b. Components of covering layer should be fastened (non metallic screws/ rivets)/glued with adhesive as recommended by manufacturer.
- c. The covering layer shall be mounted with 40...50 mm overlaps along longitudinal and transversal joints.
- d. On vertical facilities the covering layer is installed from the bottom upwards, on horizontal facilities the covering layer is installed in the direction opposite to declination.
- e. The covering layer (cladding) of cylindrical part of equipment shall be installed:
 - after installation of the covering layer of thermal insulating structure of bottoms of horizontal apparatuses;
 - after installation of the covering layer of thermal insulating structure of the lower bottom of vertical apparatuses;
- f. Covering layer (cladding) of straight sections of pipelines shall be mounted after installation of covering layer on thermal insulating structure of piping bends.
- g. Pitch between non metallic self-tapping screws shall be:
 - 150 mm for longitudinal joints between components of covering layer and lobes of spherical bottoms;

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- 300...350 mm for transversal joints between components of covering layer.
- h. For assembly of components of covering layer of thermal insulating structure of piping bends the two self-tapping screws are to be installed on a longitudinal joint of each section of the covering layer.
- i. Where projected parts (unions, hatches, man-holes, supports) penetrate the covering layer, the finishing linings made of the material of covering layer shall be installed.
- j. The aluminium adhesive tape shall be used for sealing the seam and transverse joints of cladding.

9. MEASUREMENT OF INSULATION:

- a. Pipe Insulation shall be measured in units of length (Rm or Running Meter) along the centre line of the insulated pipe. The linear measurements shall be taken before the application of the insulation. For piping measurements, all valves, orifice plates and strainers shall be considered strictly by linear measurement along the centre line of the pipes, and no special rate shall be applicable for insulation of any accessories, fixtures or fittings whatsoever.
- b. Duct Insulation shall be measured on in surface area (Sq.m) along the centre line of insulation thickness. The surface area of externally thermal insulated or acoustically lined duct shall be based on the perimeter at the centre of thickness of insulation, multiplied by the centre-line length of ducting including tapered pieces, bends, tees, branches, etc. as measured for bare ducting. In the case of tapering pieces, their average perimeter shall be considered.
- c. All duct insulation shall be measured on the basis of the duct prime surface area and excluding all openings for grilles, diffusers but including all flanges, dampers etc.
- d. In case of bends, tapers etc. the duct prime surface shall be determined on the basis of average dimensions.
- e. Insulation of flanges associated with equipment (equipment and mating flange) and valves (flanged or screw-ended valves with flanged tail pipes) shall form part of the valve or equipment. The outer surface area of insulation box measured in square meter will be considered for payment.

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- f. The equipments like valves, pumps etc. Shall be measured in square meter calculated over the surface of completed insulation over the cladding.
- g. The insulation of pipe supports, mountings will be measured in Square meter (Sq.m) calculated over the external surface of the insulation.

10. EXAMINATION & TESTING

All materials required for insulation, including jacketing and other finishing materials shall be new and subject to the approval of the NPCIL.

All the insulation material received at the plant site shall be stored in the batches properly identified. The Quality Plan (QAP) for material shall be submitted for approval of BHEL & NPCIL prior to commencement of work. All test certificates providing the proof of the requirements shall be provided for each batch as per approved QAP. NPCIL has the right to ask for additional testing at no extra cost in order to satisfy himself, that the insulating materials fully meet the requirements.

The application of the insulation and finishing of the insulation work shall be of first class workmanship subject to the approval of the NPCIL.

11. SUBMISSION OF TECHNICAL DOCUMENTS:

The following documents shall be submitted by the contractor for approval by BHEL & NPCIL after placement of the order and before taking up the job

- Insulation application procedure in detail indicating step by step complete activities for each job
- Quality control/ detailed QAP and procedures indicating step by step complete quality control / inspection program at all stages of each job.
- Inspection and test procedures.

Approval of above technical documentation by NPCIL shall not relieve the contractor from full responsibility for correct interpretation of NPCIL specifications and drawing and for the completeness and accuracy of contractor's technical documentation. It shall be the total responsibility of the contractor to ensure that the product supplied and installed is in accordance with the governing specifications.

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2.2.25 TECHNICAL SPECIFICATION FOR ERECTION, WELDING AND DRILLING OF O-LET (BOSS) ON PIPE SPOOLS AT SHOP AND IN-SITU.

Sr No	Description
1	Purpose
2	Scope
2.1	General Description
2.2	Mounting of O-let / Thermo Well Lug:
2.3	Welding and final drilling.
3	Reports & Records

1. Purpose:

Purpose of this specification is to provide guidance to contractor to understand the scope, quantum of work and technical requirements to be followed during erection of O-lets in various piping systems covered under this contract in various buildings at various locations and elevations.

2. Scope:

The contractor scope work involves but not limited to the following.

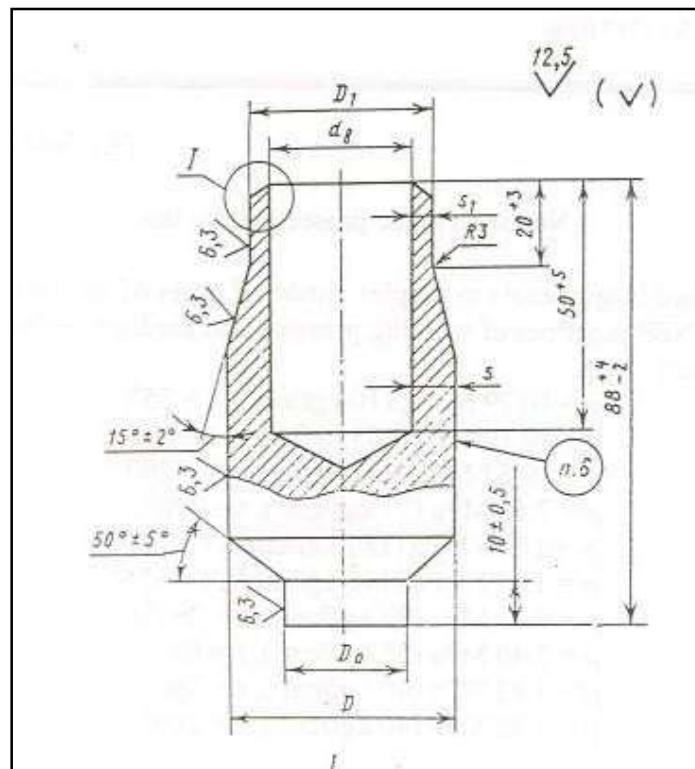
- i. Study of drawings, preparation of network schedules.
- ii. Preparation and approval of QAP, erection, welding and inspection procedures.
- iii. Receipt of material from NPCIL store, transportation, storage
- iv. Receipt of material , handling & preparation of IMIR ,
- v. Identification of pipe spools and O-lets,
- vi. Handling, shifting to contractor's shop and storage.
- vii. Marking position & orientation of O-let, pilot hole drilling, fit-up of O-let.
- viii. Welding using GTAW process for root & stabilizing passes and SMAW for balance pass welding.
- ix. Carrying out visual inspection and other NDE as per requirement.
- x. Carrying out final drilling of O-lets of various sizes ranging from 10NB to 150NB (NB is the branch pipe size connecting to O-let).
- xi. Carrying out visual inspection and other NDE as per requirement.

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2.1 General Description:

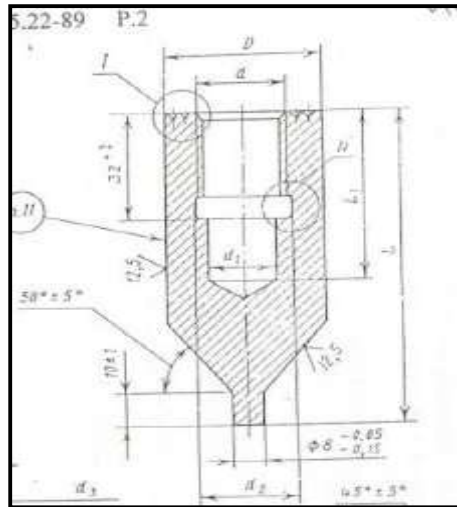
- i. Branch pipe connections for vent, drain and I&C of process piping / tubing from the main pipe will be made using weld O-lets. These O-lets will be supplied in loose condition and are to be mounted on the supplied pipe spool / fabricated pipe spool. Material of construction of these O-lets shall be of carbon steel or stainless steel.
- ii. In addition to O-lets, for mounting various sensors such as for temperature measurement thermo well lugs will be mounted on the pipe lines. Thermo well lugs (boss) will be supplied in loose condition and shall be mounted at shop or at site insitu as indicated in drawings. Material of construction of these lugs shall be of carbon steel or stainless steel.

Typical construction of O-lets with dimensions.



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Typical construction of Thermo well lugs with dimensions.



2.2 Mounting of O-let / Thermo Well Lug:

- i. As shown in the above sketches, O-let / Thermo well lugs are machined components made of forged material. These are machined for final external dimensions.
- ii. Erection, welding, drilling and inspection of O-lets / thermo well lugs shall be taken up on the pipe blocks in the contractor fabrication facility itself, before shifting of pipe blocks to site. However care shall be taken to prevent damage to welded O-let connection.
- iii. The contractor scope also includes o-let / thermo well lugs erection, welding, drilling on already erected pipe blocks at insitu. Equipments of required size & length to accommodate at places required for mounting the O-lets / lugs shall be mobilized by the contractor.
- iv. The diameters of the pipe blocks on which O-lets / lugs are to be mounted will range from 80 NB to 600NB. Mobilized machinery shall be able to accommodate this range of pipelines.
- v. ID of both O-let / Thermo well lugs will be in solid condition, ID shall be drilled through to the final dimension after welding of O let to the pipe block.
- vi. O-let / Thermo well lugs are need to be mounted on both small bore and big bore pipelines.
- vii. Marking shall be carried out for position and orientation of the O-let. The same shall be offered for checking the correctness before proceeding for drilling pilot hole and pilot hole shall be drilled as per the marking to required diameter as per the configuration of the O-let.
- viii. Machinery required for drilling of pilot hole shall be arranged by the contractor. Drilling may be done using a pedestal drilling machine or radial

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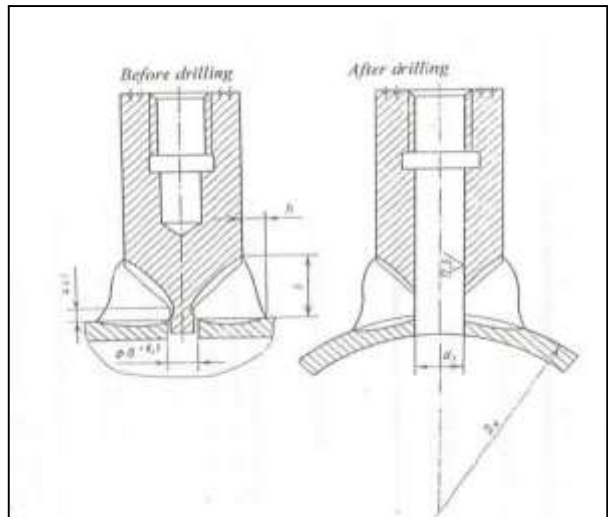
drilling machine or pipe mounted drilling machine based on the size and configuration of the pipe block. Typical sketch of pipe mounted drilling machine is as shown below



- ix. During mounting of drilling machines (in case of pipe mounted drilling machine) packing material shall be used to prevent direct contact of carbon steel with the stainless steel pipes.
- x. O-let / Thermo well lugs shall be mounted in the pilot hole. Fit up shall be made as per the requirements provided in the drawings and the relevant standards.

2.3 Welding and final drilling.

- i. Once fit up is completed, O-let / Thermo well lugs shall be released for welding as per the welding procedure.
- ii. Welding of O-let / Thermo well lugs with the pipe spools shall be carried out using GTAW /SMAW.
- iii. On completion of welding of O-let / thermo well lug with the pipe spool, carryout inspection and other NDEs and clearance for final drilling shall be obtained.
- iv. Final hole dimensions shall match with the size of the connecting pipe. As mentioned above final drilling can be carried out using pedestal drilling machine/ radial drilling machine or pipe mount drilling machine based on the configuration of the pipe blocks.
- v. Arrangements of all the required drill bits of various sizes are included in the scope of work.



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2.2.26 TECHNICAL SPECIFICATION FOR SUPPLY, FABRICATION, GRIT BLASTING, PRIMER APPLICATION, ERECTION, WELDING AND PAINTING OF METAL STRUCTURE

Sr No	Description
1	Purpose
2	Brief Scope of work
3	Detailed scope of work
3.1	Supply of Raw material
3.2	Fabrication
3.3	Grit blasting & painting
3.4.1	Erection
3.4.2	Field Connections
3.4.3	Metal grating erection
3.4.4	Hand rails and toe guards
3.5	Modification
4	Inspection
5	Reports and Records

1. Purpose:

Purpose of this specification is to provide guidance to contractor to understand the scope, quantum of work and technical requirements to be followed during fabrication and erection of metal structure in various buildings covered under this contract.

2. Brief Scope of Work:

The contractor scope work involves but not limited to the following.

- i. Study of drawings, preparation of network schedules.
- ii. Preparation and approval of QAP, erection, welding and inspection procedures.
- iii. Supply of structural steel material conforming to IS 2062, E250, Quality B0/BR consisting plates/ sheets/ angle/ channel/ beam, metal gratings, high strength structural cadmium coated bolts, nuts, lock nuts and washers, with test reports, transportation, storage, and acceptance with IMIR.

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- iv. Handing, fabrication involving cutting, grinding, bending to required shape, drilling, fit up & welding, surface preparation by grit blasting, supply & application of zinc based primer.
- v. Erection of scaffolding / temporary platforms for erection of the metal structures.
- vi. Shifting, erection, welding & inspection of fabricated metal structures & gratings in the required location of various buildings as per the working drawings and technical specification.
- vii. Machining of seismic arrester plates for mounting the beams, fastening of beams with the brackets to required torques as per the requirements.
- viii. Supply and application of epoxy based Apcodur 641 or Apcodur 641CS of Asian paints or protectomastic of Berger paints or any other equivalent paint with prior approval from NPCIL for a total DFT of 240-260 microns.

3. Detailed scope of work:

3.1 Supply of Raw material :

- i. Raw material shall conform to IS 2062, E250 GRADE and Quality B0/BR, until unless specified in the drawings.
- ii. Indian equivalent material as against Russian grade materials is specified in Table-1.
- iii. Profile standards shall be as per IS 808, until or unless not specified in the drawings.
- iv. Supplied material shall be produced with original test certificates from approved manufacturers / tested at the NPCIL approved laboratories.
- v. Supply of raw material shall be from NPCIL approved manufacturers only. List of approved brands of NPCIL may be referred.
- vi. Supply also includes necessary self tapping screws for fixing metal grating with members. Also necessary mechanical fasteners of various strength class for assembly and erection metal structures.
- vii. Electrodes (E-7018 electrodes of NPCIL approved brand) and filler wires for welding shall be from NPCIL approved manufacturers/ suppliers. They shall be baked as per manufactures recommendations/specifications prior to welding. The electrodes shall be kept in carry ovens and shall not be exposed to the atmosphere.
- viii. Supply of zinc silicate primer as per the painting specification.

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- ix. Supply of epoxy based Apcodur 641 or Apcodur 641CS of Asian paints or protectomastic of Berger paints or any other equivalent paint with prior approval from NPCIL for a total DFT of 240-260 microns. With required test certificates.

3.2 Fabrication.

- i. Contractor has to develop detailed fabrication drawings based on the basic drawings issued by NPCIL. Contractor has to design the weld sizes in case that were not provided in the working drawing based on RF codes and standards.
- ii. Scope includes arrangement of necessary tools, tackles, machinery, consumables, welding electrodes, cleaning agents, bending machines, etc.
- iii. Scope also includes arrangement of necessary and qualified manpower for carrying out the job.
- iv. Carryout field survey, measurement as per field condition, taking the field measurements and comparing with the dimensions provided in the drawing. If there are any difference between the field condition and the drawing dimension, the same shall be brought to the notice of Engineer.
- v. After obtaining the clearance from Engineer, marking and cutting shall be done as per the field condition.
- vi. All fabrication and erection shall be taken up as latest revision of drawings and DCNs / instructions issued.
- vii. No holes are permitted using gas cutting, only drilling machine shall be used for performing drilling operation.
- viii. Connection between the bracket and the members are locked by special arrangement with different profile for withstanding the seismic loads. Such profile cutting shall be done only using special machinery or milling machine etc. No gas cutting is permitted as the tolerances in the seating areas are very close.
- ix. Also in some locations beams are of fabricated type instead of readymade sizes, this involves huge quantum of welding. Bidder shall consider these factors while submitting the offer.

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3.3 Grit blasting, primer application and painting.

Refer technical specification for grit blasting and painting.

3.4 Shifting and Erection of metal structure:

3.4.1 Erection

- i. Fabricated, grit blasted and painted structure shall be shifted to the erection site.
- ii. Meticulous planning is required while erection of the metal structure. Since there will be other agencies working in the same area for various works, contractor shall not dump the material at once in the site. Shifting of material at location shall be done in a phased manner based on the daily or weekly planning. And this shall not hamper the work and cause hindrance to the other agencies.
- iii. For erection, contractor shall consider that there will be other agencies working in the same area. In view of this proper planning and a cordial relation with the other agencies shall be maintained.
- iv. Carrying out survey for mounting the brackets, identifying the embedded parts for the brackets, in case the brackets are to be mounted using the anchor fasteners, the same shall be carried out by the contractor. Measurement and payment for the anchor fasteners will be done in the relevant BOQ item.
- v. Many areas where platforms to be erected is provided with the liner to prevent water ingress into the concrete. In view of this no dragging of fabricated structural steel shall be permitted. Even with liner or without liner. Any damage to the liner shall be rectified by contractor at his own risk and cost.
- vi. To the extent possible only erection and assembly works shall be carried out at site. Maximum fabrication shall be carried out in fabrication shop. Welding shall be as minimum as possible.
- vii. Without application of primer material shall not be shifted to site for erection.
- viii. As explained above there is special arrangement between the beam and the bracket, in-order to withstand the seismic loads. Typical arrangement is as shown in sketch-1.
- ix. Beam alignment with the bracket axis shall be done carefully, it shall be noted that the beam axis shall match with the bracket axis.

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- x. Levels shall be ensured after placing the beams; any adjustments shall be made in the brackets. Horizontality shall be maintained as per the working drawings.

3.4.2 Field Connections:

- i. Field connections by bolting are by using High tensile bolt and nut as per the strength class of the WD or Russian standard or its equivalent of Indian standard turned bolts or welding.
- ii. All bolts, nuts, washers, taper washers, electrodes, screws etc. are to be the Contractor's supply.
- iii. Bolts shall be tightened by proper established sequence" Manual Torque Control" where tightening is by hand wrench equipped with a torque indicator and calibrated for the desired bolt tension of WD.
- iv. The Contractor shall obtain the prior written approval of the Engineer for the method proposed (procedure) to be adopted for tightening the High strength friction grip bolts. For preliminary assembly and before use of these bolts, he shall use his own erection bolts.
- v. Bolt spacing shall be decided based on RF codes and standards.

3.4.3 Metal grating erection:

- i. Top of the metal platform are provided with metal grating with approx 20mm angle with combination of strips and the rods.
- ii. Scope includes fabrication and erection of the metal gratings also.
- iii. In view of work involved and the production rate, supply, fabrication and erection of metal gratings were kept under separate item of BOQ.
- iv. Metal platform shall be installed along with the metal gratings, platforms shall not be left without gratings, and this will lead to safety hazard. If any platforms erected without metal gratings, payments of such gratings will be kept under hold as per the stage payments.
- v. Metal gratings may be fabricated at site or readymade grating may be purchased from the market, this option is left with the contractor. Whereas prior approval shall be obtained from BHEL & NPCIL in any case. Also NPCIL approval and quality shall be full filled even for brought out items.

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- vi. Usually fastening of the metal gratings to the metal structure was carried out using the self tapping screws. Supply of such self tapping screws is included in the scope of work.

3.4.4 Hand rails, ladders and toe guards:

- i. Completed metal platforms shall be provided with the hand rails, where ever designed openings are provided.
- ii. Such hand rails are provided with the toe guards, until unless it is specified in the drawings.
- iii. Also scope includes erection of the ladders and landings for making the approach to the higher elevations.
- iv. All these works includes fabrication and erection of very light structures which involves lots of efforts where the production rate will be very less when compared to the metal platforms. Contractor shall consider all these factors while submitting the bid for fabrication and erection of the light metal structure.
- v. Handrails shall be provided on sides of platforms, stairways and around all openings as shown on drawings. Until unless specified Handrails shall be of hollow square tube 40X40 mm or mild steel pipe of flush welded construction, ground smooth, using 32 mm nominal bore medium class pipe provided with double rail, top rail about 1000 mm above platform level and pipe posts spaced not more than 1.5m apart and 150 mm high 6mm thick toe plate.

3.5 Modification of the existing platforms & gratings:

- i. Metal platforms once erected (Erected in this contract or by other agencies) are subjected to modification due to modification in piping supports, due to any design change, due to any other changes.

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- ii. This modification includes cutting of existing platform members, gratings, modifying the dismantled ones or fabricating the new ones and carrying out erection as per the modified drawings.
- iii. During carrying out modification , for gas cutting or for carrying out grinding, fire resistant fabrics shall be used so that to prevent the spatter to fall on the equipment, pipes, valves, cables etc laying below.
- iv. Scope includes such modification also. Payment for such modification will be measured and made in the relevant BOQ item.

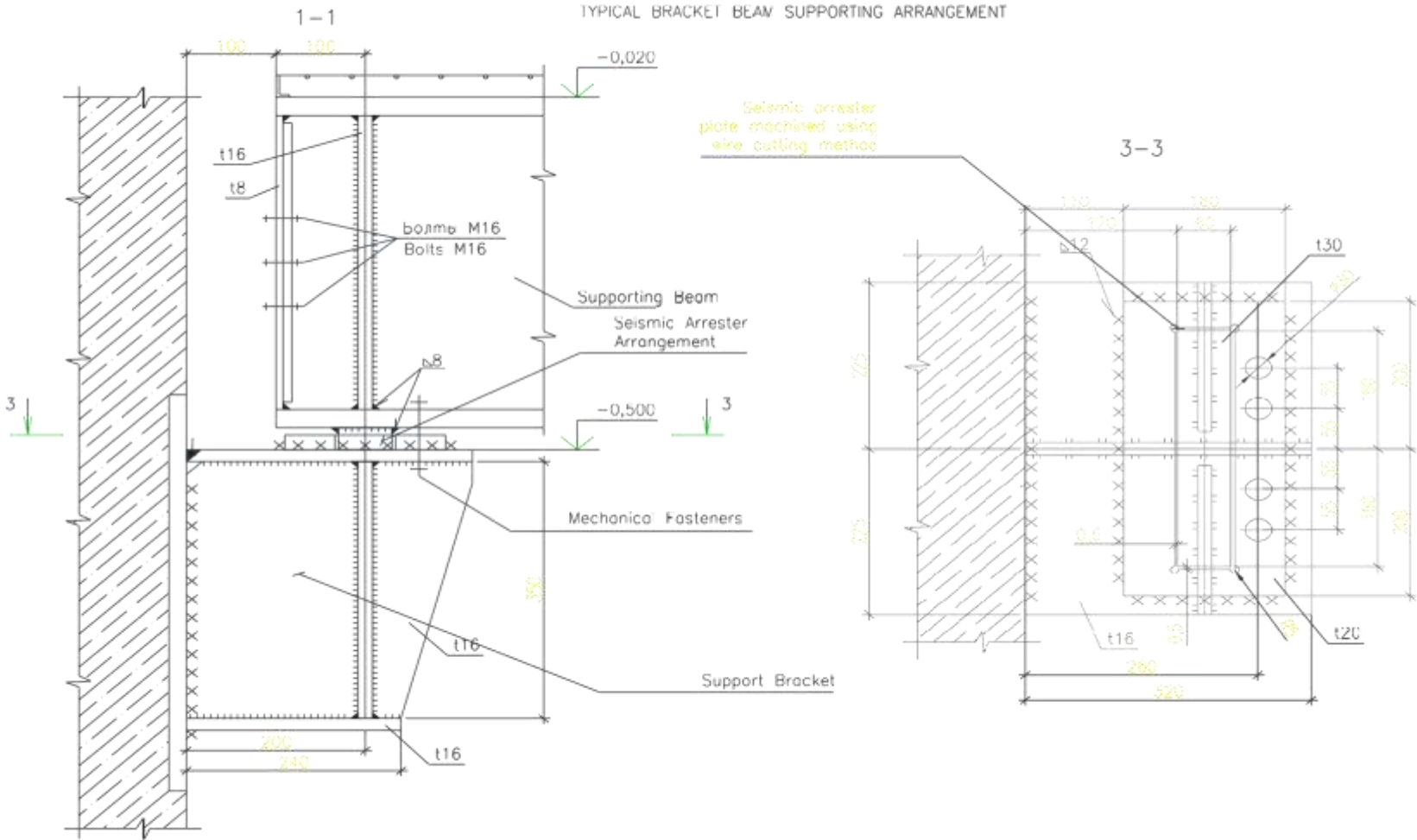
4. Inspection:

- i. Inspection includes various NDE such as visual inspection and DPT as specified in working drawings.
- ii. There is no separate payment for NDE, scope includes NDEs also for metal structure works.
- iii. Inspection shall be offered to BHEL/NPCIL execution and quality based on the approved QAP. There shall not be any deviation from the QAP. In case any deviation found there is ever right to BHEL/NPCIL to order rework at risk and cost of contractor.

5. Reports and records.

- i. Reports for the executed work shall be prepared and submitted for acceptance after completion of work.
- ii. As built drawings shall be prepared after completion of the fresh erection or any modification work. The same shall be submitted to the Engineer for acceptance.

Sketch-1



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Table -1

INDIAN EQUIVALENT MATERIAL FOR RUSSIAN GRADES

SRNO	Russian Grade specified in WD's	SECTION	Acceptable Indian Grade	Remarks
1	S235" as per GOST 27772-88	Rolled sections	Grade "E 250 Quality A" as per IS 2062-2011	
		Plates (all thicknesses)	Grade "E 250 Quality A" as per IS 2062-2011	
2	S245" as per GOST 27772-88	Rolled sections	Grade "E 250 Quality A" as per IS 2062-2011, with additional impact requirement of 27 J at room temperature (25°C)	Impact tests shall be conducted on products having thickness less than 12mm also in accordance with clause 12.1.1 of IS:2062-2011.
		Plates (all thicknesses)	Grade "E 250 Quality BR" as per IS 2062-2011	
3	S255" as per GOST 27772-88	Rolled sections	Grade "E 250 Quality B0" as per IS 2062-2011 with additional impact requirement of 27 J at (-)20°C	Impact tests shall be conducted on products having thickness less than 12mm also in accordance with clause 12.1.1 of IS:2062-2011.
		Plates (all thicknesses)	Grade "E 250 Quality C" as per IS 2062-2011	
4	"S345" as per GOST 27772-88	Plates (all thicknesses)	"SAILMA 350 HI" with additional impact requirements as per Special Note (a) below	
5	S375" as per	Plates (all	"SAILMA 410 HI" with	

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	GOST 27772-88	thicknesses)	additional impact requirements as per Special Note (a) below	
6	S235" as per GOST 27772-88 and sizes as per IS 1161	Pipe sections	Hot finished seamless tube (HFS) of YSt 240 as per IS 1161-2014	
7	"S245" as per GOST 27772-88 and sizes as per IS 1161	Pipe sections	Hot finished seamless tube (HFS) of YSt 240 as per IS 1161-2014 with additional impact requirement of 27 J at room temperature (25°C)	Impact tests shall be conducted on products having thickness less than 12mm also in accordance with clause 12.1.1 of IS:2062-2011.
8	"S255" as per GOST 27772-88 and sizes as per IS 1161	Pipe sections	Hot finished seamless tube (HFS) of YSt 240 as per IS 1161-2014 with additional impact requirement of 27 J at (-)20°C	Impact tests shall be conducted on products having thickness less than 12mm also in accordance with clause 12.1.1 of IS:2062-2011.
9	"S235" as per GOST 27772-88 and sizes as per IS 1239	Pipe sections	Hot finished seamless tube (HFS) of UTS 320 MPa as per IS 1239 (Part 1)-2004	

TECHNICAL CONDITIONS OF CONTRACT (TCC)

2.2.27 TECHNICAL SPECIFICATION FOR FABRICATION, ERECTION, ALIGNMENT, FIT UP AND WELDING OF SS LINER

SRNO	DESCRIPTION
1	Purpose
2	Scope
3	General Description
3.1	Fuel pool , Reactor cavity and Inspection Well
3.2	Pre-erection works
3.3	Fabrication
3.4	Erection & welding
3.5	Testing
4	Reports ,Records and Mode of payment

1. Purpose:

Purpose of this specification is to provide guidance to contractor to understand the scope, quantum of work and technical requirements to be followed during handling, transportation, shifting, erection and welding of stainless steel liner for Fuel pool, Reactor cavity and Inspection well including other floor & wall liner.

2. Scope

The contractor scope of work involves but not limited to the following.

- i. Study of drawings, preparation of network & schedules.
- ii. Preparation and approval of QAP, erection, welding and inspection procedures.
- iii. Receipt of material liner panels and the welding filler wire from NPCIL store, transportation, handling & preparation of IMIR and de-preservation
- iv. Survey of embedded parts, embedded channels, comparing with the readings of post pour concrete and checking completeness of concrete finishing works.
- v. Taking field measurements, fabrication of liner including marking, cutting, bending, drilling etc.

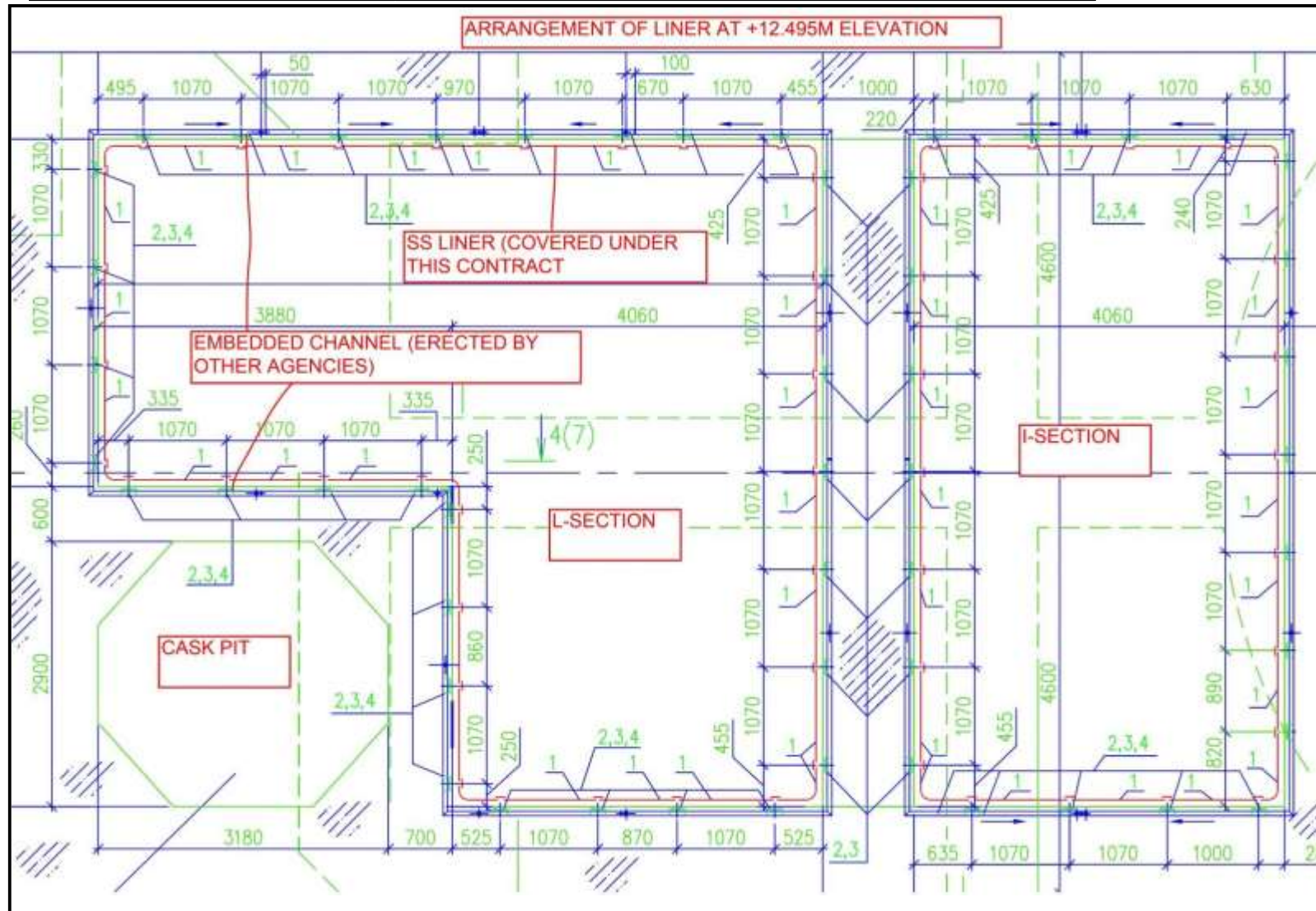
TECHNICAL CONDITIONS OF CONTRACT (TCC)

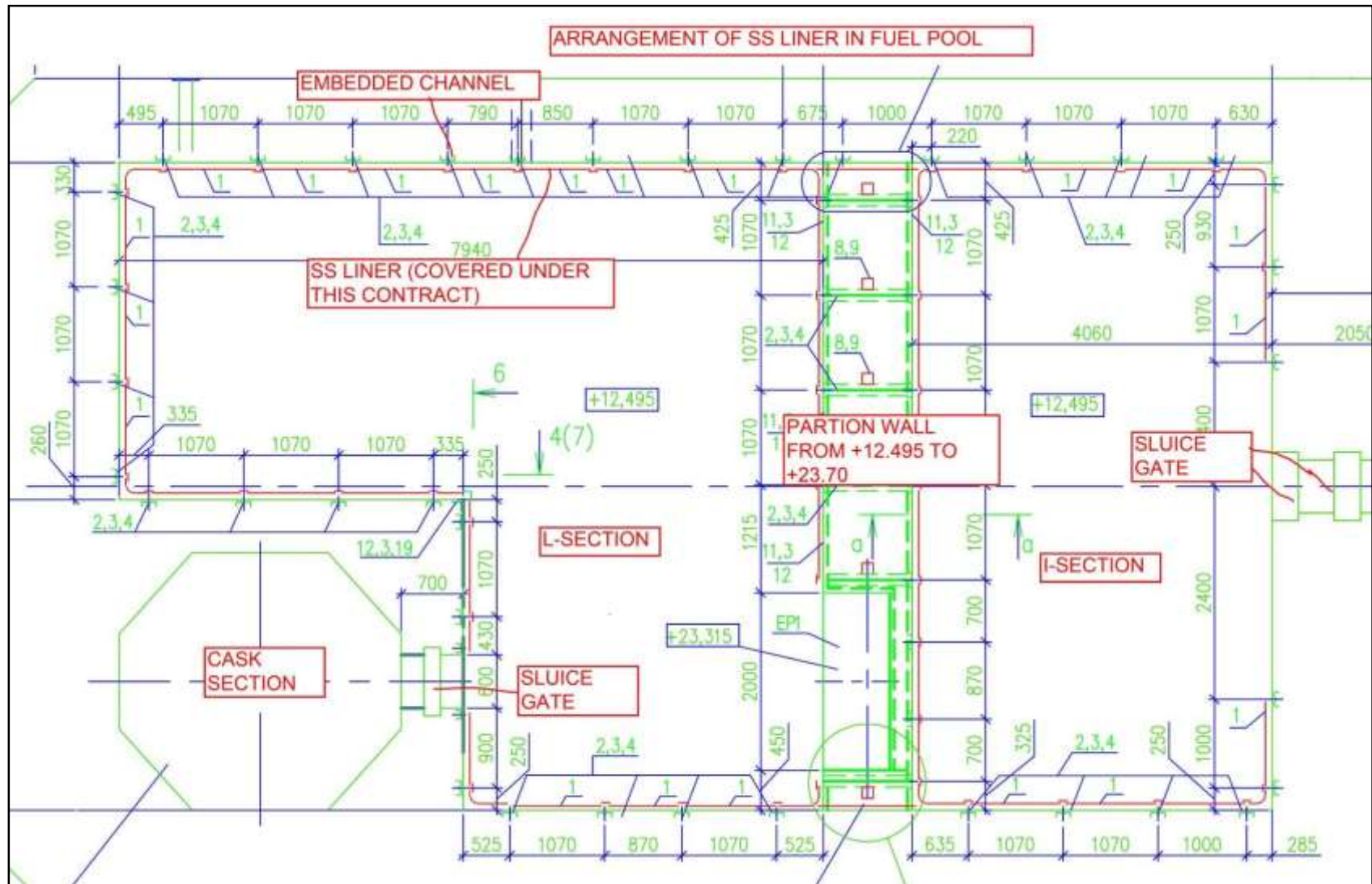
- vi. Handling, shifting, erection, alignment, fit up and welding of the stainless steel liner.
- vii. Carrying out weld inspection and assisting during fill test of the fuel pool, reactor cavity and inspection well for leak search.
- viii. Preparation of reports and submission for acceptance.

3. General Description:

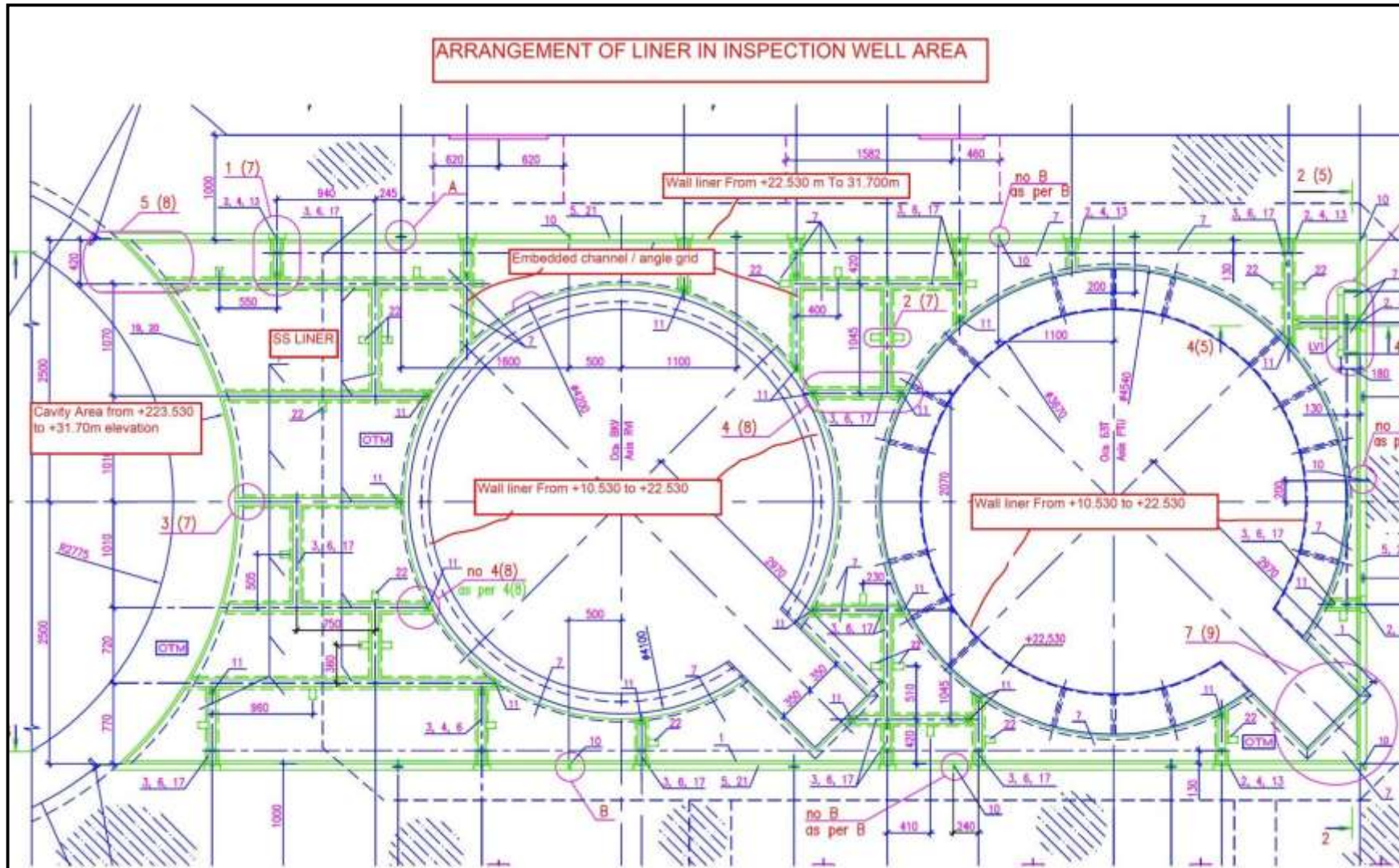
3.1 Fuel pool , Reactor cavity and Inspection Well

- i. Reactor building houses spent fuel pool inside reactor building for storing the spent fuel unloaded from the reactor.
- ii. Spent fuel pool starts from +12.130m to +31.70m elevation of operating floor at reactor building. It is located towards north of the reactor (0° orientation).
- iii. Spent fuel pool consists of mainly three partitions as shown below, viz. I- section, L- Section and Cask section. Both I & L section are meant for storing the spent fuel, where as the Cask section is to receive the fresh fuel container and the spent fuel container.
- iv. Reactor Cavity is the portion above the reactor flange i.e. from +22.530 m elevation to +31.7m elevation.
- v. There are two inspection wells adjacent to the reactor cavity towards south of the reactor, starting from +10.530m to +22.530m elevation and up to +31.7m elevation it form part of reactor cavity.
- vi. Cavity and inspection well area is connected to the fuel pool by means of sluice gate, for connection and isolation during re-fueling activities.
- vii. During re-fueling whole cavity along with inspection well area is connected to fuel pool and is filled with borated water.
- viii. To prevent the interaction of the active water directly with concrete, stainless steel liner has been provided over the floor and the walls of the fuel pool, reactor cavity and inspection well.
- ix. Before erecting of any equipment in fuel pool such as fuel pool rack supports, fuel pool racks, cask section equipment etc, liner works shall be carried out, welded, inspected, tested and accepted in all aspects.
- x. General arrangement of the liner of fuel pool, cavity and the inspection well is as shown below.





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3.2 Pre-erection works:

- i. Erection of temporary structure for making enclosure for providing clean room environment. Temporary structure work will be measured and paid in the respective BOQ item.
- ii. Arrangement of proper ventilation in the work area, air supply during working in inspection well area.
- iii. Erection of working platform and aluminum scaffolding for erection of liner panels. No separate payment will be made for any kind of working platforms. Quoted rates shall include rate for working platforms also.
- iv. Since all the liner works are of stainless steel, no carbon steel scaffolding is permitted, only aluminum scaffolding and platforms are permitted.
- v. Arranging qualified and experienced man power for carrying out erection of the liner erection.
- vi. Completed liner (floor) shall be protected with rubber sheet with vinyl flooring. Measurement and payment for rubber sheet will be paid under relevant BOQ item.

3.3 Fabrication :

- i. There shall be separate fabrication shop established for liner works. Fabrication shop shall be as per the requirements established for clean room condition.
- ii. Liner fabrication includes Marking, cutting, bending, rolling, drilling and forming activities before they get erected at site.
- iii. Liner panels are supplied in flat panels of dimensions approx 2 m x 1m. Size of this panel is subjected to vary depending on location of liner.
- iv. Prior to proceeding for fabrication, field measurements of the embedded channel grid work dimensions shall be checked, surface smoothness and cleanliness shall be ensured.
- v. Marking, cutting, fabrication of panels shall be carried out as per the field measurements.
- vi. Corner liner plates shall be bent and bending shall be carried out only by bending / rolling machines / hydraulic press, bending shall not be carried out using hammering.
- vii. For circular profiles, as in case of inspection well, cavity, etc, liner panels shall be marked, cut and rolled to the required radius. Hammering and bending at site by fit up is strictly prohibited.

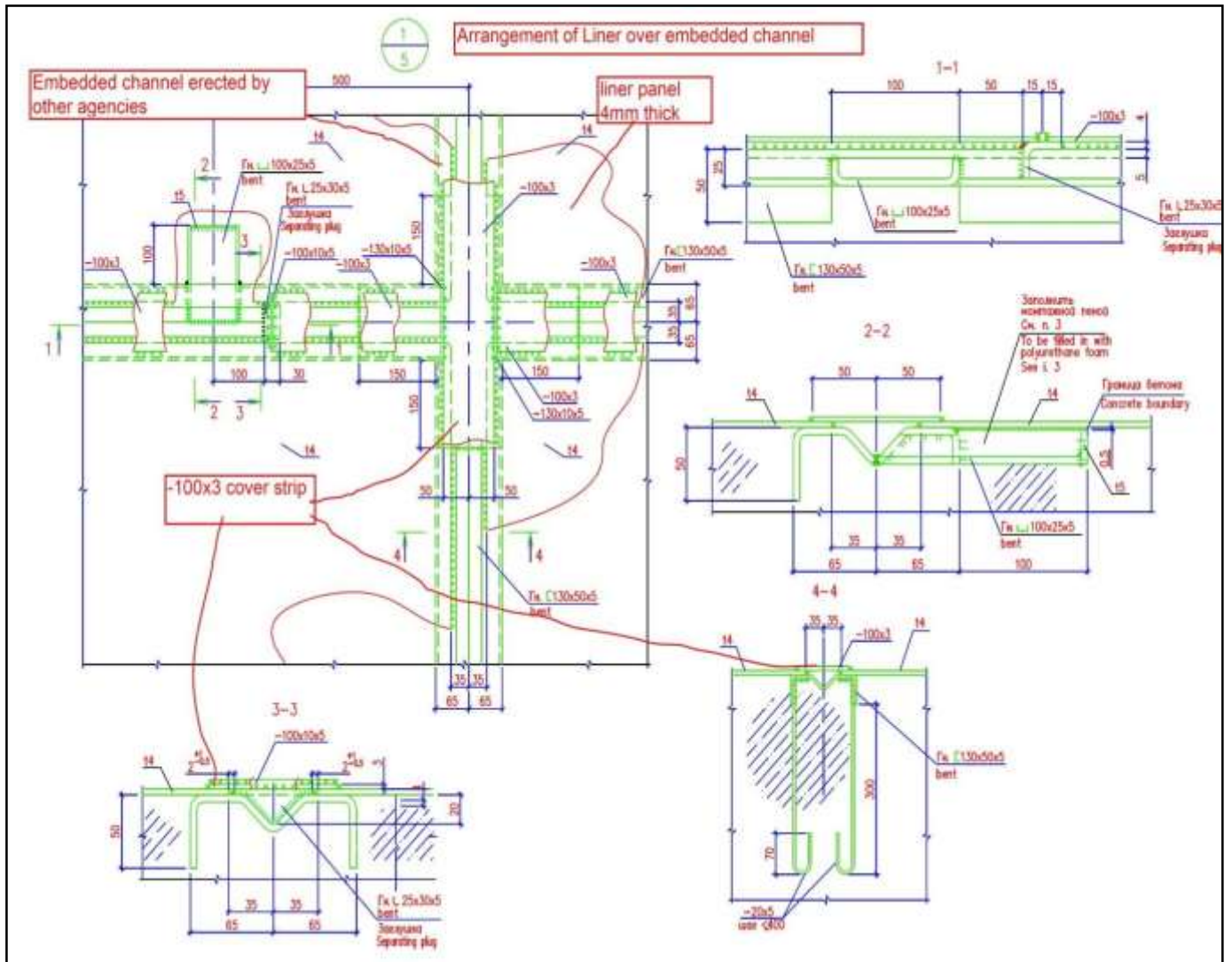
TECHNICAL CONDITIONS OF CONTRACT (TCC)

- viii. All formed items shall be inspected thoroughly for any kind of defects. Once defective panel is erected and identified only at the time of fill test, replacing will be very difficult. This will affect the project schedule.
- ix. Fabricated members shall be properly identified before shifting to site for erection.
- x. All tools and equipments used for SS liners shall be identified with proper color coding and mixing of tools for SS and CS fabrication is strictly prohibited.

3.4 Erection & welding:

- i. Shifting of fabricated liner panels to the building and location. Material required on day to day basis only shall be shifted to site. Material shall not be stacked at site.
- ii. Before proceeding for erection thoroughness of all the drain chutes, drain collection gutters, drain pipes shall be ensured using compressed air, problem identified if any shall be brought to the notice of BHEL/NPCIL for rectification and further action.
- iii. Also concrete surface shall be checked for flatness before liner erection and ensure it is within the tolerances (within 2mm per 1meter) given in the working drawings. Only experienced & qualified manpower shall be deployed for executing this job.
- iv. Erection shall be carried out in proper sequential manner. Handling liner panels shall be done using nylon webbing slings, belts rather than metal slings.
- v. During liner erection no tack welding / arc strike is permitted on the surface of the liner plates. Any tack welding required for fit up of the liner, it shall be done at the weld edge only.
- vi. Welding of fuel pool, reactor cavity and inspection well floor & wall liner shall be performed using GTAW process only. Other floor & wall liner of thickness up to 3mm to 5mm also to be welded using GTAW process. Filler wire for welding of the liner plate will be issued by NPCIL on free issue basis.
- vii. Joint configuration such as square butt, fillet etc shall be as per approved drawings.
- viii. Typical joint configuration is shown in the given below.
- ix. During fit up, no hammering is permitted for achieving required profile. Only nylon mallets to be used sparingly.
- x. Also during welding of cover strip, stopper plates are to be installed as per drawing for making drain compartments.
- xi. Other than filler wire, all other consumables like argon gas, tungsten electrode, cleaning aids, etc. are in the scope of contractor.
- xii. For welding requirements, welder qualification, weld repair requirements refer technical specification for welding.

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3.5 Testing:

- i. Weld inspection and testing shall be as specified in working drawings.
- ii. It is to be noted that the liner weld joints shall be subjected to 100% visual, 100%
- iii. vacuum box testing and dye penetrant testing as specified in the working drawings.
- iv. All the equipment required for VBT is to be arranged by the contractor, Scope includes arrangement various profile vacuum box for carrying out VBT. Sufficient number of boxes of required profile shall be maintained in order to avoid any delay during contingencies.
- v. After final completion of the liner erection, total volume shall be fill tested. Water filling test will be carried out by NPCIL, where as leak search and assistance during testing shall be provided by the contractor.
- vi. Any defect, deficiency observed during the fill test, shall be properly identified, the same shall be rectified after draining the area.
- vii. This process will repeat till successful completion of the testing.

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4. Reports , Records and Mode of payment:

- i. Erection of liner panels is measured in MT and welding is measured in RM (Running meter)
- ii. One running meter of welding includes welding of one meter of panel on both sides (up to 5mm fillet) plus welding of one meter cover strip on either side (up to 5mm fillet). i.e. total 4meters of welding up to 5mm fillet for measuring 1 Running meter.
- iii. Welding inspection reports, fabrication reports, erection reports, inspection reports, test reports etc shall be prepared and submitted on day to day basis.

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2.2.28 TECHNICAL SPECIFICATION FOR INTERNAL PRESERVATION OF EQUIPMENTS USING SILICA GEL AND NITROGEN

Sl No	Description
1	Purpose
2	Scope
3	Preservation of equipments
3.1	Preservation of equipments with silica gel
3.2	Preservation of equipments with industrial nitrogen

1. Purpose:

The purpose of this procedure is to provide guidance to contractor to understand the scope & quantum of work and technical requirements to be followed during internal preservation of equipments. Preservations are divided in to following type.

- a) Preservation using silica gel
- b) Preservation using Nitrogen gas.

2. Scope:

The scope of the contractor's work comprises but not limited to the following.

- a) Study of drawings, preparation of network schedules.
- b) Preparation and approval of QAP, preservation procedures.
- c) Receipt of material (nitrogen cylinders) from NPCIL store, transportation, storage.
- d) Issue of manufacturer's recommendation for preservation of equipments\pipelines.
- e) Supply of silica gel (indicating, non-indicating), cotton bags, CAF gaskets.
- f) Providing Baking ovens, confined space lighting arrangements (24V)

3. Preservation of equipments:

3.1 Preservation of equipments with silica gel: General :

Steam generator, Reactor pressure vessel, Relief tank etc., and other equipments are Critical components of nuclear steam supply system which

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needs continuous internal preservation with silica gel in order to maintain humidity level inside the equipments.

The preservation will be done by non indicating white silica gel (act as desiccant) and monitored by self indicating silica gel which in its dehydrated form is blue in colour but changes to pink when it absorbs moisture to its capacity. The change in color indicates whether silica needs regeneration or not.

Reference Document:-

412.05 I1 : Steam generator preservation manual (typical document)

A brief detail of work is provided below for understanding the scope of work. However contractor has to execute the work by fulfilling all the requirements of working drawings\manufacturer's instructions for satisfactory completion of said work.

The contractor's scope of work includes, but not limited to the following.

- a) Arranging baking ovens, air blowers, 24V power supply, local ventilation fans etc.
- b) Baking ovens (Electric hot air drier) shall be capable of supplying hot air at temperature of 150°-180° C, and the capacity for holding silica gel should be as high as possible(180Kg apprx) as we need to complete baking in shortest possible time.
- c) Supply & arranging cotton bags of various sizes (1kg, 5kg, 10,20kg.) along with nylon rope, CAF gaskets for fixing and holding of silica gel of various capacities inside equipments
- d) Arranging storage facility (container) for storing sufficient quantity of silica gel (both indicative and non- indicative),All necessary tools and tackles required for removing, handling and closing of temporary/permanent covers of equipments. All lifting tools, tackles to be used shall be duly certified and test certificates for the same to be submitted for their review and verification. Necessary torque wrenches to be arranged for opening of nuts, bolts as per the drawing requirement.
- e) Arranging scaffolding frames including clamps ,aluminium ladders, platforms wherever required and all accessories preferably of aluminium / or of high quality steel and all tools and tackles for removing the covers

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and arrangements for taking the silica gel in and outside of equipments. For measurement of quantity necessary weighing arrangement shall be made available.

- f) Maintaining required cleanliness as per requirements at erection sites and housekeeping of the areas under the contractor control by continuous mopping. Manpower shall use shoe covers, hand gloves, clean dress with no loose items when entering inside the equipment and shall ensure that no foreign item has entered inside the equipment.
- g) Temporary closing of equipments bottom nozzles/openings with stainless steel sheets of required thickness to avoid falling of silica gel and other things during preservation activities.
- h) Arranging skilled and unskilled manpower and technical staff and competent persons for maintaining of records (History Cards) during the contract period. Preservation status of various equipments shall be Reported to BHEL & NPCIL on Weekly basis.
- i) Preparation of preservation schedule, estimation of quantity of silica gel required based on equipments manufacturers recommendation.
- j) Foreign material exclusion (FME) practices shall be followed during preservation of equipments. Complete cleaning and removal of all foreign material (including SS sheets) shall be ensured after completion of preservation work.
- k) Generic activities involved in silica gel preservation for steam generator detailed below, for other equipments' also similar requirements shall be met.

I. Removal, handling and closing of covers of NSSS equipments

After making working platforms at various locations to access the nozzles covers (permanent/temporary), arrangements to be made with necessary tools and tackles to Remove the permanent/temporary covers (weights varies from few Kgs to 1000Kgs) of steam generators & other equipments' and check the condition of indicating silica gel already exists in side equipments at regular time intervals as per the agreed schedule. After opening the covers of equipments confined space safety norms and foreign material exclusion (FME) norms are to be followed while entering and doing any work Inside of the equipments. Based on the condition of indicating silica gel regeneration of silica gel shall be done, after regeneration silica gel shall be restored inside

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equipments and sealing covers shall be provided. Utmost care should be taken to avoid damage to the surface of the equipment while handling manhole covers.

II. Removal, Regeneration and Replacing of silica gel inside NSSS equipments

1. Steam generator Primary side:

After opening the temporary/permanent covers of steam generator primary collectors check the condition of the indicating silica gel (colour changes from blue to pink after absorbing moisture to its capacity), assess whether silica gel needs regeneration or not, if it needs regeneration Remove the entire silica gel exists inside the Primary side of SG, silica gel shall be dried in the electric hot air drier furnace(baking ovens) with hot air at temperature of 150°-180° for about 3 hours, immediately after drying the silica gel shall be placed in the cotton bags and replaced inside equipments. The time intervals for checking the condition of self indicating silica gel is as per manufacturer's preservation instruction.

The amount of silica gel, put in each coolant collector of the steam generator is not less than 11kg, standard of putting silica gel set at the rate of 1Kg/m³. Prior to putting into SG silica gel shall be packed in cotton bags. Integrity of bags with silica gel shall be performed visually before putting them into SG.

Bags with silica gel shall be put into the primary circuit collectors in compliance with the drawings issued by Engineer-in-charge. Number of bags for each collectors will be based on volume of equipments. The bags shall be evenly located along the collector height and fastened on the SS tie-rod or rope so as to prevent contact of the bags with the header surface and their displacement during transportation. Ensure integrity of the cotton bags before placing inside equipments. Arrangement of bags with silica gel shall be inspected by the authorized representative of BHEL & NPCIL.

Time between the beginning of arrangement of silica gel and the end of sealing shall not exceed 2 hours.

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2. Steam generator Secondary side:

For the secondary side of Steam generator Silica gel shall be put through the hatch manhole cover. After opening the temporary/permanent covers of steam generator manhole covers check the condition of the indicating silica gel (colour changes from blue to pink after absorbing moisture to its capacity), assess whether silica gel needs regeneration or not, if it needs regeneration Remove the entire silica gel exists inside the secondary side of SG, silica gel shall be dried in the furnace(baking ovens) with hot air at temperature of 150°-180° for around 3 hours, immediately after drying the silica gel shall be placed in the cotton bags and replaced inside equipments. The time intervals for checking the condition of self indicating silica gel is as per agreed schedule.

After regeneration the amount of silica gel to be placed in side Secondary side is 180 kg at the rate of 1kg / m³. Mass of one bag with silica gel shall not exceed 15kg, the shape of bags shall provide the large surface to volume ratio. Bags with silica gel shall be placed on SG perforated plate. For this purpose packing material (CAF gasket) is put on the perforated plate. Fastening of bags shall be made in site using twine.

After putting silica gel the hatch manhole shall be tightened in compliance with the requirements of drawings and sealed up. Time from beginning of putting silica gel to termination of sealing the hatch shall not exceed four hours for secondary side of steam generator.

While going inside equipments the lighting should be either 24V or battery power light should be used.

Time from beginning of putting silica gel to termination of sealing the covers shall be done in minimum possible time.

Maintain required cleanliness as per requirements at erection sites and housekeeping of the areas under the contractor control.

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Records/Reports:

The Contractor shall maintain records pertaining to the quality of work and inspection attesting compliance with all technical requirements. The records shall be on forms agreed by the Engineer. The Contractor shall submit the copies of such-records to the Engineer every week. The report concerning inspection, regeneration of silica gel shall be duly accepted by BHEL & NPCIL as per approved quality plan. Log book for the work done when starting for any equipment has to be maintained mentioning each and every activity with time recorded for such activity, the tools tackles taken inside the equipment and personnel entry.

3.2 Preservation of equipments with Industrial Nitrogen:

General : Steam generator, Reactor internals, Emergency core cooling system tanks, pressurizer and other equipments etc are Critical components of nuclear steam supply system which needs internal preservation with nitrogen during storage.

The preservation will be done by Industrial nitrogen (Dew point not over 45 deg.C, oxygen volumetric part is not over 0.05%, oil free)

Reference Document:-

412.05 I1 : Steam generator preservation manual (typical document)

The contractor's scope of work includes, but not limited to the following.

- a) Preparation of preservation schedule based on equipments manufacturers' recommendation.
- b) Arranging scaffolding frames\working platforms including clamps, aluminium ladders, wherever required for accessing the nitrogen charging point, monitoring pressure gauge of equipments.
- c) Arranging skilled and unskilled manpower and technical staff for shifting of nitrogen cylinders from NPCIL stores/designated point, for maintaining of records (History Cards) during the contract period.
Preservation status of various equipments Reported to BHEL & NPCIL on Weekly basis.
- d) Shifting and stacking of nitrogen cylinders shall be carried out by following prevailing industrial safety norms.

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- e) Generic activities involved in nitrogen preservation for steam generator detailed below, for other equipments' also similar requirements shall be met.
- f) Supply, fabrication, erection of nitrogen charging fixtures including pressure gauges, safety relief valve, venting fixtures, nitrogen regulators etc. Ensure calibration certificates for pressure gauges, regulators. Minimum two pressure gauges on each equipment and one pressure gauge at charging point shall be provided.
- g) Establish nitrogen cylinders storage/charging station outside reactor building at +0.00 mtr elevation by following safety norms for cylinder storage.
- h) Supply, arranging high pressure nitrogen hoses of various lengths, fittings for connecting Equipments with nitrogen charging station.
- i) Arranging communication facilities for communicating from cylinder charging point to various equipments inside buildings.
- j) Check the Pressure inside equipments as per the agreed schedule and carryout the charging of nitrogen to the required pressure as stated in the manufacturers recommendation of each equipment. In general typical pressures in the range of 0.20-0.3 kg/cm² shall be maintained inside the equipment.
- k) Records/Reports:

The Contractor shall maintain records pertaining to the preservation work and inspection attesting compliance with all technical requirements. The records shall be on forms agreed by the Engineer. The Contractor shall submit the copies of such-records to the Engineer every week. The report concerning inspection shall be duly accepted by BHEL & NPCIL as per approved quality plan. Log book for the work done when starting for any equipment has to be maintained mentioning each and every activity with time recorded for such activity, the tools tackles taken inside the equipment and personnel entry.

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2.2.29 Technical Specification for Erection of Ventilation systems of UJA and UJB

Sr. No	Description
1.	Introduction
2.	Scope
3.	Applicable codes ,standards & specification
4.	Specifications of material and consumables
5.	Erection requirements of hvac system in reactor building (UJA & UJB)
6.	Ventilation ducting
7.	Fabrication and erection of metal mesh
8.	Access doors
9.	Collar pieces
10.	Duct mountings/ instrumentation tapings & inspection holes
11.	Supply fabrication and erection and testing of vent box
12.	Thermal insulation of ventilation duct and vent box
13.	Mode of measurement
Appendix-1	Typical sketches of ventilation equipments
Appendix-2	CS/SS duct fabrication- typical sketches

1. INTRODUCTION:

1.1 Description of Ventilation Systems of the Reactor Building:

Reactor building is rectangular, 72.0x42.0 m, with the double containment cylindrical part of 52.0 m diameter and of 79.0 m height. It has many floors from - 7.250 m. to 34.1 m. Total heat load from the operating process equipment is 4,350 kW.

According to layout details based on possibility of accident occurrences the reactor building UJA is subdivided into the following groups of rooms:

UJA - hermetic rooms confined by the primary containment designed for overpressure of 0.4 MPa;

UJB - hermetic space between two containments (annulus);

The design envisages independent ventilation systems for every group of the rooms.

Inside reactor building the primary containment rooms ventilation (UJA building) are considered on the basis of dividing containment rooms into two zones:

- unattended area, personnel access to which is allowed only in PPM mode, is an enclosed primary containment volume, including SG and RCP boxes,

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reactor vault, valves rooms and other rooms, where primary circuit equipment and pipe- lines are located;

- Controlled-access area, personnel access and short-term presence in which is allowed during power unit operation on load, includes central hall, RCP electric motors rooms and other rooms.
- For ventilation and cooling of the primary containment rooms the design considers the following systems:
- KLA01–recirculation cooling system of the primary containment unattended rooms;
- KLA03 – recirculation cooling system of CPS drives;
- KLA04–recirculation cooling system of the primary containment controlled-access rooms;
- KLA02 – recirculation air purification system of the primary containment;
- KLA41, KLA21 – repair-emergency plenum-exhaust ventilation systems;
- KLA42, KLA22 – plenum-exhaust ventilation systems for the containment rarefaction.

1.1.1 Air Cooling System of the Primary Containment Unattended Rooms

KLA01and KLA03:

Recirculation system KLA01 is intended for removing heat and moisture emission from process equipment and pipe-lines, located in the primary containment unattended area (RCP boxes, valves chambers, etc.), as well as for cooling reactor concrete vault.

Recirculation system KLA03 is intended for CPS drives air cooling.

The re-circulating units consist of radial fans with asynchronous motors and air coolers with separators and trays. On the discharge line there are installed hermetic check valves with electrical motors.

1.1.2 Air cooling system of the primary containment controlled-access rooms

KLA04:

Re-circulating system KLA04 is intended for air cooling in personnel controlled-access area rooms for servicing the primary containment– reactor hall, ventilation center, RCP electric motors maintenance rooms.

System KLA04 consists of four ventilation units- two operating and two standby. Each cooling unit consists of fan and two air coolers groups.

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1.1.3 Re-circulating air purification system of the primary containment rooms

KLA02:

Re-circulating system KLA02 is intended for air cleaning off radioactive contamination and maintaining radiation situation in controlled-access rooms for servicing the primary containment at assigned level in normal operation mode, except power loss mode, PPM and refueling, as well as for creating differential pressure of 50 Pa between controlled-access area and unattended zone.

The System KLA02 consists of two units - one operating and one standby, combined by air ducts common network. A motorized leak-proof check valve is provided at inlet to the filtering unit for preventing non-cleaned air release from the reactor coolant circuit (RCC) rooms through system KLA02 air ducts in power loss mode.

The re-circulating units consist of radial fans with asynchronous motors and filtering units for cleaning off radioactive aerosols and iodine. On the suction line there are installed hermetic check valves with electrical motors.

1.1.4 Repair-emergency exhaust and plenum ventilation systems of the primary containment KLA21 and KLA41:

Exhaust system KLA21 is intended for airing the primary containment in combination with plenum system KLA41 aimed at creation conditions for repair works, as well as for air cleaning after accidents.

The equipments of exhaust and plenum systems KLA21, KLA 41 are located in the reactor auxiliary building, carbon steel duct with anticorrosive painting is available for exhaust / supply systems in UKC, UJB. The ducting inside reactor (UJA) is made of stainless steel.

For isolation of the plenum units during operation of the exhaust system KLA21 in re-circulation mode a hermetic valve DN 1000 is installed at the common air duct and two hermetic valves DN 1000 are installed in sequence on the line interlaced with the primary containment.

1.1.5 System of rarefaction creation in the primary containment KLA22 and KLA42:

Exhaust system KLA22 and plenum system KLA42 are intended for ventilation of the primary containment during normal operation, as well as for creation of rarefaction not less than 150 Pa in the personnel controlled-access rooms during the NPP power unit running under load (except power loss mode).

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System KLA22 provides assigned rarefaction with keeping required tightness of the structural elements and during joint operation with system KLA42.

The main equipments are located in UKC building and carbon steel duct with anticorrosive painting is provided in UKC and UJB building. Stainless steel ducting is provided inside the reactor building.

At points of systems KLA22 and KLA42 air ducts running through the primary containment there are installed quick-acting hermetic check valves.

1.1.6 Pressure Suits air Supply System KLA43

The purpose of system KLA43 is fresh air supply to the individual protection means (pressure suits).

The system capacity equal to 1500 m³/h permits about 40 pressure suits to be simultaneously connected, ensuring the air supply of no less than 24 m³/h to every pressure suit, provided that the pressure of no less than 5000 Pa is maintained upstream of air-distributing comb.

The ventilation plants of System KLA43 are located in UKC and the SS ducting /piping is used for air distribution to various location.

1.1.7 Ventilation Systems in the Annulus of Building UJB

The following systems are provided in the design for annulus ventilation and air cooling. KLB22, KLB42 – annulus rooms plenum-exhaust ventilation systems; KLB01 – recirculation system of normal operation cables penetrations sector cooling; KLB02 – recirculation system of safety cables penetrations sector cooling.

1.1.8 Plenum-exhaust ventilation systems KLC41, KLC22, KLB22, KLB42:

Purpose of systems KLB22 & KLB22 is to create rarefaction in the annulus for NPP emergency modes for preventing release of air, contaminated with radioactive substances, beyond the annulus space due to leaks in the building structural elements.

In normal operation mode KLC21 and KLC41 systems ensures the annulus ventilation.

Air ducts of the exhaust and plenum ventilation systems in the controlled-access area are made of carbon steel sheets.

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1.1.9 Description of recirculation cooling systems KLB01, KLB02:

Recirculation systems KLB01 and KLB02 are intended to remove heat from safety and normal operation and cable rooms located in the annulus.

2. SCOPE:

This specification describes the technical requirements for erection of ventilation systems like fans, filters valves dampers etc., fabrication, erection, inspection and testing of ventilation ducting systems including stainless steel, carbon steel ducts/ fittings, vent box, vanes, splitters, metal mesh, grills for ducting of UJA and UJB. The specification gives the requirements thermal insulation of ducts inside UJA and UJB, specification for duct mountings for measurement of various parameters like temperature, humidity, flow, pressure etc. This specification shall be referred in conjunction with the general technical specification for erection activities enclosed elsewhere in the tender document. The contractor shall note the following;

- a. This specification gives the applicable codes and standards for supply, fabrication and erection of Stainless steel (SS), Carbon Steel (CS) ducting and vent box. The specification details the duct materials, thickness, fabrication methodology, various types of seam as well as transverse joint configuration, fittings fabrication, sizing of stiffeners, cross bracing, tie rods and vanes and splitters, flexible duct connections, configuration.
- b. The structural supports for ventilation ducts shall be fabricated and erected as per the technical specification for structural steel works enclosed elsewhere in the tender.
- c. This technical specification give the specific/ additional requirements for erection of equipments and shall be referred in conjunction with the general technical specification for erection.
- d. The thermal insulation of ventilation systems shall be done as per the technical specification for thermal insulation enclosed elsewhere in the tender.
- e. The erection of ventilation systems in buildings of UKC, UKA, UKB and UJE/ UCC is not included in the contractor scope.

The detailed quantum of work to be performed by the contractor will be elaborated in working document which will be issued to the contractor progressively.

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2.1 NPCIL Scope of Work:

NPCIL Scope of work limited to following;

- a. Issue of free issue materials from stores.
- b. Approval of duct spool and schedule list prepared and submitted by the contractor for further carrying out fabrication activities.
- c. Inspection and acceptance of ducts spools/ fittings at various stages as per QAP.
- d. Progressive release of work front.

2.2 Contractor's Scope of Work:

In general, the Contractor's scope of work comprises but not limited to the following:

- a. Receipt of free issue materials from store, handling, transportation to site.
- b. Supply of stainless steel sheet and plate, carbon steel sheet of required thickness, grade and standard for fabrication of duct and fittings.
- c. Establishing the CS and SS duct fabrication workshop.
- d. Fabrication and erection of duct spools, fittings, along with the flanges, stiffeners as per the accepted spool list.
- e. Fabrication and erection of various parts of vent box as per the WD requirements.
- f. NDE inspection of fabricated/ erected ducts, vent box parts and other structural members as per the approved QAP and WD requirements.
- g. Shifting and transportation of fabricated spools to site, handling and erection as per WD requirements.
- h. Supply, Fabrication and installation of access doors on ducting including the supply and fixing of clamps for the door.
- i. Supply, fabrication and erection of collar piece for installation of grills and mesh.
- j. Supply of various types of gaskets like EPDM/ Nitrile rubber adhesive, non asbestos gaskets for bolted flange joints.
- k. Supply of various types of rivets, fasteners duct fabrication and erection.
- l. Preparation of inspection reports at various stages, as built drawings of ducts, equipments, vent box submission for engineer's review and acceptance.

3. APPLICABLE CODES, STANDARDS & SPECIFICATIONS:

The Supply of materials, fabrication and erection of ventilation duct systems shall comply with all currently applicable codes and standards specified below and as listed in other relevant NPCIL's documents like Data Sheet and applicable Indian/ Russian/ American Standards. Nothing in this specification shall be construed to relieve contractor of his responsibility. The requirements are based on norms,

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standard and practices followed for ducting work. Table 1: List of Applicable Codes and Standards:

SMACNA	: HVAC Duct construction standards-Metal and flexible.
ASHRAE Standards	: Handbook and ASHRAE Systems and Equipment for design and fabrication of ductwork
TU4860-001-04739663-01	: Metallic air duct for TPS and NPP
TU4860-002-04739663-01	: Flanges for ventilation air ducts
TU4860-004-04739663-01	: Parts & assemblies of ventilation systems for NPPs
SNiP-3.05.01-85	: Internal sanitation system
SNiP-41-01	: Heating, Ventilating And Air Conditioning
IS:513-2008	: Cold rolled steel sheet
IS: 655-2006	: Specifications for Air ducts
IS: 1363	: Hexagon Head Bolts, Screws and Nuts of Product Grade 'C'
IS: 1367	: Technical Supply Conditions for Threaded Steel Fasteners,
IS 2062:2011	: Hot Rolled Medium And High Tensile Structural Steel — Specification
ASTM A 240-02a	: Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications

In the event of conflicting requirement between the specification and the drawing, the governing requirement shall be at the discretion of engineer. In the instance where the contractor is unable to achieve any particular technical requirement, he must apply to EIC with full justification for regularisation of non –conformance. Any deviation from the technical requirements shall be recorded and duly approved by Engineer. The contractor shall take prior approval from engineer before fabricating any job outside the project area. All items fabricated outside the project all material to be supplied by the contractor is subjected to Quality surveillance by Engineer.

4. SPECIFICATIONS OF MATERIAL AND CONSUMABLES:

Material of construction and specification for ducting and its components are given in Table 2. All materials used in ventilation ducting shall have valid test certificate indicating relevant mechanical and chemical properties as per the requirements of material specification.

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Table 2: Materials and their Grades/ standards used in ducting work:

SI No	Item/ Description	Material Grade/ Standard
1	Carbon Steel [CS] Ducting Sheet and Pipe:	
1.1	Carbon steel ducting sheet 2.0 mm thick	Cold rolled Carbon Steel sheets/ plate as per the standard confirming to IS 513-2008 of designation CR3
2	Stainless Steel [SS] Ducting Sheet and Pipe:	
2.1	Stainless steel ducting 2.0 mm	ASTM A 240-02a, TYPE -321 No 2B finish with IGC tested as per ASTM 262 A – Practice –E
2.2	SS plate 3 mm, 4 mm and 5 mm for vent box.	ASTM A 240-02a, TYPE -321 No 2B finish with IGC tested as per ASTM 262 A – Practice –E
3	Structural Steel:	Refer Technical Specification for supply, fabrication
4	Fasteners for bolted flange joints of CS	GI coated IS:1363 Grade-C and IS:1367 Property class 5.6
4a	Fasteners used in SS	SA193Gr.B7 & SA194 Gr.2H or equivalent
5	Gasket	- Fire retardant EPDM/ Nitrile Foam rubber, ribbon porous monolithic rubber of 4–5 mm thick – - Acid resistant non asbestos gasket for ducts carrying acid fumes- Make Champion, Ferolite or equivalent.
6	Duct Sealants/ putty	Silicon duct Sealant – white/ light grey – Make: 3M,
7	Metal Mesh: SS Mesh	Mesh of opening size 10 mm x 10 mm of wire; dia 1.0 mm material for Stainless steel SS 304L. GI : GI coated mesh
8	Welding Consumables	
8.1	SS Filler wire	ER 308L as per ASME Sec-II Part C SFA -5.19
8.2	CS Filler Wire	ER 70 S2 as per ASME Sec-II, Part C, SFA -5.18
8.3	SS Electrode	E 308L
8.4	CS Electrode	AWS E7018
8.5	SS-CS dis-similar electrode	E 309L as per ASME Sec-II Part C SFA -5.19

Contractor may propose any alternative equivalent material than that of specified above. However, the material proposed should be of good practice pertinent for the construction of ventilation and Air Conditioning duct system and shall obtain prior approval of NPCIL.

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Any alternate material shall be subjected to approval of NPCIL for recommencement of manufacturing/ fabrication. Any deviation from this specification, the purchase order or approved drawings and documents, shall have the prior approval of NPCIL.

5. ERECTION REQUIREMENTS OF HVAC SYSTEM IN REACTOR BUILDING (UJA & UJB):

5.1 Ventilation Equipment:

Following are the different types of ventilation equipment included in the erection scope of contractor;

- i. Re-circulating cooling Plants (RCPs):
- ii. Filtering Plants
- iii. Containment Isolation valves:
- iv. Shut check Valves
- v. Check valve/ dampers
- vi. Fire Dampers
- vii. Air distribution terminal block

5.2 Re-circulating cooling plants:

Re-circulating cooling plant consists of centrifugal fan, cooling coil, moisture separator arrangement, and a tray for collecting the condensate with the provision of drain. Generally, the re-circulating cooling plants in (UJB), centrifugal fans (inside UJA) are issued as single assembled units. The units are erected over base frame by bolting arrangement. The base frame is fabricated with the channel and is welded to the EP provide over the pedestal.

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- i. The re-circulating cooling plants in UJA are supplied in parts with separate fan- motor assembly and cooling coil- Moisture separator assembly. The contractor shall assemble the individual parts at the erection location. A typical sketch of re- circulating cooling plant inside reactor building is enclosed as Figure-1 of appendix-1. Following shall be noted while erecting equipment.
- ii. In general all the free issue ventilation equipments will be issued well in advance of erection schedule, so that over dimension equipments which cannot pass through the door can be taken to the location before the closing of slab/ side wall. Contractor shall make arrangement for drawl, shifting, handling and lowering of equipments inside the room location.
- iii. In the cases wherever it is not possible to take the equipments as an assembled single unit, contractor shall dismantle the equipment into the smaller parts and shift to the location and reassemble after taking the written approval from engineer. The dismantling of equipments shall be done strictly by using the standard tools, skilled manpower and as per manufacturer recommendations. Each dismantled part shall be identified by part no, and orientation part, sequence of assembly shall be strictly followed. After shifting to the location, the contractor shall carryout the reassembling of equipment and completes the erection work.
- iv. In case of equipment issued already in disassembled form, the contractor shall carryout the assembling of equipment and completes the erection activity as per the manufacturer recommendation and the requirements of WDs.
- v. In case the requirement of cutting of base frame arises, for shifting the equipment to location, contractor shall take prior written permission from ENGINEER, and shall mark the location of cutting of frame. Cutting of equipment frame shall be done only with suitable cutting wheel / plasma cutting and no gas cutting is allowed.
- vi. After shifting the parts to the location, the contractor shall prepare the edge preparation, and shall carryout fit up and welding carryout DPT of weld area.

All the consumable items like rivets, screws, gaskets, silicon sealant, welding gas, electrode, filler wire etc. required for completing the work is covered in the scope of contractor supply.

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5.3 Exhaust Radioactive Filter:

These units are located at the upstream of the exhaust fans. The filter housing is made up of stainless steel and usually supplied in parts of different filters for easy handling and transportation. The various components of filter housing are:

- i. Heater element.
- ii. Fine filter housing (F-9)
- iii. HEPA filter unit (H-11)
- iv. Charcoal filter housing
- v. HEPA filter unit (H-13).

A typical sketch of exhaust radioactive filtering plant is shown in Figure- 2 (a) and 2 (b) of Appendix-1.

Individual components of filter housing are taken to the location, assembled over foundation, leveled and connected to each other unit by bolted flange arrangement. The support legs of housing are alignment and accepted filter housing to be welded with EPs. The filter housing shall be pneumatically tested for leak tightness before connection of ducting. The ventilation duct is connected to the filter units with bolting. Following shall be noted while assembling, erection and testing of filter housing.

- i. Utmost care shall be taken by the contractor while handling, transporting, shifting, assembling and erection of filter housing parts. Only Nylon slings or belts shall be used while shifting of various parts of filters. Dragging of filter housing is strictly prohibited.
- ii. Before carrying out the welding of filter supports on to the pedestal, the individual parts of filters shall be aligned, and assembled with flange connection. Only SS fasteners shall be used in flange connection. The stainless steel support members shall be welded/ fixed on to the pedestal as per the WD requirements. Only SS shims are allowed to use while leveling the filter housing. Welding of filter supports on to the base frame/ EP of pedestal is included in the scope of erection of filter housing and no separate measurement/ payment shall be made for the same.
- iii. After completion of the assembling, welding of filter housing over the pedestal, pneumatic testing of the housing shall be carried out by pressurizing the entire

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- iv. housing assembly up to a pressure of 2000 Pa or with a pressure recommended by equipment manufacturer.
- v. The quoted rates shall be inclusive of assembling, erection, welding of filter legs over EP and testing of filter as per the manufacturer recommendation.

5.4 Fire Damper / Valve [FRV]:

Fire dampers are used in ventilation systems for preventing the propagation of fire from one compartment to other by physically cutting off the air movement.

Typical Fire damper/ smoke damper is shown at Figure-3 of Appendix-1. The fire valves are erected over the embedded part of wall / floor penetration with a bent channel frame made up of 2 mm carbon steel sheet. The Fire valve is bolted to the frame and the other end is connected to ventilation duct/ open to the room. The contractor shall make proper arrangement for covering of electric actuator and valve to prevent from the dirt and debris during construction activities.

5.5 Motor Operated Butterfly Valves and shut check valves:

The motor operated Butterfly valves are used in ventilation system, where it is essential to ensure leak tightness. The operation of valves is generally done by an actuator-motor assembly mounted over the valve.

Shut check valves are mounted over the re-circulating cooling plants KLA01, KLA03 and KLA04. The valves are intended for shutoff the ventilation equipments. The valves have electric motor assembly with solenoid valve arrangement for initial opening of valves and also have a counter weight for shutoff the valve during power off condition. Typical shut off check valve is shown at Figure-4 a, b and c of Appendix-1.

The weight of the valve is supported over the metal structure and unless specified in working drawings only high strength fasteners of grade 8.8 shall be used fixing the valve over the metal structures.

Care shall be taken for preserving the counter weight of the valve, solenoid actuators during construction activities.

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5.6 Isolation Valves:

These valves are used in exhaust ventilation systems handling activated air. The valves installed on the inner containment by welding to embedded penetration EP. The valves are tested for seat leak tightness as per manufacturer's recommendation before and after completion of erection. The typical sketch of isolation valve is shown in Figure-5 of Appendix-1.

5.7 Check valves:

Check valves/ check dampers commonly known as back draft dampers used in the ventilation system for preventing the back flow/ reverse flow of air. The valves are located at the suction and discharge ducts connecting to the centrifugal fans. The valves are erected in line with the ducting and are connected by means of bolted flange arrangement.

5.8 Throttle Valves/ dampers:

Throttle valves are used in ventilation ducting for adjusting flow through a branch/ main air duct. Throttle valves/ dampers are erected in line of the ducting system and are fixed by flanged joints.

5.9 Over Pressure Relief Valves [ORV]:

ORVs are designed for automatic relief of air or gases through air ducts running from one room to another when differential pressure is no less than 50 Pa. An ORV consists of two flanges, one flange is welded to EP in wall and bolted to the another flange. Flange welding EP shall be done in controlled manner. The counter weight shall be removed and stored by the contractor before erection. Typical Sketch of ORV is shown in Figure-6 of Appendix-1.

6. VENTILATION DUCTING:

Ducting system at KKNPP 3&4 consists of rectangular, circular straight duct, reducer, bends, elbows, T-Joints, splitters, collar piece, exhaust hoods, intake plenum ducts etc. The dimension of ducts varies from 100 mm to 3000 mm and is available in various sizes. The ducts are supported with metal structural supports from side wall/ floor/ ceiling/ metal structural plat from.

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Generally ducts are routed through corridors and vent shafts. Manual flow control dampers are installed in the branch ducts for regulating the air flow to the design value. Fire retardant valves (FRV) are installed in the air duct systems for isolating the systems in case of any fire incident. These valves are installed at the transit location of duct crossing from one room to other room of different category. Air supply in to the room/ exhaust from the rooms is normally done through metal mesh fixed over the duct. Flow control grills, diffusers are also used in some locations for precise control of flow through each opening.

Vent box made up of 3 mm and 5 mm stainless steel plate is used inside reactor building for handling high air flow rates.

6.1 Ventilation ducting inside Vent Shafts:

Number of ventilation ducts of different systems of different sizes will be passing through the vent shaft at very close distance from each other. These ducts may have thermal insulation as well. Ventilation ducting in some portion of UJB present in vent shaft.

6.2 Sequence and Scheduling of Ducting:

Ducting layout drawings will be issued to contractor progressively. Based on the overall schedule, the contractor shall prepare schedule of ducting and submit for approval of engineer before the start of work. However the sequence of fabrication, erection shall be decided by Engineer based on availability of erection fronts, drawings and equipment.

The planning and sequencing of ventilation duct erection in the vent shaft and other congested areas shall be made in meticulously. The contractor shall plan all the activities including fabrication, of duct spools by taking consideration of difficulty in erection of temporary approach platform, scaffolding etc. The contractor may be required to modify the transverse joints of duct spools in case of flanged/ welded ducts.

Due to congestion, it may not be possible to shift fully fabricated duct spools to the location. The contractor shall list out all the duct spools required to be shifted in semi fabrication state to site and take necessary action before the start of fabrication activity. No separate payment for the duct erection at vent shaft, congested areas, in side tunnels, and will be paid as per any other duct spools in the building or structure.

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In some location of reactor building the ventilation ducts are located very close to the ceiling/ adjacent walls. Conventional method of flange bolting/ circumferential joint welding may not be possible in this location due to access problem. The contractor shall prepare the methodology of duct erection in such cases and shall be approved by the Engineer.

The present contract scope also covers the erection of fire water piping, the contractor shall ensure the proper sequence of erection of ventilation ducting and fire water pipelines to avoid interference, access/ routing difficulties.

The general sequence of fabrication & erection shall be;

- a) Preparation of spool list/ fabrication drawings of ducts, fittings etc. as per working
- b) drawings issued for construction and field conditions.
- c) Fabrication of SS and CS ducts (circular, rectangular) supports and fittings such as bends, elbows, T-joints, taps, vanes, tie rods, bracings etc.
- d) NDE of fabricated ducts as per the QAP.
- e) Dye penetrant testing of all shop weld joints of CS and SS ducts.
- f) Grit blasting, painting of carbon steel ducts and duct supports at shop as per
- g) specifications.
- h) Handling, transportation of fabricated ducts to various buildings.
- i) Erection of ducting spools, supporting them on permanent/temporary supports and completion of welding/ assembling together the spools in the field.
- j) Site NDE inspection of for erected ducts as per QAP.
- k) Dye penetrant testing of all field weld joints of CS and SS ducts.
- l) Measurement of erected ducting, preparation of report, as built drawing and CCC.

For carrying out the above activities co-ordination with other Contractors working in that area for erection of piping, cable tray, etc., will be required. This is to avoid unnecessary cutting and re-working of ducting, piping, supports etc.

6.3 General Fabrication and Erection Requirements of Ducting:

The ducting shall be fabricated out of SS/ CS pipe as given in duct schedule. The air duct network are assembled from individual straight section of air ducts, non-straight section of air ducts (Branches, semi branches, reducers, T- pieces, vanes, tie rods, etc.) which are here in after referred to as 'fittings', connecting

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parts (flanges, bands, nipples, joint strips, buckles, etc.) and multipurpose elements (diaphragm, gates, valves, dampers etc.).

The contractor shall establish separate fabrication shop respectively for SS and CS ducting to avoid intermixing of materials and tools. The contractor is also allowed to fetch pre-fabricated/ semi-fabricated ducts and duct fittings with the approval from BHEL/NPCIL. Before carrying out the fabrication of ducts, the contractor shall survey the area/ work front for conformity with drawings issued. Any modification requirements in duct sizing/ routing due to field constraints shall be intimated to EIC and modifications shall be carried out with the due approval from NPCIL.

The Contractor shall pre assemble ducts and fittings in shop to the maximum extent feasible to minimize the field joints. Duct line shall be made with the minimum feasible number of joints.

All threaded connections shall be either capped or have thread plugs inserted until the associated equipment has been installed.

The gasket material required for all bolted flange connection shall be supplied by the Contractor. Cutting of gasket sheets to required size and shape is included in Contractor scope of work.

The Contractor shall take adequate care to prevent damage to duct, fittings during storage, handling and erection. Under no circumstances ducts/ fittings shall be dropped, dragged over the floor. Nylon belts/ ropes shall be used for handling of ducts.

6.4 Duct Fabrication and Erection:

6.4.1 General Instruction:

6.4.1.1 The straight section of ducts shall be of straight seam or spiral seam design and shall be made by seaming or welding. The longitudinal seam in rectangular as well as round duct shall be positioned in any of the kinds illustrated in Figure-1 of Appendix-2.

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6.4.1.2 The prefabricated length of straight section of individual air duct spool shall not be more than 2500 mm & shall not be less than 200 mm. However it is allowed to fabricate round duct with spiral seam up to length of 6000 mm.

6.4.1.3 It is not permitted to have more than one seam joint over the duct face in case of rectangular / square ducts.

6.4.1.4 The seams shall be of uniform width on the entire length, shall be uniformly & tightly upset. In the points of seam intersection there should be no 4-fold metal thickness. In case of longitudinal and transverse seam available these should be connected so as to avoid cross-shaped joints.

6.4.1.5 The pitch distance of spiral seam shall be as given below;

Internal Diameter (mm)	Pitch of seam (max)
100 mm	125 mm
$100 < d \leq 1250$	150 mm

6.4.1.6 It is allowed to use standard pipe sections for the ducts size less than 200 mm diameter. The pipe and pipe fittings used for the ducting shall meet the TU/ standards specified at Clause 3.0.

6.4.1.7 The way of the mounting of the air ducts design for the transportation of moisten air must exclude the presence of longitudinal joints on the bottom parts of the air ducts. The air duct portions where dewfall from the transported moistened air is possible should be run with slope of 0.01–0.015 towards the dryness facilities. The dimensional tolerances for fabricated air ducts shall meet the requirements specified TU standards listed in Clause 3.0.

6.4.1.8 Branches/ Elbows and Bends:

- The Branches, elbows and bends in ducting system are used for changing the air flow direction.
- The air ducts with angle of 90 degree referred to as Branches and angle less than 90 deg are referred as semi braches.
- The mean radius of curvature of round section lateral up to and including 315 shall be 1.5 Diameter, and size above 315 shall be 1 Diameter.

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- d. The mean radius of rectangular section laterals with dimension of vertical side upto and including 300 mm shall be 1.5 dimension of the lateral vertical side, and above 300 mm it shall not less than 450 mm.
- e. The round duct branches (elbow 90 deg) with mean radius up to 1.5 D shall be made up of 5 parts joined by 4 joints. The semi branches / bends of round duct less than 90 deg shall be made up of 3 parts with 2 joints.
- f. The branches and semi branches, elbows of rectangular section shall be fixed with splitters/ vanes and vane runners as per the recommendations of SMACNA, and the position and numbers of vanes shall be as shown in Figure-2 of Appendix-2.
- g. The splitters/ vanes shall be stitch welded to the duct, starting from the edge. The length of each weld shall not be less than 25 mm, and the pitch distance shall not be more than 100 mm.

6.4.1.9 Reducers, Transition Piece:

- a. Reducers / transition pieces are used to connect two different sizes of air ducts.
- b. Reducers can be of circular – circular, rectangular – rectangular and circular – rectangular type. The construction of reducers can be centre type (concentric type) or off-centre type (eccentric type).
- c. The reducers and transition piece shall be fabricated as per the specifications and dimensions indicated in the TU standard listed in Clause 3.0.

6.4.1.10 T- Joints:

- a. T- Joints/ tap off branches are used to tap off the air from main header duct.
- b. The T- joints/ tapping of ducts shall be fabricated with welding.

6.4.1.11 All sizes of carbon and stainless steel ducts are of welded construction by using GTAW technique. The duct connection at the site also shall be of welded construction. All weld joints of shop and field shall be inspected for Dye penetrant test.

6.4.1.12 All carbon steel ducts shall be painted at shop also touch up paint at field shall be done for all welded joints.

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6.4.1.13 The duct connection with equipment, dampers and valves shall be bolted flange connection. The contractor may weld flange at shop with the duct and connect the ducts at field by welding. The flanges made of angles shall be welded by a continuous seam from inside and outside the duct. It is not permitted to have more than one seam joint over the duct face in case of rectangular / square ducts. Typical weld joints used in manufacture of air ducts is shown at Table-1 of Appendix-2. Welding of duct with flange shall be as shown in Table-2 of Appendix-2.

6.4.1.14 The length of the duct spool for the size upto 400 mm (rectangular/ square/ circular) shall not be more than 1250 mm to ensure inside painting of duct. The transverse joints of CS ducts of size ≤ 400 mm shall be of flanged type. The flanges shall be welded by a continuous seam from inside and outside the duct as the article.

6.4.1.15 The end faces of air duct shall not project beyond the flange faces. The flange face shall be clean and smooth.

6.4.1.16 When assembling the lateral & other fittings seamed, beaded or welded joints shall be used. For SS welded ducts welded joints shall be used and for flanged ducts (CS) seamed/ beaded joints with weld connection shall be used.

6.4.1.17 The welds shall be dense and clean, without lack of penetration & burn through.

6.4.1.18 The flanges shall be attached to the air ducts by raising the edges; making beads or welding. The flanges shall be welded by a continuous seam from inside and outside the duct as the article. The dimensions & types of finish of the air duct end faces for other joints shall conform to the requirements of the construction of the joints as per approved procedure.

6.4.1.19 Stiffeners:

On the straight section of the rectangular air ducts with the cross section side dimension over 400 mm, stiffeners in the form of angle flange welded (stitch welded) with the duct at a spacing of 800–1200 mm shall be fixed.

On the straight sections and fittings of the rectangular seamed air ducts with the side dimension over 1200 mm, and round-section air ducts with the diameter over 1000 mm, the external lateral stiffening frames in the form of additional flanges shall be installed by welding (stitch) at a distance of 800–1300 mm from the end-face of the air duct.

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6.4.1.20 The transverse duct joint flanges should be secured to the structure with the use of flanging, by full welding of flange with duct is required of joint type as per Table-2 of Appendix-2.

6.4.1.21 The carbon steel ducts, fittings shall be grit blasted on both surfaces, 2 coats of zinc rich epoxy primer (50 micron thick each) shall be applied and 2 coats of finished coat epoxy paint to get over all thickness not less than 240 to 250 microns shall be applied as per Technical specification for anticorrosive painting described elsewhere in the tender. The color of finish coating shall be as approved by Engineer.

7. FABRICATION AND ERECTION OF METAL MESH:

Supply, fabrication and erection of metal mesh in accordance to the drawing requirement are in the scope of contractor. For fixing over SS ducts only stainless steel mesh type SS 304 shall be used, while for fixing over CS ducts GI coated metal meshes shall be used.

The contractor shall develop and submit the fabrication and installation drawing of metal mesh of each type for approval of engineer before the start of work.

The mesh shall be cut and fabricated according to the sizes specified in the drawing. In case of SS mesh, the edges of the mesh shall be encased within the SS sheet 2 mm thick and minimum width not less than 25 mm on one side. The corners of the metal frames shall be grounded to remove sharp edges. The inside edges of the metal sheet shall be stitch welded to mesh at a pitch distance of 30 mm.

The metal meshes shall be erected over the rectangular ducting with removable type of arrangement. Typically flange made with SS sheet (3 mm/ 5 mm thick) shall be used for fixing of mesh over the SS duct, and CS angle flange for fixing over carbon steel duct. EPDM/ Nitrile adhesive rubber gasket shall be fixed between the flange and the metal mesh. In case of erection of mesh over circular ducts/ suitable collar piece shall be fabricated with SS in case of SS ducts and CS in case of CS duct. SS fasteners shall be used for fixing of mesh over SS duct and GI coated fasteners shall be used in case of CS ducts.

TECHNICAL CONDITIONS OF CONTRACT (TCC)

8. ACCESS DOORS:

8.1 All main ductwork shall be accessible throughout using tight fitted hinged access doors. Access doors are generally to be provided where fittings like dampers, controls, etc. are located. Also access doors shall be provided outlet of fan / plenum chambers, vent box, and the transition duct connected between cooling coil and fan inlet flange of RCP to ensure trouble free operation of check dampers, inspection of bearings as per the direction of engineer.

8.2 The actual locations for these doors shall be decided jointly with the approval of engineer during preparation of duct fabrication drawings for each building and system. Doors shall have sponge rubber gaskets. The Contractor shall supply necessary accessories i.e., latches, handle etc. for the work.

9. COLLAR PIECES:

9.1 Grills, diffusers, mesh & registers shall be provided as per schedule and shall be fixed to main duct with the collars piece of suitable dimensions and size fabricated with the same duct sheet material.

9.2 For SS and CS ducts, the collar piece shall be fixed to the duct by welding to the main air duct.

10. DUCT MOUNTINGS/ INSTRUMENTATION TAPINGS & INSPECTION HOLES:

10.1 Installation of Instrumentation lugs/ adopters for installation of Temperature [CT], pressure [CP], radiation monitoring [CR], Flow [CF] and moisture [CM] sensors over the ventilation ducts as per drawings is in the scope of contractor.

10.2 Typical installation drawings of adopters over SS, CS duct is shown in Figure 2 of Appendix -2.

10.3 The CT adopters are fixed over the SS/ CS duct by drilling a hole and welding the lug. Tapping of lug to form M20 internal threading is in the scope of contractor.

10.4 The supply of welding filler wire/ electrode, and other consumables required for the installation of the adopter is in the scope of contractor.

10.5 The i.h openings are made in stainless steel/ carbon steel ducts for measuring various air parameters during commissioning of the systems. The typical i.h arrangement setup for is shown in the Figure 3 of Appendix -2.

TECHNICAL CONDITIONS OF CONTRACT (TCC)

11. SUPPLY FABRICATION AND ERECTION AND TESTING OF VENT BOX:

The vent box structure is provided in the ventilation system for handling high volume of air flow rates. Vent box structure is made up of 3 mm thick SS plate supported with the fabricated Channel/ angle made from 5 mm thick SS plate. One of the faces of vent box consists of the wall of the reactor building structure itself. The fabricated channels are fixed onto the EP provided on the walls of the reactor building, with the help of anchor bolts already embed in the concrete. The contractor shall ensure the holes drilled on the fabricated box/ channel shall match with the location and pitch distance of anchor fasteners in the wall. Fluoro-carbon polymer tube of size dia 8mm x 1mm is fixed all along the length of the fabricated channel fixed on to the embedded anchors on the wall/ floor/ ceiling. The supply of fluorocarbon polymer tube is included in the scope of contractor. The rate quoted by for vent box work shall be inclusive of supply of fluorocarbon tube also.

The SS structural used in ventilation duct supports as poison plate, SS duct flanges and stiffeners shall be fabricated and erected in accordance with the technical specification for SS fabrication and erection.

12. THERMAL INSULATION OF VENTILATION DUCT AND VENT BOX:

The thermal insulation of ventilation duct and vent box shall be carried out as per the general technical specification for Insulation of enclosed elsewhere in the tender document.

13. MODE OF MEASUREMENT:

Measurements of various components such as duct, fittings, duct mountings, mesh, dampers/valves etc, will be done as given below. The measurements shall be rounded off to maximum of 3 decimal points for certification.

13.1 HVAC Equipments:

The HVAC equipments are measured and paid in terms of weight of equipments/valve erected.

- a) Re-circulating cooling plant: Measured and paid in terms of MT of equipment assembly including fan, motor, cooling coil and chute (transition duct connecting cooler and fan suction) supplied as free issue material.

TECHNICAL CONDITIONS OF CONTRACT (TCC)

- b) Radiation filter housing: Measured and paid in MT of filter housing consisting of HEPA, Charcoal, fine filter housing, heater, sampling valve, support legs and the transition ducts issued as free issue material. There is no separate payment for welding, inspection of support legs over EP/ pedestal.
- c) Localizing sealing valve, motorised air dampers, shut check valve, fire dampers and air supply terminal block: Measured in terms of Kg of respective item erected.

13.2 Ducting -

- i. Measurement of ducting (rectangular and round sizes) shall be done in Square meter (Sq.m) (inside surface area), calculated from the size of air duct (duct size as specified in drawings) and the length measured along the centreline of duct.
- ii. The duct fitting (rectangular and round sizes) fittings like bends, elbows, Tees, reducer, shoe collar, duct sheet used for fabrication of metal mesh frames shall be calculated based on approved drawings for different sizes based on standard drawings and paid in Square meter (Sq.m) under the ducting category.
- iii. Access doors is measured in Sqm. and paid under relevant BOQ item of ducting by considering the outer dimension. There shall not be any payment towards hinges, knobs or locking arrangements fixed over the door.
- iv. Splitters, vanes fixed in the duct fittings are measured in Square meter (Sqm) and paid as per relevant item of BOQ.
- v. All the seam and circumferential weld joints shall be 100% dye penetrant tested. The quoted rates for ducting shall be inclusive cost for conducting DPT.
- vi. In case of CS ducts the quoted rates shall be inclusive of the rates for surface preparation, grit blasting, primer and finished paint application as per the requirements.
- vii. The rate quoted by the contractor shall be inclusive of wastage generated during duct fabrication & erection of material brought by contractor. The contractor will be permitted to take back all scrap material generated from contractor supply progressively with the approval of engineer.
- viii. The quoted rate shall be inclusive of consumables such as Rivets, screws, fasteners, Adhesive gaskets, non asbestos gaskets, duct sealant, welding wire, electrodes, argon gas etc. used in fabrication and erection of ducting, grills mesh, valves etc.

TECHNICAL CONDITIONS OF CONTRACT (TCC)

- ix. In case of carbon steel and stainless steel ducting, all the seam and circumferential weld joints shall be 100% dye penetrant tested. The quoted rates (CS & SS) ducting shall be inclusive cost of welding and conducting DPT. No separate payment for welding and DPT.
- x. Surface preparation, grit blasting, primer, painting of CS duct (inside and outside surface) is included in the scope. No separate measurement or payment shall be done for this work.

13.3 Metal Mesh:

Metal mesh (SS & GI) are measured in Square meter (Sq.m), calculated based on size specified in drawings / approved drawings. No separate payment towards the hidden area of metal mesh covered inside the flange / frame.

The quoted rate under relevant items shall be inclusive of consumables like screws, fasteners, sealant, welding electrode/ filler wire etc. for fixing of mesh.

13.4 Grills and Diffusers:

Erection of grills and diffusers are measured in Sqm calculated based on the dimensions / size specified in drawings / approved drawings. Payment shall be made only to the superficial area. over laps, corrugations/ profile shall not be considered for measurement and payment.

The quoted rate under relevant items shall be inclusive of consumables like screws, fasteners, gaskets etc. for fixing of grills/ diffusers.

13.5 Insulation of ventilation duct and vent box:

Thermal Insulation:

a	Supply and application of thermal Insulation of ventilation ducting/valves/ dampers Fixed type: Ceramic and Nitrilerubber.	Sq m	Measured as outside finished area of insulation structure calculated from the outside perimeter of finished insulation surface (thickness of cladding will not added for perimeter calculation) and length of insulation measured along the centre line. IS recommendations for measurement of insulation surface area shall not be considered.
b	Removable type : ceramic	Sq m	Measured as the outside

TECHNICAL CONDITIONS OF CONTRACT (TCC)

	insulation		surface area of the removable insulation (excluding thickness of cladding). IS recommendations for measurement of insulation surface area shall not be considered.
c	Erection of Insulation over ventilation duct and vent box inside reactor building	Sq m	Measured as the outside surface area of insulation structure of duct/ vent box. IS recommendations for measurement of insulation surface area shall not be considered.

13.6 Modification of erected ducts

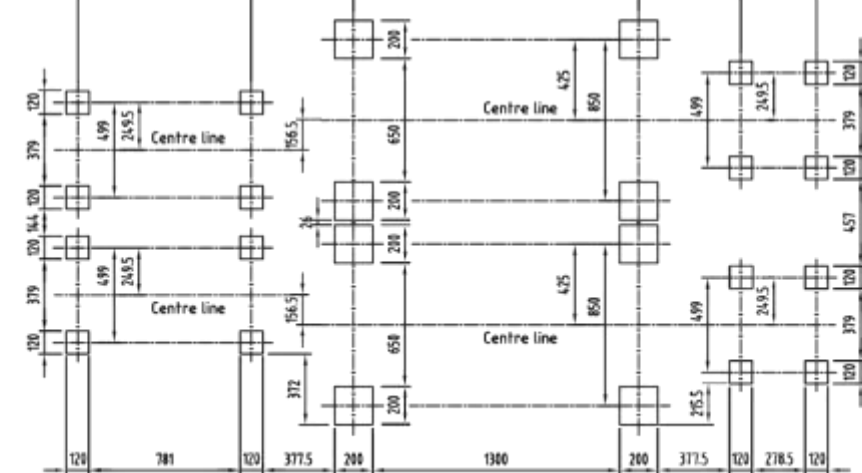
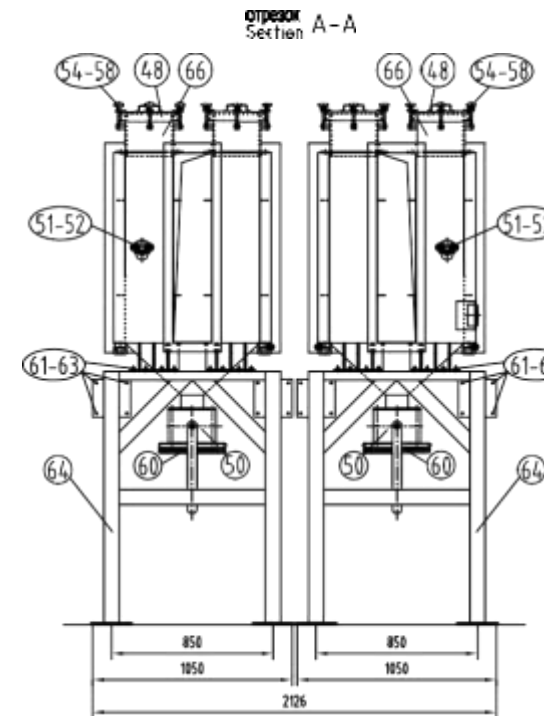
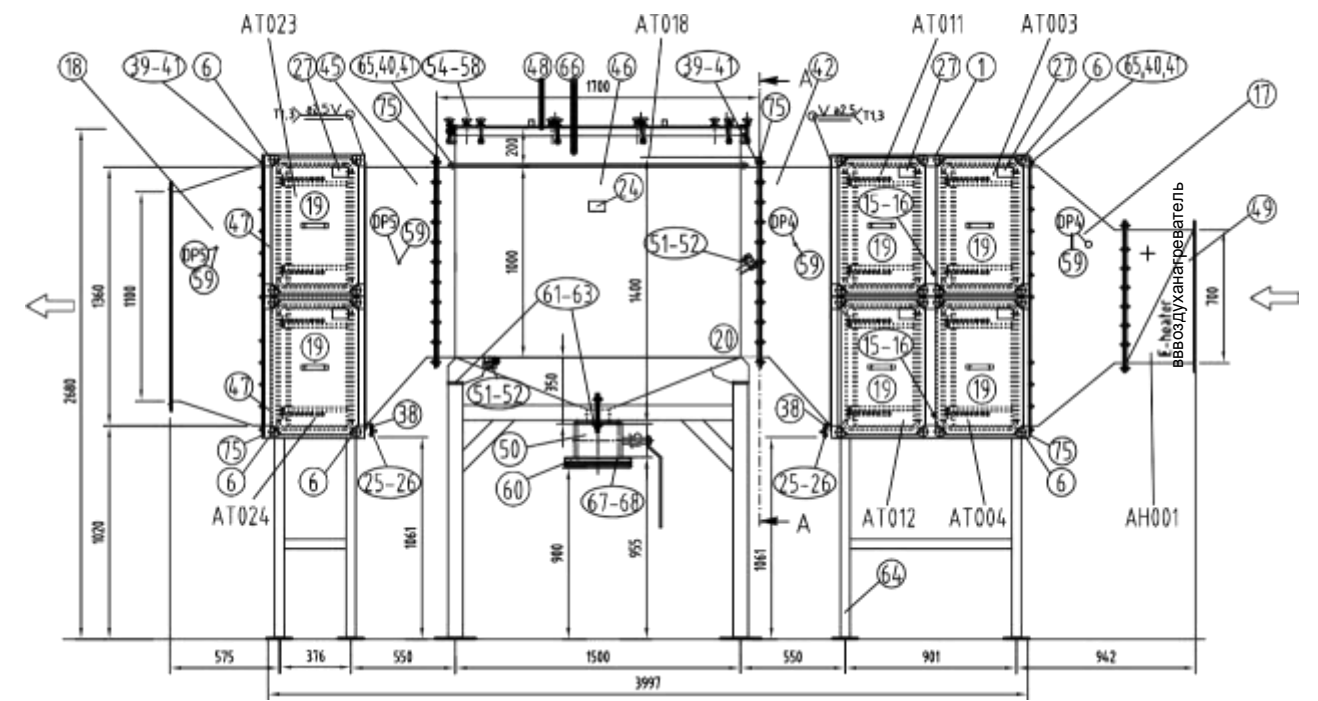
a	Modification of SS/ CS ducts Dismantling of erected duct and fittings	kg	Calculated from the weight of dismantled components such as duct spools, fittings, stiffeners, flanges, vanes, splitters, mesh, duct instrument mountings etc.
b	Modification/ re-fabrication/ re-erection of ducts, fittings with dismantled duct spools.	Sq m	Measurement shall be done in similar to the mode of measurement as described for ducts and fittings. This also includes area of vanes, splitters. There is no separate measurement and payment for touch up painting.

13.7 Supply fabrication and erection of SS structure and vent box:

Measured in Kg of erected weight certified based on the BOM/ "As built drawing" of the vent box structure. The NDT inspection of weld joints shall be measured and paid under relevant BOQ items for NDT.

Figure-1





Расчётное давление <i>Design Pressure</i>		<i>SCM Pa</i>		Проворочное давление <i>Tact Pressure</i>		<i>2000 Pa</i>	
Расчётная температура <i>Design Temperature</i>		<i>130°C</i>		Рабочее вещество <i>Operating Medium</i>		<i>Air 1300kPa/h</i>	
Материал <i>Material</i>		<i>LAMH</i>		Вес <i>Weight</i>		<i>100kg</i>	
Спецификация <i>Specification</i>		Выпуск <i>Edition</i>		Уровень требований <i>Requirement Class</i>		Допустимая утечка <i>Ac Leakage Rate</i> max. 0.03m³ at 10Pa and differential pressure of 30 s/min	
Предварочная документация / Test Documents							
Список расчёта параметров <i>Calculation Sheet</i>				План чистки <i>Cleaning Plan</i>			
Перечень материалов <i>Part List of Materials</i>				Верхний листок <i>Cover Sheet</i>			
План последовательности проверки <i>Inspection Plan</i>				Планы плит <i>Beam Plans</i>			
Сеismический расчёт <i>Sismic calculation</i>				Сварочный план <i>welding plan</i>			
Замечания / Remarks							

E	2005-09-04	Bredl	Kerbeln	Kuhn	Adjustment of the construction units
D	2005-06-19	Bredl	Kerbeln	Kuhn	Adjustment of the iodine-filter-housing
C	2005-01-26	Kuhn	Kerbeln	Bredl	Revision of Connection
B	2004-11-29	Kuhn	Kerbeln	Bredl	Drainpipe connection, Dimensioning
Final	Date	Проверено checked	Подготовлено constr.	Проверено checked	Заметки по изменениям Remarks

2004	Date	Фамилия Name	HS LUFTFILTERBAU GmbH Bunsenstrasse 33 D - 24145 KIEL Tel. ++49 (0)431/71953-0 Fax. ++49 (0)431/71953-30	№ чертёжа <i>Drawing no.</i>
Подготовлено constr.	09.27.	Kerbeln		
Проверено checked	09.28.	Kuhn		

Проверено checked		AGE	Date	Name

Project / Project		NPP KUDANKULAM	KS/PK
2004	Date	Version	Type
Подпись Signature	09.27.	Kerbeln	1 : 20
Подготовлено constr.	09.28.	Kuhn	Чертёж общего обзора аэрозольно-йодная фильтровальная комбинация сварочная группа Arrangement drawing Aerosol-Iodine Filtercombination welding group
Проверено checked	10.02.	Bredl	
Одогов. Signat.	TS		
		Detail name / Detailname	Unit
		Ревизия Rev.	Вёрсия Version
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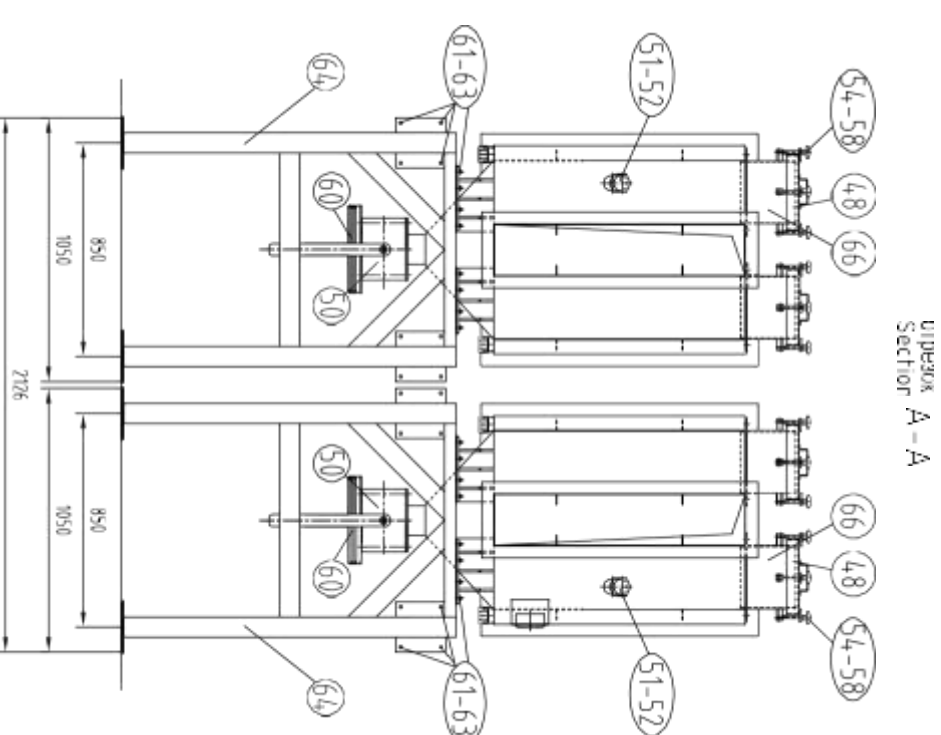
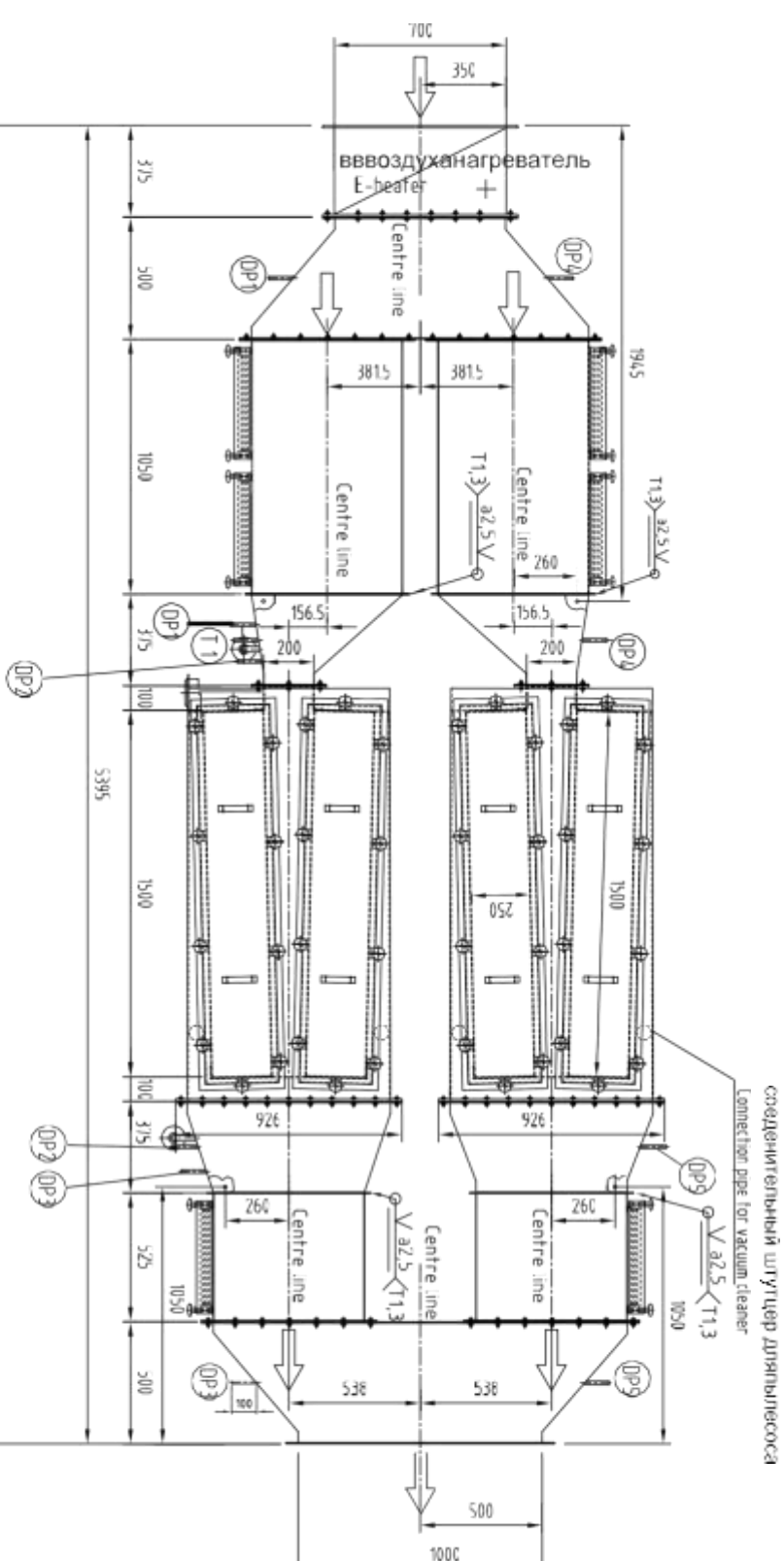
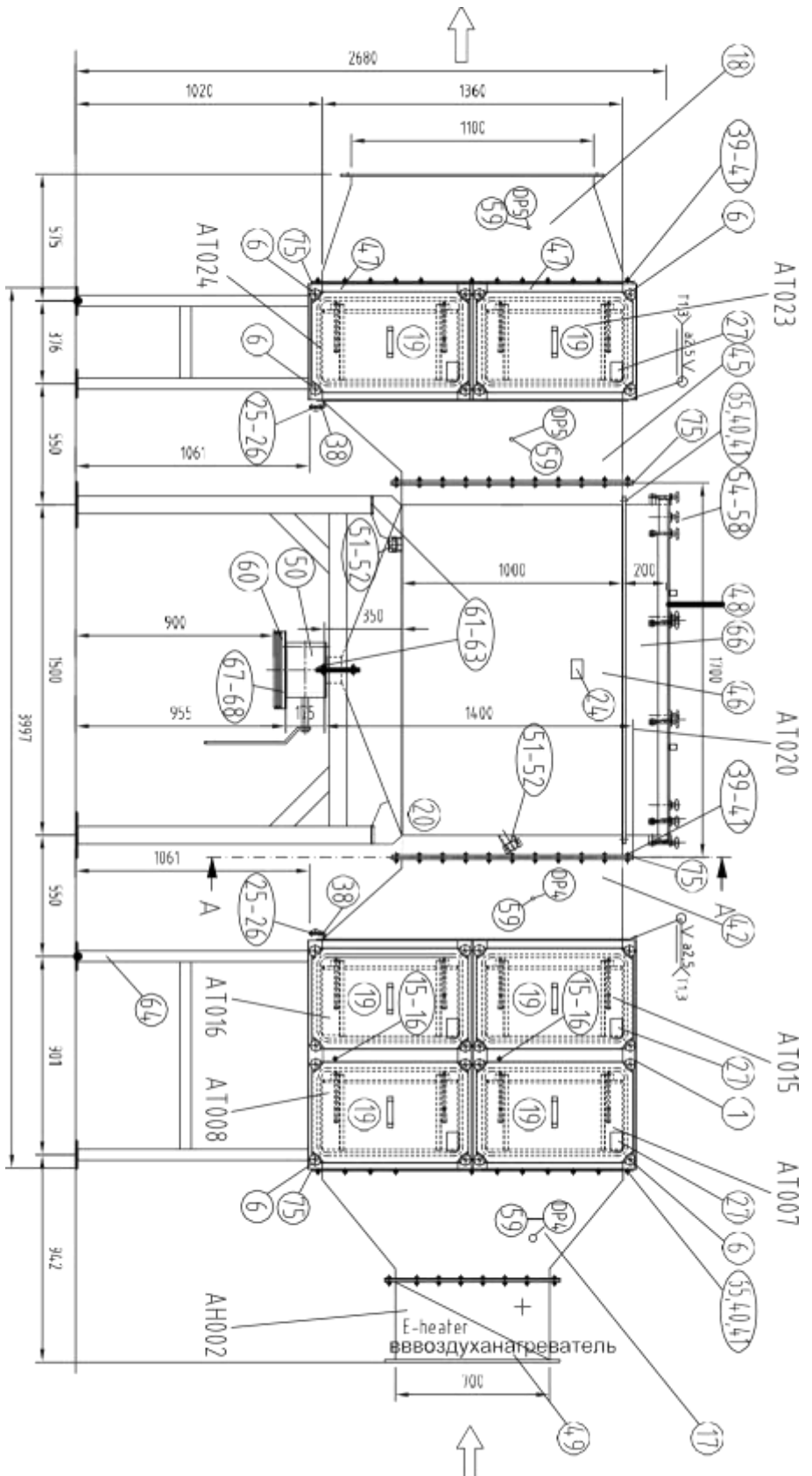
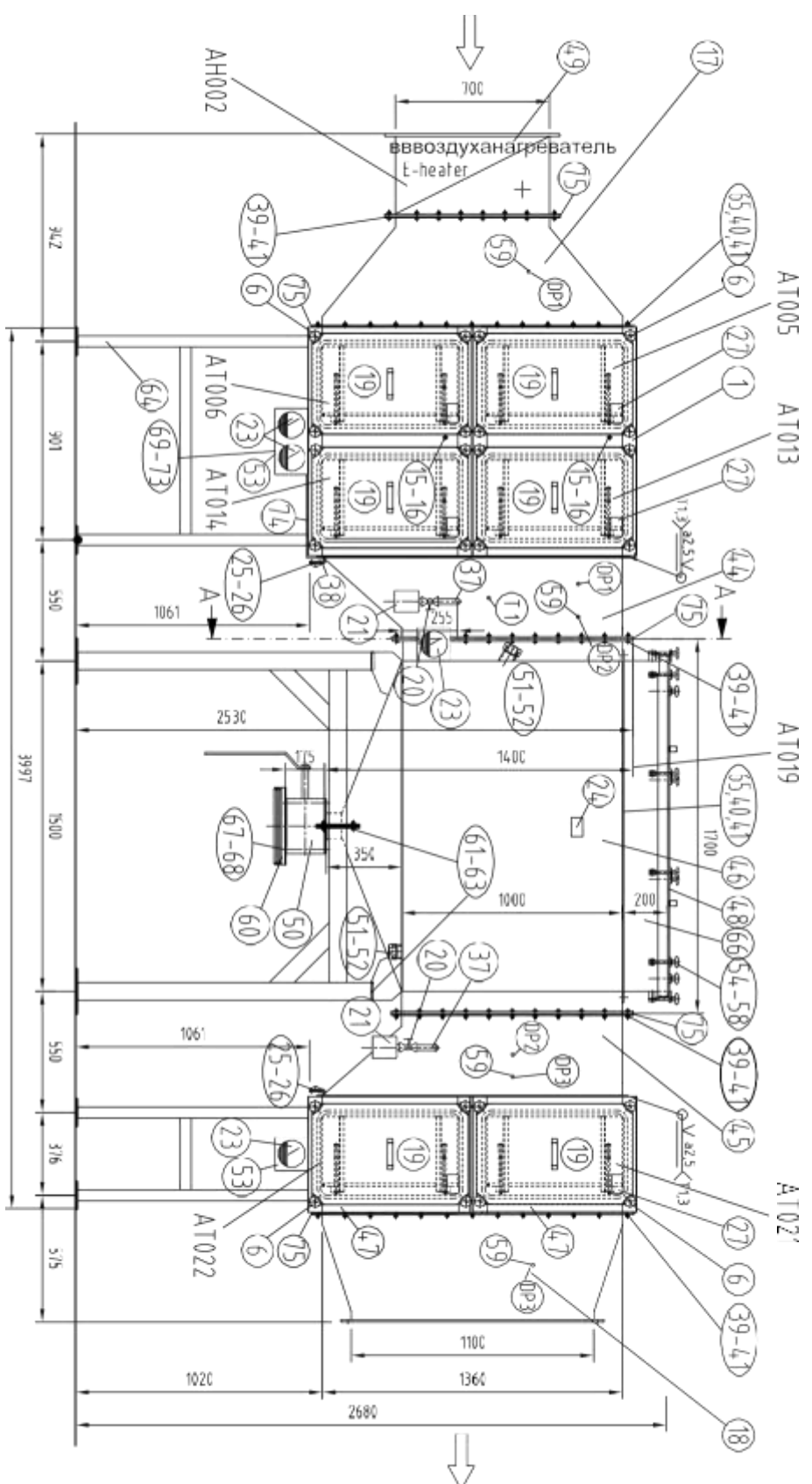
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				1 of 2

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[illegible]

2014	2.26 2.36	2.26 2.36	 IIS LUFTFLIEGERBAU GmbH Büsenstraße 33 D - 24 45 MIEL Tel. +49 (0)4431/71953-0 Fax. +49 (0)4431/71953-30	e: info@iis.de Internet:
2013	09.27	10.00		

[illegible][illegible]

Annexure-1; Figure-3

Technical characteristics

Parameter	Value
Working media	Air
Working pressure, Pa	2000
Fire resistance limit, minutes, more than	120
Smoke penetrating resistance, m^3/kg	$3 \cdot 10^{-5}$
Smoke removal temperature, $^{\circ}\text{C}$, less than	600
Local resistance coefficient at open flap, less than	3

Designation	B, mm	H, mm	B1, mm	B2, mm	H1, mm	H2, mm	n, mm	n1, mm	L1, mm	n2, mm	L2, mm	ax6, mm	Mass, kg
AC.501.000.00	150	150	180	240	180	325	8	2	90	2	90	7x10	21
-01	200	200	230	290	230	375	8	2	115	2	115	7x10	27
-02	250	250	280	340	280	425	8	2	140	2	140	7x10	33
-03	300	300	330	390	330	475	8	2	165	2	165	7x10	40
-04	400	400	430	490	430	575	12	3	143,3	3	143,3	10x16	52
-05	500	500	536	590	536	675	16	4	134	4	134	10x16	66

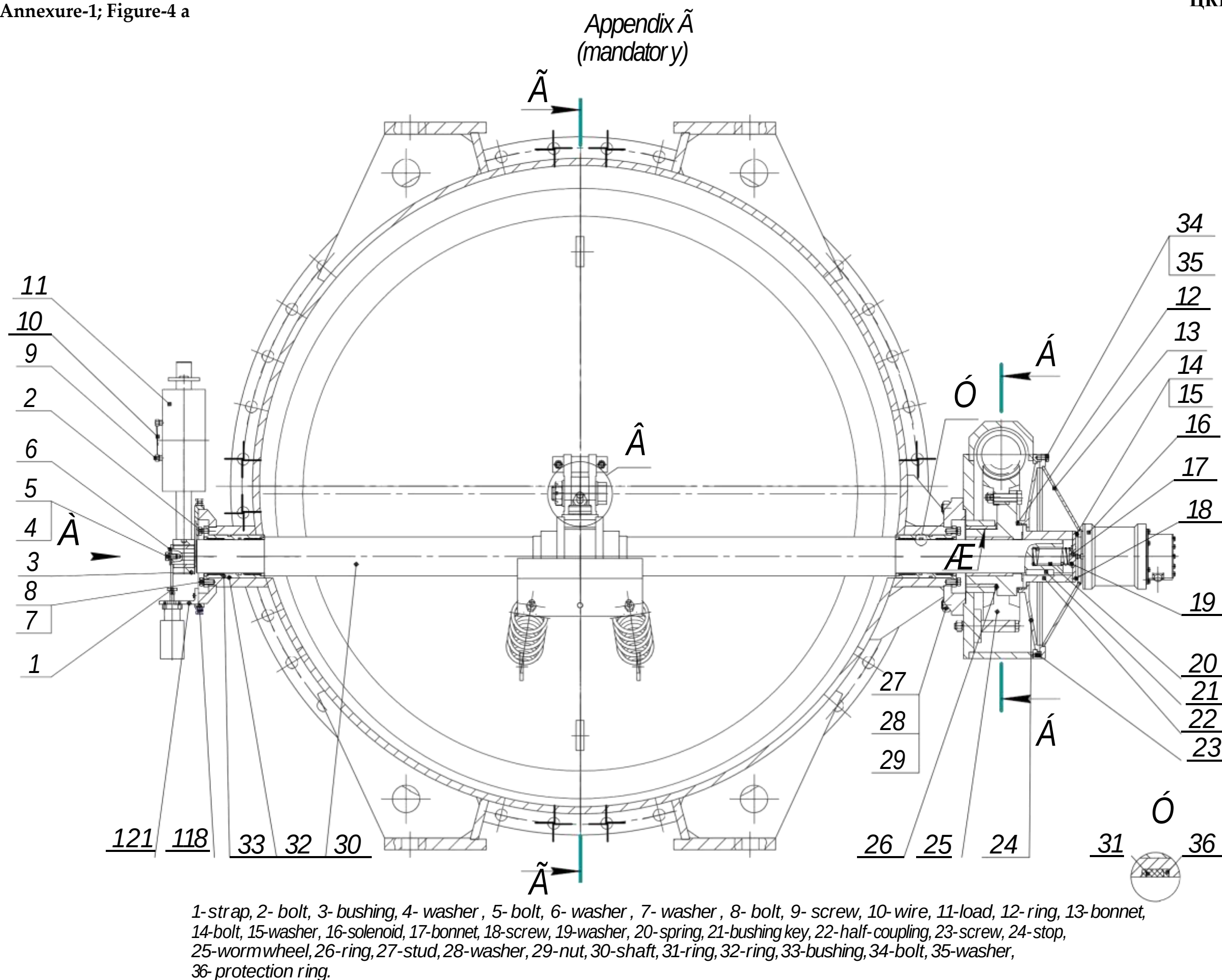
Technical requirements

1. Technical requirements for valve manufacturing and supply - according to technical assignment TY TY4854-248-04612941-10.
2. Valve is of 4 safety class as per PNAEG-01-011-97 (ОПБ 88/ 97) (НП-001-97).
3. Category of seismic stability - I, II as per PNAEG-5-006-87 (НП-031-01).
4. Reference dimensions
5. Subject valve to pressure test in accordance with the requirements of TY TY4854-248-04612941-10.
6. Mark sign of final acceptance.
7. Valve initial position and working sequence is defined by its function
 - Fire retarding valve (HO) is initially open
 - Smoke removal (H3) is initially closed.
8. Valve storping is according to scheme.
9. Coverage:
 - Ground AK-070, 2 layers 10 mcm
 - Enamel ЭП-525 GOST 22438-85, grey.

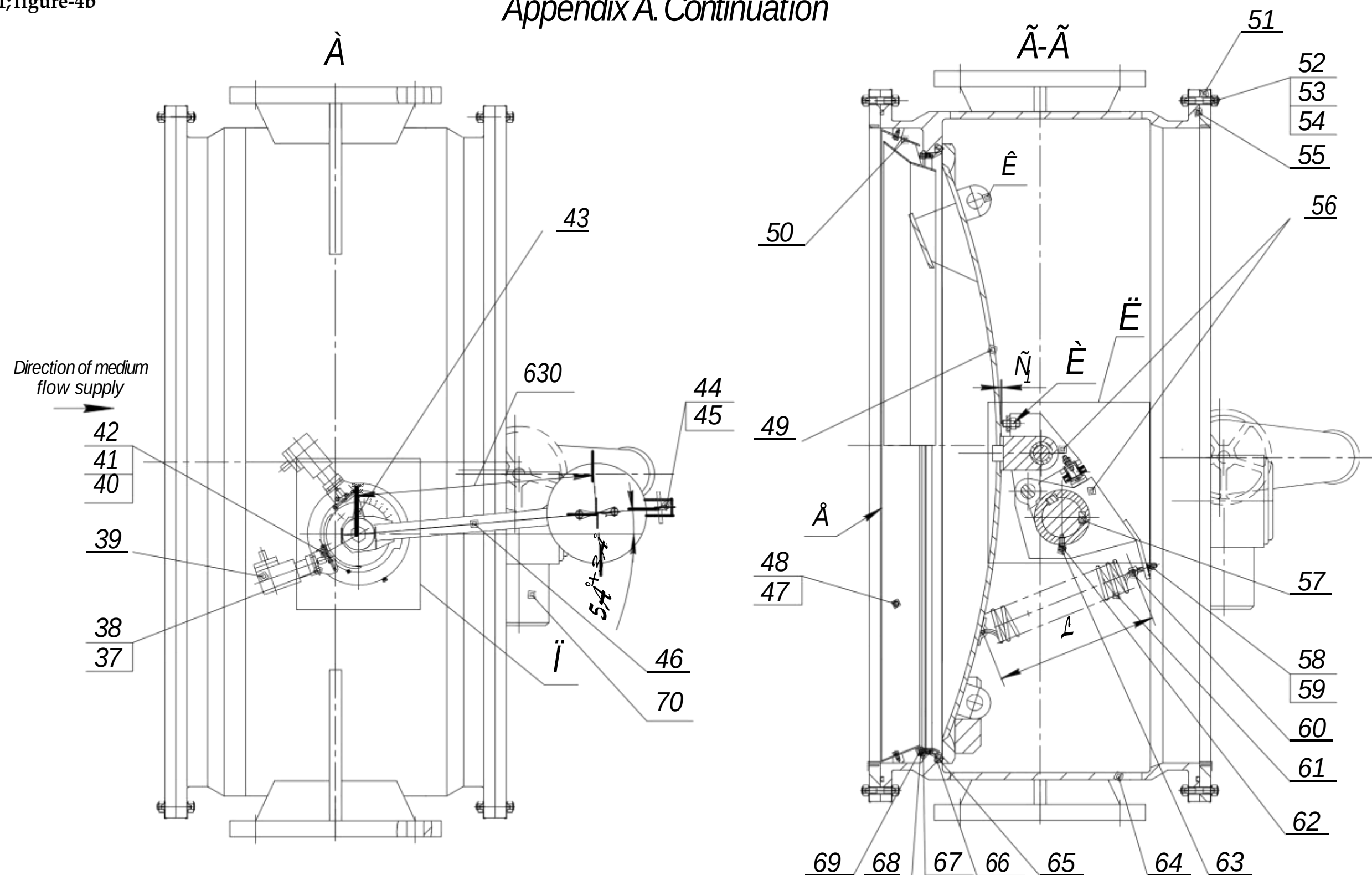
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Разработ. Широков		Лист	Масса	Масштаб
Designed Широков		Лист	Масса	Масштаб
Начальник Малахов		Лист	Масса	Масштаб
Inspector Малахов		Лист	Масса	Масштаб
Ум. Сидоров		Лист	Масса	Масштаб
Approved Сидоров		Лист	Масса	Масштаб

AC.501.000.00BO
Fire valve
КПВС-1.Ку-120-4
General view drawing
Лист 1
Листов 2
ВОЗДУХОТЕХНИКА
Format A1

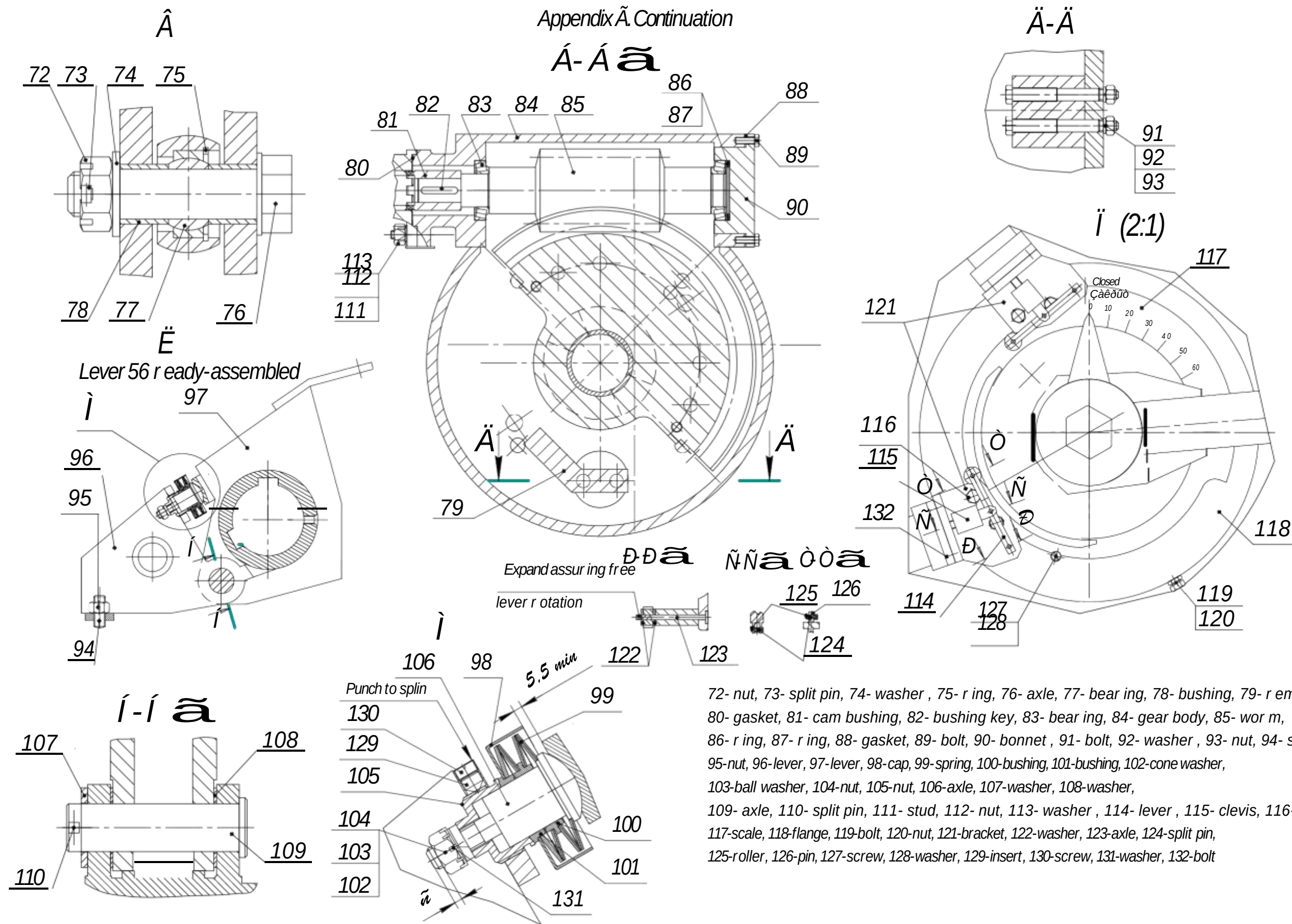


Appendix Ã. Continuation



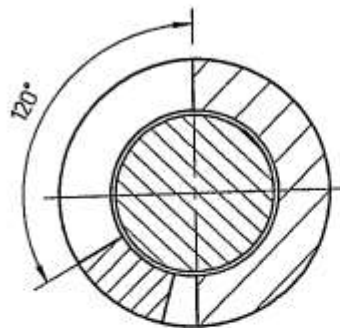
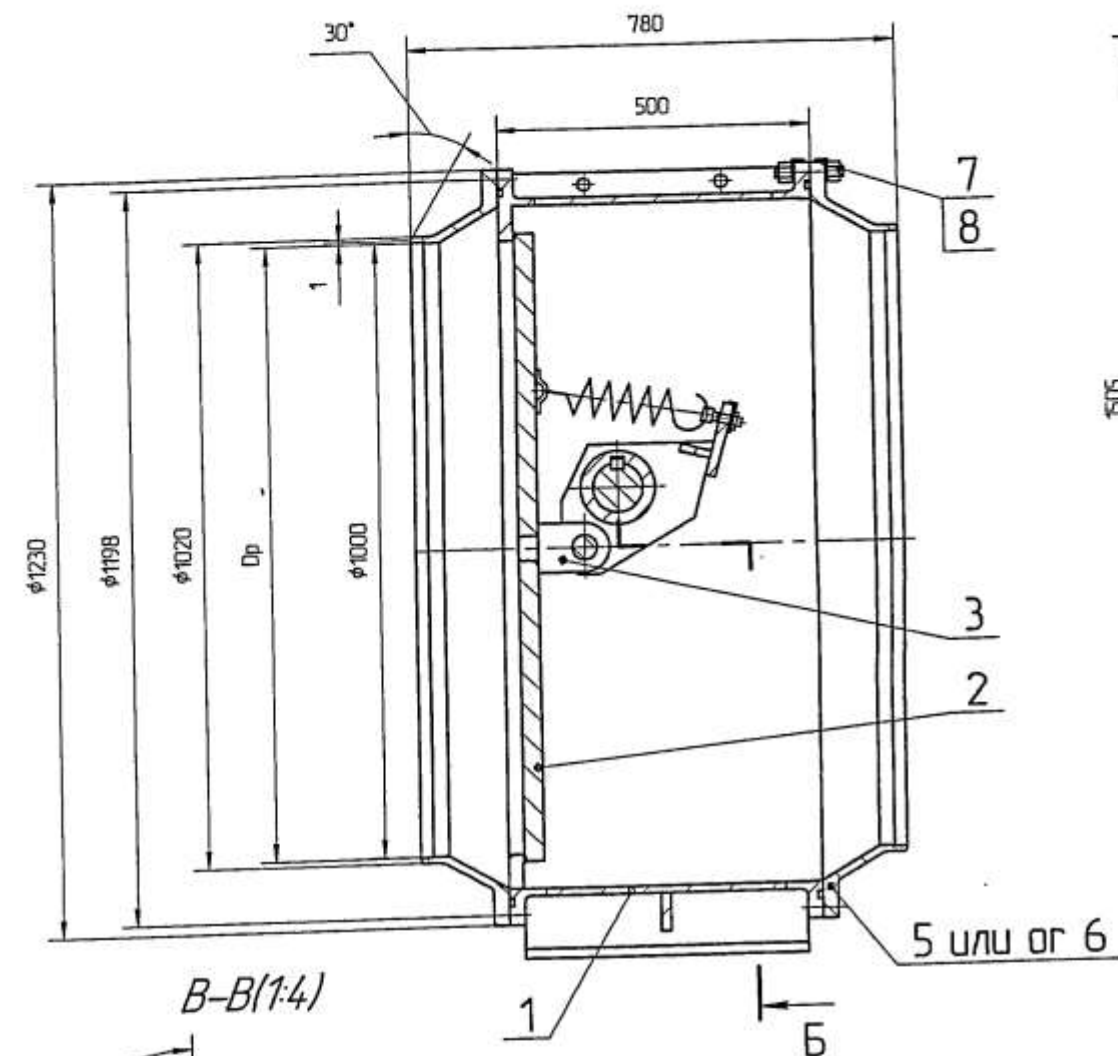
37- bolt, 38-washer, 39-signaling device, 40-bolt, 41-washer, 42-washer, 43-indncator, 44-washer, 45-split pin, 46-lever, 47-bolt, 48-washer, 49-disk, 50-cone, 51-flange, 52-stud, 53-washer, 54-nut, 55-ring, 56-lever, 57-bushing key, 58-washer, 59-nut, 60-rod, 61-spring, 62-screw, 63- wir e, 64- body, 65- sealing r ing, 66- r ing, 67- ring, 68- bolt , 69- locking wir e, 70- elect r ic actuator

Annexure-1; Figure-4c

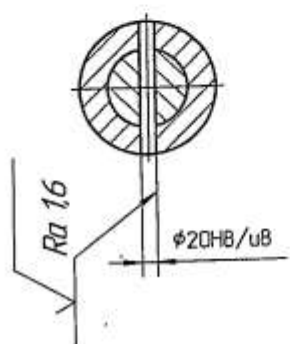


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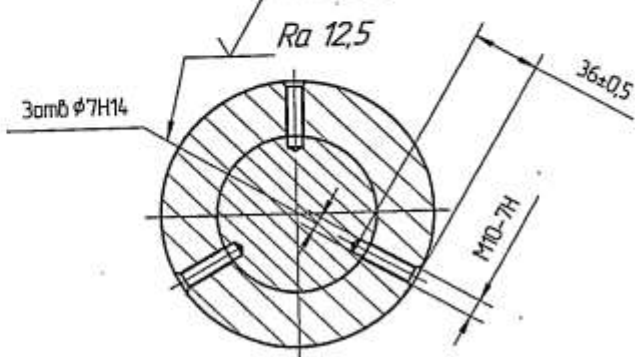
Annexure-1; figure-5



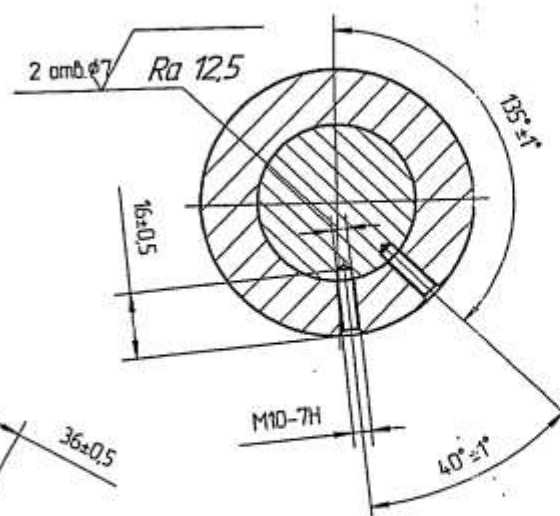
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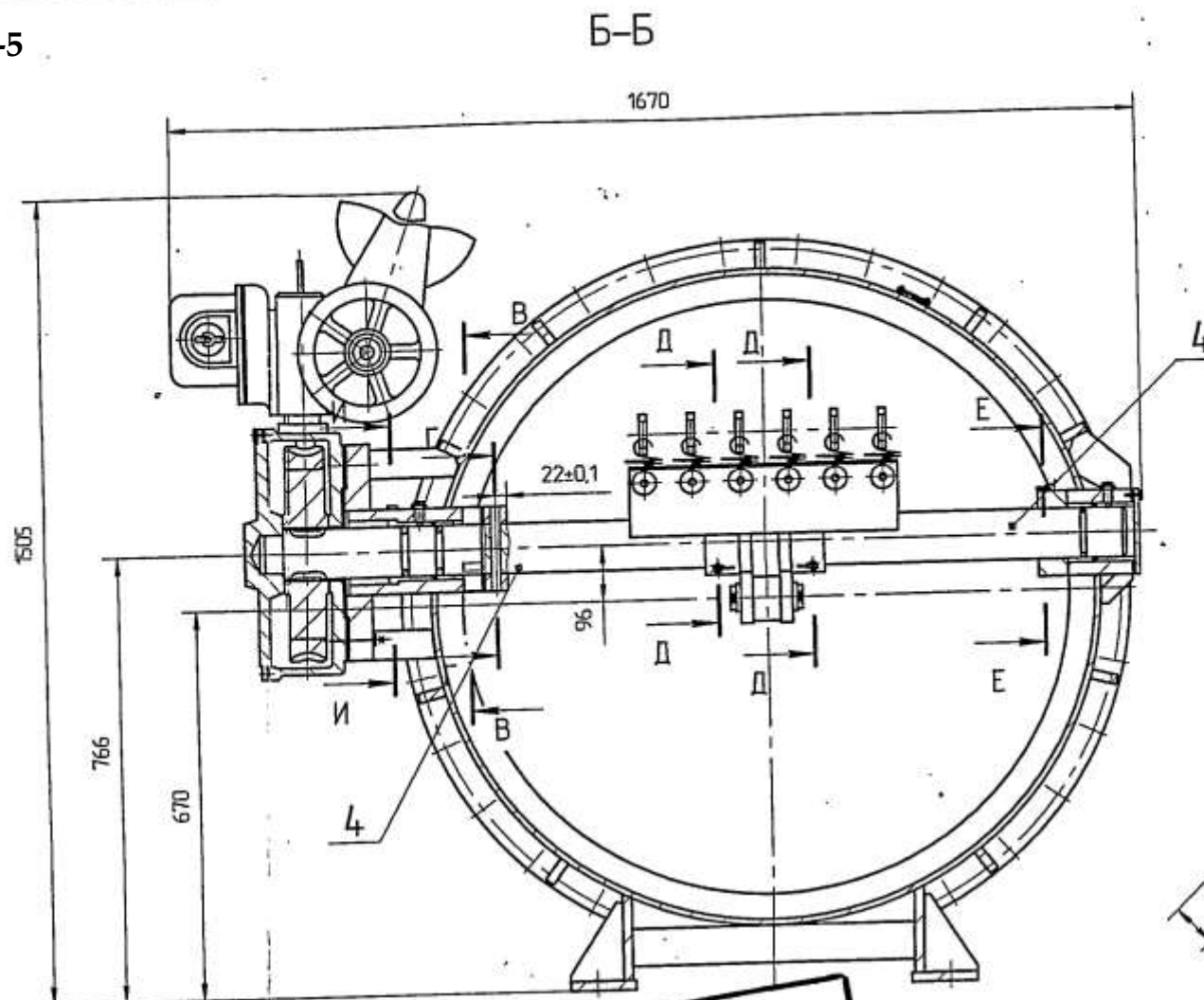
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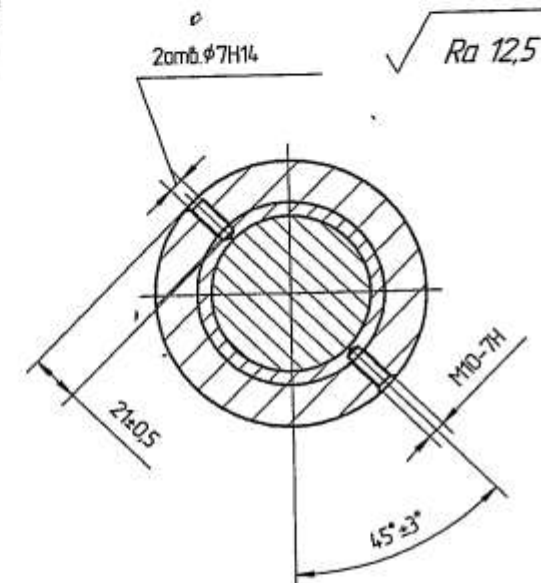
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Для АЭС
For NPS



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P_h 6.0

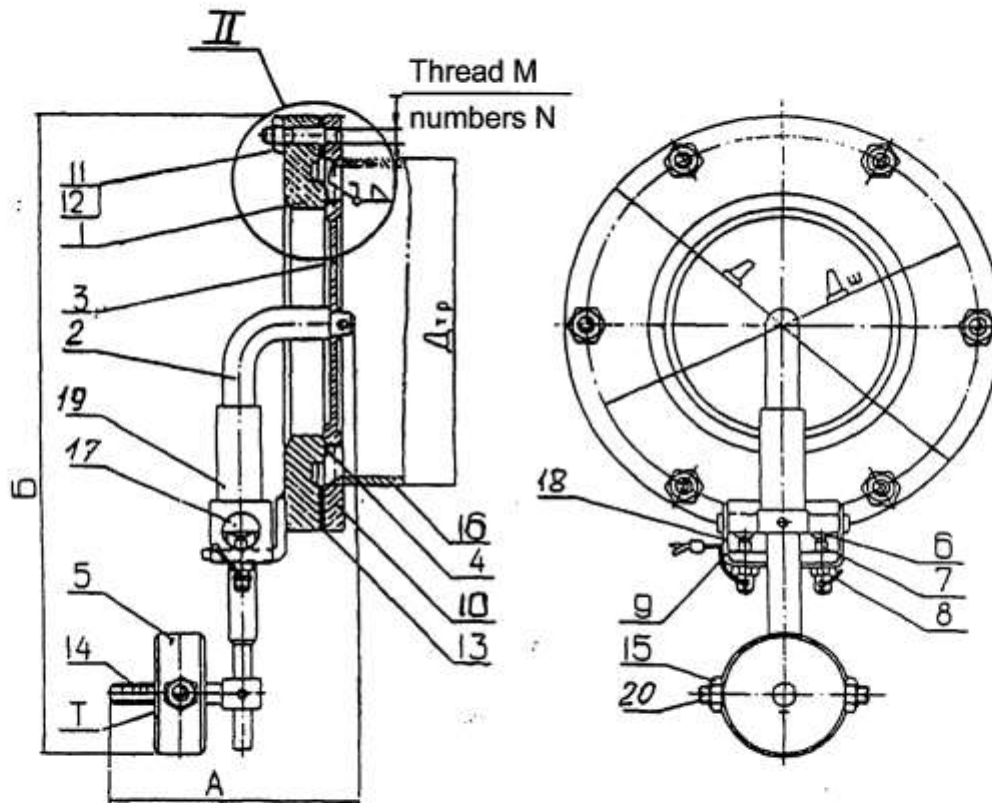
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Поз. Position	Обозначение Designation	Наименование Name	Кол. Quant	Материал Materials	Примеч. Remark
8		Шпилька Stud	60	Сталь Steel 20X13	
7		Гайка Nut M10	120	Сталь Steel 20X13	
6		Фланец Flange	2	Сталь Steel 20	Ø=1002 ⁺¹⁰
5		Фланец Flange	2	Сталь Steel 08X18H10T	Ø=1003 ⁺¹⁰
4		Вал Shaft	1	Сталь Steel 14X17H2	
3		Пружина Staple	1	Сталь Steel 08X18H10T	
2		Диск Disk	1	Сталь Steel 08X18H10T	
1		Корпус Body	1	Сталь Steel 08X18H10T	

Rev.	Sheet	Docum. No.	Signature	Date	ЦКБ МО1030-1000 СБ		
Изм.	Лист	№ докум.	Подп.	Дата	Клапан герметический DN 1000, P 0.05, t 150 °C Сварочный чертеж Butterfly valve DN 1000, P 0.05, t 150 °C Assembly drawing		
Разраб.	Петухова			20.10.04			
Designed	Petuchova			20.10.04			
Н.контр.	Дупаевский			20.10.04			
Inspector	Dupaevsky			20.10.04			
Умб.	Кизьмин			20.10.04			
Approved	Kuzmin			20.10.04			
					Лист Let	Масса Mass	Масштаб Scale
						*980	1:4
					Лист Sheet	Листов Sheets	2
					ЗАО "НПО ЦКБА" ЗАО "НПФ ЦКБА"		

Appendix 1
Valve design

Figure-6



1 – Flange; 2 – Rocking rod; 3 – Disk; 4 – Collar; 5 – Counter balance; 6 – Ferrule; 7 – Needle; 8 – Nut M8; 9 – Seal; 10 – Mating flange; 11 – Stud; 12 – Nut; 13 – Gasket; 14 – Rod; 15 – Nut M8; 16 – Pipe; 17 – Support; 18 – Clamp; 19 – Tube; 20 – Screw M8.

Figure 1.1 - Valve design

Construction weld, type 3-01, category IIIC to
PNAEG-7-009-89 and PNAEG-7-010-89

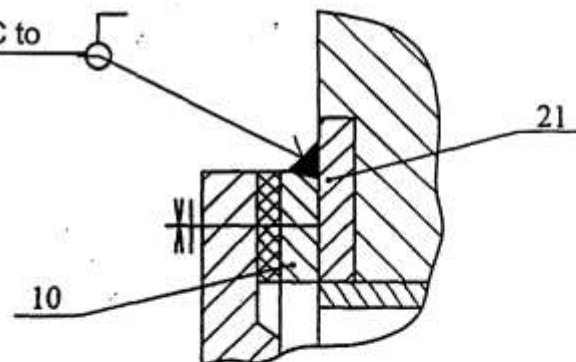


Figure 1.2 - II – The second version of welded joint of the mating
flange 10 and embedded structure 21

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Appendix-2. : CS/ SS Duct Fabrication- Typical Sketches

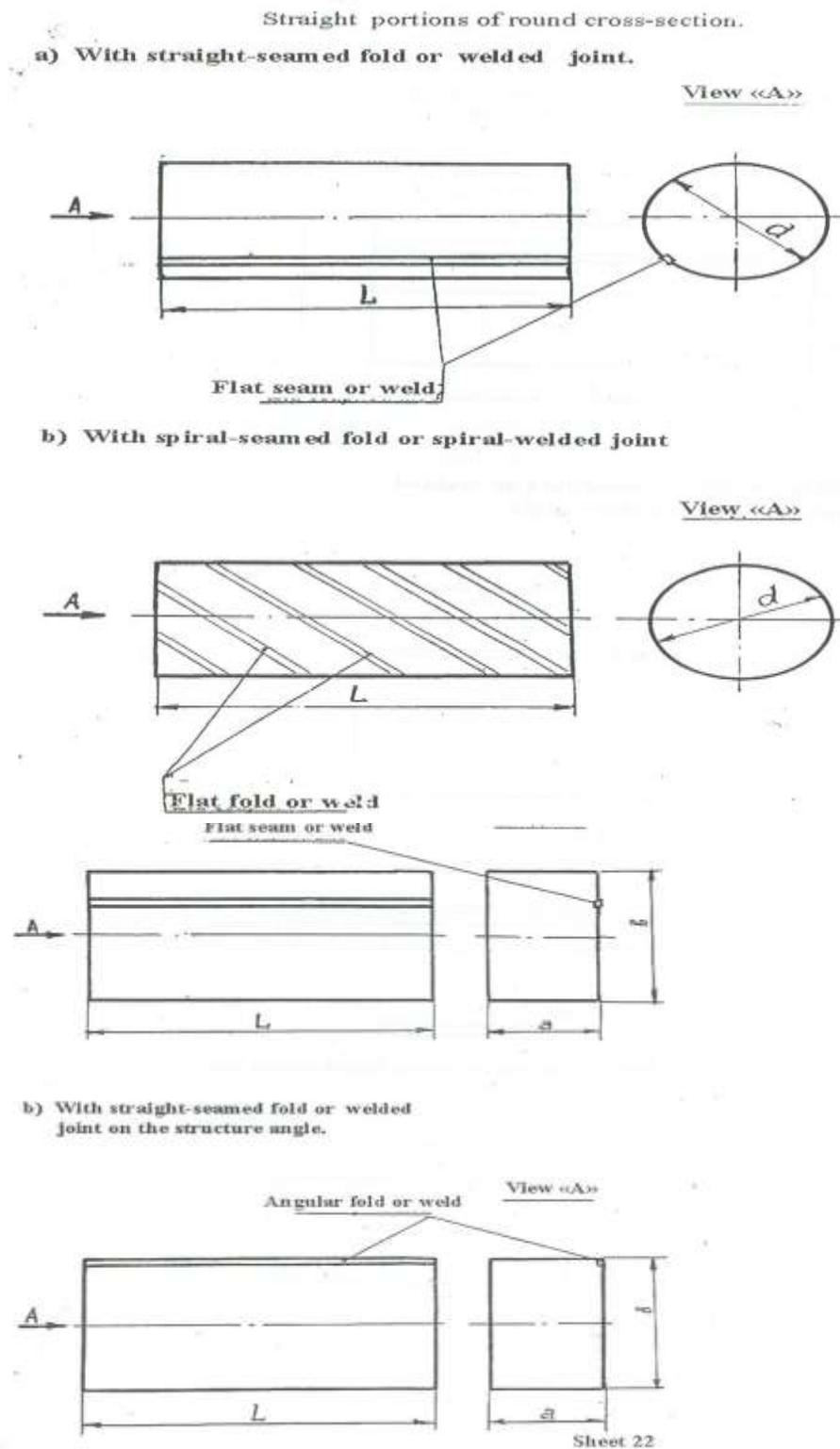


Figure-1: Location of seam position in Circular and Rectangular Duct

Radius Bend

Width - mm	Splitters	Splitter Position		
		A	B	C
400 - 800	1	W/3	-	-
801 - 1600	2	W/4	W/2	-
1601 - 2000	3	W/8	W/3	W/2

Splitters not Required in Bend Angles Less Than 45°

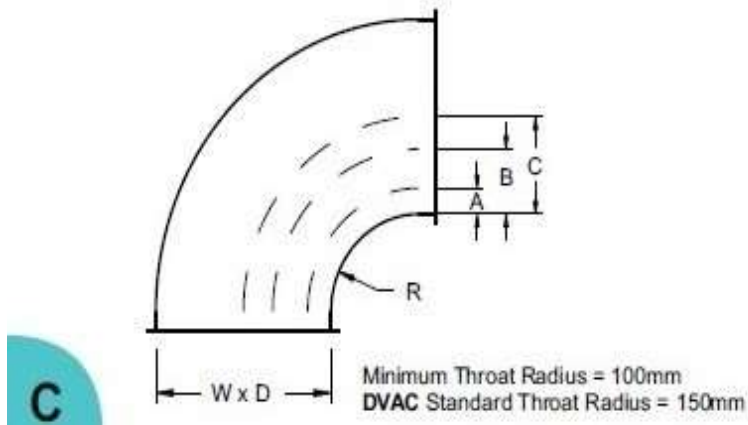
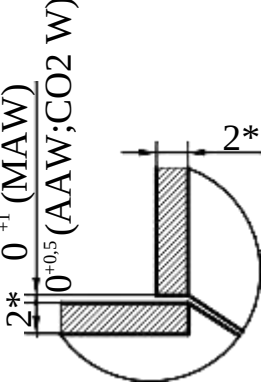
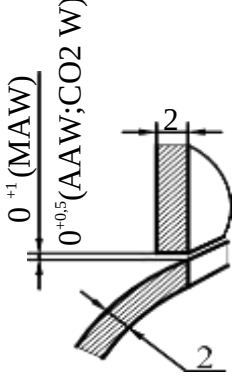
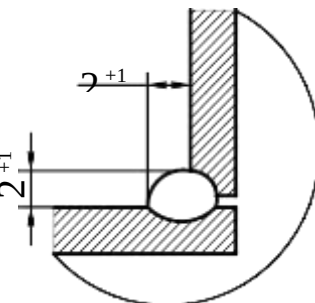
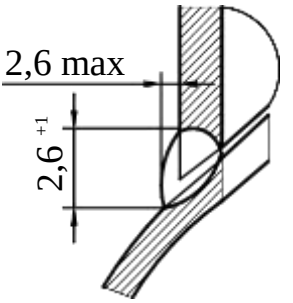
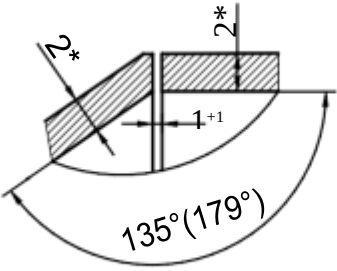
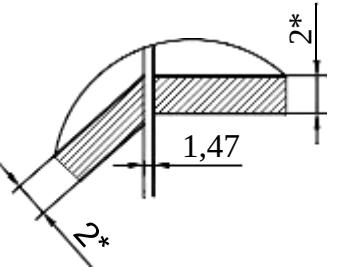
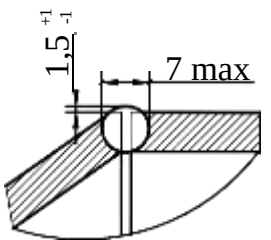
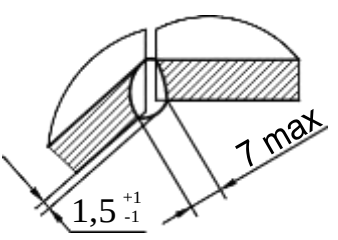


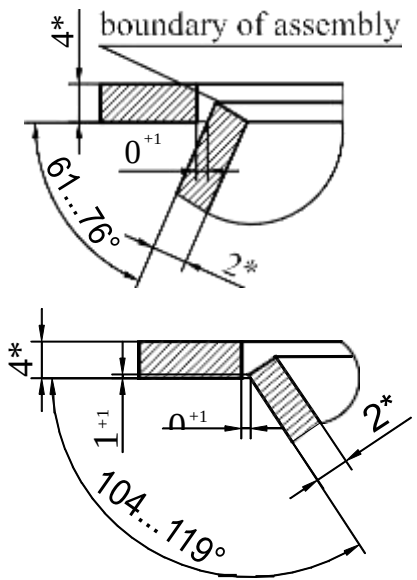
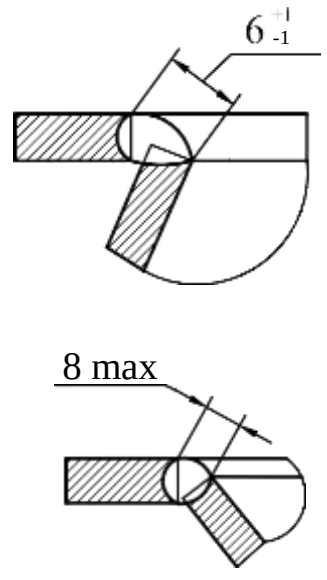
Figure-2: Location of Splitters in Rectangular Elbow/ Branch

Table.1 -WELDED JOINTS USED IN MANUFACTURE OF AIR DUCTS [CS AND SS AIR DUCTS]

Type of welded joint	Structural dimensions			
	Of assembly and prepared edges of parts for welding method		Of welded joints	
	MAW	AAW; CO2 W	MAW	AAW; CO2 W
U17 GOST 16037-80				
T1 GOST 11534-75				

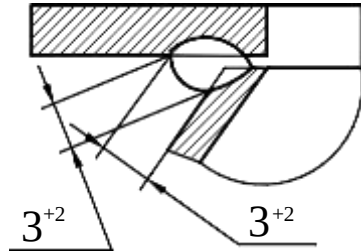
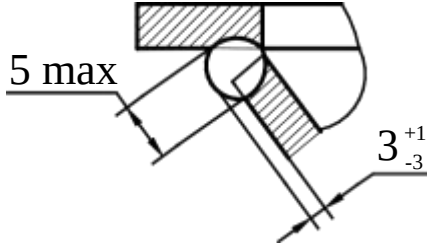
APPENDIX-2 Technical specification for erection of ventilation systems in Reactor building

Table -1 (Cont.)

Type of welded joint	Structural dimensions			
	Of assembly and prepared edges of parts for welding method		Of welded joints	
	MAW	AAW; CO2 W	MAW	AAW; CO2 W
GOST 11534-75 GOST 23518-79 U1				

APPENDIX-2 Technical specification for erection of ventilation systems in Reactor building

Table -1 (Cont.)

Type of welded joint	Structural dimensions			
	Of assembly and prepared edges of parts for welding method		Of welded joints	
	MAW	AAW; CO2 W	MAW	AAW; CO2 W
GOST 11534-75 GOST 23518-79 T1	0^{+1} (MAW) $0^{+0.5}$ (INp; CO2 W) 4^* $61...76^\circ$ 2^*			
T5	0^{+1} $104...119^\circ$ 2^*			

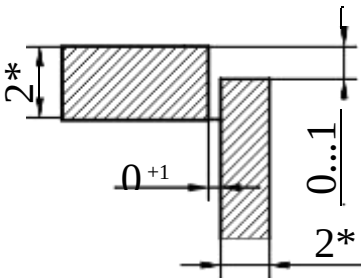
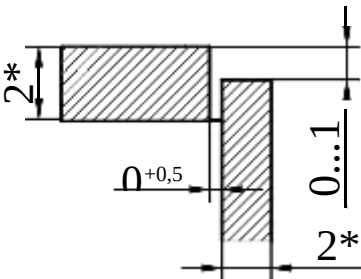
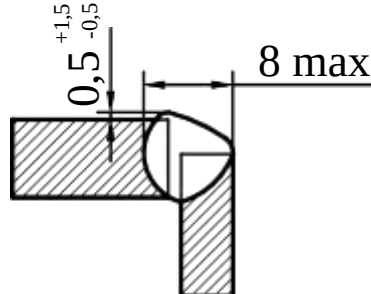
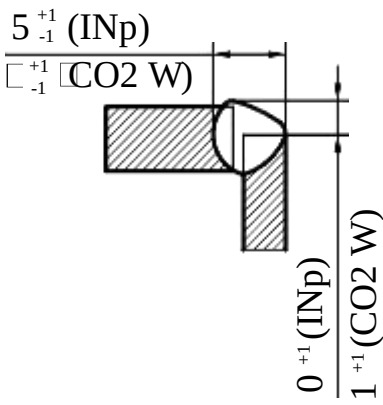
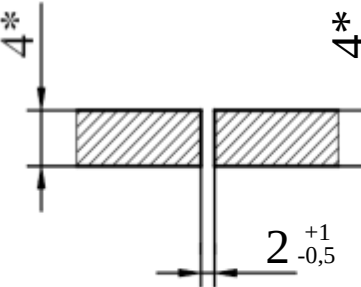
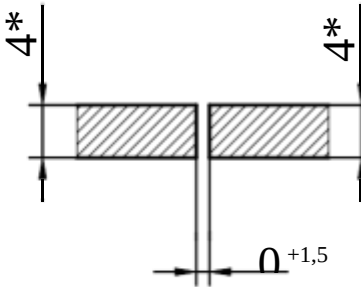
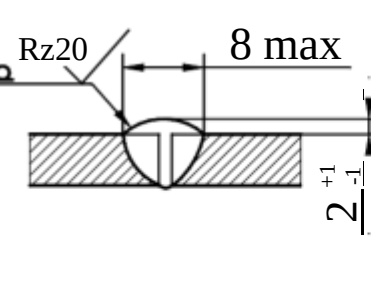
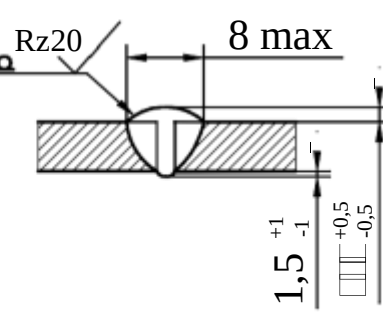
APPENDIX-2 Technical specification for erection of ventilation systems in Reactor building

Table -1 (Cont.)

Type of welded joint	Structural dimensions			
	Of assembly and prepared edges of parts for welding method		Of welded joints	
	MAW	AAW; CO2 W	MAW	AAW; CO2 W
T1 GOST 5264 GOST 14771				

APPENDIX-2 Technical specification for erection of ventilation systems in Reactor building

Table -1 (Cont.)

Type of welded joint	Structural dimensions			
	Of assembly and prepared edges of parts for welding method		Of welded joints	
	MAW	AAW; CO2 W	MAW	AAW; CO2 W
U4 GOST 5264 GOST 14771				
GOST 5264 GOST 14771 C2				

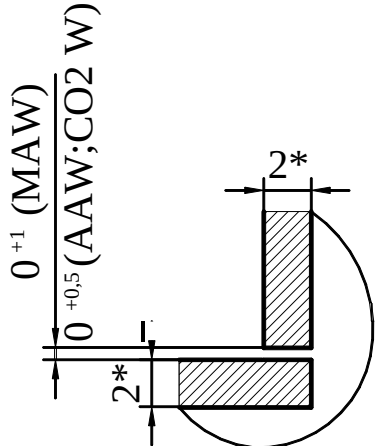
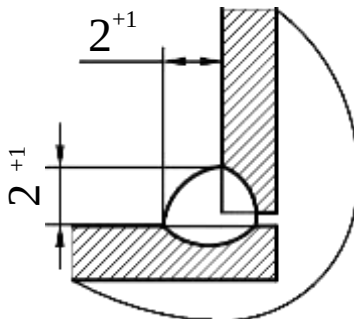
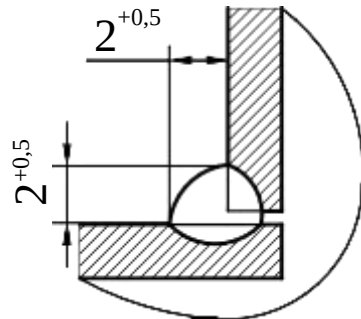
APPENDIX-2 Technical specification for erection of ventilation systems in Reactor building

Table -1 (Cont.)

Type of welded joint	Structural dimensions			
	Of assembly and prepared edges of parts for welding method		Of welded joints	
	MAW	AAW; CO2 W	MAW	AAW; CO2 W
GOST 5264 GOST 14771 C7				
U4 GOST 5264 GOST 14771				

APPENDIX-2 Technical specification for erection of ventilation systems in Reactor building

Table -1 (Cont.)

Type of welded joint	Structural dimensions			
	Of assembly and prepared edges of parts for welding method		Of welded joints	
	MAW	AAW; CO2 W	MAW	AAW; CO2 W
T1 GOST 5264 GOST 14771				

APPENDIX-2 Technical specification for erection of ventilation systems in Reactor building

Table -1 (Cont.)

Type of welded joint	Structural dimensions			
	Of assembly and prepared edges of parts for welding method		Of welded joints	
	MAW	AAW; CO ₂ W	MAW	AAW; CO ₂ W
GOST 5264 GOST 14771 C2			1,5 ⁺¹ ₋₁	

Notes

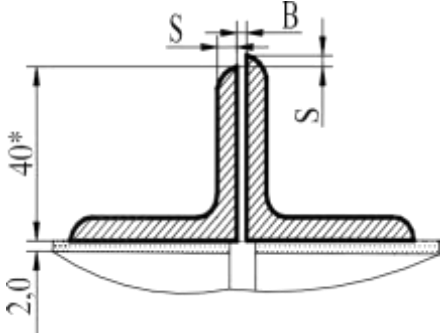
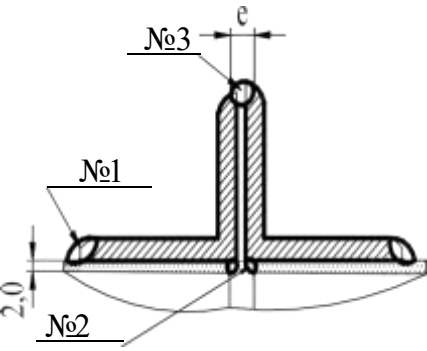
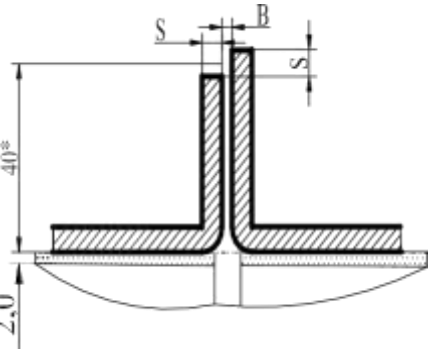
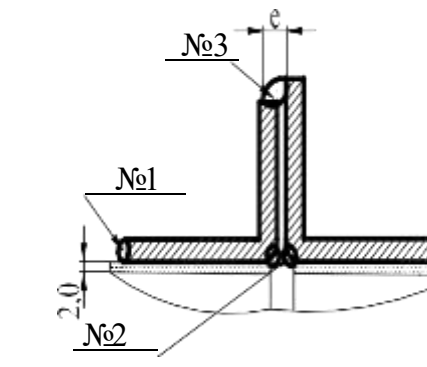
1 * - thickness of parts to be welded will be refined in working documentation developed by FSUE Atomenergoproekt.

2 MAW – manual arc welding, AAW – argon-arc welding, INp – consumable electrode welding in inert gases and their combination with CO₂ and oxygen; CO₂ W – wire CO₂ welding.

3 Rz – surface roughness parameter, μm .

APPENDIX-2 Technical specification for erection of ventilation systems in Reactor building

Table 2: Welding of flanges in assembly of air ducts

Type of welded joint	Structural dimensions		S, MM	B, MM		e, MM not more than
	Of assembly and prepared edges of parts for welding method	Of welded joint		Nominal	Extreme deviation	
Overlap			4*	0	+1,0	S+1
Overlap			4*	0	+1,0	S+1

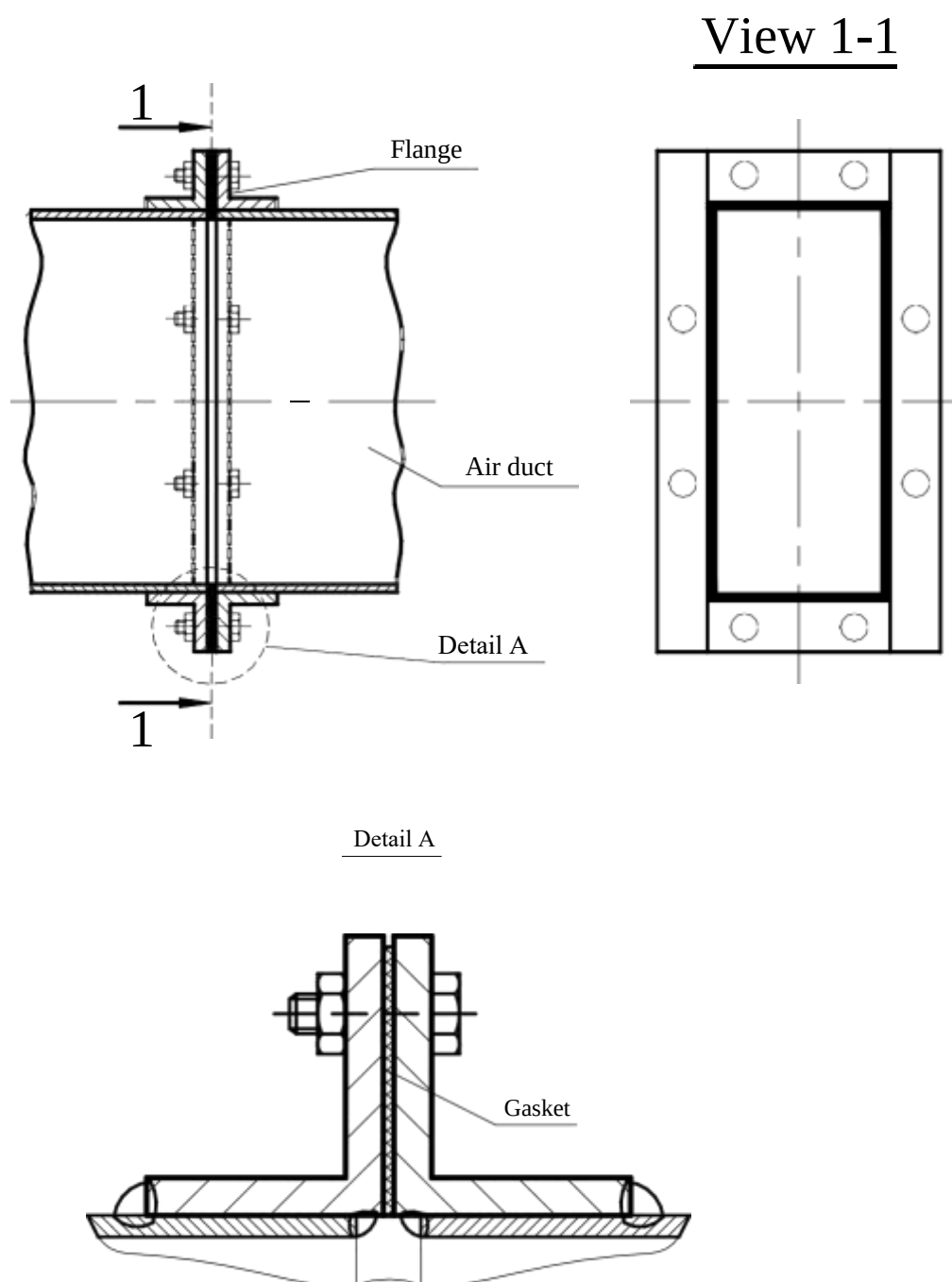


Figure- 1: Bolted Flange connection of air duct parts [CS/ SS ducts]

APPENDIX-2 Technical specification for erection of ventilation systems in Reactor building

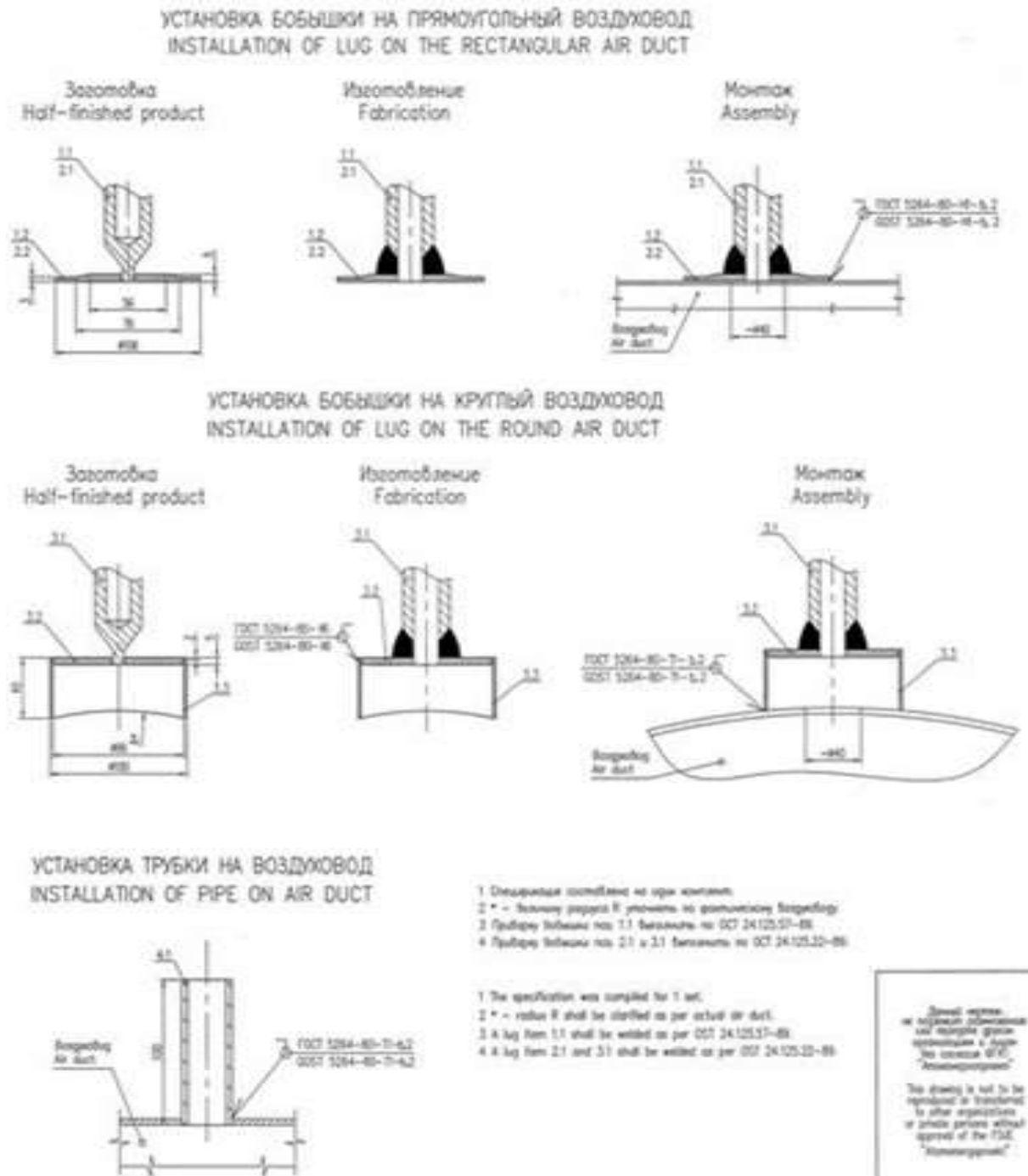


Figure- 2: Typical drawing of adopter over SS and CS duct

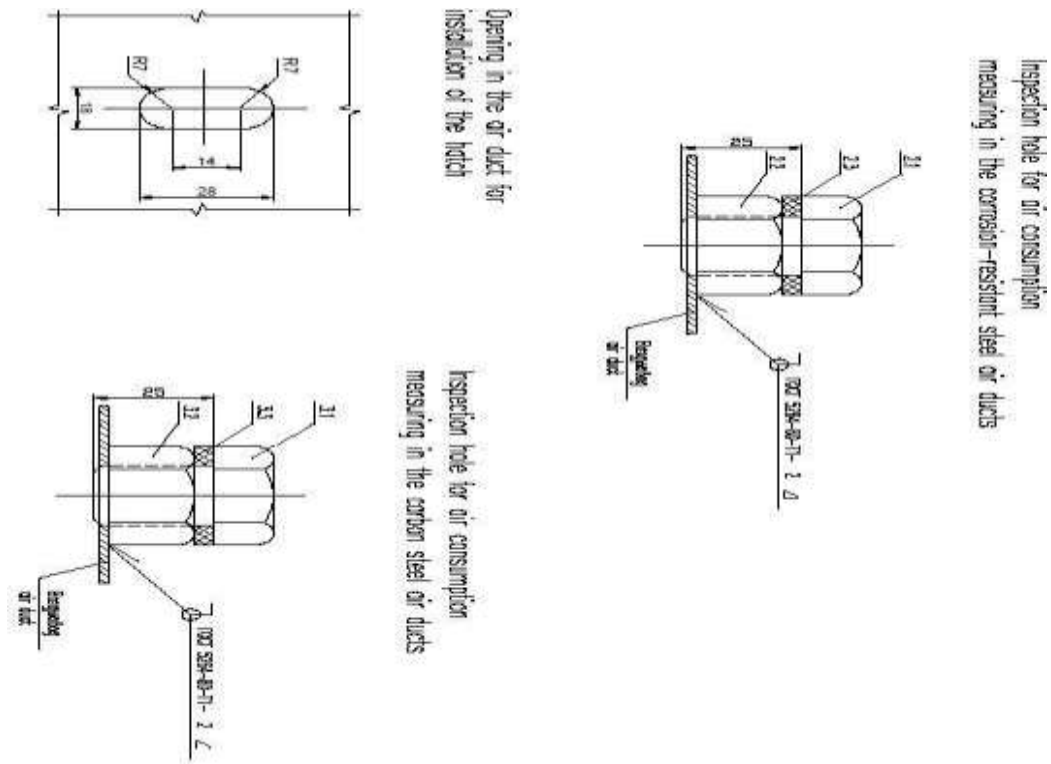


FIGURE-3a, b Typical sketch for IH hole opening made in stainless steel/carbon steel

TECHNICAL CONDITIONS OF CONTRACT (TCC)

2.2.30 TECHNICAL SPECIFICATION FOR RADIOGRAPHY FOR NIEP ERECTION PACKAGE WORKS

S.No	Description
1	Scope
2	Application
3	Applicable documents and Standards
4	Personnel Qualification
5	RT Equipments / Accessories
5.1	RT Films
5.2	Image Quality Indicators
6	Examination By Radiography
6.1	Radiography Techniques.
7	General Requirements.
7.1	Safety during Radiography.
7.2	Storage and processing of RT Films
8	Acceptance Standards.
9	Reporting of RT Results.
Annexure I	References
Annexure II	Equipments/Accessories
Annexure III	RT Technique Sheet
Annexure IV	Selection of IQI
Annexure V	Shooting diagrams
Annexure VI	RT Acceptance Standard Table (Table 13 of PNAE

1. SCOPE:

This specification describes the methods and techniques of Radiography examination of weld joints equipments and piping during construction of KKNPP.

2. APPLICATION:

This Specification is applicable for all equipments/piping works during construction/erection of KKNPP. This is a general specification which shall be followed. Based on this specification, the contractor shall prepare the detailed procedure and get it approved by KKNPP. However any special requirements in the working documents shall be covered in separate procedures.

TECHNICAL CONDITIONS OF CONTRACT (TCC)

3. APPLICABLE DOCUMENTS AND STANDARDS :

Refer list of documents enclosed as annexure- I (i.e References).

4. PERSONNEL QUALIFICATION:

RT shall be carried out by qualified personnel or by personnel having sufficient experience and under the supervision of qualified radiography operators and interpretation shall be done by RT interpreter having training in interpretation of weld radiographs and/or having RT Level-II qualification. A qualified Radiography site in charge shall handle the RT facility and works at site and shall be responsible for safety and quality of works related to Radiography.

5. RT EQUIPMENTS/ACCESSORIES:

Only NPCIL concurred models/make of RT cameras and X-ray machines shall be deployed for RT works. Some of the approved brands of RT Cameras and x-ray machines are given in Annexure-II.

The RT camera must provide sufficient shielding against high curie Co-60/Ir-192 source and shall have guide tube and handle for RT from a remote safe distance. A calibrated survey meter shall be used to check the radiation level in the vicinity of radiography source.

When X-ray machine is used for examination it must have proper Kv rating (say upto 400Kv) with current(exposure) controlling arrangement for x-raying thickness as low as 3mm . Only approved brands of X-ray machines shall be used.

5.1 RT FILMS:

Where thickness involved is less and high contrast is desired slow speed RT films shall be used and for higher thickness medium speed films may be used. Some of the approved brands of RT films in descending order of contrast (speed ascending order) are given in Annexure-I.

Intensifying screens made of pure Lead or any alloy of 6% antimony and 94% Lead may be used.

Screen shall be free from surface streaks of lower atomic number materials and from wrinkles, dirt, grease, lint and scratches. Screens showing evidence of physical damage shall be discarded.

Screens shall be in intimate contact with both sides of the film during exposure.

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To avoid back scatter radiation affects, protective screens(Lead foil or high atomic no. material) of thickness from 0.5mm minimum to 1.5 mm shall be placed between film and the specimen being radiographed.

5.2 IMAGE QUALITY INDICATORS(IQI) OR PENETRAMETERS:

Russian or DIN Wire type IQI shall be used to ascertain the quality of radiography technique. The penetrameter will preferably be placed on source side. If it is not possible to place the IQI on source side, they may be placed on film side. The selection of IQI shall be based on the thickness and the sensitivity requirements of the job under examination. If any specific requirements are not given, Tables given in Annexure-IV can be used for selection of IQI.

The radiograph must have optical density(O.D) of 1.5 to 3.5 for satisfactory results. Calibrated densitometers shall be used to measure the density.

Location marker and Lead identification numbers as per standard practice shall be used to identify the weld joints being radiographed.

6. EXAMINATION BY RADIOGRAPHY:

For specific job, a specific RT/X-ray technique sheet shall be made and approved by Head QA, KK site. The technique sheet shall cover material specification(Thickness, dia), welding process, details of Radiography source/X-ray machine, RT films, intensifying screens, penetrameters and their placement . A shooting sketch of the Radiography technique proposed shall also be enclosed. A sample of technique sheet is enclosed as Annexure-III. Based on above procedure the technique should be actually demonstrated before start of actual job radiography.

6.1 RADIOGRAPHY TECHNIQUES:

The butt joints and fillet welds(whenever specified) of equipments/pipelines shall be radiographed according to the diagrams given in Fig:3(Ref: Annexure-V as per PNAE- G-7-17-89). Diagrams a, b, f, g and h show single wall exposure. If possible, the source should be located inside the article being radiographed.

Fig. 3(f) shows panoramic arrangement of RT and is recommended upto 2 meter dia.(irrespective to %age of RT) and for 100%(Full Radiography) over 2 meter of diameters.

TECHNICAL CONDITIONS OF CONTRACT (TCC)

Other arrangements, like double wall exposure (single wall viewing), double wall exposure (elliptical for dia. below 100 mm and high thickness) shall also be used where applicable.

For pipe branches/nozzles, RT techniques as per Fig.4 (Annexure-V) shall be used.

Any technique other than mentioned above shall be elaborated by technique sheet (by the contractor) and get it approved by NPCIL prior to execution of work.

Minimum four no. of IQI shall be placed for panoramic technique, each IQI placed in each sector to cover full diameter.

The geometrical unsharpness shall not exceed half the sensitivity upto 2mm and maximum 1.0mm for sensitivity more than 2mm.

The angle between the radiation direction and normal to the film within the limits of section inspected in one exposure shall not exceed 45°.

Suitable no. of exposures shall be taken to cover the scope of radiography specified and to avoid any missing details due to enlargement on images/details towards the ends showing thickness of the pipe being radiographed.

An overlapping of minimum 20mm of weld length shall be provided, when more than one segment of the same weld joints are radiographed.

The width of RT film shall be taken to cover the weld as well as minimum 20mm of heat affected zone on both sides of the weld width (Minimum 50mm of HAZ in case of electro slag welding)

Use of compensators shall be made, (where the joint configuration causes a portion of RT film hanging and in direct exposure to the radiation beam) to provide material cover on RT film out side the radiographed thickness.

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6.1.1 Source to object distance :

- There are many factors affecting the source to film distance, for the all the techniques shown in the above sketch.
- Final values shall be decided by the approved procedures and the technique sheets.
- The source to surface of the welded joint (f in the above sketch) selected in such a way that
 - When film is located close to the welded joint being inspected , the lack of geometrical sharpness of the images of the defects on the pictures shall not exceed the half of the required sensitivity of inspection at sensitivity of up to 2mm and shall not exceed 1 mm at sensitivity over 2mm.
 - The relative enlargement of the dimensions of the images of the defects located from the side of the source of radiation (relative to the defects located from the side of the film) shall not exceed 1.25.
 - The angle between the radiation direction and normal to the limits film within the limits of the section inspected at one exposure shall not exceed 45° .
- Selection of distance from radiation source to welded joint being inspected and length or quantity of sections to be inspected.

f = distance from the radiation source to the weld joint.

h = Radiation thickness of the section being inspected, mm

$\emptyset$ = the maximum size of the focal, spotthe radiation source, mm.

K = the required sensitivity of the inspection,

D = Outer dia of the pipe

D = Inner dia of the pipe

$C = 2 \emptyset/K$ at $\emptyset/K \geq 2$

$C = 4$ at $\emptyset/K < 2$

For fig (C) in the techniques shown in the above figure , $f \geq C D$

For fig (d) , $f \geq 0.5 [1.5C(D-d)-D]$

For fig (e) , $f \geq 0.5 [C(1.4D-d)-D]$

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Typical Calculation for the technique sheet given below:

$D = 38\text{mm}$, $d = 31\text{mm}$, $K = 0.2\text{mm}$, $\varnothing = 2.7\text{mm}$,

$\varnothing/K = 2.7/0.2 = 13.5$, $C = 2 \times 2.7 / 0.2 = 27\text{mm}$

Value of $CD = 27 \times 38 = 1026\text{mm}$, $f \geq 1026$ and selected value is 1050mm which fulfill the requirement.

- Above illustration shows that the source to object distance may vary from zero to above one meter.
- This distance will increase the exposure time for carrying out radiography, which will reduce the productivity.
- Also for aligning the source to required orientation and distance will take great amount of time which will affect the productivity.
- Quoted rate shall include this entire factors considering into account.

7. GENERAL REQUIREMENTS:

7.1 SAFETY DURING RADIOGRAPHY: All radioactive sources shall be handled by qualified personnel only. Storage, transportation, handling etc shall be done only from radiography source room approved by statutory authority. To avoid radiation exposure to general construction workers, RT shall be performed preferably during night time or in case of urgency during such time so as not to allow any exposure to general public. Suitable barricading of the area, where radiography is being done shall be done with "Danger" sign. The personnel performing RT shall wear TLD and carry calibrated dosimeter and survey meters to measure the dose and radiation level.

7.2 STORAGE AND PROCESSING OF FILMS:

Suitable dark room with controlled atmosphere shall be established with provision of processing tanks, dry work bench, film cutters, safe light for loading and processing of RT films, Illuminator for interpretation of films and storage space for processed radiographs. RT film shall not be exposed to temperatures more than 26°C and high humidity conditions for longer time. Approved brands of developer, fixer and stop bath solutions shall be used. Depleted or contaminated solutions shall be replaced when detected or film artifacts attributable to poor quality of developer/fixer are noticed.

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Developer temperature shall not exceed 20°C. Washing of fixed radiographs shall be done in running water for at least 30 minutes or alternately each radiograph shall be washed thoroughly in running water for at least 30 seconds.

Drying of processed radiographs shall be done away from dust, dirt or area susceptible to contamination of radiographs. Use of good quality wetting agent, rubber wiper may also be done.

The accepted films shall be stored in controlled atmosphere and dust free room. The films shall be segregated according to system and circuit wise until handing over to NPCIL with proper indexing no. at the time of handing over the system.

8. ACCEPTANCE STANDARDS:

The radiographs shall be interpreted by qualified inspectors and RT results recorded in Radiography inspection reports. RT acceptance standards shall be as per working documents and approved standards. The following defects are not acceptable.

- i) Any indication representing crack, lack of penetration and lack of fusion.
- ii) Defects which are beyond the acceptance levels of Tables 13 of PNAE-G-07-10-89 (Ref; Annexure-VI, given as indicative of acceptance standards)

9. REPORTING OF RT RESULTS:

Radiography inspection report format shall be agreed with the Engineer/Head QA. It shall cover the following details:

Contract details with W.O no. and date

Job(article) description(Thickness, diameter etc), system, KKS code etc. Drawing No. of weld joint, process, Jt. Category.

RT procedure/Technique sheet No. Applicable standard

Radiography source type, strength, size, Kv and mA in case of X-ray. IQI designation/placement, sensitivity

Radiographer name, date of radiography, RT film type, size,

Scope of RT i.e 100%, random etc.

Fresh, Repair, retake or repeat shot identification

Jt, numbers, Segments radiographed with interpretation results Remarks, observations for final inspection, interpreting NPCIL inspector Signature of interpreter with date.

TECHNICAL CONDITIONS OF CONTRACT (TCC)

Annexure - I

REFERENCES:

- i) PNAE-G-007-017-89 : Unified control techniques of basic materials(Semifinished products) welded connections and claddings of Nuclear plant unit equipments and pipelines -Radiography control.
- ii) PNAE-G-007-010-89 : Welded connections and claddings of Nuclear plant unit equipments and pipelines- Inspection regulations.
- iii) GOST 7512-82 : Non-destructive inspection. Welded joints. Radiographic method.
- iv) SNiP 3.05.05-84: Technological equipments and technological pipelines.
PB.03.75-94, Rules for and safe operation of Steam and Hot water pipelines.

Annexure-II

Equipments/Accessories:

RT CAMERA:

The commonly brands of RT cameras which are approved to be used in NPCIL NPPs are as given below-

- i) Teletron SU-50A
- ii) Tech-op
- iii) Spec-2T

X-Ray Machines (Preferably to be used for radiography of small thickness say upto 19mm)

- i) X-ray machine of Philips make (Suitable KV and Ampere rating.)
- ii) X-ray machine of Andrex make (Suitable KV and Ampere rating.)
- iii) BALTEAU-NDT, Model C-ram-235, 50 to 235 Kv, 7 Amp.

RT Films:

- i) NDT 45, Afga D2, Kodak-M., RT-5 (Slow speed films)
- ii) NDT 55, D4, Kodak-Mx 125., RT-4Sh, RT-4M (Medium speed films)

TECHNICAL CONDITIONS OF CONTRACT (TCC)

Annexure-III

TECHNIQUE SHEET FOR RADIOGRAPHY:

Technique sheet No. KKNPP/RT/

1. Scope:
2. Personnel Qualification:
3. Material Specification:
4. Welding Process:
5. Thickness:
6. Surface condition and reinforcement:
7. Source of Radiation/X-ray machine parameters
(e.g curie and mm size in source and Kv/mA of X-ray machine)
8. Type of film and size:
9. Technique/No. of exposure and shooting sketch reference:
10. Type of screen:
11. Penetrameter type and placement:
12. Sensitivity required:
13. Source to film distance:

TECHNICAL CONDITIONS OF CONTRACT (TCC)

14. Geometric unsharpness:

15. Optical density of film.

16. Density variation:

17. Acceptance standards.

18. Reporting format.

Prepared by:

Reviewed by:

Approved By: (NPCIL QA)

TECHNICAL CONDITIONS OF CONTRACT (TCC)

Annexure-IV

Selection of IQI:

TABLE : Guidelines for IQI Selection.

PENETRATOR DESIGNATION, THICKNESS AND WIRE DIAMETERS
(FOR SYSTEMS COVERED UNDER QA1, QA2 and QA3 Categories)

Table of testing sensitivity for radiographs

Radiation Depth (at place of installation of sensitivity standard) in mm	Sensitivity Rating		
	1	2	3
Up to 5	0.10	0.10	0.20
Over 5 up to 9 inclusive	0.20	0.20	0.30
Over 9 up to 12 inclusive	0.20	0.30	0.40
Over 12 up to 20 inclusive	0.30	0.40	0.50
Over 20 up to 30 inclusive	0.40	0.50	0.60
Over 30 up to 40 inclusive	0.50	0.60	0.75
Over 40 up to 50 inclusive	0.60	0.75	1.00
Over 50 up to 70 inclusive	0.75	1.00	1.25
Over 70 up to 100 inclusive	1.00	1.25	1.50
Over 100 up to 140 inclusive	1.25	1.50	2.00
Over 140 up to 200 inclusive	1.50	2.00	2.50
Over 200 up to 300 inclusive	2.00	2.50	-
Over 300 up to 400 inclusive	2.50	-	-

Note: When using the wire sensitivity standards values 0.30, 0.60, 0.75 and 1.50 mm are replaced with values 0.32, 0.63, 0.80 and 1.60 mm.

Depending upon the wire diameter required as per specification/drawings the IQI selection can be made from standard sets of GOST/DIN type penetrameters as given below.

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As per DIN 54:109/ISO

IQI Designation:	Wire Dia. Range:
1 ISO 7	0.8 mm to 3.2mm
6 ISO 12	0.25 mm to 1.0mm
10 ISO 16	0.10 mm to 0.40mm.

As per GOST 7512-82

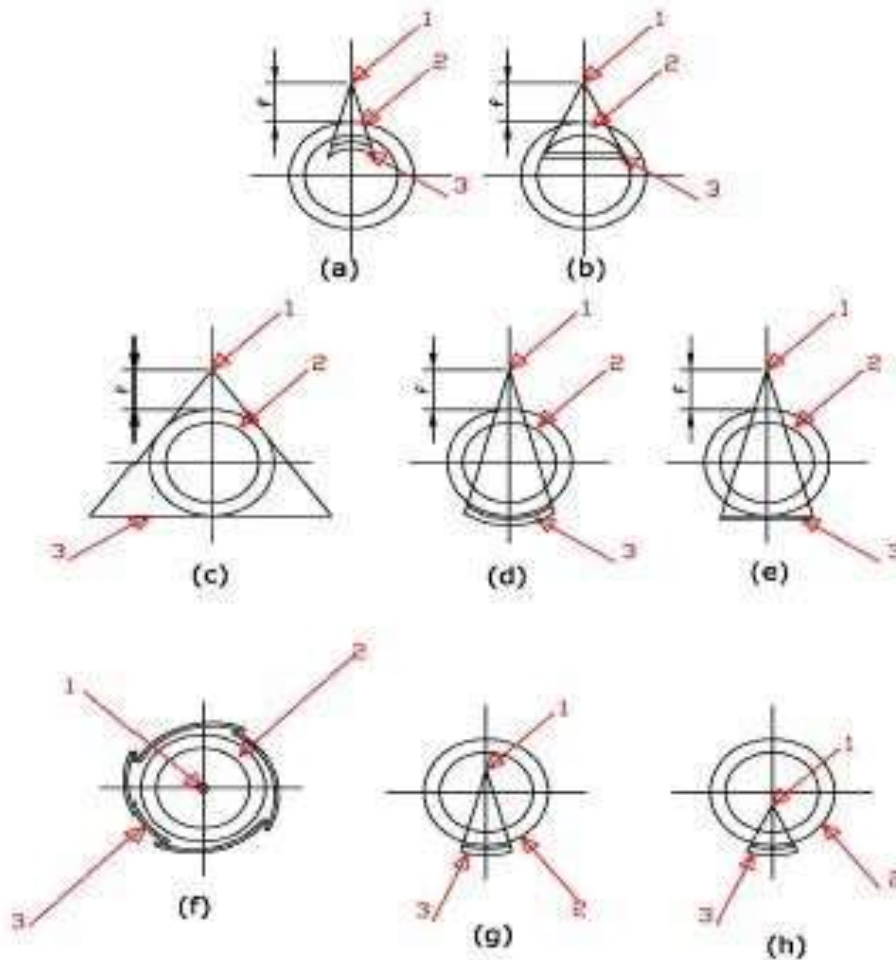
IQI Designation:	Wire Dia. Range:
Standard No. 1	0.05mm to 0.2mm
Standard No. 2	0.10mm to 0.4mm
Standard No. 3	0.32mm to 1.25mm
Standard No. 4	1.00mm to 4.0mm

TECHNICAL CONDITIONS OF CONTRACT (TCC)

Annexure-V

Shooting sketches as per PNAE-G-7-10-89

1) Diagrams of inspection of Butt - Circular welded joints of Cylindrical and Spherical Hollow articles.



1) Radiation source 2) Section Under Inspection
3) Cassette
 f = Distance of source of radiation to welded joint being inspected

TECHNICAL CONDITIONS OF CONTRACT (TCC)

Annexure-VI

Table : 13 of PNAE-G-7-10-89(Acceptance standards as indicative only)

Table 13: Norms of Individual and Combined Test Results Permissible in Welded Joints during Radiographic Inspection

Radiolucent area of voids or slag in part of welded joint	Required percentage of acceptance, mm	Individual and combined test results				Individual large inclusion		
		Permissible percentage		Permissible number of inclusions and character size number of voided joint (100 mm long)	Permissible total radiated area of inclusion in char. analysis in any portion of welded joint (100 mm)	Permissible		Permissible number in any section of welded joint 100 mm long
		Inclusion, mm	Char. size			percentage size, mm	maximum in width, mm	
1	2	3	4	5	6	7	8	9
Welded joints of the 1 category								
Over 1.0 to 1.5 inclusive	0.1	0.2	0.2	10	0.15	5.0	0.2	1
Over 1.5 to 2.0 inclusive	0.1	0.3	0.4	10	0.3	3.0	0.3	1
Over 2.0 to 2.5 inclusive	0.1	0.4	0.6	10	0.6	3.0	0.4	1
Over 2.5 to 3.0 inclusive	0.1	0.5	0.8	10	1.0	3.0	0.5	1
Over 3.0 to 4.5 inclusive	0.1	0.6	1.0	10	1.4	3.0	0.6	1
Over 4.5 to 6.0 inclusive	0.2	0.8	1.2	11	2.5	3.0	0.8	1
Over 6.0 to 7.5 inclusive	0.2	1.0	1.5	12	4.0	2.0	1.0	1
Over 7.5 to 10.0 inclusive	0.2	1.2	2.0	12	5.5	3.5	1.2	1
Over 10.0 to 12.0 inclusive	0.2	1.3	2.5	13	7.5	3.5	1.5	1
Over 12.0 to 14.0 inclusive	0.2	1.5	3.0	13	9.0	4.0	1.5	1
Over 14.0 to 18.0 inclusive	0.3	2.0	3.0	13	11.0	4.0	2.0	1
Over 18.0 to 21.0 inclusive	0.2	2.0	3.0	14	14.0	4.0	2.0	1
Over 21.0 to 24.0 inclusive	0.4	2.0	3.0	14	17.5	5.0	2.0	1
Over 24.0 to 27.0 inclusive	0.4	2.5	3.5	15	20.0	5.0	2.5	2
Over 27.0 to 30.0 inclusive	0.4	2.5	3.5	15	22.0	6.0	2.5	2
Over 30.0 to 35.0 inclusive	0.5	2.5	4.0	16	26.0	6.0	2.5	2
Over 35.0 to 40.0 inclusive	0.5	3.0	4.5	17	30.0	7.0	3.0	2
Over 40.0 to 45.0 inclusive	0.6	3.0	4.5	18	34.0	8.0	3.0	2
Over 45.0 to 50.0 inclusive	0.6	3.0	4.5	19	38.0	9.0	3.0	2
Over 50.0 to 55.0 inclusive	0.6	3.0	4.5	20	42.0	10.0	3.0	2

Table 13 (continued)

1	2	3	4	5	6	7	8	9
Over 55.0 to 65.0 inclusive	0.75	3.5	5.0	21	48.0	10.0	3.5	2
Over 65.0 to 75.0 inclusive	0.75	4.5	5.0	22	56.0	10.0	4.5	2
Over 75.0 to 85.0 inclusive	1.0	4.0	6.0	23	64.0	10.0	4.0	2
Over 85.0 to 100.0 inclusive	1.0	4.0	6.0	24	72.0	10.0	4.0	2
Over 100.0 to 115.0 inclusive	1.25	4.0	6.0	25	80.0	10.0	4.0	2
Over 115.0 to 125.0 inclusive	1.25	4.0	7.0	25	100.0	10.0	5.0	2
Over 125.0 to 135.0 inclusive	1.5	5.0	7.0	24	100.0	11.0	5.0	2
Over 135.0 to 145.0 inclusive	1.5	5.0	7.0	24	115.0	11.0	5.0	2
Over 145.0 to 175.0 inclusive	2.0	5.0	7.0	25	130.0	11.0	5.0	2
Over 175.0 to 200.0 inclusive	2.0	6.0	8.0	26	150.0	11.0	5.0	2
Over 200.0 to 230.0 inclusive	2.5	6.0	8.0	27	180.0	12.0	7.0	2
Over 230.0 to 300.0 inclusive	3.0	6.0	8.0	28	220.0	12.0	8.0	2
Over 300.0 to 350.0 inclusive	3.0	7.0	10.0	29	260.0	13.0	7.0	2
Over 350.0 to 400.0 inclusive	4.0	6.0	12.0	30	300.0	13.0	8.0	2
Over 400.0 to 450.0 inclusive	4.5	7.0	14.0	30	360.0	13.0	9.0	2
Over 450.0 to 500.0 inclusive	5.0	10.0	15.0	31	380.0	14.0	10.0	2
Over 500.0 to 550.0 inclusive	5.5	11.0	16.0	32	420.0	14.0	11.0	2
Over 550.0	6.0	12.0	18.0	33	460.0	14.0	12.0	2
Welded joints of the 2 category								
Over 1.0 to 1.5 inclusive	0.1	0.2	0.4	11	0.4	4.0	0.2	1
Over 1.5 to 2.0 inclusive	0.1	0.4	0.6	11	0.6	4.0	0.4	1
Over 2.0 to 2.5 inclusive	0.1	0.5	0.8	11	1.2	4.0	0.5	1
Over 2.5 to 3.0 inclusive	0.1	0.6	1.0	11	1.7	4.0	0.6	1
Over 3.0 to 5.0 inclusive	0.2	0.8	1.2	11	3.0	4.0	0.8	1

TECHNICAL CONDITIONS OF CONTRACT (TCC)

2.2.31 TECHNICAL SPECIFICATION FOR UT FOR NIEP ERECTION PACKAGE WORKS

S.No	Description
1	Scope
2	Application
3	Applicable documents and Standards
4	Personnel Qualifications
5	Instrumentation
5.1	Equipment
5.2	Search Units
6	Surface Preparation
7	Couplant
8	General Instructions
9	Calibration Block
9.1	Standard Samples (SS)
9.2	Standard Samples Factory (SSF)
9.3	Certification of Reference Blocks
10	Calibration
10.1	Sensitivity Calibration
10.2	Straight Beam Calibration
10.3	Angle Beam Calibration
10.4	Recalibration
11	Scanning
12	Evaluation and Recording
13	Acceptance Standard
14	Post Examination and Cleaning
Annexures:	
Annexure I	References.
Annexure II	UT Report Format.

TECHNICAL CONDITIONS OF CONTRACT (TCC)

1. Scope

This Specification describes the requirements for Ultrasonic Testing (UT), by Pulse-Echo Contact method by manual scanning of pressure retaining weld joints in steel piping of 5.5 mm to 400 mm thickness and cladding during construction of KKNPP.

2. Application

This Specification is applicable for all the systems of KKNPP during construction and pre-service examination of welds of equipments and piping of KKNPP. The scope and extent of inspection shall be as per working documents. This is a general specification, which shall be followed. Based on this specification, the contractor shall prepare the detailed procedure and get it approved by KKNPP. However any special requirements in the working documents shall be covered in separate procedures.

3. Applicable Documents and Standards

Refer Annexure – I for references.

4. Personnel Qualifications

Scanning should be carried out by personnel qualified to UT Level II or Level I (ISNT). Verification of calibration, scanning, analysis of indications and reporting shall be by personnel qualified to UT Level II (ISNT). However, theoretical and practical capability of the personnel performing UT shall be checked periodically by KKNPP at site. The procedure shall be approved by person with Level III certification (ASNT/ISNT).

5. Instrumentation

5.1 Equipment

A Standard Ultrasonic Flaw Detector operating on the pulse-echo method capable of generating frequencies of 1 MHz to 5 MHz and satisfying the requirements mentioned below shall be used. (Performance characteristic verification of instrument and) verification system shall be done at every 3 months.

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Screen height Linearity

The Flaw Detector Instrument shall provide linear vertical presentation within + 5% of full screen height for 20% to 80% of calibrated screen height.

Amplitude Control Linearity

The Flaw detector Instrument shall utilize an amplitude control accurate over its useful range to + 20% of nominal amplitude ratio, to allow measurement of indications beyond the linear range of vertical display on screen.

The flaw detector instrument shall be checked for accuracy of measurement of distance by height reference blocks. The error shall be < 2.5% at distance of 50 mm and more.

Microprocessor based instruments with conventional Cathode Ray Tube (CRT) based display may also be used. The flaw detector shall be equipped with amplifier/attenuator with scale division of not more than 2 dB and range of at least 80 dB.

List below gives some standard make/model of UT flaw detectors commonly used.

Sonic USA - FTS MKI & MK IV

Crautkramer, Germany – USK 7, USIP-11, USIP-12, USM-2, USM-2M, USD-30 & USL48M

EEC, India - ESM-2, ESM-2M, EX-10, EX-100, Echoscan

Sonajest, Germany -

Note : Any other make and model with specific concurrence of NPCIL can be used.

5.2 Search Units

The Table-I & II give combination of search units/Inclined Transducers (IT)/ Piezoelectric Transducers (PZT) that are recommended for use with different thicknesses.

The frequency of vibration radiated from inclined transducer shall not differ from rated value by more than 10%.

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The beam entry angle and transducer movement shall be selected in such a way as to make it possible to examine the weld by direct or direct/primary reflected beams.

Probes with matching curved shoes are recommended for piping below 50 mm diameter. With pipe dia 250 NB and below extra care shall be taken for making proper contact of the probe with surface being examined.

6. Surface Preparation:

The contact surfaces shall be free from dirt, dust, scale, weld spatter, roughness or other conditions like paint, oil spots which interfere with free movement of search unit or which can impair the transmission of ultrasound in the job. Examination shall be conducted on welds and adjacent base material in their completed surface condition.

The surface of welded joints on both sides in the zones of probe movement shall be cleaned from dust, dirt, scales, dents and other irregularities. The surface shall be having surface finish of 6.3 micron and waviness of surface shall not exceed 0.015 mm.

7. Couplant

Oil, grease, glycerine, water or cellulose paste may be used as couplant. It must have sufficient wettability, viscosity and must be transparent to ultrasound. It must be harmless to skin and easily removable.

8. General Instructions

8.1 Ultrasonic examination shall be conducted after correcting the defects

detected at visual and measuring inspection & LPT/MPE as the case may be.

8.2 Final acceptance of UT shall be conducted after final heat treatment, cladding

and machining if they are the part of process. However intermediary examination may be required to ensure final acceptable welds.

8.3 Inaccessible areas for examination shall be marked in the Technique Sheet and agreed by KKNPP.

When required, the weld reinforcement may have to be ground to provide adequate coverage. Such recording should be made in the Technique Sheet.

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8.4 When voltage fluctuations interfere with UT examination, stabilizer shall be used.

The equipment shall have back up battery.

8.5 The examination shall be carried out in horizontal or vertical position.

Examination in overhead position shall be avoided.

8.6 No examination shall be planned during 12 midnight up to 6 AM. The lighting should be such that it does not hamper observation of screen.

8.7 The equipment, cables, probes shall be maintained and kept in workable condition. No loose connections, broken cables are permitted. Connecting sockets shall be cleaned regularly of grease and oil. Batteries shall be maintained in charged conditions and spares made available.

8.8 The joint numbers shall be engraved/ punched and verified before taking up any inspection. Each joint shall be divided in to sectors and marked by a standard method.

8.9 Based on this specification and working documents detailed UT procedure shall be prepared specific to each job.

The procedure should address but not limited to the following variables:

- a) Characteristics of transducer [Piezoelectric Transducer (PZT)]
- b) Flaw detector and its response to probe
- c) Dead zone
- d) Beam exit point
- e) Angle of beam entry
- f) Distance and front resolution
- g) Pulse duration
- h) Distance measurement error
- i) Reference Block Test Sensitivity

The Technique Sheet (Control Sheet) for each type, size of joints shall be prepared. It shall be approved by engineer with Level III certification in UT.

Technique Sheet (the control chart) shall contain information about category of object under inspection (control), degree of accessibility, diagram and direction of test, scanning parameters, method of adjustment of sweep and sensitivity, attenuation, radius of curvature, sensitivity requirement and equivalent area of maximum permissible discontinuity, number of discontinuities permitted in 100mm etc.

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- 8.10 The scope of inspection by Ultrasonic Examination shall be as per working documentation and corresponding inspection regulation.
- 8.11 When Ultrasonic Examination of joints is not practically possible the same may be replaced by visual and capillary/magnetic powder inspection (layer by layer) in consultation with KKNPP.
- 8.12 Weld Examination of austenitic Stainless steel pipes and examination of anticorrosion cladding (surfacing) fillet welds require special ultrasonic examination procedures.
- 8.13 Ultrasonic examination evaluation using DGS diagram may be carried out after submission and approval of procedure by NPCIL.
- 8.14 When welded joints with higher thickness are examined attenuation shall be taken into account.
- 8.15 When examining the pipe welded joints using once reflected beam, it is necessary to take into account the loss of energy on internal cylindrical surface as per PNAE-G – 7– 30 – 91 Part-II.

9. Calibration Block :

(Standard Sample referred as “SS” or “CO” and Standard Sample of Factory referred as “SSF” or “COP”)

9.1 Standard Samples (SS)

These are Standard Reference Blocks. Reference Blocks of International Welding Institute conforming to VI (DIN54120) or V2 (54122) can be used. For calibration of TR probe, step wedge can be used.

9.2 Standard Samples Factory (SSF)

These calibration blocks are made for specific job and purpose See Fig.1 for Sample “SSF”.

- 9.2.1 Blocks shall be made of material with same acoustic properties and have same surface roughness as the item under testing. They shall not contain defects as examined by any NDT methods. Following difference in properties between the Reference Block and item under inspection are permitted.

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By the speed of sound	:	+ 5%
By acoustic impedance	:	+ 5%
By damping factor	:	+ 20%
By surface roughness	:	2.5 microns
By back wall signal at equal thickness	:	4 dB

Reference Blocks shall be of sufficient size to ensure absence of influence from side walls on defect echo signal.

9.2.2 The calibration block shall be of the same product form and material specification or the equivalent material. For calibration blocks for dissimilar metal welds, the material selection shall be based on the side of the weld from which the examination will be conducted. Where two or more material thicknesses are involved, the calibration block shall be determined by the average thickness of the weld.

The calibration block shall preferably receive the same type of heat-treatment as the material specification.

9.2.3 Following tolerances are specified for the SSF.

- i. $\pm 0.30^\circ$ for angle between flat bottom hole and acoustic axis of the transducer.
- ii. $- 0.2, + 0.05$ mm for width and height of reflector.
- iii. ± 2.00 for angle between the reflecting flat of the angular reflector and the sample surface.

9.2.4 For examination in materials where the examination diameter is more than 500 mm, a block of essentially the same curvature or alternatively a flat basic calibration block shall be used. When carrying out testing of cylindrical articles of radius less than 250 mm on the convex surface and of less than 500 mm on concave surface the radius of reference block R_{ref} shall satisfy following:

$$0.9 R_{art} < R_{ref} < 1.2 R_{art}$$

When R_{art} is radius of article under test.

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9.3 Certification of Reference Blocks:

Standard Samples & Standard Factory Samples shall be checked, tested and certified by Level-III person in UT. For these blocks sketches showing dimensional details of material shall be made available. Each block shall bear distinctive identification number and Register of blocks available with contractor with date of certification.

10. Calibration

10.1 Sensitivity Calibration

Distance (Sweep range) and Distance Amplitude calibration shall be made on SSF as per working document and inspection regulation for calibration using the reference blocks (SSF) following levels of sensitivity are specified for amplitude calibration.

- a. Sorting Level: Permissibility of detected discontinuity is evaluated at this level by the echo signal amplitude. For this maximum permissible equivalent area are specified in control regulation.
- b. Control Level: Characteristics of detected discontinuities are measured and their permissibility is evaluated by conventional height, width & length of defect. For determining sizes of discontinuities probe is moved until indication drops by 6 dB. This means that control level is 6 dB below sorting level.
- c. Searching Level: This is 6 dB above sorting level. This is same as "Scanning gain".
- d. Reference Level: Reference level at which echo signal from reflector in SSF has pre set height say (50%) on flaw detector screen.

10.2 Straight Beam Calibration

10.2.1 Sweep Range Calibration shall be done in such a way that greatest part of sweep on screen correspond to beam path in the welded joint under test.

10.2.2 Distance Amplitude Curve: This shall be plotted using reference block (SSF) at minimum of 3 metal distances using FBH (Flat Bottom Hole) as per fig. 1 'a'.

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10.3 Angle beam calibration

10.3.1 Sweep Range Calibration shall be done in such a way that greatest part of sweep on screen correspond to beam path in the welded joint under test.

10.3.2 Distance Amplitude Curve: This shall be plotted using reference block (SSF) at minimum of 3 metal distances using FBH as per fig. 1 'c'.

By directing beam on flat bottom reflector of known area S_{sam} (2 mm dia.) adjust indication height say 50% of screen height. Gain dB is noted down say "x" which is Reference level. If Control regulation permits maximum defect area as S_{st} , then sensitivity correction to be applied to get sorting level is

$$\Delta A = 20 \log \frac{S_{st}}{S_{sam}}, \Delta A \text{ shall be less than 12 db.}$$

Searching level (scanning level) shall be +6dB from sorting level. Control level for sizing of defect will be sorting level – 6 dB.

When maximum discontinuity permitted by control regulation and area of flat bottom hole in standard sample of factory (SSF) are ~~same~~. $A = 0$ and Reference level and sorting level are same and can be called as "Calibration gain".

Calibration using side drilled holes as per references PNAEG – 7 – 30 – 91 Part-II are also acceptable.

10.4 Recalibration

10.4.1 Calibration check on basic calibration block (SSF) shall be made when any part of examination system (including personnel) is changed or in the beginning/end of shift or work/every 4 hrs. or less but more than one hour, to verify points on sweep and DAC values satisfy the original setting.

10.4.2 If a point on DAC curve has moved on the sweep line more than 10% of the sweep reading, or 5% of full sweep whichever is greater, correct the sweep range calibration and note the correction in the examination record. If reflectors are recorded on the data sheets, those sheets shall be voided and new calibration shall be recorded. All recorded indications since the

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last valid calibration shall be re-examined with the corrected calibration and their values shall be changed on data sheets.

- 10.4.3 If a point on DAC curve has decreased 20% or 2 dB of its amplitude, all data sheets since the last calibration/calibration check shall be marked void. A new calibration shall be made and recorded. The area covered by invalid data, shall be re-examined. If any point on DAC curve has increased more than 20% or 2 dB of its amplitude, all recorded indications since the last valid calibration, shall be re-examined with the corrected calibration and their values shall be changed on the data sheets.

11. Scanning

- 11.1 The entire volume of the weld and heat affected zone shall be covered by manual scanning and visual monitoring with 10% overlap of transducer dimension perpendicular to direction of scan.
- 11.2 The rate of search unit movement for examination shall not exceed 150 mm per second.
- 11.3 The normal beam scanning of the base material adjacent to the weld region shall be carried out to detect reflectors that might affect interpretation of angle beam results and is not to be used as an acceptance/rejection examination. Location of such reflectors shall be recorded.
- 11.4 When specified, weld and base metal shall be scanned upto a distance of $3T$ on both side of weld, where T is thickness of thicker plate with the straight beam search unit. The scanning shall be done at primary reference level + 6 dB (searching level). Evaluation shall done at PRL (Sorting level). For this weld bead shall be ground smooth.
- 11.5 Scanning shall be done with angle beam directed at approximately right angle to the weld axis from two directions. The search unit shall be manipulated so as to maximize the response from the possible defect. When required Scanning shall be done with a set of two probe combination to ensure proper evaluation of the indication detected.
- 11.6 While scanning cylindrical items curvature shall be taken into account. Butt joints with thickness > 60 mm shall be scanned by direct beam as per Fig.2 "a" where possible.
Butt joints with thickness < 60 mm and circular welds of pipe lines and vessels with internal diameter of < 800 mm can be scanned as per fig.2 "b".

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But joints with reinforcement removed shall be additionally examined by straight beam probe selected as per "Table-III".

For Stainless Steel clad pipes scanning shall be done by two angle (45 & 65) reflected beam should be avoided. It is preferable to do UT of weld before cladding as well as after cladding.

- 11.7 Tee joint welds in which thickness of item welded is over 60 mm scanning shall be done as per Fig.2 'c'.

Tee joint welds for thickness upto 60 mm can be scanned as per Fig. 2 'd' using reflected beam.

- 11.8 Butt & Tee weld joints with reinforcement removed shall be examined along the weld & HAZ. The probe shall be swiveled by 10 degrees as shown in Fig.3 'a'. For welds with reinforcement scanning shall be on the side of the weld as shown in fig 3 'b'.

- 11.9 If height of echo signal is below 20% of sorting level scanning is continued. If echo height is equal to or exceeding 20% sorting level characteristics of discontinuity are measured and recorded. Indications above sorting level are unacceptable.

12. Evaluation & Recording

Any imperfection which causes an indication in excess of 20% of DAC shall be recorded with respect to location, response level, dimension, depth below the reference, surface and physically marked. Record indication in a report format (annexure-II) and investigated to the extent that it can be evaluated in terms of relevant acceptance standard. If any repair is to be carried out, it shall be done as per relevant procedure. Removal of defect shall be ensured by capillary control. Whenever possible the removal shall be ensured by Ultrasonic examination. Re- examination of the repaired area shall be done as per the same procedure as used for the original detection of defect. The repaired area shall be marked "R1", "R2", etc.

13. Acceptance Standard

- 13.1 Indication characterized as crack, lack of fusion or incomplete penetration, are unacceptable regardless of length.
- 13.2 Other imperfections are unacceptable if their size, numbers, etc. exceed the limits specified in respective inspection regulation and working documents. Typical acceptance standard for PNAE-G-7-10-89 for

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pipelines of nuclear power plants (welded joints and cladding) is given in Table IV, V & VI. These acceptance standards are based on equivalent areas of individual discontinuities and numbers permitted.

14. Post Examination and Cleaning

After the examination the test surface shall be thoroughly cleaned free from grease, oil, using dry cloth, moistened cloth with acetone. The status of UT examination like UT examination "Satisfactory", "Repair", "Rejected", shall be marked / tagged. The repair and Reject shall be intimated to concerned execution group for necessary action.

Repaired joint shall be monitored and reexamined by the same procedure for a final acceptance.

REFERENCES

This document is based on the following:

1. GOST-14782-86 : Non-Destructive Testing, welded joints, ultrasonic methods
2. PNAE-G-007-30-91: Ultrasonic Testing Part-II – Unified Control Techniques of Part-II welded connections & cladding of Nuclear Power Unit equipment & pipe lines.
3. PNAE-G-7-32-91 Ultrasonic Testing-Austenitic Steel Welded Joints
4. PNAE-G-7-14-89 Ultrasonic Control of Basic Materials Part-I
5. PNAE-G-7-10-89 Equipments & Pipelines of Nuclear Power & Plants welded joints & weld surfacing inspection 2000 – R1 regulations.

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ANNEXURE-II

Ultrasonic Examination Report for Weld Joint

Report No.

Date:

Component Detail:

Joint No.:

Weld Category:

Applicable Procedure No:

Applicable Technique Sheet No:

Control Specification:

Material of Pipe:

Dia of Pipe:

Thickness of Pipe:

Test Date:

Type of joint:

Probe	Make	Type	Frequency

Name of equipment :

Model:

Amplitude Calibration

Ref. Level dB:

Ref. Echo Height:

Sorting level dB:

Sorting Echo Height

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--- Searching Level dB:

--- Surface Condition:

Calibration Range

Couplant

Scanning Technique:

UT Examination:

Data Record of Observations (Enclose sketch)

Area which cannot be examined:

Percentage Examination

Indication Serial No.:

Indication Size:

Defect Depth from Surface:

Distance along Weld from Lo:

Maximum Indication amplitude (% of DAC):

Type of Defect Indication:

Distance between Defects (min.):

Number of Defects for Specified Length of weld (Max. in worst location):

Remarks: Acceptable/Rejected/Repair

UT Examination done by:

Witnessed by:

Evaluated & Certified by:

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Table-I
Selection of IT (Nominal Values)

Thickness of the welded joint mm	Frequency MHz	Input angle at control, deg.	
		By direct beam	By once reflected beam
From 5.5 to 9 inclusive	4-6	70 ⁺⁵	70 ⁺⁵
From 9 to 12 inclusive	4-6	65 ⁺⁵	65 ⁺⁵
From 12 to 20 inclusive	2.5-5	65 ⁺⁵	65 ⁺⁵
From 20 to 40 inclusive	2.5-4	65 ⁺⁵	45 ⁺⁵
From 40 to 60 inclusive	1.8-4	65 ⁺⁵	45 ⁺⁵
From 60 to 100 inclusive	1.8-2.5	60 ⁺⁵ ; 45 ⁺⁵	Not permissible
From 100 to 200 inclusive	1.25-2.25	60 ⁺⁵ ; 45 ⁺⁵	Same
Over 200	1.25-2.25	60 ⁺⁵ ; 45 ⁺⁵	Same

Notes: 1. Welded joints with thickness of 60 mm are controlled by transducer with input angle of 60-65° and more by direct beam only to the depth up to 60 mm.

2. For cladded welded joint with thickness from 20 to 60 mm PT with input angle of 45⁺⁵⁰ is used additionally.

3. The control parameters in the control chart or US production process chart should be indicated clearly. It is not permissible to indicate the ranges of parameter values.

4. To increase the accessibility to control, it is permissible to use extra PTs and other control diagrams.

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Table-II

Selection of direct and SCT-transducers (nominal values)

Thickness of welded joint, mm	Type of transducer	Frequency, MHz
Upto 20 inclusive	Direct SC	4-6
Over 20 to 40 inclusive	Same	2.5-4.0
Over 40 to 60 inclusive	Same	1.8-4.0
Over 60	Direct combined	1.25-2.5

Table-III

Instructions on control for the transverse cracks

Type of welded joint	Scanning surface	Diameter of base element, mm	Thickness of base element, mm	Diagram of control
Butt joint: - without reinforcement - with reinforcement	Surface of the weld Base metal of near the weld zone	300 and more 800 and more	34 and more	Fig.3a Fig. 3b
Tee joint with reinforcement	Control from the side of base element (zone of the weld projection plus 10 mm)	800 and more	34-60	Fig.3a
Control from the side element to be welded (branch pipe)		800 and more ²	60 and more	Fig. 3b

1. In absence of access from the side of base element, examination is conducted from the side of element to be welded.
2. At diameter of element to be welded < 800 mm, examination for transverse defect is not conducted.

Norms of Permissible Individual Discontinuities during Ultrasonic Inspection of Welded Joints of Steels of Pearlitic Class and/or High-Chromium Steels

From 300 to 400, inclusive	25.0			50			10		
From 400 to 600, inclusive	35.0			60			10		

Note: The norms of the equivalent area in the table are given with reference to inspection with the use of a standard flat-bottom reflector. It is permitted to use other kinds of reflectors provided the provisions of GOST 14782-86 with respect to the identify of inspection results are duly observed.

Note: The norms of the equivalent area in the table are given with reference to inspection with the use of a standard flat-bottom reflector. It is permitted to use other kinds of reflectors provided the provisions of GOST 14782-86 with respect to the identify of inspection results are duly observed.

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Table-V

Norms of Permissible Individual Discontinuities in the Zone of fusion between Coated Metal and Base Metal during Inspection of Edges of Parts of Pearlitic Steel class of from High-Chromium Steel buttered with Austenitic Filler Materials.

Rated thickness of buttered edge, mm	Equivalent area of individual discontinuities, mm ²		Permissible number of registered individual discontinuities per any 100 mm of the length of buttered edge, pcs.		
	Minimum registered	Maximum permissible	Category of welded joint		
			I	II	III
Over 10 to 40, inclusive	3.5	7	3	4	5
Over 40 to 60, inclusive	3.5	7	4	5	6
Over 60	3.5	5	5	6	7

Table-VI

Norms of Permissible Individual Discontinuities in the Zone of fusion of the Built-up Metal with Base Metal during Inspection of Anticorrosive Weld Coating.

Rated thickness of weld coated part (article) without account of coating, mm	Equivalent area of individual discontinuities, mm ²		Permissible summary equivalent area of individual discontinuities on any section 200 x 200 mm ² in size
	Minimum registered	Maximum permissible	
Up to 100, inclusive	10	20	75
Over 100 to 300, inclusive	15	30	100
Over 300	20	40	125

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Standard Samples of factory (SSF) –Reference block

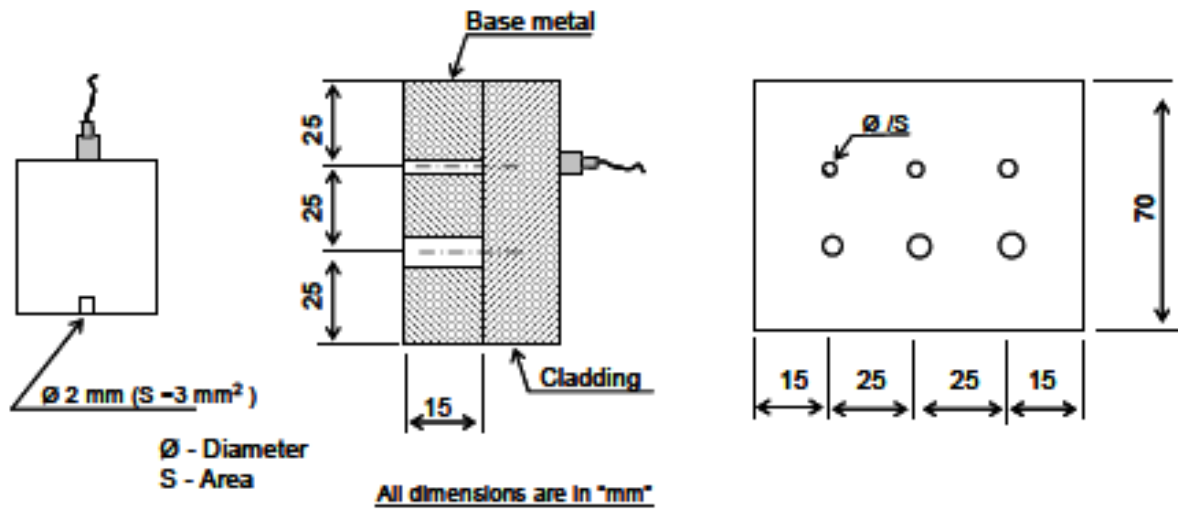
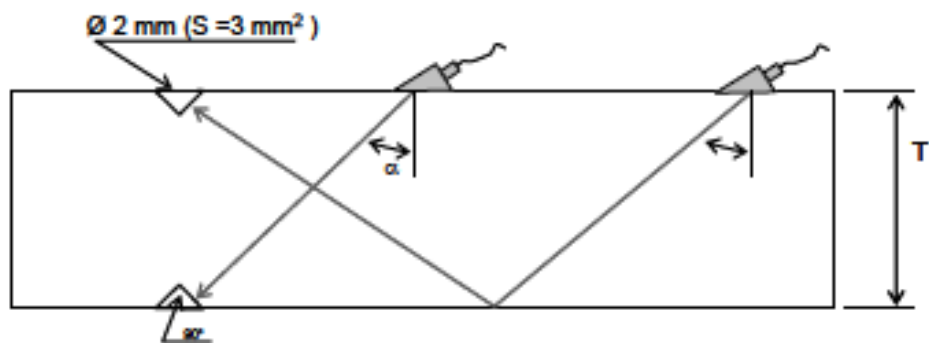


Fig-1(a)

Fig-1(b)



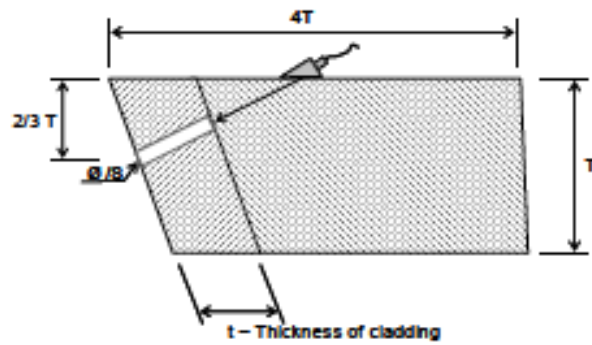
α - Probe angle

T -

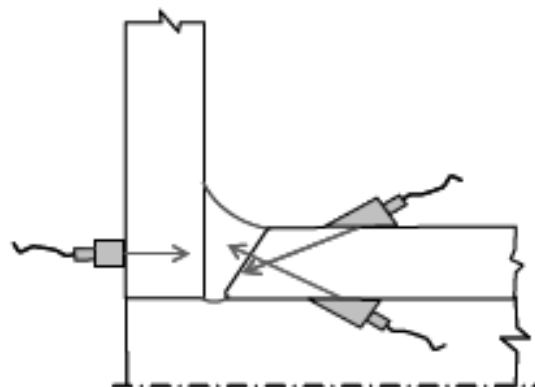
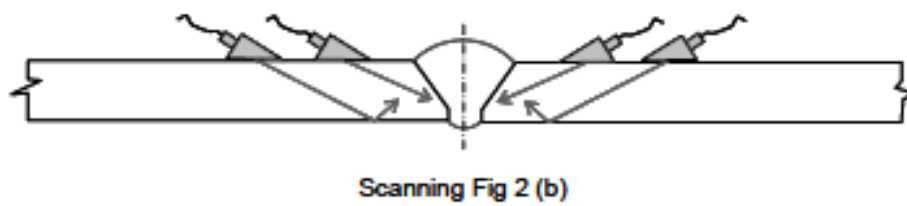
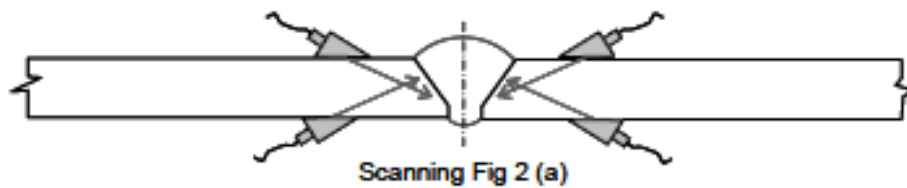
Thickness of weld

- Note – 1) For different angles & thickness different blocks are required
 2) Other types of blocks with necessary corrections can be used

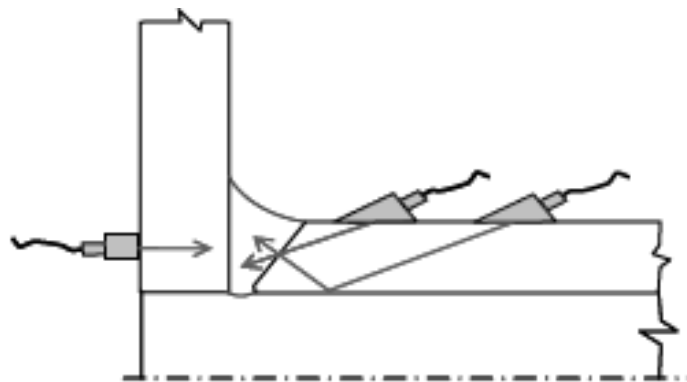
Angle Beam (Weld Examination) – Fig-1(c)



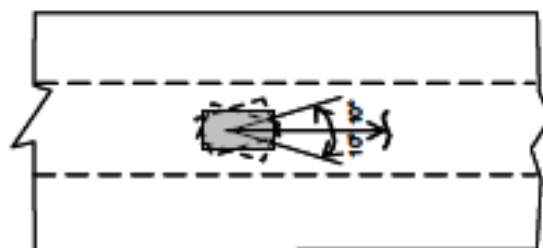
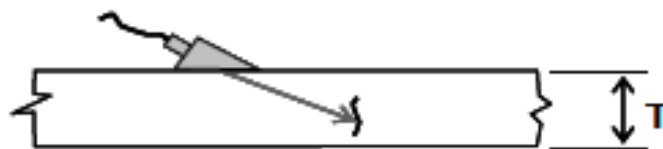
Angle Beam (Cladding Examination) – Fig-1(d)



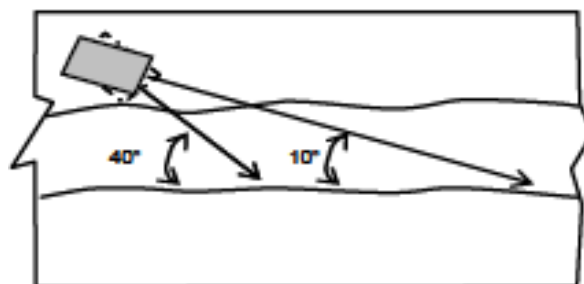
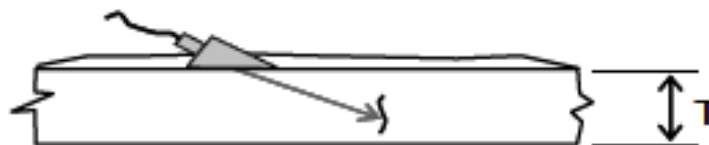
Scanning Fig 2 (c)



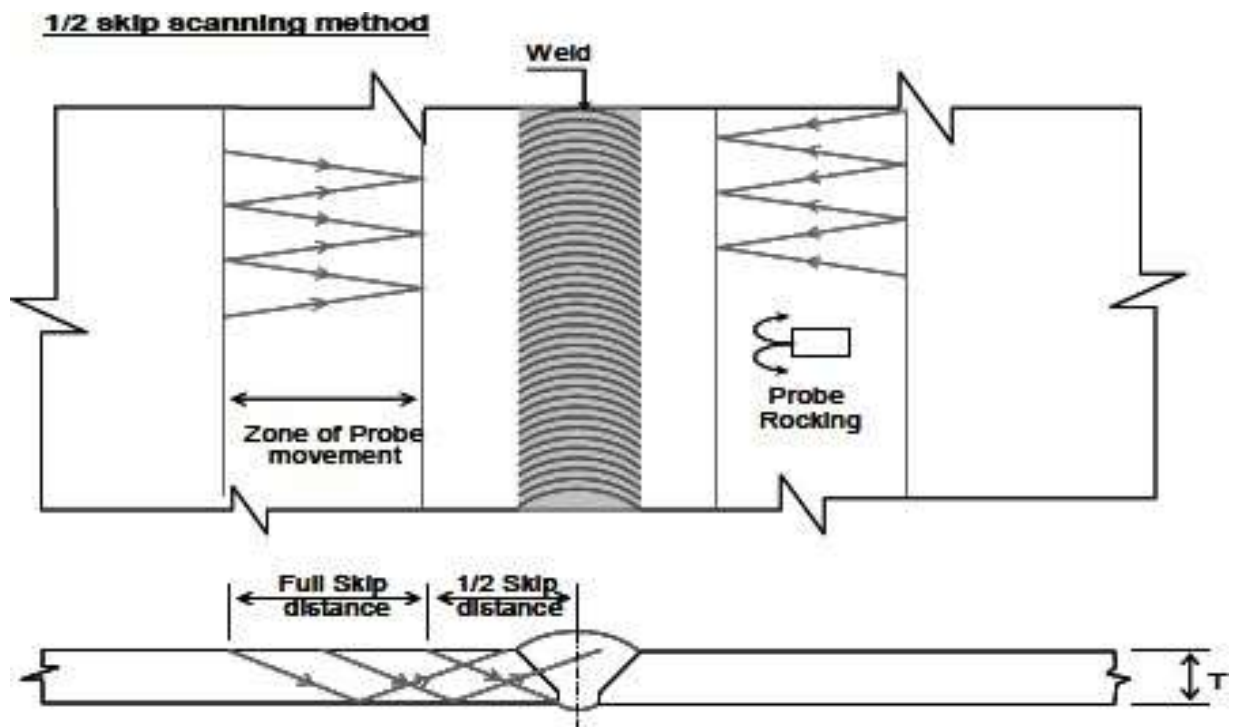
Scanning Fig 2 (d)



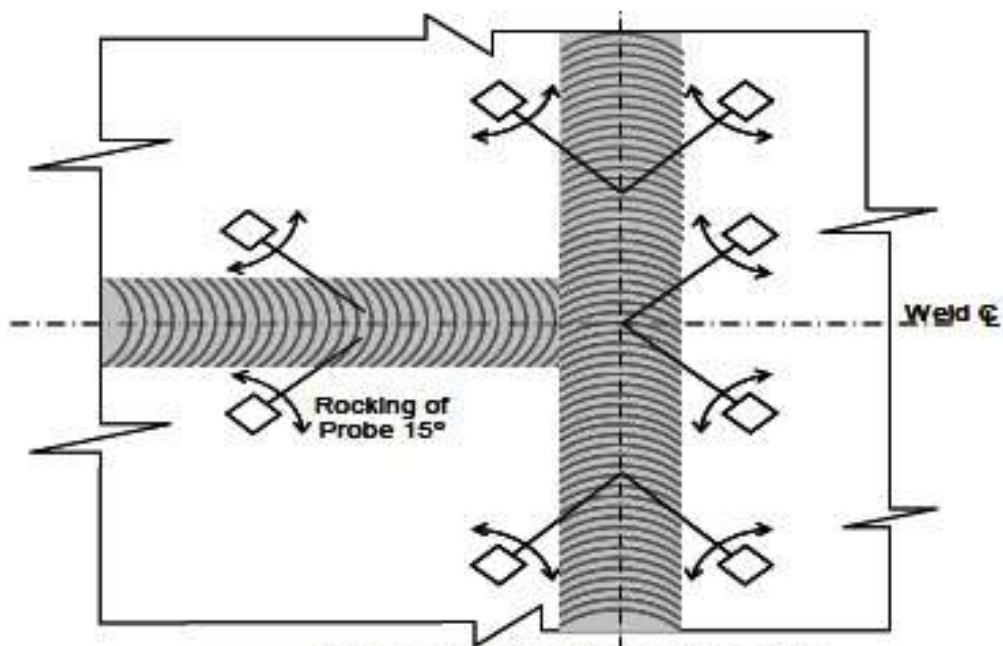
Scanning Fig 3 (a)



Scanning Fig 3 (b)



(a) Scanning for transverse cracks



(b) Scanning for weld intersection

Figure -04

TECHNICAL CONDITIONS OF CONTRACT (TCC)

2.2.32 TECHNICAL SPECIFICATION FOR LPT FOR NIEP ERECTION PACKAGE WORKS

S.No	Description
1	Scope
2	Application
3	Applicable documents and Standards
4	Personnel Qualification
5	PT Materials
6	Examination By LPT (Technique and sequence of operations
6.1	Illumination
6.2	Surface condition
6.3	Penetrant Application
6.4	Excess Penetrant Removal
6.5	Developer Application
6.6	Examination
7	Evaluation of Indications
8	Reporting of PT Results
9	Acceptance Standards
10	Repair of Defects and Reexamination
11	Post Cleaning
Annexures:	
Annexure I	References Documents
Annexure-II	Norms of Permissible Surface Inclusions in Welded Joint and

LIQUID PENETRANT EXAMINATION:

1) SCOPE:

This specification describes the method, technique and acceptance standard for the Liquid penetrant testing of welds of equipments, piping and base materials during construction of KK Nuclear power project.

2) APPLICATION:

This specification is applicable for all the systems of KKNPP and to the surfaces as welded (cladded), clean, dry and free of scale, dust, rust etc. ground or machined having a temperature between 16° to 52°C. This is a general specification, which shall be followed. Based on this specification, the

TECHNICAL CONDITIONS OF CONTRACT (TCC)

contractor shall prepare the detailed procedure and get it approved by KKNPP. However any special requirements in the working documents shall be covered in separate procedures.

3) APPLICABLE DOCUMENTS AND STANDARDS:

Refer list of documents enclosed as annexure- I (i.e References).

4) PERSONNEL QUALIFICATION:

The LPT shall be performed by personnel having minimum ISNT/ASNT (PT Level-I) qualification and for interpretation of the results Level-II qualified manpower (inspectors) shall be deployed. NPCIL shall have the right to ask for requalification of any person who in his opinion is not performing satisfactorily. The PT procedures shall be approved by ISNT / ASNT Level - III qualified personnel.

5) PT MATERIALS:

Only NPCIL approved brands of PT materials (Cleaner, penetrant, developer etc.) shall be used for PT examination. The sulphur and halogen contents of the PT material shall not exceed 25ppm and the flash point shall be more than 60°.

6) EXAMINATION BY LPT(Technique and sequence of operations):

The PT examination shall be conducted by Visible red dye penetrant, solvent removable / water washable and non aqueous wet developer method. If required other methods like fluorescent dye penetrant system may be used.

6.1 Illumination: The area to be examined shall have sufficient natural/artificial illumination. The lighting shall be minimum 350 Lux. The examination shall be carried out by placing the eye within 60 cms of the surface with angle not less than 30° to the surface under examination. Magnifying glasses with magnification around 7 can be used to assist examination.

6.2 Surface condition: Prior to PT examination, the surface shall be visually examined for freedom from cracks, peel off marks, pits, incomplete fusion, under cuts etc. The surface should be free from any dirt, grease, dust, scale, welding slag, weld spatter or any extraneous matter that may interfere with the test. Before PT, visual and measurement inspection of weld shall be completed. The surface shall be pre-cleaned with lint free cloth soaked in acetone or cleaner and then natural evaporation for drying of surface.

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- 6.3 Penetrant Application: The penetrant shall be applied by Swabbing/brushing or spraying. The penetrant shall be allowed to remain on surface for a minimum of 10 minutes. It shall be ensured that the penetrant remains wet during the dwell time.
- 6.4 Excess Penetrant removal: On completion of penetrant time, the excess dye shall be removed by dry cloth followed by lightly soaked lint free cloth with cleaner. Precautions should be taken to avoid over cleaning to avoid sucking up of dye from discontinuities.
- 6.5 Developer application: Developer shall be applied by Aerosol can only (use of handpump is not permitted), immediately after the removal of excess penetrant. A uniform thin layer of developer shall be formed over the surface by keeping the aerosol can at a distance of 150 to 300mm and shall cover a length of about 300mm at a time.
- 6.6 Examination: Minimum of 7 minutes to Max. 20 minutes of development time shall be given and the job shall be observed at the time of application of developer so as to know the nature of the defect, which may develop out. As the developer dries to a smooth and even white coating, red indications will appear at the locations of the discontinuities due to bleeding out of the penetrant.

7) EVALUATION OF INDICATIONS:

The indications, as mechanical discontinuities at the surface will be indicated due to bleeding out of the penetrant. Indications of mechanical discontinuities are called relevant indications.

Localised surface imperfections, which may occur due to poor surface conditions, part geometry etc. are not relevant indications. All indications however shall be regarded as a defect, until the indication is either eliminated by surface conditioning or it is demonstrated to be non-relevant.

- 8) REPORTING OF RESULTS: Records shall be maintained in approved format for PT testing.

The LPT report shall contain but not limited to the following details-

- i. W.O Name/Number and date.
- ii. Equipment/component description.
- iii. Drg. No./Rev No. of the component.

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- iv. LPT procedure No./date
- v. Material spec./weld category/weld identification etc.
- vi. Date and stage of inspection.
- vii. Applicable standard and sensitivity of inspection.
- viii. Surface conditions/temperature.
- ix. Make /brand of LPT materials with expiry date.
- x. Name/Qualification of the operator/examiner.
- xi. Acceptance standards.
- xii. Evaluation results/remarks.
- xiii. Signatures of accepting/approving authority.

9) ACCEPTANCE STANDARDS: The acceptance standards shall be as per Working drawings and applicable standards. Acceptance standards as per Russian specification PNAE-G-007-10-89 (Table-7, Cl. 11.2) are given below as indicative .

- i. Indications of defects like cracks, non fusion, incomplete penetration, undercuts as revealed by LPT are unacceptable.
- ii. rounded indications below 0.6mm are acceptable regardless of thickness.
- iii. upto four indications of max. 3mm size rounded are acceptable in anticorrosive coatings in 100mmx100mm area.
- iv. Maximum Five inclusions(size max. 3mm) are acceptable in 25 sq. cm of weld overlays.
- v. Refer Table (enclosed as annexure-II) for acceptance standards for different category of weld joints.

10)REPAIR OF DEFECTS AND RE EXAMINATION: Unacceptable defects shall be removed and re-examined to assure the complete removal of the defects. The defect shall be merged into the surrounding surface, if no further welding of the area is required. Completed repair area are also to be re-examined.

11)POST CLEANING: After the completion of the LPT, the examined area shall be cleaned thoroughly by dry cloth followed by moistened(with cleaner) cloth.

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ANNEXURE - I

Reference documents:

- i) PNAE-G-007-018-89 : Unified control techniques of basic materials(Semifinished products) welded connections and claddings of Nuclear plant unit equipments and pipelines -Capillary control.
- ii) PNAE-G-007-010-89 : Equipments & Pipelines of Nuclear Power Plants welded joints & weld surfacing inspection regulations.

ANNEXURE-II

Table . Norms of Permissible Surface Inclusions in Welded Joint and Buttered Edges
(For LP Examination)

Rated Thickness of welded (weld coated) parts, mm	Permissible maximum size of inclusion (Rounded/Elongated) in welded joints (weld surfacing) of categories, mm					Maximum permissible number of inclusions on any 100 mm of the length of welded joint (coating) of categories				
	I _H	II _H	I	II	III	I _H	II _H	I	II	III
Up to 2 inclusive	-	-	-	-	0.9	-	-	-	-	2
Over 2 to 3 inclusive	-	-	-	0.9	1.2	-	-	-	2	3
Over 3 to 4 inclusive	-	-	0.9	1.2	1.5	-	-	2	3	4
Over 4 to 5 inclusive	-	0.9	1.2	1.5	1.8	-	2	2	3	4
Over 5 to 6 inclusive	0.9	1.2	1.5	1.8	2.4	2	2	2	3	4
Over 6 to 8 inclusive	1.2	1.8	2.4	2.4	3.0	2	2	3	4	5
Over 8 to 10 inclusive	1.5	1.8	2.4	3.0	3.6	2	3	3	4	5
Over 10 to 15 inclusive	1.8	2.4	3.0	3.6	4.5	3	3	3	4	5
Over 15 to 20 inclusive	2.4	3.0	3.6	4.5	6.0	3	3	4	5	6
Over 20 to 40 inclusive	3.0	3.6	4.5	6.0	6.0	3	4	4	5	6
Over 40 to 100 inclusive	3.6	4.5	4.5	6.0	7.5	4	4	5	6	7
Over 100 to 200 inclusive	4.5	4.5	4.5	6.0	7.5	4	5	6	7	8
Over 200	4.5	4.5	4.5	6.0	7.5	5	6	7	8	9

Notes. 1. Indication of Inclusions of maximum size up to 0.6 mm are disregarded irrespective of the rated thickness of welded (weld coated) parts both when counting the number of individual inclusions and when considering the distance between inclusions.

2. Any combination of inclusions (individual clusters, group of inclusions), which may be inscribed into a square with a side size not exceeding the maximum permissible size of an individual inclusion, may be considered as a single solid inclusion.

Note: i) This table has been reproduced from Table:7 of PNAE-G-7-10-89 with appropriate multiplication by a factor 3.

ii) Weld joint category I, II, III, I_H & II_H are as per PNAE – G – 7 – 010 – 89 and details are also mentioned in Welding Specification.

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2.2.33 TECHNICAL SPECIFICATION FOR WELDING FOR NIEP ERECTION PACKAGE WORKS

S.No	Description
1.	Scope
2.	Welding processes
3.	Welding procedure
4.	Qualification and performance records of welders
5.	General welding requirement
6.	Welding of clad materials
7.	Joint preparation
8.	Fit up
9.	Weld profile
10.	Welding of structural attachments, hangers and supports
11.	Tack welds
12.	Repairs
13.	Seal welds
14.	Shielding and backing gases
15.	Heat treatment of welds
16.	Welding of GI pipes
17.	Examination methods and requirements
18.	References

1. SCOPE

This specification describes the requirements concerning welding of piping and equipments for the Kudankulam Nuclear Power Plant. It is applicable to shop welding and field erection welding for piping. This specification provides general requirement as guidelines, however the work will be carried based on detail requirement specified in the working documentation, manufacturer's documents. In case of any conflict in the requirement specified in the specification, the requirement specified in the working document and Russian standards will govern.

2. WELDING PROCESSES:

2.1 Following welding methods may be used for making welded joints in equipment's and pipelines.

- Automatic submerged arc welding (SAW)
- Manual arc welding with covered electrodes (SMAW)

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- Automatic, semiautomatic and manual arc welding (GTAW, GMAW, MIG)

2.2 Two or more welding methods of those specified above can be used for making the welded joint (combination welding)

3. WELDING PROCEDURE

3.1 A Welding Procedure Specification (WPS) (Welding Technology) is a written document that provides direction to the welder for making production welds.

The procedure should specify following minimum variables

- Welding methods
- Qualification of welders
- Types of welded joints to be performed
- Type and polarity of welding current
- Welding equipment to be used
- Combination of grades of basic and welding materials
- Necessity, methods and conditions of preliminary and accompanying heat up in welding
- Space positions of welding
- Range of filler materials
- Procedure of putting in runs and layers of seam and beads (whenever required)
- Types of thermal treatment of welded joints and built up of metal parts
- Conditions of welded joints from completion of welding till the start of thermal treatment

The WPS shall make reference to the supporting Procedure Qualification Record(s) (PQR). The contractor may include any other information in the WPS that may be helpful in making a weldment. Enclosed sample form-A has been provided as guide for the WPS

3.2 Procedure Qualification Record (PQR)/ (Welding Technology Certificate)

Each manufacturer or contractor shall be required to prepare a procedure qualification record, which is defined as follows:

A PQR is a record of the welding data used to weld a test coupon. The PQR is a record of variables recorded during welding of the test coupons. It also contains the test results of the tested specimens. Recorded variables normally fall

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within a small range of the actual variables that will be used in production welding.

Enclosed form-B has been provided as guide for the PQR. Also the type of tests, number of tests, and test results shall be listed in the PQR.

For welding technology certification (PQR) requirements of destructive and non-destructive testing as specified in the working documents is the basis.

Order of removal of specimen is also mentioned. The length of welded joint (Test Coupon) shall be sufficient to take required number of specimen.

The weld joint (test coupon) can be made in down hand position. When outside diameter of the production joint exceed 500 mm, it is permitted to make test on plate.

3.3 Methods of determining dimensions of specimens, requirements and conditions for execution of test and calculation of results for Static Tensile Test (refer GOST 1497-73) and for Impact Bending Test (refer GOST 9454-78) and GOST 6996-66 shall be used if specified unless otherwise specified in the documents.

3.3.1 Quantity of specimens intended for mechanical tests shall not be less than two for tests at each temperature.

3.3.2 If results of mechanical tests of any type are unsatisfactory, then retests shall be allowed with specimens of doubled number. Results of retests shall be final.

3.3.3 When there are special requirements of the design documentation, mechanical properties of cladding material of austenitic steel shall be defined where they are intended for a structure which is after welding will be heat treated.

3.4 Metallographic Analysis

3.4.1 The quality of welded joints subjected to Metallographic analysis should be considered satisfactory if the following conditions are concurrently satisfied;

- The macrosection has no cracks and incomplete penetrations

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- The maximum dimensions of any inclusions and clusters do not exceed the maximum permissible size specified PNAEG-7-10-89 (refer Table-19)
- The distance between any two inclusions and clusters is at least three times the maximum size of any one of two considered inclusions or clusters.

The sum of the maximum sizes of inclusions and clusters discovered on the macrosection does not exceed three times the largest permissible size of an individual inclusion specified in PNAEG-7-10-89 (table 19- Norms of Individual Inclusions and Clusters Permissible in Welded joints during Metallographic analysis) for the corresponding rated thickness of the welded parts, the inclusions and clusters with the maximum size up to 0.2 mm should be disregarded.

3.5 Intercrystalline Corrosion Test

Corrosion-resistant steels and alloys including two-layer ones, welded joints, deposited metal and weld metal made using austenitic welding materials shall be subject to intercrystalline corrosion test.

Intercrystalline corrosion test is performed by "AM" or "AMU" methods (refer GOST 6032-84)

3.5.1 AM Method

Principal of the method: Steel samples should be kept in boiling aqueous solution of copper sulphate and sulphuric acid in presence of metal copper

- 3.5.1.1 Solution for test: Copper Sulphate (130.0 ± 0.1) g in weight should be added to water of volume (1000 ± 3) cm³ and then sulphuric acid of (120 ± 3) cm³ volume is added by small portions.
- 3.5.1.2 Holding in the boiling solution shall last for (24.00 ± 0.25) h. In case of forced termination of test the specimens are not withdrawn out of the solution. Duration of test is calculated as total number of boiling test hours.
- 3.5.1.3 After holding in solution the specimens shall be washed and dried.
- 3.5.1.4 To detect intercrystalline corrosion the specimens shall be bent for an angle of (90 ± 3)° upon completion of holding.
- 3.5.1.5 Examination of the bent specimens is performed by means of magnifier with a magnification of 8-12 power.
- 3.5.1.6 When the test specimens are broken at bending or the cracks are detected after bending except for the longitudinal ones and the cracks directly on the edges, and also if on the specimens with thickness less than 0.1 mm the

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bend does not reveal intercrystalline corrosion or specimen bending is not possible (because of its dimensions), then resistance to intercrystalline corrosion of the specimens having passed the tests in solution shall be evaluated by metallographic method.

- 3.5.1.7 Presence and depth of intercrystalline corrosion using the metallographic method are defined on the etched metallographic specimens with magnification of at least 200 power. Etching is carried out only till the grain boundaries are slightly revealed. The metallographic specimen is examined from a side of the controlled surface to define maximum depth of failure revealed in six fields of vision. These fields of vision shall include the sections with the highest depth of intercrystalline corrosion.
- 3.5.1.8 A sign of resistance to intercrystalline corrosion during metallographic examination is considered to be failure of the grain boundaries for the maximum depth of not more than 30 μm unless otherwise specified in the standards for metal products; in the metal product specimens with thickness less than 1.5 mm – for the depth of not more than 10 μm .

3.5.2 AMU Method

This method consists in holding the steel specimens in the boiling aqueous solution of copper sulphate and sulphuric acid of increased concentration as compared to the “AM” method in presence of metallic copper. The method is an accelerated one and is applied for the same steels as the “AM” method.

- 3.5.2.1 Solution for testing: In water of (1000 ± 3) cm^3 volume one shall dissolve copper sulphate of (50.0 ± 0.1) g and then sulphuric acid of (250 ± 3) cm^3 shall be added by large portions.
- 3.5.2.2 Holding in solution lasts for (8.00 ± 0.25) h.
- 3.5.2.3 Intercrystalline corrosion is detected in the same way as specified above.

3.6 Determination of the Content of ferrite phase in built up metal

The content of ferritic phase in the built-up metal should be within 2 to 8% in the welded joints of structures that operate at temperatures up to 350 deg. C and 2 to 5% for structures operating at temperatures above 350 deg. C, but in all cases, it should not exceed the upper limit established in the standards or specifications covering the corresponding filler.

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4. REQUIREMENT ON QUALIFICATION AND PERFORMANCE RECORDS OF WELDERS

4.1 The welders are certified by testing their theoretical knowledge and practical skills. The theoretical knowledge of welder shall be assessed by the certification committee. The practical skills of the welders are checked by making test weld joints. Welders who have successfully meet the above mentioned requirements are granted permit certificates allowing them to perform corresponding welding operations by the committee.

4.2 The welding operations are subdivided into the following types used in certification testing of the welders

- Welded joints making (including groove facing for welding i.e. welding/buttering of groove joint)
- Welding of pipes into pipe grids
- Corrosion-preventive facing (cladding)

4.3 When testing the practical skills of the welder, he has to make test welded joints with following instructions

- The test length of a seam should not be less than 200 mm with manual and semiautomatic welding on plates and not less than 400 mm with automatic welding
- The number of test welded joints in welding pipes is to be established according to the nominal outside diameter of the pipes as given below
 1. Diameter below 25 mm – minimum 5 test joints
 2. Diameter 25 to 100 mm – minimum 2 test joints
 3. Diameter above 100 mm – minimum 1 test joint
- The number of pipes in welding into pipe grids (Tube to Tube sheet weld) should not be less than 7 with one of the pipes in the central position with reference to the rest of them
- The gauge of plates in making test specimens for cladding of the corrosion preventive material should not be less than 40 mm.

4.4 Welded joints made by welders shall be tested using the following methods

- Visual
- Measuring
- Radiographic (except for test welded joints of pipe grids)

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- Ultrasonic (except for test welded joints of parts with a nominal wall thickness up to 5.5 mm)
- Magnetic powder or capillary (except for test welded joints of the III category)

4.5 In performing certification testing, the following characteristics of the welded joints should be provided

- Category of welding (the details of welding categories are given in section 5.16)
- Group of main welding materials. Certification testing should be carried out separately for each of the group of materials mentioned in following table.

Group of main welding materials is given in following table

Group No	Types and characteristics of materials
1	Pearlitic steel with limited yield at normal temperatures up to 315 MPa requiring no heating up in the welding
2	Pearlitic steel with limited yield at normal temperatures up to 315 MPa requiring heating up in the welding
3	Pearlitic steel with limited yield at normal temperatures above 315
4	High alloy chrome martensitic and martensitic-ferritic steel
5	High alloy chrome ferritic steels
6	High alloy corrosion resistant austenitic steels
7	Nickel based and ferronickel base alloys
8	Aluminium and its alloys
9	Copper and copper based alloys
10	Zirconium and its alloys
11	Titanium and its alloys

- Type and dimensions of welding parts (refer PNAE-G-7-009-89. appendix-3, Basic Types of welded Joints)
- Welding positions

There are 14 welding positions as follows:

- Bottom (downhand) position
- Horizontal position
- Vertical position upward
- Ceiling (unsupported) overhead position

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- Bottom (downhand) position with horizontal axis of pipes to be welded with turning
- Horizontal position with vertical axis of pipes to be welded
- Changing position with horizontal axis of pipes to be welded without turning
- Gravity position
- Vertical position upward
- Ceiling (unsupported) position
- Bottom (downhand) position with horizontal axis of a pipe to be welded with turning
- Bottom (downhand) position with vertical axis of a pipe to be welded
- Changing position with horizontal axis of a pipe to be welded without turning

4.6 Certification testing should be conducted separately for each category of the welded joints (I, II, III) in accordance with the Russian specifications.

4.7 Certification testing in pipe welding is to be conducted separately for the following pipe diameters: below 25 mm, above 25 and up to 100 mm, above 100 mm to 500 mm. Parts above 500 mm are equated to plates.

4.8 Welder certification testing could be divided into primary, additional, periodic and special. The primary certification is meant for welder who have not been allowed before to conduct welding or facing operations on the equipment or pipelines.

The additional certification is meant for welder who have passed the primary certification but who need a permit to conduct welding operation not shown in their certificates. It is also meant for welders who have more than 6 months break in their experience in conducting welding operations.

The periodic certification is meant for welder in order to extend the validity term of their certificates and to make out the permits to work. It is to be carried out every two years.

The special certification is meant for welders who have been temporarily debarred from work for violations in welding operation technology or for recurring bad quality of welding operations conducted by the welders.

4.9 Permit certificates to make welded joints of the category I cover permits to make welded joints of the II and III categories as well. (Contractor may choose to qualify welder in higher category).

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4.10 The welded joints and surface parts should be adequately marked, thus making it possible to identify the name of the welder responsible for performing the welding operation. The stamps of all welders participating in the welding operation should be applied on each welded joint. In this case, in front of the stamp of welder responsible for buttering operation, additional stamp "B" should be applied, whereas in the front of the stamp of the welder responsible for the root weld, additional stamp "R" should be applied. In case welded joint is made all over the section by the same welder, the above specified additional stamps need not be applied.

5. GENERAL WELDING REQUIREMENT

5.1 Before the beginning of the welding, following points should be checked:

- Availability of a procedure and qualification record of the operator to perform the work in hand
- Availability of markings and/or of record of fit up clearance of the weld confirming the compliance of the assembly with the established requirements
- Cleanliness (absence of visible dirt, dust, rust, oil, etc) of edges and adjoining surfaces to be welded and of the sections of base metal subject to nondestructive inspection
- Grades and nomenclature of welding materials used
- Baking of coated electrodes and fluxes or correspondence of moisture content of fluxes and electrode coating to the established requirements
- Availability of the shielding gas supply
- Temperature of preheating
- Sequence of application of beads and layers

5.2 Storage of Electrodes

After baking, the covered electrodes and fluxes should be stored in closed bags made of waterproof cloth (polyethylene film) or in closed containers with a rubber sealed cover or in a drying chambers at a temperature of $80 \pm 20^{\circ}\text{C}$ or in a stored room at room temperature and relative humidity of 50% nominal.

In storage after baking in store rooms as specified in above para, the covered electrodes and fluxes can be used without moisture content check and repeated baking within terms specified in the working document and terms being specified shall not exceed:

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- 5 days for electrodes with basic coating intended for pearlitic and high chromium steels
- 15 days for remaining electrodes
- 3 days for the fluxes, (Russian grades)
- 15 days for fluxes of other grades

If the storage conditions specified in above section 5.2 is not met, then electrodes and fluxes should be checked for moisture content or should be baked prior to using it.

5.3 The root section of the seam of welded joints of I category of parts made from iron nickel alloys at a rated wall thickness at the point of welding exceeding 6 mm and from steel at a rated wall thickness at the points of welding exceeding 20 mm should be subjected to radiographic control.

5.4 In the butt weld connections of components with different thickness, gradient junction from big to the small section shall be ensured by means of appropriate one side / two sides mechanical treatment of the end of element having more thickness. Inclination angle of transitions surfaces shall not exceed 15°

5.5 In case of difference of wall thickness less than 30% from the wall thickness of the thinner element but no more than 5 mm, it is allowed to make the specified gradient junction from the side of edge opening due to inclined location of the weld surface.

5.6 Distance from the transverse weld joint of the pipeline to the edge of the support or suspension bracket shall be selected on the assumption of possible examination, inspection and heat treatment.

5.7 All pipelines welded connections (including welds of the components to be welded) shall be located in the way to ensure possibility to inspect them by methods stipulated by standards for the goods.

5.8 Angle butt welds for which tightness requirement are specified in the drawing should be made in at least two layers

5.9 With two side welding, partial or complete removal of the root portion of the made weld is allowed before starting welding on the other side

5.10 In carry out the multiple passes of welded joints of the parts made of austenitic steels and iron-nickel alloys, welding should be stopped after each pass until metal cools down in the zone of welding restoration to a temperature not exceeding 100°C

TECHNICAL CONDITIONS OF CONTRACT (TCC)

5.11 The root portion of welded, joints of parts made of steels grade 08x18Hx12T and also pipe made of carbon steels with a rated thickness of wall exceeding 12 mm are recommended to be welded with the use of filler wire

5.12 Manual arc welding with covered electrodes and rods made of austenitic steels should be made of narrow passes with width not exceeding three times the diameters of used electrode

5.13 When welding butt joints, full penetration should be ensured (welded joints with backing plates remained including the ring spacers are considered to be joints with full penetration.

5.14 It is not allowed to manufacture welded pipes and shells with the nominal outer diameter of up to 920 mm with the longitudinal joints if they consist of three or more sectors. When manufacturing pipes and shells consisting of two sectors, the central angle of the small sector α should not be less than 90°

5.15 It is allowed to manufacture the welded pipes and shells with nominal diameter more than 920 mm of 3 sectors and central angle of the small sector α should not be less than 90°

5.16 Categories of Welded Joints

The welded joints for equipment and pipelines of Nuclear Power Plants are divided in to following categories. Quality of weld and extent of NDE coverage are based on category of welds.

- Category I
- Category II
- Category III

Categories II and III are further subdivided into following subcategories

- Sub-category IIa
- Sub-category IIb
- Sub-category IIIa
- Sub-category IIIb
- Sub-category IIIc

6. WELDING OF CLADDED MATERIALS

6.1 In preparing for welding parts made of two layer steels, the cladding layer on sections adjoining the edges to be welded (on the side of their opening), and also in areas of making angular welds should be removed.

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- 6.2 The width of the cladding layer removal zone should be at least 5 mm in manual arc welding with covered electrodes and argon- arc welding.
- 6.3 For angular and T joints, the cladding layer removal zone should go beyond the angular weld limits by at least the specified width values.
- 6.4 For welded joints whose base layer is made pearlitic steels is subjected to ultrasonic and/or radiographic examination before the cladding layer is applied, the width of cladding layer removal zone should be such as to make provision for the specified examination.
- 6.5 In making welded joints with removal of the cladding layer, the first welding is of base layer made of pearlitic steel and then welding of the cladding layer.
- 6.6 The base layer should be welded with the use of welding materials intended for welding of parts made of base layer steel parts.
- 6.7 Welding of cladding layer comprises performance of grooving and protective weld cladding (refer sketch in annexure-5).
- 6.8 The protective and grooving weld surfacing with the aid of arc welding with covered electrodes should be in separate lengthwise beads at a width not exceeding three diameters of used electrode rod. In case specified in the working documents, the grooving weld surfacing beads width is allowed to be increased up to four diameters of electrode rod.

7. JOINT PREPARATION

- 7.1 The edges surface of the parts of welding should be prepared by mechanical treatment (Machining, Grinding).
- 7.2 The edges of the parts made of carbon and silico-manganese pearlitic steels are allowed to be prepared by oxygen, air arc or plasma arc cutting with subsequent mechanical treatment until the traces of cutting are removed (1.5 mm minimum)
- 7.3 When it is required to prevent the development of the cracks, cutting should be made by preliminary heating of the metal as specified in the production process documentation.
- 7.4 The shape and structural elements of part edges prepared for welding shall meet the requirements of these guidelines or drawing

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8. FIT-UP

8.1 All weld joint fit up shall comply with the tolerances specified in the drawings.

8.2 Before fit up of the weld joint, the profile and dimensions of the weld end preparation should be checked. If the specified tolerances are exceeded, this shall be corrected by grinding, machining.

8.3 Fit-ups should be examined prior to welding the root pass

9. WELD PROFILE

9.1 The weld metal reinforcement shall not exceed the limits specified in respective standards.

9.2 The misalignment of faces of the parts assembled for arc welding with two side preparation of edges should not exceed 0.5mm at their rated section up to 1mm inclusive, half the rated size of the faces at its value above 1 up to 4 mm inclusive and 2 mm at a rated size of faces exceeding 4 mm.

9.3 The dimension of convexity of the weld root during one-sided welding of pipes without backing rings and the fusion of the edges and backing ring in the course of welding should meet the requirement specified

10. WELDING OF STRUCTURAL ATTCHMENTS, HANGERS AND SUPPORTS

10.1 The welded joint should normally be located outside the supports

The supports may be located over the welded joints provided the following requirements are simultaneously met with

- Construction and location of the supports make it possible to inspect during operation a welded joint arranged under the support .
- When manufacturing or mounting the equipment, the welded joints should be subjected to the ultrasonic or radiographic test and section of the welded joint located under the support by the magnetic powder or capillary test

10.2 The welded pipe branches should meet the following requirement

- No circumferential welded joints can be made on the branches with the longitudinal joint within the curvilinear section

10.3 When welding the plates intended for supports and hangers to the pipeline consisting pipes with the spiral joints, the distance between the edge of the corner joint used to weld the plate and end of the butt spiral joint of the pipe should not be less than three nominal thickness values of the pipe wall

TECHNICAL CONDITIONS OF CONTRACT (TCC)

11. TACK WELD

- 11.1 All tack welds shall be made using qualified procedure and qualified welders. Any preheat requirements specified in the welding procedure shall also be apply to tack welds.
- 11.2 The number and size of tack welds shall be kept as small as is consistent with adequate strength and joint alignment.
- 11.3 As the welding proceeds, tack welds shall be either removed completely or shall be properly prepared by grinding or fitting their stopping and starting ends so that they may be satisfactorily incorporated into the final weld

12. REPAIRS

- 12.1 All defects detected in welded joints and surface articles during their nondestructive examination should be subjected to correction.
- 12.2 The surface defects should be corrected mechanically with provision for continuous transition in the areas of the grooves (by abrasive tools, cutting, or chipping with subsequent grinding).
- 12.3 Correction of surface defects without subsequent welding is allowed on following welded joints
- On welded joints with permanent thickness of the weld and base metal at the area of maximum depth of the groove should not be less than 75% of it rated thickness
- 12.4 The defects resulting from welding up of grooves in welded joints made by the arc welding and subject to thermal treatment, should be corrected after tempering of the welded joint (pretempering, intermediate, or final tempering) Defects are allowed to be corrected before the welded joints are tempered, if they are allowed to be cooled down to room temperature after termination of welding
- 12.5 The internal defects (defective areas) should be corrected mechanically (by abrasives tool, cutting, or chipping with subsequent grinding).
- 12.6 In correcting defects in the course of carrying out welded joints, the following requirement should be met
- In detecting cracks, welding should be stopped and only after removal of the cracks, rewelding may be started by taking measures that could prevent their origination

TECHNICAL CONDITIONS OF CONTRACT (TCC)

- In detecting burns of the backing ring, the pipe welded joints inaccessible for welding on the inner side should be completely removed and made new (if it is possible to correct the defect without cutting)
- The number of corrections of the weld root on the same section should not exceed three

13. SEAL WELDS

- 13.1 Seal welding shall be done by qualified welders and in accordance with approved procedure.
- 13.2 Threaded joints that are to be seal welded shall be made without the use of a thread lubricating compound.
- 13.3 Seal welds should not be considered as contributing to the strength of the joints. Backing off to correct misalignment of screw connections is not permitted.
- 13.4 The threads for making the joint shall be adequately prepared by grinding and circumferentially covered by seal weld. The surface of the seal weld shall merge smoothly into the parent metal surface and shall be suitable for the proper interpretation of non destructive examination of the weld.

The details of welding wire, covered electrodes, flux used in different class of steel is given in Annexure 1

14. SHIELDING AND BACKING GAS

The rate of flow of gas (The purity of Argon gas should be 99.9%) for shielding purposes is given in annexure 2

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15. HEAT TREATMENT OF WELDS:

- 15.1 The erection of equipments and pipelines supplied from Russian federation may require welding, preheating and post weld heat treatment at site.
- 15.2 Procedures for welding of similar materials (i.e. alloy steel to alloy steel), building of austenitic SS on alloy steel and welding of branch connections/supports etc on equipments shall be made and approved taking into account the requirement specified in Russian specification for welding these items. For welding, building up, preheating and PWHT of these alloys, the requirement of RTD 2730.300.02.91 and PNAE-G-09-89 shall be followed. The thermocouples and recorders should be calibrated and record chart shall be provided.
- 15.3 Upto 12 mm of CS plates/flats can be welded to any thickness of 10GN2MφA steel without preheating if it is followed by PWHT.
- 15.4 The preheat and additional heating of the parts to be welded should be heated with the aid of electric, gas or other heating devices that provides the required heat up of weld joint.
- 15.5 The minimum temperature of preheating in welding parts depending on the steel grade and thickness of the parts to be welded as given in the table (refer annexure- 3).
- 15.6 Maximum temperature of heating should not exceed the specified minimum temperature by more than 150°C.
- 15.7 when welding parts featuring different thickness, minimum temperature is specified in the working document and when this temperature is not specified in the working document, then refers the annexure 1/3 for the rated thickness of the wall.
- 15.8 Welding of the parts made of carbon and silico-manganese steels with anticorrosion cladding is performed with no heating.
- 15.9 When depositing an anticorrosion coating on parts made of the alloyed steels, the minimum temperature of heating is defined depending on the grade of the steel and thickness of the parts being faced as specified in the annexure 2/3.
- 15.10 The need for and type of thermal treatment to be performed on welded joints and faced articles are specified in compliance with the requirements of these guidelines and specified in the drawings.

TECHNICAL CONDITIONS OF CONTRACT (TCC)

- 15.11 If no thermal recovery is specified, the welded joints should be kept under conditions during the time interval between end of welding and start of thermal treatment (refer annexure 3/3).
- 15.12 Minimum temperature and duration of thermal recovery are given in table 14 (refer annexure 3/3)
Maximum temperature of thermal recovery should not exceed the 100°C of minimum temperature mentioned in an annexure 3/3
- 15.13 The temperature of the furnace, when loading the welded article therein for thermal treatment, should not be more than 300°C the temperature of the metal subject to thermal treatment.
- 15.14 In performing precladding of edges of parts made of pearlitic steels and high chromium steels with austenitic filler materials, heating is effected in cladding the first layer only. For the necessity and minimum temperature of the specified heating, refer to annexure 1/3.
- 15.15 Parts made of pearlitic steels and high chromium steels (whose edges are preliminary cladded with austenitic filler materials) are welded (between themselves and also with parts made of austenitic steels) with no heating.
- 15.16 In carrying out precladding of edges of parts made of pearlitic class with high chromium filler materials, the minimum heating temperature should not below 100°C.

16. WELDING OF GI PIPES

- 16.1 The joint design, welding and inspection shall be as specified for non galvanized pipes mentioned in this specification.
- 16.2 Joints must be thoroughly cleaned immediately prior to welding to remove all oxides, paints, oil, grease, dust, etc. Zinc coating shall be removed prior to welding.

17. EXAMINATION METHODS AND REQUIREMENTS

Nondestructive inspection of the quality of welded joints and coated metal should be performed by the methods prescribed in working documents.

- With regard to the scope of inspections, the nondestructive inspection is subdivided into 100% inspection and selective inspection (scope 50,25,15,10 or 5%)

TECHNICAL CONDITIONS OF CONTRACT (TCC)

- If welded joint is subject to mandatory radiographic and ultrasonic inspection, the radiographic inspection may be performed before thermal treatment with mandatory 100% ultrasonic inspection after thermal treatment
- The 100% inspection should be carried over the entire length of each welded joint of the coated surface
- Selective inspection of individual areas is prescribed for circular welded joints of parts with rated outside diameter over 250 mm
- If any defects are discovered during the selective inspection by any method, additional inspection should be carried out by the same method in twice the original scope (in case of a 50% selective inspection, it is necessary to carry out 100% inspection)
- The sensitivities of the used inspection methods should be sufficient for discovering the discontinuities
- The inspected zone should include the entire volume of the weld metal and the adjoining areas of the base metal on both side of the weld
- The inspected zone for butt welds made by arc welding, width of weld should not be less than 5 mm at thickness of the 5 mm inclusive and not less than 20 mm at a rated thickness of the welded parts above 20 mm
- If the welded joint is accessible for visual inspection on both sides, these joints should be examined both from internal and external sides
- The radiographic inspection of corner, Tee, edge and overlap welded joints should be undertaken only in the case when the summery radiation thickness of the material inspected does not exceed 100 mm
- If the welded joint has to be subjected to selective radiographic and ultrasonic inspection, but the later is technically impossible, the scope of radiographic inspection should be doubled
- The quality of Tack welds should be inspected visually, while their dimension and layout are checked by measurement

Methods and scope of Nondestructive inspection of welds of parts made of pearlitic class and high chromium steels is given in Annexure 4

TECHNICAL CONDITIONS OF CONTRACT (TCC)

18. REFERENCES

- Regulation for Design and safe operation of the atomic power plant equipment and pipelines - PNAEG-7-008-89
- Welding and Facing guidelines - PNAEG-7-009-89
- Welded joints and overlays inspection regulation - PNAEG-7-010-89
- Regulation to permit welders to work on the equipment and pipelines at Nuclear Power Plant - PNAEG-7-003-87
- GOST 6996-66
- Methods for testing the resistance to Intercrystalline corrosion - GOST 6032-84
- Methods of determination of mechanical properties of welded joints - GOST 1497-73
- Static tensile test for welded joints - GOST 1497-73
- Impact Bending Test for welded joints GOST 9454-78

Records

- 1) Welding Procedure Specification (WPS) –Sample Form-A
- 2) Welding Procedure Qualification Record (PQR) –Sample Form-B

TECHNICAL CONDITIONS OF CONTRACT (TCC)

FORM-A WELDING PROCEDURE SPECIFICATION (WPS)

Company Name _____ By _____

Welding Procedure Specification No. _____ Date _____ Supporting PQR No. (s) _____

Revision No. _____ Date _____

Welding Process(es) _____ Type(s) _____

(Automatic, Manual, Machine, or Semi-Auto)

JOINTS

Joint Design _____

Backing (Yes) _____ (No) _____

Backing Material (Type) _____

(Refer to both backing and retainers)

☐ Metal ☐ Nonfusing Metal

☐ Nonmetallic ☐ Other

Sketches, Production Drawings, Weld Symbols or Written Description Should show the general arrangement of the parts to be welded. Where Applicable, the root spacing and the details of weld groove may be specified.

(At the option of the Manufacturer, sketches may be attached to illustrate joint design, weld layers and bead sequence, e.g., for notch toughness procedures, for multiple process procedures, etc.)

TECHNICAL CONDITIONS OF CONTRACT (TCC)

*BASE METAL

Group _____ No. _____

Specification _____ type _____ and _____ grade _____

To _____
Specification _____ type _____ and _____ grade _____

Chem. _____ Analysis _____ and _____ Mech. _____ Prop. _____

Thickness Range :

Base Metal: _____ Groove _____ Fillet _____

*FILLER METALS

Spec. _____ No. _____

Size _____ of _____ Filler _____ Metals _____

Weld _____ Metal _____

Thickness Range :

Groove _____

Fillet _____

TECHNICAL CONDITIONS OF CONTRACT (TCC)

Electrode-Flux _____ (Class)

Consumable _____ Insert

* Each base metal-filler metal combination should be recorded individually.

Note:

Welding Process: SMAW – Shielded Metal Arc Welding (coated electrodes)

GTAW/TIG – Gas Tungsten Arc Welding, Tungsten – inert gas welding

GMAW – Gas Metal Arc Welding – Gas may be CO₂/Argon, etc.

POSITIONS Position(s) of Groove _____ Welding Progression Up _____ Down _____ Position(s) of Fillet _____	POSTWELD HEAT TREATMENT Temperature Range _____ Time Range _____					
PREHEAT Preheat Temp. Min. _____ Interpass Temp. Max. _____ <u>Rate</u> Preheat Maintenance _____ (Continuous or special heating where applicable should be recorded)	GAS <table style="width: 100%; border-collapse: collapse;"> <tr> <th style="text-align: left;">Percent Composition</th> </tr> <tr> <th style="text-align: left;">Gas(es) (Mixture) Flow</th> </tr> <tr> <td>Shielding _____</td> </tr> <tr> <td>Trailing _____</td> </tr> <tr> <td>Backing _____</td> </tr> </table>	Percent Composition	Gas(es) (Mixture) Flow	Shielding _____	Trailing _____	Backing _____
Percent Composition						
Gas(es) (Mixture) Flow						
Shielding _____						
Trailing _____						
Backing _____						

TECHNICAL CONDITIONS OF CONTRACT (TCC)

ELECTRICAL CHARACTERISTICS				
Current AC or DC _____ Polarity _____				
Amps (Range) _____ Volts (Range) _____				
Amps and volts range should be recorded for each electrode size, position, and thickness, etc. This information may be listed in a tabular form similar to that shown below).				
Tungsten Electrode Size and Type				
(Pure Tungsten, 2%				
Thoriated, etc.)				
Mode of Metal Transfer for GMAW				
(Spray arc, short circuiting				
arc, etc.)				
Electrode Wire feed speed range				
TECHNIQUE				
String	or	Weave		Bead
Orifice	or	Gas	Cup	Size
Initial and interpass Cleaning (Brushing, Grinding, etc.)				

TECHNICAL CONDITIONS OF CONTRACT (TCC)

— Method of Back Gouging _____ Multiple or Single Pass (per side) _____ Multiple or Single Electrodes _____ Travel Speed (Range) _____ Peening : permitted/not permitted_____								
Weld Layer(s)	Process	Filler Metal		Current		Voltage Range	Travel Speed Range	Other (e.g. Remarks, Comments, Hot Wire Addition, technique, Torch Angle, etc.)
		Classes	Dia.	Type	Polarity	Amp. Range		

PROCEDURE QUALIFICATION RECORDS (PQR)				
Record Actual Conditions Used to Weld Test Coupon				
Company _____				Name _____
Procedure _____	Qualification _____	Record _____	No. _____	Date _____
WPS _____				No. _____
Welding _____				Process(es) _____
Types _____	(Manual,	Automatic,	Semi-Auto)	
JOINTS				
Groove Design of Test Coupon (For combination qualifications, the deposited weld metal thickness shall be recorded for each filler metal or process used.)				

BASE METALS				POSTWELD HEAT TREATMENT			
Material _____ Spec. _____				Temperature _____			
Type _____ of _____ Grade _____				Time _____			
Thickness _____ of _____ Test _____ Coupon _____				Other _____			
Diameter _____ of _____ Test _____ Coupon _____				_____			
Other _____				_____			
_____				GAS			
_____				Percent Composition			
_____				Gas(es) Mixutre Flow Rate			
_____				Shielding _____			
_____				Trailing _____			
_____				Backing _____			
FILLER METALS				ELECTRICAL CHARACTERISTICS			
Specification _____				Current _____			
Classification _____				Polarity _____			
Filler _____ Metal _____				_____			
Size _____ of _____ Filler _____				Amps _____			
Metal _____				_____			
Other _____				Tungsten Electrode Size _____			
_____				Other _____			
Weld _____ Metal _____ Thickness _____				_____			
_____				_____			

TECHNICAL CONDITIONS OF CONTRACT (TCC)

PQR No. _____						
Tensile Test						
Specimen No.	Width	Thickness	Area	Ultimate Total Load lb	Ultimate Unit Stress psi	Type of Failure & Location

Guided-Bend Tests	
Type and Figure No.	Result

Toughness Tests							
Specimen No.	Notch Location	Specimen Size	Test Temp.	Impact Values			Drop weight Break (Y/N)
				FT.lbs	% Shear	Mils	

Comments:

TECHNICAL CONDITIONS OF CONTRACT (TCC)

Fillet-Weld Test	
Result – Satisfactory: Yes _____ No _____	Penetration into Parent Metal: Yes _____ No _____
Micro – Results	

Other Tests *	
Type of Test	_____
Deposit Analysis	_____
Other	_____
.....	
.....	
Welder's Name _____	Clock No. _____ Stamp No. _____
Tests conducted by: _____ Laboratory Test No. _____	
We certify that the statements in this record are correct and that the test welds were prepared, welded, and tested in accordance with the requirements of Section IX of the ASME Code.	
Manufacturer _____	
Date _____	By _____

(Detail of record of tests are illustrative only and may be modified to conform to the type and number of tests required by the Code.)

* Hardness Inter-granular Corrosion Test, Ferrite Test, Micro examination & Macro examination as per requirement.

TECHNICAL CONDITIONS OF CONTRACT (TCC)

Annexure-1

(reference)

INDEX OF STANDARD-AND-ENGINEERING DOCUMENTATION FOR WELDING MATERIALS ALLOWED TO BE USED IN MANUFACTURE, ERECTION, AND REPAIR OF EQUIPMENT AND PIPELINES IN NUCLEAR POWER PLANTS

Welding materials ,		Designation of document
Description	Grade	
Welding wire	Св-08А,, Св-08АА, Св-08ГА	GOST 2246-70
	Св-10ГА, Св-10Г2, Св-08ГС	
	Св-12ГС, Св-08Г2С, Св-08ГСМТ	
	Св-10НМА, Св-08ХМ,	
	Св-08ХМФА	
	Св-10ХМФТ, Св-08ХГСМА	
	Св-08ХГСМФА, Св-04Х2МА	
	Св-13Х2МФТ, Св-10Х11НВМФ	
	Св-06Х14, Св-06Х19Н9Т	
	Св-08Х19Н10Г2Б	
	Св-08Х19Н10М3Б	
	Св-04Х19Н11М3, Св-07Х25Н13	
	Св-10Х16Н25АМ6	
	Св-30Х15Н35В3Б3Т	
	Св-06А	ТУ 14-1-1569-75
	Св-10ГНМА, Св-10ГН1МА,	ТУ 14-1-2860-79
	Св-10ГН2МФА	
	Св-10ХМФТУ	ТУ 14-1-3034-80
	Св-12Х2Н2МА, Св-12Х2Н2МАО	ТУ 14-1-2502-78
	Св-09ХГНМТА,	ТУ 14-1-3675-83
	Св-09ХГНМТАА-ВН	
	Св-16Х2НМФТА	ТУ 14-1-3633-83
	Св-01Х12Н2-ВН	ТУ 14-1-1212-74
	Св-01Х12Н2МТ-ВН	ТУ 14-1-3595-83
	Св-09Х16Н4Б	ТУ 14-1-1692-76
	Св-03Х16Н9М2	ТУ 14-1-2208-77
	Св-021Х17Н10М2-ВН	ТУ 14-1-1005-74
	Св-04Х17Н10М2	ТУ 14-1-1959-74
	Св-04Х20Н10Г2Б	ТУ 14-1-3252-81
	Св-03Х24Н13Г2Б	ТУ 14-1-2205-77
	Св-03Х15Н35Г7М6Б	ТУ 14-1-2143-77
	Св-08АА-ВН	ТУ 14-1-4355-81
	Св-03Х20Н45Г6М6Б-ВН	ТУ 14-1-2206-77
	Св-06ХГСМТА,	ТУ 14-1-2808-79
	Св-14Х12НВМФ	
	Св-13Х2МФТА	ТУ 14-1-4370-87

TECHNICAL CONDITIONS OF CONTRACT (TCC)

1	2	3
Welding strip	Св-08Х19Н10Г2Б	ТУ 14-1-3146-81
	Св-04Х19Н11МЗ	
	Св-07Х25Н13,	
	Св-10Х16Н25АМ6	
	Св-04Х20Н10Г2Б	ТУ 14-1-2270-77
	Нп-03Х22Н11Г2Б	ТУ 14-1-2750-79
	Св-03Х24Н13Г2Б	ТУ 14-1-2207-77
Covered electrodes	Св-03Х15Н35Г7М6Б	ТУ 14-1-2162-77
	ЦУ-5, ЦУ-6, ЦУ-7, ЦУ-7А	ОСТ 108.948.01-86
	ЦУ-2ХМ, ЦЛ-20, ЦЛ-21,	
	ЦЛ-25/1, ЦЛ-25/2, ЦЛ-32	
	ЦЛ-38, ЦЛ-39, ЦЛ-45, ЦЛ-48,	
	ЦЛ-51, ЦЛ-59, ПТ-30, РТ-45А,	Certificate ЦЭ No. 223-73
	РТ-45АА, ЦТ-10, ЦТ-15К,	
	ЦТ-26, ЦТ-26М, ЦТ-36М, ЦТ-45,	
	ЦТ-48	
	ЦЛ-52	*
	ЗИО-8	
	ОЗС-4	
	ОЗС-6	
Welding flux	УОНИИ-13/45, УОНИИ-13/45А,	*
	УОНИИ-13/55, УОНИИ-13/45АА	
	УОНИИ-13/55АА,	
	УОНИИ-13/10Х13, Н-3, Н-6,	
	Н-10, Н-20, Н-23, Н-25, РТ-45Б,	GOST 9466-75
	ЭА-395/9, ЭА-400/10У,	
	ЭА-400/10Т, ЭА-582/23,	
	ЭА-855/51, ЭА-898/21Б,	
	ЭА-902/14, ЭМ-959/52, А-1,	GOST 9467-75
	А-1Т, А-2, А-2Т, КТЧ-7	
	АНО-4, МР-3	
	ТМУ-21, ТМЛ-1У,	GOST 9087-81
	ТМЛ-3У	
	ОСЦ-45, АН-348А, АН-348АМ	
	АН-8, АН-22, АН-17М, АН-26	
	АН-26С	ТУ 5.965-11087-78
	КФ-27	
	КФ-30	

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1	2	3
Welding flux	АН-42, АН-42М, ОФ-6, ОФ-10 НФ-18М, КФ-16, КФ-19, КФ-28 ФЦ-11, ФЦ-16, ФЦ-16А, ФЦ-17 ФЦ-18, ФЦ-19, ФЦ-21, ФЦ-22	
Welding sticks made of lanthanide tungsten	- ВЛ	Тy 48-19-27-77
Welding sticks made of yttrium tungsten	СВИ-1	ТУ 48-19-221-76
Welding sticks made of tungsten	ЭВЛ, ЭВИ-1, ЭВИ-2, ЭВИ-3, ЭВТ-15	GOST 23949-80
Gaseous and liquid argon	Highest and first quality	GOST 10157-79
Helium	-	ТУ 51-940-75
Gaseous commercial oxygen	First and second quality	GOST 5583-78
Gaseous and, liquid carbon dioxide	Highest and first quality	GOST 8050-85

TECHNICAL CONDITIONS OF CONTRACT (TCC)

Annexure ½ (Annexure-2)

Manual Argon-Arc Welding with Nonconsumable Electrode

Class of steel	Type of Welding joint	Rated thickness of parts at welding spot, mm	Diameter of tungsten electrode, mm	Diameter of filler wire, mm	Current Strength A		Argon flow rate l/min	
					Root Pass	Groove filling	Per torch	Per heave
Austenitic and pearlitic	1-23	Above 3 and upto 4 (inclusive)	1.6 – 4.0	1.6 – 2.0	45-90	50-70	8 – 10	4 – 5
		Above 4 and upto 6 (inclusive)	1.6 – 4.0	1.6 – 3.0		90-100	8 – 10	4 – 5
	2-03	Above 4 and upto 6 (inclusive)	1.6 – 4.0	-	70-100	100-	8 – 10	4 – 5
	2-04	Above 4 and upto 6 (inclusive) Above 6	1.6 – 4.0	-	80-110	140 120-160	8 – 10	4 – 5
Iron-nickel alloys	1-23	Above 3 and upto 4 (inclusive)	1.6 – 4.0	1.6 – 2.0	40-70	40-70	8 – 10	4 – 5
		Above 4 and upto 6 (inclusive)	1.6 – 4.0	1.6 – 2.0	65-80	65-80	8 – 10	4 – 5
	2-03	Above 4 and upto 6 (inclusive)	1.6 – 4.0	1.6 – 2.0	55-80	55-80	8 – 10	4 – 5
	2-04	Above 4 and upto 6 (inclusive) Above 6	1.6 – 4.0	1.6 – 2.0	60-90	60-90	8 - 10	4 - 5

TECHNICAL CONDITIONS OF CONTRACT (TCC)

Annexure 2/2 (Annexure-2)

Manual Argon-Arc welding of pipelines of Austenitic class with nonconsumable electrode in pulse operation

Rated thickness part at Welding spot, mm	No. of pass	Diameter of tungsten electrode , mm	Diameter of filler wire, mm	Pulse time, s	Break time, s	Welding Current A		Argon flow rate, l/min	
						Pulse	pilot	Per torch	Per heave
1.0-1.5	1	2.0	-	0.1-	0.15-	40-50	6-8	6-8	2-5
	2	2.0	1.2	0.15 -	0.25 -	40-50	-	6-8	2-5
2.0-2.5	1	2.0	-	0.4-	0.3-0.5	50-70	6-8	6-8	2-5
	2	2.0	1.6	0.6 -	-	50-70	-	6-8	2-5
Above 2.0 and up 4.0 (inclusive	1	2.0-3.0	-	1.5-	0.3-0.5	105-	6-8	7-10	2-5
	2 and subsequ ent	2.0-3.0	2.0-2.5	2.0 -	-	125 105- 125	-	7-10	2-5
Above 4.0 and upto 9.0 (inclusive	1	3.0	-	1.5-	0.3-0.5	140-	6-8	10-12	2-5
	2 and subsequ ent	3.0	2.5-3.0	2.5 -	-	180 140- 180	-	10-12	2-5
Above 9.0 and upto 20.0 (inclusive)	1	3.0-4.0	-	2.5-	0.3-0.5	150-	6-8	12-15	2-5
	2 and subsequ ent	3.0-4.0	3.0-4.0	3.0 -	-	200 150- 200	-	12-15	2-5

TECHNICAL CONDITIONS OF CONTRACT (TCC)

Annexure -1/3 (Annexure-3)

Table 11. Minimum Temperature of Preheat and Additional Heat in Making Welded Joints

Grades of steels of parts to be welded	Rated thickness parts to be welded, mm	Heat-up minimum temperature, °C		
		in arc welding	in electroslog welding	in buttering with use of austenitic filler materials
1	2	3	4	5
Cr3cn5, 10, 15, 15Л, 20, 20Л, 20K	Up to 100 (inclusive) Above 100	- 100	- -	- -
22K, 25Л	Up to 60 (inclusive) Above 60	Heat-up not required* 100	- -	- -
10XCHД *	Up to 40 (inclusive) Above 40	Heat-up not required 100	- -	- -
10XH1M	Up to 40 (inclusive) Above 40	Heat-up not required 100	- -	- 50
15ГC, 16ГC, 09Г2C, 20ГCЛ, 16ГHMA	Up to 30 (inclusive) Above 30	Heat-up not required 150	- -	- 150
10ГH2MΦA, 10ГH2MΦAJ, 15ГHMA	Up to 50 (inclusive) Above 50	50 120	- 100*2	- 100
12MX, 12MX, 15XM	Up to 10 (inclusive) Above 10 and up to 30 (inclusive) Above 30	Heat-up not required 150 200	- 50 100	- 100 150
20XM, 20XMЛ, 20XMA	Up to 6 (inclusive) Above 6	- 200	- 100	- 150
10X2M	Up to 6 (inclusive) Above 6	- 100	- -	- 100
12X1MΦ *	Up to 6 (inclusive) Above 6 and up to 30 (inclusive)	- 200	- 150	- 100
15X1M1Φ, 15X1M1ΦЛ	Up to 6 (inclusive) Above 6 and up to 30 (inclusive) Above 30	- 250 300	- 200 250	- 150 200
15X2HMΦA, 15X2HMΦA-A, 15X3HMΦA, 15X3HMΦ-A	Irrespective of thickness	150	150	150
12X2MΦA	Up to 80 (inclusive) Above 80	200 200	100 150	150 150
15X2MΦA, 15X2MΦA-A, 16X2MΦA	Irrespective of thickness	200	150	150
08X13, 05X12H2M	Up to 6 (inclusive) Above 6	- 100	- -	- 100
06X12H3Д	Up to 30 (inclusive) Above 30	- 100	- -	- 100
12X11B2MΦ	Up to 30 (inclusive) Above 30	250 300	150 200	250 250

*Necessity of heating in welding parts made of steel, grade 22K, is established in consultation with the leading materials technology agency.

**With thickness of up to 150 mm, inclusive, heating need not be performed.

TECHNICAL CONDITIONS OF CONTRACT (TCC)

Annexure –2/3 (Annexure-3)

Table 12. Minimum Heat-up Temperature in Weld surfacing third Layer of Antirust Coating

Grade of steel of part being faced.	Type of filler material	Rated thickness of part being faced, mm	Minimum heat-up temperature, °C
20XMA	Strip	Irrespective of thickness	-
	Covered electrodes, wires	Up to 100 (inclusive)	-
		Above 100	100
10XH1M 10ГН2МΦА 10ГН2МΦЛ	Strip	Up to 100 (inclusive)	-
	Covered electrodes, wire	Above 100	50
		Up to 50 (inclusive)	-
		Above 50	50
15X2HMΦА 15X2HMΦА-А 15X3HMΦА	Strip	Up to 100 (inclusive)	-
	Covered electrodes, wire	Above 100	50
		Up to 100 (inclusive)	50
		Above 100	100
		Irrespective of thickness	150
12X2MΦА 15X2MΦА 15X2MΦА-А 18X2MΦА	Stripe covered electrodes, wire	Irrespective of thickness	150

TECHNICAL CONDITIONS OF CONTRACT (TCC)

Annexure –3/3 (Annexure-3)

Table 13. Conditions of stay of butt welded joints in time interval between the end of welding and start of thermal treatment

Grades of steels of welded joints	Rated thickness of wall of parts being welded, mm	Minimum temperature of metal in welded joint zone, °C	Tolerable time interval, h
10ГН2МФА, 10ГН2МФЛ 15ГНМФА	Above 50	70	Unspecified
20ХМ, 20ХМЛ, 20ХМА	Irrespective of width	Unspecified	72
10Х2М	Above 30	100	Unspecified
12Х1МФ, 15Х1МФ	Above 6	Unspecified	72
05Х12Н2М	Above 30	80	Unspecified
15Х2НМФА, 15Х2НМФА-А 15Х3НМФА, 15Х3НМФА-А	Irrespective of thickness	150	Unspecified
12Х1В2МФ	Above 3	Unspecified	72
06Х12Н3Л	Above 10	100	Unspecified
12Х2МФА	Irrespective of thickness	175	Unspecified
15Х2МФА, 15ХМФА-А	Irrespective of thickness	200	Unspecified
18Х2МФА	Irrespective of thickness	300	Unspecified

Table 14. Conditions of Thermal Recovery of Butt Welded Joints Made by Arc or Electron-Beam Welding

Grades of steels of parts being welded	Rated thickness of wall of parts being welded, mm	Thermal recovery condition	
		minimum temperature, °C	minimum duration, h
10ГН2МФА, 10ГН2МФЛ	Above 50 and up to 110 (inclusive)	150	8
15ГНМФА	Above 110	150	18
10Х2М, 05Х12Н2М	Above 30	100	8
12Х1МФ	Above 6	130	8
15Х1МФ	Above 6	150	10
06Х12Н3Л, 15Х3НМФА, 15Х3НМФА-А	Irrespective of thickness	150	12
08Х13	Above 10	100	8

TECHNICAL CONDITIONS OF CONTRACT (TCC)

Annexure –1/4 (Annexure-4)

Methods and scope of Nondestructive inspection of welded joints of tubes in tube plate and Headers is given below in table below

Category of welded joint	Scope of Inspection %			
	Visual and Measuring	Capillary and magnetic powder	Radiographic	Pressure tightness
I	100	100	100	100
Ila	100	50	50	-
IIB, IIIa	100	-	25	-
IIIB	100	-	10	-
IIIC	100	-	-	-

Methods and scope of Nondestructive inspection of buttering parts from steel of Pearlitic class and from High Chromium steels

Type of welding	Category of welded joint	Scope of Inspection, %				
		Visual and Measuring	Capillary and Magnetic Powder	Radiographic		Ultrasonic
				Up to DH = 325 mm	Over DH = 325 mm	
Buttering with austenitic filler materials	I	100	100	100	100	100
	IIB, IIIa	100	100	100	100	50
	IIIB	100	100	100	100	25
	IIIC	100	100	100	100	10
Buttering with high-chromium or pearlitic filler materials	I	100	100	100	100	100
	Ila	100	50	50	100	100
	IIB	100	25	25	50	100
	Ila	100	25	10	25	100
	IIIB, IIIC	100	-	-	-	100

TECHNICAL CONDITIONS OF CONTRACT (TCC)

Coated anticorrosive coating	-	100	-	-	-	100
Reinforcing surfacing						

Annexure-5

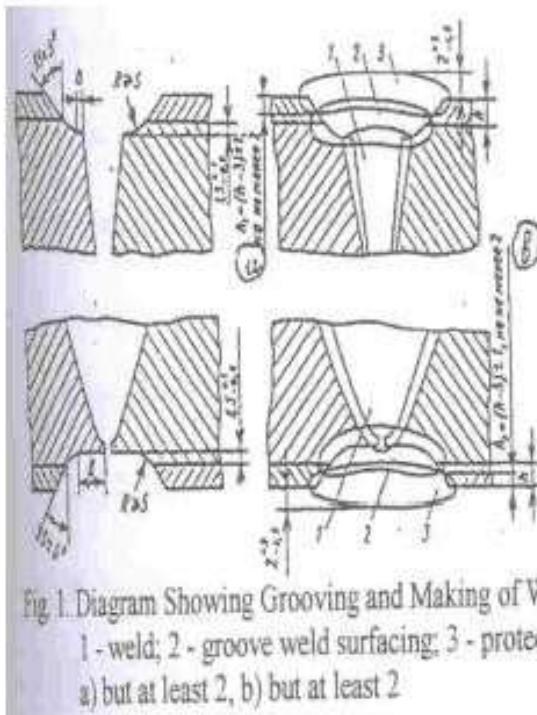


Fig. 1. Diagram Showing Grooving and Making of Welded Joints of Two-Layer Steel Parts
 1 - weld; 2 - groove weld surfacing; 3 - protective weld surfacing
 a) but at least 2, b) but at least 2