

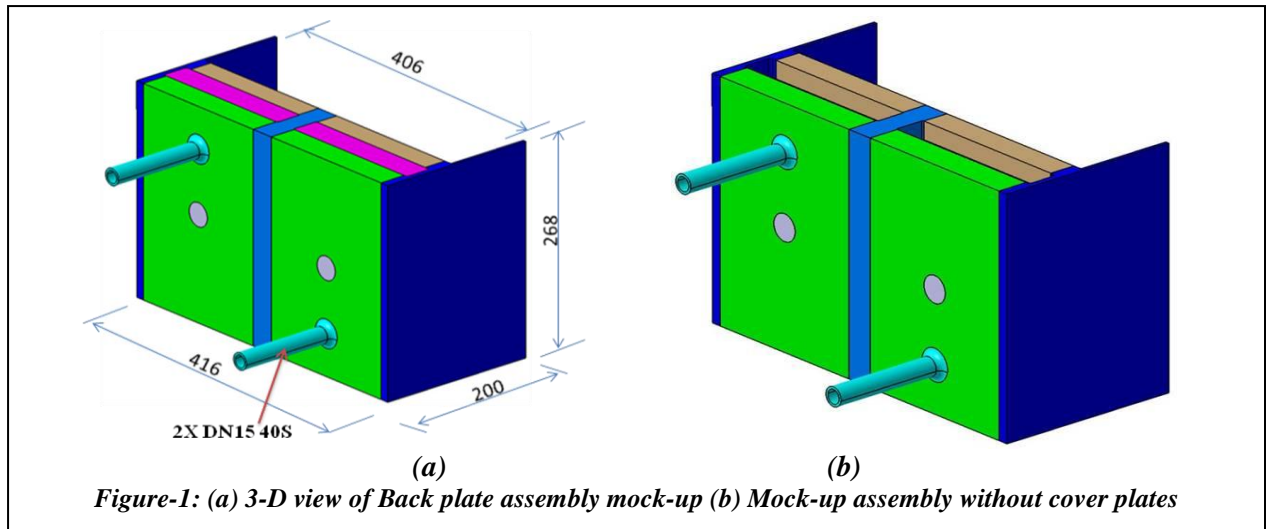
**PART-I (B)**

**Technical Specification for Fabrication, Testing & Supply of  
Back plate assembly mock-up**

**INTRODUCTION**

Test blanket module (TBM) is a structural box made of different components and sub-components assemblies. Back plate assembly is one of the sub-components assemblies. Back plate assembly in turn comprise of different components namely; U-shaped first wall (FW), back plate-1, back plate-2, mid plate, top & bottom cover plates and connecting pipes. The details of different components are found in attached drawing (BKPA\_IPR\_01).

The overall dimensions of full scale back plate assembly is 0.484 m (l) x 0.534 m (b) x 1.66 m (h). The U-shaped FW made of hollow square channels of dimensions 20mm x 20mm (total 65 nos. channels) running along the length (l) and width (b). There are 13 circuits, each circuits consisting of 5 channels with inlet machined on the 1st channel and the outlet machined on the 5th channel of each circuits. High pressure helium (He)-gas shall flow through these channels at 8 MPa pressure and at 300°C temperature under operation condition. The back plate assembly forms two manifolds (He-inlet and He-outlet) which are separated by mid-plate. Both manifolds are covered with top and bottom plates and play a role of reservoir and collector respectively. The high pressure He-gas flows through helium loop at 300 °C temperature which enters in the He-inlet manifold via inlet pipe welded on the back plate-1. He-inlet manifold acts as reservoir from where He-gas distributes into flow circuits through respective inlets, machined on the inside face of FW at location between back plate-1 and back plate-2, at either legs of U-shaped FW. He-gas circulates through each flow circuits and absorbs the heat generated to maintain the structure temperature within the design limit. The Hot He-gas collected in the He-outlet manifold through respective outlets machined on inside face of FW, at same location as inlets, but at either legs of U-shaped FW. He-outlet manifold acts as collector from where He-gas diverts to helium loop again via He-outlet pipe welded on the back plate-1. Hot He- gas is passed through the heat exchanger, where it exchanges the heat and lowers the temperature of He-gas up to 300°C.



To check the fabrication feasibility and to validate the assembly sequence of back plate assembly, it is required to fabricate a scale down mock-up of back plate assembly as shown in figure 1. In this mock-up assembly, the U-shaped FW is not incorporated; instead a solid plate without channels is considered. The overall dimensions of back plate assembly mock up are 416 mm (l) x 200 mm (b) x 268 mm (h). The structural material considered for this mock-up fabrication is modified 9Cr-1Mo steel (grade 91class 2).

## 1. SCOPE

1.1. The item of supply constitutes:

<i>Sr. No.</i>	<i>Description</i>	<i>Drawing no.</i>	<i>Quantity</i>
01	Back plates assembly mock-up	BKPA_IPR_01	1

- 1.2. Preparation and submission of Quality assurance plan (QAP) for the complete work (manufacturing, welding, inspection, testing, cleaning, etc.) indicating hold point, witness point, review at each stage of work execution.
- 1.3. Preparation of fabrication drawings based on the engineering drawing (BKPA\_IPR\_01) provided by IPR following the requirements detailed in section 4 of this document.
- 1.4. Vendor shall estimate the structural material required (Including the welding trials, welding procedure qualification etc.) towards successful fabrication of back plate assembly mock-up. The same may be uploaded along with the technical bid.
- 1.5. The structural material considered for fabrication of back plate mock-up assembly will be provided by IPR as free issue material (FIM) along with the material test certificates. The details of structural material products are provided in section 5 of this document.
- 1.6. Vendor shall obtain insurance for the FIM of value Rs. 15 Lakhs.
- 1.7. All machining related activities shall be carried out following the requirements detailed in section 6 of this document.

- 1.8. Development of suitable fixture, gauges, clamps, etc. for holding the components during fabrication, inspection and testing.
- 1.9. All welds shall be performed by Electron beam welding (EBW) only. The requirement for welding and post weld heat treatment (PWHT) for this mock-up assembly are provided in section 7 of this document.
- 1.10. The vendor should follow the preferred assembly sequence and welding direction as shown in Annexure-1 for fabrication of back plate assembly mock-up.
- 1.11. Inspection and testing of fabricated mock-up assembly shall be performed following the requirements detailed in section 8 of this document.
- 1.12. Preparation of documentation, including photographs/videographs, at various stages of work progress during execution.
- 1.13. Packing and safe delivery of fabricated mock-up component to IPR.
- 1.14. Any item/service, which may not have been specifically mentioned herein but are needed for satisfactory completion of work, shall also be treated as included and the same shall also form part of scope, unless otherwise specifically excluded.

## **2. APPLICABLE CODE & STANDARD**

- 2.1. All aspects of manufacturing, welding, heat treatment, inspection, testing etc. shall be performed in accordance to ASME Section VIII Div-1, ASME section III and ASME section IX.
- 2.2. Welding qualification shall be performed as per guidance provided in ASME section IX.
- 2.3. Non-destructive examinations shall be performed as per procedures mentioned in ASME section V.
- 2.4. Structure materials supplied by IPR will be in accordance with ASME section II part A.

## **3. DRAWINGS**

- 3.1. The fabrication drawings should provide manufacturing details such as different stages of machining with machining margin, weld edge preparation, surface finishes, dimensions with numerical value of tolerances, geometrical tolerances of form and positions, accuracy of built-in dimensions, weld joint details, bill of materials, surface treatment instructions (if any) etc.
- 3.2. The fabrication and assembly drawings shall clearly indicate the welding process, weld serial no. and weld joint design considered for production of joints during assembly.
- 3.3. Fabrication drawings shall also identify the inter-stage checks or inspections to be performed at different stages of assembly.
- 3.4. The vendor should submit the detailed fabrication drawings to IPR in the form of hard copies (Two sets) and soft copies for review and acceptance prior to start of fabrication. If any corrections or modifications required, they shall be incorporated in the drawings by vendor with the approval of IPR.

3.5. Prior to shipment of fabricated mock-up assembly, the vendor shall prepare ‘As-Built’ drawings which shall show actual dimensions achieved on the fabricated component. ‘As-built’ drawings shall be sent to IPR before delivery of fabricated mock-up assembly.

**4. MATERIAL OF CONSTRUCTION**

4.1. The structural material considered for Back plate mock-up assembly fabrication is 9Cr-1Mo steel (Grade 91).

4.2. Chemical composition, mechanical properties and other details of structural material products are in accordance with following standards:

- For plates – ASME SA387/ASTM A387 Grade 91 Class 2
- For rods – ASME SA 182/ASTM A182M (Pipe of specified dimensions shall be machined from this rod).

4.3. All mill test certificates obtained along with the structural material products will be provided with the FIM.

4.4. The details of structural materials available with IPR for fabrication of this mock-up assembly are mentioned here below. Based on the estimation submitted by vendor, the overall required materials size (plates and rod in approximate length and width) are cut from available stock and shall be supplied to the vendor as FIM.

Thickness of plates (t)	25 mm, 40 mm and 45 mm
Diameter of rods (d)	40 mm diameter

**5. MACHINING**

5.1. The cutting of material from the supplied lot should ensure sufficient margin to avoid heat affected areas causing material degradation.

5.2. During machining, the cutting fluids used shall be water soluble, non-halogenated and phosphorus and sulphur free. Vendor should obtain prior approval from IPR for the usage of cutting fluid. The details of cutting fluid to be uploaded along with the technical bid.

5.3. Machined parts and sub-components shall be degreased using solvents or alkaline detergents, rinsed with demineralized water, and dried completely before starting welding job.

## **6. WELDING**

### **6.1. General**

- 6.1.1. Welding shall be carried out by qualified welding operators and qualified welding procedures only.
- 6.1.2. The welds shall be subjected to post-weld heat treatment (PWHT). PWHT shall be carried out for the welds at 750°C ( $\pm$  5°C) for 2 hours and cooled within the furnace/electrically heated coils for thickness up to 25mm. Plate thickness over 25 mm, the hold time shall be added 1 hr/nch of plate thickness.
- 6.1.3. Partial penetration weld is not permitted. All weld joints shall be full penetration weld.

### **6.2. Welding Procedure Qualifications**

- 6.2.1. The Vendor shall be responsible for qualifying welding procedure and welding operator before start of any welding activity.
- 6.2.2. Qualification of the welding procedures to be adopted shall be as per ASME section IX.
- 6.2.3. The procedure qualification test performed by the Vendor shall be witnessed by IPR representatives. The welding procedure specification and a complete set of test results shall be submitted to the IPR for review and approval.
- 6.2.4. A weld map with weld descriptions and fabrication drawing (sketch) that specifies where each procedure will be used shall be submitted to the IPR along with the Welding Procedure Specification (WPS) and Procedure Qualification Record (PQR) documents for each component.
- 6.2.5. All welds in a component shall be identified by serial nos. indicated on a weld reference sketch and a Weld data sheet (WDS) shall be filled for each of these welds.

### **6.3. Weld Repair**

- 6.3.1. Repair of welding shall be performed using a qualified and approved welding procedure. In-process repairs (i.e. repairs performed prior to completion of the joint, using the same welding procedures as for the original fabrication) during production do not require a separate procedure.
- 6.3.2. For each individual repair, a written procedure shall be prepared by the vendor and submitted to IPR for review and approval. This written procedure shall include a sketch detailing extent and location of the defects, how defects will be removed, how removal will be verified, qualified welding procedure to be used, subsequent heat treatment and non-destructive examination.
- 6.3.3. All repaired welds shall be inspected using the original testing method.
- 6.3.4. Repair of surface defects in welds by grinding is permitted provided the minimum required wall thickness is maintained without abrupt changes in section thickness.

## **7. INSPECTION & TESTING at FACTORY (FAT- Factory Acceptance Test)**

### **7.1. General**

The vendor is responsible for arranging and performing all inspection and testing detailed below. The vendor shall provide inspection and testing procedures to IPR for review and approval before starting the job.

### **7.2. Liquid Penetrant Test (LPT)**

7.2.1. All welded joints shall be tested by vendor with Liquid Penetrant Test as per guidance provided in ASME Section III Division I Sub-section NB-5350 and ASME Section V Article 6.

7.2.2. The Liquid Penetrant tested areas shall be cleaned by hot detergent wash. The water temperature shall be kept at 60°C and then these tested areas shall be dried completely. In case, vendor finds unacceptable defect, the same shall be notified to IPR.

7.2.3. The procedure for testing shall be submitted to IPR for review and approval.

#### **7.2.4. Acceptance criteria:**

- a) Imperfections producing indications with major dimensions greater than 1/16 in. (1.5 mm) shall be considered relevant imperfections.
- b) Imperfections producing the following indications are also unacceptable:
  - Any cracks or linear indications with length three times greater than the width;
  - Rounded indications with dimensions greater than 3/16 in. (5 mm);
  - Four or more rounded indications in a line separated by 1/16 in. (1.5 mm) or less edge to edge;
  - Ten or more rounded indications in any 6 sq in. (4000 mm<sup>2</sup>) of surface with the major dimension of this area not to exceed 6 in. (150 mm) with the Area taken in the most unfavorable location relative to the indications being evaluated.

### **7.3. Dimensional Inspection**

7.3.1. The dimensions of fabricated mock-up assembly shall be measured and verified with dimension and tolerances mentioned in the approved fabrication drawings.

### **7.4. Radiography Testing**

7.4.1. Radiography testing for weld joints shall conform to guidance provided in ASME Section-III ND paragraph 5320 ASME section V Article 2 together with other requirements as mentioned herein.

7.4.2. Radiographic film interpretation shall be done by ASNT level II certified personnel.

7.4.3. For all thickness X-rays shall be used as source of radiation. Gamma rays shall be employed only when X-rays is not feasible.

7.4.4. Procedure for Radiography testing shall be submitted to IPR for review and approval.

#### 7.4.5. Acceptance criteria:

- a) Cracks, Lack of Penetration (LOP), Lack of Fusion (LOF), Oxidation, Undercuts, Linear and angular defects of any type, surface defects in the region of weld and HAZ involving either stress raisers or loss of wall thickness, root concavities shall not be acceptable.
- b) Porosity and spherical inclusions in excess of limits stated below:
  - i. Plate thickness 3mm & less: Defect free weld is required.
  - ii. Plate thickness  $> 3\text{mm}$  and  $\leq 6\text{mm}$ : Isolated globular inclusions / porosity permitted provided they are not larger than 0.8 mm diameter in any portion of the weld and do not exceed 4 in number in any length of 300 mm and are separated from each other by at least 4 times their diameter.
  - iii. Plate thickness  $>6\text{mm}$  and  $\leq 16\text{mm}$ : Isolated globular inclusions / porosity permitted provided they are not larger than 1.5 mm diameter in any portion of the weld and do not exceed 4 in number in any length of 300 mm and are separated from each other by at least 4 times their diameter.
  - iv. Plate thickness  $>16\text{mm}$  and  $< 50\text{mm}$  : Isolated globular inclusions / porosity permitted provided they are not larger than 4 mm diameter in any portion of the weld and do not exceed 4 in number in any length of 300 mm and are separated from each other by at least 4 times their diameter.
- c) Indications shown on the radiographs of welds and characterized as imperfections are unacceptable under the following conditions:
  - (a) Any indication characterized as a crack or zone of incomplete fusion or penetration;
  - (b) Any other elongated indication that has a length greater than
    - (1)  $1/4$  in. (6 mm) for t up to  $3/4$  in. (19 mm), inclusive
    - (2)  $1/3t$  fort from  $3/4$  in. to  $2 \text{ \& } 1/4$  in. (19 mm to 57 mm), inclusive
    - (3)  $3/4$  in. (19 mm) for t over  $2 \text{ \& } 1/4$  in. (57 mm)Where t is the thickness of the thinner portion of the weld

### 7.5. Ultrasonic Examination

7.5.1. Ultrasonic examination shall be carried in accordance with ASME section V Article 4 (For weld) and ASME Section III Division I Sub-section NB – 5300.

7.5.2. The Ultrasonic Examination procedure shall be submitted to IPR for review and approval.

#### 7.5.3. Acceptance criteria:

Imperfections which produce a response greater than 20 % of the reference level shall be investigated to the extent that the operator can determine the shape, identity, and location of all such imperfection and evaluate them in terms of the acceptance standards given in (a) and (b) Below;

- a) Imperfections are unacceptable if the indications exceed the reference level amplitude and lengths exceeding:

- i.  $\frac{1}{4}$  in. (6 mm) for t up to  $\frac{3}{4}$  in. (19 mm), inclusive
- ii.  $\frac{1}{3}t$  for t from  $\frac{3}{4}$  in. (19 mm) to  $2\frac{1}{4}$  in. (57 mm), inclusive
- iii.  $\frac{3}{4}$  in. (19 mm) for t over  $2\frac{1}{4}$  in. (57 mm)

Where t is the thickness of the weld being examined; if the weld joint two members having different thickness at the weld t it the thinner of these two thicknesses.

- b) Indications characterized as cracks, lack of fusion, or incomplete penetration are unacceptable regardless of length.

## **7.6. Helium leak testing**

7.6.1. The vendor is responsible to carryout helium leak testing of fabricated mock-up assembly as per guidance provided in ASME Section V Article 10.

7.6.2. The leak rate shall not exceed  $1 \times 10^{-9}$  mbar liters/second during testing of back plate mock-up assembly. The appropriate procedure for helium leak testing shall be submitted to IPR for review and approval.

7.6.3. The vendor shall make appropriate connections and fixtures for testing the mock-up assembly.

7.6.4. The test shall be performed before and after hydro test in the presence of IPR representatives.

## **7.7. Hydro test**

7.7.1. The hydro-test of the mock-up assembly shall be carried out as per guidance provided in ASME Sec. III (ND) and ASTM-E-1003.

7.7.2. The procedure for testing shall be prepared by the vendor and submitted to the IPR review and approval.

7.7.3. The test shall be carried out at 150 bar. It shall be conducted in steps of 20 bar up to 150 bar. The vendor shall make suitable connections and fixtures for hydro-testing.

7.7.4. The Test shall be performed in the presence of IPR representatives only.

## **8. PACKING & SUPPLY**

8.1. After issuance of dispatch clearance by IPR, the fabricated and tested back plate assembly mock-up shall be appropriately packed by the vendor to avoid any damage during transportation to IPR premises.



**9. INFORMATION TO BE FURNISHED WITH TECHNICAL BID (MANDATORY)**

The vendors are expected to go through the technical specification before filling the form below apart from the additional information sought in the Purchase Order.

<b>Sr. No.</b>	<b>Technical Description</b>	<b>Your Offer and Acceptance</b>
9.1	Do you have machining facility at your premises? In case, yes; upload list of machines capable to handle this particular job.	
9.2	Do you have Electron Beam welding facility at your disposal that is capable to handle particular job with full penetration? (Refer assembly sequence in Annexure-1)	
9.3	Do you have heat treatment facility required for this work? Give details of the same.	
9.4	Do you have inspection and testing facilities at your end? If not, how do you plan to do it?	
9.5	Do you have experience in development job with IPR or any other Dept. of Atomic Energy unit?	
9.6	Are you familiar with Quality Assurance Plan? Enclose the proposed quality assurance plan for tender job showing Review, Hold point and Witness points.	