

Annexure-A1

Fire proof sealing system (FPS)

- 1.1 Fire proof sealing system shall consist of
- (i) Fire-stops/fire-seals for sealing of cable/cable tray and conduit/pipe penetrations, both horizontal and vertical, through brick or RCC walls/floors, to prevent the spread of fire from one area, which is separated from others by fire-resistant barriers.
 - (ii) `Fire-breaks' provided on long runs of cable racks/trays to prevent the propagation of fire along the cable rack, within a single fire-area or fire- zone.
- 1.2 The FPS system shall also include all the necessary accessories and equipment required for supporting, holding in position, fixing and installation of the fire-stop/fire-break.
- 1.3 The FPS system shall comply in all respects with the requirements of the codes and standards listed below
- IEEE-634
 - ASTM-E-814
 - ANSI-IEEE-383
 - IEC-331
 - IEC-332
- 1.4 Fire Stop/Seal
- The FPS system adopted for cables or cable trays penetrating through walls and floor openings, or cables passing through embedded conduits/pipes/ pipe-sleeves, constitutes a `fire stop/seal', which is meant to prevent spreading of fire between areas separated by fire-resistant barriers.
- 1.5 Fire Break
- The fire proofing system, other than fire-stops, adopted to retard flame propagation along long runs of horizontal or vertical cable trays in the same fire zone or area, in an event of a fire, shall constitute a `fire-break' and shall be provided by applying a suitable fire-resistant coating on cables and cable trays for the required length, with or without a fire resistant panel, at the point of the fire break to obtain the fire-rating specified.

1.6 Performance Requirements

(i) Requirement of fire stops

- The material, design and construction of the fire stops shall be such as to provide the fire-rating of 120 minutes for a fire on any side and meet all requirements listed in this specification and the relevant codes and standards.
- The materials used in the fire stops shall be non-hygroscopic, compatible with the type of cables.

(ii) Requirements of fire breaks

- Each firebreak shall have a fire-rating of 30 minutes and shall be capable of withstanding for the duration specified, a fire on any side of the fire break.

1.7 Application of fire proof sealing system

(i) Fire stops

Fire stops shall be provided for cable penetration openings listed below

- The passage of cables/cable trays pipe sleeves/embedded conduits through walls / floors.
- Vertical raceways, which carry cables between successive floors, through openings provided in the RCC floor slab, shall be sealed by fire stops at each floor level.
- Cable entry through openings in floor slabs below HT/LT switchgear, MCCs, various control and relay panels and other bottom entry panels, shall be effectively sealed by fire stops.

(ii) Location of fire breaks

- Firebreaks shall be provided on both cable rack and trenches at all cable tray intersections and tee-offs.
- On linear runs of cable trays between fire stops or fire breaks, fire breaks shall be provided at intervals of 15 metres on horizontal cable runs and 5 m on vertical cable runs.
- Fire breaks in linear runs of cable trenches between intersections and tee-offs shall be provided at intervals of 30 metres.

- 1.8 Contractor shall furnish the test certificates for the fire stops and fire breaks after award of contract for Owner / Owner's Representative review. If the certificates are not satisfactory all the tests shall be conducted free of cost. The offered system i.e. fire stops and fire breaks shall be identical (or better) with the system which is successfully type tested for the specified rating i.e. the composition density of the material, thickness of coating in case of fire breaks and any other properties of the material / system offered shall be identical or better than the tested system and shall be subject to Owner / Owner's Representative approval.

1.9 **Performance Tests: Tests on Fire Stops**

- (a) The fire stops shall be subjected to the following type tests:

- (i) Fire Rating Test
- (ii) Hose Stream Test

- (b) Type tests shall be conducted on different fire stop test specimens described above as per IEEE-634. The sizes of the fire stop test specimens, shall be similar to the largest of the sizes being used in the plant.

- (c) Preconditioning of fire stop test specimens

Before conducting the fire rating and hose stream tests, each test specimen shall be preconditioned for thermal ageing, water immersion and vibration.

- (d) Test on Fire Stops

During the fire rating test, the transmission of heat through the cable penetration fire stop shall not raise the temperature on its unexposed surface above the self ignition temperature of the outer cable covering, the cable penetration fire stop material, or material in contact with the cable penetration fire stop, with a maximum temperature limit on the unexposed surface of 200°C.

- (e) Tests on fire breaks

Firebreaks shall undergo the following tests as per ANSI-IEEE-383:

- (i) Ampacity test
- (ii) Flame test

ANNEXURE- A2

SUB-SECTION – B-13

FIRE PROOF CABLE PENETRATION SEALING SYSTEM

CLAUSE NO.	TECHNICAL REQUIREMENTS			
1.00.00	CODES AND STANDARDS			
1.01.00	The fire proof cable penetration (FPCP) sealing system shall conform to the requirement of latest edition including amendments of BS:476 Part-20 Fire tests on Building materials and structures.			
1.02.00	Fire penetration seal complying with any other international standards will also be considered if it ensures performance equivalent or superior to standard listed above.			
1.03.00	The Bidder shall clearly indicate the standards adopted and furnish a copy of the English version of the latest editions of standards alongwith the bid, and shall clearly bring out the salient features for comparison.			
2.00.00	SYSTEM DESCRIPTION			
2.01.00	The fire proof cable penetration sealing system shall be of the following types;			
	i) Type - A Type A fire sealing system is either Silicone foam or equivalent foam system or using individual blocks for each cable along with suitable frame work rated for one hour. Type A is to be implemented at floor openings below C&I panels, control panels/Boards etc. in CER & CCR.			
	ii) Type-B Type B fire sealing system is any proven fire sealing system rated for one hour. This will comprise of rest of wall and floor crossings of cables/cable trays, opening below HT/LT Switchgears/board other than those covered under Type A.			
2.02.00	The penetration system, shall be installed immediately after the completion of cable termination in a particular switchboard/control panel/area after clearance from the Project Manager.			
3.00.00	GENERAL INFORMATION			
3.01.00	The cables shall generally be laid in cable trays/racks, conduits, ducts. The fire proof cable penetration system shall be designed in such a way that the existing supporting structure/cable is not disturbed.			
3.02.00	The penetration system shall be suitable for site condition at 50 ⁰ C ambient temperature and relative humidity of 100%.			
3.03.00	The penetration system of each wall/floor crossing shall be adequately designed/sized such that 20% addition of cables is possible at any later date without disturbance/wastage of material in the penetration system.			
3.04.00	Contractor shall plan the schedule of supply of the materials in consultation with Project Manager and use the material within stipulated shelf life of material. After			
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	award of work, drawings for each penetration seal shall be prepared by the contractor after verifying the actual installation of cables at site and approval shall be taken from the Project Manager's representative before proceeding with the actual work. The requirement of fire sealing material shall be quantified accordingly. Fire sealing material to be supplied shall be based on the net area to be sealed, wastage, thickness, density and other parameters as per the type test report approved under this contract.			
4.00.00	TECHNICAL REQUIREMENTS			
4.01.00	The fire proof cable penetration system shall fully comply with the requirements of BS:476 Part-20 and also to the requirements specified in this specification.			
4.02.00	The penetration system shall prevent spreading of fire in cable beyond the seal system in case of fire and shall have minimum 1 hour fire resistance rating.			
4.03.00	The penetration system shall be physically, chemically, thermally stable and shall be mechanically secure to the masonry/concrete/structural members. The system shall be mechanically robust and capable of giving satisfactory performance under vibrations encountered in power stations.			
4.04.00	The penetration system shall be capable of withstanding mechanical loads, foot traffic drop loads, vibrations, wind pressure, etc.			
4.05.00	The penetration system shall be completely gas and smoke tight.			
4.06.00	The penetration system shall retain integrity and perform satisfactorily even after remaining in water for long period.			
4.07.00	The materials used in FPCP sealing system shall be non-toxic and harmless to the working personnel.			
4.08.00	The penetration materials shall have no reaction with cable sheath/galvanising/painting of structural steel.			
4.09.00	The penetration materials shall have anti-rodent and anti-termite properties.			
4.10.00	The penetration materials shall have no shrinkage or cracking after the setting for the complete life of the power Plant.			
4.11.00	Under normal load, short circuit and fire conditions, cables may be subjected to movement and vibration. The FPCP sealing system shall be designed to withstand and perform satisfactorily under these conditions.			
4.12.00	The penetration system shall not affect the current carrying capacity of cables passing through it.			
4.13.00	Asbestos shall not be used in the construction of fire penetration seal system.			
4.14.00	The penetration system shall have life expectancy of 40 years.			
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4.15.00	The penetration system shall not emit any corrosive or toxic fumes or smoke on the unexposed face of the barrier.			
4.16.00	Any wastage of the compound during the process of mixing for preparing the FPCP sealing compound shall be to Contractor's account.			
4.17.00	For foam type of systems, only the foam shall form the penetration seal of specified rating, having the damming board removed after curing of the foam.			
5.00.00	PACKING AND STORAGE			
5.01.00	All materials and components of penetration system shall be supplied in packing to avoid contamination of materials due to dust/moisture and temperature during transit and storage. All packing shall be of durable quality and the date of expiry and the date of manufacture shall be printed on it.			
6.00.00	INSTALLATION			
6.01.00	The contractor shall take adequate care to ensure that cables are not damaged in any manner during penetration system installation.			
6.02.00	Wherever the floor/wall opening provided in the vicinity of penetration seals larger or smaller than that required for the cable fire penetration, these opening size can be reduced or increased in an approved manner by the contractor using the same materials as provided around the opening and of the same thickness. Generally the walls in the power station comprises of brickwork and the floors are made of RCC/steel work. The Contractor shall be paid for this work at the unit rates for the respective brickwork/ R.C.C.			
6.03.00	The work to be carried out under this specification shall be done under the supervision of Project Manager's representative.			
6.04.00	All work shall be carried out in accordance with the agreed "field quality plan" and approved drawings. The "field quality plan" shall additionally specify the fire sealing material thickness, minimum cured density and other related parameters achieved in the approved type tests for the contract. The work shall be done to the satisfaction of the Project Manager and the same shall be subject to Project Manager's approval for acceptance.			
6.05.00	The installation shall be carried out in a neat workmen like manner by the skilled, experienced and competent workmen.			
6.06.00	Installation work at site shall be properly coordinated with other services.			
6.07.00	All materials being supplied or consumed during installation by the Contractor in the process of installation shall be of the best quality and according to relevant standards. All materials shall be inspected and approved by the Project Manager before the same is used for installation work. Also regarding inspection of work, the engineer shall have the right to inspect at any stage during installation, testing and commissioning.			
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CLAUSE NO.	TECHNICAL REQUIREMENTS		
6.08.00	The drilling and welding of building-steel or fixing supports etc. shall be carried out by contractor after taking prior approval of Project Manager.		
6.09.00	Any work like chipping, breaking of existing structure like wall, floors, fabrications, any civil work etc. shall be done after taking prior approval of the Project Manager.		
6.10.00	The following jobs are also in the scope of contractor's work		
	a) Reasonable amount of drilling, cutting and welding surface preparation to fix the fire stops.		
	b) Supply of necessary cement, gravel, sand etc. required for grouting necessary supports.		
	c) All supporting arrangement.		
7.00.00	TYPE TESTS, ROUTINE & ACCEPTANCE TESTS		
7.01.00	All equipment to be supplied shall be of type tested design. During detail engineering, the contractor shall submit for approval the reports of all the type tests as listed in this specification and carried out within last ten years from the date of bid opening. These reports should be for the test conducted on the equipment similar to those proposed to be supplied under this contract and the test(s) should have been either conducted at an independent laboratory or should have been witnessed by a client.		
7.02.00	However if the contractor is not able to submit report of the type test(s) conducted within last ten years from the date of bid opening, or in the case of type test report(s) are not found to be meeting the specification requirements, the contractor shall conduct all such tests under this contract at no additional cost to the Owner either at third party lab or in presence of client/owners representative and submit the reports for approval.		
7.03.00	All acceptance and routine tests as per the specification and relevant standards shall be carried out. Charges for these shall be deemed to be included in the equipment price.		
7.04.00	The type test reports once approved for any projects shall be treated as reference. For subsequent projects of SCCL, an endorsement sheet will be furnished by the manufacturer confirming similarity and "No design change". Minor changes if any shall be highlighted on the endorsement sheet.		
7.05.00	Following Type test reports as per the setup and procedures given in subsequent clauses for the Fire proof cable penetration sealing system shall be submitted:		
	a) The accelerated ageing test		
	b) Water absorption test		
	c) Fire rating test		
	d) Hose stream test		
	e) Vibration test followed by fire rating test		
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CLAUSE NO.	TECHNICAL REQUIREMENTS
7.05.01	Tests a, b, c and d should have been carried out on same test sample subsequently one after the other without any touching up/repair/modifications in the same sequence and in accordance with the clause 9.00.00. The test sample shall be assembled as per clause 8.00.00.
7.05.02	Test indicated in clause 7.05.00 (e) above should have been carried out on a separate sample and as per the procedure indicated under clause 9.05.00.
7.05.03	Physical, chemical and mechanical properties of various components/ingredients used should have been also be tested as a part of type tests.
7.05.04	Test reports shall contain the following information: 1. Type of penetration material tested 2. Details of various components/ingredients used alongwith their catalogue. 3. Physical, chemical and mechanical properties of various components/ingredients used. 4. Description of the various test assemblies tested. 5. Details of method of conditioning. 6. The observations as called for in BS:476 Part-20 and technical specification.
7.06.00	ROUTINE & ACCEPTANCE TESTS Routine and acceptance tests to be carried out on Type-A and Type-B cable fire sealing system shall be mutually agreed based on the type of fire sealing material offered before placement of award.
8.00.00	TEST SPECIMEN ASSEMBLY
8.01.00	The test specimen shall be assembled as per enclosed drawing and shall resemble typical floor crossing cable penetration system.
8.02.00	The test specimen shall be designed to seal an opening of adequate size in a concrete slab of 200 mm thickness. Two lengths of 300/600 mm wide ladder type cable tray shall be assembled with required layer of XLPE/PVC insulated, PVC sheathed unarmoured cables in touching formation. Type and number of cables in the cable tray shall be as per enclosed drawing. Cables shall be adequately clamped with tray at both the sides of the penetration as shown in the drawings. However, for penetration system with blocks which require staggered arrangement, cables can be clamped at an adequate distance from the penetration and the tray need not pass through the penetration seal.
8.03.00	The opening in the test specimen then shall be sealed with fire proof cable penetration sealing materials.
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CLAUSE NO.	TECHNICAL REQUIREMENTS			
9.00.00	TEST PROCEDURES			
9.01.00	ACCELERATED AGEING TEST The test specimen assembled as per clause 8.01.00 with damming board removed shall be subjected to accelerated ageing test by storing in air furnace where the temperature of the inside air shall be maintained at 85 degree centigrade for 168 hours. The temperature controlled furnace should have 7 air changes per hour approx.			
9.02.00	WATER ABSORPTION TEST			
9.02.01	The test specimen shall be immersed in fresh clean water at a temperature of 20 deg. C $\pm$ 2 deg C. The test specimen must be separated from the bottom and sides of the soak tank by at least 10 mm and it shall be covered by approximately 25 mm of water. At the end of the 24 hour soak period the specimen shall be removed from water and mopped up with a damp cloth.			
9.03.00	FIRE RATING TEST			
9.03.01	The test specimen after withstanding water absorption test shall be subjected to fire rating test as per BS: 476 part-20.			
9.03.02	Oil/Gas fired furnace shall be used for heating. The furnace shall have achieved standard time/temperature characteristics for fire tests as per BS:476 part-20.			
9.03.03	The pressure inside the furnace at the time of test shall be within 1.5 $\pm$ 0.5 mm water gauge.			
9.03.04	Cables in the test specimen shall be anchored on the hot side to a structure independent of the barrier and its penetrations. This is to ensure that any differential movement between the penetration and the cable that could occur during a fire, is produced in the type tests and the reliability of the integrity of the penetration is checked.			
9.03.05	Cables shall be protruding between 1 to 2 metre, from the penetration face on the unexposed side and protruding into the furnace as far as it is practicable with a minimum length 750 mm. The ends of the cables shall be capped on the unexposed face to prevent gases and fumes to escape from the furnace during the fire.			
9.03.06	The test specimen shall be subjected to fire test with surface exposed to controlled fire in the furnace confirming to time/temperature characteristics specified in BS:476(20).			
9.03.07	During the test the temperature of both the faces of the fire stop i.e. one which is exposed to fire and other unexposed shall be measured by calibrated thermo couples after regular interval of 5 minutes.			
9.03.08	Atleast 3 thermo couples shall be provided for temperature measurement of each face. The results at the end of the test shall be interpreted for failure criteria as under.			
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CLAUSE NO.	TECHNICAL REQUIREMENTS
	1. The system is deemed to have failed to maintain stability if there is a total collapse of the fire proof seal. 2. In case cracks are seen on the face of the fire stop or cracks through which the flame/ hot gas can pass the systems deemed to have failed to maintain integrity. The development of crack is characterised by appearance of black soot on cotton wool held near the penetration on the unexposed surface at a distance of about 100mm. 3. Failure shall be deemed to have occurred when the mean temperature of the unexposed surface of the specimen assembly increases by more than 140⁰C above the initial temperature or if the temperature of the unexposed surface is increased at any point by more than 180⁰C above the initial temperature. During the test the specimen shall meet all the three criteria simultaneously.
9.03.09	Temperature measurement on the unexposed side of penetration seal shall be measured by thermocouples at a distance of 25 mm from unexposed side of fire stop.
9.04.00	HOSE STREAM TEST
9.04.01	A hose stream test shall be conducted on the test specimen immediately following a fire resistance test on that assembly. The specimen must first be removed from the furnace since the hose stream is to be applied to the exposed face. This must be done quickly since it is the intention of the test that the stream be applied to the specimen whilst it is hot.
9.04.02	The hose stream shall be long range narrow angle, (20 ⁰ - 90 ⁰ set at 30 ⁰ included angle). High velocity water spray provided from a 28 mm hose discharging through an appropriate nozzle. The water pressure shall be 5 bar calculated at the base of the nozzle and the minimum flow rate shall be 4.7 litres/second. The stream shall be supplied perpendicularly to the exposed face of the test specimen with nozzle 3 m away from the exposed face.
9.04.03	Application shall be for minimum of two and a half minutes per 9 sq.m. of the test specimen including the barrier.
9.05.00	VIBRATION TEST
9.05.01	The test assembly is to comprise a single ladder rack penetration in 1 m x 1m high normal section of fire barrier which is securely supported. The penetration seal shall be formed in the middle of the barrier around 1 m length of 600 mm ladder rack. The tray shall be fully loaded with cables in touching formation. The penetration assembly shall be formed symmetrically through the fire barrier as in service. The penetration sealant material shall then be allowed to cure for atleast as long as the time required for conditioning to constant mass. A vibration test shall then be conducted on the sample as set out below.
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CLAUSE NO.	TECHNICAL REQUIREMENTS		
9.05.02	The vibration shall be of 100 Hz frequency and of 0.5 mm amplitude (1.0 mm peak to peak) and this shall be applied to one rail of the ladder rack or the centre of a cross member secured to the two rails at 250 mm from the centre line of the penetration. This vibration shall be applied to the sample for the minimum period of 3 hrs. Immediately following this vibration test the barrier/ penetration assembly shall be successfully subjected to a fire test in accordance with clause no. 9.03.00.		
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