

- 2.04.10 All openings in the floor and wall for cable access shall be sealed after installation of the cable system with non-inflammable materials, as follows :
- i) Fire stop/Penetration seal shall be installed in the cable spreaders and cable raceways.
  - ii) Similarly in the trenches fire stop/penetration seals shall be provided at suitable interval to avoid spread of fire.

- iii) For all H.T., L.T., Relay and Control panels, Control desk, instrumentation panels, battery charger, D.C. Dist. boards and other miscellaneous panels, fire-stops should be provided below base plate.
- 2.04.11 All floor/wall openings for cable entry to the electrical equipment and accessories shall be sealed with non-inflammable materials, after completion of cable installation. Thickness of such materials shall be equal to the thickness of floor/wall unless specified otherwise.
- 2.04.13 Refer Clause No. 3.00.00 below for details of fire-proof sealing and fire protection coating.
- 3.00.00 **FIRE-PROOF SEALING / FIRE PROTECTION COATING SYSTEM**
- 3.01.00 The Fire proof sealing / fire stop system / fire protection coating system is required to prevent spreading of fire from one place to other place (or one zone to other zone) through the openings in wall / floor, cables laid in trays / racks and openings below Electrical Switchgear / MCC / Distribution boards / Cabinets / Panels, etc. The fire proof sealing system shall conform to the latest edition including amendments of BS-476.
- 3.02.00 **Scope of Work**
- 3.02.01 The scope of work includes but is not limited to the following supply and services:
  - i) Fire Stops in wall / floors.
  - ii) Fire stops below switchgear / MCC / Switchboards, junction boxes / panels / cabinets, etc. which are floor mounted type.
  - iii) Fire retardant coating to be applied for installed cables.

- iv) Minor civil / structural works for installation of the entire work.
- v) All necessary erection materials, consumables and sundry items to complete the entire work for satisfactory and trouble free operation.
- vi) Any special tools & tackles.
- vii) Conducting the type test of fire proof sealing system in presence of Owner's engineers.
- viii) All relevant Drawings, Data sheets and instruction manuals.
- ix) Fire proof barrier walls.
- x) Fire proof doors.

**3.03.00 Design Criteria**

**3.03.01 Fire Proof Sealing System**

The material / components used for fire-proof sealing system shall be provided to meet the following requirements:

- i) Life expectancy should not be less than 30 years from the date of installation.
- ii) Free from shrinkage or cracking or asbestos in composition and should achieve smoke and gas tightness during fire and should be modifiable.
- iii) Not to generate toxic gas and harms to the personnel handling the system.
- iv) Prohibition of production of acid or alkali during gas generation.
- v) Will not produce suffocating / corrosive gas.
- vi) Repellant to paste / rodent / termite.
- vii) Expansion co-efficient - very low which is to be comparable with masonry concrete.
- viii) Not soluble / reactive to acid, water, alkali.
- ix) Thermal conductivity - low.
- x) The material in contact with the cables in the fire-proof sealing system shall be compatible with the material used for outer sheath of cables.
- xi) It should not have any adverse effect on the cables and should not alter the current carrying capacity of the cables.

- xii) Retrofit in design to accommodate not less than 15% more addition of cables depending upon the size of cables, physically and chemically stable.
- xiii) Capable of withstanding vibrations, drop-loads, foot traffics, mechanical loads, etc.
- xiv) The F.P.S. system shall maintain its integrity and perform satisfactory even after
  - a. Remaining in water for a long time.
  - b. Accelerated thermal aging.
  - c. Sustaining vibrations.
- xv) The design and construction of F.P.S. system shall specifically take into account the fact that under seismic disturbances, normal load, short circuit and fire conditions, the cable / cable trays will be subject to movement, expansion and oscillation and this shall not result in any damage or cause dislocation of the F.P.S. system or the material constituting the FPS System.
- xvi) Non-hygroscopic, non-inflammable and shall not get affected over a period of time due to humidity, moisture and ozone etc. and should not contain volatile solvents which may cause a fire hazard during application.
- xvii) The fire rating shall not be less than one (1) hour and the system shall be stable after applicable of water jet in the exposed side in order to extinguish fire.

**3.03.02 Fire Protection coating to be applied on installed Cables:**

The cables shall be coated with fire protection material of 2 mm dry thickness at the strategic locations as follows so as to limit the spread of fire:

- i) At fire stops in walls and floors on either side upto 500 mm length.
- ii) At fire stop below Electrical Switchgears/ MCCs/ Panels/ Cabins, etc. on one side coating of 500 mm length, i.e., on the cable vault side / cable trench side.
- iii) Length of 500 mm on all sides of the junction/crossing of cabling work in open cable routes/ cable trench.
- iv) In fire risk areas and where specified at suitable intervals as decided upon site conditions in open cable routes.
- v) Where necessary and specified at site intervals along cable routes in cable trenches.
- vi) The coating shall be applied evenly on the cables only.

**3.03.03 The fire protection coating shall have the following properties/composition:**

- i) Asbestos free, non-volatile, not eatable by vermin, harmless and non-irritant to skin of human.
  - ii) Not affecting the current carrying capacity of the cables and the properties of the installed cables.
  - iii) It shall delay fire damage to cables and prevent flame spreading meeting the requirement of IEEE - 383.
  - iv) Coating material shall show no signs of cracking and peeling when the coated cable is bent to the radius of minimum 12 times the diameter of the maximum size cable at 180°C.
  - v) The limiting oxygen index of the material shall not be less than 60% as per ASTM D - 2863.
  - vi) Life expectancy equivalent to the cable installations.
- 3.03.04 The various openings in the cable vault, vertical/ horizontal raceways of cables penetrating walls/ floors and the bottom of Electrical switchgears/ MCCs/ distribution boards/ Cabinets/ Panels shall be provided with fire stop systems. Cables passing through the openings at various locations are laid on various tiers of the cable trays/ racks in the bunch formation. Bidder shall visit the site to assess and get acquainted with the type of cable installation where fire stops and fire protection coating are to be provided. In case steel frames are required to be fabricated and fixed in the openings, the fabrication of frame & fixing of the same shall have to be done by the Contractor without any extra cost. The necessary steel section for fabrication of frames shall be supplied by the Contractor without any extra cost. Any civil works required to be done in the openings shall be carried out by the Bidder. Bidder shall also include one set of tools & accessories required for addition or removal of cables after the seal is made.
- 3.04.00 The bidder shall quote the unit rates for provision of supply, installation, testing & commissioning of the fire proof seals as given in the specification. Bidder is requested to quote the unit rates per square metre (i.e., area) basis of the area of the fire sealing material.
- 3.05.00 **Type Test On Penetration Seals**
- 3.05.01 The type tests for fire proof/ penetration seal for floor and wall opening/ fire stop system for bottom of electrical switchgear/ MCC/ panel base are as under:
- i) Fire rating test.
  - ii) Hose Stream test.
  - iii) Accelerated aging test.
  - iv) Fire rating test on the penetration seal system built out of accelerated aged components followed by hose stream test.
  - v) Temp. rise test for cable in the fire stop.

- vi) Water absorption test followed by fire rating test.
- vii) Flame Resistance test for fire retardant coating material.
- viii) Anti-rodent test.

3.05.02 Fire Rating Test

This test shall be carried out to prove the guaranteed power rating duration of the system in respect of stability, integrity and insulation characteristics of the complete system. The penetration seal system as a whole conforming to ASTM 814 and as per BS:476 Part-8 shall be built with the necessary component. The fire test shall be built with the necessary component.

The test specimen of the penetration seal built with 9-10 nos. armoured cables of various sizes passing through the seal shall be fitted to the gas fired furnace and shall form the upper most face of the furnace. The gas fired furnace shall have provision to achieve standard time temperature characteristics for fire tests as mentioned in BS-476 Part-8, according to which the temperature required to be maintained are as under:

<u>Heating time in minutes</u>	<u>Temperature in the furnace</u>
30 minutes	821°C
90 minutes	886°C
120 minutes	1029°C
150 minutes	1062°C
180 minutes	1090°C
210 minutes	1113°C
240 minutes	1133°C

The pressure inside the furnace at the time of test shall be more than 2 mm water gauge. The penetration shall be subjected to fire test with surface exposed to controlled fire in the furnace conforming to time / temperature characteristics as mentioned above. During the test, the temperature of both the faces of the penetration seal, i.e. one which is exposed to fire and the other unexposed, shall be measured by calibrated thermocouples after regular interval of 5 minutes. At least 3 thermocouples shall be provided for temperature measurement of each face.

3.05.03 The results at the end of the tests shall be interpreted or failure criteria as under:

- i) The system is deemed to have failed to maintain stability if there is a total collapse of the penetration seal.
- ii) In case cracks are seen on the face of the penetration seal or cracks through the sealing system through which the flame / or gas can pass,

the system is deemed to have failed to maintain integrity. The development of crack is characterized by ignition cotton wool held near the seal on the unexposed surface at a distance of about 30 mm from the aperture.

- iii) In case the mean temperature rise of unexposed surface of seal exceeds 140°C above the initial temperature or temperature of unexposed surface exceeds 180°C, the system shall be deemed to have failed in respect of insulation characteristics.
- iv) Temperature measurement on the unexposed side of the penetration seal specimen shall be measured by the thermocouple on the surface of penetrating items and on fire stop material in accordance with ATME-814/UL 1479 at a distance of 25 mm from fire stop material and penetration items respectively.

#### 3.05.04 Hose Stream Test:

The intention of the hose stream test is to ascertain whether the penetration seal assembly maintains its stability on application of water jet after withstanding the fire for 1 hour i.e. the guaranteed fire rating duration.

The test apparatus for this test shall be similar to the one used for carrying out the fire rating test. The penetration seal system shall be subjected to the action of hose stream at the nozzle pressure of 30 psi supplied for a duration of 1.5 sec./ sq.ft. of exposed area. The hose stream shall be applied with 1.1/ 8" dia. nozzle at a perpendicular distance of approximately 17 ft. from the centre of the assembly on a line approximately 270 deg. from the line normal to the centre for the test assembly. The water stream shall be applied within 4 minutes and 30 seconds after completion of fire rating test.

However, this period shall not exceed more than 10 minutes in case of practical difficulties experienced by testing stations. The application of water stream shall be maintained through out the test duration and shall traverse the complete fire stop system.

The fire stop assembly is deemed to have passed the hose stream test successfully if no through projection of water is noticed on the unexposed surface of the seal. Further on completion of hose stream test, the appearance of the penetration seal system shall not alter substantially indicating thereby that the stability of the system has been maintained.'

#### 3.05.05 Accelerated aging test

The intention of accelerated aging test is to ascertain whether the artificial aging of the systems and components thereof results into change in the mechanical properties or in the form. In order to simulate aging, artificial aging shall be resorted to.

For the purpose of subjecting the penetrations seal system components to accelerated aging, the system / components shall be stored for 336 hours in air furnace where the temperature of the inside air, shall be maintained at 100 degree centigrade. However, for system components in pliable form, system component shall be stored for 448 hours in air furnace where temp. of air inside the furnace shall be maintained at 75°C. It is assumed that the

changes occurring during test period would roughly correspond to the effect on aging over a period of about 40 years.

After completion of 336 hours / 448 hours, the mechanical properties such as tensile strength element, elongation and hardness of the material (as may be applicable) shall be tested. These results shall be compared with corresponding values before subjecting to accelerated aging test.

The change in the form of system / components shall also be compared with the form before the tests to ascertain whether the system / components thereof have undergone any permanent change.

In case the mechanical properties before and after the accelerated aging do not indicate substantial change, the system shall be deemed to have passed the accelerated aging test. Similarly the variation in the form of the system components at the end of the test shall not indicate permanent deformation which is likely to affect the ceiling properties of the system.

**3.05.06 Fire Rating test After Accelerated Aging:**

Intention to this test is to ascertain whether the penetration seal built out of components already subjected to accelerated aging still passes the fire rating test for guaranteed fire rating duration.

The test apparatus for this test shall be similar to the one used for fire rating test mentioned above. The assembly or the penetration seal shall be carried out with the components which were subjected to accelerated aging test based on the test procedure mentioned above. In case there is a problem of co-ordination with the test station, the prototype assembly may be subjected to aging in manufacturer's works under the conditions mentioned above and live fire test should be carried out at manufacturer's works in presence of Owner's representative.

In live fire test, the temperature of fire shall be of the order of 1000 deg.C at the end of 3 hours. The test shall be carried out at atmospheric pressure.

The interpretation of test results for failure shall be similar to those mentioned under fire rating test/live fire test at (1) - (c) above.

**3.05.07 Temperature rise test for cable in the fire stop:**

This test shall be carried out to ascertain whether due to inadequate dissipation of heat at the location of fire stop, the temperature of cable conductor or outer sheath in contact with the fire stop, rises beyond the acceptable limits due to which whether any derating is required for cables.

Fire stop systems shall be erected with, at least 8-10 armoured cables, specially power cables. While laying the cable through penetration seal, thermocouple shall be placed on the outer surface of cable in contact with the fire stop system. The location shall be selected where there exists possibility of inadequate dissipation of heat from cables to the atmosphere due to fire stop components. Two thermocouples shall also be located on the two surfaces of the fire penetration seal system. Similarly thermocouples shall also be placed on the other surface of cables where there exists contact of free air without any obstruction so as to enable adequate nature cooling.



In case the temperature of outer surface of the cable in contact or inside the fire stop system does not exceed 75 degree centigrade, it is inferred that no derating of cable is required for cable when used in conjunction with the particular fire stop system.

Test shall be repeated with reduced current till the temperature of cable outer surface in contact with fire stop system is limited to 75°C. The rate of the current so guaranteed by the cable manufacturer as free air rating shall be the derating factor.

**3.05.08 Water Absorption Test:**

The test specimen shall be immersed in fresh clean water at a temp. of 20°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 hours soak period, the specimen shall be removed from the water and mopped up with a damp cloth.

Fire rating test after water absorption is to ascertain whether the penetration seal subjected to water absorption still passes the fire rating test for guaranteed fire rating duration.

The test apparatus for this test shall be similar to the one used for fire rating test at Sr. No.1. In case there is problem of coordination with test stations, the prototype assembly may be subject to water absorption test at manufacturer's works followed by live fire test which should be carried out at manufacturer's works in presence of Owner's representative. In line fire test, the temp. of furnace shall be of the order of 1000°C at the end of 3 hours. The test shall be carried out at atmospheric pressure.

**3.05.09 Flame Resistance Test for fire Retardant Coating Material:**

Sample strips shall be of ½ " wide, 12" long and approximately 70 mills in thick (without any reinforcement). Each strip shall be held vertically (clamped at the top) in a natural gas burner flame, (blue cone of flame touching bottom edge of sample) for 10 minutes. The flame shall then be removed and observation shall be recorded. In case, any flaming of the samples should cease after the removal of gas burner. White charred length of the sample should not exceed 1 & ½".

**3.05.10 Anti-Rodent Test:**

Physical tests:

- a) This test shall be carried out to ascertain the anti-rodent properties of the components of the Fire proof sealing system.
- b) This test shall be carried out at approved test station performing sealing system tests on pharmaceutical products. The complete Fire Proof sealing system shall be subjected to attack of insect / vermin such as rat for about 20 days.
- c) At the end of the test condition of the surface of Fire Proof sealing system the test material shall be compared with the surface condition

before commencement of the test. The fire stop shall be deemed to have passed this test in case no marks of growth are seen on the surface.

**3.05.11 Test Certificates**

Certified copies of all tests carried out at works and at site shall be furnished in requisite number of copies.

Test reports shall be complete with all details and shall also contain limit valves specified in the relevant standards, wherever applicable, to facilitate review of Test Report/ Certificates.

The fire proof sealing system shall be installed only after receipt of approval of the test reports.

**3.05.12 Testing Charges**

The bidder has to indicate that unit rates for conducting the type test successfully alongwith the offer, which will be considered for evaluation of tender.