1.0 INTENT OF SPECIFICATION

This section covers the design and performance requirements of the following types of fire protection systems:

a) Nitrogen Injection Fire Prevention cum Extinguishing System
b) Portable Fire Extinguishers

1.1 It is not the intent to completely specify all details of design and construction. Nevertheless, the system design and equipment shall conform in all respects to high standard of engineering, design and workmanship and shall be capable of performing in continuous commercial operation in a manner acceptable to the Owner. The system design shall also conform to TAC/ NFPA norms.

1.2 The scope of work includes complete installation of fire protection system wherever it is required.

1.3 The equipment offered shall comply with the relevant IEC. The equipment conforming to any other approved international standards shall meet the requirement called for the latest revision of relevant Indian Standard or shall be superior.

1.4 Ambient temperature for design of all equipment shall be considered as 50° C.

1.5 The successful bidder shall prepare detailed layout and piping drawing and also other drawing such as road, drainage, cable trench, switch yard layout, etc. as furnished by the Employer during detailed engineering.

2.0 NITROGEN INJECTION FIRE PREVENTION CUM EXTINGUISHING SYSTEM

2.1 General:

Provision of inbuilt Complete Nitrogen Injection Fire Prevention cum Extinguishing System

Nitrogen Injection System for the Protection of Transformers against fire due to an arc, during internal faults and external fires is required to be provided with the 160MVA & 315 MVA Transformers for preventing tank explosion.

2.2 The system should comprise the following:-

i). Fire Extinguishing Cubicle with base frame and containing, oil drain assembly, nitrogen cylinder, electric mechanical control unit for oil drain and nitrogen
release detections necessary for monitoring system flanges on top panel for connecting pipe connections from transformer, panel lighting etc.

ii). Control Box for monitoring system operation, automatic control and remote operation, with alarms, indication light switches, push buttons, audio signal, suitable for tripping and signaling on 220 V DC supply.

iii). Pre-stressed non-return valve (PNRV) working on transformer oil flow rate, with proximity switch for remote alarm indication and with visual position indicator.

iv). Required number of fire detectors rated for 141°C for heat sensing, each fitted with two number cable glands.

v). Signal box for terminating cable connections from PNRV and fire detectors.

vi). Pressure relief valve with limit switch.

2.3 The following arrangements are required to be made on the transformer Tank at the time of fabrication of the tank :-

i). Oil drain opening with pipe, flange and manual gate valve at about 120mm below the top cover. Pipe size DN125 for 160 MVA and higher ratings.

ii). Nitrogen Injection openings with pipe size DN 25 with flange and manual gate valve on tank sides at about 100-200 mm from the bottom plate.

iii). Flanges having 4 Nos. 18 dia. holes with pcd as 155mm and dummy pipe on the conservator pipe between buchholz relay and conservator tank manual gate valve, for fixing PNRV.

iv). Supply and welding of fire detector brackets on top cover.

v). Supply and welding of the brackets for fixing signal box at a suitable location on top cover or tank size wall.

2.4 The following jobs shall also be within the scope of the Contractor/Sub-Contractor :-

i). Civil work including oil pit and fire wall.

ii). Material handling facility for placing F.E. cubicle on plinth

iii). Required electric signals connections to control box except fire detectors and PNRV.

However all cabling, piping and any other material required shall be supplied by the manufacturer Installation and Pre-commissioning tests shall also be in the scope of Contractor/Sub-Contractor.
2.5 **ACTIVATION OF NIFPES:**

2.5.1 Mal-functioning of fire prevention / extinguishing systems is their major shortcoming which leads to interruption in power supply. The Contractor/Sub-Contractor shall ensure that the chances of malfunctioning of NIFPES are practically nil. To achieve this objective, the Contractor/Sub-Contractor shall work out his scheme of activating signals which, while preventing mal-operation, should not be too rigorous to make the operation of NIFPES impracticable in case of actual need. Transformer isolation shall be the mandatory pre-requisite for activation of the system in Automatic mode or Remote mode in the control room. In addition, at least following electrical-signals shall be provided in series for activating NIFPES.

2.5.2 **Auto Mode**

a) For Prevention of Fire : i) Differential Relay Operation
target: Parallel with Buchholz Relief Valve or RPRR. (Rapid Pressure Release Relay)
ii) Tripping of all concerned breakers is a pre-requisite for initiation of system activation.

b) For Extinguishing Fire : i) Fire Detector
ii) Buchholz Relay paralleled with Pressure Relief Valve or RPRR.
iii) Tripping of all connected breakers is a pre-requisite for initiation of system activation.

2.5.3 **Manual Mode (Local/Remote)** : Tripping of all connected breakers is a pre-requisite for initiation of system activation.
2.5.4 Manual Mode (Mechanical) : Tripping of all connected breakers is a pre-requisite for initiation of system activation.

2.6 General Description of NIFPES
2.6.1 Schematic of the System
NIFPES should be a stand alone dedicated system for oil filled. It should have a fire extinguishing (FE) cubicle placed on a plinth at a distance of 6-10 mtrs. from the transformer. The F.E. cubicle may be connected to the transformer oil tank (near its top) and to the oil pit from its bottom through oil pipes with gate valves. The F.E. cubicle should house a pressurized nitrogen cylinder connected to the transformer oil tank (near its bottom). Cable connections are to be provided from signal box placed on the transformer to the control box in the control room and from control box to F.E. cubicle. Fire detectors placed at the top of transformer are to be connected in parallel to the signal box. The signal box may be connected to a pre-stressed non-return valve fitted between the conservator tank and Buchholz relay. Control box is also to be connected to relay panel is control room for system activation signals.

2.6.2 Operation
On receipt of all activating signals, drain of pre-determined quantity of oil commences thus removing high temp. top oil layer. Simultaneously nitrogen is injected under high pressure at a pre-fixed rate, string the oil thus bringing the temperature of top oil layer down. Nitrogen occupies the space created by oil drained out and acts as an insulating layer between the tank oil & fire on top cover. Pre-stressed non return valve blocks oil flow form conservator tank, thus isolating it & preventing aggravation of fire.

2.6.3 System Components
Broadly, NIFPES shall consist of the following components. It is emphasized that all components irrespective of their exclusion in the details given below, necessary for fast reliable & effective working of NIFPES shall be considered within the scope of supply.
2.6.4 **Fire Extinguishing Cubicle**

It shall be made of 3mm thick steel sheet, painted dark red from inside & outside with hinged split doors fitted with high quality tamper proof lock. It shall be complete with the base frame and the following :-

- Nitrogen gas cylinder with regulator and falling pressure electrical contact manometer
- Oil drain pipe with mechanical quick drain valve.
- Electro mechanical control equipment for oil drain and pre-determined regulated nitrogen release.
- Pressure monitoring switch for back-up protection for nitrogen release.
- Limit switches for monitoring of the system.
- Flanges on top panel for connecting oil drain and nitrogen injection pipes for transformer.
- Panel lighting (CFL Type)
- Oil drain pipe extension of suitable sizes for connecting pipes to oil pit.

2.7 **Control Box**

Control Box for monitoring system operation, automatic control and remote operation, with following alarms indication, light switches, push buttons, audio signal, line fault detection suitable for tripping and signaling on 220V DC supply:

- System on
- PNRV open
- Oil drain valve closed
- Gas inlet valve closed
- PNRV closed
- Fire Detector Trip
- Buchholz Relay Trip
- Oil drain valve open
- Extinction in pressure
- Cylinder pressure low
- Differential relay trip
- PRV/RPRR trip
- Transformer trip
- System out of service
> Line fault free detector
> Line fault differential relay
> Line fault buchholz relay
> Line fault PRV
> Line fault transformer trip
> Line fault PNRV
> Auto/Manual/Off
> Extinction release on
> Extinction release off
> Lamp test
> Visual / Audio Alarm
> Visual / Audio alarm for DC supply fail

The signals marked (*) shall be in the topmost row of control box panel.
The signals marked (^) shall follow next.

2.8 **Pre-stressed Non Return Valve (PNRV)**
PNRV is to be fitted in the conservator pipe line between conservator & Buccholz relay. It shall have the proximity switch for remote alarm, indication and with visual position indicator. The PNRV should be of the best quality because malfunction of PNRV shall be of serious consequence as its closing leads to stoppage of breathing of transformer.

2.9 **Fire Detectors**
The system shall be complete with adequate number of fire detectors fitted on the top of oil tank, OLTC/Off ckt. Tap changer rated for 141°C for heat sensing each fitted with two no. cable glands (water proof/weather proof).

2.10 **Signal Box**
It shall be fitted on the transformer for terminating cable connections from PNRV & fire detectors and for further connection to the control box.

2.11 **Cables**
Fire survival cables, able to withstand 750°C, 4 core x 1.5mm sq. for connection of fire detectors in parallel shall be used.
Fire retardant low smoke (FRLS) cable 12 core x 1.5mm sq. for connection between transformer signal box/marshalling box to control box and control box to fire extinguishing cubicle shall be used.

Fire retardant low smoke (FRLS) cable 4 core x 1.5mm sq. for connection between control box to DC supply source and fire extinguishing cubicle to AC supply source, signal box marshalling box to pre-stressed non return valve connection on transformer shall be used.

2.12 Pipes
Pipes, complete with connections, flanges, bends, tees etc. shall be supplied alongwith the system.

2.13 Other items

a) Oil drain and nitrogen injection openings with gate valves on transformer tank at suitable locations

b) Flanges with dummy piece in conservator pipe between Buchholz relay and conservator tank for fixing PNRV.

c) Fire detector brackets on transformer top cover.

d) Spare potential free contacts for system activating signals i.e. differential relay, buchholz relay, pressure relief valve, transformer isolation (master trip relay).

e) Pipe connections between transformer to fire extinguishing cubicle and fire extinguishing cubicle to oil pit.

f) Cabling on transformer top cover for fire detectors to be connected in parallel and inter cabling between signal box to control box and control box to fire extinguishing cubicle

h) Gate valves on oil drain pipe & nitrogen injection pipe should be able to withstand full vacuum. A non-return valve shall also be fitted on nitrogen injection pipe between transformers & gate valve.
i) Pressure relief valve, wherever not fitted on the existing transformer, shall also be in the scope of supply of Contractor/Sub-Contractor, along with its installation.

j) The F.E. cubicle shall be painted with post office red colour (Shade 538 of IS-5). All the exposed parts i.e. pipes, supports, signal box etc. shall be painted with enameled paint.

2.15 Modification on the transformer

No modification on the transformer shall be allowed which affects its performance (i.e. efficiency, losses, heat dissipation ability etc.), safety, life etc. or its any other useful parameter. This requirement shall be of paramount importance and shall form the essence of the contract.

However, in any case, performance of transformer should not be affected in any manner by having NIFPES system and the Contractor/Sub-Contractor shall give an undertaking to this effect. All pipes should be washed/rinsed with transformer oil. If any damage is done to the transformer and/or any connected equipment during installation & commissioning full recovery therefore shall be effected from the Contractor/Sub-Contractor, of NIFPES system.

It shall be solely the responsibility of Contractor/Sub-Contractor to install, carry out pre-commissioning tests & commission NIFPES at East of Loni
indicated in this Specification, to the entire satisfaction of the Employer and/or his representative.

2.16 Interlocks
It shall be ensured that once the NIFPES gets activated manually or in auto mode, all the connected breakers shall not close until the system is actually put in OFF mode. Also PNRV shall get closed only if all the connected breakers are open.

2.17 Scope of work
Bidder to substations.
The bidder may visit the substations in order to prepare a realistic bid especially w.r.t.

a) The probable location of various components of NIFPES in consultation with DTL. The location of oil pit shall be such that the same could be used for other transformer of the substation to be covered under NIFPES. The possibility of common oil pit for the transformer at substation to be covered with NIFPES.

b) Required lengths of various pipes & cables.

c) The design of NIFPES to ensure that it does not interfere with general maintenance/other activities carried on the transformer & in the substation and provision of NIFPES on remaining transformers at the substation.

2.18 Technical Particulars
2.18.1 Fire Extinction period

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>On commencement of Nitrogen Injection</td>
<td>Maximum 30 seconds</td>
</tr>
<tr>
<td>From the moment of system activation to</td>
<td>Maximum 3 minutes</td>
</tr>
<tr>
<td>complete cooling</td>
<td></td>
</tr>
<tr>
<td>Fire detectors heat sensing temperature</td>
<td>141°C</td>
</tr>
<tr>
<td>Heat sensing area</td>
<td>800mm radius</td>
</tr>
<tr>
<td>Pre-stressed non return valve setting for</td>
<td>minimum 60 ltr. Per minute</td>
</tr>
<tr>
<td>Operation</td>
<td></td>
</tr>
<tr>
<td>Capacity of Nitrogen cylinder</td>
<td>Minimum 68 litre water capacity And shall hold</td>
</tr>
</tbody>
</table>
minimum 10 cubic meter gas to 150 bar pressure.

Power Source:
Control Box : 220V DC
Fire extinguishing cubicle for lighting : 230V AC

Guaranteed technical particulars as per Section GTP shall be submitted along with the bid. The bidder shall clearly specify the following in the bid:

a) The maintenance and testing schedule for NIFPES.
b) All the steps required to be undertaken for restarting the transformer and connected equipment after operation and mal-operation (if any) of the NIFPES.
c) The process of venting nitrogen in case nitrogen pressure in the cylinder exceeds the stipulated maximum value.

2.19 Previous Experience for qualifying Bidder
The Bidder shall have a minimum experience of five years in the design, manufacturing, erection, testing and commissioning of nitrogen injection fire protection, system on power transformers of similar or higher rating. At least 6 sets of the system shall be in successful operation on power transformers on similar & higher ratings with at least three different organisations for a minimum period of the 2 years. The Bidder shall furnish the details of nitrogen injection fire prevention and extinguishing systems supplied by them so far giving order reference, name and address of the customer, indicating the dates of commissioning as well as performance certificate from customers, of successful and satisfactory operation for minimum two years.

2.20 CODES AND STANDARDS
The design and installation of complete fire protection system shall comply with the latest applicable Indian standards wherever Indian standards are not available relevant British / I.E.C. / codes shall be followed. The following standards / codes shall be followed in particular.

a) Approval certificate should be obtained from Loss Prevention Association (LPA).
b) National Fire Codes 1993 of National Fire Protection Association (NFPA) USA.

The entire fire protection system shall be designed, erected and commissioned in accordance with the regulation of Tariff Advisory Committee (TAC). In the absence of TAC regulations NFPA regulation shall be adhered to.

2.21 TESTS

Type Tests
Type test reports including that for detectors along with declared response time as per TAC’s letter shall be submitted along with the tender.

Certificates of the test on the system carried out by national/international testing bodies & TAC’s approval, if any, shall also be submitted with the bid.

Factory Test
Tests will be carried out on individual equipment of the system, as applicable and the total system in the Contractor/Sub-Contractor’s workshop in presence of Employer’s representative.

Performance Test
Performance test of the complete system shall be carried out after complete erection at site by the Contractor/Sub-Contractor’s representative. These tests shall include simulation and verification of the response of the complete system without injection of the nitrogen gas.

Drawings and Manuals
Detailed layout drawing along with the equipment drawing & control ckt. Drawing shall be given by the bidder along with complete bill of materials. After awarding of contract, detailed dimensional drawing of the system complete bill of materials including location and size of plinth for cubicle and oil pit shall be submitted for Employer’s approval as per GCC.

2.22 DOCUMENTATION

All drawings shall conform to Internationals standards organization (ISO). All dimensions and data shall be in system International Units.
Bidder shall furnish four sets of following drawings along with the offer.

a) A detailed write up on operation of the offered protection system also describing its effectiveness for quenching fire in an oil filled power transformer.

b) General outline drawing of the complete system with technical parameters.

c) Drawing showing clearances from ground and other live points of transformers and system.

d) The drawings showing the details of detectors to be provided on transformers.

e) Drawing indicating the details of fire alarm control panel.

f) Mounting details/installation and commissioning instruction of system equipment.

h) The manufacturing of the equipments shall be strictly in accordance with the approved drawings and no deviation shall be permitted without the written approval of the Employer. All manufacturing and fabrication work in connection with the equipment prior to the approval of the drawing shall be at the Contractor/Sub-contractor’s risk.

i) Approval of drawings/works by Employer shall not relieve the Contractor/Sub-contractor of any of his responsibility and liability for ensuring correctness and correct interpretation of the drawings for meeting the requirements of the latest revision of applicable standards, rules and codes of practices and effective performance of the system. The Employer shall have the power to reject any work or material which in his judgment is not in accordance therewith.