Annexure-1

Technical Specifications for Nitrogen Injection Fire Prevention and Extinguishing System (NIFPES) for Oil Filled Transformer.

1.0 SCOPE:

The scope of this specification covers design, engineering, manufacture/integration, supply and testing at works before dispatch, erection, testing and commissioning and performance demonstration of "Fire prevention and extinguishing system by nitrogen injection method". The necessary civil work which will be required for construction of oil soak pit for the storage of oil coming out from the transformer and plinth for Fire Extinguishing Cubicle (FEC) is outside the scope of this specification. However, supply and laying of oil pipe, nitrogen injection pipe, electrical cables, control boxes, extinguishing cubicle, nitrogen cylinder, necessary valves, fire detectors and other equipments & accessories required for erection, testing, commissioning and performance demonstration of the complete fire protection system is in the scope of the NIFPES manufacturer. It will be the responsibility of the transformer manufacturer to coordinate with the supplier of the Fire Protection System for all the arrangements for the complete erection, testing, commissioning and performance tests.

2.0 GENERAL DESCRIPTION:

2.1 Nitrogen Injection system shall be used to prevent the transformer explosion and possible fire, in the case of internal fault and such acts as a fire preventer. In certain cases, tank explosion cannot be prevented and transformer oil catches fire. In such cases and also in the event of fire by external causes, it shall acts as firefighting system. In either way it shall protect the transformer and eliminate or minimize the post fire damages. Thus, the system shall be suitable for protecting the transformer tank from explosion and also transformer, OLTC and cable box from fire.

2.2 The system shall drain a pre-determined quantity (approx. 10% by volume) of the of oil from the tank top through outlet valve to reduce the tank pressure and inject nitrogen gas at predetermined pressure from the lower side of the tank through inlet valves to create stirring action and reduce the temperature of top oil surface below flash point to extinguish the fire.

2.3 The system shall consist of following major components:

a) Fire Extinguishing Cubicle (FEC) placed on a plinth at about 5-10 meter away from the transformer.
b) Control box/panel placed in the control room.
c) Transformer Conservator Isolation valve (TCIV) in the conservator pipe.
d) Fire Detectors to be provided on the tank cover.
e) Signal box fitted on the transformer tank side wall.

3.0 Details of Major System components:

3.1 Fire Extinguishing Cubicle (FEC): Fire Extinguishing Cubicle shall have the following:

A. Requirements for Nitrogen Injection:

3.1.1 Nitrogen gas cylinder with required pressure reducer or pressure regulator. Necessary gauges shall be provided to monitor the nitrogen cylinder pressure as well as nitrogen injection pressure. Also, provision shall be provided for indication in the control box, if cylinder pressure is reduced than specified pressure.

3.1.2 The nitrogen gas cylinder should be of sufficient capacity considering the actual quantity of the transformer oil. Such as, if the oil quantity is 15000 liter, the 10% of it be the 1500 liter i.e. 1.5 m^3. Considering the additional safety margin of 3 times, 4.5m^3 volume of nitrogen is

required. The Pressure of the gas filled in the cylinder should be of 150kg/cm^2. Accordingly the capacity of the cylinder should be decided by the NIFPES manufacturer in the consultation with transformer manufacturer. The capacity of cylinder should be mentioned on the cylinder for reference of Railways.

3.1.3 The nitrogen shall be contained within the cylinder and released from the cylinder through an operating valve only upon activation of fire protection system. No used cylinders should be provided. Proper approvals and certificates should be provided with each cylinder. NIFPES manufacturer shall ensure to provide the cylinders having the PESO (Petroleum and Explosive safety Organisation) certificates. Nitrogen purity shall be 99.99%.

3.1.4 Nitrogen Injection valve and Control equipment for operation of nitrogen injection valve for injecting gas at predetermined pressure.

3.1.5 Isolation valves for nitrogen injection pipe with necessary flanges shall be provided on top of the Fire Extinguishing Cubicle (FEC) for connecting nitrogen injection pipes with transformer.

B. Requirements for Oil Drain Mechanism: (These requirements may or may not be the part of FEC as per the design of NIFPES manufacturer)

3.1.6 Oil drain pipe with oil drain valve and Control equipment for operation of oil drain valve.

3.1.7 Isolation valves for oil drain pipe with necessary flanges shall be provided at suitable location for connecting oil drain pipes with transformer.

C. Other requirements

3.1.8 Fire Extinguishing Cubicle (FEC) shall have LED light and heater with thermostat. Heater should be operated as per the setting of thermostat. FEC should have IP 55 protection.

3.1.9 Oil drain pipe should be terminated at the oil soak pit of the Traction Sub Station (TSS).

3.1.10 Provision should be provided to avoid unnecessary operation of NIFPES system, during maintenance and/or testing of transformer and /or NIFPES system.

3.1.11 Provision should be provided for giving the status of oil drain and nitrogen injection valves in the Control Box provided at Control Room.

3.2 **Control box/panel:** Control Box/panel shall have the following provisions:

3.2.1 Control Box/panel should be microprocessor based /PLC based compatible to be interfaced with existing RTU for Railway Traction SCADA system. For communication with SCADA, Control Box shall have provision for interfacing with RTU through RS485 over MODBUS protocol or IEC61850 communication protocol. Following minimum indications of NIFPES are to be interfaced with SCADA:

- NIFPES active in prevention mode.
- NIFPES active in extinguishing mode.
- Status of NIFPES i.e. in Auto/Manual/OFF position.
- NIFPES system is healthy

3.2.2 Control box/panel shall have activating, monitoring devices and line faults indicators. It should have audio visual alarm indication and push button switches for test response.

3.2.3 Following minimum indications (LED type) shall be provided on the Control Box.

SN	Indication	Colour	SN	Indication	Colour
a)	System On	Green	b)	LV Circuit Breaker Open	RED
c)	Oil Drain Valve Closed	Green	d)	HV Circuit Breaker Open	RED
e)	Nitrogen Injection Valve Closed	Green	f)	Differential Relay Trip	RED
g)	System Healthy	Green	h)	Restricted Earth fault Relay Trip	RED

i)	TCIV Open	Green	j)	Overcurrent Relay Trip	RED
k)	System out of Service	RED	l)	Bucholz Relay trip	RED
m)	TCIV Closed	RED	n)	Pressure Relief Valve Trip	RED
o)	Oil Drain valve open	RED	p)	Fire Detector Trip	RED
q)	Extinction in progress	RED	r)	DC supply fail	RED
s)	Nitrogen Cylinder Pressure Low	RED	t)	AC Supply fail	RED
u)	Auto operation failed	RED			

3.2.4 Other provisions on the Control Box/panel.

SN	Description
a.	Push Button for lamp test
b.	Mode Selection Switch, Auto/Local/OFF
c.	Extinction Release (manual operation) Push Button
d.	Audio Alarm

3.3 Transformer Conservator Isolation valve (TCIV): TCIV to be fitted in the conservator pipe line, between conservator and buchholz relay to block oil passage to isolate conservator tank oil. Thus, prevent escalation of fire at the time of the activation of NIFPES. It shall also have electrical signal for monitoring the status and a transparent window for visual inspection of the status of valve.

3.4 Fire Detectors: Shall be as per the following;

3.4.1 Fire detectors shall be specially designed to generate an electrical signal to the NIFPES system after sensing higher temperature.

3.4.2 Fire detectors are to be fixed on transformer tank top cover. Mounting of the detectors on top of the transformer tank shall be as per Annexure-9.

3.4.3 NIFPES supplier shall specify the replacement/maintenance plan of fire detectors used in the system in their Operation & maintenance manual of NIFPES.

3.4.4 NIFPES manufacturer to ensure that the condition of the sensor (i.e. covered in a mounting conduit or not) used for the third party testing lab, NIFPES live demonstration testing & actual installation at site should be same.

3.5 Signal box: Signal Box shall be provided for terminating cable connections from fire detectors and TCIV.

3.6 Signal Box, Control Box & FEC should be vermin proof and cable glands (as required) shall be provided for terminating cables.

4.0 OPERATIONAL CONTROLS: Following mode of control shall be provided for the activation of NIFPES.

4.1 Automatic control in fire prevention and fire extinction modes after receipt of the system activating signals.

4.2 An electrical push button on control box for activating the NIFPES. This push button should be covered under glass to avoid false pressing.

4.3 The operation of the NIFPES should also be possible in case of failure of 110V DC Supply of TSS.

5.0 SYSTEM ACTIVATING SIGNALS:

5.1 Transformer isolation shall be an essential pre-condition for activating the system.

5.2 In activation of auto mode, NIFPES system should also give a command to isolate the Traction Power Transformer through Master trip relay or circuit breaker (HV and LV side in series) before oil depressurization and nitrogen injection.

5.3 System operation in auto mode: This operation shall be active when selector switch on control box is in auto mode. In auto mode, there shall be two modes of operation of Fire protection system i.e. Fire prevention mode and Fire Extinction Mode. The inputs to be used for the activation of the system are as below:

Mode	Inputs to be used for activation of NIFPES:
Fire Prevention Mode	For activation in Prevention Mode any one of the following two options shall be accepted:
	Option 1 • Signals from both HV and LV Circuit Breakers for open condition • Differential Relay **OR** Over Current Relay **OR** Restricted Earth fault relay. • Buchholz Relay **OR** Pressure relief valve. Description: The NIFPES should be activated only after the receipt of both HV & LV circuit Breaker open signals **AND** signal for activation of any one or more of the three i.e. Differential, Over Current , Restricted Earth fault relay **AND** signal for activation of any one or more of the Buchholz Relay, pressure relief valve.
	Option 2 • Signals from both HV and LV Circuit Breakers for open condition • Differential Relay **OR** Over Current Relay **OR** Restricted Earth fault relay. • Pressure relief valve. Description: The NIFPES should be activated only after the receipt of both HV & LV circuit Breaker open signals **AND** signal for activation of any one or more of the three i.e. Differential, Over Current , Restricted Earth fault relays **AND** signal for activation of pressure relief valve.
Fire Extinction Mode	• Signals from both HV and LV Circuit Breakers for open condition • Fire Detector • Differential relay **OR** Over Current relay **OR** Restricted Earth fault relay **OR** Pressure relief valve **OR** Buchholz Relay Description: The NIFPES should be activated only after the receipt of both HV & LV circuit Breaker open signals **AND** signal for activation of fire detector **AND** signal for activation of any one or more of the these i.e. Differential, Over Current , Restricted Earth fault relays, Buchholz Relay, Pressure relief valve.

5.4 System operation in manual mode: This operation shall be active when selector switch on control box is in manual mode.

- A push button on the control Box should be provided for activation the system.
- The operating personnel should ensure that the HV & LV breaker are open.

5.5 System operation in in case of failure of 110V DC Supply of Traction Sub Station (TSS).

- System shall have provision for oil draining and Nitrogen injection. The procedure for operation should be provided in both Hindi and English.
- The operating personnel should ensure that the HV & LV breaker are open.

5.6 The NIFPES manufacturer should provide the warning information on the Control Box and FEC that "Ensure HV & LV breaker are open before operating in Manual mode" in Hindi and English both.

6.0 OTHER REQUIREMENTS FOR SYSTEM INSTALLATION:

SN	Requirement	Responsibility
6.1	Oil drain and nitrogen injection openings with valves of suitable size on transformer tank at suitable locations.	Transformer manufacturer
6.2	Flanges with dummy piece in Conservator pipe between Buchholz relay and conservator tank for fixing TCIV.	
6.3	Suitable Fixtures (as required) on transformer top cover for mounting fire detectors.	
6.4	Support/frame on tank side wall for mounting signal box.	
6.5	Spare potential free contacts in control box of NIFPES for system activating signals i.e. Differential relay, Over Current relay, Restricted Earth Fault Relay, Buchholz relay, Pressure relief valve, HV Circuit Breaker Open, LV circuit Breaker open, Transformer Isolation (master trip relay) and fire detector trip.	NIFPES manufacturer
6.6	Pipe connections between transformer to Fire Extinguishing Cubicle (FEC)/Oil Pit as required. The pipes shall be of galvanized iron material.	
6.7	Cabling on transformer top cover for fire detectors, interconnection cabling between Signal box to Control Box and Control Box to Fire Extinguishing cubicle. The cabling should be suitably done for proper functioning of the system.	
6.8	In order to place the fire Extinguishing Cubicle, plinth shall be constructed as per the drawing provided by the NIFPES manufacturer.	
6.9	In order to collect the drained oil upon activation of the system, the oil soak pit of the Traction Sub Station is to be used. To achieve speedy drain of oil, the oil drain piping should have minimum bend and shall be directly terminated in to oil drain pit.	
6.10	All other consumables necessary for operation of complete system.	

7.0 DATA SHEET:

SN	Item	Requirements
1.	Fire Extinction period on commencement of Nitrogen injection	Maximum 30 seconds
2.	Fire detectors heat sensing temperature	130 ± 2^0 C
3.	Power Source: Control Box. Fire extinguishing cubicle for lighting and heater	 110 V DC (+10% & -15%) 240 V AC
4.	Nitrogen Cylinder (PESC approved)	As per IS:7285 (Part – 2)
5.	Degree of protection of FEC	IP 55
6.	Sheet of FEC, Control Box & Signal Box	Steel sheet shall be as per grade CR 2 of IS: 513, part-1. Thickness shall not be less than 2mm.
7.	Colour of cubicles & Nitrogen Injection pipes	Shade 538 of IS: 5
8.	Quantity and pressure of Nitrogen gas in the Cylinder	As described in para 3.1.2
9.	Size of Oil Drain valve (01 No.)	Size: 80 mm, 01 No.
10.	Size and number of Nitrogen injection valve	Size: 25mm, 04numbers, 02 each on HV & LV side

8.0 Cabling:

8.1 Fire survival cables, able to withstand 750 ^{0}C, 1.5 mm sq. with necessary no. of Conductors for connection of fire detectors in parallel shall be used (if applicable). The manufacturer's test certificates for the cables shall be submitted.

8.2 Fire retardant low smoke (FRLS) cable 1.5 mm sq. with necessary no. of Conductors for connection between transformer signal box/ marshaling box to control box and control box to fire extinguishing cubicle shall be used. The manufacturer's test certificates for the cables shall be submitted.

8.3 Fire retardant low smoke (FRLS) 1.5 mm sq. with necessary no. of Conductors for connection between Control and Relay panel to Control Box, Control box to DC supply source, Control box to AC supply source and fire extinguishing cubicle to AC supply source, signal box /marshaling box on transformer shall be used. The manufacturer's test certificates for the cables shall be submitted.

9.0 TESTS

a. TYPE TESTS

i. Type test report of Fire detector: Type test report of the Fire Detector shall be submitted to RDSO along with the design/drawing documents. The Fire detector shall be tested at laboratory as specified in para 6.1.4 (Page no. 28) of this specification as per the procedure mentioned below. The report should contain photographs of testing set-up used for testing detector.

Test	Type	Procedure	Requirement	Observed Value
Testing of the fire detector	Type of the detector along with the make and model no. is to be mentioned in this column	1. Heat sensor is to be tested by immersing in heating liquid with temperature measurement or by suspending in hot air oven with temperature measurement. 2. The temperature of the liquid/air is to be increased at the rate of 1^{0}C per minute and reading of the thermocouples to be noted. 3. Thermocouple for measuring the temperature is to be provided at the tip/surface of the detector. 4. The temperature of the liquid/air is to be increased till the detector bursts/activates.	The detectors should be bursts/activates at a temperature of 130 ± 2^{0}C.	The temperature, at which the detector activates, is to be recorded.

b. FACTORY TEST

Functional verification of NIFPES shall be conducted by RDSO at the works of NIFPES manufacturer as per the format mentioned at Para 13.0 of this NIFPES specification.

c. PERFORMANCE TEST

Performance test of the complete system shall be carried out after complete erection at site by the Transformer manufacturer's representative. It shall also be ensured that the interfacing of NIFPES with SCADA has been completed. These tests shall include simulation and verification of the response the complete system without actual draining of the oil and injection of the nitrogen gas. In addition to above, additional tests as required necessary shall be conducted. These tests shall be witnessed by the Zonal Railway.

10.0 DRAWINGS AND MANUALS

Detailed layout drawing along with the equipment drawings and complete bill of materials shall be submitted to RDSO through transformer manufacturer for approval.

11.0 Following test certificates/details shall also be submitted by Transformer Manufacturer during the approval of drawings of NIFPES.

i. Self-certification of compliance of the NIFPES requirements by the NIFPES manufacturer.
ii. Type, make, and quantity of Fire detector being used with Railway Transformer.
iii. IP-55 protection certificate of Fire Extinguishing Cubicle (FEC).
iv. Type, make and quantity of the fire survival cable and manufacturer's test certificate of the cable reflecting withstand temperature (if applicable).
v. Type and make of the FRLS cable of 1.5mm sq. along with Cable manufacturer's Test Certificate.
vi. Type test reports as mentioned in the Para 9.0.
vii. The copy of Manual of NIFPES.
viii. The purity certificate of Nitrogen gas of 99.99% purity.

12.0 Circuit diagram of the Control Box/panel and FEC Cubicle

Suitable schematic diagram plates made of stainless steel or anodized Aluminium with black lettering and lines shall be fixed on the inside surface of the Control Box and FEC Cubicle.

13.0 FORMAT FOR THE FACTORY TEST

13.1 Visual Inspection: Visual examination of the NIFPES equipment i.e. Fire Extinguishing Cubicle, Control box, Signal Box, Transformer Conservator Isolation Valve, Fire detectors, Fire survival cables and Fire Retardant Low Smoke cables shall be made as per the approved drawings and requirements mentioned in the clause no. 3.0 of this NIFPES spec.

13.2 It should be checked that Electrical Circuit diagram of the Control Box and Fire Extinguishing Cubicle are provided the respective cubicles as per Para 12.0 along with coding of terminals/control wires.

13.3 Functional Test: Following functional tests on the Fire Extinguishing Cubicle and Control Box/panel of NIFPES shall be conducted. The testing shall be done at 121V, 110V & 93.5V DC supply (+110%, 100% & 85%) separately. After each test system shall be reset so that system shall be ready for next test.

Test Voltage ..... Volt				
SN	**TESTS**	**Procedure**	**Requirement**	**Status**
1.	System On	Switch on Power Supply	➢ System ON Indicating Lamp should glow ➢ System Healthy Indicating lamp should glow	
2.	Lamp test	Push lamp test button	➢ All indication lamps should glow.	
3.	Out of service/Under maintenance	Arrangement should be made for locking of the system as per design of NIFPES manufacturer.	➢ In this conditions system out of service/under maintenance, Indicating lamp should glow ➢ System Healthy indicating lamp should go OFF.	
4.	Transformer Conservator	Put TCIV in open condition	➢ TCIV open Indication should glow	

	Isolation Valve (TCIV) open		➢ TCIV close Indication should OFF	
5.	Transformer Conservator Isolation Valve (TCIV) closed	Put TCIV in close condition.	➢ TCIV closed Indication should glow ➢ TCIV open Indication should OFF ➢ Audio Alarm should activate	
6.	Oil drain valve open.	Open Oil Drain Valve.	➢ Oil drain valve open Indication lamp should glow. ➢ System Healthy Indicating lamp should OFF ➢ Audio Alarm should activate	
7.	Oil drain valve closed	Close Oil Drain Valve.	➢ System Healthy Indication lamp should ON. ➢ Oil drain valve closed Indication lamp should glow.	
8.	Extinction in progress	Operate nitrogen release device in Fire Extinguishing Cubicle manually.	➢ Extinction in progress Indication lamp should glow. ➢ System Healthy Indication lamp should OFF ➢ Audio Alarm should activate	
9.	Nitrogen Injection valve closed	Close nitrogen release device in Fire Extinguishing Cubicle manually	➢ System Healthy Indication lamp should ON ➢ Nitrogen Injection valve closed Indicating lamp should glow.	
10.	Nitrogen Gas Cylinder pressure low	Adjust manometer below the specified pressure.	➢ Cylinder pressure low Indication lamp should glow. ➢ System Healthy Indication lamp should OFF ➢ Audio Alarm should activate	
11.	Differential relay trip	Activate the signal at potential free contact of Differential Relay trip on terminal bar	➢ Differential Relay trip Indicating lamp should glow. ➢ System Healthy Indication lamp should turn OFF ➢ Audio Alarm should activate	
		Deactivate the signal.	➢ Healthy condition Indication lamp should turn ON ➢ Differential Relay trip Indicating lamp should go OFF.	
12.	Over Current Relay (OCR) Trip	Activate the signal at potential free contact of OCR trip on terminal bar	➢ OCR trip Indicating lamp should glow. ➢ System Healthy Indication lamp should OFF ➢ Audio Alarm should activate	
		Deactivate the signal.	➢ System Healthy Indication lamp should turn ON ➢ OCR Relay trip Indicating lamp should go OFF.	

13.	Restricted Earth Fault (REF) relay trip	Activate the signal at potential free contact of REF trip on terminal bar	➢ REF trip Indicating lamp should glow. ➢ System Healthy Indication lamp should OFF ➢ Audio Alarm should activate	
		Deactivate the signal.	➢ System Healthy Indication lamp should turn ON ➢ REF Relay trip Indicating lamp should go OFF.	
14.	Pressure Relief valve (PRV) Trip	Activate the signal at potential free contact of PRV trip on terminal bar	➢ PRV trip Indicating lamp should glow. ➢ System Healthy Indication lamp should OFF ➢ Audio Alarm should activate	
		Deactivate the signal.	➢ System Healthy Indication lamp should turn ON ➢ PRV trip Indicating lamp should go OFF.	
15.	Bucholz Relay Trip	Activate the signal at potential free contact of Bucholz Relay trip on terminal bar	➢ Bucholz Relay trip Indicating lamp should glow. ➢ System Healthy Indication lamp should OFF ➢ Audio Alarm should activate	
		Deactivate the signal.	➢ System Healthy Indication lamp should turn ON ➢ Bucholz Relay trip Indicating lamp should go OFF.	
16.	HVCB Open	Activate the signal at potential free contact HVCB Open on terminal bar	HVCB open indication should glow	
		Deactivate the signal	HVCB open indication should off	
17.	LVCB Open	Activate the signal at potential free contact LVCB Open on terminal bar	LVCB open indication should glow	
		Deactivate the signal.	LVCB open indication should off	
18.	Fire Detector Trip	Activate the signal at corresponding potential free contact on terminal bar	➢ Fire detector trip Indication lamp should glow. ➢ System Healthy Indication lamp should go OFF ➢ Audio Alarm should activate	
		Deactivate the signal.	➢ Healthy condition Indication lamp should turn ON ➢ Fire detector trip Indication lamp should go OFF.	
19.	DC Supply fail	Switch OFF DC Supply to Control Box	➢ DC Supply Fail indication should glow ➢ Audio Alarm should activate	
20.	AC Supply fail	Switch OFF AC Supply to Control Box	➢ AC Supply Fail indication should glow	

21.	System test for prevention mode (Auto mode) (Logic mentioned at d, e, f is not applicable, if NIFPES manufacturer is providing the NIFPES as per the option 02 as mentioned in the specification, Para 5.3.)	a) Activate the following signals at potential free contacts on terminal bar i. HVCB & LVCB Open ii. Differential relay Trip iii. Pressure Relief Valve trip b) Activate the following signals at potential free contacts on terminal bar i. HVCB & LVCB Open ii. REF Trip iii. Pressure Relief Valve trip c) Activate the following signals at potential free contacts on terminal bar i. HVCB & LVCB Open ii. OCR Trip iii. Pressure Relief Valve trip d) Activate the following signals at potential free contacts on terminal bar i. HVCB & LVCB Open ii. Differential relay Trip iii. Bucholz relay trip e) Activate the following signals at potential free contacts on terminal bar i. HVCB & LVCB Open ii. REF Trip iii. Bucholz relay trip f) Activate the following signals at potential free contacts on terminal bar i. HVCB & LVCB Open ii. OCR Trip iii. Bucholz relay trip	➢ Oil Drain valve should open ➢ Nitrogen gas should release ➢ Audio Alarm should activate. ➢ Following Indication lamps should glow - Oil drain valve open -Extinction in progress -Corresponding Indication of system activating signals ➢ System Healthy Indication lamp should go OFF.	
22.	System test for Extinction mode (Auto mode)	a) Activate the following signals at potential free contacts on terminal bar i. HVCB & LVCB Open ii. Fire Detector trip iii. Bucholz relay trip b) Activate the following signals at potential free contacts on terminal bar i. HVCB & LVCB Open ii. Fire Detector trip iii. PRV trip c) Activate the following signals at potential free contacts on terminal bar i. HVCB & LVCB Open	➢ Oil Drain valve should open ➢ Nitrogen gas should release ➢ Audio Alarm should activate. ➢ Following Indication lamps should glow - Oil drain valve open - Extinction in progress - Corresponding Indication of system activating signals ➢ System Healthy Indication lamp should go OFF.	

		ii. Fire Detector trip iii. Differential relay trip		
		d) Activate the following signals at potential free contacts on terminal bar i. HVCB & LVCB Open ii. Fire Detector trip iii. REF trip		
		e) Activate the following signals at potential free contacts on terminal bar i. HVCB & LVCB Open ii. Fire Detector trip iii. OCR trip		
23.	System test for from Control Box by Manual push button	Activate following signals: i. Ensure LV & HV Breakers are trip/open ii. Mode Selection switch in manual mode iii. Press Manual Extinction Operation Push Button on control Box.	➢ Oil Drain valve should open ➢ Nitrogen gas should release ➢ Audio Alarm should activate. ➢ Following Indication lamps should glow -Oil drain valve open -Extinction in progress ➢ System Healthy Indication lamp should go OFF.	
24.	System test in case of 110V DC Failure of Traction Sub Station (TSS)	➢ Disconnect the 110V DC supply of control Box. ➢ Operate the Oil Drain & Nitrogen Injection Valve as per the design of the NIFPES supplier	➢ Oil Drain valve should open ➢ Nitrogen gas should release	
25.	Panel Lighting	➢ Switch on 240V AC supply in fire extinguishing cubicle ➢ Open Door of fire extinguishing cubicle	Panel Lights should be in working condition when door is open	
26.	Heater operation	Switch on the heater in Fire extinguishing cubicle	Heater should be in working condition with auto ON/OFF at preset temperature levels.	
27.	High voltage test to be separately done on Control Box and Signal Box	Apply 2kV AC for 1 minute between terminal bar and Box body	Should withstand.	
28.	Communication with SCADA	Control Box shall have provision for interfacing with RTU through RS485 over MODBUS protocol	The NIFPES manufacturer should verify the MODBUS protocol at their works or submit a declaration by an RDSO approved SCADA vendor that, the NIFPES system as desired in clause no. 3.2.1 has been verified by them for communication with RTU through RS485 over MODBUS protocol	

13.4 Functional Test of Transformer Isolation Conservator Valve (TCIV):

SN	Test	Procedure	Requirement	
1.	Leakage Test	Immerse the TCIV in the oil and fill the inlet pressure as 4 kg/ cm^2 for 6 hours.	There should no leakage from TCIV body	
2.	TCIV Close test (A or B as per the design of TCIV)	A. For oil flow rate based TCIV i. Mount TCIV with approx. 3 degree inclination on test jig ii. Switch ON oil Pump iii. Increase oil flow rate gradually	➢ TCIV should close at flow rate specified by manufacturer. ➢ Flap closing shall be visible through transparent glass inspection window. ➢ Normally open (NO) contacts in TCIV should close/TCIV Close indication in control Box should be reflected.	
		B. For Motorised TCIV i. Mount TCIV with approx. 3 degree inclination on test jig ii. Generate a set of input signal for the activation of NIFPES system	➢ TCIV should close. ➢ Flap closing shall be visible through transparent glass inspection window. ➢ Normally open (NO) contacts in TCIV should close/TCIV Close indication in control Box should be reflected.	
3.	Reset test	Reset the TCIV in the normal position.	➢ Close contact in TCIV should become open/ TCIV open indication in control Box should be reflected. ➢ Flap opening shall be visible through transparent glass inspection window.	
4.	High voltage test	Apply 2kV AC for 1 minute between terminals and body	TCIV should withstand.	

13.5 Functional Tests of Fire detector:

13.5.1 The test report of the fire detector as mentioned in Para 9.0 (i) shall be submitted. The operating temperature shall be as per the requirement mentioned in Para 7.0 (2) this specification.

13.5.2 The NIFPES manufacturer shall submit the declaration that the make and model/design of the Fire detector supplied with transformer and which has been tested at the third party laboratory are same.

13.6 Live demonstration test: To verify the working of the system, live demonstration is to be conducted in both fire prevention and extinguishing mode. Following to be ensured;

(i) Demonstration is to be carried out at the works of NIFPES Manufacturer. It shall be responsibility of NIFPES manufacturer to arrange a suitable location at the works for live testing.

(ii) A dummy tank of minimum 5000 litres oil capacity and filled with oil, which should be available with NIFPES manufacturer, can be used as a transformer tank for testing.

(iii) The FEC and Control Box tested in para 13.3 are to be used for live testing.

(iv) Separate filled Nitrogen cylinder should be used for live tests.

(v) Testing shall be conducted as per procedure mentioned below;

13.6.1 Testing in Fire Prevention Mode

13.6.1.1 Procedure:

(i) Oil Drain Pipe, Nitrogen Injection pipe, FEC, Control box, Signal box, TCIV, oil pit with all necessary pipes and cable connections shall be connected with transformer tank.

(ii) Nitrogen gas Cylinder pressure should be recoded.

(iii) The NIFPES System shall be made ON.

(iv) Any one set of input of the fire prevention mode shall be generated by a suitable method.

13.6.1.2 Observations/Result:

(i) Due to fulfill of required condition, system gets activated in auto mode.

(ii) Oil Drain should be started.

(iii) Nitrogen should be injected.

(iv) TCIV should close.

(v) Following Indications at control Box has been turned ON:

a)	Oil Drain valve open	b)	Buchholz Relay trip or PRV Trip
c)	Extinction in progress/Nitrogen Injection valve open	d)	Differential Trip or REF Trip or OCR Trip
e)	Audio Alarm activated	f)	LVCB open
g)	HVCB open	h)	Nitrogen cylinder pressure low
i)	TCIV Close		

(vi) Nitrogen Gas cylinder pressure should be recorded at stage when nitrogen injection has stopped.

13.6.2 Testing in Fire Extinguishing Mode (By igniting the transformer oil of the tank)

13.6.2.1 Procedure:

(i) There should be an opening on the Transformer tank to ignite the transformer oil.

(ii) Fire detector should be mounted at the distance of 800mm from the opening (mentioned in point, i)

(iii) Oil Drain Pipe, Nitrogen Injection pipe, FEC, Control box, Signal box, TCIV, oil pit with all necessary pipes and cable connections shall be connected with transformer tank.

(iv) The NIFPES System shall be made ON.

(v) The Bucholz Relay or PRV Trip and HVCB & LVCB open Signal shall be activated by a suitable method.

(vi) Ignite the transformer oil by any method such as pouring any flammable liquid (example- petrol) or any suitable chemical spray and igniting the flame.

(vii) Start the timer/ stop watch on commencement of Nitrogen injection.

13.6.2.2 Observations:

(i) Due to fulfill of required conditions of fire extinguishing mode, system should get activated in auto fire extinguishing mode.

(ii) Oil Drain should be started.

(iii) Nitrogen should be injected.

(iv) TCIV should close.

(v) Following Indications has been turned ON:

a)	Oil Drain valve open	b)	Buchholz Relay trip or PRV Trip
c)	Extinction in progress/Nitrogen	d)	Fire detector trip

	Injection valve open		
e)	Audio Alarm activated	f)	LVCB open
g)	HVCB open	h)	Nitrogen cylinder pressure low
i)	TCIV Close		

(viii) Stop the timer/ stop watch when fire extinguishes.

13.6.2.3 Results:

SN	Details	Requirement	Observation
1.	Fire Extinction period on commencement of Nitrogen injection	Maximum 30 seconds	..... seconds

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Annexure-1

Technical Specifications for Nitrogen Injection Fire Prevention and Extinguishing System (NIFPES) for Oil Filled Transformer.

1.0 SCOPE:

The scope of this specification covers design, engineering, manufacture/integration, supply and testing at works before dispatch, erection, testing and commissioning and performance demonstration of "Fire prevention and extinguishing system by nitrogen injection method". The necessary civil work which will be required for construction of oil soak pit for the storage of oil coming out from the transformer and plinth for Fire Extinguishing Cubicle (FEC) is outside the scope of this specification. However, supply and laying of oil pipe, nitrogen injection pipe, electrical cables, control boxes, extinguishing cubicle, nitrogen cylinder, necessary valves, fire detectors and other equipments & accessories required for erection, testing, commissioning and performance demonstration of the complete fire protection system is in the scope of the NIFPES manufacturer. It will be the responsibility of the transformer manufacturer to coordinate with the supplier of the Fire Protection System for all the arrangements for the complete erection, testing, commissioning and performance tests.

2.0 GENERAL DESCRIPTION:

2.1 Nitrogen Injection system shall be used to prevent the transformer explosion and possible fire, in the case of internal fault and such acts as a fire preventer. In certain cases, tank explosion cannot be prevented and transformer oil catches fire. In such cases and also in the event of fire by external causes, it shall acts as firefighting system. In either way it shall protect the transformer and eliminate or minimize the post fire damages. Thus, the system shall be suitable for protecting the transformer tank from explosion and also transformer, OLTC and cable box from fire.

2.2 The system shall drain a pre-determined quantity (approx. 10% by volume) of the of oil from the tank top through outlet valve to reduce the tank pressure and inject nitrogen gas at predetermined pressure from the lower side of the tank through inlet valves to create stirring action and reduce the temperature of top oil surface below flash point to extinguish the fire.

2.3 The system shall consist of following major components:

a) Fire Extinguishing Cubicle (FEC) placed on a plinth at about 5-10 meter away from the transformer.
b) Control box/panel placed in the control room.
c) Transformer Conservator Isolation valve (TCIV) in the conservator pipe.
d) Fire Detectors to be provided on the tank cover.
e) Signal box fitted on the transformer tank side wall.

3.0 Details of Major System components:

3.1 Fire Extinguishing Cubicle (FEC): Fire Extinguishing Cubicle shall have the following:

A. Requirements for Nitrogen Injection:

3.1.1 Nitrogen gas cylinder with required pressure reducer or pressure regulator. Necessary gauges shall be provided to monitor the nitrogen cylinder pressure as well as nitrogen injection pressure. Also, provision shall be provided for indication in the control box, if cylinder pressure is reduced than specified pressure.

3.1.2 The nitrogen gas cylinder should be of sufficient capacity considering the actual quantity of the transformer oil. Such as, if the oil quantity is 15000 liter, the 10% of it be the 1500 liter i.e. 1.5 m^3. Considering the additional safety margin of 3 times, 4.5m^3 volume of nitrogen is

required. The Pressure of the gas filled in the cylinder should be of 150kg/cm^2. Accordingly the capacity of the cylinder should be decided by the NIFPES manufacturer in the consultation with transformer manufacturer. The capacity of cylinder should be mentioned on the cylinder for reference of Railways.

3.1.3 The nitrogen shall be contained within the cylinder and released from the cylinder through an operating valve only upon activation of fire protection system. No used cylinders should be provided. Proper approvals and certificates should be provided with each cylinder. NIFPES manufacturer shall ensure to provide the cylinders having the PESO (Petroleum and Explosive safety Organisation) certificates. Nitrogen purity shall be 99.99%.

3.1.4 Nitrogen Injection valve and Control equipment for operation of nitrogen injection valve for injecting gas at predetermined pressure.

3.1.5 Isolation valves for nitrogen injection pipe with necessary flanges shall be provided on top of the Fire Extinguishing Cubicle (FEC) for connecting nitrogen injection pipes with transformer.

B. Requirements for Oil Drain Mechanism: (These requirements may or may not be the part of FEC as per the design of NIFPES manufacturer)

3.1.6 Oil drain pipe with oil drain valve and Control equipment for operation of oil drain valve.

3.1.7 Isolation valves for oil drain pipe with necessary flanges shall be provided at suitable location for connecting oil drain pipes with transformer.

C. Other requirements

3.1.8 Fire Extinguishing Cubicle (FEC) shall have LED light and heater with thermostat. Heater should be operated as per the setting of thermostat. FEC should have IP 55 protection.

3.1.9 Oil drain pipe should be terminated at the oil soak pit of the Traction Sub Station (TSS).

3.1.10 Provision should be provided to avoid unnecessary operation of NIFPES system, during maintenance and/or testing of transformer and /or NIFPES system.

3.1.11 Provision should be provided for giving the status of oil drain and nitrogen injection valves in the Control Box provided at Control Room.

3.2 **Control box/panel:** Control Box/panel shall have the following provisions:

3.2.1 Control Box/panel should be microprocessor based /PLC based compatible to be interfaced with existing RTU for Railway Traction SCADA system. For communication with SCADA, Control Box shall have provision for interfacing with RTU through RS485 over MODBUS protocol or IEC61850 communication protocol. Following minimum indications of NIFPES are to be interfaced with SCADA:

- NIFPES active in prevention mode.
- NIFPES active in extinguishing mode.
- Status of NIFPES i.e. in Auto/Manual/OFF position.
- NIFPES system is healthy

3.2.2 Control box/panel shall have activating, monitoring devices and line faults indicators. It should have audio visual alarm indication and push button switches for test response.

3.2.3 Following minimum indications (LED type) shall be provided on the Control Box.

SN	Indication	Colour	SN	Indication	Colour
a)	System On	Green	b)	LV Circuit Breaker Open	RED
c)	Oil Drain Valve Closed	Green	d)	HV Circuit Breaker Open	RED
e)	Nitrogen Injection Valve Closed	Green	f)	Differential Relay Trip	RED
g)	System Healthy	Green	h)	Restricted Earth fault Relay Trip	RED

i)	TCIV Open	Green	j)	Overcurrent Relay Trip	RED
k)	System out of Service	RED	l)	Bucholz Relay trip	RED
m)	TCIV Closed	RED	n)	Pressure Relief Valve Trip	RED
o)	Oil Drain valve open	RED	p)	Fire Detector Trip	RED
q)	Extinction in progress	RED	r)	DC supply fail	RED
s)	Nitrogen Cylinder Pressure Low	RED	t)	AC Supply fail	RED
u)	Auto operation failed	RED			

3.2.4 Other provisions on the Control Box/panel.

SN	Description
a.	Push Button for lamp test
b.	Mode Selection Switch, Auto/Local/OFF
c.	Extinction Release (manual operation) Push Button
d.	Audio Alarm

3.3 Transformer Conservator Isolation valve (TCIV): TCIV to be fitted in the conservator pipe line, between conservator and buchholz relay to block oil passage to isolate conservator tank oil. Thus, prevent escalation of fire at the time of the activation of NIFPES. It shall also have electrical signal for monitoring the status and a transparent window for visual inspection of the status of valve.

3.4 Fire Detectors: Shall be as per the following;

3.4.1 Fire detectors shall be specially designed to generate an electrical signal to the NIFPES system after sensing higher temperature.

3.4.2 Fire detectors are to be fixed on transformer tank top cover. Mounting of the detectors on top of the transformer tank shall be as per Annexure-9.

3.4.3 NIFPES supplier shall specify the replacement/maintenance plan of fire detectors used in the system in their Operation & maintenance manual of NIFPES.

3.4.4 NIFPES manufacturer to ensure that the condition of the sensor (i.e. covered in a mounting conduit or not) used for the third party testing lab, NIFPES live demonstration testing & actual installation at site should be same.

3.5 Signal box: Signal Box shall be provided for terminating cable connections from fire detectors and TCIV.

3.6 Signal Box, Control Box & FEC should be vermin proof and cable glands (as required) shall be provided for terminating cables.

4.0 OPERATIONAL CONTROLS: Following mode of control shall be provided for the activation of NIFPES.

4.1 Automatic control in fire prevention and fire extinction modes after receipt of the system activating signals.

4.2 An electrical push button on control box for activating the NIFPES. This push button should be covered under glass to avoid false pressing.

4.3 The operation of the NIFPES should also be possible in case of failure of 110V DC Supply of TSS.

5.0 SYSTEM ACTIVATING SIGNALS:

5.1 Transformer isolation shall be an essential pre-condition for activating the system.

5.2 In activation of auto mode, NIFPES system should also give a command to isolate the Traction Power Transformer through Master trip relay or circuit breaker (HV and LV side in series) before oil depressurization and nitrogen injection.

5.3 System operation in auto mode: This operation shall be active when selector switch on control box is in auto mode. In auto mode, there shall be two modes of operation of Fire protection system i.e. Fire prevention mode and Fire Extinction Mode. The inputs to be used for the activation of the system are as below:

Mode	Inputs to be used for activation of NIFPES:
Fire Prevention Mode	For activation in Prevention Mode any one of the following two options shall be accepted:
	Option 1 • Signals from both HV and LV Circuit Breakers for open condition • Differential Relay **OR** Over Current Relay **OR** Restricted Earth fault relay. • Buchholz Relay **OR** Pressure relief valve. Description: The NIFPES should be activated only after the receipt of both HV & LV circuit Breaker open signals **AND** signal for activation of any one or more of the three i.e. Differential, Over Current , Restricted Earth fault relay **AND** signal for activation of any one or more of the Buchholz Relay, pressure relief valve.
	Option 2 • Signals from both HV and LV Circuit Breakers for open condition • Differential Relay **OR** Over Current Relay **OR** Restricted Earth fault relay. • Pressure relief valve. Description: The NIFPES should be activated only after the receipt of both HV & LV circuit Breaker open signals **AND** signal for activation of any one or more of the three i.e. Differential, Over Current , Restricted Earth fault relays **AND** signal for activation of pressure relief valve.
Fire Extinction Mode	• Signals from both HV and LV Circuit Breakers for open condition • Fire Detector • Differential relay **OR** Over Current relay **OR** Restricted Earth fault relay **OR** Pressure relief valve **OR** Buchholz Relay Description: The NIFPES should be activated only after the receipt of both HV & LV circuit Breaker open signals **AND** signal for activation of fire detector **AND** signal for activation of any one or more of the these i.e. Differential, Over Current , Restricted Earth fault relays, Buchholz Relay, Pressure relief valve.

5.4 System operation in manual mode: This operation shall be active when selector switch on control box is in manual mode.

- A push button on the control Box should be provided for activation the system.
- The operating personnel should ensure that the HV & LV breaker are open.

5.5 System operation in in case of failure of 110V DC Supply of Traction Sub Station (TSS).

- System shall have provision for oil draining and Nitrogen injection. The procedure for operation should be provided in both Hindi and English.
- The operating personnel should ensure that the HV & LV breaker are open.

5.6 The NIFPES manufacturer should provide the warning information on the Control Box and FEC that "Ensure HV & LV breaker are open before operating in Manual mode" in Hindi and English both.

6.0 OTHER REQUIREMENTS FOR SYSTEM INSTALLATION:

SN	Requirement	Responsibility
6.1	Oil drain and nitrogen injection openings with valves of suitable size on transformer tank at suitable locations.	Transformer manufacturer
6.2	Flanges with dummy piece in Conservator pipe between Buchholz relay and conservator tank for fixing TCIV.	
6.3	Suitable Fixtures (as required) on transformer top cover for mounting fire detectors.	
6.4	Support/frame on tank side wall for mounting signal box.	
6.5	Spare potential free contacts in control box of NIFPES for system activating signals i.e. Differential relay, Over Current relay, Restricted Earth Fault Relay, Buchholz relay, Pressure relief valve, HV Circuit Breaker Open, LV circuit Breaker open, Transformer Isolation (master trip relay) and fire detector trip.	NIFPES manufacturer
6.6	Pipe connections between transformer to Fire Extinguishing Cubicle (FEC)/Oil Pit as required. The pipes shall be of galvanized iron material.	
6.7	Cabling on transformer top cover for fire detectors, interconnection cabling between Signal box to Control Box and Control Box to Fire Extinguishing cubicle. The cabling should be suitably done for proper functioning of the system.	
6.8	In order to place the fire Extinguishing Cubicle, plinth shall be constructed as per the drawing provided by the NIFPES manufacturer.	
6.9	In order to collect the drained oil upon activation of the system, the oil soak pit of the Traction Sub Station is to be used. To achieve speedy drain of oil, the oil drain piping should have minimum bend and shall be directly terminated in to oil drain pit.	
6.10	All other consumables necessary for operation of complete system.	

7.0 DATA SHEET:

SN	Item	Requirements
1.	Fire Extinction period on commencement of Nitrogen injection	Maximum 30 seconds
2.	Fire detectors heat sensing temperature	130 ± 2^0 C
3.	Power Source: Control Box. Fire extinguishing cubicle for lighting and heater	 110 V DC (+10% & -15%) 240 V AC
4.	Nitrogen Cylinder (PESC approved)	As per IS:7285 (Part – 2)
5.	Degree of protection of FEC	IP 55
6.	Sheet of FEC, Control Box & Signal Box	Steel sheet shall be as per grade CR 2 of IS: 513, part-1. Thickness shall not be less than 2mm.
7.	Colour of cubicles & Nitrogen Injection pipes	Shade 538 of IS: 5
8.	Quantity and pressure of Nitrogen gas in the Cylinder	As described in para 3.1.2
9.	Size of Oil Drain valve (01 No.)	Size: 80 mm, 01 No.
10.	Size and number of Nitrogen injection valve	Size: 25mm, 04numbers, 02 each on HV & LV side

8.0 Cabling:

8.1 Fire survival cables, able to withstand 750 ^{0}C, 1.5 mm sq. with necessary no. of Conductors for connection of fire detectors in parallel shall be used (if applicable). The manufacturer's test certificates for the cables shall be submitted.

8.2 Fire retardant low smoke (FRLS) cable 1.5 mm sq. with necessary no. of Conductors for connection between transformer signal box/ marshaling box to control box and control box to fire extinguishing cubicle shall be used. The manufacturer's test certificates for the cables shall be submitted.

8.3 Fire retardant low smoke (FRLS) 1.5 mm sq. with necessary no. of Conductors for connection between Control and Relay panel to Control Box, Control box to DC supply source, Control box to AC supply source and fire extinguishing cubicle to AC supply source, signal box /marshaling box on transformer shall be used. The manufacturer's test certificates for the cables shall be submitted.

9.0 TESTS

a. TYPE TESTS

i. Type test report of Fire detector: Type test report of the Fire Detector shall be submitted to RDSO along with the design/drawing documents. The Fire detector shall be tested at laboratory as specified in para 6.1.4 (Page no. 28) of this specification as per the procedure mentioned below. The report should contain photographs of testing set-up used for testing detector.

Test	Type	Procedure	Requirement	Observed Value
Testing of the fire detector	Type of the detector along with the make and model no. is to be mentioned in this column	1. Heat sensor is to be tested by immersing in heating liquid with temperature measurement or by suspending in hot air oven with temperature measurement. 2. The temperature of the liquid/air is to be increased at the rate of 1^{0}C per minute and reading of the thermocouples to be noted. 3. Thermocouple for measuring the temperature is to be provided at the tip/surface of the detector. 4. The temperature of the liquid/air is to be increased till the detector bursts/activates.	The detectors should be bursts/activates at a temperature of 130 ± 2^{0}C.	The temperature, at which the detector activates, is to be recorded.

b. FACTORY TEST

Functional verification of NIFPES shall be conducted by RDSO at the works of NIFPES manufacturer as per the format mentioned at Para 13.0 of this NIFPES specification.

c. PERFORMANCE TEST

Performance test of the complete system shall be carried out after complete erection at site by the Transformer manufacturer's representative. It shall also be ensured that the interfacing of NIFPES with SCADA has been completed. These tests shall include simulation and verification of the response the complete system without actual draining of the oil and injection of the nitrogen gas. In addition to above, additional tests as required necessary shall be conducted. These tests shall be witnessed by the Zonal Railway.

10.0 DRAWINGS AND MANUALS

Detailed layout drawing along with the equipment drawings and complete bill of materials shall be submitted to RDSO through transformer manufacturer for approval.

11.0 Following test certificates/details shall also be submitted by Transformer Manufacturer during the approval of drawings of NIFPES.

i. Self-certification of compliance of the NIFPES requirements by the NIFPES manufacturer.
ii. Type, make, and quantity of Fire detector being used with Railway Transformer.
iii. IP-55 protection certificate of Fire Extinguishing Cubicle (FEC).
iv. Type, make and quantity of the fire survival cable and manufacturer's test certificate of the cable reflecting withstand temperature (if applicable).
v. Type and make of the FRLS cable of 1.5mm sq. along with Cable manufacturer's Test Certificate.
vi. Type test reports as mentioned in the Para 9.0.
vii. The copy of Manual of NIFPES.
viii. The purity certificate of Nitrogen gas of 99.99% purity.

12.0 Circuit diagram of the Control Box/panel and FEC Cubicle

Suitable schematic diagram plates made of stainless steel or anodized Aluminium with black lettering and lines shall be fixed on the inside surface of the Control Box and FEC Cubicle.

13.0 FORMAT FOR THE FACTORY TEST

13.1 Visual Inspection: Visual examination of the NIFPES equipment i.e. Fire Extinguishing Cubicle, Control box, Signal Box, Transformer Conservator Isolation Valve, Fire detectors, Fire survival cables and Fire Retardant Low Smoke cables shall be made as per the approved drawings and requirements mentioned in the clause no. 3.0 of this NIFPES spec.

13.2 It should be checked that Electrical Circuit diagram of the Control Box and Fire Extinguishing Cubicle are provided the respective cubicles as per Para 12.0 along with coding of terminals/control wires.

13.3 Functional Test: Following functional tests on the Fire Extinguishing Cubicle and Control Box/panel of NIFPES shall be conducted. The testing shall be done at 121V, 110V & 93.5V DC supply (+110%, 100% & 85%) separately. After each test system shall be reset so that system shall be ready for next test.

Test Voltage ..... Volt				
SN	**TESTS**	**Procedure**	**Requirement**	**Status**
1.	System On	Switch on Power Supply	➢ System ON Indicating Lamp should glow ➢ System Healthy Indicating lamp should glow	
2.	Lamp test	Push lamp test button	➢ All indication lamps should glow.	
3.	Out of service/Under maintenance	Arrangement should be made for locking of the system as per design of NIFPES manufacturer.	➢ In this conditions system out of service/under maintenance, Indicating lamp should glow ➢ System Healthy indicating lamp should go OFF.	
4.	Transformer Conservator	Put TCIV in open condition	➢ TCIV open Indication should glow	

	Isolation Valve (TCIV) open		➢ TCIV close Indication should OFF	
5.	Transformer Conservator Isolation Valve (TCIV) closed	Put TCIV in close condition.	➢ TCIV closed Indication should glow ➢ TCIV open Indication should OFF ➢ Audio Alarm should activate	
6.	Oil drain valve open.	Open Oil Drain Valve.	➢ Oil drain valve open Indication lamp should glow. ➢ System Healthy Indicating lamp should OFF ➢ Audio Alarm should activate	
7.	Oil drain valve closed	Close Oil Drain Valve.	➢ System Healthy Indication lamp should ON. ➢ Oil drain valve closed Indication lamp should glow.	
8.	Extinction in progress	Operate nitrogen release device in Fire Extinguishing Cubicle manually.	➢ Extinction in progress Indication lamp should glow. ➢ System Healthy Indication lamp should OFF ➢ Audio Alarm should activate	
9.	Nitrogen Injection valve closed	Close nitrogen release device in Fire Extinguishing Cubicle manually	➢ System Healthy Indication lamp should ON ➢ Nitrogen Injection valve closed Indicating lamp should glow.	
10.	Nitrogen Gas Cylinder pressure low	Adjust manometer below the specified pressure.	➢ Cylinder pressure low Indication lamp should glow. ➢ System Healthy Indication lamp should OFF ➢ Audio Alarm should activate	
11.	Differential relay trip	Activate the signal at potential free contact of Differential Relay trip on terminal bar	➢ Differential Relay trip Indicating lamp should glow. ➢ System Healthy Indication lamp should turn OFF ➢ Audio Alarm should activate	
		Deactivate the signal.	➢ Healthy condition Indication lamp should turn ON ➢ Differential Relay trip Indicating lamp should go OFF.	
12.	Over Current Relay (OCR) Trip	Activate the signal at potential free contact of OCR trip on terminal bar	➢ OCR trip Indicating lamp should glow. ➢ System Healthy Indication lamp should OFF ➢ Audio Alarm should activate	
		Deactivate the signal.	➢ System Healthy Indication lamp should turn ON ➢ OCR Relay trip Indicating lamp should go OFF.	

13.	Restricted Earth Fault (REF) relay trip	Activate the signal at potential free contact of REF trip on terminal bar	➢ REF trip Indicating lamp should glow. ➢ System Healthy Indication lamp should OFF ➢ Audio Alarm should activate	
		Deactivate the signal.	➢ System Healthy Indication lamp should turn ON ➢ REF Relay trip Indicating lamp should go OFF.	
14.	Pressure Relief valve (PRV) Trip	Activate the signal at potential free contact of PRV trip on terminal bar	➢ PRV trip Indicating lamp should glow. ➢ System Healthy Indication lamp should OFF ➢ Audio Alarm should activate	
		Deactivate the signal.	➢ System Healthy Indication lamp should turn ON ➢ PRV trip Indicating lamp should go OFF.	
15.	Bucholz Relay Trip	Activate the signal at potential free contact of Bucholz Relay trip on terminal bar	➢ Bucholz Relay trip Indicating lamp should glow. ➢ System Healthy Indication lamp should OFF ➢ Audio Alarm should activate	
		Deactivate the signal.	➢ System Healthy Indication lamp should turn ON ➢ Bucholz Relay trip Indicating lamp should go OFF.	
16.	HVCB Open	Activate the signal at potential free contact HVCB Open on terminal bar	HVCB open indication should glow	
		Deactivate the signal	HVCB open indication should off	
17.	LVCB Open	Activate the signal at potential free contact LVCB Open on terminal bar	LVCB open indication should glow	
		Deactivate the signal.	LVCB open indication should off	
18.	Fire Detector Trip	Activate the signal at corresponding potential free contact on terminal bar	➢ Fire detector trip Indication lamp should glow. ➢ System Healthy Indication lamp should go OFF ➢ Audio Alarm should activate	
		Deactivate the signal.	➢ Healthy condition Indication lamp should turn ON ➢ Fire detector trip Indication lamp should go OFF.	
19.	DC Supply fail	Switch OFF DC Supply to Control Box	➢ DC Supply Fail indication should glow ➢ Audio Alarm should activate	
20.	AC Supply fail	Switch OFF AC Supply to Control Box	➢ AC Supply Fail indication should glow	

21.	System test for prevention mode (Auto mode) (Logic mentioned at d, e, f is not applicable, if NIFPES manufacturer is providing the NIFPES as per the option 02 as mentioned in the specification, Para 5.3.)	a) Activate the following signals at potential free contacts on terminal bar i. HVCB & LVCB Open ii. Differential relay Trip iii. Pressure Relief Valve trip	➢ Oil Drain valve should open ➢ Nitrogen gas should release ➢ Audio Alarm should activate. ➢ Following Indication lamps should glow - Oil drain valve open -Extinction in progress -Corresponding Indication of system activating signals ➢ System Healthy Indication lamp should go OFF.	
		b) Activate the following signals at potential free contacts on terminal bar i. HVCB & LVCB Open ii. REF Trip iii. Pressure Relief Valve trip		
		c) Activate the following signals at potential free contacts on terminal bar i. HVCB & LVCB Open ii. OCR Trip iii. Pressure Relief Valve trip		
		d) Activate the following signals at potential free contacts on terminal bar i. HVCB & LVCB Open ii. Differential relay Trip iii. Bucholz relay trip		
		e) Activate the following signals at potential free contacts on terminal bar i. HVCB & LVCB Open ii. REF Trip iii. Bucholz relay trip		
		f) Activate the following signals at potential free contacts on terminal bar i. HVCB & LVCB Open ii. OCR Trip iii. Bucholz relay trip		
22.	System test for Extinction mode (Auto mode)	a) Activate the following signals at potential free contacts on terminal bar i. HVCB & LVCB Open ii. Fire Detector trip iii. Bucholz relay trip	➢ Oil Drain valve should open ➢ Nitrogen gas should release ➢ Audio Alarm should activate. ➢ Following Indication lamps should glow - Oil drain valve open - Extinction in progress - Corresponding Indication of system activating signals ➢ System Healthy Indication lamp should go OFF.	
		b) Activate the following signals at potential free contacts on terminal bar i. HVCB & LVCB Open ii. Fire Detector trip iii. PRV trip		
		c) Activate the following signals at potential free contacts on terminal bar i. HVCB & LVCB Open		

		ii. Fire Detector trip iii. Differential relay trip		
		d) Activate the following signals at potential free contacts on terminal bar i. HVCB & LVCB Open ii. Fire Detector trip iii. REF trip		
		e) Activate the following signals at potential free contacts on terminal bar i. HVCB & LVCB Open ii. Fire Detector trip iii. OCR trip		
23.	System test for from Control Box by Manual push button	Activate following signals: i. Ensure LV & HV Breakers are trip/open ii. Mode Selection switch in manual mode iii. Press Manual Extinction Operation Push Button on control Box.	➢ Oil Drain valve should open ➢ Nitrogen gas should release ➢ Audio Alarm should activate. ➢ Following Indication lamps should glow -Oil drain valve open -Extinction in progress ➢ System Healthy Indication lamp should go OFF.	
24.	System test in case of 110V DC Failure of Traction Sub Station (TSS)	➢ Disconnect the 110V DC supply of control Box. ➢ Operate the Oil Drain & Nitrogen Injection Valve as per the design of the NIFPES supplier	➢ Oil Drain valve should open ➢ Nitrogen gas should release	
25.	Panel Lighting	➢ Switch on 240V AC supply in fire extinguishing cubicle ➢ Open Door of fire extinguishing cubicle	Panel Lights should be in working condition when door is open	
26.	Heater operation	Switch on the heater in Fire extinguishing cubicle	Heater should be in working condition with auto ON/OFF at preset temperature levels.	
27.	High voltage test to be separately done on Control Box and Signal Box	Apply 2kV AC for 1 minute between terminal bar and Box body	Should withstand.	
28.	Communicatio n with SCADA	Control Box shall have provision for interfacing with RTU through RS485 over MODBUS protocol	The NIFPES manufacturer should verify the MODBUS protocol at their works or submit a declaration by an RDSO approved SCADA vendor that, the NIFPES system as desired in clause no. 3.2.1 has been verified by them for communication with RTU through RS485 over MODBUS protocol	

13.4 Functional Test of Transformer Isolation Conservator Valve (TCIV):

SN	Test	Procedure	Requirement	
1.	Leakage Test	Immerse the TCIV in the oil and fill the inlet pressure as 4 kg/ cm^2 for 6 hours.	There should no leakage from TCIV body	
2.	TCIV Close test (A or B as per the design of TCIV)	A. For oil flow rate based TCIV i. Mount TCIV with approx. 3 degree inclination on test jig ii. Switch ON oil Pump iii. Increase oil flow rate gradually	➢ TCIV should close at flow rate specified by manufacturer. ➢ Flap closing shall be visible through transparent glass inspection window. ➢ Normally open (NO) contacts in TCIV should close/TCIV Close indication in control Box should be reflected.	
		B. For Motorised TCIV i. Mount TCIV with approx. 3 degree inclination on test jig ii. Generate a set of input signal for the activation of NIFPES system	➢ TCIV should close. ➢ Flap closing shall be visible through transparent glass inspection window. ➢ Normally open (NO) contacts in TCIV should close/TCIV Close indication in control Box should be reflected.	
3.	Reset test	Reset the TCIV in the normal position.	➢ Close contact in TCIV should become open/ TCIV open indication in control Box should be reflected. ➢ Flap opening shall be visible through transparent glass inspection window.	
4.	High voltage test	Apply 2kV AC for 1 minute between terminals and body	TCIV should withstand.	

13.5 Functional Tests of Fire detector:

13.5.1 The test report of the fire detector as mentioned in Para 9.0 (i) shall be submitted. The operating temperature shall be as per the requirement mentioned in Para 7.0 (2) this specification.

13.5.2 The NIFPES manufacturer shall submit the declaration that the make and model/design of the Fire detector supplied with transformer and which has been tested at the third party laboratory are same.

13.6 Live demonstration test: To verify the working of the system, live demonstration is to be conducted in both fire prevention and extinguishing mode. Following to be ensured;

(i) Demonstration is to be carried out at the works of NIFPES Manufacturer. It shall be responsibility of NIFPES manufacturer to arrange a suitable location at the works for live testing.

(ii) A dummy tank of minimum 5000 litres oil capacity and filled with oil, which should be available with NIFPES manufacturer, can be used as a transformer tank for testing.

(iii) The FEC and Control Box tested in para 13.3 are to be used for live testing.

(iv) Separate filled Nitrogen cylinder should be used for live tests.

(v) Testing shall be conducted as per procedure mentioned below;

13.6.1 Testing in Fire Prevention Mode

13.6.1.1 Procedure:

(i) Oil Drain Pipe, Nitrogen Injection pipe, FEC, Control box, Signal box, TCIV, oil pit with all necessary pipes and cable connections shall be connected with transformer tank.

(ii) Nitrogen gas Cylinder pressure should be recoded.

(iii) The NIFPES System shall be made ON.

(iv) Any one set of input of the fire prevention mode shall be generated by a suitable method.

13.6.1.2 Observations/Result:

(i) Due to fulfill of required condition, system gets activated in auto mode.

(ii) Oil Drain should be started.

(iii) Nitrogen should be injected.

(iv) TCIV should close.

(v) Following Indications at control Box has been turned ON:

a)	Oil Drain valve open	b)	Buchholz Relay trip or PRV Trip
c)	Extinction in progress/Nitrogen Injection valve open	d)	Differential Trip or REF Trip or OCR Trip
e)	Audio Alarm activated	f)	LVCB open
g)	HVCB open	h)	Nitrogen cylinder pressure low
i)	TCIV Close		

(vi) Nitrogen Gas cylinder pressure should be recorded at stage when nitrogen injection has stopped.

13.6.2 Testing in Fire Extinguishing Mode (By igniting the transformer oil of the tank)

13.6.2.1 Procedure:

(i) There should be an opening on the Transformer tank to ignite the transformer oil.

(ii) Fire detector should be mounted at the distance of 800mm from the opening (mentioned in point, i)

(iii) Oil Drain Pipe, Nitrogen Injection pipe, FEC, Control box, Signal box, TCIV, oil pit with all necessary pipes and cable connections shall be connected with transformer tank.

(iv) The NIFPES System shall be made ON.

(v) The Bucholz Relay or PRV Trip and HVCB & LVCB open Signal shall be activated by a suitable method.

(vi) Ignite the transformer oil by any method such as pouring any flammable liquid (example- petrol) or any suitable chemical spray and igniting the flame.

(vii) Start the timer/ stop watch on commencement of Nitrogen injection.

13.6.2.2 Observations:

(i) Due to fulfill of required conditions of fire extinguishing mode, system should get activated in auto fire extinguishing mode.

(ii) Oil Drain should be started.

(iii) Nitrogen should be injected.

(iv) TCIV should close.

(v) Following Indications has been turned ON:

a)	Oil Drain valve open	b)	Buchholz Relay trip or PRV Trip
c)	Extinction in progress/Nitrogen	d)	Fire detector trip

	Injection valve open		
e)	Audio Alarm activated	f)	LVCB open
g)	HVCB open	h)	Nitrogen cylinder pressure low
i)	TCIV Close		

(viii) Stop the timer/ stop watch when fire extinguishes.

13.6.2.3 Results:

SN	Details	Requirement	Observation
1.	Fire Extinction period on commencement of Nitrogen injection	Maximum 30 seconds	..... seconds