

ODISHA TRANSMISSION CORPORATION LIMITED



## **TECHNICAL SPECIFICATION**

**FOR**

## **NITROGEN INJECTION TYPE FIRE PREVENTION & EXTINGUISHING SYSTEM**

## **NITROGEN INJECTION TYPE FIRE PREVENTION & EXTINGUISHING SYSTEM**

**General:** - Scope of work is to design, supply, erection, testing and commissioning of Nitrogen Injection system for protection against the transformer explosion and fire for above Transformers including all required civil works of oil sump, foundations, any other required for satisfactory working of system. The NIFPS shall be guaranteed in line with the transformer guarantee period.

Each oil filled transformer shall be provided with a dedicated Nitrogen Injection system for prevention against the transformer explosion which shall use nitrogen as quenching medium. The system shall prevent transformer oil tank explosion and possible fire in case of internal / external cause. In the event of fire by external causes such as bushing fire, OLTC fires, fire from surrounding equipment etc., it shall act as a fast and effective fire fighter. It shall accomplish its role as fire preventer and extinguisher without employing water or carbon dioxide. Fire shall be extinguished within reasonable time (not more than 3 minutes so as not to harm the transformer) of system activation and within 30 seconds (maximum) of commencement of nitrogen injection. The offered NIFPS system should have been in successful operation in Indian installations for at least last five years for protection of transformers of **132 KV and higher voltage class**. The list of past supplies in India along with performance certificate from Central or State Government Power sector utilities, using the above system shall be submitted along with the bid offer.

Nitrogen Injection system should be a dedicated system for each oil filled transformer. It should have a Fire Extinguishing Cubicle (FEC) placed on a plinth at a distance of 5-10 m away from transformer / reactor or placed next to the firewall (if fire fighting wall exists). The FEC shall be connected to the top of transformer / reactor oil tank for depressurization of tank and to the oil pit (capacity is approximately equal to 10% of total volume of oil in transformer / reactor tank / or existing oil pit) from its bottom through oil pipes. The FEC should house a pressurized nitrogen cylinder (s) which is connected to the oil tank of transformer / reactor oil tank at bottom. The Transformer Conservator Isolation Valve (TCIV) is fitted between the conservator tank and Buchholz relay. Cable connections are to be provided from signal box to the control box in the control room, from control box to FEC and from TCIV to signal box. Detectors placed on the top of transformer / reactor tank are to be connected in parallel to the signal box by Fire survival cables. Control box is also to be connected to relay panel in control room for receiving system activation signals.

### **5.4.25.2 Activation of the system**

The system shall work on the principle of Drain & stir. On activation, it shall drain a pre-determined quantity of oil from the tank top through drain valve to reduce the tank pressure, isolate conservator tank oil and inject nitrogen gas at high pressure from the bottom side of the tank through inlet valves to create stirring action and reduce the temperature of oil below flash point to extinguish the fire. On operation, the quantity of oil removed from the tank shall be such that adequate amount of oil shall remain to cover active part (i.e. core coil assembly).

Mal-functioning of the Nitrogen injection system could lead to interruption in power supply. The supplier shall ensure that the probabilities of chances of malfunctioning of the Nitrogen injection system are practically zero. To achieve this objective, the supplier shall

plan out scheme of activating signals which should not be too complicated to make the system inoperative in case of actual need. The system shall be provided with automatic controls to prevent the explosion of transformers. Besides automatic control, remote electrical push button control at Control box and local manual control in the cubicle shall also be provided. The following electrical-signals shall be used for activating the system under prevention mode/fire extinguishing mode.

#### **5.4.25.2.a Auto Mode**

##### **For prevention:**

- Differential relay operation.
- Buchholz relay paralleled with pressure relief valve or RPRR (Rapid Pressure Rise Relay)
- Tripping of all circuit breakers (on HV & LV/IV side) associated transformer / reactor is the pre-requisite for activation of system.

##### **For extinguishing**

- Fire Detector
- Buchholz relay paralleled with pressure relief valve or RPRR (Rapid Pressure Rise Relay).

Tripping of all circuit breakers (on HV & LV/IV side) associated with transformer / reactor is the pre-requisite for activation of system.

#### **5.4.25.2.b Manual Mode (Local / Remote)**

Tripping of all circuit breakers (on HV & LV / IV side) associated with transformer / reactor is the pre-requisite for activation of system.

#### **5.4.25.2.c Manual Mode (Mechanical)**

- Tripping of all circuit breakers (on HV & LV / IV side) associated with transformer / reactor is the pre-requisite for activation of system.

The system shall be designed to be operated manually in case of failure of power supply to the system.

#### **5.4.25.3 Operation**

On receipt of all activating signals, the system shall drain - pre-determined volume of hot oil from the top of tank (i.e. top oil layer), through outlet valve, to reduce tank pressure by removing top oil and simultaneously injecting nitrogen gas at high pressure for stirring the oil at pre-fixed rate and thus bringing the temperature of top oil layer down. Transformer conservator isolation valve blocks the flow of oil from conservator tank in case of tank rupture / explosion or bushing bursting. Nitrogen occupies the space created by oil drained out and acts as an insulating layer over oil in the tank and thus preventing aggravation of fire.

- Electrical isolation of transformer shall be an essential pre-condition for activating the system, to avoid nitrogen injection in energized transformer.
- The system shall have provision of testing on live transformers to ensure healthiness at all times.
- The system shall have mechanical locking arrangement for nitrogen release system as well as oil drain to avoid unnecessary operation during maintenance and /or testing of the transformer and / or system.
- The system shall have provision to monitor nitrogen injection pressure as well as cylinder pressure.
- Pressure monitoring switch for back up protection for nitrogen release as redundancy to first signal of oil draining commencement for nitrogen release shall preferably be provided.
- System shall have individual mechanical release devices and provision for oil drain and nitrogen release to operate manually in case of operation DC supply failure.
- Nitrogen release scheme shall be designed in such a way that the nitrogen gas shall not enter the energized transformer tank even in case of passing / leakage of valve.
- Individual system component / equipment should operate on station DC voltage. AC-DC / DC-DC converter shall not be used for reliable operation.
- All outdoor panels / equipment shall be of IP-55 protection class.

#### **5.4.25.4 System components:-**

Nitrogen Injection system shall broadly consist of the following components. However, all other components which are necessary for fast, reliable and effective working of the system shall be deemed to be included in the scope of supply.

#### **5.4.25.4.a CUBICLE (FEC):-**

The Cubicle Frame shall be made of CRCA sheet of 3 mm (minimum) thick complete with the base frame, painted inside and outside with post office red colour (shade 538 of IS -5). It shall have hinged / hinged split doors fitted with high quality tamper proof lock. The doors, removable covers and panels shall be gasketed all round with neoprene gaskets. The degree of protection shall be IP55. The following items shall be provided in the Cubicle.

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

#### **5.4.25.4.b Under Ground Oil Storage Tank:-**

Each transformer unit shall be provided with an underground oil storage tank. The oil storage tank shall have Non Corrosive, water proof, epoxy coated (from Inside) mild steel (minimum thickness 6 mm) to store drained-out oil on operation of NIFPS. The tank shall be painted from outside as per Clause no. 5.4.8. The total capacity of storage tank shall be at least 10% of transformer tank oil to avoid overflowing of oil considering that drained oil volume shall be around 10% of transformer tank oil. Necessary arrangement shall be made on underground storage tank so as to take out the drained oil from the tank for further processing and use. All the pipes and physical connections from transformer to oil pit shall be in the scope of contractor.

This storage tank shall be placed in the pit made up of brick walls with PCC (1:2:4) flooring with suitable cover plates to avoid ingress of rain water. The design of tank and pit shall be finalized during detailed engineering.

#### **5.4.25.4.c Control box:-**

Control box is to be placed in the control room for monitoring system operation, automatic control and remote operation. The following alarms, indications, switches, push buttons, audio signal etc. shall be provided.

- System Oil.
- TCIV open.
- Oil drain valve closed.
- Gas inlet valve closed
- TCIV closed
- Detector trip
- Buchholz relay trip
- Oil drain valve open
- Extinction in progress
- Cylinder pressure low
- Differential relay trip
- PRV / RPRR /OSR trip
- Transformer / reactor trip
- System out of service
- Fault in cable connecting fault detector
- Fault in cable connecting differential relay
- Fault in cable connecting Buchholz relay
- Fault in cable connecting PRV / RPRR / OSR
- Fault in cable connecting transformer reactor trip
- Fault in cable connecting TCIV
- Auto / Manual / Off
- Extinction release on / off
- Lamp test
- Visual / Audio alarm for AC supply fail
- Visual / Audio alarm for DC supply fail

As far as possible, the control box should be so devised that all the transformers and reactors or group thereof should be controlled from single spot.

**5.4.25.4.d Transformer Conservator Isolation Valve:-**

Transformer conservator isolation valve (TCIV) is to be fitted in the conservator pipe line, between conservator and buchholz relay, which shall operate for isolating the conservator during abnormal flow of oil due to rupture / explosion of tank or bursting of bushing. The valve shall not isolate conservator during normal flow of oil during filtration or filling or refilling, locking plates to be provided with handle for pad locking. It shall have proximity switch for remote alarm, indication with visual position indicator.

The TCIV should be of the best quality as malfunctioning of TCIV could lead to serious consequence. The closing of TCIV means stoppage of breathing of transformer / reactor.

Locking plates shall be provided for pad locking.

**5.4.25.4.e Detectors:-**

The system shall be complete with adequate number of detectors (quartz bulb) fitted on the top cover of the transformer / reactor oil tank.

**5.4.25.4.f Signal box:-**

It shall be mounted away from transformer / reactor main tank, preferably near the transformer marshaling box, for terminating cable connections from TCIV & detectors and for further connection to the control box. The degree of protection shall be IP55.

**5.4.25.4.g Cables:-**

Fire survival cables (capable to withstand 750° C.) of 4 core x 1.5 sq. mm size for connection of detectors in parallel shall be used. The fire survival cable shall conform to BS 7629-1, BS 8434-1, BS 7629-1 and BS 5839-1, BS EN 50267-2-1 or relevant Indian standards.

Fire Retardant Low Smoke(FRLS) cable of adequate size shall be used for connection of signal box / marshaling box near transformer / reactor and FEC mounted near transformer/ reactor with control box mounted in control room.

Fire Retardant Low Smoke (FRLS) cable of 4 core x 1.5 sq. mm size shall be used for connection between control box to DC & AC supply source, FEC to AC supply source, signal box / marshaling box to transformer conservator isolation valve connection on transformer / reactor. Separate cables for AC supply & DC supply shall be used.

**5.4.25.4.h Pipes:-**

Pipes complete with connections, flanges, bends and tees etc. shall be supplied along with the system.

**5.4.25.4.i Other items to be supplied:-**

- a) Oil drain and nitrogen injection openings with gate valves on transformer / reactor tank at suitable locations.
- b) Flanges between Buchholz relay and conservator tank for fixing TCIV.
- c) Detector brackets on transformer / reactor tank top cover.

- d) Spare potential free contacts activating the system i.e. in differential relay, Bucholz relay. Pressure Relief Device / RPRR , Circuit breaker of transformer / reactor.
- e) Pipe connections between transformer / reactor and FEC and between FEC and oil pit required for collecting top oil.
- f) Cabling for detectors mounted on transformer / reactor top cover.
- g) Inter cabling between signal box, control box and FEC.
- h) Butterfly valves / Gate valves on oil drain pipe and nitrogen injection pipe which should be able to withstand full vacuum.
- i) Supports, signal box etc. which are to be painted with enameled paint.
- j) Any other item required for satisfactory operation of system.

#### **5.4.25.5 Power supply:-**

For Control Box: As per substation DC voltage i.e.220V, DC, 2 Wire.

For FEC Auxiliary: 230 V AC

#### **5.4.25.6 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 Nitrogen Injection Fire Prevention Cum Extinguishing System (NIFPES) 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 supplier / Sub-Contractor to install, carry out pre-commissioning tests & commission NIFPES at the mentioned Sub-Station in this specification, to the entire satisfaction of the OPTCL.

#### **5.4.25.7 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 PRV shall get closed only if all the connected breakers are open.

#### **5.4.25.8 Tests:-**

Supplier has to carry out the type test as per relevant IS/IEC. Specifically IP 55 on FEC or have to produce the report from NABL approved Lab.

Reports of all routine test conducted as per relevant IS/IEC standards in respect of various bought out items including test reports for degree of protection for FEC / control box / signal box shall be submitted by the supplier.

The supplier shall demonstrate the entire functional tests, associated with the following as Factory Acceptance Tests:

- FEC, Control Box
- Fire Detector
- Transformer Conservator Isolation Valve

The performance test of the complete system shall be carried out after erection of the system with transformer at site.

Detailed layout drawings, equipment drawing along with 4 sets of Operation and Maintenance manual along with soft copies (In CDs) shall be submitted by the supplier along with the consignment.

The guaranteed technical particulars for the offered system are indicated in Ann-IV. Any other particulars, considered necessary in addition to those listed in that Section may be furnished by the Bidder.

**GUARANTEED TECHNICAL PARTICULARS NITROGEN INJECTION SYSTEM FOR PREVENTION OF FIRE/ EXPLOSION FOR TRANSFORMERS/REACTORS.**

Sr. No.	Description	Guaranteed Particulars
1	Name of Manufacture and country of origin	
2	Reference standards	
3	Details of system equipments	
4	FEC (Fire Extinguishing Cubicle)	
4.1	Dimensions (LXBXH) mm	
4.2	Weight	
4.3	Capacity of Nitrogen cylinder	
4.4	Number of cylinders	
4.5	Pressure of Nitrogen filing	
4.6	Minimum distance of FE cubicle from the transformer	
4.7	Method of mounting	
4.8	Whether the following items are provided in FE cubicle. If so furnish make, type & other details	
4.9	Contact Manometer	
4.10	Pressure Regulator	
4.11	Oil Release Unit	
4.12	Gas release unit	
4.13	Oil drain assembly	
4.14	Pressure / limit switches	
4.15	No. of contacts & spare contacts (NO & NC)	
4.16	Oil drain Valve (ABOVE FEC)	
4.17	Make	
4.18	Type	
4.19	Size	



4.20	Type of metal	
4.21	Nitrogen Injection Valve (Above FEC)	
4.22	Make	
4.23	Type	
4.24	Size	
4.25	Oil drain pipe	
4.26	Size	
4.27	Length	
4.28	Number of openings in the transformer tank	
4.29	Material	
5	Control Box	
5.1	Dimensions (LXBXH) mm	
5.2	mm	
5.3	Type & Thickness of sheet steel	
5.4	Details of components provided in the control box	
5.5	Control voltage	
5.6	Method of mounting	
5.7	Whether audio and visual alarm provided?	
6.	Transformer Conservator Isolation Valve	
6.1	Make	
6.2	Type	
6.3	Location	
6.4	Whether suitable for pipe of size 80 mm dia	
6.5	No. of contacts & spare contacts (NO & NC)	
6.6	Padlocking provision	
7	Detectors	
7.1	Make	
7.2	Type	
7.3	Quantity required	
7.4	Method of fixing	
7.5	Effective heat sensing area	
7.6	Temperature recommended for effective heat sensing	
7.7	Number of contacts NO / NC	
7.8	Necessity and condition of Refilling	
8	Whether approved by Tariff Advisory Committee of India	
9	TECHNICAL PARTICULARS FOR NITROGEN INJECTION SYSTEM FOR PREVENTION OF TRANSFORMER EXPLOSION	
10	Power Supply	
10.1	Control box	
10.2	FEC (lighting)	
10.3	Extinction period	

10.4	On system activation	
10.5	On commencement of Nitrogen injection	
11	FEC Suitable for capacity	
11.1	Dimensions (LXBXH) mm	
11.2	Weight	
11.3	Nitrogen cylinder capacity	
12	Control Box	
12.1	Dimensions (LXBXH) mm	
12.2	Weight	
13	Detectors	
13.1	Heat sensing temperature	
13.2 Time of operation	Transformer Tank Explosion Prevention	Fire Extinction
For system activation		
For reduction of pressure in tank by Nitrogen Release		

13.3 Any other technical details not covered above.