ISO 9001 - 2008

NATIONAL
SWITCHGEARS

NEUTRAL GROUNDING RESISTOR
FOR BETTER SYSTEM STABILITY

The earth fault is the most common short circuit occurring on electrical power system. When the neutral of a system is not grounded, destructive transient over voltages several times the normal can appear from the line to ground causing failure of insulation at various locations. Under faulty conditions the flow of current through the expensive power equipments like Transformers, Generators etc., is enormous and it is restricted only by their own impedance. The system grounding which differs from Equipment Grounding is to connect the neutral point of the Transformer or Generator to the earth/ground either directly or through an impedance. The grounding of the system can be classified as Unearthed, Solidly Earthed and Earthed through an impedance.

The relative merits of various types of earthing methods call for exhaustive study and we confine here to the grounding through resistor which has the following advantages:

1. Reduces the magnitude of transient over voltages and that minimizes the equipment damage.
2. Improved lightning protection.
3. Better safety for operating personnel by eliminating electric shock hazards.
4. Improvement in overall maintenance of the system.
5. Easier location of ground fault.
6. Reduction of Mechanical stress in equipments carrying in fault current.
7. Pre-determining the fault current sufficient to operate protective relays.

Among many forms of neutral grounding, resistive earthing has been proved to be economical, safe and reliable, ultimately improving system performance. Usage of liquid type Neutral Grounding Resistor (NGR/NER) has been discontinued because of its many disadvantages like evaporation of electrolyte and inconsistency in maintaining resistive value and it is replaced by Metallic Resistors.

Nowadays most of the NGRs are of Metallic Type which have the following advantages.

1. Factory set resistance value remains throughout their life.
2. Negligible Maintenance.
3. Easy handling and installation.
4. Temperature time constant is shorter and hence ideally suited for short time rated equipments like NGR.
5. Limiting fault current to predetermined maximum values permits better coordination of protection relay and quick location of the fault.

STANDARDS AND RATINGS

The American Standard IEEE-32 is universally followed by the manufacturers. Most important parameters to be considered from the standards are:

A. TEMPERATURE RISE

The temperature rise of the resistive element depends upon the material and fault duration.

Time Rating	Temperature rise in ^{0}C	
	For Stainless Steel	For Cast Iron
10 Sec, to less than 10 min	760	510
10 min	610	460
Continuous	385	385

Higher temperature rise and shorter duration make the NGR more cost effective and compact in size. Unusually lower temperature rise and longer time duration inflate the cost of NGR. Normally designers prefer 5, 10 or 30 seconds depending upon the design parameters of the protective system. The temperature rise is sometimes restricted to 250, 350 or 550 ^{0}C at the request of the customer.

National Switchgears has taken special interest in conducting temperature rise test on short time rated equipment like NGR. Most of the conventional temperature measuring sensors record accurate temperature after a certain time interval. In other words, their response time is much more than the rating of the resistor itself and hence the design parameters for the NGR cannot be assured. In order to confirm the design factors, we have tested our 66kV/200A

& 11kV/2000 A NGRs at KEMA, Netherlands for 10 Sec temperature rise. Heat and Flow department of Philips and KEMA jointly conducted the test by employing very sensitive INFRARED cameras and the temperature rise was compared metallurgically with thermal readings of the computer. The result was well within our design figures. The testing was covered by the house magazine of KEMA.

ENCLOSURE:

The standard sheet steel enclosure with drip proof top and side covers conforming to IP23/33 is suitable for both indoor and outdoor applications. In extreme environmental conditions other degrees of protection can be provided.

RATED VOLTAGE

The NGR is always rated on the basis of voltage between phase and neutral (System voltage divided by √3). The power frequency withstand voltage and the creepage distance of outdoor bushing are calculated on the value of rated voltage only. National Switchgears manufactures NGRs upto a system voltage of 66 kV.

RESISTIVE EARTHING

LOW AND HIGH VALUE RESISTANCE GROUNDING are two methods generally adopted by the system designers.

A. LOW RESISTANCE GROUNDING

In this method, the fault current is always limited to a high value of current normally 300/400 A for a duration of 10 Sec and the current may be allowed to go upto the rated current value of the protected equipment. The fault current will be of sufficient value to operate the protective relays speedily through a CT and the minimum value is normally limited to 100 A for a medium voltage system. This also helps to clear the fault quickly thereby minimizing damage to the equipment, limiting overheating and mechanical stress on the conductors.

It improves overall safety of personnel. The magnitude of the current should be at least as large as the current flowing through the system's shunt capacitance, for the resistance to adequately limit the transient over voltages, limiting current up to 2000 A is not uncommon.

B. HIGH RESISTANCE GROUNDING:

High resistance is added in the neutral circuit in such a manner that the fault current does not exceed higher 10 A which should be slightly higher than capacitive current of the system. The resistance is continuously rated to enable easy fault location.

It is always desirable to have high resistance limiting the current to a low value of 5/10 A to avoid damage to the iron-core of the stator in the event of an earth fault. But it has a certain disadvantage as low current and high resistance elements will be constructed out of resistive material having a very thin or small wire diameter. The important aspect in the design of an NGR is that it should be robust and reliable both electrically and mechanically.

This difficulty is overcome by connecting the neutral of the generator to the primary of a single phase step down transformer and the secondary is connected to a higher ampere loading resistor. Nowadays most of the generators in hydro, nuclear and thermal plants are having this system.

RESISTORS ELEMENT

Resistive element is the heart of the NGR. National Switchgears manufactures all types of elements, viz. punched stainless steel, formed alloy (wire wound) and cast iron. The merits and demerits of different types of elements cannot be narrated here.

However, we have added few suggestions. The cast iron resistor is ideally suited for short time rated equipment, but they suffer from fragility during transit. Secondly, their short time current rating is very much limited and very low rating may not be possible in view of its bulkiness. The formed alloy resistor will be flimsy in construction and it will have rigidity only in particular current ratings. They mainly suffer from their insulating material viz, mica tubes. The punched stainless steel is rugged in construction and their main insulating material is high aluminium oxide ceramic material. The spacer ceramics will have special profile to increase the creepage distance.

The main advantage with punched stainless steel is that they can be offered for widest current ratings with a very rigid construction. In view of its profile it is totally non-inductive. We can offer punched resistors for a continuous current rating as low as 15 A and short time current rating of 50 A for 10 Sec.

OPTIONS

1. Cap and Pin type stand off insulator.
2. Screened protective enclosure.
3. Aluminium, Hot Dip Galvanized or stainless steel Covers.
4. Support structure to increase the height of terminal bushing.
5. All hardwares of stainless steel.
6. Chromium/Aluminium alloy resistive element to give very low temperature coefficient of resistance viz. 0.00027.
7. Electronic Monitoring/over current earth fault relays.

TESTING ON NGR

Unless and otherwise specified only routine tests in accordance with IEEE-32 recommendations, will be conducted at the factory premises. The tests are Resistance Test and Applied Potential Test.

RESISTANCE TEST

The DC resistance value should not exceed +/- 10% when it is corrected to a temperature of 200 ^{0}C. At normal ambient temperature, the resistance is approximately 10% lower than the nominal value.

IMPULSE TEST

Impulse Test is not required for Neutral Grounding Resistor.

APPLIED POTENTIAL TEST

The power frequency withstand voltage having RMS value equal to 2.25 times the rated voltage plus 2 kV is to be applied for 1 minute between the terminal and ground of the frame assembly.

Typical values are: (in kV)

System voltage	Rated voltage	Applied Potential
3.6	2.1	7
7.2	4.2	12
12	7	17
24	14	34
36	21	50

NGR CUBICLE

In a power famine stricken country like India, the demand for independent power is fast increasing and utility agency takes extra precaution in protecting expensive generators. The most important protective equipment in Neutral Grounding Resistor and Associated accessories viz. CT, EARTH FAULTY RELAY, SINGLE POLE ISOLATOR etc. In order to contain space, all the above equipments are housed in one cubicle. Over the years we have perfected the technique of manufacturing in a customer friendly manner. Normal arrangements are:

1. Resistor compartment at the rear in IP 33 enclosure.
2. CT, Isolator, Relay etc., at the front in IP 42/54/55 enclosures.
3. Separate LT compartment at the right side bottom with hinged doors.

Being a manufacturer of our own isolators and switch disconnectors our operating handle mechanism is unique and by using sealed bearings the handle is made to suit IP55 conditions. It can be locked in both ON and OFF positions.

The cubicle can be made for indoor and outdoor service. On specific request the above arrangements can be modified.

NATIONAL SWITCHGEARS

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