

# Case Studies – Failure of NGR Surge Arrester in 765kV Line Reactors

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# INTRODUCTION

- Neutral Grounding Reactor (NGR) is used for grounding the neutral point of Line Reactors so as to limit the secondary arc current and by limiting the recovery voltage.
- Neutral Grounding Reactor (NGR) is subject to transient voltages whenever a fault occurs in 765kV system connected to NGR.
- Surge Arrester of suitable rating (Voltage & Energy) is connected across NGR so to guard the NGR & Line Reactor from any kind of over voltages.

# Neutral Point Voltage

- In case of single phase to earth fault, voltage at neutral point i.e. across NGR increases.
- Voltage at Neutral Point is calculated as per following:

$$V_n = 1/(2 + X_1/X_n)$$

Where

$X_1$  : Main Reactor Reactance

$X_n$  : NGR Reactance

# 765kV Line Reactor – NGR Surge Arrester

- Rating of NGR Surge Arrester – 765kV Line Reactor:

Sl	Technical Parameters	Value
1.	Rated Voltage	132kV
2.	COV	106kV
3.	Energy Handling Capacity	12kJ/kV
4.	LIPL – 10kA	314kVp
5.	SIPL – 1kA	280kVp

# CASE STUDY - I

- Multiple incidents of failure of NGR Surge Arrester were observed during single to phase earth fault in 765kV Transmission line.
- Details of Line & Rating of NGR Surge Arresters:

Sl	Technical Parameters	Value
1.	Line Length	268km
2.	Line Reactor at each end	240MVAR
3.	NGR Ohmic value	700 $\Omega$
4.	NGR Surge Arrester Rated Voltage	120kV

# CASE STUDY - I

- During single phase to earth fault, unbalanced condition shall be created leading to high voltage at neutral point of reactor and across NGR & Surge Arresters.

- Voltage at Neutral Point of Reactor :  $V_n = 1/(2 + X_1/X_n)$


$$X_1 = (765\text{kV} \cdot 765\text{kV}) / 240\text{MVAR} = 2440 \text{ ohm}$$

$$X_n = 700 \text{ ohm}$$

$$V_n = (1/(2 + 2440/700)) = 0.18 \text{ p.u.}$$

$$V_n = 0.18 \cdot 800 \cdot 1.414 / 1.732 = 117\text{kVp}$$

# CASE STUDY - I

- From waveforms of Disturbance Recorder, it was found that NGR voltage is very high i.e., about 700-800kV/  $\sqrt{3}$  kV for 10 cycles which is due to unbalance oscillating voltage on line side. 
- Considering above, the ratings of NGR Surge Arresters were reviewed and it was found that rated voltage and energy handling capability needs to be increased. Voltage at Neutral Point of Reactor

## CASE STUDY - II

- In 765kV Double Circuit Transmission lines, failures of NGR Surge Arresters were observed. These Surge Arresters are provided with the modified Technical Specifications.
- Details of Line & Rating of NGR Surge Arresters:

SI	Technical Parameters	Value
1.	Line Length	350km
2.	Line Reactor at each end	330MVAR
3.	NGR Ohmic value	240MVAR
4.	NGR Surge Arrester Rated Voltage	1600 $\Omega$



## CASE STUDY - II

- During single phase to earth fault as well as during double phase to earth fault, the voltage at neutral point i.e. across NGR shall be very high.
- Voltage at Neutral Point of Reactor :  $V_n = 1/(2 + X_1/X_n)$   
 $X_1 = (765\text{kV} \times 765\text{kV})/330\text{MVAR} = 1773 \text{ ohm}$   
 $X_n = 1600 \text{ ohm}$   
 $V_n = (1/(2+1773/1600)) = 0.32 \text{ p.u.}$   
 $V_n = 0.32 \times 800 \times 1.414/1.732 = 210\text{kVp}$
- Considering above, it was decided to install 02 nos. of 132kV & 12kJ/kV rated Surge Arresters in parallel across NGR.

# CONCLUSION

- NGR Surge Arrester failure rate has reduced considerably after change in Technical parameters like rated voltage, energy handling capacity.

**THANKYOU**

