Modelling and Testing of Temporary Protective Grounds Cable Systems for High Fault Current Applications

Anil **PODA**, Josh **PERKEL**, Thomas **LANCASTER**, Nigel **HAMPTON;** GATECH/NEETRAC, (USA),
Anil.poda@neetrac.gatech.edu, Joshua.perkel@neetrac.gatech.edu, Thomas.lancaster@neetrac.gatech.edu,
Nigel.hampton@neetrac.gatech.edu

ABSTRACT

Temporary protective grounds are cable systems (cables, connectors and special terminating clamps) that are used to provide adequate protection to line workers while working on the de-energized electrical power systems that can accidentally become energized. In typical applications a single cable system TPG is used, however, there is a growing number of high fault current substations where the capacity of a single TPG is insufficient, yet the critical safety application of a TPG cable system is required.

Consequently installing more than one TPG for high fault current applications is a widely accepted practice in the electric utility industry. The extreme electro-mechanical forces present under high fault current conditions can cause failures of TPG assemblies below their cumulative single rating. Unlike thermal energy, the electro-mechanical forces on individual TPGs do not reduce in the same proportion as the current. The laboratory tests were performed on three parallel TPG sets with different spacing distances at 80 kA in a similar method to ASTM F855 requirements. The results strongly indicate that the spacing between the parallel TPGs should be installed as close as possible to each other to reduce the likelihood of failure due to electro-mechanical forces during the high fault current conditions.

This poster will provide details of the testing to verify the critical design parameters and the circuit modeling of the TPG cable systems in a multi parallel arrangement. The value of the modeling, whereby the experience can be extended to many different cases as shown with selected case studies.

KEYWORDS

Grounding, electrical safety, sizing TPG sets.

INTRODUCTION

Temporary protective grounds (TPGs) are intended to be installed on de-energized lines and equipment to protect workers from death or injury in case of accidental energization of the line during installation or maintenance work. Application of TPGs on de-energized lines and bus work creates a short circuit path, which limits the voltage between the phase and neutral/shield conductors, and carries the fault currents to neutral/shield conductors at the work site [1]-[3]. This allows any upstream protection to operate. TPG assemblies consist of clamps, ferrules, and interconnecting cable with a jacket [3].

In grounding applications, there are certain situations where a single temporary grounding cable does not have the required current carrying rating. In this situation, identical ground cables may be connected in parallel to achieve the necessary rating. In a typical application location, such as transmission lines and substations at some distance from generating station, an accidental switch closing can initiate a highly asymmetrical fault current due to sub-transient, transient, steady state ac components, and the dc offset components. The application of multiple TPGs reduces the size requirements for any individual TPG assembly [5], [7]. ASTM F855 recommends that the users seeking applications of multiple assemblies at high X/R locations should perform their own tests to verify the performance of the assembly. It is unclear, however, how much current a parallel configuration can successfully carry as compared to a single TPG configuration.

SELECTION OF TEMPORARY PROTECTIVE GROUNDS

ASTM F855 recommends performing internal testing when there is a need to use multiple TPGs on a single phase conductor. This standard also provides ratings for different individual TPG configurations up to 68 kA. However, there are locations with available fault currents well in excess of 68 kA, sometimes even above 80 kA. In addition to the available fault current, there are physical size limits to the conductors themselves as line personnel must be able to maneuver and attach the cables to the appropriate structure. Therefore, it is also possible that a utility may decide to use multiple small conductor TPGs instead of a single large TPG to carry the same amount of high fault current.

The most commonly used sizes and designs of TPGs for different fault currents were identified based on a survey conducted among 40 utility and manufacturing companies located in North America (representing around 70 million utility customers). A 6.1 m (20 ft) long 4/0 conductor design was selected for a three parallel TPG configuration that was ultimately tested at 80 kA. Other parts of the TPG design were also chosen from the survey, as specified in Table I. All the components required to build the TPGs were assembled by the manufacturer and were then tested at the Nicholas J. Conrad High Power Laboratory (NJCL) located in Chicago, IL, USA.

Table I: TPG Component Specification

Component	4/0 Specification
Cable Size	4/0 AWG
Ferrule	Threaded with shroud
Strain Relief	Yes
Top Clamp	Grade 5 C-Clamp
Bottom Clamp	Grade 5 C-Clamp
Cable Length	6.1 m (20 ft)
Install torque	Manufacturer specified