

# NATF Redacted Operating Experience Report

## Insufficient Insulation and Drivability of Substation Aggregate

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## Topic

Insufficient Insulation and Drivability of Substation Aggregate

## Description

During a visit to a substation construction site with energized facilities, a potential safety issue of inadequate crushed rock covering the substation yard and gate apron was identified. Engineering studies were performed to assess the impact of inadequate gravel in the substation. The model indicated an unsafe condition in the gate area. This information was shared with members of the project team and safety department. The situation was corrected by adding additional crushed rock.

Follow-up conversations with the construction contractor indicated that the crushed rock (#57 gravel) was open-graded (poor gradation) and could not be compacted to a tight formation. An 8- to 10-inch layer of this rock usually causes significant driving difficulties and severe rutting inside the substation, which was the reason the contractor did not install enough crushed rock in the first place. The Substation Standards Group reviewed this information, conducted additional investigations, and learned this problem (the driving difficulty) was common at other sites.

A small team was formed to investigate this situation and update the company substation aggregate specifications. By analyzing historical data, performing pilot installations and testing, the team found a satisfactory solution by revising the single layer open-graded aggregates to a two-layer aggregate system. This two-layer system consists of dense-graded aggregates as the underlayer (6-inch thick) and open-graded aggregates as the upper layer (2-inch thick). The dense-graded aggregates can be easily compacted to a tight formation. This two-layer system provides great vehicle drivability while maintaining its erosion mitigation and dust control capabilities. The substation grounding design procedure was modified to account for lower resistivity values of the dense-graded aggregates sub-layer. This has resulted in the need to install additional grounding rods, but the cost increase is insignificant.

## Lessons Learned

1. Substation aggregates not only serve as an insulating material to reduce touch and step potential, they also serve as an access roadbed for construction and maintenance vehicles.
2. Open-graded aggregates tend to have high resistivity values but cannot be compacted well due to poor gradation, which leads to drivability problems.
3. A balanced aggregate system design is essential to account for insulation to reduce touch and step potential and long-term serviceability.

## Actions Taken

1. A new substation aggregate specification and grounding design procedure was developed and is required to be applied on new substation construction.
2. Remediations were performed to substation aggregates at existing substations where aggregates were known to cause driving difficulties.

## Extent of Condition

Driving difficulties at eight substations were identified as part of the investigation. Each of these substations had 8 to 10 inches of open-graded yard aggregates (#57 gravel). The former substation aggregate specification clearly did not meet expectations, which prompted an overhaul of the aggregate design and grounding design.