FIRE PREVENTION METHOD FOR 275KV OIL-FILLED CABLE IN TEPCO

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ABSTRACT

There are many advantages in laying cables in a tunnel in congested area, such as large transmission capacity and easy maintenance. Tunnel installation is selected now more than ever in many countries. But High Voltage Oil-Filled (SCOF) cable fault in a tunnel may cause a fire, and the fire may expand to all the cables inside the tunnel. It is difficult to extinguish tunnel fire due to its low accessibility. One cable fault, however, shall never cause tunnel fire nor affect other circuits. Fire prevention method is crucial.
And the fault caused by negative oil pressure makes larger fault energy, it is important to prevent negative pressure in cables.
This paper describes fire prevention methods developed by Tokyo Electric Power Company (TEPCO), based on many short-circuit tests.

KEYWORDS

SCOF cable, fault, fire prevention, tunnel fire, negative pressure

1. BACKGROUND

As an electric power system becomes larger, the short-circuit current and the ground-fault current in the system become larger. Especially in the EHV power lines (500kV and 275kV in case of TEPCO), those currents tend to become large, because they apply directly grounded system and many power plants are connected. The maximum ground-fault current has increased together with the EHV network expansion in TEPCO.

The increase of the short-circuit current and the ground-fault current cause the following problems.

- Reinforcement of circuit breakers (and other apparatus if necessary)
- Electromagnetic induction to communication wire
- Damage caused by fault current
- Electromagnetic force to the cables

In many cases of EHV underground transmission lines, each cable conductor is shielded in single-phase and only the ground-fault is considered for damage at the fault point.

In the case of SCOF cable fault, fire concern is the greatest. EHV SCOF cable or joint fault in a tunnel may cause a fire, and the fire may expand to all the cables and the ancillary facilities inside the tunnel, because it is difficult to go underground and extinguish the fire.

Therefore, it is necessary to avoid the damage of other circuits and the fire occurrence at the time of a cable fault.

In this paper, the fire prevention method in TEPCO and its background are reported.

2. ASSUMED GROUND-FAULT MODE

2.1.Ground-fault mode

Before discussion about a fire prevention method for SCOF cables, their ground-fault modes were reviewed.
The causes of ground-fault are as follows.

Aging
Long term deterioration by heat and/or electric field may cause insulation deterioration. Contamination or initial defect may trigger the deterioration**.**

Movement of cable core or external stress
Movement of cable core (longitudinal move of the cable core) may make joint insulation paper touch the joint case, and may damage insulation.

Absorption of moisture
External damage or aging of the plastic sheath may cause the degradation of the aluminum sheath, leading to intrusion of water into the cable or absorption of the moisture. It deteriorates insulation.

Negative oil pressure
SCOF cables should be used under positive oil pressure. Used under negative oil pressure, the breakdown voltage may become less than normal operating voltage level.

2.2. Ground-fault path

Ground fault paths are analyzed for the above mentioned modes.

Aging
Usually, conductor is the hottest and has the highest electric field in the cable. It is considered that heat and/or electric deterioration starts near the conductor.
Sometimes fault current path runs from the starting point (conductor) to the shielding layer in the shortest distance. Sometimes the path runs along the insulation paper gradually and the fault current path includes longitudinal direction.
In a cable fault due to the aging, therefore, both short and long fault paths can occur, as shown in fig.1.

Movement of cable core or external stress
In this case, it is considered that the fault path starts the damaged part, runs the shortest path through the insulation.