Study Committee B1

Insulated Cables

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Kansai Transmission and Distribution

Replacement by utilizing existing facilities for EHV Underground Transmission Lines

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INTRODUCTION

In Japan, underground transmission lines that were installed in the 1970s now need to be replaced.

Issues to be addressed in replacement

TSOs are required to;

- Minimize the period under the N-1 condition, which is unavoidable during the replacement process, in order to keep supply reliability as high as possible.
- Reduce the environmental impact caused by the work.

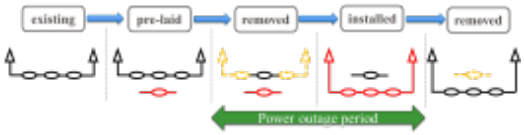
These issues, which arise from social expectations, must be addressed in order to ensure the sustainable development of the electricity business.

OUTLINE OF CABLE REPLACEMENT PROCEDURE

Conventional method

- The new cables are installed after removing the aged ones.
- Power outage is required during whole works form removing work to installation.

Pre-laying method



- The new cables are laid in vacant ducts except for the sections at both ends including terminations.
- Then, the line is placed out of service, the aged facilities in both sections are removed and the new ones are installed.
- Most of the removal work can be performed without stopping the power.

The pre-laying method has potential not only to shorten the outage period during replacement work but to reduce the environment impact by utilizing existing facility without excavation also.

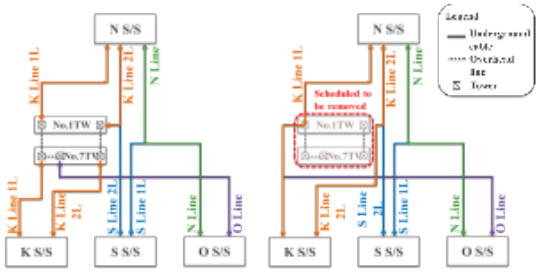
Necessary condition for Pre-laying method application

- Vacant ducts are necessary for the pre-laying method due to install the new cables in advance.
- But in some practical cases, it is not easy to obtain or use the vacancy, in which cases some ingenuities should be performed for the pre-laying method application.

PRACTICAL EXAMPLES
CASE A (utilizing existing ducts and manholes)

Outline of the project

- Case A shows a cable replacement project in a 275 kV grid. This grid (Fig. 2) mainly consists of aged, self-contained fluid-filled (SCFF) cables, so they are being sequentially replaced by cross-linked polyethylene (XLPE) cables.



(a) All SCFF cables as of 2005 (b) All XLPE cables as of 2025

Fig.2 275 kV line cable system

Issues in the project

- The duct system itself for the cables of the K line had no vacant ducts for pre-laying.
- After a detailed survey, an alternative route for replacement (ducts built for other lines) was found, but involved a technical issue related to the dimensions of manholes.
- It is because SCFF and XLPE have a difference in their extension characteristics. XLPE requires much space in manhole.
- Therefore, it needed to apply the joints with less space than the prefabricated joints that had been used in the past projects.

Study for premold one piece joint in narrow manhole

- To apply the joint into narrow manholes built for SCFF, it was necessary to verify the properties of that by taking the influence of thermal expansion of the cable into consideration.
  - A) Insulation performance
  - B) Surface pressure at interface between the rubber of the joint and the insulation layer of the cable
  - C) Workability in a narrow space.

(a) Simulated environment (b) Assembly

Fig. 4 Workability test in a narrow space

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Replacement by utilizing existing facilities for EHV Underground Transmission Lines continued

PRACTICAL EXAMPLES
CASE A

Measures

- Application of the premold one piece joints enabled new XLPE cables to be installed into the existing manholes with narrow space on the alternative route.
- It means that the large-scale civil engineering works such as manhole expansion or duct construction could be avoided.

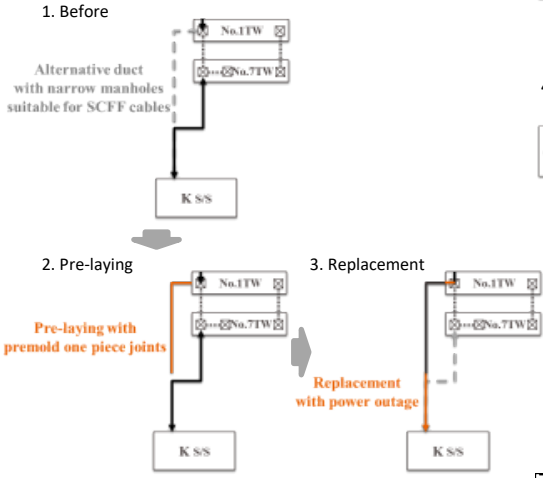

Fig. 3 K line 1L replacement work utilizing alternative route

CASE B (utilizing existing cable lines)

Outline of the project

- Case B shows an ongoing cable replacement project in a 154 kV grid with reviewing the whole equipment on the grid.
- In this case, H line needed to be replaced because of the age of 50 years.

Issues in the project and measures to them

- Unlike case A, there was no alternative route that could connect the No. 60 tower and H substation.
- Further investigation found a route for which the pre-laying method could be used between the No. 60 tower and S substation.
- Therefore, the cable replacement procedure was revised to utilize the existing S line and the route effectively.
- First, the new cables for replacing S line are laid in advance, and at the timing of switching the cables, the old S line is diverted for the H line.
- This method can significantly reduce the number of sections of the laying of the new H line.

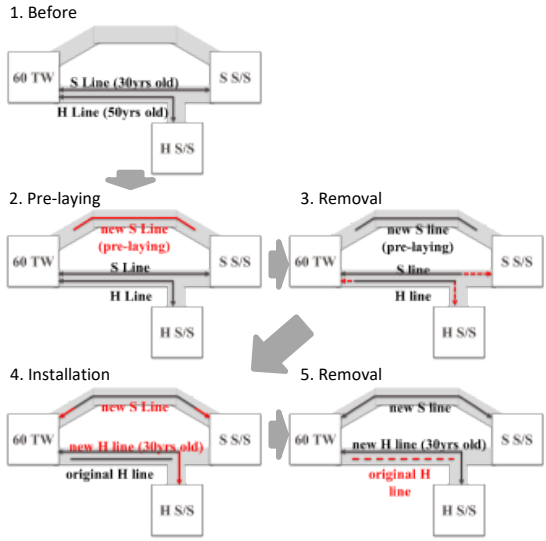

Fig. 5 H line replacement work utilizing S line

COMPARISON OF REPLACEMENT METHODS

In each case, Pre-laying method achieved the best results. Here, “Conventional method A” is to lay new cables in ducts after removing the original cables, and “Conventional method B” is to construct a new conduit system for laying new cables.

	Case A			Case B		
Replacement method	**Pre-laying method**	Conventional method A	Conventional method B	**Pre-laying method**	Conventional method A	Conventional method B
Power outage period	3 months	21 months	2 months	3 months	12 months	1 months
Environmental impact	Low	Low	High	Low	Low	High
Assessment	Excellent	Good	Poor	Excellent	Good	Poor

CONCLUSIONS

It is indispensable for the sustainable development of the electricity business to meet the benefit of society by addressing the issues to;

- Shorten the power outage time associated with the replacement work
- Reduce the environmental impact caused by civil engineering work

The pre-laying method by utilizing existing facilities is one effective measure. In order to utilize this method, the important points are to;

- Design and construct equipment taking future replacement into consideration
- Confirm if the original equipment and new equipment have a good interface
- Make a replacement plan taking overall optimization of the grid into consideration.