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Installation of a 220 KV XLPE cable in a deep shaft for a hydroelectric power plant

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Abstract:

The hydroelectric power plant at Montorio al Vomano (province of Teramo in central Italy) has been in service since 1954.

This plant uses the different levels of the Vomano river, which also feeds two other power plants at S. Giacomo al Vomano and Provvidenza.

The Montorio power plant is installed in a cavern, and three 46 MVA generators are connected to the external switchgear station by three cable circuits installed in a 240 m deep shaft.

During the recent refitting of the power plant, ENEL decided to replace not only the rotating machines but also the 45 year old 220 kV oil filled cables. In order to avoid the presence of oil, XLPE insulated cable was selected for this installation.

The shaft civil and steel works existing from the previous installation were reused for the new cable circuits. A suitable cable design was selected in order to adapt to the existing structures and guarantee the required performances. Modification of the existing structures was therefore reduced to a minimum.

Résumé:

La centrale hydraulique de Montorio al Vomano (située en province de Teramo ou centre d'Italie) est en service depuis 1954. Cette centrale utilise différents niveaux du fleuve Vomano, qui alimente aussi deux autres centrales situées à S. Giacomo al Vomano et à Provvidenza. La centrale de Montorio est installée dans une caverne, et les trois générateurs de 46 MVA sont connectés à des postes de commutation avec trois circuits de câbles placés dans un puits de 240 m de profondeur. Pendant le récent renouvellement de la centrale, ENEL a décidé de remplacer non seulement les machines tournantes mais aussi les vieux câbles 220 KV à huile fluide qui datent de plus de 45 ans.

Pour éviter la présence de l'huile, un nouveau câble en XLPE a été choisi pour cette installation.

Le puit et les matériels de fixation existants ont été réutilisés pour la nouvelle liaison des câbles.

Le nouveau câble en XLPE a été conçu pour s'adapter aux structures existantes et pour garantir la nécessaire fiabilité. Avec cette démarche les modifications à la structure du puit et à la centrale ont été réduites au minimum.

1 – Introduction

The hydroelectric power station at Montorio al Vomano is part of an important and large hydroelectric facility, which had been built at the end of the 1940s and the beginning of the 1950s. The water flow is 54 m³/sec with an average difference in level of 258 m, providing a total production of energy of approximately 250 GWh per year. The hydroelectric layout is given in the figure 1.

The power station is completely located in a deep cavern and is composed of three Francis turbines, with vertical axes of 38.5 MW each, and three small Pelton turbines for the auxiliary services. In order to avoid possible interferences in case of failure, all the electrical machinery (alternators/transformers) is housed in different rooms connected together by means of galleries. Three 46 MVA step up transformers 12.5/220 kV are connected to the outdoor switchgear by means of three 220 kV cable circuits.

The open air switchgear station is situated at the top of the mountain and connected to the cavern

generating station by means of a 240 m deep shaft in which there is an elevator for access. This shaft is also used for the 220 kV cable installation.

After the power station had been in service from 1954 for more than 45 years, ENEL decided in the second part of the nineties to completely overhaul the plant but maintain the same civil structure. All the rotating machinery was subjected to special maintenance and inspection and all the parts, which had been subjected to normal wear and tear, were replaced where necessary. The transformers as well the 220 kV cables were completely replaced.

2 – Choice of the Cable

Despite the good experience lasting for more than 45 years, it was decided that the existing three circuits of oil filled cables had reached the end of their operating lives and could not guarantee sufficient reliability for the improvement and complete renewal of the hydroelectric power station.

The characteristics of the oil filled cables were the following: