Close and Return

DESIGN OF A 45 CIRCUIT DUCT BANK

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ABSTRACT

Bankside power station in London, closed in 1981 but the substation that is housed in the same building has remained operational. The remainder of the building has housed the Tate Modern art gallery since 2000. EDF Energy Networks is now engaged in a project to upgrade and modernise Bankside substation. Part of this work involves the diversion of about 45 cable circuits into a duct block within the basement of the substation. The circuits include pilot circuits, LV circuits and 11 kV, 22 kV, 66kV and 132 kV circuits. This paper describes the process involved in designing the duct bank.

KEYWORDS

Duct bank, Magnetic field, Surface temperature, Cable rating.

INTRODUCTION

Bankside power station, on the south bank of the Thames in London, closed in 1981 but the substation that is housed in the same building has remained operational. In 1995 work was started to transform part of the power station building into an art gallery, The Tate Modern, which was opened in 2000. EDF Energy Networks is now engaged in a project to upgrade and modernise the Bankside substation. Part of this work involves the diversion of about 45 cable circuits into a duct bank within the basement of the substation. The circuits include pilot circuits, LV circuits, 11 kV, 22 kV, 66kV and 132 kV circuits.

The proposed duct bank was to be approximately 100 m long over a width of 13 m with a depth of 1.2 m.

Because of potential future uses for the area above the duct bank there were a number of factors that had to be taken into account when designing the duct configuration and selecting the cable sizes to be used. These included:

- Maximum cable conductor temperature
- Floor surface temperature
- 50 Hz Magnetic field levels
- Cable routing requirements

The calculation methods used to design the duct bank were a mixture of traditional cable rating calculations, analytical calculations for floor surface temperatures and magnetic field levels and finite element methods to determine shielding requirements.

CIRCUIT REQUIREMENTS

The duct block was designed to carry the following XLPE insulated cable circuits without exceeding the operating temperature of any cable within the duct block.

- Four 400/230V circuits with a cyclic loading of 300A.
- Twenty 11kV circuits with a cyclic loading of 400A.
- Sixteen 20kV circuits with a cyclic loading of 400A
- Four 66kV circuits with a cyclic loading of 300A
- Two 132kV circuits with a cyclic loading of 700A
- Six pilot circuits.

The cyclic load was taken to be a step wave with 100 % load factor from 08.00hrs to 20.00hrs and 0.8pu from 20.00hrs to 08.00hrs.

The cables selected for this installation were of types commonly used by distribution companies in the UK. They were:

- 400 V, 3 or 4-core XLPE insulated, unarmoured, cables,
- 11 kV, Single-core cables laid in triplex formation generally to BS 7870-4.10,
- 20 kV, Single-core cables laid in triplex formation generally to BS 7870-4.10,
- 66 kV, Single-core, XLPE insulated cables with copper wire and aluminium foil screen,
- 132 kV, Single-core, XLPE insulated cables with copper wire and aluminium foil screen.

150 mm diameter plastic ducts to ENA Technical Specification 12-24 were selected.

The 132 & 66 kV circuits were to be installed in trefoil ducts and the other circuits were to be installed in single ducts.

RATINGS CALCULATIONS

Nominal Ratings

The first stage in the calculations was to obtain nominal single circuit, steady state, in duct, ratings for the cable types to be used in the installation.

The steady-state current ratings for the LV cables were taken from a base data used to develop ERA Report 69-30 Pt V, [1], those for the 11 kV cables were taken from the steady state section of Engineering Recommendation P17 Part 3, [2]. Nominal steady-state current ratings for the 20 kV, 66 kV and 132 kV cables were calculated, using the methods set out in IEC 60287, [3], from nominal cable dimensions provided by cable manufacturers. All of the current ratings were adjusted for an ambient temperature of 20°C and a soil thermal resistivity of 1.2 K.m/W. It was