THE NEPLAN SOFTWARE PACKAGE
A UNIVERSAL TOOL FOR ELECTRIC POWER SYSTEMS ANALYSIS

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Abstract

The NEPLAN software package has been used by CERN’s Electric Power Systems Group since 1997. The software is designed for the calculation of short-circuit currents, load flow, motor start, dynamic stability, harmonic analysis and harmonic filter design. This paper describes the main features of the software package and their application to CERN’s electric power systems. The implemented models of CERN’s power systems are described in detail. Particular focus is given to fault calculations, harmonic analysis and filter design. Based on this software package and the CERN power network model, several recommendations are given.
1 INTRODUCTION
Following a comprehensive market survey, the NEPLAN software package was first introduced to CERN in 1997. At the time, about 20 different software packages had been tested of which NEPLAN was found to be the most appropriate for CERNs needs.

NEPLAN is a product of the Swiss Company Busarello+Cott+Partner Inc. and has been developed and optimized over a period of more than twelve years, in cooperation with the ETH Zurich (Switzerland) and ABB Calor Emag Schaltanlagen AG Mannheim (Germany).

2 CAPABILITIES OF THE NEPLAN SOFTWARE
2.1 General
The NEPLAN software is a general tool for electric power systems analysis, containing several individual software modules for different types of calculations. CERN is currently using the software version 4.1 (Rev. 30.5.2000).

All modules use the same graphical interface for the representation of the electric power network and the input of the component parameters. All input data can be linked to any SQL-type equipment database.

2.2 The Short-Circuit Module
This module is certainly the most important component for CERN’s Power Systems Group. It covers the calculation of all types of short-circuits, such as minimum and maximum currents of three-phase, two-phase and ground faults. The calculations can be performed according to IEC909, ANSI-IEEE and the superposition method.

The short-circuit module is of major importance for the analysis of CERNs power network, all major substations are now represented in the network model.

2.3 The Loadflow Module
Loadflow calculations can be performed based on Current Iteration, Newton Raphson and Voltage Drop Method. This module is particularly interesting for complex networks or loops. Potential thermal overload of electric power components is clearly shown by the software.

2.4 The Motorstart Module
This module allows the analysis of motorstart conditions and the calculation of the bus voltage behavior during motorstart. This module has been used for a number of critical applications for the LHC cryogenics systems.

2.5 The Harmonic Analysis and Filter Design Module
The NEPLAN software allows the comprehensive static calculation of harmonics, network impedance characteristics and filter design. The harmonic analysis module uses the same network model as the modules for short-circuit, loadflow and motorstart, making it particularly convenient to compare the performance of different variants of harmonic filters connected to the existing network. NEPLAN is one of the few software packages which includes cable impedances and capacities in the harmonic analysis, thus facilitating a detailed and precise filter design. The software also provides predefined models for the most common types of harmonic filters.

3 POWER SYSTEMS ANALYSIS AT CERN
3.1 Network Model
So far, all of CERN’s 400kV and 66kV substations, all major 18kV substations and a number of critical 3.3kV substations have been implemented into the network model, totaling to about 50 substations with almost 350 feeders. Different voltage levels or sections of the network are represented on individual drawing layers of the NEPLAN software. The drawing layers are “electrically” interconnected to each other. The node impedance matrices are built up using the complete network on all layers.
A technical note has been published [1] in 1999, comprising the short-circuit calculations for CERN’s major substations. Since then, this note has been further evolved and kept up-to-date. Each new project or the renovation of an existing substation includes the short-circuit calculations. These calculations have been added to the existing technical note and, as a result, CERN has now built up a comprehensive collection of short-circuit calculations including the associated recommendations for the protection settings, serving as a working document for future electrical engineering projects.

3.2 Harmonic analysis for the new Static Var Compensator 150 Mvar 18 kV

The new 150Mvar 18kV Static Var Compensator BEQ2 for the SPS accelerator, as well as the two existing 92 Mvar 18 kV compensators BEQ1 and BEQ3 have been modeled using the NEPLAN software package. NEPLAN has extensively been used in the design phase of the new Static Var Compensator BEQ2. Several different variants of filter design have been analyzed and the expected harmonic performance evaluated.

As these calculations are based on the same network model as the short-circuit analysis, cable impedances are automatically taken into consideration.
4  RECOMMENDATIONS

NEPLAN has proven to be a valuable tool for the analysis of CERN’s electric power systems, in particular the short-circuit and harmonic analysis modules.

The existing network model should of course be further refined and updated whenever appropriate, results of short-circuit calculations should be added to the existing technical note [1].

It is recommended to publish a similar note detailing the filter design and harmonic performance of CERN’s existing Static Var Compensators.

For the future, it seems to be necessary to introduce an additional software package for transient calculations which are not covered by NEPLAN.