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IEC PAS 62344

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2007-05

General guidelines for the design of ground electrodes for high-voltage direct current (HVDC) links

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General guidelines for the design of ground electrodes for high-voltage direct current (HVDC) links

Commission Electrotechnique Internationale
International Electrotechnical Commission
Международная Электротехническая Комиссия

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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GENERAL GUIDELINES FOR THE DESIGN OF GROUND ELECTRODES FOR HIGH-VOLTAGE DIRECT CURRENT (HVDC) LINKS

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The text of this PAS is based on the following document:	This PAS was approved for publication by the P-members of the committee concerned as indicated in the following document:
Draft PAS	**Report on voting**
22F/116/NP	22F/128/RVN

Following publication of this PAS, which is a pre-standard publication, the technical committee or subcommittee concerned will investigate the possibility of transforming it into an International Standard.

This PAS shall remain valid for an initial maximum period of three years starting from 2007-05. The validity may be extended for a single three-year period, following which it shall be revised to become another type of normative document or shall be withdrawn.

INTRODUCTION

Most of the world's HVDC links have been (or still are) in a first monopolar stage, because this solution gives the lowest costs. If the connection between a monopolar pair of converter terminals consists of an overhead line construction, the extra costs of a return conductor on the pylons are moderate. This is certainly not the matter if the connection mainly consists of a long submarine cable, because the return cable, which must have about the same cross-section as the main cable, but much lower design voltage, may easily cost 30-50 % of the main cable.

The evaluation of the additional losses in the return path must be included when costs of different possible solutions are compared. A return path via ground electrodes will normally have a considerably smaller resistance than any reasonable metallic conductor return.

When a monopolar link becomes bipolar, the use of the return path and the number of hours of operation with nominal current decrease. At this stage the evaluation of losses in the return path loses importance; but the return path will be important for raising the overall reliability/availability of the link.

The sites chosen for converter stations belonging to a specific HVDC scheme under design/construction are generally finalized at an early stage of the time schedule of the project, while a choice of electrode station sites, or even a general analysis, whether ground return is feasible (or possible), is often postponed to a later stage in the time schedule.

The summary of existing electrode stations [0][1] shows distances from converter stations to electrode stations ranging from 8 km to 85 km. The need for a minimum distance will be explained in 4.3. The need for a maximum distance is a matter of economy. The selection of a site for an electrode station should generally involve the following considerations.

a) The possibility of obtaining permission to establish and operate the station at the intended site, and to obtain the ownership of the area, if appropriate.

b) The distance to metallic objects such as pipelines, cables, grounding networks at a.c. stations (including the converter station itself), and other infrastructure.

c) The geology of the site must fulfil certain limits for resistivity, moisture content, thermal conductivity, water exchange, water depth, etc.

The technical circumstances which could be problematic when establishing a ground return may roughly be divided into two groups.

d) Problems at some distance or far from the station: The field, produced by the current in the earth, might have an unacceptable influence on other infrastructure.

e) “Local” constructional difficulties, such as high resistivity and too dry soil. Furthermore, chemical aspects such as chlorine production may cause local difficulties. This is further described in Clause 10.

There is good reason to mention the “distance” field problem as the most important, because the remote field produced by an electrode is independent of the construction of the station, and only depends on the geology of the subsoil. This will be explained further in Clause 3.

As a general rule, local constructional difficulties may be handled to a great extent by making the size of the station greater, the number of subelectrodes larger, etc.

Following the definition in [3], the electrode stations are divided into three groups:

– land electrodes, located far away from the sea;
– shore electrodes, located on a shore against (salt) seawater. Shore electrodes can be located either on the beach at a short distance (<50 m) from the waterline or in the water, but protected by a breakwater;
– sea electrodes, located in the water at some distance (>100 m) from the coastline.

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[1] Figures in square brackets refer to Clause 14.

GENERAL GUIDELINES FOR THE DESIGN OF GROUND ELECTRODES FOR HIGH-VOLTAGE DIRECT CURRENT (HVDC) LINKS

1 Scope

The purpose of this PAS is to provide a guide for the design of electrode stations for HVDC links intended for ground return. This design guide was prepared by the CIGRÉ Working Group 14.21: *HVDC Ground Electrode Design* during the period 1995-1998.

It is not the purpose of this report to provide detailed instructions on how to work out an HVDC link from the initial idea to final decisions on sites, ratings, constructional principles for converter stations and for connecting lines/cables. In the often hectic planning phase of a new link, the main emphasis will be concentrated on converter stations and the line/cable, while less attention is paid to a simultaneous evaluation of possible current return principles.