Basic HEMP Protection Means for a Power Substation: A Quick Guide

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Protection of modern sensitive electronics used in power systems (Digital Protective Relays - DPR, control devices and microprocessor-based communication equipment, etc.) against High Altitude Electromagnetic Pulse (HEMP), and also protection of power transformers, is a vital task for today's world. The purpose of this article is to inform civilian specialists in power engineering, in a very simple, short, but illustrative form, about the means of protection of power substations which are now available for use.

I. INTRODUCTION

Protection of the electronic and power equipment of modern substations against destructive impacts of High Altitude Electromagnetic Pulse (HEMP) - is a challenge in itself, even at a modern level of development of protection technologies. The basic methods and means of such protection have already been developed for a long time [1]. During this time many tens of detailed scientific reports and standards presenting this phenomenon and measures of protection from it have been published [1]. Nevertheless, for the last several decades, one country of the world has not undertaken any practical measures regarding protection of national infrastructures against HEMP. Why? Obviously, because most such publications are written as scientific reports and scientific articles for the specialist in the HEMP field, or contrariwise, as very popular articles intended for laymen.

It is very difficult for the practical specialist of power engineering to perceive and to use technical information presented in such forms.

An additional problem is the difference of essential methods and means of protection of new designed substations and those for already existing substations. This creates even more complications in the practical use of known methods of protection.

Below is a table of the basic data of protection methods presented separately for new designed substations and for existing substations. For simplification of perception of the material, the table is presented in the form of graphical figures equipped by brief comments enabling technical specialists and managers to clearly understand the protection means.

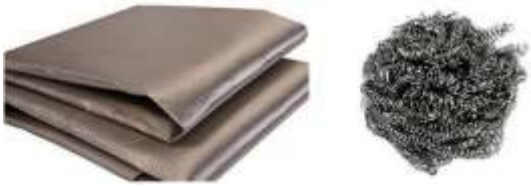
The described methods are common methods which are applicable for all kinds of electronic equipment and power transformers. However, it must be taken into consideration that not all electronic devices need to be protected, only the critical equipment which is placed on critical sites [1]. Such critical equipment and critical sites must be initially determined by the technical personnel.

HEMP PROTECTION MEANS FOR NEW DESIGNED AND EXISTING SUBSTATIONS

Full Protection for New Designed Substation	**Part Protection for Existing Substation**
buildings and control rooms [1]	
Special HEMP protected buildings and control rooms with HEMP resilience requirements at initial project stage. 	Special protection means for existing buildings and control rooms: metal facing panels, conductive fabric, shielding curtains, carpets, cloth, conducive films and wall paint, stainless steel mesh. 

control cabinets for electronic equipment [1]	
Specially designed control cabinets manufactured using a special alloy (Alyzinc®), with enhanced protection from HEMP fitted with special mesh, lined with an electrically conductive rubber gasket, shielded ventilation windows, etc.	Special means for HEMP protection for existing control cabinets with glass doors (conductive sponge, film, electrically conductive glass, conductive grease, shielding spray, shielding gaskets).


SUPER SHIELD



screened control cables [1]

Special multicore control cables with screened twisted-pair wires and addition two-layer common external combined screen: foil and copper braided with 85% coverage.

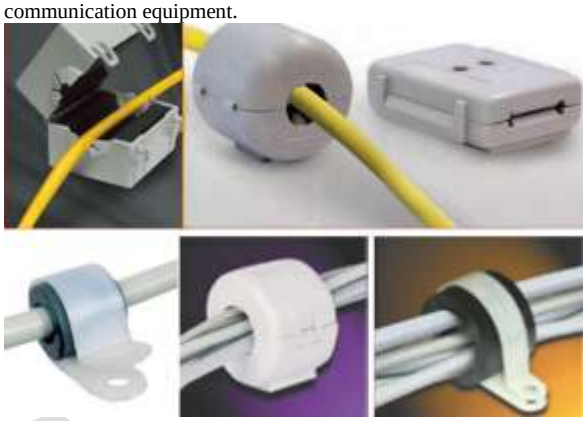
Special screened cable trays.

Additional П-shaped metal shield in the long external cable trays, zip-closing screening sleeves and jackets for single interior cables.

filters [1]

Special HEMP LC-filters inserted in inputs and outputs of control cabinets, communication and control circuits, power supply circuits.

Ferrite bead that are not necessary for cables cutting. The set of 3 beads must be tested and completed according to [1]. HEMP LC-filters might be necessary only for some kind of very sensitive communication equipment.



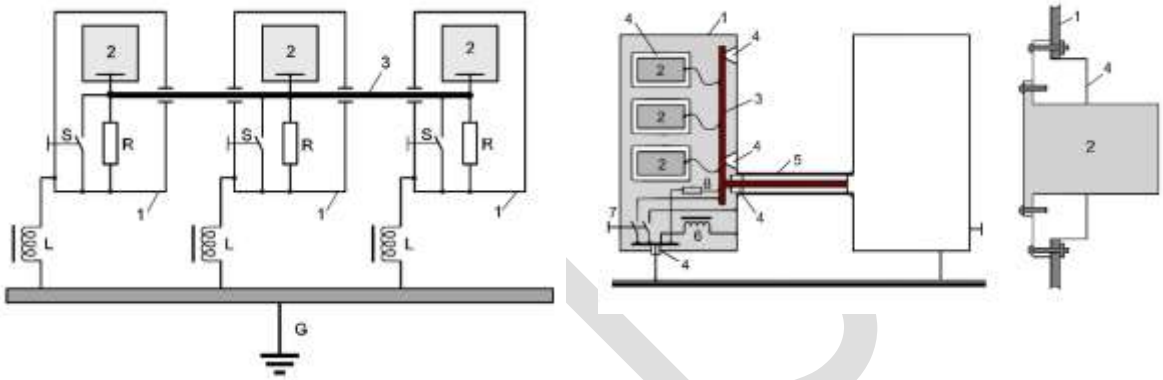
surge protective devices [1]

Fast surge protective devices (metal-oxide varistors or combined devices) must be added to all power AC and DC circuits and also to control circuits. Best choice – protection devices based on very fast power TVS-diodes.

Transient Suppressor Diodes
(TVS-diodes)

grounding [2, 3]

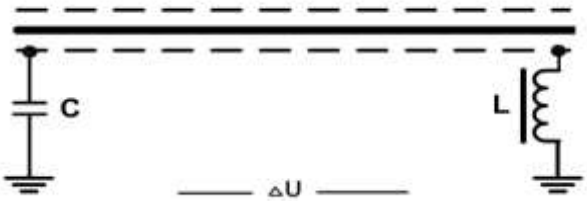
Special floating grounding



1 – metal cabinets with electronic equipment; 2 – electronic devices; 3 – copper bus establishing the local area of common (reference) zero potential (local ground); 4 – insulators; 5 – screening enclosure; 6 (L) – choke; 7 (S) – contact breaker with electric locker on the cabinet's door; 8 (R) – high-voltage high-resistance resistor (100 MOhm); S – contact-breaker; G –facility's grounding system

High-frequency chokes

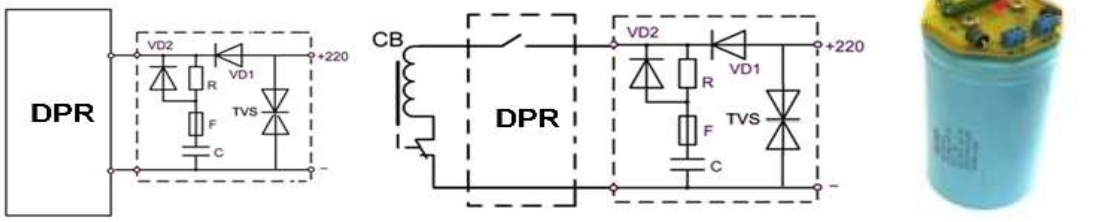
The offered way of control cable shields grounding



Contact breaker

reserve power supplies [1]

Reserve power supplies based on HEMP protected and shielded accumulating capacitors for digital protective relays (DPR) feeding, for controls of circuit breakers (CB), provided single operation as minimum without substation batteries, chargers and UPS.

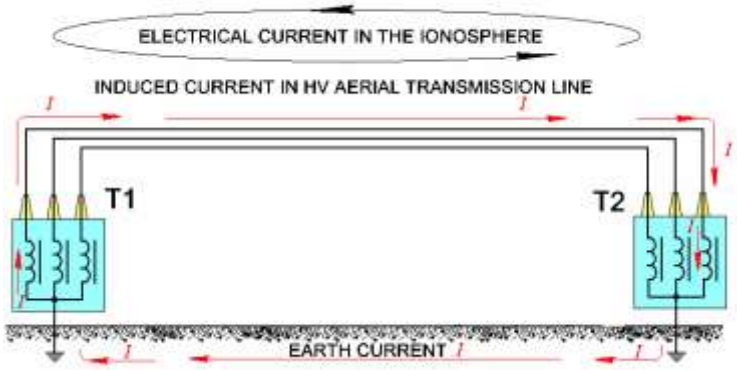


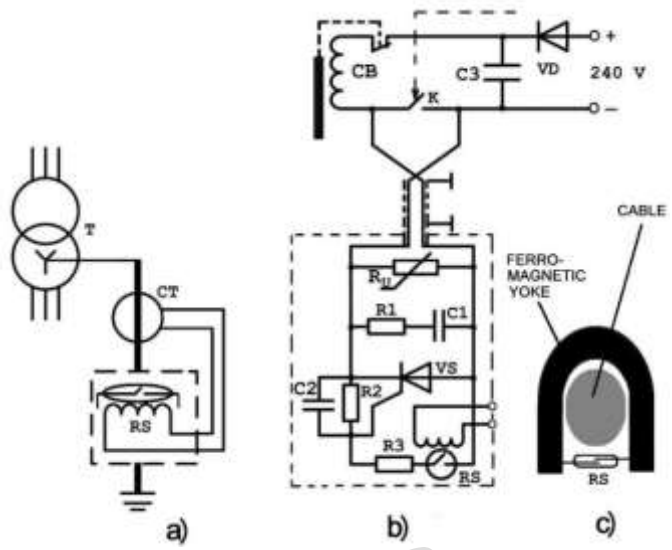
spare parts [1]

Electronic equipment replacement modules for critical equipment on critical sites (tested, fully adjusted and with actual setting) in HEMP protected aluminum boxes.

power transformers protection [1]

Disconnection of power transformer at increasing of DC component in the neutral more than 10 A by means of special HEMP protected relay.





HEMP protected relay

reference source

1. Gurevich V. Protection of Substation Critical Equipment Against Intentional Electromagnetic Threats. – Wiley, 2017, 228 p.
2. Gurevich V. The Issues of Electronic Equipment Grounding at the Power Facilities. – International Journal of Research Studies in Electrical and Electronic Engineering, 2017, Volume 3, Issue 1.
3. Gurevich V. Grounding of Control Cable Shields: Do We have a solution? – Energize, 2017, No. 4.