DEPARTMENT OF HIGH-VOLTAGE PULSE INSTALLATIONS , GROUNDING AND LIGHTNING PROTECTION

1. ***Diagnostics of the grounding devices of existing electric power stations, substations and other objects according to :***

- **Design and Erection of Electrical Power Installations in Systems with Nominal Voltages Above 1kV A.C.;**
- **Std. 81-2012 – IEEE Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Grounding System;**
- **Std 80-2000 IEEE Guide for Safety in AC Substation Grounding;**
- **Pravyla ulashtuvannja elektroustanovok [Electrical Installation Regulations]. 2017. 760 p. (Ukr);**
- **СОУ-Н ЕЕ 20.302:2007 Standard to test electrical equipment;**
- **Viprobuvannya ta kontrol' prystroyiv zazemlennya elektroustanovok. Tipova instruktsiya [National Standard of Ukraine SOU 31.2-21677681-19:2009. Test and control devices, electrical grounding. Standard instruction].**

2. ***Diagnostics of the lightning protection system of existing electric power stations, substations and other objects according to :***

- **EN 62305-3:2011. Protection against lightning – Part 3: Physical damage to structures and life hazard.**
- **Pravyla ulashtuvannja elektroustanovok [Electrical Installation Regulations]. 2017. 760 p. (Ukr).**
- **DSTU B V.2.5-38:2008 Inzhenerne obladnannya budynkiv i sporud. Ulashtuvannya blyskavkozakhystu budivel' i sporud (IEC 62305:2006 NEC). 2008. 63 s (Ukr).**

3. ***Investigation of the electromagnetic environment in order to provide electromagnetic compatibility*** **of equipment on existing industrial facilities in accordance to IEC 61000-4-XX**

4. ***Development and creating of high-voltage pulse installations and devices***

ELECTROMAGNETIC DIAGNOSTICS OF THE GROUNDING DEVICES OF EXISTING ENERGY OBJECTS

The method of electromagnetic diagnostics consists of three main stages

1. Experimental Stage:

- determination of design the grounding device (GD) by the induction method;

- determination of ground electrophysical parameters by the method of vertical electrical sounding (by Wenner method);

- determination of the rated GD parameters (grounding impedance and voltage, touch voltage and resistance of the contact joints).

2. Calculation stage:

- interpretation of the results of vertical electrical sounding;

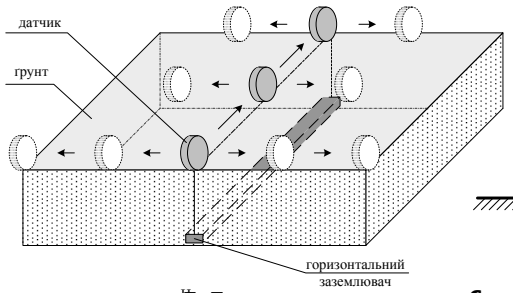
- simulation of electromagnetic processes in the GD to determine the touch voltage on all equipment in all possible modes of single-phase earth fault.

3. Stage of development of recommendations to:

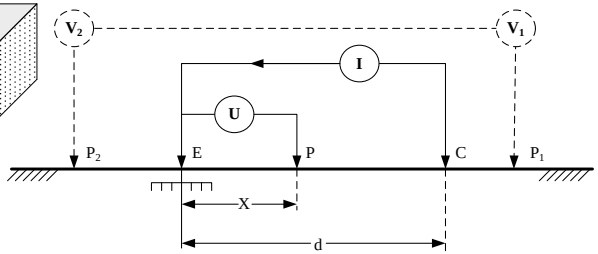
- bringing the design of GD in accordance with regulatory requirements;

- ensure the permissible values of electrical rated parameters of the GD.

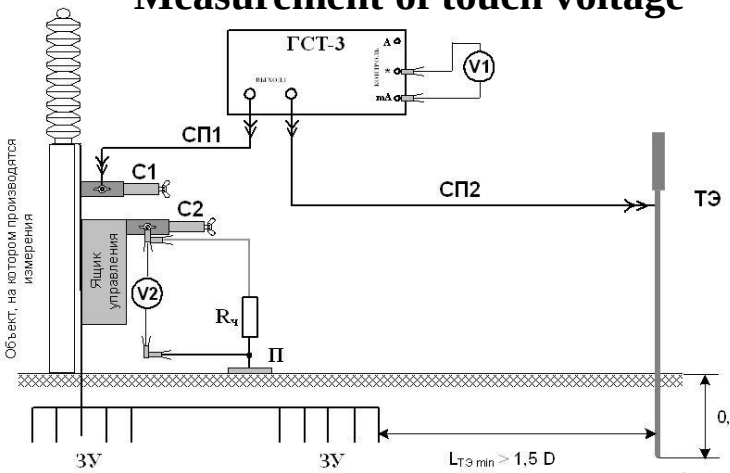
Determination of the real location of the grounding electrodes



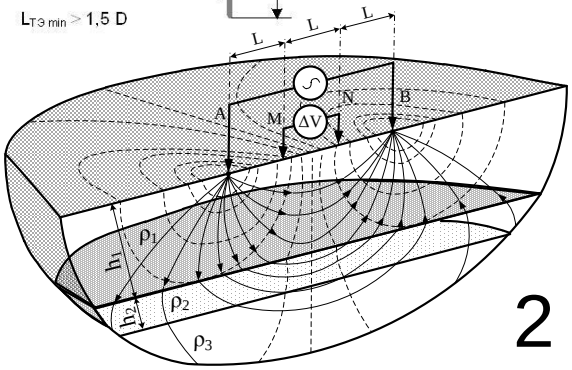
Measurement of GD impedance



Measurement of touch voltage



Vertical electrical sounding (VES)

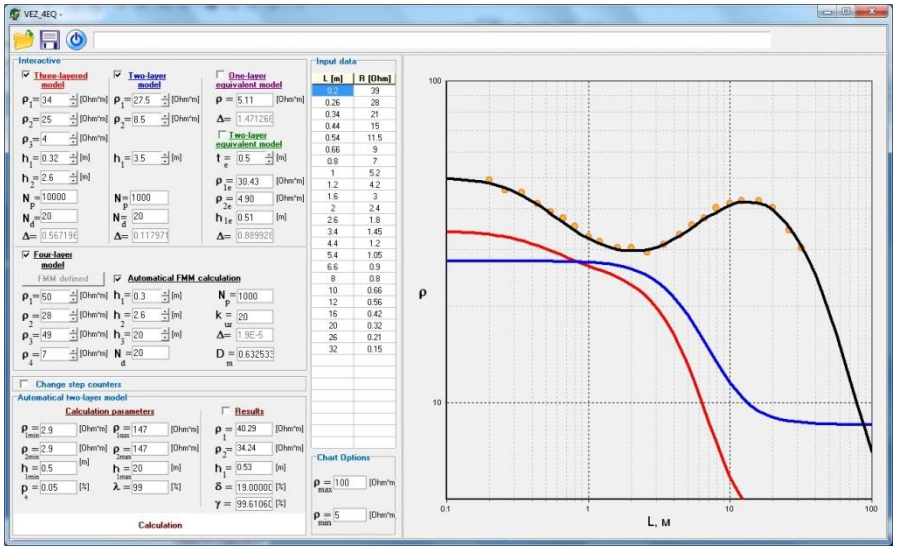


ELECTROMAGNETIC DIAGNOSTICS OF THE GROUNDING DEVICES OF EXISTING ENERGY OBJECTS

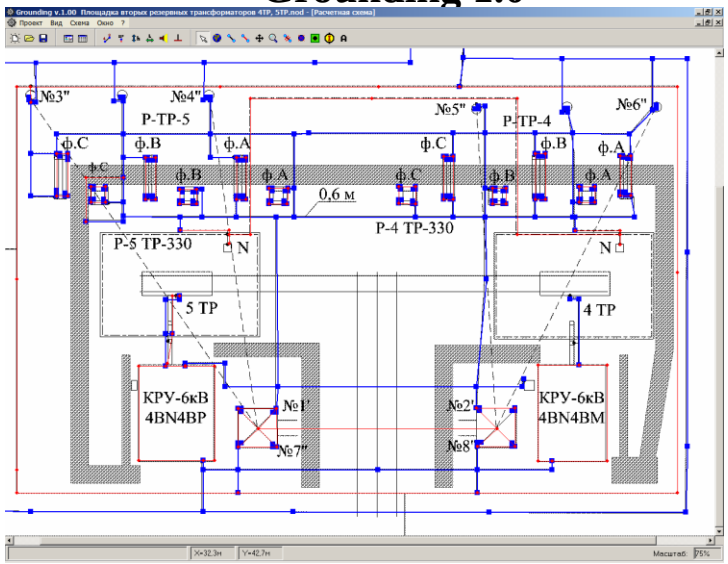
Determination of the GD design and rated parameters on existing energy objects

The device for the complex diagnostics of the GD "KDZ-1U"

Interpretation the results of VES for multilayer soil



Calculation of GD rated parameters using "Grounding 1.0"

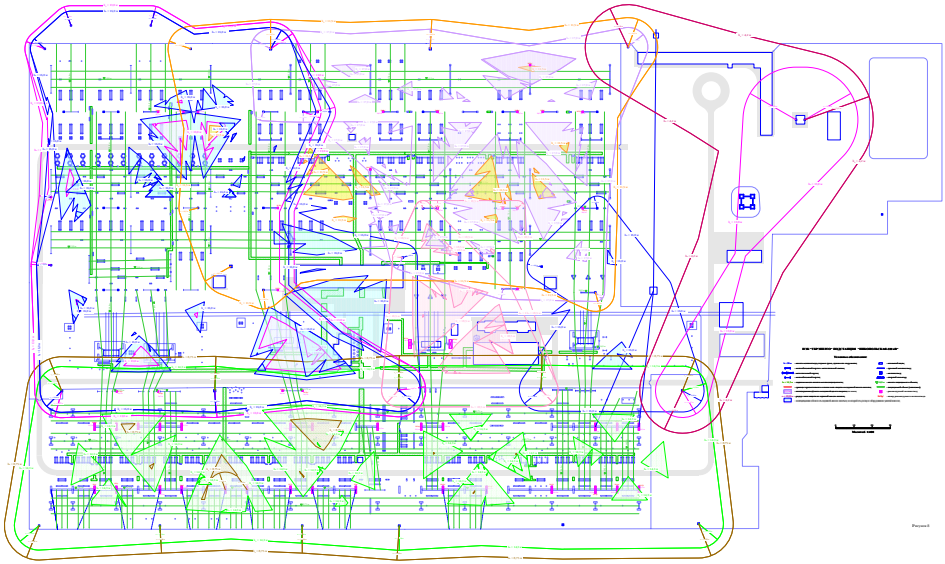


DIAGNOSTICS OF THE LIGHTNING PROTECTION SYSTEM OF EXISTING ENERGY OBJECTS

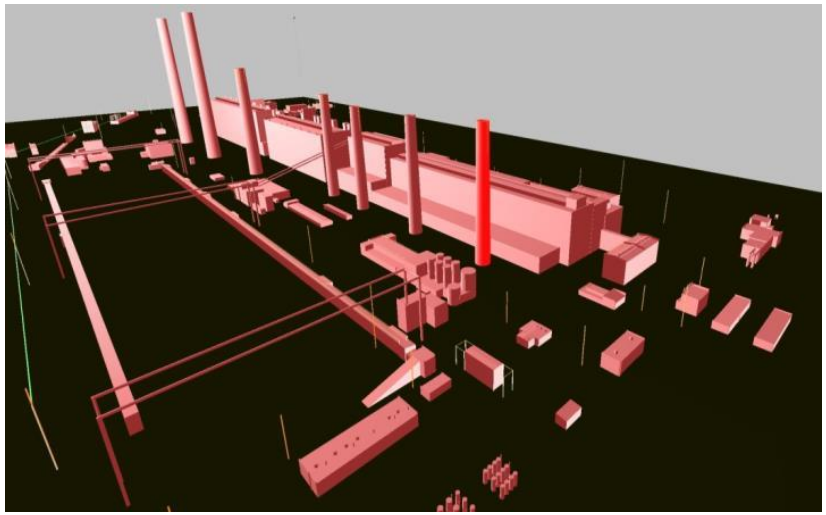
On performing diagnostics of the lightning protection system, it is determined:

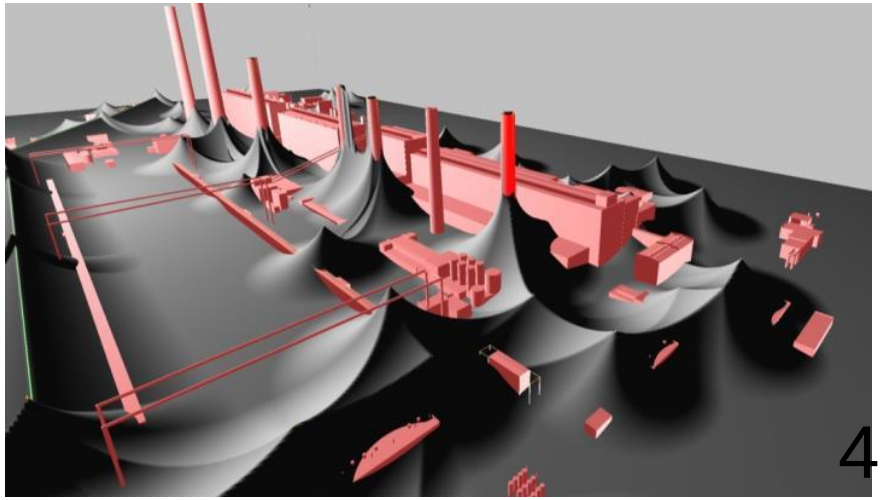
- the location and dimensions of objects that must be protected from a direct lightning strike;
- location and characteristics of lightning rods (height, material, section);
- availability and characteristics of current leads (location, material, section);
- the presence and characteristics of grounding (location, material, section, depth);
- the value of the lightning rods resistance;
- ground resistivity by VES method.

Horizontal cut of lightning protection zones for substations with a voltage class of 330/150 kV



3D models of objects and lightning protection zones built by the sphere rolling method





INVESTIGATION OF THE ELECTROMAGNETIC ENVIRONMENT IN ORDER TO PROVIDE ELECTROMAGNETIC COMPATIBILITY

INVESTIGATION OF INTERFERENCE IN SECONDARY CIRCUITS :

1. In high-frequency (HF) communication cables with simulating a lightning strike.

2. In HF cables at a short-circuit on substation.

3. In cables of voltage transformers at a short-circuit on substation.

4. In cables of current transformers at a short circuit on the substation.

5. Interference caused by inductive coupling of primary and secondary circuits.

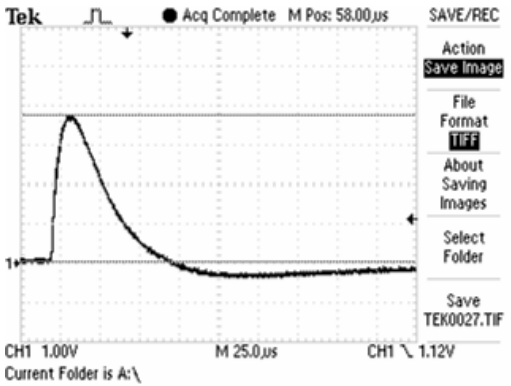
6. Interference caused by capacitive coupling of primary and secondary circuits.

7. Influence of the design of grounding device on the efficiency of relay protection equipment circuits.

INTERFERENCES IN THE HF COMMUNICATION CABLES WITH SIMULATING LIGHTNING STRIKE IN RADIO TOWER

Appearance of the device "GAI-1"

Oscillogram when giving impulses

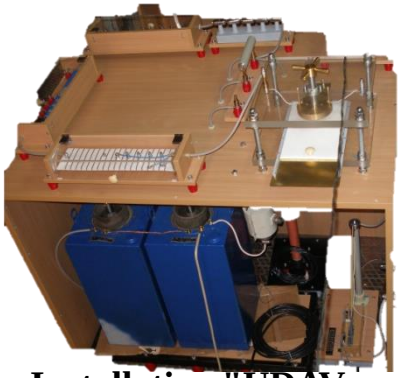


ELABORATION AND CREATING OF HIGH-VOLTAGE INSTALLATIONS

The developed high-voltage test installations and devices (pulse current generator, pulse voltage generators, test installation AC) allow to:

- **test the objects by the direct lightning strike;**
- **test the objects with special values of amplitude-time characteristics of the electromagnetic field;**
- **test high-voltage equipment (such as overvoltage limiters) of different voltage class to assess their electrical characteristics;**
- **test the cables and equipment on the action of emergency current and voltage;**
- **carry out the simulation of transient processes in the action of emergency currents of electrical installation;**
- **to explore ways of isolations breakdown;**
- **carry out special technological work (magnetic pulse welding, electrohydraulic and ultrasonic machining , etc.);**
- **evaluate the impact of electromagnetic interference from power lines, substations, etc.**

Installation "UIV-3" for testing the overvoltage limiters with rated pulses of current



Installation "GIT-20" for the treatment of metallurgical sludge's

Installation "UDAV-5000" for diagnostics of AC switches

Breakdown voltage oil tester "UIM-90"