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PS 2 “Experience and Existing Practice of Using IEC 61850 Processor Bus. Experience of Factory Acceptance Tests, Site Acceptance Tests and Commissioning”.

### **IEC 61850 Standard-Based Integrated Tests and Certification of Secondary Switching Equipment on the Digital Substation Test Site of R&DC FGC UES JSC**

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The report addresses some aspects of the technology [1] known as Digital Substation in Russia, specifically, integrated tests and certification of secondary equipment. The technology is based on IEC 61850 standard.

Basic components for the development of the Digital Substation technology are interoperability tests of equipment from various manufacturers (interoperability standard - compliance check) and functional tests of new equipment under various types of disturbances that may occur in electric grids and power facilities. In addition, a need arises to assess the quality of the communication environment surrounding the secondary switching devices (relay protection and emergency automation terminals, emergency registration devices, electric power metering and quality assessment systems, etc., known as Intelligent Electronic Devices (IED) in terms of IEC 61850 standard).

To solve these problems, JSC «R&DC FGC UES» created a pilot polygon "Digital substation" on the basis of the existing 110/10 kV alternating current substation. The experimental polygon consists of 2 parts, - substation and laboratory, connected by a single communication environment. The substation part includes: a substation control center with IED protection and measurement terminals, a communication network, equipment of time synchronization, measuring optical current and voltage transformers, field converters of analog and discrete signals (SAMU) are installed at 110 kV outdoor switchgear. The basis of the laboratory part of the test site is the software hardware complex of real time Real Time Digital Simulator (RTDS) and other software hardware complexes for testing (OMICRON CMC 256 plus, RETOM-61850).

Using the hardware and software complex RTDS allows you to simulate all types of short-circuits in the adjacent network and substation, and to conduct a comprehensive check of the relay protection devices for compliance with the declared characteristics.

To conduct studies to assess the quality of the communication network and to determine the delays in the transmission of GOOSE messages and SV streams for various network configurations was developed a specialized instrumental test system for execution of multi-level testing of communication interaction between the components of the Digital Substation software and hardware complex (HSC DS). This set of tools includes two test-modeling complexes (TMC), designed to provide testing at all levels of the stack model OSI / ISO (open system interconnection basic reference model) - the basic reference model for the interaction of open systems from the physical to the applied levels:

1. Complex of the analysis of the communication interaction of the components of the HSC DS;

2. Complex for checking the dynamic characteristics of the communication interaction of the components of the HSC DS.

It should be noted that the polygon tests, first of all, are designed to test a complex of secondary equipment for a specific electrical installation, and for a separate device, certification tests are conducted to assess its compliance with the standard.

The international organization Utilities Communication Architecture International User's Group (hereinafter UCAiug) defines the verification rules of equipment (certification tests) for compliance with the standard IEC 61850. The international company DNV GL Energy (DNV GL) has a UCA accredited testing laboratory "KEMA Nederland B.V.".

KEMA Nederland B.V. (currently DNV GL Energy) since 2014 has been cooperating with JSC «R&DC FGC UES» for the organization and conduct of certification tests at JSC "Scientific and Technical Center FGC UES".

Within the framework of cooperation, the parties agreed that certification of equipment in JSC «R&DC FGC UES» will be carried out in two stages.

The first stage of the preliminary testing is performed by personnel of JSC "Scientific and Technical Center FGC UES" independently.

The second stage of certification tests is conducted jointly with the test engineer DNV GL and the Applicant. In this case, the Applicant (the manufacturer of the product), upon successful passing of the certification tests, receives certificate UCA of "level A".

The cooperating parties agreed that equipment certification in JSC «R&DC FGC UES» would be held in two steps.

The first step of the preliminary testing shall be performed by JSC R&DC FGC UES using its own resources.

The second step of the certification tests shall be held together with a DNV GL test engineer and the Applicant. In this case, if the certification tests are passed successfully, the Applicant (the product manufacturer) is granted a level A international certificate.

During the period of joint cooperation with DNV GL, from 2015 to 2017, was carried out certification of secondary equipment (relay protection and automation devices, accession controllers) of Russian companies.

During the certification process, errors can be detected in the software and for testing, the identified inaccuracies are eliminated by DNV GL specialists during the testing period.

.Certificates UCAiug for compliance with the standard IEC 61850 -8-1 server Ed.1 and Ed. 2 "Level A" were issued to 11 applicant organizations at 15 IEDs.

**Keywords:** Digital Substation technology, IEC 61850 standard, field tests, RTDS, testing and modeling complex, communication network, UCA, certification