ISSN 2181-8622

Manufacturing technology problems

Scientific and Technical Journal Namangan Institute of Engineering and Technology

INDEX COPERNICUS INTERNATIONAL

Volume 10
Issue 2
2025

Google Scholar
Crossref doi
SLIB.UZ Scientific library of Uzbekistan

UDC 624.313.0198.3

DIAGNOSTICS OF THE CONDITION OF ELEMENTS OF ELECTRIC POWER SUPPLY SUBSTATION

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Abstract: The article examines the issues of diagnostics of the state of elements of the power supply substation. It is shown that the development of a diagnostic system for the technical condition of electrical equipment of a power supply substation requires the availability of technical means for measuring and monitoring the current state of the substation elements, the availability of computing equipment and should be implemented at a specific operating power supply substation. It is indicated that diagnostics of the main equipment of the power supply substation involves prompt detection of faults as a result of processing the readings of the sensors of the standard control system, readings of the sensors, the standard control system, sensor readings entered manually once a day, monthly and special test data and, taking into account, the problem of diagnosing electrical equipment of a power supply substation is considered. The diagram of the algorithms for diagnosing the state of electrical equipment of a power supply substation and the input parameters for diagnosing the state of a power supply substation are given. An algorithm for assessing the state of a power transformer based on the temperatures of the cooling oil and water, as well as an algorithm for assessing the state of a power transformer based on the temperatures of the winding and core, have been developed. The implementation of the developed diagnostic algorithms allows not only to increase the reliability of equipment operation and reduce the number of serious accidents, but also to provide the station personnel with retrospective technological information for the analysis and planning of equipment operation, its repair and increased efficiency.

Keywords: diagnostics, elements, substation, power, supply, algorithm, program, oil, water, winding, core, temperature, transformer, sensor, system, control.

Introduction. The development of a diagnostic system for the technical condition of electrical equipment at a power supply substation (PS) requires the availability of technical means for measuring and monitoring the current state of the unit, the availability of computer technology (CTC) and must be implemented at a specific operating power supply substation.

The means for measuring process parameters are: for the sensor, TSM-100 thermal alarms and TSM-1-X1 thermal sensors and the L-64 logometer for measuring the temperatures of the winding and core, cooling oil and air, and monitoring the pressure of the cooling oil. In addition to the listed measuring instruments, the air and oil cooling system of the transformer is equipped with EKM type electric contact pressure gauges, which provide pressure control [1-3]. Diagnostics of the main equipment of the power

supply substation involves prompt detection of faults as a result of processing the readings of the sensors of the standard control system, readings of sensors entered manually once a day, data from monthly. Let us consider the problem of diagnostics of pumping stations [4-6].

The developed software and hardware complex (SHC) of the automated process control system (APCS) must ensure normal control in the operating modes of the electrical equipment of the PE [7-9].

Methodology & empirical analysis. The requirements for the structure and functioning of the entire system as a whole are as follows: - The PTC ACS TP must architecturally represent a multi-level functionally and territorially distributed multi-machine system. The upper and lower levels are connected by a local area network (LAN), through which information about the technological process is transmitted from the bottom up, and remote control commands initialized by operators and automatic control systems are transmitted from the top down. This ensures the implementation of the functions of measurement, signaling, technological protection, automatic regulation and remote control of equipment.

Receiving initial data for the task of diagnosing the technical condition of the PE and forming a data archive is carried out [10-12]:

according to the parameters included in the substation's automated control system - from the automated control system database upon request of the program (once per minute);

– according to the parameters controlled at the place of installation of the mechanism – from the daily report (within 24 hours);

– according to the parameters obtained as a result of control tests – after the next tests (according to the schedule approved by the chief engineer) or extraordinary tests. The user enters parameters into the database using the corresponding menu in dialog mode.

The state diagnostics algorithm is launched when the initial data from the daily report is entered, when any parameter goes beyond the algorithm launch setting (10–20% below the warning alarm setting).

The result of the technical condition diagnostics program is recorded in a protocol. Upon request, a protocol of the current state of the power supply substation and graphs of retrospective parameter values for a period of time selected by the user with an indication of operating hours, number of starts, a protocol of repair quality assessment and a protocol of special tests can be obtained.

The program for technical diagnostics of the condition of electrical equipment PE uses the following as initial criteria for assessing the condition:

- technical data of the manufacturer (passport, technical description and operating instructions)

- features of the operating mode provided for by the project;

- normative and technical documentation (TOR, SR, scope and standards for testing electrical equipment, PS buildings);

- data from start-up and post-repair tests, which are accepted as basic for assessing the current state;

- retrospective assessment of changes in the state of the object under comparable conditions (modes).

The technical diagnostics program is built similarly to expert systems for diagnostics of the condition, taking into account cause-and-effect relationships, design features and operating parameters of each unit.

After the launch tests and during the first period of trial operation, changes may be made to the diagnostic algorithms related to the refinement of the operating parameters.

The task launch, information input, viewing and printing of results must be carried out in dialog mode [13-15].

Results. Diagnostics of electrical equipment of the PE is determined by the main units, the technical condition of which affects the operability of the PE. This paper considers the search for faults in the following units: - transformer winding and core, algorithm for assessing the condition by temperature; algorithm for assessing the quality of repair.

Diagnostic algorithms are built in the form of a step-by-step logical structure, at the first stage of which parameters that deviate from normative or reference values are identified, which are usually called diagnostic features. Based on the analysis of several (or one) diagnostic features and, if necessary, some additional conditions, logical chains of decision-making such as rules (productions) “if…, then…” are formed. The presentation of suspected faults to operating personnel is accompanied by the issuance of a list of measures that can ensure their detection and elimination.

The diagnostic system being developed is based on the following:

- diagnostics are carried out in real time in the normal operation mode of the unit;

- detection of defects is based on technological algorithms as a result of the analysis of diagnostic signs and decision-making on the presence of equipment malfunctions;

-defects can be detected both at an early stage of their development and at the moment of their appearance and development;

- initial information comes from both standard control means during equipment operation, and from manual measurements and as a result of special tests and measurements [16,17].

The diagram of the diagnostic algorithms for the state of electrical equipment of a power supply substation is shown in Fig. 1.

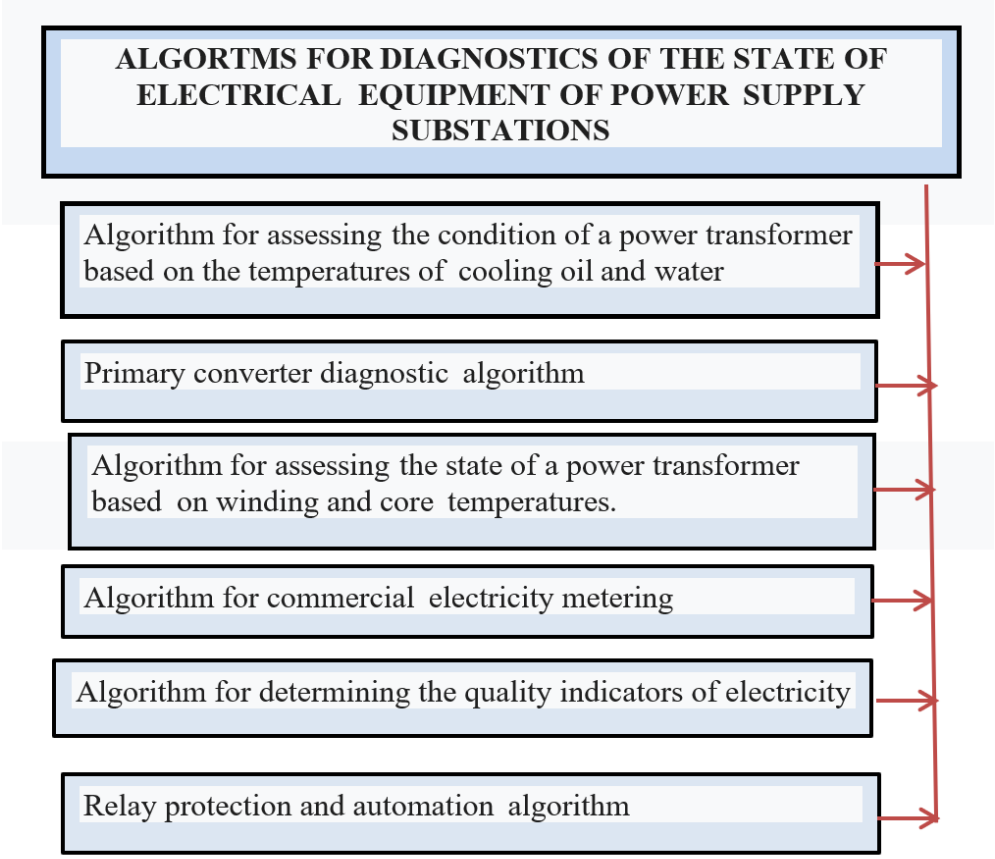

Figure 1. Scheme of algorithms of the diagnostic system of the state of electrical equipment PS

Input information can be divided into 4 groups:

a) Values of parameters entered automatically from the ACS database;
b) Values of parameters entered manually in the daily report;
c) Values of parameters entered manually (current vibration measurements during monthly tests);
d) Values of parameters entered manually, obtained during special tests;

The general list of analog and discrete parameters used in the program is contained in special reference books, to which the user of the program has access for viewing and correction.

The input parameters for diagnostics of the state of the power supply substation are shown in Fig. 2.

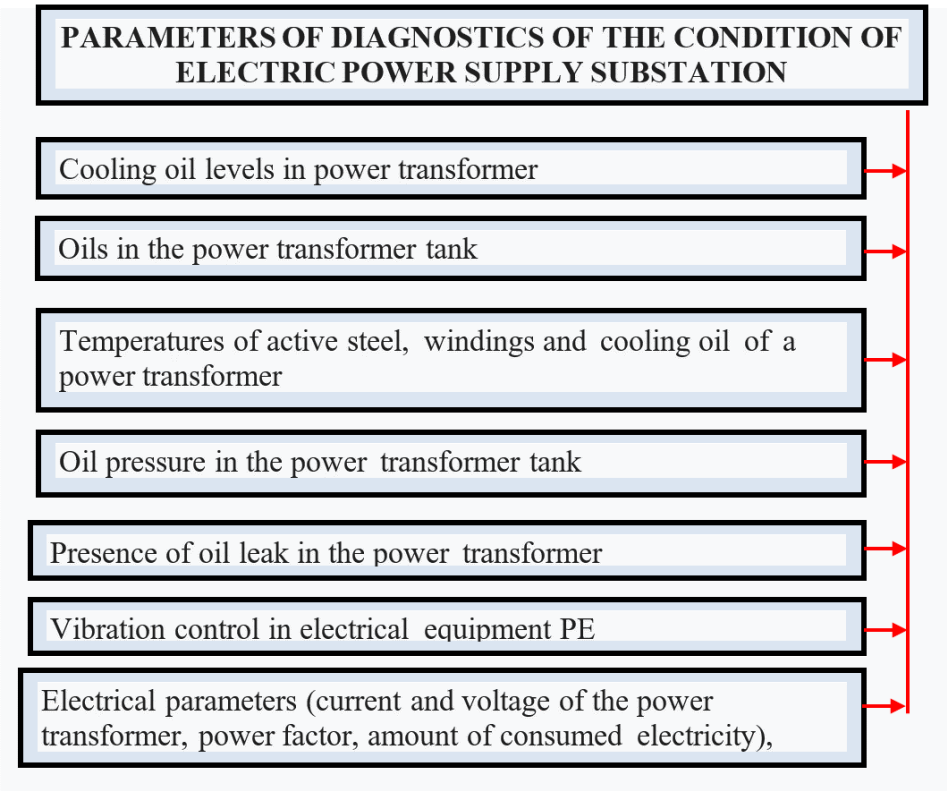

Figure. 2. Diagram of input parameters for diagnostics of the state of electrical equipment of a power supply substation

Taking into account the input parameters of the diagnostics of the state of the PE shown in Fig. 2, the following were developed: an algorithm for assessing the state of the power transformer based on the temperatures of the cooling oil and water (Fig. 3) and an algorithm for assessing the state of the power transformer based on the temperatures of the winding and core of the power transformer (Fig. 4).

Input information for algorithms:

1. Winding and core temperature. Tvo, Tno,. Tvs, Tns
2. Oil level in power transformer; Nm
3. Cooling oil temperature; Tom

The operation of the power transformer temperature diagnostic algorithm begins with the input of initial data. The fact of occurrence of malfunctions is the excess of the temperature of the windings and the core.

The increase in the temperature of the power transformer may be caused by the following faults listed below:

1. Low oil level in the power transformer housing. Raise the oil level, eliminate the cause of the leak.
2. High oil level in the power transformer housing. Reduced oil viscosity. Conduct an oil analysis, eliminate.
3. Increase in temperature of the winding and core of the power transformer.

The increase in winding temperature may be caused by the following faults listed belowx [18]:

1. Poor operation of the oil cooler and cooling system. Inspect the oil cooler and cooling system;
2. Contamination of the power transformer windings. Clean the end parts;
3. Weakening of the pressing of the active steel of the power transformer.

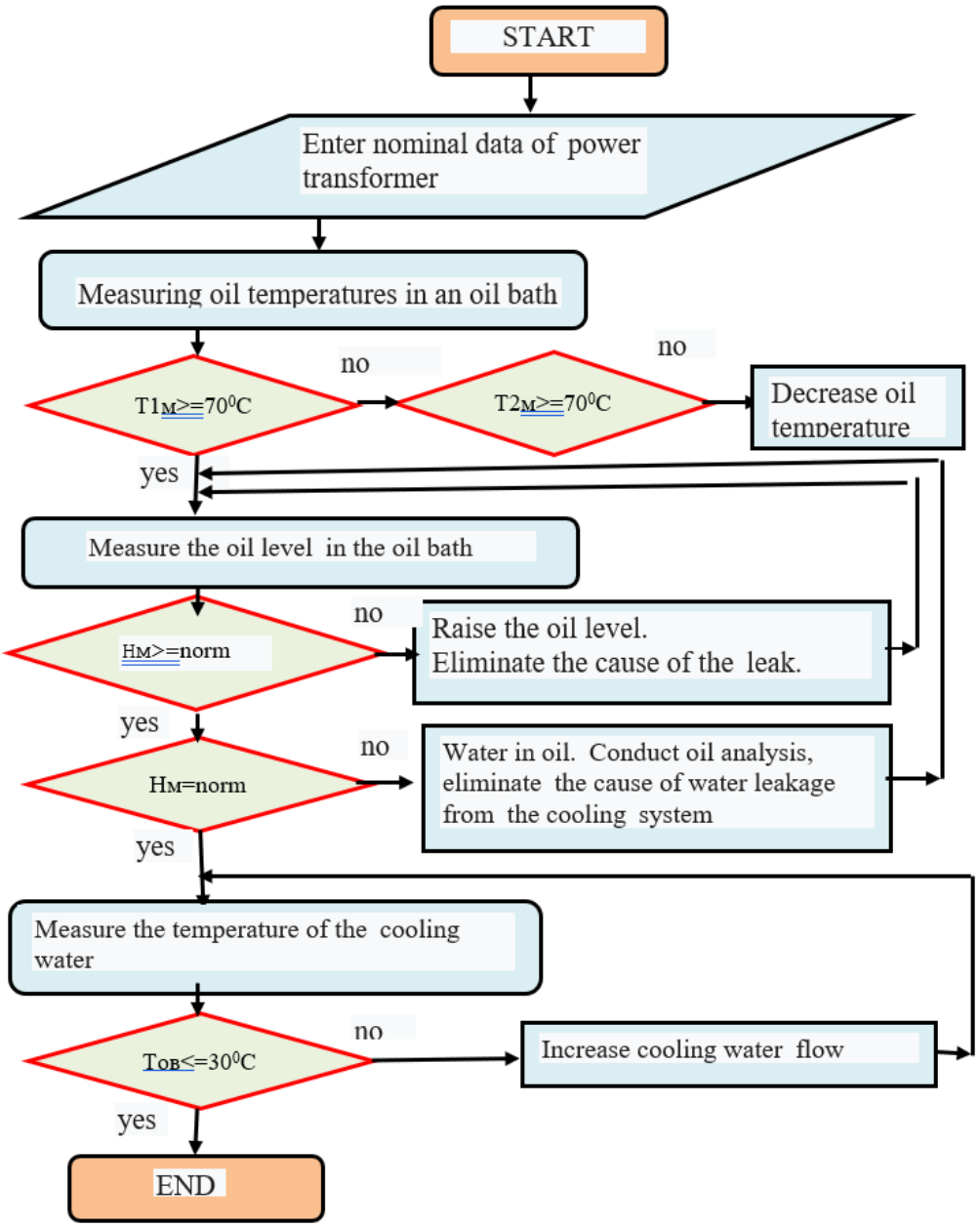

Figure 3. Block diagram of the algorithm for assessing the condition of a power transformer based on the temperatures of cooling oil and water

Self-loosening or breakage of tie rods or release bolts. Inspect the stator core. If necessary, replace the tie rods and release bolts,

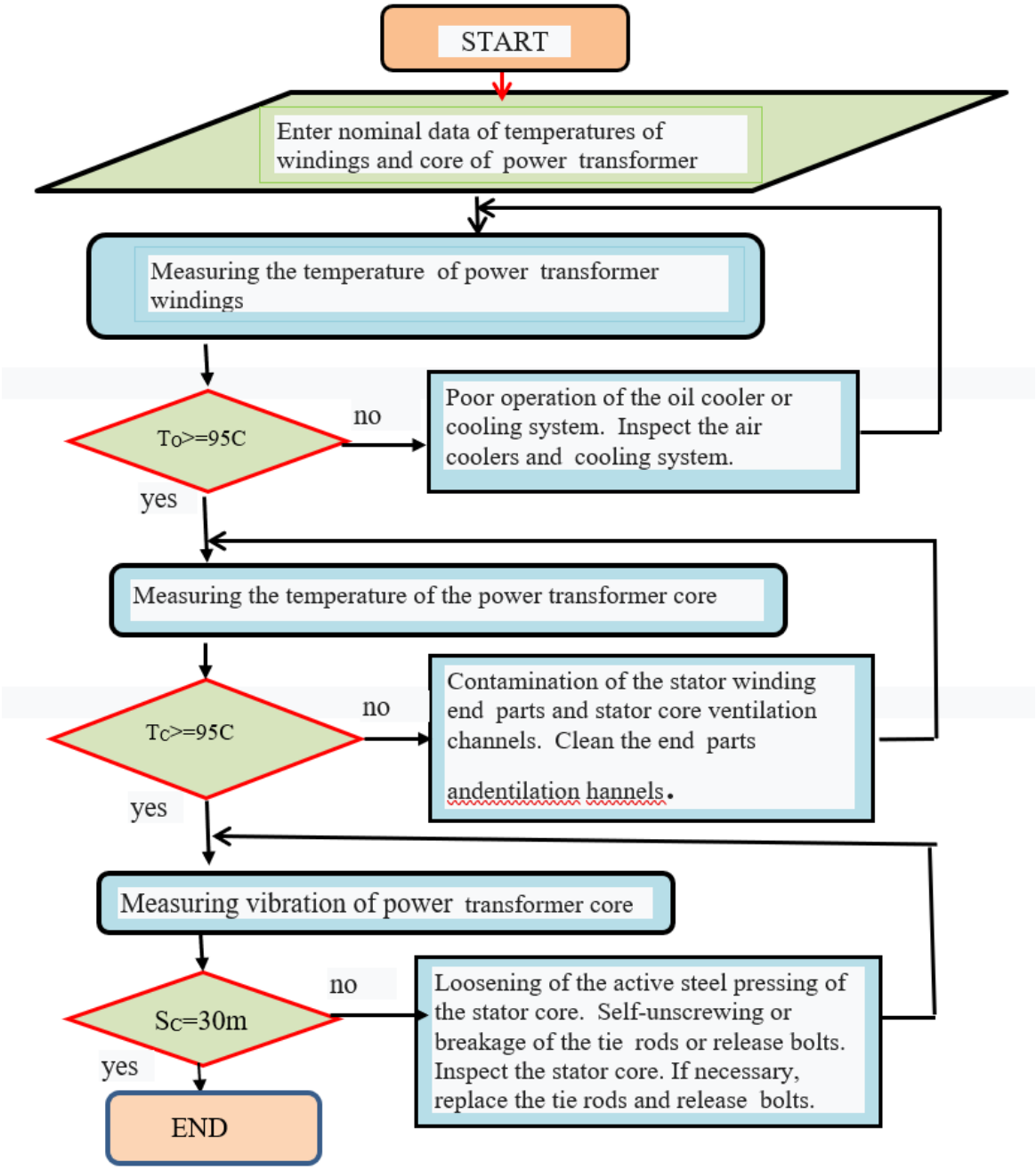

Figure 4. Scheme of the algorithm for assessing the state of a power transformer based on the temperatures of the winding and core

Conclusions. Developed algorithms for diagnostics of the state of electrical equipment of the power supply substation and defined parameters for diagnostics of the state of the power supply substation. allows identifying emergency situations of electrical equipment of the power supply substation, notify service personnel about the application of corrective measures to improve the safety and reliability of the power substation.

The implementation of the developed diagnostic algorithms allows not only to increase the reliability of equipment operation and reduce the number of serious

accidents, but also to provide the station personnel with retrospective technological information for the analysis and planning of equipment operation, its repair and increased efficiency.

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