Methodical Bases of the Integrated Electrotechnical Complexes Life Cycle Logistic Support

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***Abstract*—Complex aspects of management by life cycle of electrotechnical complexes of the oil-extracting enterprises by a method of the integrated logistic support are considered.**

***Keywords:* life cycle; electro-technical complexes; technical condition; integrated logistics.**

I. Introduction

Oil industry is the key one for the economics of Russia Federation. Taking into account that the cost of oil production in Russia is high relative to most other oil producing countries, and the expenditures for electricity and maintenance of the energy sector are the most significant, (from 30 up to 50%), the task for developing measures as well as software and hardware tools to improve the usage of electrotechnical complexes (ETCs) of oil industry (OI) is very important.

Valid till the 90s documents and statutory documents, industrial standards fixed high level of control maintenance, repair, and operations system (MRO) management system in the oil industry at that times.

But unfortunately the situation was changed in the last years. The reached positions weren't developed and as a result were lost. The change of social and economic structure of the country brought to the reforming and reorientation of the business processes of OI (with the orientation to the "building in the world economics"), but it didn't affect the engineering and social responsible aspects. Service companies (also so called energy service companies), providing the support of the life cycle (LC) electrotechnical complexes of the oil companies, are in operation apart from the OI, the goals of their business processes are mostly different. The existing disadvantages in the part of creating the industrial relation system are acquiring in decreasing the efficiency and reliability of electrical engineering system [1].

No doubt, a number of international guidelines and standards describing the principles of modern life cycle management systems of different objects; the MRO task is considered by the leading enterprises as part of the whole life cycle management tasks, taking into account their engineering- social-economic aspects. At the same time, we must take into account the following factors:

First, foreign standards are making the feedback "object MRO- configuration MRO" on the base of analysis of fault operating data, but not foreseen the usage of the MRO results for chancing the MRO system without having the failure, but the scientific based solution of the problem is not being opened. The appearance of failure fact in the corresponded exploitative documents of the enterprise is rare situation, because of the existing preventive maintenance service and because of relations between the enterprises and the service company. Information base of the made decisions is getting narrow, and there is a need in searching the ways of MRO applied results.

Second, for LC management in ETC of OI there is necessity in the adaption to the foreign standards (differences in exploitative documents, different reading in local and foreign composite functions of LC ETC management, supervisory control, information management complex, etc.). Also there is a problem of different

Also, there is the problem of the different requirements for schematic images and symbols of electric power system elements. Differ in terms of the standards and requirements for the provision of information and energy life cycle ETC management process.

Thus, the solution to the problem of process management of ETC OI lifecycle support in accordance with international quality standards and embedding it in a single, integrated enterprise management system requires the development of evidence-based connection between analyzed results of operating ETC OI and changes in LC system support configuration [1].

II. Methodological Foundations Of Integrated Logistics Support Life Cycle Of Electrotechnical Complexes For Oil Industry

The key task in providing the ETC LC is the support for integration of all information flows about the LC not only in the process of planning and development but in distribution, integration, and operating.

The system approach in LC planning of any object and after a complex of administrative measures, aimed at cutting the costs, are combined under the term of integrated logistic support.

ILS – methodology of object LC cost optimization in accordance with criteria of its best availability to the operation support, reliability and repair capability based on creating the integrated logistic support.

Applied to ETC OI in ILS should be considered [2]:

- Research perspectives of the ETC;
- Determination of infrastructure services of ETC during the operation, including the planning procedures logistics, diagnostics, repairs, etc.;
- Respect for the maintainability of ETC design, development of sophisticated technology services along with the development of the ETC;
-Calculation of reliability and longer uptime ETC;
- Calculation of the production costs and operation costs of the ETC;
- Determination of the composition and the quantity of spare parts;
- Staff Training;
- Support links between producers and consumers by consumers access the integrated database of equipment in order to simplify its diagnostics and repair, as well as obtaining the manufacturer of faults and failures in order to take measures to improve the reliability of the ETC;
-Classification and codification of goods and materials needed in simplification the search of the right data in directories and databases (DB) to avoid duplication of projects, accelerating the preparation of applications for supply of components, etc.;
-Development and maintenance of exploitative documentation;
-Traditional logistic procedures (packing, storage, transportation, etc.).

The system of integrated logistic support (ILS) of the ETC of the OI is the integrated logistic system, providing support of the ETC operation during the whole its LC in accordance with the ILS specifications and industry characteristic of the enterprise.

Correspondence of the ETC LC stages and LC of the ILS is shown on the Fig.1.

Engineering stage of the ETC is equal to the ILS system engineering stage (engineering the strategy of operating support). The method of successive approximations defines structural features of ETC, providing the best availability for the support service. Each option has its own design and functional characteristics, respectively, the characteristics of ILS.

On the operating stage (support of ETC operation) the monitoring, diagnostics, analyses of ETC conditions and its ILS system are being carried out in order to check the adequacy of the measured and predicted value of its characteristics. Discovered imbalance between measured and predicted value can lead to the revision of the ILS system, and in the worst case scenario it can lead to the revision of the functional features and even the whole concept of the ETC.

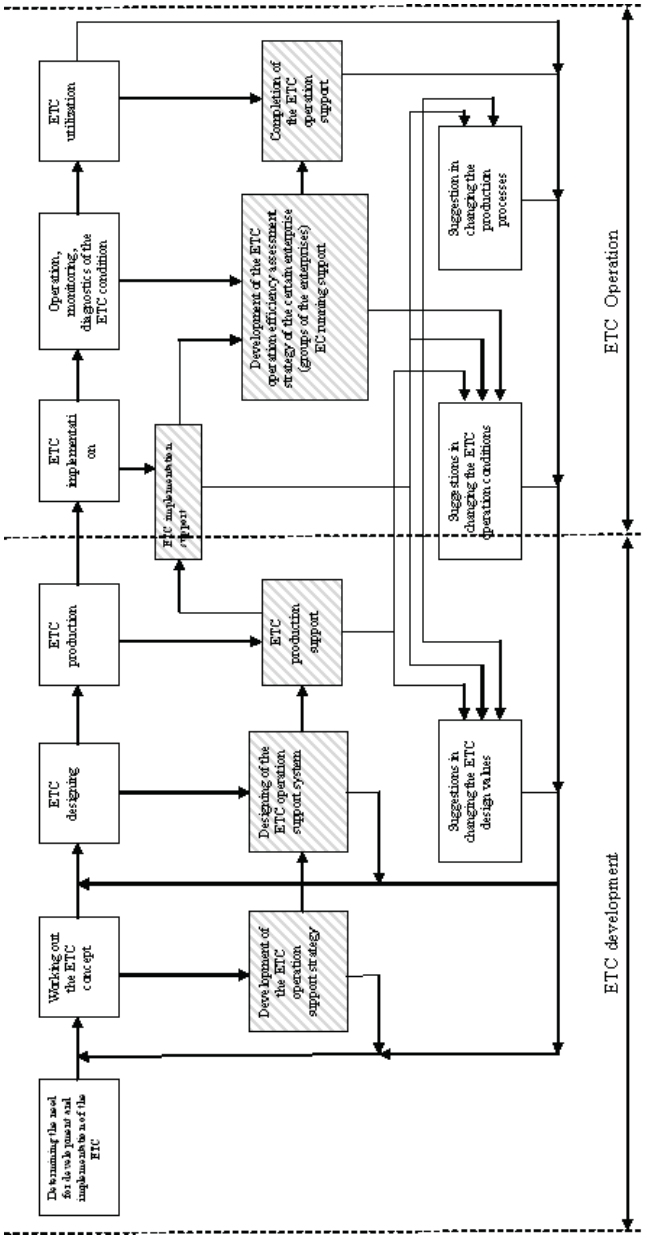

Fig. 1. ILS and ETC Life cycles.

After utilization of the ETC the total cost is being calculated of the ETC LC and the total efficiency of the ILS organization is estimated. Such estimation together with historical data about the ILS system can be used during the organization ILS for the ETC of the same type or use.

The main thing one should pay attention on is the

permanent control for the current cost and real cost of the ETC LC. The importance of the strict control is the necessity to prove the enterprise-exploiter that the got cost of the ETC LC is optimum [2].

ILS includes the following procedures:

1) ETC Logistic Support Analysis, which is run with the aim to provide with necessary reliability level, repair capability, available to support and requirements determination:

- to individual components of the ETC items, placing units and units subject to regular maintenance, replacement and repair;
- to the support and test equipment;
- to the number and qualifications of operating and maintenance personnel;
- to the system and training facilities;
- to the range and quantity of spare parts, consumables, etc.
- to the organization of storage, transport, packaging, etc.

2) Maintenance, Repair, And Operation Planning:

- Development of the MRO concept, requirements to the ETC in its maintenance and implementation of the MRO plan;

3) Integrated Supply Support Procedures Planning – integrated procedures of logistic support of the operation processes, maintenance and repair including:

- Determination of the parameters of the initial and current logistics;
- Codification of supply items;
- Planning of products supply;
- Management of orders for supplies delivery;
- Management of payments ordered provisioning items;

4) Measures in providing the staff with electronic maintenance documentation, electronic repair documentation, which are held on the stage of designing and implemented in the process of certain assembly line of the equipment. Mentioned documentation is used during the purchase, transferring, supplying, implementation, during the operation, maintenance and repair of the electrotechnical complex.

One of the most important phases in terms of a given program ETC life cycle, as well as taking into account the specific characteristics of the enterprise, is the stage of the equipment operation.

The main types of impacts and support of the ETC OI operations are the following [3]:

1) Changes in the ETC operating mode (change operating procedures and power reduction);

2) ETC upgrading (with a second vehicle diagnostic systems, improve operational parameters);

3) Change in the ETC strategy maintenance.

Evaluation of the ETC OI technical conditions is an important task, which can detect the early stages of incipient defects and, thus, to prevent accidents that can result in serious adverse effects [2]. Instead of the current system in most enterprises of preventive work, which includes periodic monitoring and prevention, more appropriate, from a technical and economic point of view, is to serve the ETC on its actual state. It means that repairs are made only when the need arises.

Therefore, a comprehensive strategy must be built in the frame of the system to ensure a given technical condition of the ETC [4].

In general the task of ILS LC ETC OI includes several stages:

Definition of the elements of power supply system (PS) based on technological inter-linkages;

Identification of the external (system) constraints;

Determination the needs of specific elements of the ETC in the amounts and timing of repair;

Definition of internal restrictions of the timing and costs (including all software repair);

Coordination of internal and external constraints;

Repair schedule, which includes timing and duration of outages.

The essence of this problem is to determine the ETC repair programs using both regulatory and technical condition assessment results (TC). This combination of information allows you to make full use of any information on the equipment, received by the diagnosis systems and due to expert's assessment [5].

Repair program means schedule of the specific sets of repairs, fully reflecting the dynamics of change in technical condition equipment.

Diagnosis and monitoring of the technical condition (TC) of the equipment involves measurement of different physical quantities: partial discharge, electrical leakage, return voltage, acoustic waves, vibration, infrared light, etc.

One needs to highlight the problem in information management. A huge amount of information influences the efficiency information management about ETC OI (there is so called "information chaos"). That is why it is necessary to create the common information space (CIS). The considered group CALS-technologies consists of known methods, which can be divided into 3 groups [1]:

1. EC designing (on the base of CAD/CAM/CAE-technologies);

2. EC production (on the base of technologies of automation processes and its planning);

3. Delivery, implementation and operation of the ETC (technology-based automation processes of the supply and use of the product), in particular:

3.1 ETC logistic support system;

3.2 E-trading systems;

3.3 Interactive electronic technical manuals (IETM) (automated systems that provide operational information to the user on a specific equipment and the ability of the hardware diagnostics, troubleshooting, training, etc.).

Analysis of the current situation in the industry enterprises showed that there is a lack of both statistical and operational, regulatory, guidance documentation about ETC and its elements, and there is a low degree of efficiency of its search.

In the frame of this approach there were developed IETM for the enterprises OOO LUKOIL–Permnefteorgsintez and OOO LUKOIL-Perm on the base of Microprocessor Units Automatization Chair, State National Research Politechnical University of Perm.

Methodological complex, providing the ETC OI LC

management by the ILS (example, 643 units of the package transformer substations 6/0,4 kV of the oil and gas workshop) was developed.

For providing the technological conditions (TC) the survey in the first year two are held, the next year - one by one (the cycles of control TC 1 time per 4 years) - only n = 5 times. The calculations on the number of one shift during the research of PTS are also done.

The analysis for implementation of managerial mechanism of the ETC OI LC was done and suggested the managerial structure of power divisions of oil industry. The scheme illustrated the TO logistic system and also was illustrated the scheme of ETC OI LC elements (objects) decision making is shown on the Fig. 2.

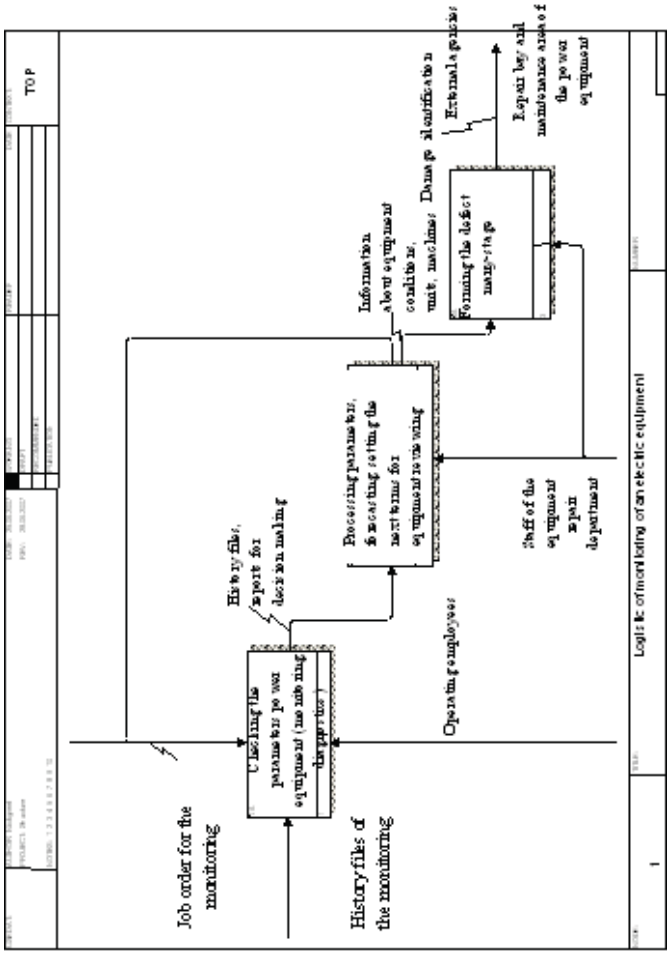

Fig. 2. The scheme illustrated the TO logistic system and also was illustrated the scheme of the elements of ETC OI LC decision making.

Key factors for the company in this matter are time monitoring and payments for its holding. The economic effect of the implemented system was significant and accounted for about 16% over the period of functioning in 4 years [6].

Methodological provision of ETC equipment control elements is developed. For example, a model of staff behavior at operation of gas protection is shown on Fig. 3.

It is necessary to note that the given procedure of subjective judgment and decision-making has positive experience of application by the commission of experts in the field of electric power industry: it was successfully applied when choosing the main schemes of electric connections, as well as schemes of own needs and electrical supply schemes.

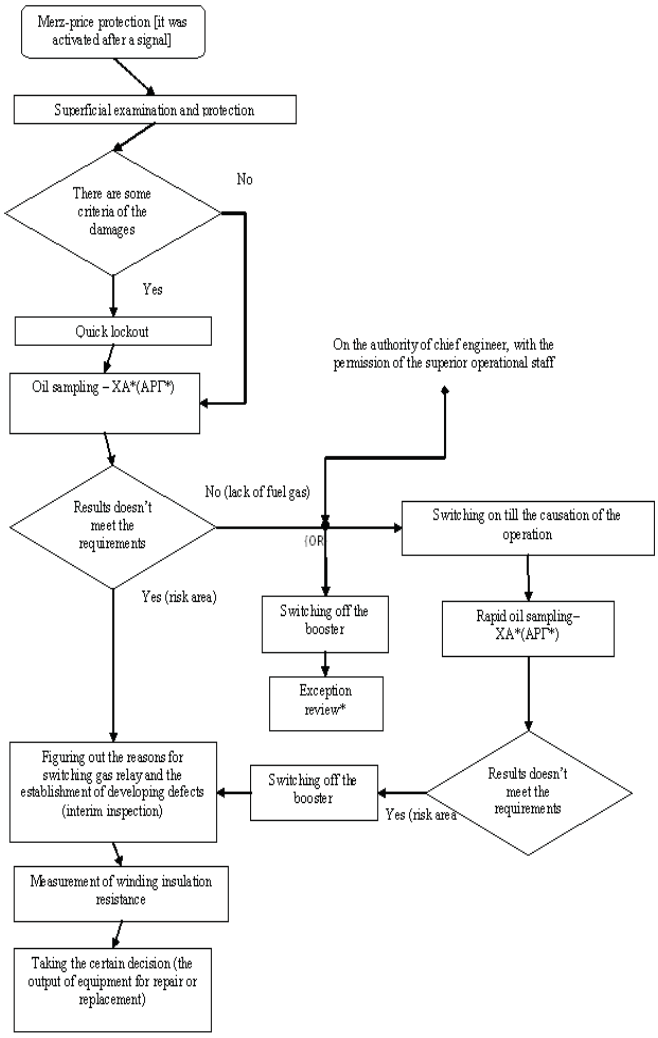

Fig. 3. Flow scheme of the maintenance staff response actions upon activation of gas protection (a fragment of the developed method).

The particular problem of money resources distribution of complex works according to the condition high-voltage electro technical equipment system (some key parameters) can be shown to expert ranging of variants of electrical supply systems [1].

In general, contemplating upon the problem of the information of technical conditions of the ETCs use for the decision-making, it is rational to allocate the following levels of adequacy of estimations:

- Identification of the technical condition with the help of reliability indicators, i.e. parameter of the refusals or intensity

restarts stream.

- Identification of the technical condition with the help of likelihood characteristics of defects and damages revealed during the certain moments of time.

- Identification of the condition with the analysis of the continuously controllable technological parameters that characterize the technical condition of the equipment elements.

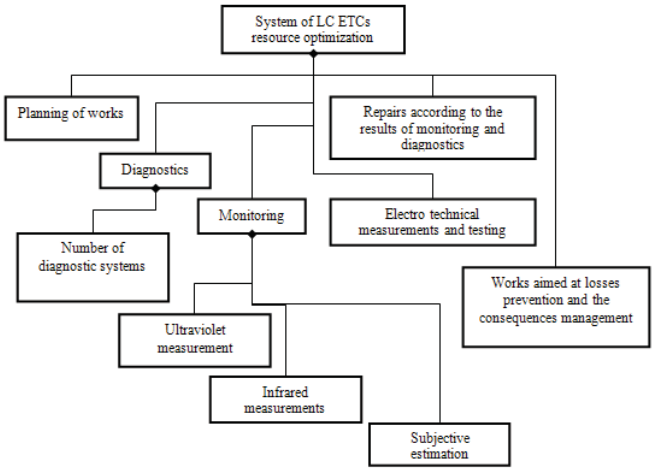

Fig. 4. Optimization principle of the resource of LC ETCs equipment system.

Realization of the third level is possible only under the condition of perfect diagnostic systems and adequate mathematical models of correlation communications between the target parameters and the technical condition of the equipment. The second level is more accessible and demands the sufficient information on the defects and damages revealed, as well as dynamics models of their development. Realization of the first level is connected only with the sufficiency of the statistical material.

The correctness of the decision-making on the introduction of the particular regulations of the maintenance service and repair depends on the technical condition of the equipment. The maintenance service and repair regulations as the system of the rules defining technology, means, volume, methods and periodicity of repair influences, depend not only on a technical condition of the considered equipment. It is influenced by the structural importance of the given equipment in the comprehensive technical system as well as concrete conditions of its functioning (including purely repair character, for example, equipment of repair base, presence of resources, etc.).

Three levels of identification of a technical condition mentioned above, as a matter of fact, are the three levels of an estimation of reliability function. The first level corresponds to the zero approach when the aprioristic information is absent. The second level corresponds to the case when aprioristic casual process of accumulation of damages of the given type is set. The third level concerns the case when the forecast is carried out separately for each realization of the casual development of refusal. Use of this or that level is defined by the necessity of the forecast accuracy and presence of corresponding means, program and supply of information [2].

The optimization principle of the resource of LC ETCs equipment system is shown on Fig. 4.

III. Conclusion

The proposed scheme corresponding to the stage of the life cycle of ETCs and stages of integrated logistics support will develop rules for the ETC documentation design based on selected ETC configuration.

There was developed methodological support for the life cycle management of key engineering equipment of ETC extraction equipment on the basis of integrated logistics support for the enterprises OOO LUKOIL–Permnefteorgsintez and OOO LUKOIL-Perm.

Electronic educational resources were developed using an educational process for training students with the specializations “Electrical Power Supply,” “Automation of Technological Processes and Production,” and “Automated Management of Product Life Cycle” of State National Research Politechnical University of Perm [7].

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