2. A hardware and software complex, which enables:
– Exploring evolution of orbits of hazardous celestial objects at long time scales and visualizing the orbital changes with time;
– Estimating probabilities of hazardous approaches of asteroids with the Earth;
– Estimating probabilities of asteroid impacts in a given area on the Earth.
3. A hardware and software complex for providing the system users with real-time, general and specific information on the ACH.
4. A hardware and software complex for modeling disaster scenarios, which will enable considering all stages of impact by a space object (from atmospheric entry to crater formation and ejection of dangerous materials) for a wide selection of the impactor parameters based on the developed methods and corresponding models.
5. A software unit for support of decision-making in selection of civil defense technologies in cases of air blasts or ground impacts of celestial objects.
6. A database of possible effects of an asteroid impact on a given territory.

The projected results can be of interest to such Russian agencies as Roscosmos, EMERCOM, and other organizations providing security of special sites, property and population in Russia. The results generated during performance of the work can be utilized for creation of the information analysis center of the System for warning of space threats or for the Federal space program of Russia.

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RESEARCH OF FAILURE MECHANISMS OF SOLENOIDS AND CONTACTORS

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This work presents the results of failure mechanisms of solenoids and contactors and their failure rates presented in the American standard NSWC-11.
Keywords: reliability, radio electronics, contactors, solenoids, failurerate.

This study (research grant № 14-05-0038) supported by The National Research University - Higher School of Economics' Academic Fund Program in 2014. In modern radio-electronic equipment and means of automatics the various actuating, program, switch, brake, fix, block and other electromagnetic units construct on the basis of such executive elements, as electromagnets, solenoids, electromagnetic coupling, etc. [1]. In addition, the operation of high-power microwave devices that use extended electron beams (klystrons, TWT, BWO, etc.), can be achieved only by using systems that limit the electron flow. As such a means of limiting the power microwave generators and amplifiers, mainly used as various forming apparatus based on magnetic fields of solenoids [2]. Thus, the failure of such components can not only lead to a decrease in the efficiency of the equipment, but also to the complete loss of functionality.

Solenoids – are electromechanical devices that convert electrical energy into mechanical motion. Usually this movement is used to move the load at a specified distance or the angle for the required time. Linear magnetic solenoids usually produce retracting movement of the plunger in the coil. They can also be equipped with a pusher attached to one end of the plunger providing thrusting movement. The plunger of the solenoid assembly, also known as armature (rotor) is made of nonferrous metal to increase the magnetism or the magnetic permeability. Rotary solenoid transforms the axial movement in the rotary move.

The simplest solenoid is able to perform movement only between the extreme positions. More advanced models of solenoids are allowed to adjust the force, velocity, acceleration and position. Special type of solenoids are linear rotary actuators. In them coil moves not rod and the motor, solenoid adequate accuracy and other characteristics (stepper or servo).

Typical designs of linear and rotary solenoids are shown in Figure 1.

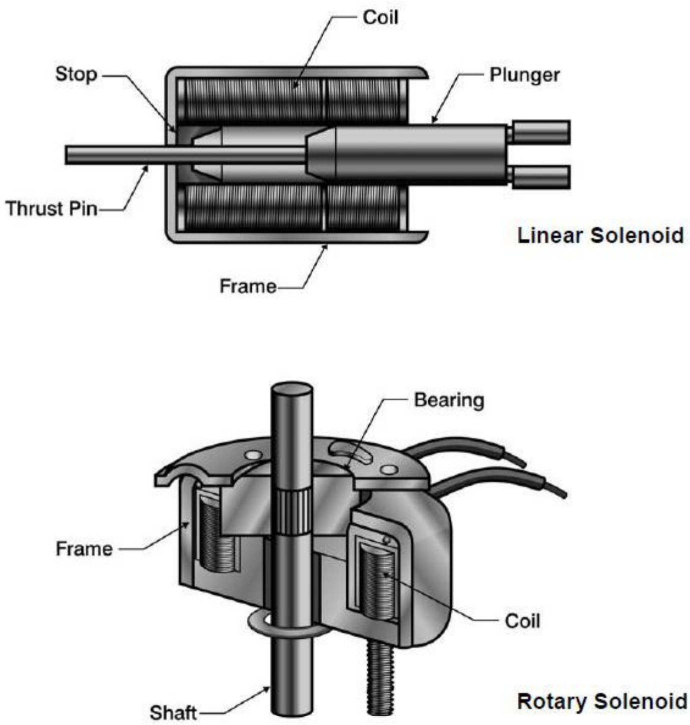

Fig. 1. Components of the linear and rotary solenoids

When voltage is applied to the coil, plunger is retracted into the solenoid, which causes the opening or closing of the valve. The backward movement of the plunger is provided with de-energized or the load itself, or spring return.

In mounting solenoid it's necessary to ensure good heat dissipation, so the surface area is significantly larger than the area of installation of the solenoid. Furthermore, solenoids have a time limit of use depending on the number of switching and the power of the input current. For example, if the operation time of the solenoid is greater than 5 minutes during one cycle, it should be seen in the continuous load (100% duty cycle).

The main failure modes of the electromagnetic solenoid are circuit at one or more coil windings, or breaking coil, usually caused by overheating. Thermal Dissipation in solenoid depends on the power consumption and operating time.

Contactors - are devices remote actions designed to enable and disable electrical power circuits apparatus. Engagement or disengagement contacts of the contactor carried out by means an electromagnetic actuator [3].

Contactor consists of the following main components: the main contacts, arc chute system, electromagnetic system and auxiliary contacts.

Main contacts carried closing and opening of the power circuit. They should be designed as a long passage of current and ON / OFF, including at high frequency. Considered normal contact position when the contactor coil is de-energized and released all the mechanical latch. Main contacts can be performed lever and bridge type. Lever contacts suggest moving the rotary system, bridging – straight suspension [4]. Typical design of contactor is shown in Figure 2.

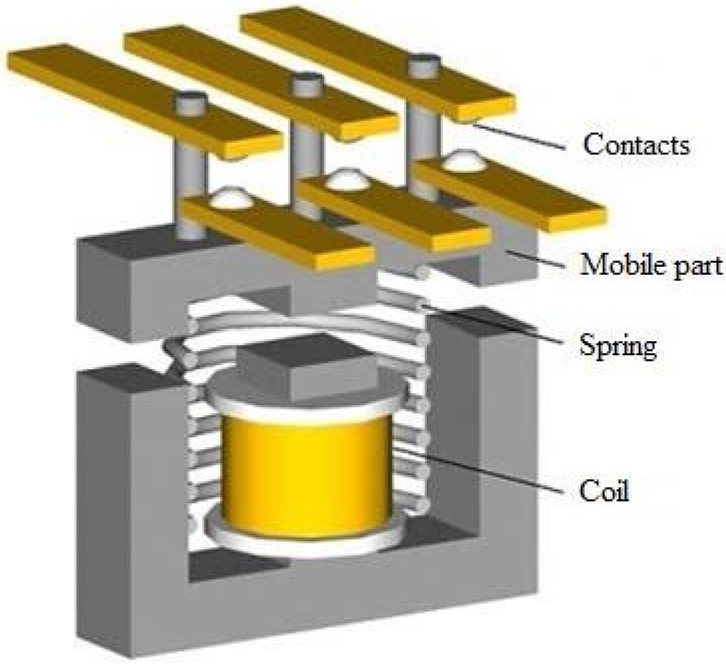

Fig. 2. Components of the contactor

Lifetime of the contactor contacts is usually limited, depending on the physical, chemical and electrical facts. Failure of the electrical contact is usually determined by increasing contact resistance by an amount exceeding the initial value of approximately twice.

Methods of calculating the reliability of mechanical and electromechanical devices, which include solenoids and contactors are considered in [5, 6], where it is shown that the most acceptable standard is methodology NSWC-11 [7]. The standard NSWC-11 considers typical failure mechanisms of solenoids and contactors, which are described in Table 1.

Table 1. Typical failure modes of a solenoids and contactors

FAILURE MODE	FAILURE MECHANISM	FAILURE CAUSE
Coil burnout	Inrush current causes coil overheating and burnout	Mechanical jamming of plunger

		Insufficient heat sink area for solenoid
		Supply voltage interruption resulting in inductive surge
	Heat builds up faster than it can be dissipated	Excessive cycling rate
Failure to operate	Increase in coil resistance preventing solenoid closure	Excessive ambient temperature
	Shorted coil at lead wires	Excessive moisture
Open inductor winding	Open lead attermination	Coil voltage over load, vibration
Armature (plunger) failure	Mismatch of solenoid force and load	Excessive plunger force creating hammering
Poor response time (pull-in time)	Insufficient solenoid force with respect to load	Jammed return spring
Poor release time (drop-out time)	Insufficient load or spring force to release plunger	Damaged/jammed spring or loss of load force
Damaged contactor	Contactor arcing	Excessive load voltage

The failure rate of the solenoid can be estimated from the following equation [7]:

$$\lambda_{SO}= \lambda_{SO,B} \bullet C_T \bullet C_K \bullet C_S$$

where: $\lambda_{SO,B}$ - base failure; C_T - temperature multiplying factor; C_K - application service factor; C_S - use rate.

The failure rate of the contactor (λ_C) can be written as [7]:

$$\lambda_C = \lambda_{C,B} \bullet v^m \bullet I^n$$

where: $\lambda_{C,B}$ - base failure rate of contactor assembly; ν - voltage across contactor assembly; I - current; m- voltage constant; n – current constant.

A more general equation can be written for AC resistive loads [7]:

$$\lambda_C = \lambda_{C,B} \bullet C_v \bullet C_I$$

where: C_v - multiplying factor considering contactor voltage; C_I - multiplying factor considering contactor current.

For AC inductive loads, the power factor must be considered, modifying Equation as follows [7]:

$$\lambda_C = \lambda_{C,B} \bullet C_V \bullet C_I \bullet C_{PF}$$

где: $\lambda_{C,B}$ - base failure rate of contactor assembly; C_{PF} - multiplying factor considering the power factor.

DC loads generate greater arcing across the contacts than do AC loads. The failure rate equation for a contactor with DC loads is written as follows [7]:

$$\lambda_C = \lambda_{C,B} \bullet C_V \bullet C_I$$

где: $\lambda_{C,B}$ - base failure rate of contactor assembly; C_v - multiplying factor considering contactor voltage; C_I - multiplying factor considering contactor current.

Thus, the above failure mechanisms and corresponding failure rates models that take into account the influence of application modes coils and contactors can be used not only for evaluating the reliability problems of these elements, but also, if necessary, to ensure the reliability of equipment problems in general.

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BUILDING KNOWLEDGE SPACE FOR SYNTHESIS OF TECHNICAL SYSTEMS WITH ENERGY-CIRCUIT METHOD

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The method of constructing the knowledge space is consider. Received ontology physico-technical effects, allowing solving the problem of synthesis of technical systems using energy-information method chains.

Keywords: knowledge space, ontology, physical and technical effect, energy-information method chains, the synthesis of technical systems

Operation of technical systems is a complex interaction of many different physical effects. The principle of operation of technical systems is present as a structured set of different physical effects, which provides the system to a given function. At the same processes in the physical chains of different origin related through a lot of the physical nature of interchain PTE.

Catalogs of physical and technical effects compiled for tentative classification and application in chemical engineering, biotech and others areas. Many researchers attempted to systematize the description technically significant effects. Recently, developer use base of physical effects in information systems support the activities of the engineer -inventor, which based on a knowledge base on physical effects, which presented special physical knowledge in a structured manner, providing more convenient to find and use them. In [1] proposed to use the energy- model of different physical chains based on phenomenological equations of no equilibrium thermodynamics. In [2] proposed a generalized theory of transducers, which based on the principle of conservation of energy and the principle of reciprocity. In [3] attempted to develop a universal system-wide device simulation based on the similarity of mathematical descriptions of various physical processes: optical, acoustic, thermal, mathematical, electrical, etc.

It is necessary to have for all analogues not just similar, but a unified description equally reflects the essence of the different processes to analyze the different physical