Algorithmic software of the automatic risk management system on offshore drilling platform with a high level of automation

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Abstract
Offshore drilling platform is a complex object that includes an integrated automation system, each element of which is the source of the risk of emergency situations occurrence. These elements include primary transducers such as sensors, actuating devices and the systems of automatic control and regulation, due to their potential possibility of incorrect response to emerging operating conditions. Implementation of these risks can lead to catastrophic consequences. An algorithm for risk management as an add-on centralized automatic management system of the drilling platform was proposed to minimize the risks and their consequences. The algorithm includes the identification of risks, their analysis, prioritization, risk management planning, the process of managing and monitoring the risk metrics, according to which the assessment of the quality and effectiveness of risk management is carried out. Planning of risk management includes the processes determining ways to manage, search for ways to reduce the risks, risk documenting and risk metrics. The algorithm is based on the analysis of scientific publications dedicated to the description of emergency situations on drilling platforms: their causes, course and consequences; database of design offices, as well as the author's own research conducted at several drilling platforms operating in the Black Sea shelf.
Key words: OFFSHORE DRILLING PLATFORM, AUTOMATIC CONTROL SYSTEM, TECHNOLOGICAL PROCESS, RISKS, SYSTEM ANALYSIS, PROACTIVE CONTROL, IDENTIFICATION

Introduction

The appearance of an emergency on an offshore drilling platform with a high degree of probability can lead to catastrophic consequences. Over the last thirty years the history counts about fifteen largest in scale accidents on offshore drilling. It is referred to the tragedies in which the number of human casualties has reached several hundred and the amount of oil poured into the ocean has reached to tens of thousands barrels and contaminated surface area has been thousands of square kilometers. So, 168 people from 224-men team died due to an accident on «OccidentalPetroleum'sPiperAlpha» platform in 1988. In 1979, as a result of the accident on a platform near the coast of Mexico about 30,000 barrels of oil were thrown out in the sea. In 2009, the accident at the «Seadrill'sWestAtlas» platform led to the contamination of 2300 square miles of the sea area near the coast of Indonesia. And these are only the most serious accidents the damage from which was calculated in each case by billions of US dollars. This article reflects some of the results obtained in the course of work on the study of risk management problems on offshore drilling platforms.

The concept of risk implies the possibility of a different kind of losses or damage that will occur as a result of the continuation of a current action or script of the process development. Risk is a function of two parameters: the probability of an undesired event occurrence and the scale of the consequences caused by it (damage). The losses include financial damage, loss of time (simple), loss of productivity, etc. The risk is a kind of harbinger of the problem, its reminder, the probability that in a given point of time of system functioning the set goals may not be met by existing resources and operations. In a complex system reducing the risk to zero is impossible, but it is possible to manage it.

Sources of risk in the automation system of drilling platforms

Modern offshore drilling platforms are completely self-contained objects, which from the automation point of view consist of many complex subsystems that have their own local and central management for the entire system. In fact, each of these subsystems, starting from elementary sensors and ending with central control units, is a set of critical components or potential sources of unwanted scenarios of processes in the system and its defects.

Management systems of modern drilling platform are interlinked and have the Control Center:

- drilling operator chair with monitoring tools and manipulators;
- place of the remote control and management, located in the office of the drilling platform-owning company;
- place of the remote control and management, located in the office of the manufacturer of the automation system company installed by the customer on this drilling platform.

All major subsystems are interconnected by a computer network. The subsystems themselves have local software and ensure the implementation of control over drilling platforms elements by algorithms embedded in programmable logic controllers.

Operator working in a chair of a drilling operator or at one of the remote control places in the coastal offices has access to the settings and monitoring the status of each of the subsystems. For example, Fig. 1 shows a window for monitoring the state of the drilling mud control subsystems. By clicking on one of the displayed items the detalization window appears displaying the status of the elements of the selected subsystem.

Figure 1. Software window of status monitoring of the drilling mud control subsystems

Presented software interface was shown for the possibility of estimation the amount of information on the automation subsystems status that must be controlled by the operator during drilling, in addition to monitoring the parameters of the drilling process and the effective management of this process. The settings window shown in Fig. 1 describes only subsystem 1. Each subsystem has the similar individual subsystem settings in general and the plurality of its components in particular.

Risks associated with incorrect settings of systems

The analysis has shown that one of the most frequent causes implementation scenarios of risk zone is the process of setting up the subsystems and their components by the operator, engineer and according to control and measuring apparatus and automation or by other members of supervisors staff. Moreover, a specific reason can be distinguished, i.e. the deliberate removal of warnings or alarms provided by the software. In the process of drilling rig operation, a lot of emerging warning messages are related to the necessity of various types of sensors testing. Some sensors break down; the other part requires periodic calibration. The automatic control system generates reports for each of the sensors in the general registry of errors and warnings, and further indicates a fault in the appropriate system control window, where the problematic sensor is installed.

Modern control systems are used in the drilling platforms due to its flexibility, implying the possibility of upgrading the drilling rig hardware. They allow setting of all alarm threshold set values.

Under these circumstances, risk of emergency conditions is associated with reaching the alarm value of certain controllable parameter. But, as practice shows, the risk is transformed into a real emergency situation when the staff intentionally removes the signaling (in some cases, automatically blocking certain operations of drilling to eliminate the causes of the alarm), changes (overestimates) of the alarm set values so that signaling is no longer triggered without eliminating the cause.

The second typical reason of risk increasing is a forcing of the sensor readings. When, in response to the warning about the incorrect functioning of a particular sensor, the staff forcibly changes the value of its output signal in the program settings producing a kind of false calibration. The process is similar to described above process, but it corrects the value of the controlled variable instead of the set values.

These actions are not always deliberate. History provides the disaster on drilling platforms, caused by an error of sensor calibration.

Risks associated with the incorrect response to the warning

The authors have carried out the analysis of a large volume of reports on identified errors and warnings generated by the centralized management system for a number of eight-hour shifts of drilling operator. On the basis of the analysis the following conclusions were made:

- generated reports on error and warnings on all studied offshore drilling platforms do not meet the requirements of the industry standard [1] in terms of the frequency of warnings on the operator's screen;
- the prioritization when warnings is absent;
- the warnings are excessive and mostly uninformative.

Analysis has shown that the main problem in terms of prevention of the unwanted scenarios for the processes development in a complex control system of the drilling platform is a large amount of warnings provided to operator by the software. Every 10-12 seconds the operator receives a new error warning. Taking into account that the operator during this time controls processes related to well drilling by carrying out the monitoring of numerous parameters and deciding on further action, to assess adequately the continuous stream of warnings is impossible. Moreover, to identify in dozens of minor warnings the only error that can lead to catastrophic consequences is also impossible. Studies have shown that even explicit in its critical level errors in the stream of warnings of such intensity are elementary lost without reaching the operator's attention [2-5].

Considering that during one shift a number of warnings provided to the operator amounts in thousands, to find warnings indirectly indicating the risk of a critical error is virtually impossible.

This situation is compounded by the fact that out of all available options for sorting of the accumulated warnings is not possible to sort errors and warnings according to the priority.

Thus, firstly the risks of adverse scenarios occurrence as a result of "lost" warnings in excess information should be defined.

Further, studies have shown that the majority of alarms noticed by staff are actually ignored. In the existing control and monitoring systems the alarm signal may be delayed or the operator can confirm that he has received a signal.

Thus, the operator can confirm the receipt of an alarm signal, but does not take measures to eliminate its causes. Often this is due to the unawareness of the causes of the alarm and, as a consequence, it is impossible to predict possible catastrophic consequences in the case of ignoring its causes.

Risk management

In the larger systems, it is impossible to predict all the possible options for the processes development. But it is possible to name the main reasons for the development or actualization of risks: lack of information, lack of time and mismanagement.

According to the objectives considered by the authors, risk management requires the establishment around the target system at risk of proactive or reactive environment (but with higher reaction rate) of decision-making, which is able to continuous identify (predict) in real time the possibility of occurrence under these scenarios conditions of the events leading the process into error.

Further, it is necessary to determine which of the identified risks have the highest priority. Based on the assigned priorities, it is necessary to implement the decision-making according to on undertaken measures capable to prevent the identified undesirable scenario of possible course of events.

The task of creating a risk management system brings us to the problem of risk management strategies development, determination of risk management processes and, consequently, the development of methods, techniques and data support tools on the risk management processes.

The difference of mentioned proactive risk management from reactive is that when the reactive management fighting with erroneous scenario begins at its culmination, which can be compared with the methods of firefighting, unlike the methods of fire occurrence prevention methods corresponding to proactively control philosophy. When proactive management special focus is not only on the development of plans for prevention of the emerging undesirable scenarios, but also on the methods of early identification of the latter and their effective prevention by all means available prior to the scenario has begun to develop, and its consequences have begun to acquire the critical scale. Therefore, the proactive nature reaction is more desirable.

Figure 2 shows the structure of the risk management process. It consists of five main functions:

- identification of risks;
- analysis of risk;
- prioritization of risks;
- planning of measures to reduce or prevent the risks development;
- implementation of measures to reduce or prevent risks;
- control of measures taken and the monitoring of the system state subjected to preventable risk (tracking for risks metrics).

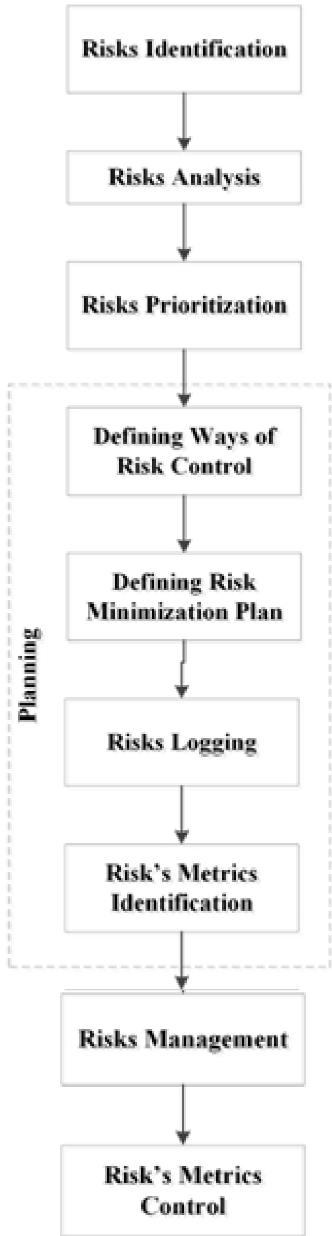

Figure 2. Structure of the risk management process

Identification of risks

For the effective risk management, firstly, it is necessary to ensure their identification. During proactive risk management, the identification should be performed prior to actualization of unwanted development scenario of the risk identified, i.e. at an early stage.

In the present study, a main class of considered risks was industrial risks, namely the risks of violations of technological processes. In turn, according to the results given above, these risks can be classified by the following main components [6-9]:

- risks associated with the human factor, i.e. with incorrect management, equipment and software setting;

- instrumental risks (hardware and software) are the risks that are associated with the occurrence of incorrect operation of the software or hardware (usually sensors);
- technological risks are risks associated with the occurrence of incorrect reaction of the management system (automatic or human operator) to the changed conditions.

Since the structure of the system, which risks are supposed to control is known, and its normal functioning criteria are determined quite definitely [10; 11], it is possible to create a basis for risks characteristic at the stage of its design complementing it during the system operation by unaccounted but arise in its work and identified risks.

Conclusions

On the basis of the proposed algorithm it is possible to create a supervisor -system integrated with a central drilling rig management system that will not only minimize the influence of the human factor in the control of warning signals and processes of information confirmation about emergency conditions, but also to identify the risks created under the given conditions in various subsystems of equipment and, consequently, to control them.

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