Safety system design and maintenance planning for oil and gas facilities located in remote areas

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Abstract:
In recent decades, the hydrocarbon energy sector has been moving into the area of the nonconventional reserves and resource development in the nonconventional environments (e.g., offshore, deep sea, arctic). The technology of oil and gas production and processing, especially in the nonconventional locations, is associated with substantial risks as the processes pose significant hazards.
In order to ensure the correct work of the facilities and the safety of the operations, Safety Instrumented Systems (SIS) are designed within the framework of an oil and gas engineering project. The purpose of this research is to provide the reasonable recommendations (requirements specification) for the safety systems design and organization of their maintenance with consideration of the three key perspectives relevant for any engineering project in the petroleum industry. These are the viewpoints of the facility operating company, the engineering design contractor, and the government. Each of these major stakeholders has their priorities and impose certain restrictions.
The contribution of this research to the area of engineering design of SIS is addressing the issues of SIS design and maintenance for the remotely located facilities. In addition to the decisions on the safety system's components and structures, and the facility overhaul frequencies, the modeling in this research aims to establish the staffing size and to determine the schedules for the crews working shifts to ensure the safe and proper facility operation. These decisions are made based on the choice of maintenance policies incorporated into the Markov model of the safety system functioning for a particular technology. The labor costs and the crews' transportation costs play a considerable role in both lifecycle cost evaluation and introducing additional restrictions for the shift-work.
The modeling employed in this research aims to maintain the lifecycle viewpoint on the technological facility with a particular SIS configuration and maintenance policy. From the economic perspective, this implies exploring a trade-off between the capital investments into the investments into the safety system's particular components and structures, and the operational expenditures associated with the system maintenance and the facility overhauls. A black-box optimization approach is applied to obtain the solution to the multi-objective engineering design problem. The recommendations on the SIS's design and maintenance, as well as the personnel organization, are provided based on the resulting Pareto-front. The data for this research is taken from a real project implemented by a Russian company.
This research is relevant to engineering departments and contractors specializing in designing the technological solutions for petroleum sector projects.

Keywords: engineering design, maintenance planning for remotely located facilities, Markov model, multi-objective optimization, oil and gas projects, remote locations, risk management, safety instrumented system, strategic planning.