

## **Assessment of Risk of Failures and Possibility of Extreme Situations for the Substructure of Tanker Loading Unit (TLU)**

*E.N. Bellendir, O.M. Finagenov*  
The B.E. Vedenev VNIIG, Inc.  
St.-Petersburg, Russia

### **ABSTRACT**

In the risk assessment for the TLU substructure, features of its composition prescribed by the main technical solutions of the project, construction, installation and operation conditions and climatic conditions of the site are taken into account. The selection and validation of the main scenario of failure for the substructure are described.

*The main damaging factors* of the considered scenario of the most severe and most probable failure of TLU substructure are:

- dynamic impact due to tanker lean-on on the TLU;
- dynamic impact of oil and oil vapors explosion;
- thermal impact of pool fire of oil and oil products from pipelines and TLU equipment.

The harmful impacts on the environment in case of the most severe and most probable failure of TLU substructure are pollution of atmospheric air by combustion products of oil and oil products emitted in the air, pollution of sea waters by toxic materials circulating on the TLU (oil, combustible lubricants) and fragments of steel elements of the substructure after their partial or complete collapse due to the failure, and loss of hydrocoles and fish reserves.

**KEY WORDS:** Reliability; risk; hazardous event; random quantity; hazard analysis; scenario of failure.

### **INTRODUCTION**

The selection and validation of the main failure scenarios of the TLU is made through identification of the hazards typical for the considered structure and with account for the construction and operation conditions and hazardous natural and technical impacts possible at the water territory of the port.

The necessary level of details is ensured through developing an as full as possible list of hazardous natural and technical impacts possible at the water territory of the port, and through decomposition of the TLU into their main elements whose faults and malfunctions may cause failures and extreme situations.

The full list of hazardous impacts on the TLU includes natural and

technical impacts.

The hazardous *natural impacts* that can trigger faults and malfunctions of the considered hydraulic facilities are:

- ◇ seismic impact (ductility level earthquake of 3 000 years return period),
- ◇ ice load (design ice load of 100 years return period),
- ◇ wave load (design wave load of 100 years return period),
- ◇ wind load (wind velocity at the water territory of the port exceeds 17 m/sec - design wind load of 10 years return period),
- ◇ thermal impact (low air temperatures during winter).

The hazardous *technical impacts* possible at the water territory of the port are:

- ◇ lean-on of a vessel (oil tanker) on the berth under difficult weather conditions and with serious violation of the rules of ship piloting in the port,
- ◇ spills of hazardous materials, fires and explosions in the processing equipment of the TLU (pipelines and loading hoses),
- ◇ fatigue damage of the materials of the elements of TLU,
- ◇ an act of terrorism within the water territory of the port or at the TLU.

The list represents the whole set of the hazardous natural and technical impacts which can trigger faults and malfunction of the TLU, because other natural impacts (mudflows, landslides, caving, etc.) are not typical for the area of the bay; storms, seiches, tsunami waves, heavy rains are not dangerous for the berths in the port; and all possible technical impacts typical for marine port facilities and Oil Export Terminal are already considered above.

### **RESULTS OF PRELIMINARY HAZARD ANALYSIS FOR THE SUBSTRUCTURE OF TLU**

The results of the preliminary hazard analysis (PHA) made for the main elements of the hydraulic facilities of TLU according to the list of hazardous natural and technical impacts which can trigger faults and malfunction of the facilities causing failure the hydraulic facilities are shown in Table 1.

*An act of terrorism* is not considered in the Preliminary hazard analysis