SEMINARIO DI AGGIORNAMENTO PER ISPETTORI AMBIENTALI ISPRA

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Contributo alla conferenza internazionale ESREL, relativo all'analisi di un caso incidentale di duplice interesse Seveso-AIA

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Cosa è ESREL 2021 ?

Da più di 30 anni *l'ESREL* è uno degli eventi chiave per lo scambio di conoscenze sul controllo dei rischi, sulla sicurezza e sull'ottimizzazione delle performance dei sistemi tecnologici.

Quest'anno la conferenza ha coperto numerosi argomenti nel campo della sicurezza, dell'affidabilità e del rischio e ha ospitato presentazioni e discussioni di paper scientifici su principi teorici, metodi e applicazioni ad una vasta gamma di settori e aree quali:

- *Accident and Incident Modeling,*
- *Risk Assessment,*
- *Structural and System Reliability*

con particolare enfasi su argomenti quali *Maintenance and Prognostic* e *Health Management*.

Sono stati affrontati aspetti multidisciplinari della scienza della sicurezza inclusi i fattori organizzativi e umani cosi come la *Resilience Engineering*.

ISPRA
Istituto Superiore per la Protezione e la Ricerca Ambientale

Sistema Nazionale per la Protezione dell'Ambiente

Tematiche trattate nell'ESREL 2021: Aree metodologiche e applicative

METHODOLOGY AREAS

- Accelerated Life Testing
- Accident and Incident Modeling
- Asset management
- Economic Analysis in Risk Management
- Foundational Issues in Risk Assessment and Management
- Human Factors and Human Reliability
- Innovative Computing Technologies in Reliability and Safety
- Maintenance Modeling and Applications
- Mathematical Methods in Reliability and Safety
- Mechanical and Structural Reliability
- Organizational Factors and Safety Culture
- Prognostics and System Health Management
- Resilience Engineering
- Risk Assessment
- Risk Management
- Risk Scenario
- Softawre Reliability
- Structural Reliability
- System Reliability
- Uncertainty Analysis

APPLICATION AREAS

- Aeronautics and Aerospace
- Automotive Industry
- Autonomous Driving Safety
- Chemical and Process Industry
- Civil Engineering
- Critical Infrastructures
- Cyber Physical Systems
- Energy
- Healthcare and Medical Industry
- Information Technology and Telecommunications
- Land Transportation
- Manufacturing
- Maritime and Offshore Technology
- Natural Hazards
- Nuclear Industry
- Occupational Safety
- Oil and Gas Industry
- Renewable Energy Industry
- Railway Industry
- Security
- Smart Cities and Systems
- Socio-Technical-Economic Systems
- Supply Chains Management
- Water Transportation Systems
- Web Systems

Session TU2G: Oil and Gas Industry

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Joaquim Rocha Dos Santos, Danilo Taverna Martins Pereira de Abreu, Carlos Henrique Bittencourt Morais, Danilo Colombo and Marcelo Ramos Martins
Decisions in conditions of uncertainty involving the development of offshore oil fields: a proposal of a framework for a Decision Support System

Fausta Delli Quadri and Geneve Farabegoli
Uncontrolled release of crude oil in the groundwater from a storage tank - critical issues and s-ems improvements linked to Seveso-IED interfaces

Deshai Botheju and Kumuduni Abeysinghe
Degradation of process safety cultures – an experience based perspective

Florent Brissaud
Automatic fault trees generation and analysis for thousands of gas transmission units

Uncontrolled release of crude oil in the groundwater from a storage tank - critical issues and S-EMS improvements linked to Seveso-IED interfaces

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ISPRA - Italian National Institute for Environmental Protection and Research -
Service for Risks and Environmental Sustainability of Technologies, Chemical Substances, Production Processes and Water Services and for Inspections

Main contents

- Accident description: slow hydrocarbons release occurred from the tank-bottom of a storage plant: environmental impact
- Accident analysis: interesting critical issues elements, linked to the root-causes of the accident, have been highlighted. Important Safety&Environmental-Management-System improvements have been carried out after Seveso and IED inspections
- Final focus: need to find ways to improve communication between Seveso and IED control activities and to adopt common approaches when dealing with the operation of an establishment in the respect of both safety and environmental issues

Accident description-dynamics

- polluted water with hydrocarbons has been found inside a sewage pipeline of the wastewater treatment plant (WWTP), close to a crude oil extraction/storage plant, during environmental monitoring/control activity of the soil
- following investigations assured that a LOC occurred from the tank-bottom of the storage plant: 26000 m^2 area polluted from top surface down to groundwater level, strong environmental impact. Almost 400 tons of crude oil released in the environment
- all plant activities suspended for 90 days; inspections and monitoring phases took place. Slow and long evolution of the event, discovered only after months from the starting of the release, during environmental monitoring/control activity of the soil
- toxic release in underground: not always quickly detectable, the effects magnitude strictly related to the intervention time. No signals before the accident, discovered only through a routine environmental soil control, and after a detailed reconstruction of the facts

Actions taken after the accident

Immediately and within 3-6 months:

- specific analysis and to identify oil characteristics
- first soil and water monitoring activities, then oil recovery (during 3 months)
- safety activities by the company, under the supervision of environmental Authorities (ISPRA, Region, local Agency); more than 150 survey points, 5 hydraulic barriers
- survey geognostic campain by the company to evaluate the hydrological - geological situation of the area, discovered the presence of a fast drainage way underground; it allowed an easy oil migration through the ground
- detailed tanks inspection showed the corrosion in the bottom thank D

After 6-8 months:

- e_MARS inspection and Seveso Inspection
- evironmental investigations-monitoring; Characterization Plan approved after the event: the activities started in November 2017
- agreement among ISPRA, Region and local Agency to carry out and coordinate environmental monitoring and protection of the site. In this context, ISPRA provided technical support for site inspections and monitoring activities

Accident analysis – major or not?

- 'major accident', for exceeding point 3.c Annex VI Seveso Directive: "significant damage to an aquifer or underground water: 1 ha or more"
- SDS provided by the company reported P5c (flammable liquid, ex CLP) as the only Seveso hazard category; no environmental Seveso hazard was associated to the oil (only H413)
- the company didn't consider the release as a 'Top event' in the SR, but an environmental scenario in the IED documents → the company didn't consider the accident as a major accident as well
- Ministry of Environment (supported by the eMARS Commission) and the local Authorities agreed to declare the accident as 'major accident', on base of the 'principle of caution' of the Seveso Directive, considering the crude-oil classification normally adopted in the national refineries (which refers to both H411 and P5c hazard categories)
- this led to consider the event as 'major accident' also for exceeding the point 1 in Annex VI of Seveso Directive: oil released more/equal than 5 % of the quantity limit in Column 3 of Part 1 or Part 2 of Annex I

Accident analysis – causes

- accident caused by the corrosion of the bottom tank D, and the formation of 3 through- holes in the central plates, and 7 through- holes in the annular ring
- oil leakage under the bottom due to possible cracks in the (flexible) bituminous membrane, in contact with the annular (rigid) concrete foundation
- oil vertical migration from soil towards the underground aquifer for 6 meters; the horizontal drainage route below the tank helped the rapid oil migration underground, and its extension outside the perimeter
- internal inspection of tank D showed the presence of crater-like corrosion on the bottom, extended to about 70% of the plates
- no signals or alerts were detected in the tank D before the accident, which was assumed to be in 'safe operation' until the end of 2017-2018 when the double bottom installation was planned
- the integration of Seveso - IED inspections allowed to highlight the root causes of the accident and to plan safety and environmental measures

Three through-holes in the central plates

Seven through-holes in the annular ring

Accident analysis – failed barriers

- failure of the primary protection system of the tank D: damage to the **bottom** due to a corrosive phenomenon, formation of through-holes and LOC from the tank
- failure of the secondary protection system of the tank D: damage to the **asphalt barrier** and consequent cracking. The oil vertical migration in the layers below the bottom of the tank was due to the damage of the impermeable layer (bituminous conglomerate barrier) 80 mm thick under the bottom. Cracks might be generated by contact of the less rigid bituminous layer with the annular (rigid) concrete foundation, due to the different behavior of the two materials under stress
- failure of **mitigating systems**, aimed at signaling the event and the uncontrolled oil release. Long vertical oil migration into the layers (1-2 m depth) below the bituminous conglomerate barrier, then into the saturated zone (underground aquifer) until the groundwater (at a depth of about 5-6 meters

Accident analysis – SMS faults

- Point 3.ii: “identification of possible accidental events, safety analysis and residual risk” - inadequate consideration, in the risk analysis, of the accident occurred and of all the appropriate safety measures to prevent and mitigate it
- Point 4.i: “Identification of plants and equipment to be subject to inspection plans” - failure in the control of the corrosion phenomenon, in the application of the operational experience and in the re-evaluation of the maintenance frequencies of the tanks
- Point 3.iii: “planning and updating of technical and/or managerial solutions for the reduction of risks” - failure in the adoption of "compensatory" prevention / protection measures expected from the construction of the double bottom
- Point 3.i: “identification of substances and processes hazards; definition of safety requirements and criteria” - lack of in-depth knowledge of the geological situation (composition, structure, risks, etc…) of the area below the plant, resulting in an underestimation of the oil loss evolution in the underground
- Point 6.iii: “controls and verifications of the management of emergency situations” - lack of implementation and correct operation of emergency mitigation and management systems

Two years later: Seveso inspections findings

SMS Seveso inspection highlighted good SMS improvements (control/maintenance activities of tanks):

- double bottoms, new continuous double bottoms monitoring system (daily manual monitoring system completely)
- control/checks activities improvement:
  - daily specific integrity-functionality checks (check list)
  - Tracer Tight tests on double tank bottoms, every 4 months
- inspections improvement during operation:
  - shell thickness control (ultrasound), every 2 years;
  - AE checks of the tank bottoms, every 2 years
  - improvement of safety instrumentation inspections

Some critical points highlighted from the inspection, including:

- the classification of the critical technical elements, should put in evidence the link with the safety analyses;
- no reference, in SR, to the Anti-Pollution Plan for the environmental accidents analysis and the safety measures adopted

Conclusions

- 'special major accident' - double face Seveso-IED critical points, in terms of safety and environmental aspects. Interesting critical points, strictly linked to the root-causes of the accident and to the SMS, have been highlighted through the double Seveso-IED analysis
- need to examine the case necessarily in both point of view, without excluding one or the other aspect to have a complete vision of the critical points
- Safety and Environment meet and need to be integrated to avoid losing important results, and the double-cross control/inspection activities of the plant coordinated by Seveso and IED authorities shows the powerful of communication and of common approaches when dealing with an establishment in the respect of both safety and environmental issues

Conclusions

- focal documents (Seveso and IED) analysed during the inspections, like Safety Report, Emergency Plan, Antipollution/ environmental Plan. Other have been drawn up after the inspections, like new Safety Maintenance Procedures, and a Characterization Plan approved on 2017 after the event
- common considerations and recommendations emerged, like the following concerning the importance of **risk analysis**:
  - after Seveso inspection: need to indicate, in the next SR review, an explicit reference to the Anti-Pollution Plan (as done for the Emergency Plan) at least for the analysis of the environmental accidents and the consideration of the necessary safety measures adopted
  - after Characterization Report presentation to the IED authorities: Region requested the company to proceed with the development of the site-specific risk analysis which should be shared with the authorities