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Multi Use Marine Space Safety Tools and Methods Factsheet

for analysing and assessing marine exploration hazards

Deliverable D2.4

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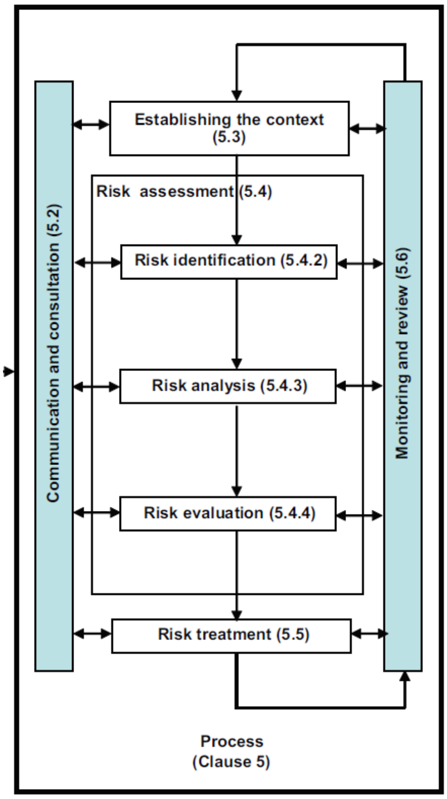
Introduction

The SOMOS project aims to develop and communicate Technical Standards for Safe Production of Food and Feed from Marine Plants and Safe Use of Ocean Space. It is funded by Lloyd's Register Foundation and carried out by Wageningen University Research and TNO. This factsheet is a deliverable of Work package 2: Safety of People and property in multi-use maritime locations: It is a fact sheet specifying tools and methods for analysing and assessing marine exploration hazards.

Title	**Safety of people and Property in multi-use maritime locations**
Multi-use examples	Exploitation activities at the location of offshore wind farms, such as fishery, fish farming, seaweed farming and associated marine services in conjunction with electric energy production.
Issue	How to assess safety implications of multiple exploitation activities at a fixed location at sea?
Approach	Select an appealing example of multiple exploitation activities at sea. Apply existing safety assessment methods and techniques on this example. Modify methods and techniques where necessary. Generalise the modified methods and techniques. A potential candidate for ***safety assessment methods*** is based on ISO 31000. Part of the process of risk management is risk assessment, as depicted. It is noted that the approach described in this ISO standard is in alignment with IMO's 'Revised Rules for Formal Safety Assessment for use in the IMO Rule making Process', MSC-MEPC.2/Circ.12, 8 July 2013. However reference to an ISO standard is made in order to be more appealing to non-maritime industries. 
Tools and methods	The process of risk assessment is schematically given by ISO 31000 and consists of the following steps: • Risk identification • Risk analysis • Risk evaluation For each step there are several tools and methods available, which are described in more detail in Deliverable 2.3. This factsheet gives a short overview of the tools and methods which cover both operational practices and design and building of structures and equipment. The tools and methods established will be used to assess the hazardous in marine exploration, as identified in Deliverable 2.1 and 2.2, with respect to probability of occurrence and severity of the associated consequences regarding safety of people and property.

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6. Synthesize data from one or more evaluations, BetterEvaluation. (n.d.). Retrieved February 2018 from https://www.betterevaluation.org/en/plan/synthesize_value/synthesize_data_single_evaluation
7. http://www.who.int/foodsafety/publications/all/en/

Risk Identification

Risk identification is about making a list of all the things that can go wrong with respect to the specific case. These hazards are considered to be a risk source where the potential consequences relate to harm. This process of risk identification results in a long list.

Possible tools and methods for risk identification are [ISO 31010 and ref. 1]:
- Information gathering techniques, e.g. brainstorm sessions
- Root Cause Analysis: RCA
- What-if/Checklist Analysis
- Preliminary Hazard Analysis – PHA
- Failure Mode and Effects Analysis – FMEA
- Failure Mode, Effects and Criticality Analysis – FMECA
- Hazard and Operability Studies – HAZOP
- Risk Screening Sessions – HAZID
- Incident Databanks

SYSTEM SAMPLE
SUBSYSTEM
SUBSYSTEM ELEMENT
PREPARED BY
APPROVED BY
DATE
REVISION
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Item Identification	Function	Failure Mode	Failure Cause	Failure Effect on: Component or Functional Assembly	Failure Effect on: Next Higher Assembly	Failure Effect on: System	Failure Detection Method	Remarks
Switch	Initiates Motor Power Function	Fails to Open	Release Spring Failure Contacts Fused	None	Maintains Energy to Circuit Relay	Maintains Energy to Pwr Circuit Through Relay	Motor Continues to Run Smoke-Visual When Pwr Circuit Wire Overheats	
Battery #2 (Relay Circuit)	Provides Relay Voltage	Fails to Provide Adequate Power	Depleted Battery Plates Shorted	None Battery Gets Hot and Depletes	Fails to Operate Relay Circuit	Systems Fails to Operate	Motor Not Running	
Relay Relay Coil	Closes Relay Contacts When Energized	Coil Fails to Produce EMF	Coil Shorted or Open	Does Not Close Relay Contacts	Does Not Energize Pwr Circuit	System Fails to Operate	Motor Not Running	
Relay Contacts	Energizes and De-Energizes Pwr Circuit	Fails to Open	Contacts Fused	None	Maintains Energy to Motor	Overheated Pwr Circuit Wire if Motor is Shorted and Circuit Breaker Fails to Open	Motor Continues to Run Smoke-Visual	
Motor	Provides Desired Mechanical Event	Fails to Operate	Motor Shorted	Motor Over-heats	High Current in Pwr Circuit	Overheated Pwr Circuit Wire if Circuit Breaker Fails to Open and Switch or Relay Fails	Smoke-Visual	
Circuit Breaker	Provides Pwr Circuit Fusing	Fails to Open	Contacts Fused Spring Failure	None	Maintains Pwr to Motor if Relay Contacts are Closed	Maintains Energy to Motor	Motor Continues to Run Smoke-Visual	
Battery #1 (Pwr Circuit)	Provides Motor Voltage	Fails to Provide Adequate Power	Depleted Battery Plates Shorted	None Battery Gets Hot and Depletes	None	System Fails to Operate	Motor Not Running	

Recommended: FMEA, since it is most used, widely applicable and has sufficient detail for the case.

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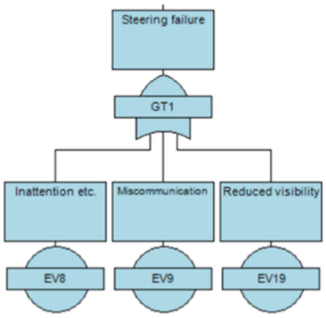
Risk Analysis	After identifying the hazards, the causes and consequences of specific hazards of an activity or hazard scenarios can be formulated and used for further analysis of the overall risk as well as for the assessment of the risk contribution from the individual components. To analyse these scenarios different risk analysis techniques exist for different steps in the risk analysis process. A suite of tools and methods is available to accommodate varying analysis needs: • for simple qualitative risk analysis there are hazard and operability analysis (HAZOP), what-if/checklist analysis, and failure modes and effects analysis (FMEA), • for simple quantitative risk analysis there are failure mode effects and criticality analysis (FMECA) and layer of protection analysis (LOPA), and • for detailed quantitative risk analysis there are fault trees (FTA) and event trees (ETA), multi-state Markov models and Bayesian network methods. Recommended: FTA/ETA, because those are most used, widely applicable, have sufficient detail for the case and are easy to communicate. 
Risk Evaluation	The resulting risk from the risk analysis is compared to an acceptable risk criterium (e.g. a standard). When the risk is too high compared to the acceptable risk criterium, the decision maker may choose to either not undertake the activity or to take measures to reduce the risk. The fault trees and event trees come into use if risk reducing measures (avoidance, mitigation, transference, acceptance or a combination) are to be taken. There are a range of options for risk evaluation (= overall judgement of merit or worth, bringing together data in terms of the acceptable risk criterium). Processes [ref. 4]: • Consensus Conference • Expert Panel Tools and methods or techniques [ref. 4]: • Multi-Criteria Analysis (MCA) • Cost Benefit Analysis • Cost-Effectiveness Analysis • Cost Utility Analysis: • Lessons learnt • Numeric Weighting • Qualitative Weight and Sum • Rubrics • Value for Money Most techniques can be used before, during or after a project. In SOMOS the case will be used to demonstrate how risks can be evaluated. At the moment there is no worldwide, nor national or corporate standard, specifically for the combination of Seaweed Aquaculture and Wind Farms. Some common standards may apply (e.g. European standards on Personal Protective Equipment, Safety of Machinery, European Building Codes or the Codex Alimentarius). Recommended: MCA, since it is a form of appraisal that, in addition to monetary impacts, measures variables such as material costs, time savings and project sustainability as well as the social and environmental impacts. Given the fact that standards are not (yet) clear, this seams the most practical way to evaluate risks.

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Conclusions	Given the tools and methods available, we conclude that a safety assessment can be done for people and property in any multi-use of ocean space. For the SOMOS project a case study was chosen to find a recommended practice. For this specific purpose and for the specific case of seaweed in combination with wind the following tools and methods were chosen: FMEA (for risk identification) in combination with fault and event trees (for risk analysis) and a (simple form of) multi criteria analysis (for risk evaluation).
Follow-up	The chosen tools and methods will be used to analyse typical hazards associated with multi-use of marine space. The results will be worked out into a recommended practice. The recommended practice on a safe approach towards the multi-use of marine space will be shared with the professional community. This will be done in conjunction with the end-user workshop (coordinated by WP5).

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