A Gap Analysis for Subsea Control and Safety Philosophies on the Norwegian Continental Shelf

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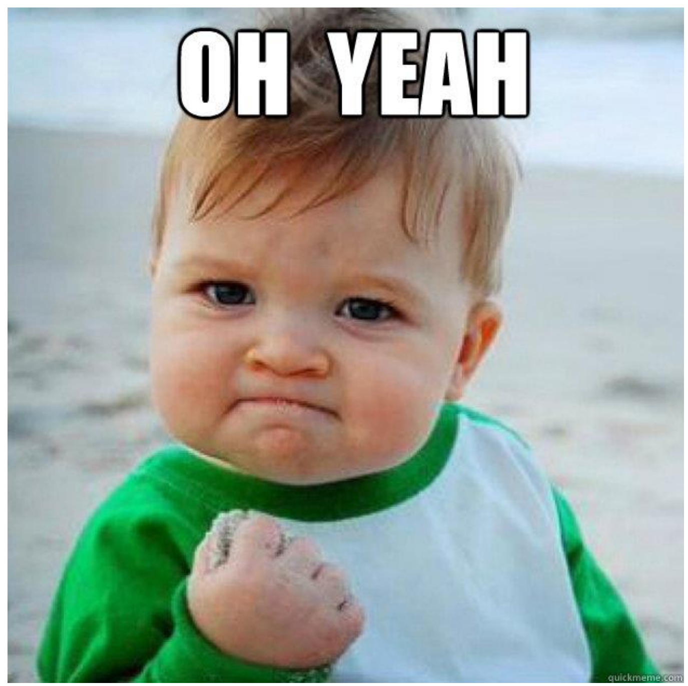
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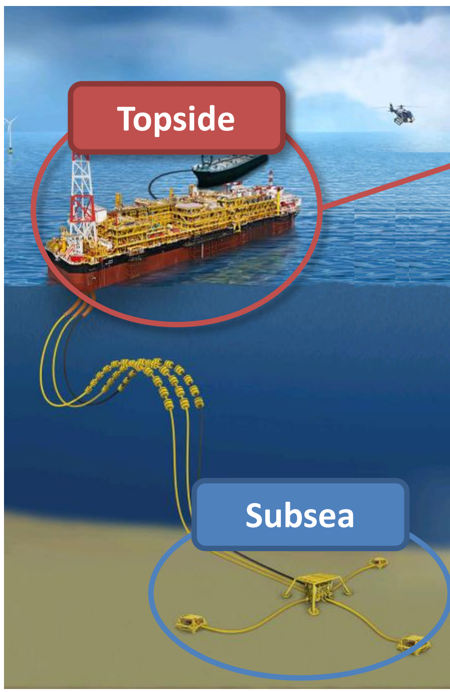
Contents

1. Introduction

1. Introduction

- Some subsea control and safety requirements are based on topside systems
- This may result in overly complex and costly design solutions
- Tailor-made solutions for subsea control and safety need to be developed
- The first step is to investigate current status and identify gaps



- Operating conditions
- Environment
- Risks

- Standards and regulations

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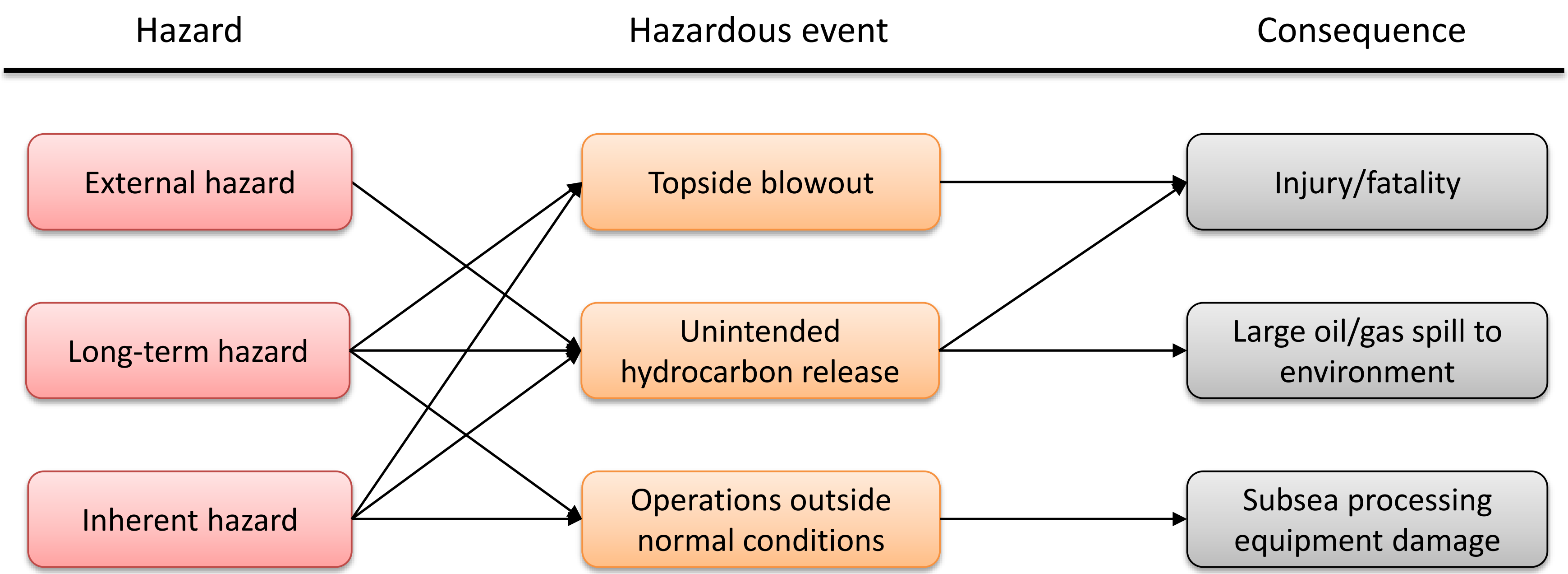
- Operating conditions
- Environment
- Risks

- Standards and regulations

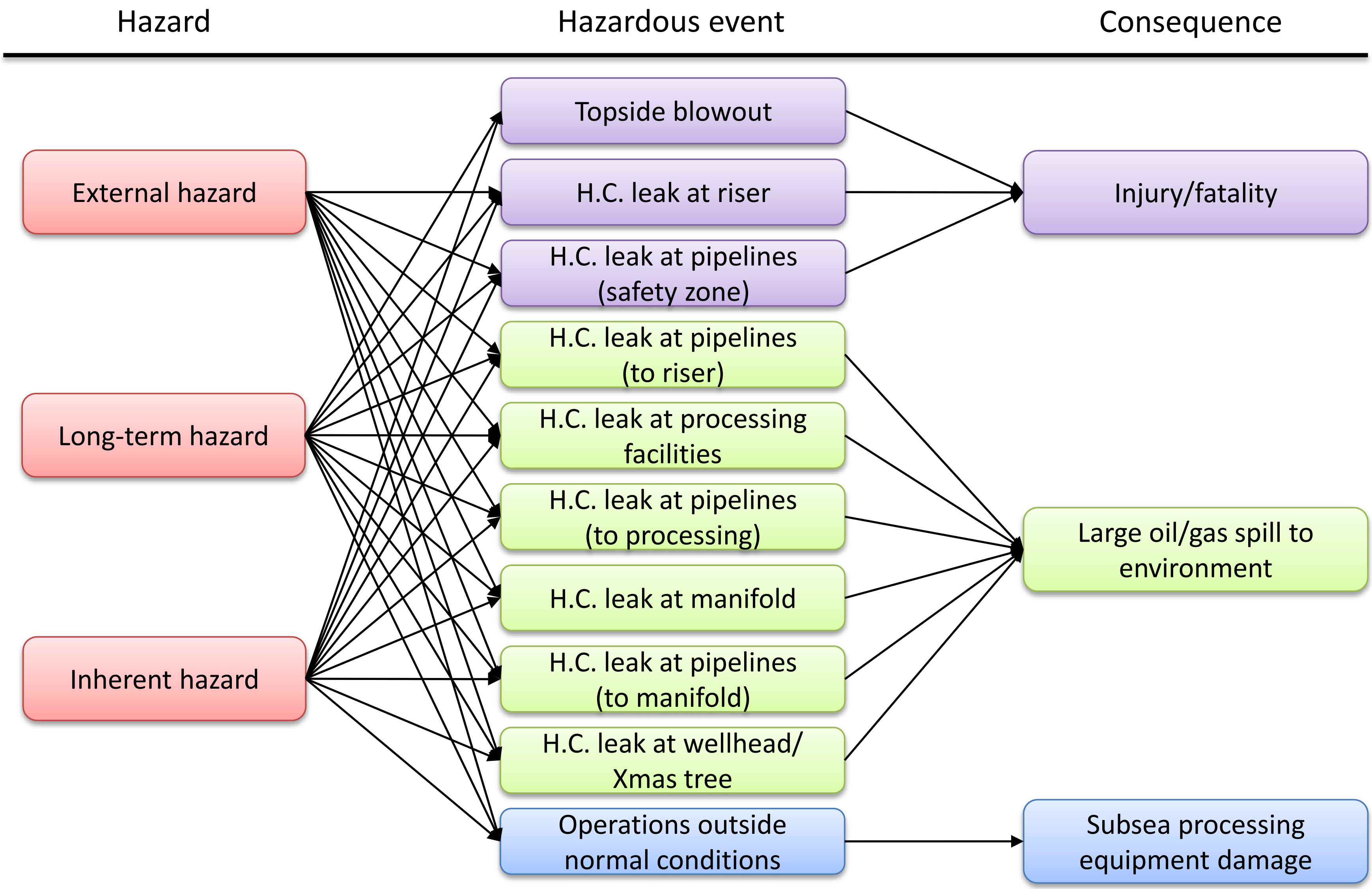
2. Background Knowledge

2. Background Knowledge

2.1 Hazard, Hazardous Event, Consequence



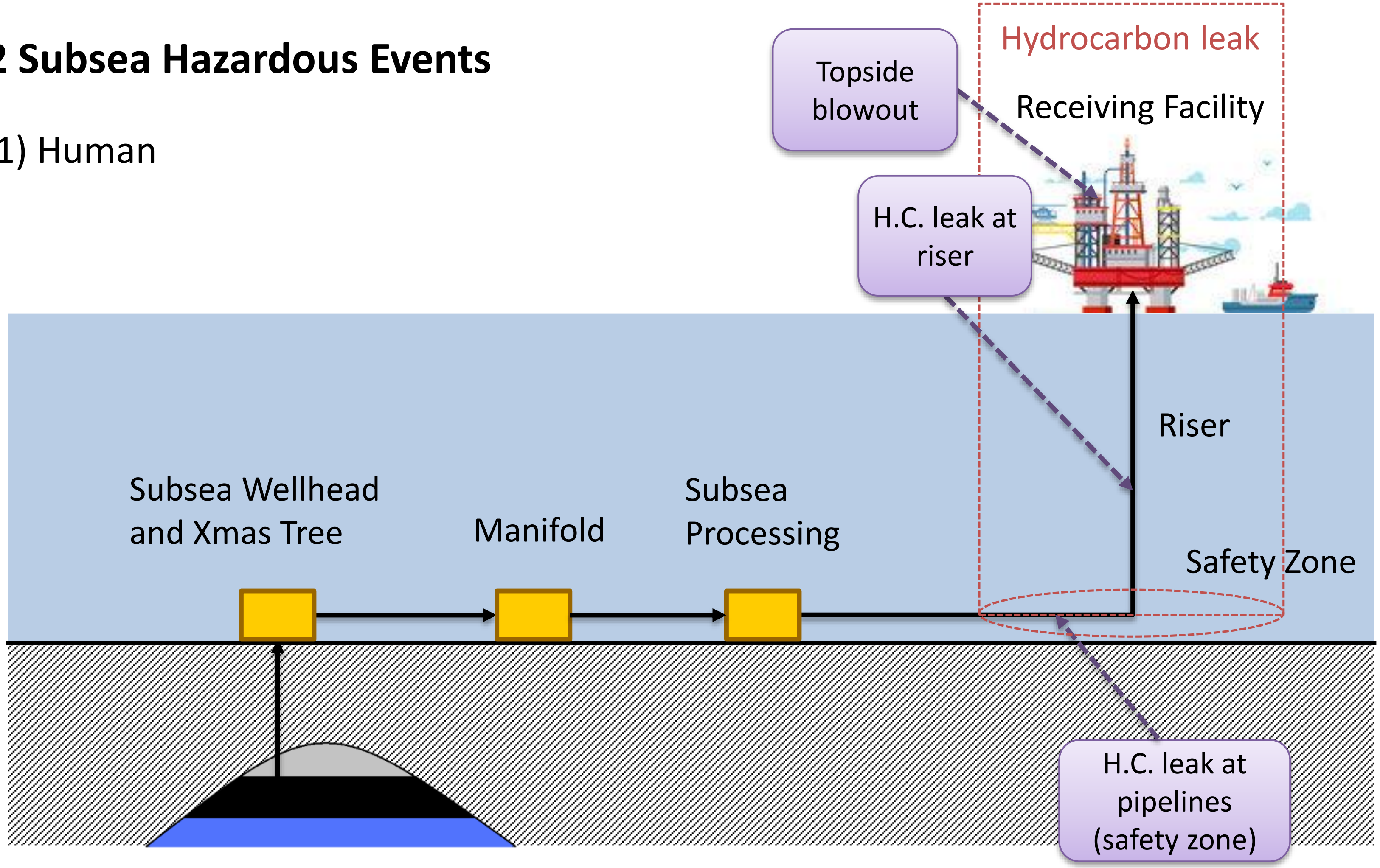
2. Background Knowledge



2. Background Knowledge

2.2 Subsea Hazardous Events

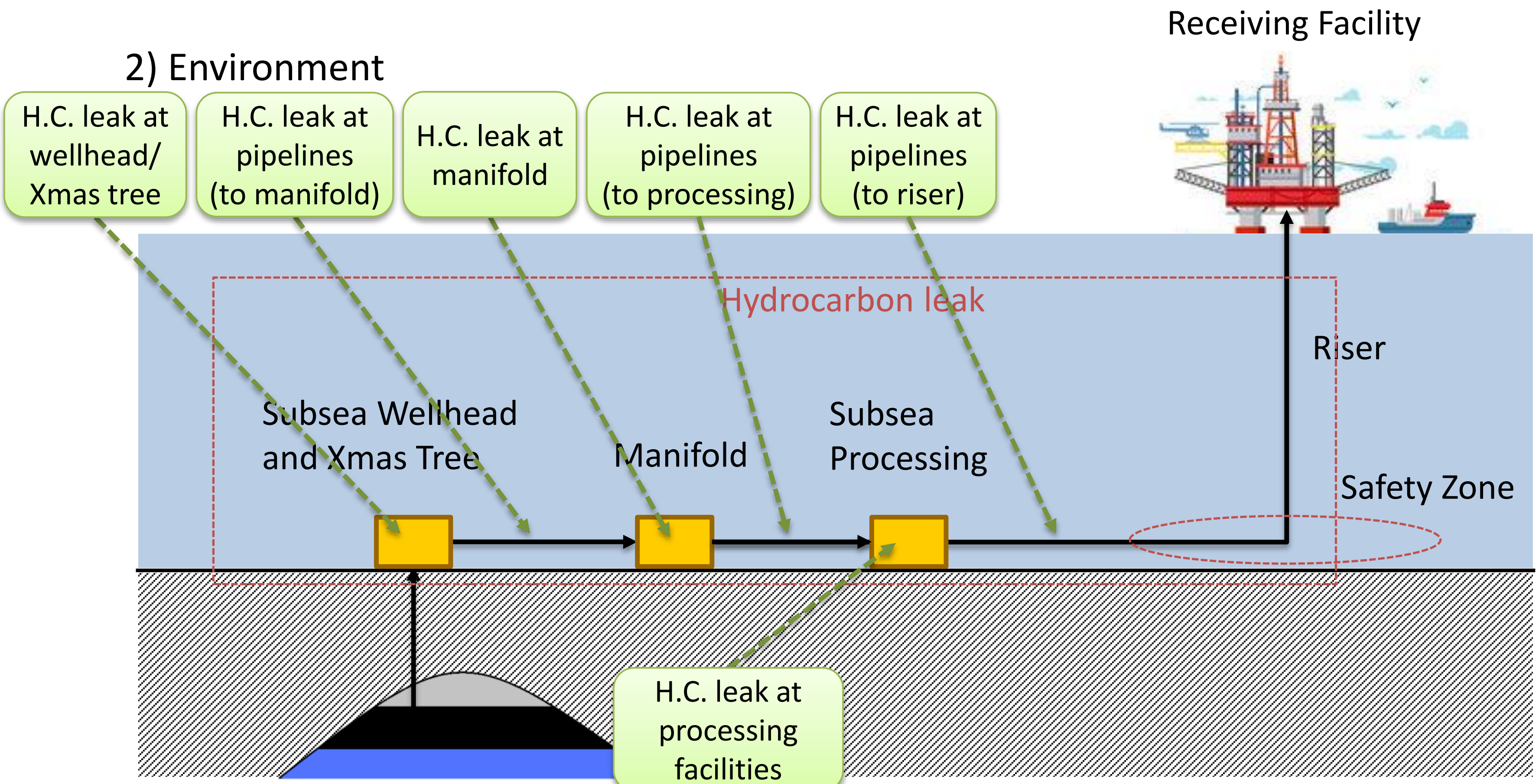
1) Human



2. Background Knowledge

2.2 Subsea Hazardous Events

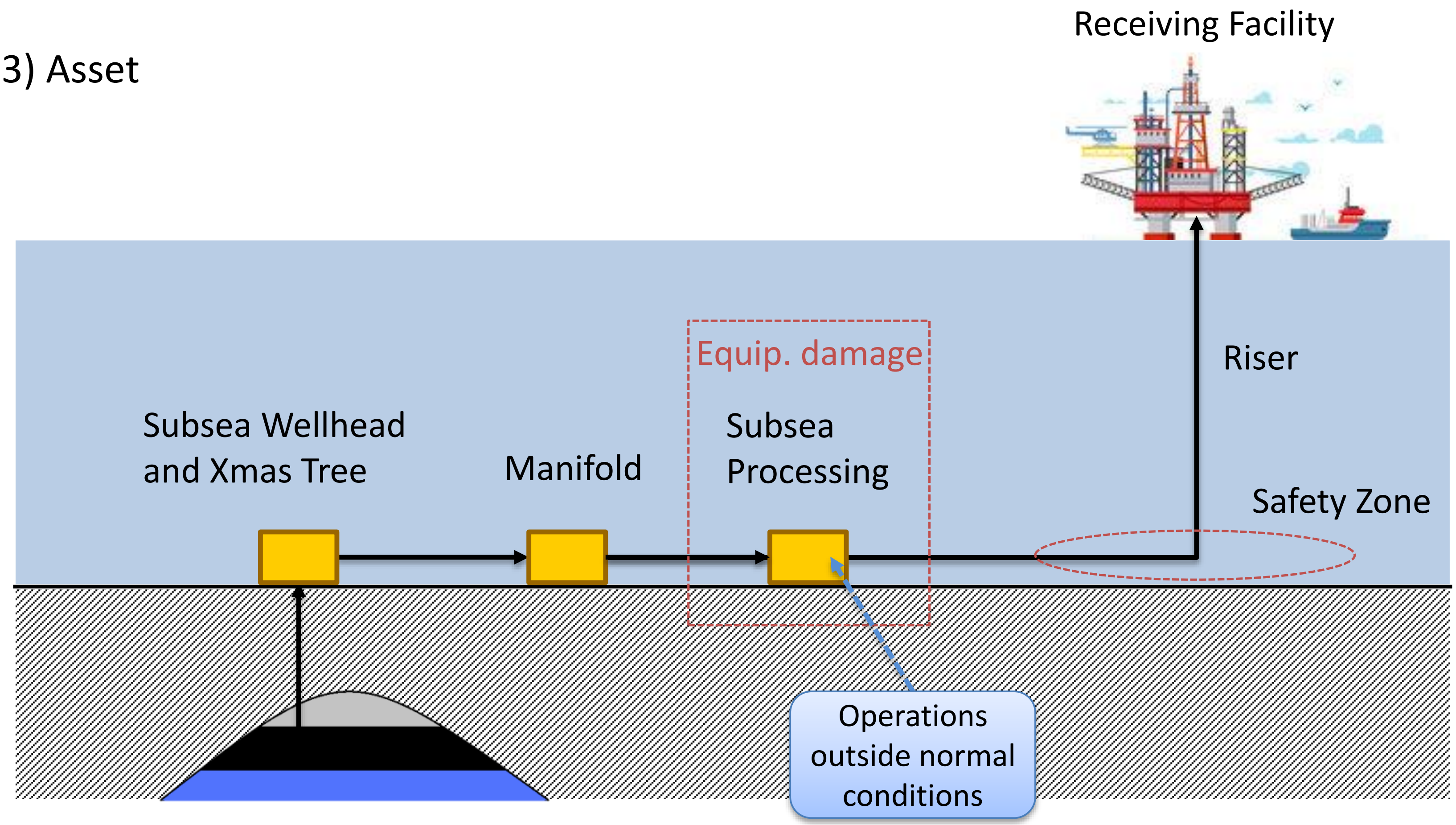
2) Environment



2. Background Knowledge

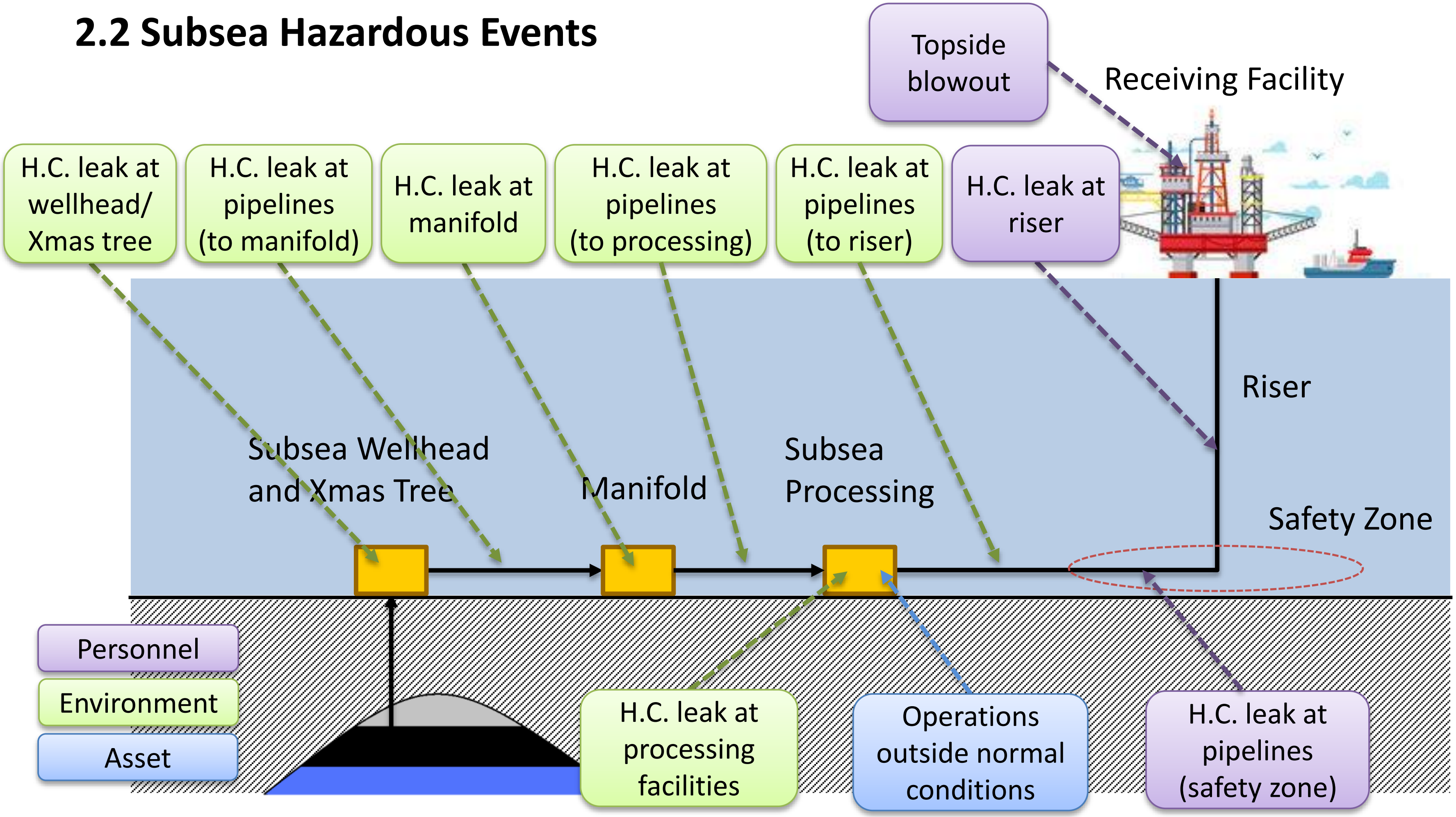
2.2 Subsea Hazardous Events

3) Asset



2. Background Knowledge

2.2 Subsea Hazardous Events



2. Background Knowledge

2.3 Subsea Safety System

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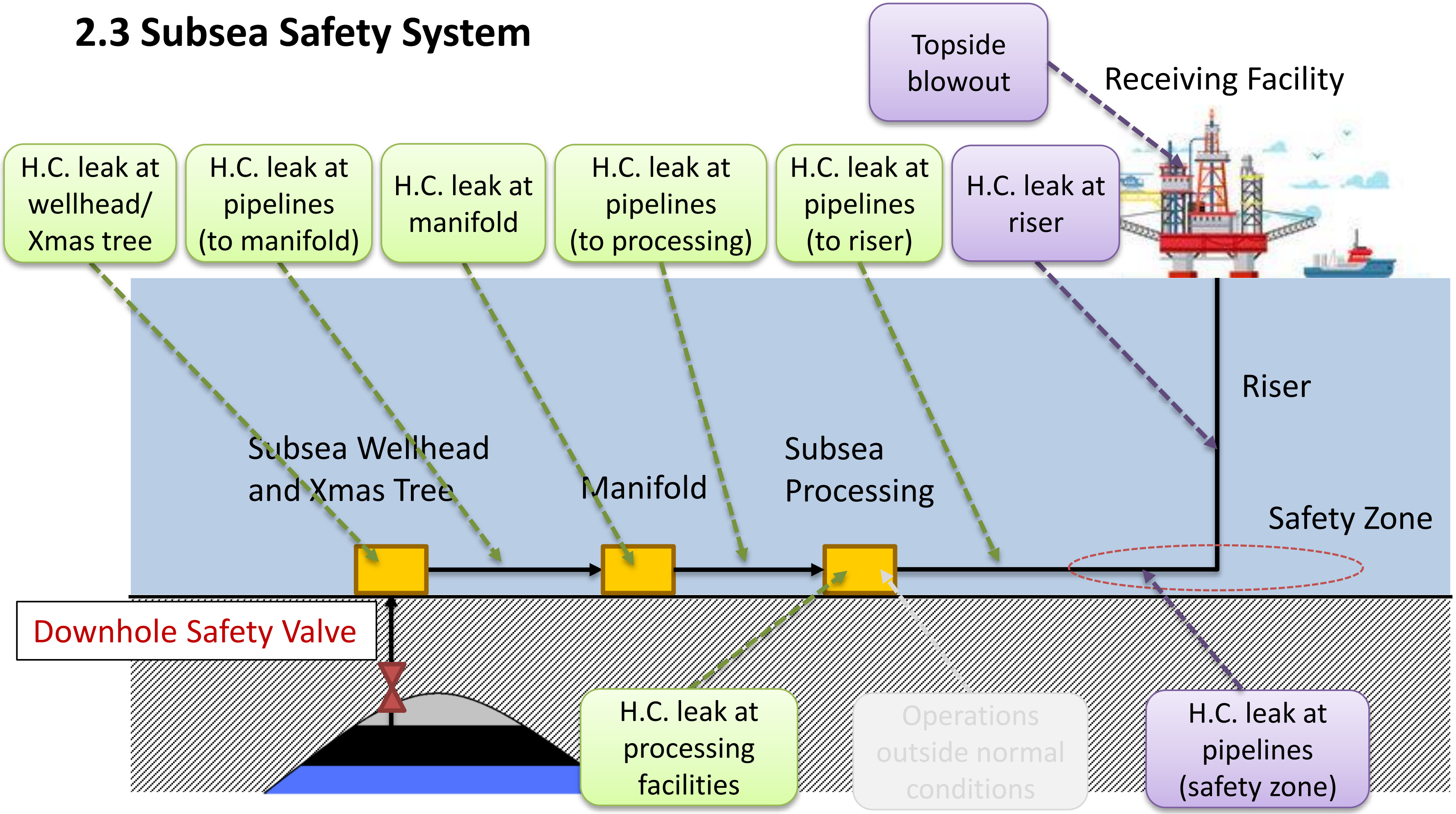

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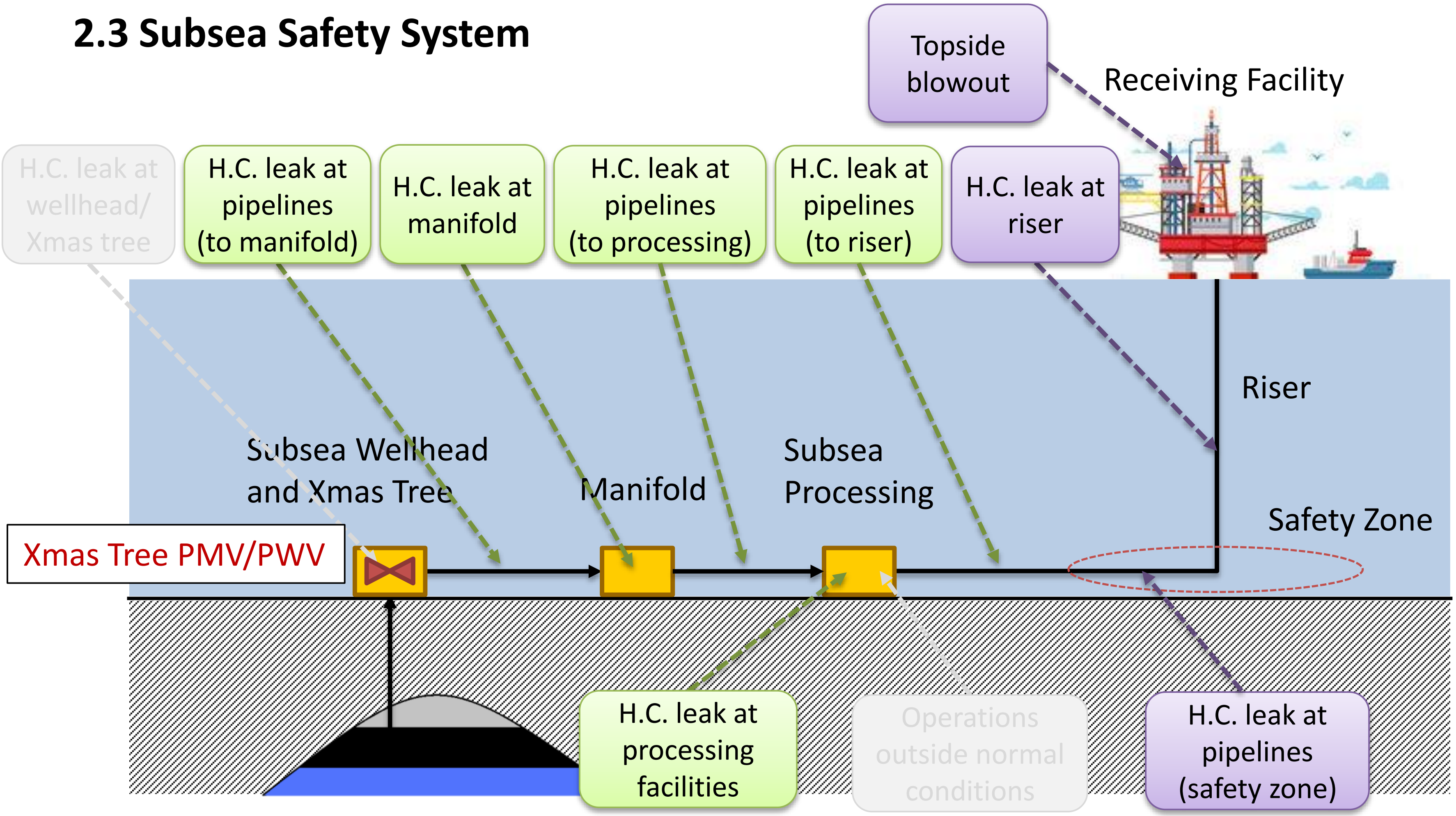

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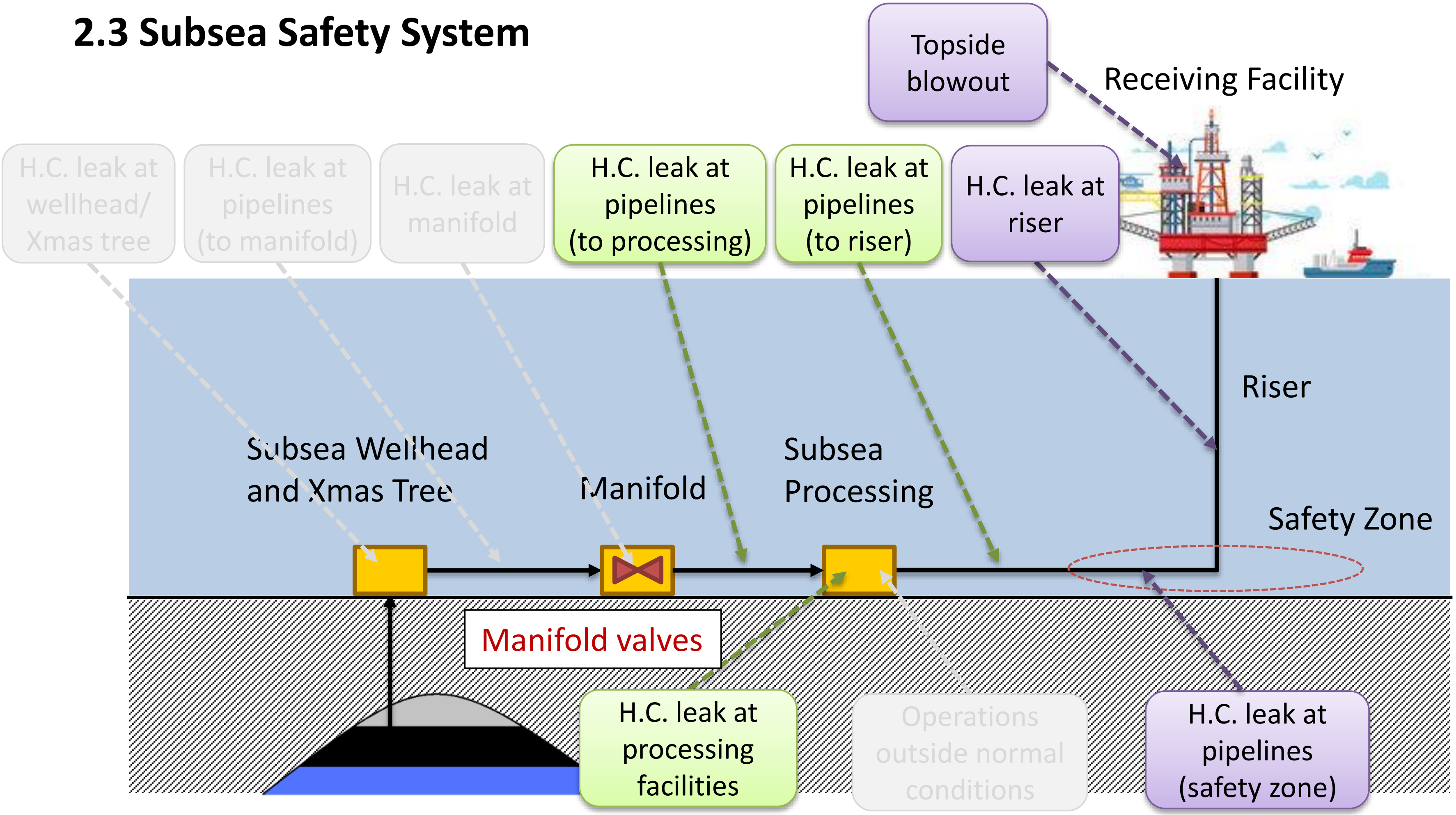
2.3 Subsea Safety System



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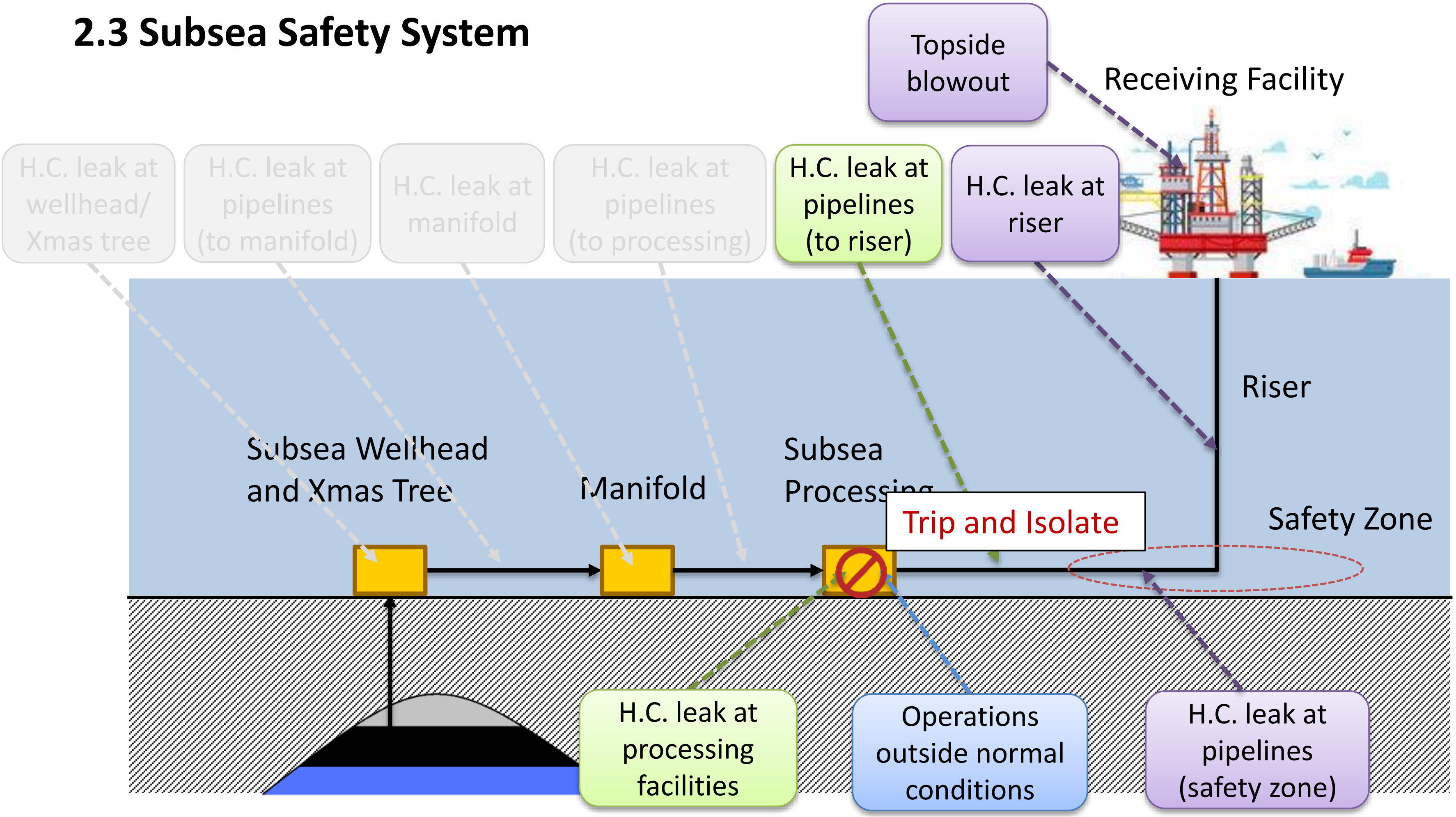
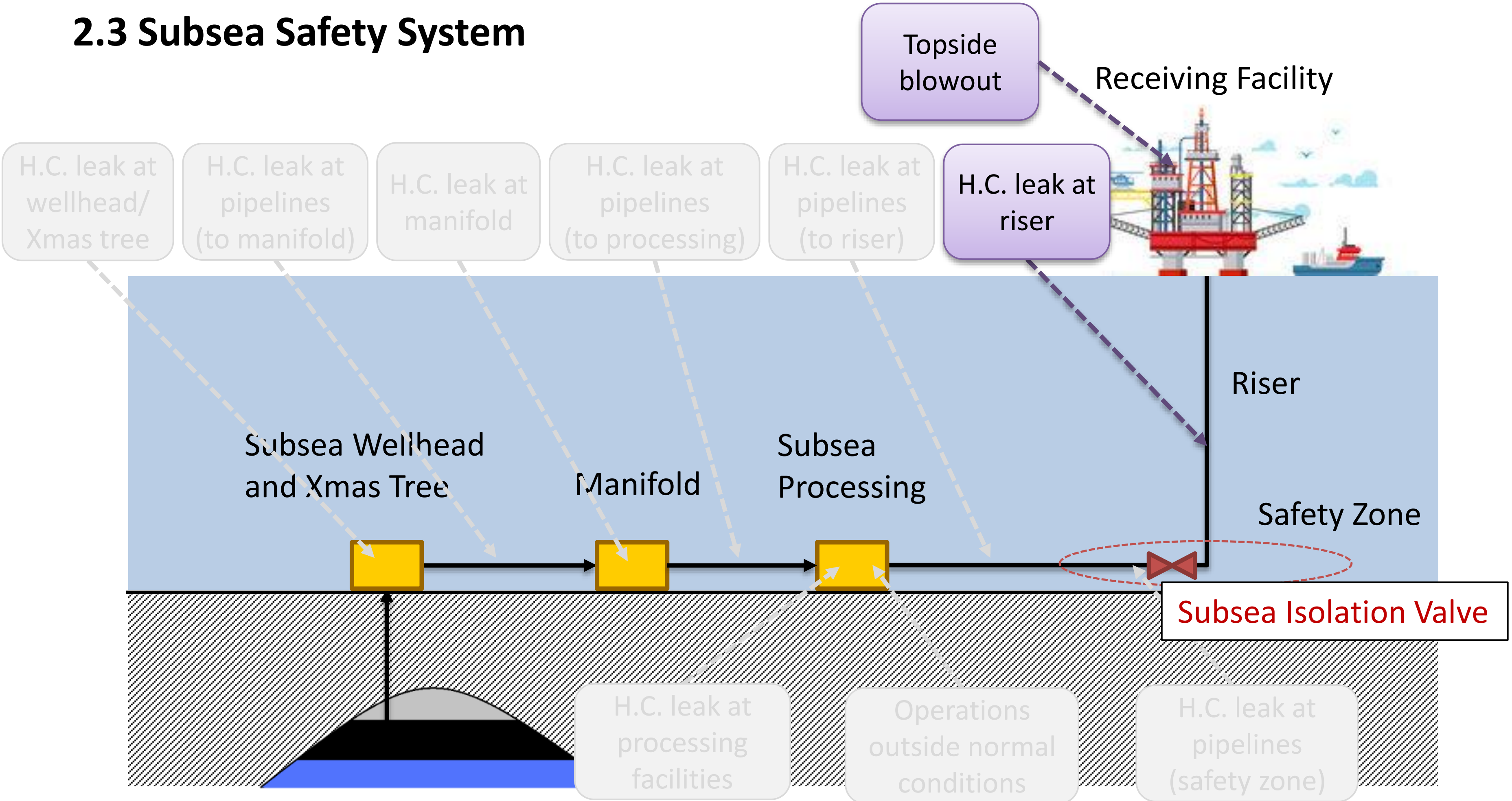


2. Background Knowledge

2.3 Subsea Safety System



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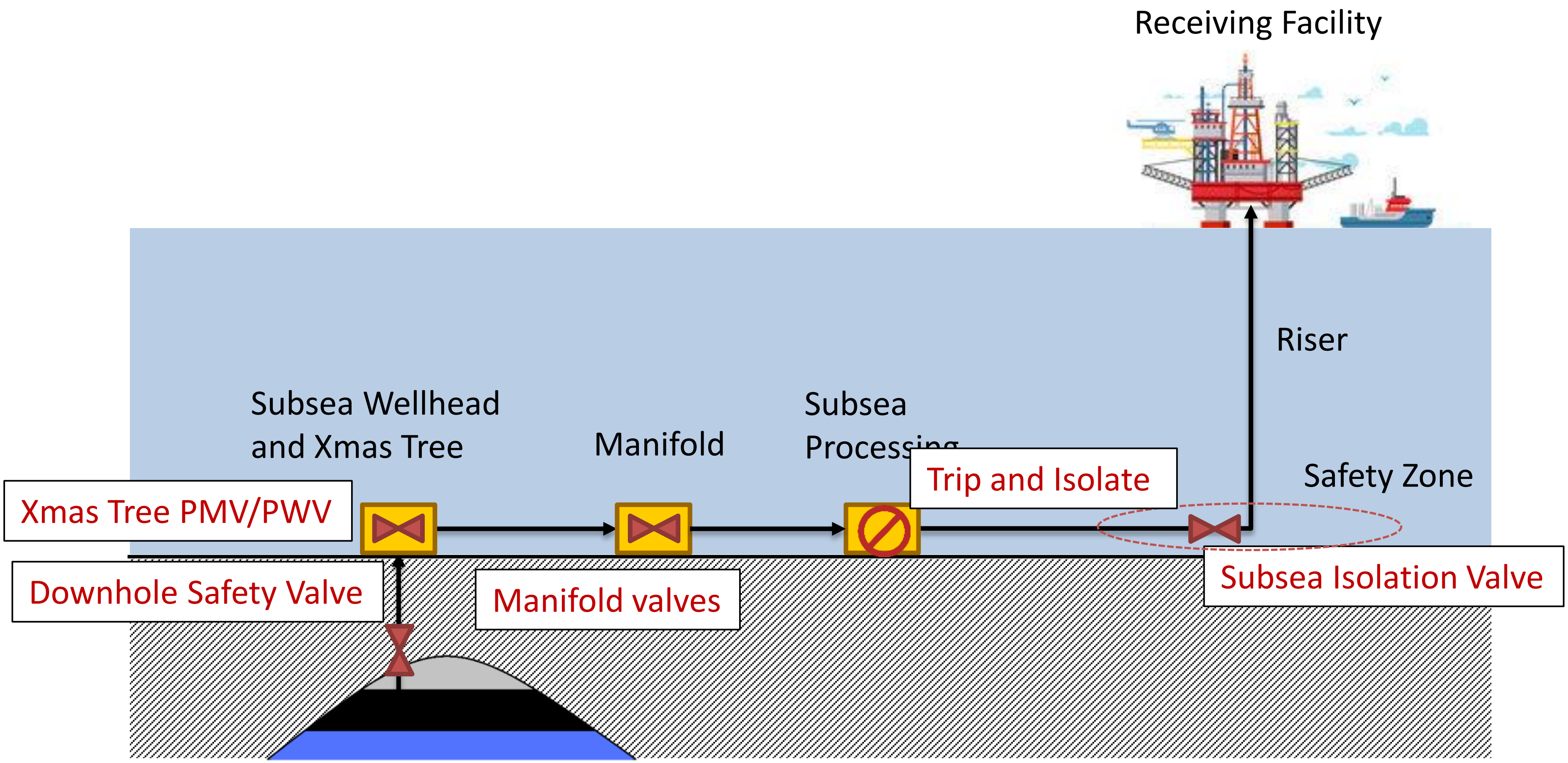
2. Background Knowledge

2.3 Subsea Safety System



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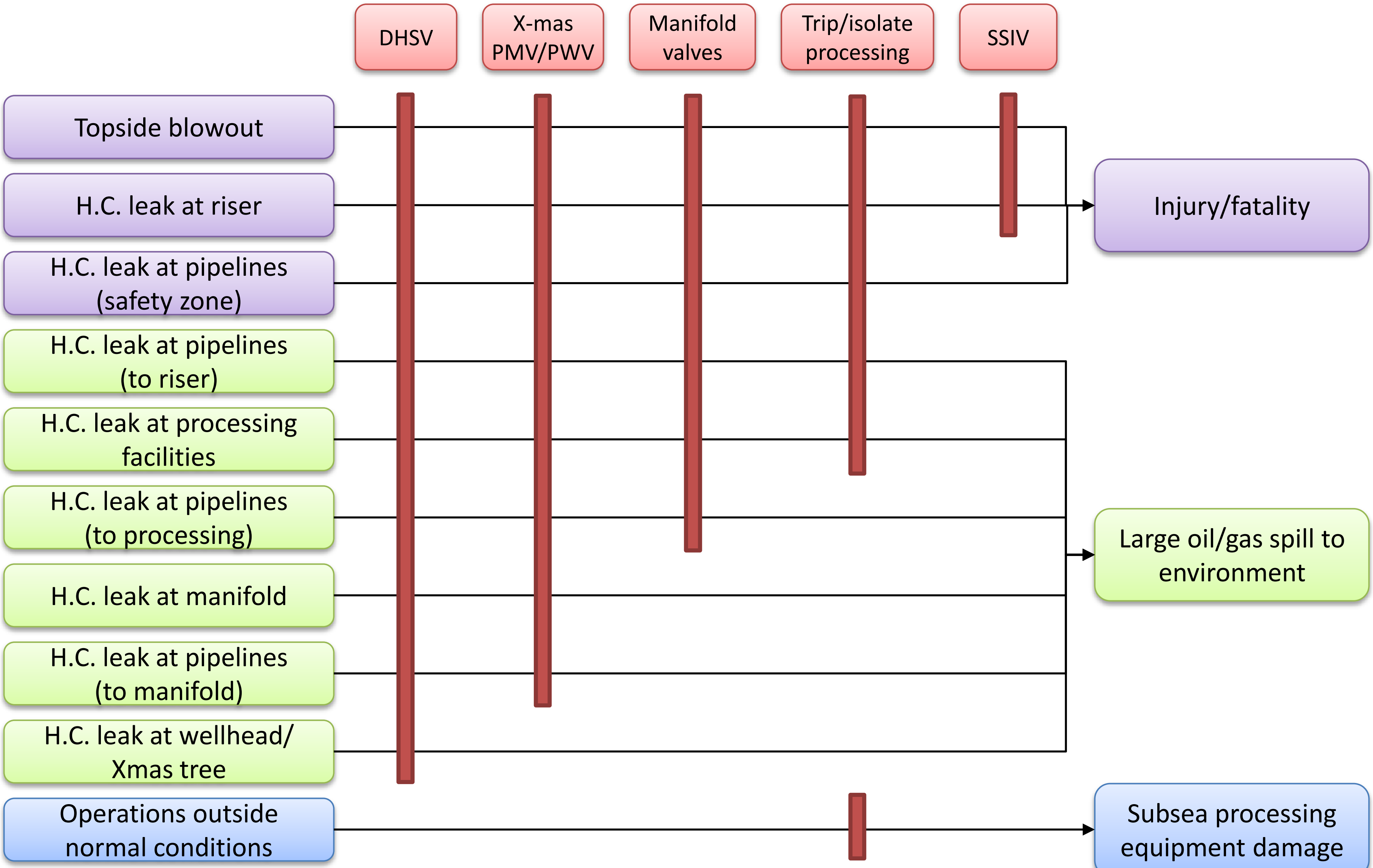
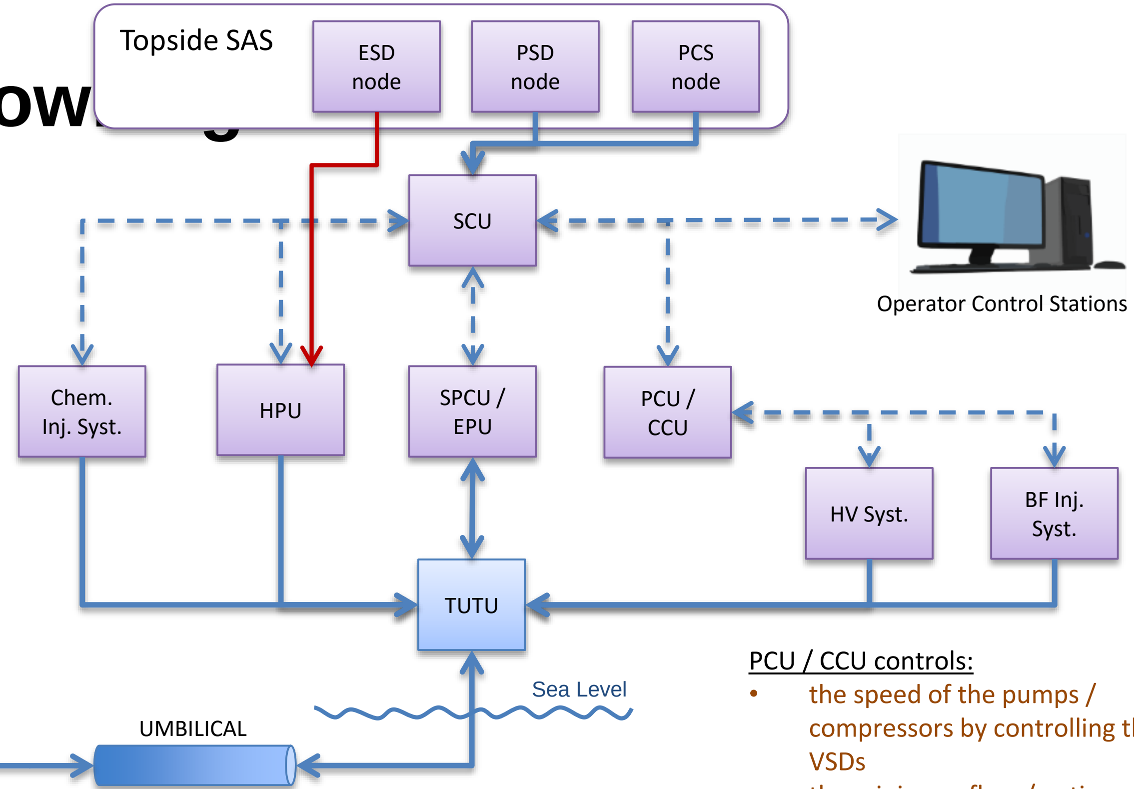


2. Background Know

2.4 Subsea Control System

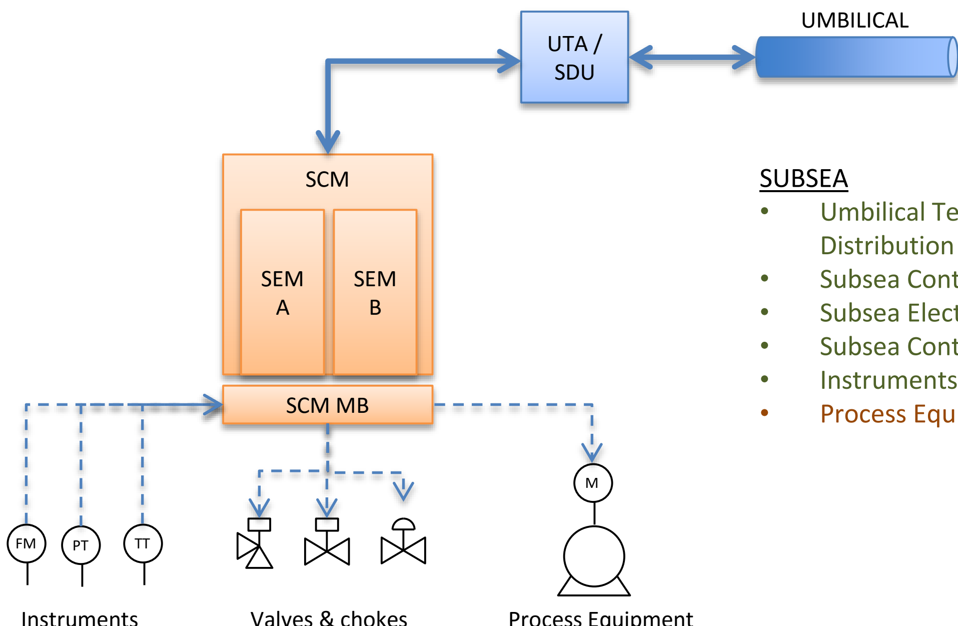


TOPSIDE

- Operator Control Stations
- Subsea Control Unit (SCU)
- Subsea Power and Control Unit (SPCU) / Electrical Power Unit (EPU)
- Hydraulic Power Unit (HPU)
- Chemical Injection System
- Topside Umbilical Termination Unit (TUTU)
- Pump Control Unit (PCU) / Compressor Control Unit (CCU)
- HV Power System
- Barrier Fluid (BF) Injection System

PCU / CCU controls:

- the speed of the pumps / compressors by controlling the VSDs
- the minimum flow / anti-surge system
- the barrier fluid system
- planned sequences like startup and shutdown



SUBSEA

- Umbilical Termination Assembly (UTA) / Subsea Distribution Unit (SDU)
- Subsea Control Module (SCM)
- Subsea Electronic Module (SEM)
- Subsea Control Module Mounting Base (SCM MB)
- Instruments, valves and chokes
- Process Equipment

Green : Subsea Production

Red : Subsea Processing

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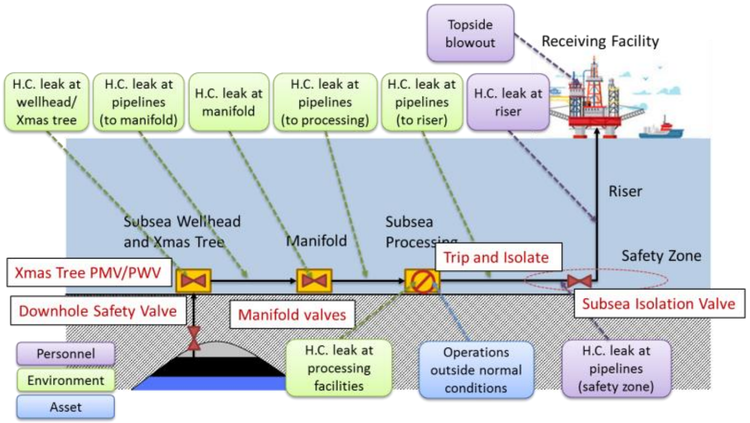
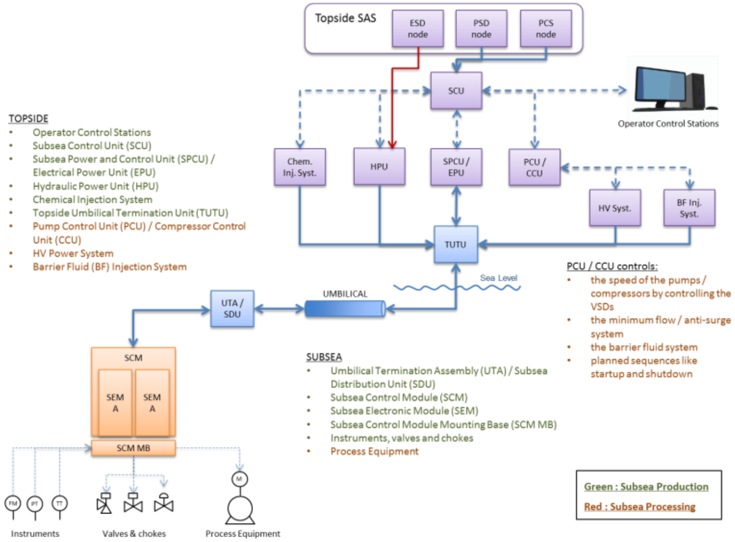
3. Presentation of Gaps

3. Presentation of Gaps

3.1 Standards and Regulations

- Subsea safety and control systems should be designed in accordance with regulations and standards





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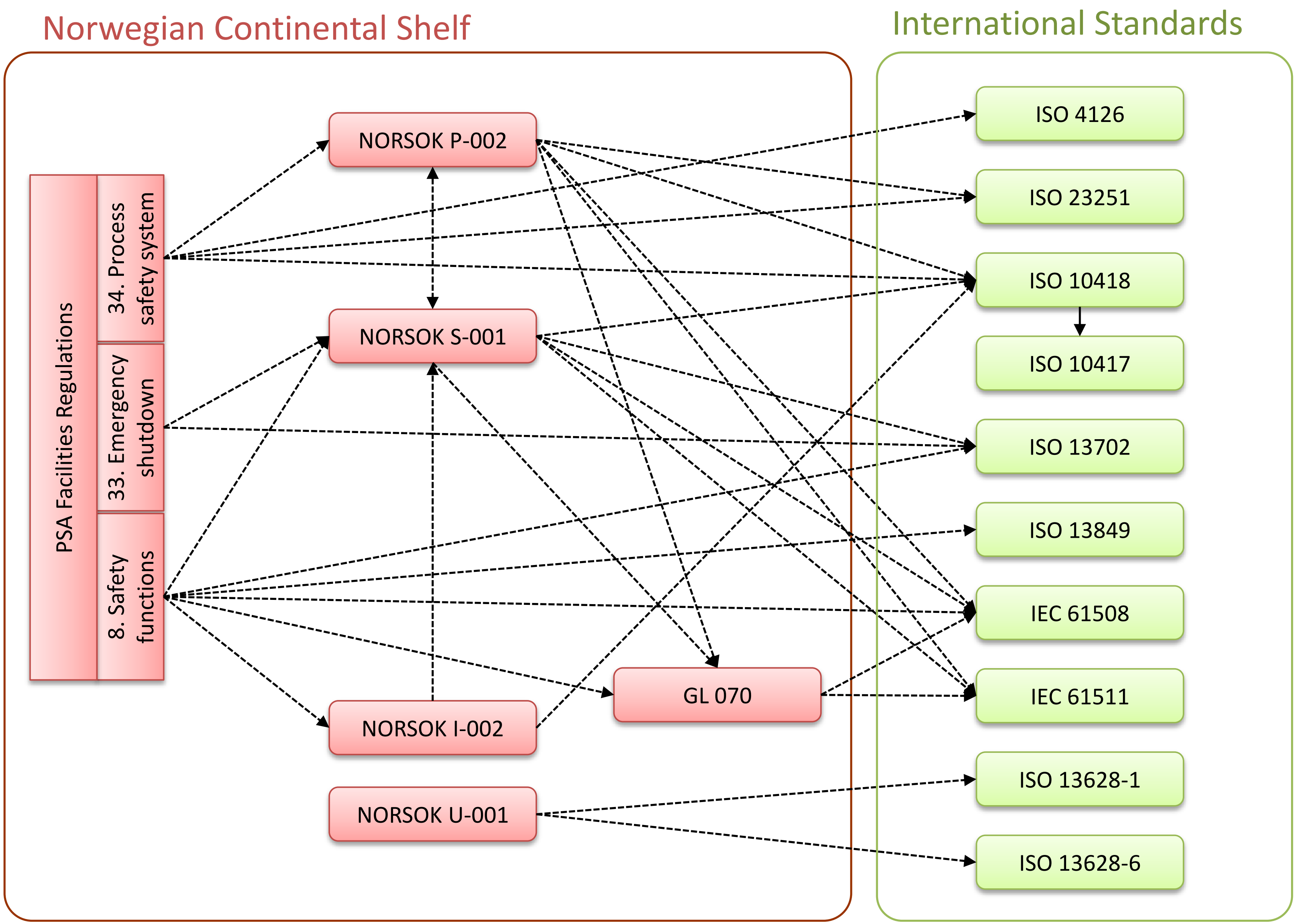
3. Presentation of Gaps

3.1 Standards and Regulations

- Facilities Regulations of The Petroleum Safety Authority Norway (PSA)
- OLF GL 070 of the Norwegian Oil and Gas Association
- NORSOK S-001, Technical Safety
- NORSOK I-002, Safety and automation system (SAS)
- NORSOK P-002, Process system design
- NORSOK U-001, Subsea Production Systems
- ISO 10418, Offshore production installations
- ISO 13628-1, Design and operation of subsea production systems - Part 1
- ISO 13628-6, Design and operation of subsea production systems - Part 6



Norwegian Continental Shelf
International Standards
PSA Facilities Regulation
34. Process safety system
33. Emergency shutdown
8. Safety functions
NORSOK P-002
NORSOK S-001
NORSOK I-002
NORSOK U-001
GL 070
ISO 4126
ISO 23251
ISO 10418
ISO 10417
ISO 13702
ISO 13849
IEC 61508
IEC 61511
ISO 13628-1
ISO 13628-6

3. Presentation of Gaps

3.2 Status and Gaps

1) Facilities Regulations – PSA	
Status	**Gaps**
• Commonly used for topside and subsea • ESD should be independent (33) • Facilities … shall have a process safety system (34) • The process safety system shall have two independent levels of safety (34)	• Most requirements are based on topside systems • May result in excessive redundancy

3. Presentation of Gaps

3.2 Status and Gaps

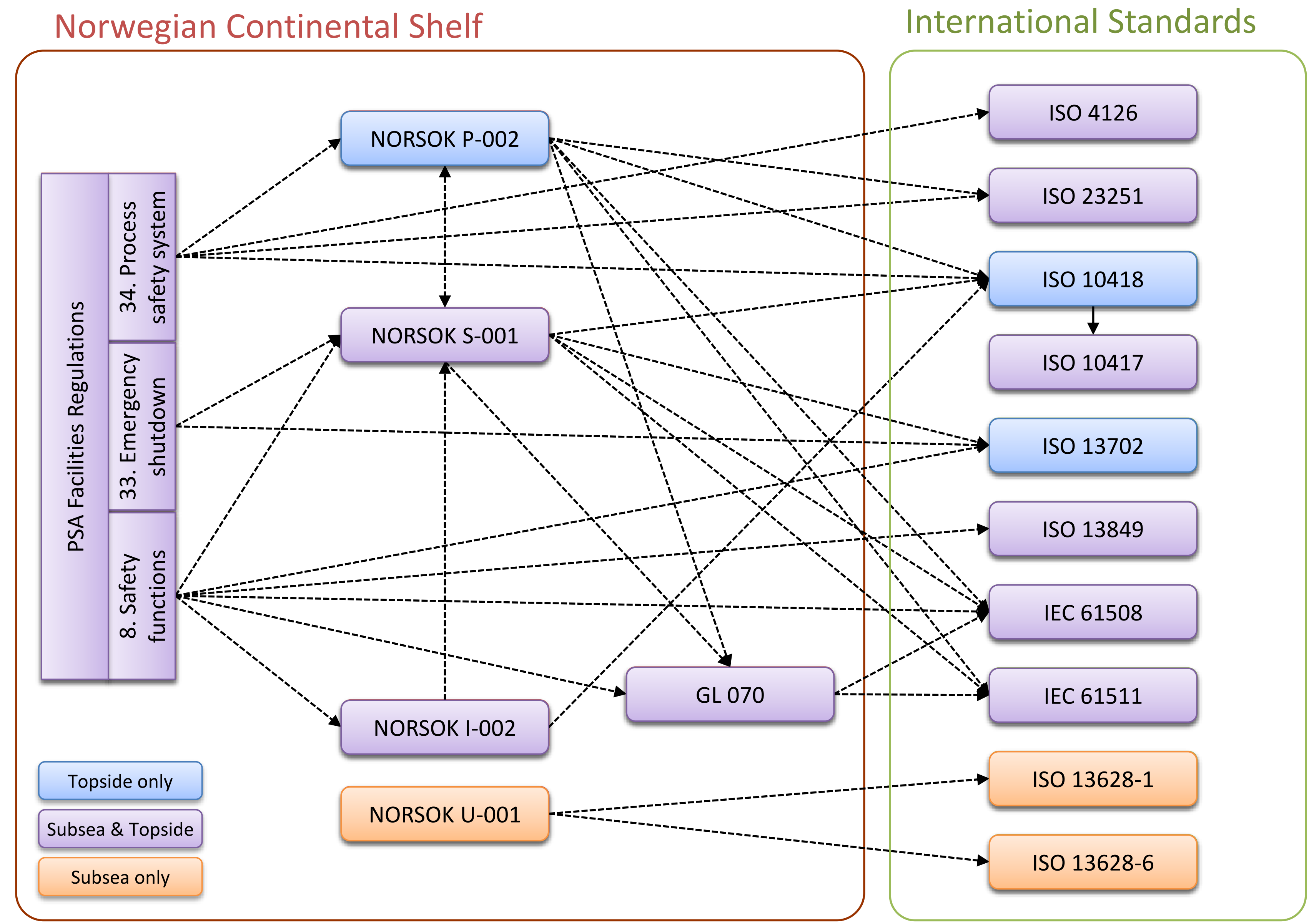
3) NORSOK S-001	
Status	**Gaps**
• Commonly used for topside and subsea • Two independent levels of protection shall be provided for process safety (9.4.1) • PSD shall be independent from PCS (9.4.1) • ESD functions shall be functionally and physically segregated from others (10.4.7) • ESD hierarchy: APS – ESD1 – ESD2 (10.4.3) • ESD response time ≤ 2 s/in (10.4.5)	• Most requirements are based on topside systems • May result in excessive redundancy • ESD node from topside. What if without topside, or topside being more remote? • No specific time response requirement for subsea processing systems

3. Presentation of Gaps

3.2 Status and Gaps

9) ISO 13628-6	
Status	**Gaps**
• Subsea-specific requirement (production) • Fail-safe philosophy (5.5.3) • Response time (5.5.4) • Subsea electrical distribution and hydraulic distribution shall be redundant or include spare (5.4.5) • ESD and optional PSD initiated from topside (7.4.9)	• No requirement for subsea processing • No specific time response requirement for subsea processing systems • ESD node from topside. What if without topside, or topside being more remote?

4. Results and Discussion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ISO 10418
ISO 10417
ISO 13702
ISO 13849
IEC 61508
IEC 61511
ISO 13628-1
ISO 13628-6
Topside only
Subsea & Topside
Subsea only

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4. Results and Discussion

4.1 Results

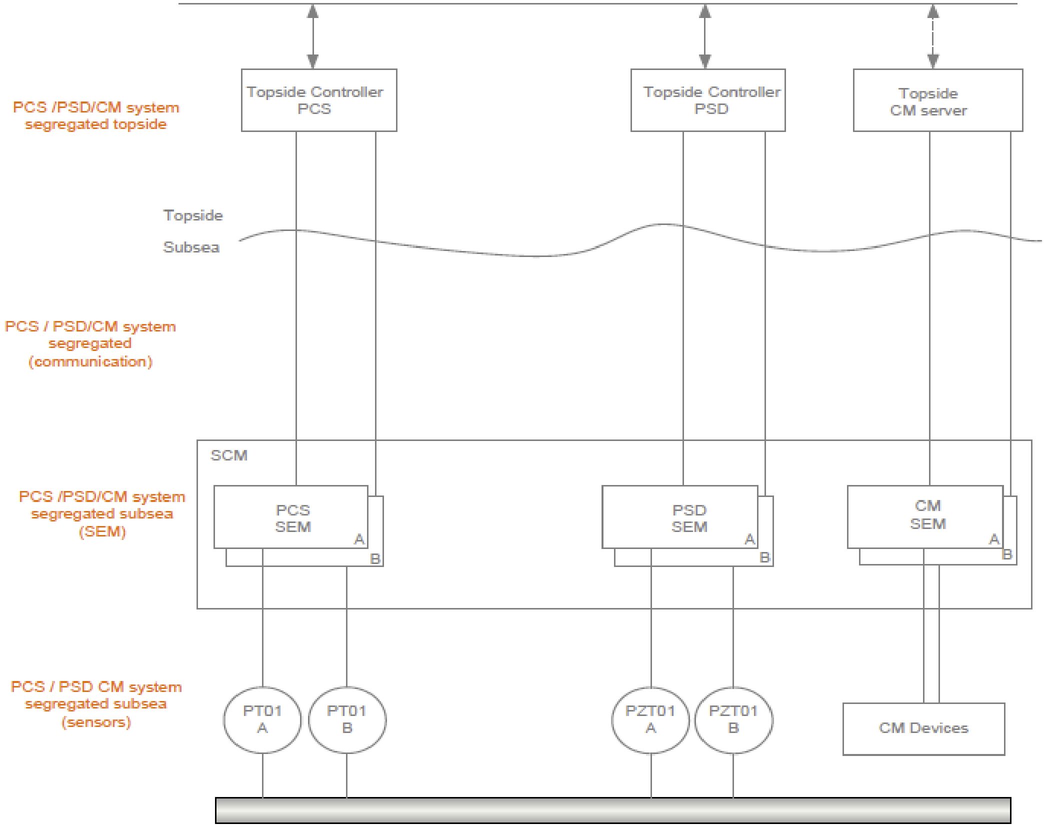
- Few subsea production requirements
- No subsea processing requirement
- Common requirements are based on topside systems
- Topside based standards require independent control and safety systems

- ESD node from topside

4. Results and Discussion

4.2 Discussion

- Topside based standards require independent control and safety systems
- This may result in excessive redundancy



Source: SUBPRO Summary of Technical Information as provided by Aker Solutions

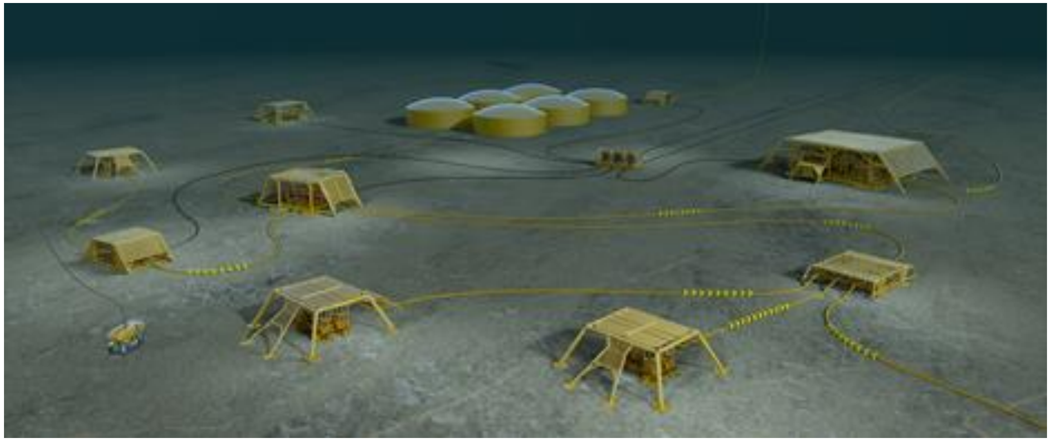
4. Results and Discussion

4.2 Discussion

- ESD node from topside. What if without topside, or topside being more remote?

  - Can we apply the same shutdown philosophy and simply exclude topside shutdown actions (e.g., shutdown of fans/heaters and bilge/ballast pumps)?

  - It may be required to establish a different type of shutdown philosophy



Source: Statoil

4. Results and Discussion

4.2 Discussion

- New processing units may introduce new hazards with potential to cause environmental leakages (e.g., subsea water treatment)

- Hydrate formation is not covered in this study
- Prevention and mitigation of hydrate formation is wholly different from the other hazardous events (closing valves vs. continuous monitoring and control)
- This hazardous event also needs to be further investigated


thank you
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