TECHNICAL SEMINAR on Onboard
Carbon Capture and Storage(OCCS) Systems

Developing Total Solutions for OCCS

Insights from "Real-Ship Projects" in Safety, Operation, and Regulation

PRESENTED BY KR PANASIA

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Introduction

- Why OCCS, its Opportunities and Challenges

Why OCCS, its Opportunities and Challenges

OCCS is an immediate solution to achieve Net Zero by 2050

1. To adopt OCCS to vessels to meet Net Zero by 2050, especially for existing fleets is inevitable
2. However, in the process of applying it to actual ships, there are various technical, operational, and regulatory hurdles.

Safety	Training	Value chain	Efficiency	Space
• Large CO_2 storage in non-gas carrier • Amine • Refrigerant	• Unfamiliar to seafarers • Assistance from shore-based experts is required.	• No experience for unloading and utilization.	• Energy is consumed during carbon capture and liquefaction.	• Equipment consumes space and adds weight, resulting in a reduction of cargo capacity.

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Chapter

Real-Ship Application Overview

- Brief on real-ship demonstration consortium
  : Korean Register, PANASIA, Samsung Heavy Industries, HMM
- Vessel Information
- OCCS Flow Diagram &Specification

Brief on real-ship demonstration consortium

Consortium for Onboard Carbon Capture System

Teaming up to reduce the GHG in short term

Classification

Survey & Research

- Drawing approval
- Risk assessment
- Safety rule development

Ship Owner

Container Ship Operation

- Ship owner
- Captured CO_2 unloading

Equipment Maker

OCCS Supplier & Retrofit

- Carbon capture system supplier
- Retrofit engineering

Ship Builder

Liquefaction Facility

- Liquefaction system supplier
- Captured CO_2 utilizing

Fundamental Design check-up points

SHIP'S PARTICULAR

Vessel Name / Flag	HMM MONGLA / JEJU, KOREA
Vessel Type	Container Vessel
Vessel Capacity	2,200 TEU
Fuel Type	HFO (With SOx-Scrubber)
1-Cycle Voyage Period	270 days voyage/year
Fuel Consumption	29.7ton per day
Vessel CO_2 Emission Per Year	24,977 Ton.CO_2/year

Item	Spec.
Electrical power	6650 kW
Composite boiler	1.6t(Exh.) / 1.8t(O.F)
F.W Gen.	25 t/day

OCCS Flow Diagram & Specification

KR x PANASIA

1 Pre-treatment of Flue Gas

Flue gas is cooled, and particles and sulfur oxides are removed. It is then pressurized and sent to the absorber.

2 CO_2 Absorption

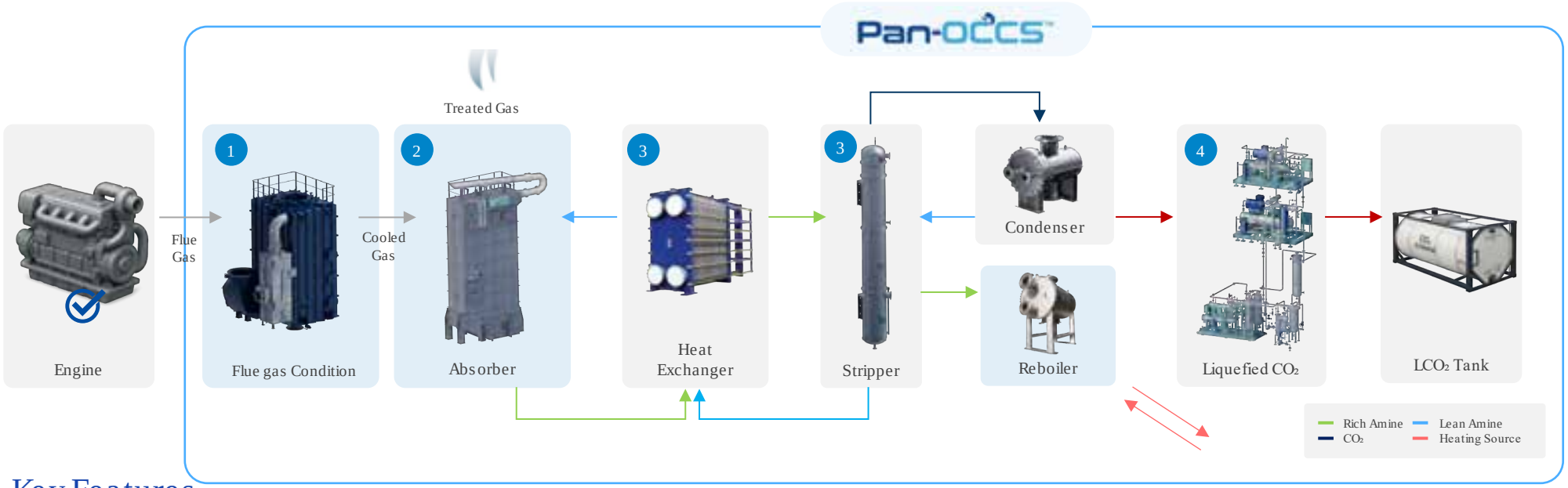
The cooled gas contacts a chemical solvent in the absorber, selectively capturing CO_2.

3 Regeneration

The solvent is heated by a reboiler to release the captured CO_2 and regenerate it for reuse.

4 Liquefaction & Storage

CO_2 is liquefied through compression and cooling, allowing safe marine storage and efficient onshore off-loading.



OCCS Specification

Items	Value
Feed Flue gas volume	14,000Nm^3/h
Capture level	90%
Captured CO_2	1,039kg/h
Product LCO_2	1,018kg.LCO_2/h
Purity of product LCO_2	99.9%
Solvent flowrate	11.3ton/h
Additional fuel for OCCS	123kg/h
Waste heat usage	15% of heat energy
Captured CO_2	6,596ton/year

Key Features

- Combined functions of Scrubber and OCCS
- Optimized Space utilization
- Improved energy efficiency

03

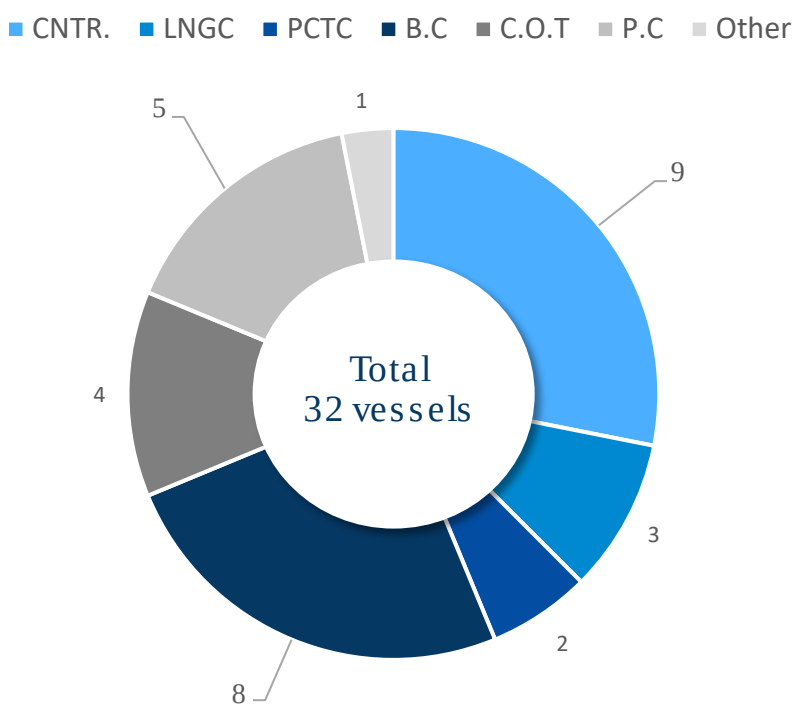
Chapter

Design Optimization and Efficiency Considerations

- Feasibility Study
- Technical Challenges
  - OCCS Optimization – Space &Energy
  - LCO_2 storage design
  - Supporting Crews
- Voyage Summary of HMM MONGLA during Past 1 Year
- Off loading LCO_2

Feasibility Study 1 Successfully Completed

The system has been applied to various vessel types, including bulk carriers, tankers, and gas carriers, with supported capacities ranging from 0.5 to 8 tons per hour.

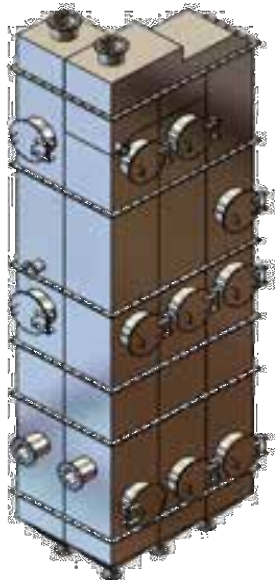


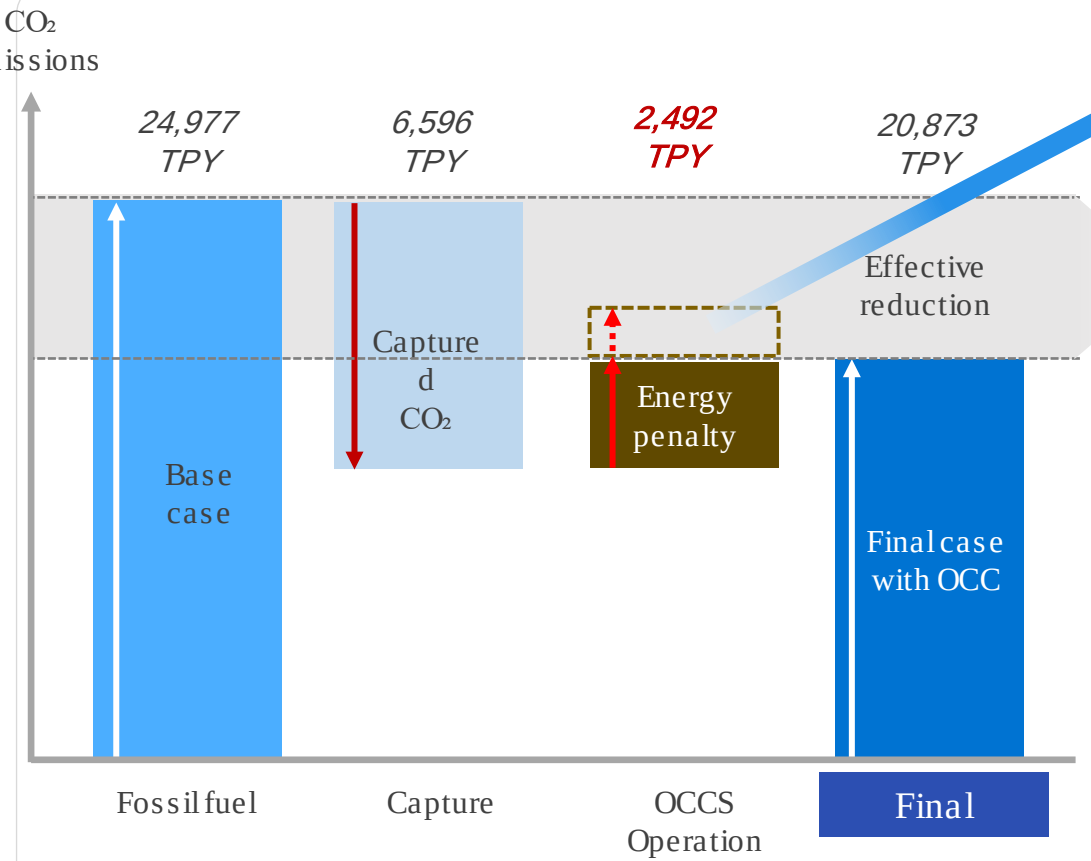
1. Technical Challenges I OCCS Optimization – Space & Energy

Adding OCCS into optimized designed vessel is a challenge.
However, one tower solution and Reboiler for Amine delivers a Optimized solution in efficiency

Initial design

Optimized design





For Reduce Energy Penalty

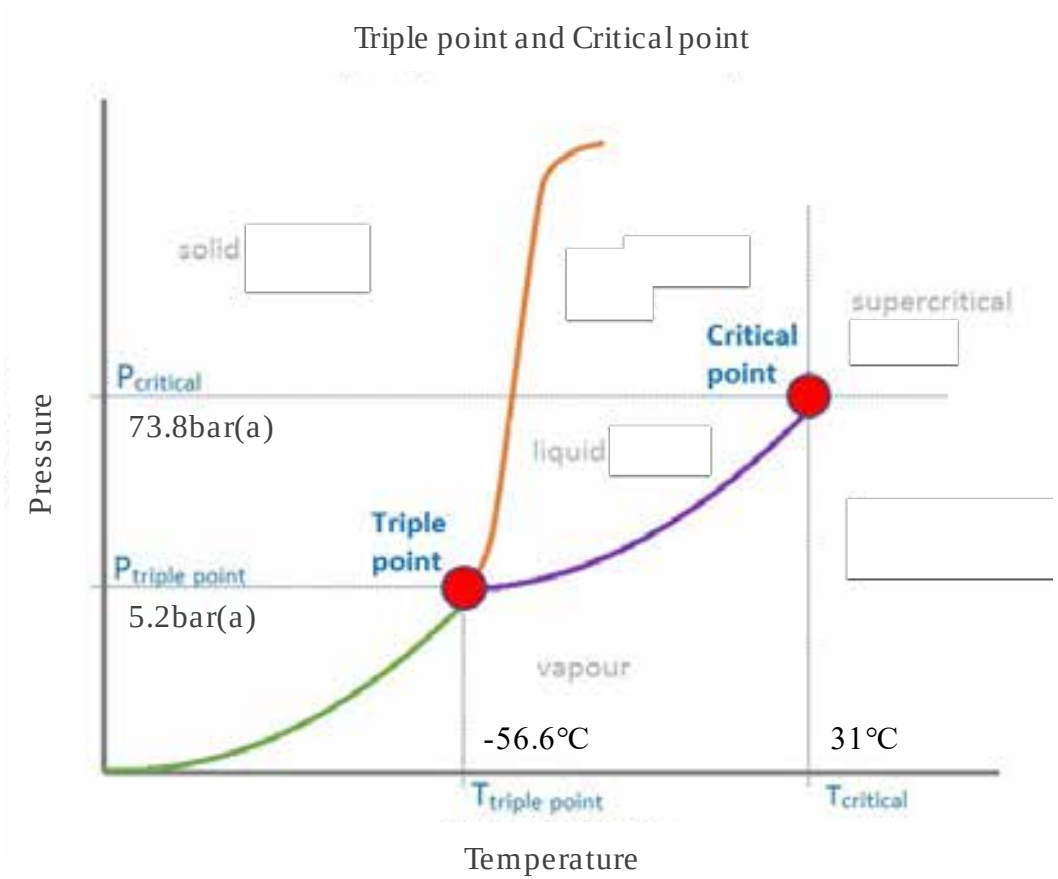
- Waste heat for amine heating
- Low energy for amine solvent
- High efficiency heat exchanger

Amine economizer

2. Technical Challenges I LCO_2 storage design

Design of LCO_2 Storage is various and requires the common standard

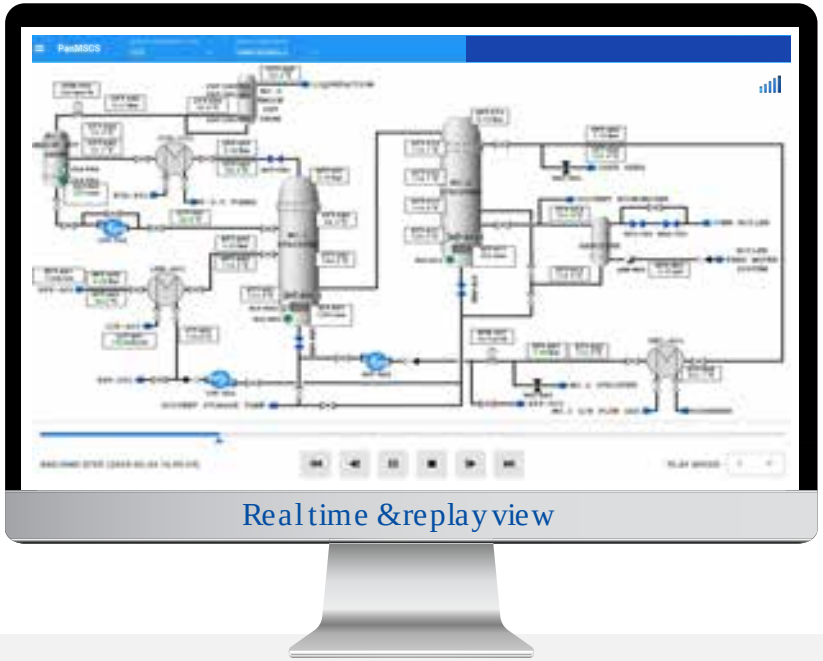
Triple point and Critical point



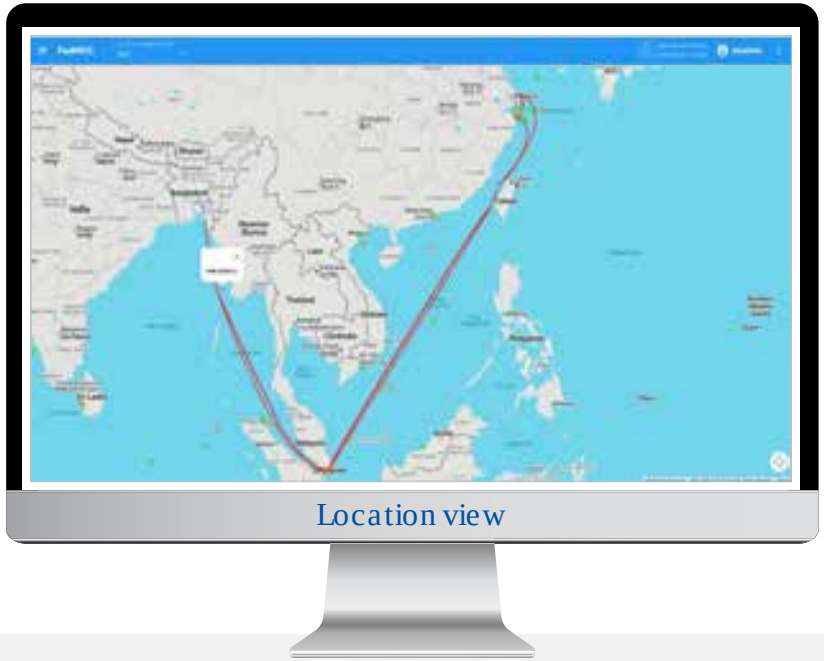
	Low Pressure	Conventional	Unit
Pressure	7 ~ 8	15 ~ 20	bar(a)
Boiling Temperature	-49 ~ -46	-29 ~ -20	℃
Density	1152 ~ 1140	1070 ~ 1029	kg/m^3
Storage Efficiency	High	Low	
Dry Ice Possibility	High	Low	
Tank Cost	Low	High	

3. Technical Challenges I Supporting Crews

Real-ship OCCS project was designed not only perform its functionality but beyond through on-line support



Real time &replay view



Location view

☑ Minimize extra work for crews

new system to crews can cause extra workload to operate

☑ Safety of crews and ships

simultaneously monitor the system from the ship and manufacturer.

☑ Providing a guide

Immediate support can be provided when necessary.

Voyage Summary of HMM MONGLA during Past 1 Year

Liquefaction Set-up

Flexible Line Purging & Valve Arrange

HMM Safety Check

Voyage Summary of HMM MONGLA during Past 1 Year

LCO2 offloaded at the port and brought to produce Green Methanol

No.	Date	Route	Detail Performance
1	Jul 12 – Aug 4, 2024	MOK – NGB – SHA – CGP	Initial setup, installation inspection
2	Sep 12 – Oct 19, 2024	SIN – NGB CGP – PKL - SIN	Testing capture system
3	Oct 19 – Nov 22, 2024	SIN – NGB CGP - SING	Testing liquefaction system
4	Nov 22 – Nov 30, 2024	SIN – NGB	Operating full OCCS and LCO_2 storage
5	Dec 31, 2024 – Jan 6, 2025	SIN – NGB	**Off-loading (17/16Ton)**
6	Feb 1 – Feb 9, 2025	SIN – NGB	OCCS Notation
7	Apr 16 – Apr 24, 2025	SIN – NGB	Operating full OCCS and LCO_2 storage
8	May 19 – May 25, 2025	SIN – NGB	**Off-loading (15/10Ton)**
9	Jul 22 – Jul 3, 2025	SIN – NGB	Maintenance

Off loading LCO_2

Real-ship results, optimized design, and regulatory compliance combine to complete the total solution.

PROPERTY	METHOD	RESULT UNITS	MIN	MIX
Carbon Dioxide	GB/T 1886.228-2016	> 99.9% (V/V)	--	-
Water by Dew Point	GB/7 5832.2-2016	2.14ppm (v/v)	-	-


SGS

SAMPLING REPORT

Declaration of CO_2 Utilization

二氧化碳利用声明

04

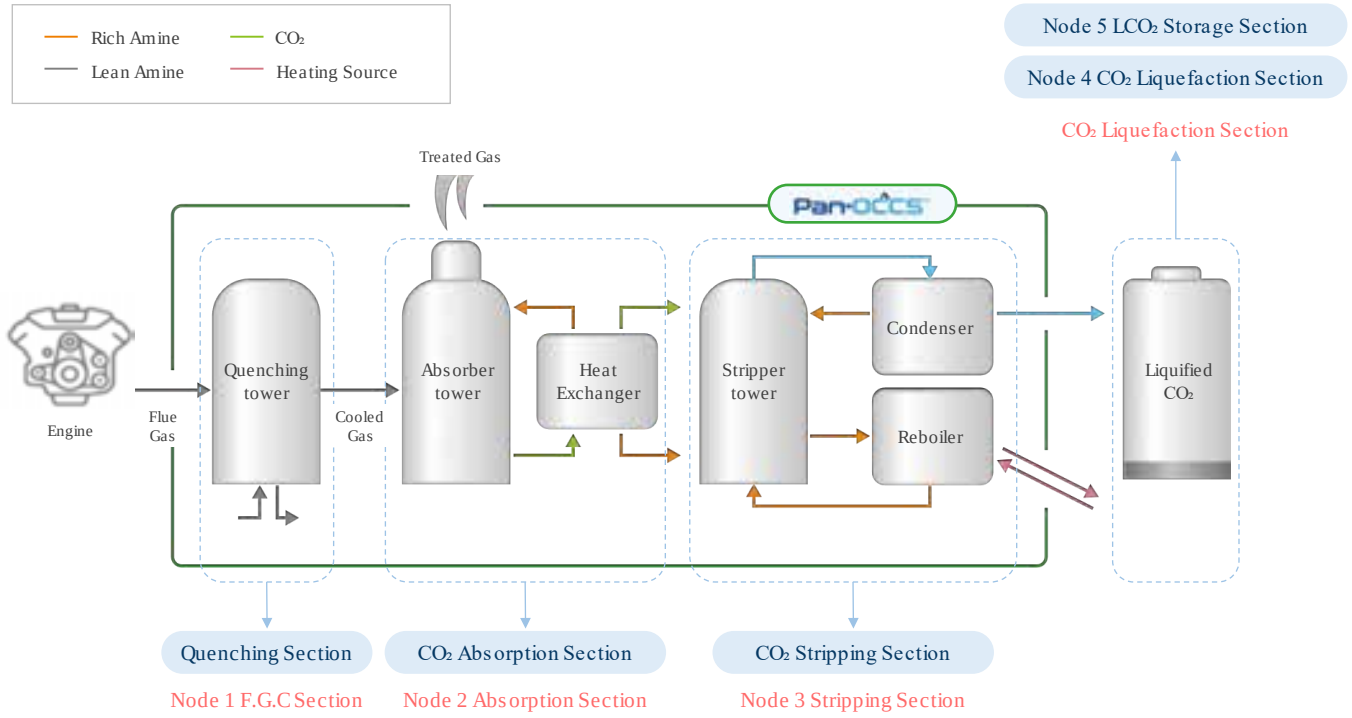
Chapter

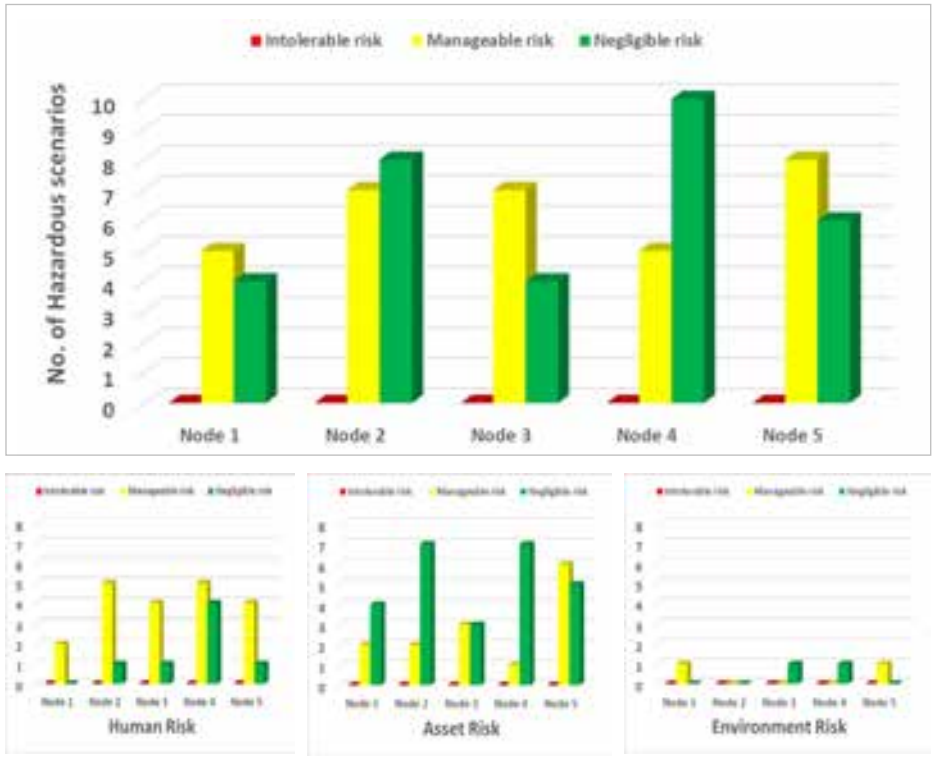
Regulatory Gaps and Class Experience

- Regulatory Gaps and Class Experience

Regulatory Gaps and Class Experience

HAZID STUDY





Regulatory Gaps and Class Experience

HAZID STUDY - Identifying 5 major issues among 252 issues

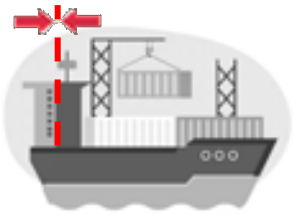
Category	Identified Issue	Measures
Solvent	Leakage	- Use of class II pipes with appropriate material - Installation of drip tray liquid detector - Forced ventilation fan in handling space - ESD valve for solvent storage area
	Freezing	- Drain lines for winter season - Heater in solvent storage area
	Personal Accident	- Personal protective equipment (PPE) - Emergency shower and eyewash
CO_2	Leakage	- Forced ventilation fan in handling space - CO_2 detector - Installation of vent mast
	Engine Room Ingress	- Separated area from engine room and accommodation
	Freezing	- Pressure control logic and alarm - Set-up procedure for tank connection
	Over-Pressure	- Maximum storage day calculation for BOG
Refrigerant	Leakage	- Forced ventilation fan in handling space - Refrigerant detector
Fire	Solvent	- Fire extinguisher (Non-flammability)
	Equipment	- Install fire detectors
	Refrigerant	- Install fixed fire extinguishing system and extinguisher
	Tank	- Water spray for CO_2 tank
Fresh Water Consumption	F.W Shortage	- Apply additional fresh water generator

Regulatory Gaps and Class Experience

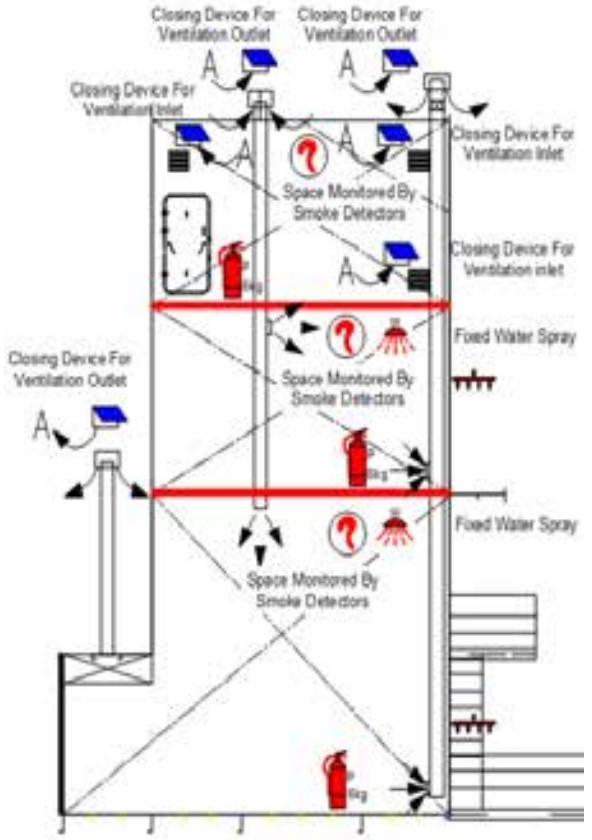
HAZID STUDY - CO_2 Leakage

Identified Hazard

Control Measure



Design



Action Taken


CO2 &refrigerant detector


Forced ventilation

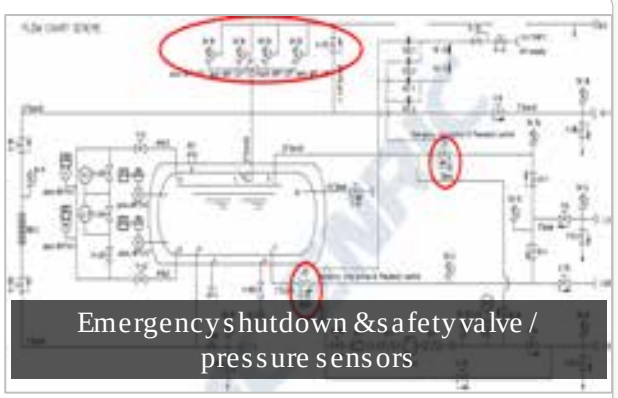
Regulatory Gaps and Class Experience

HAZID STUDY - Liquified CO_2 Tank

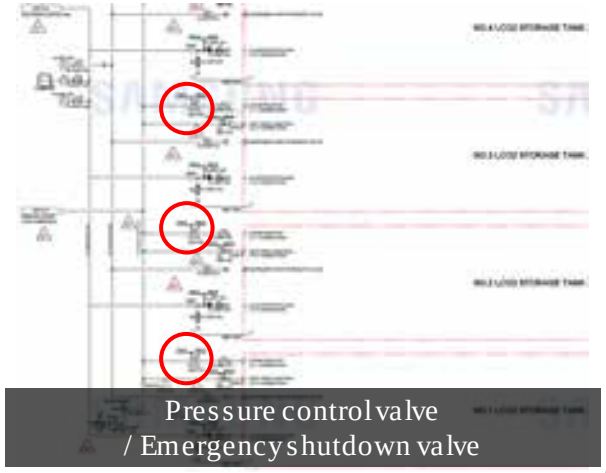
Identified Hazard

Control Measure

Design



Emergency shutdown & safety valve / pressure sensors



Pressure control valve / Emergency shutdown valve

Action Taken

Fixed water spray

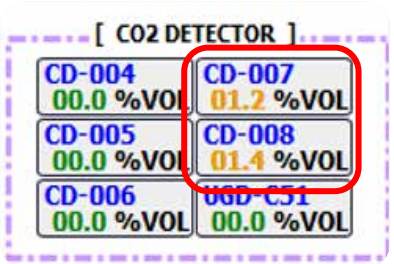
Emergency shutdown valve/ safety valve / pressure sensors

Regulatory Gaps and Class Experience

Safety issues and Measures 1 Near miss In Operation

Amine Solvent Leakage

CO2 Leakage



Done Safely in Accordance with the Guidance

Future Improvements

Minimizing Leakage of Solvent & CO_2

- Minimizing flanged connection
- Minimizing instruments
- Optimizing piping routes

Regulatory Gaps and Class Experience

ROK's Past Activities and Future Plans at the IMO

Proposal - IMO guideline

MSC 109 Presentation

OCCS Technical Seminar

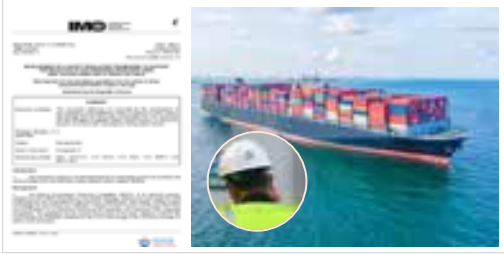
CCC9 → MSC 108 → MSC 109 → MSC 110 → CCC 11 → CCC 12 → OCCS Guideline

Proposal - UI CO2 Tank

HMM MONGLA installation

INF - HAZID Report

Proposal Plan based on real experience



05

Chapter

Conclusion

Conclusion – Optimized Resolution

Through this Project, We aim to develop safe and efficient OCCS to achieve decarbonization.

Safety

- Through HAZID study, Safety Rule developed
- Real time monitoring provide safety.

Training

- Land base support can make crew less burdened

Value Chain

- Unloaded CO2 and Utilized it as Methanol

Efficiency

- High efficiency Carbon Capture with waste heat recovery.

Space

- Minimize the required space for OCCS.

“ True progress in decarbonization comes from innovation, collaboration, and shared responsibility. ”

Thanks for your attention

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