



Blue Mining: Vertical Transport System Comprising an Open Permanent Magnet Motor



Outline



- Introducing Blue Mining project
- Hydraulic design of the Vertical transport system
- Development of the Deep Sea Special Motor.



Breakthrough Solutions for the Sustainable Exploration and Extraction of Deep Sea Mineral Resources



Key project Figures

The Blue Mining project has received funding from the European Union's Seventh Framework Programme for research, technological development and demonstration under grant agreement no 604500

19 partners from 6 countries

Start date: 1 Feb 2014
End date: 31 Jan 2018
Duration: 48 Months
Total costs: 15 M€
Total EC Funding: 10 M€

Industry

Research Institutes

Service Supplier

Background



Extinct SMS

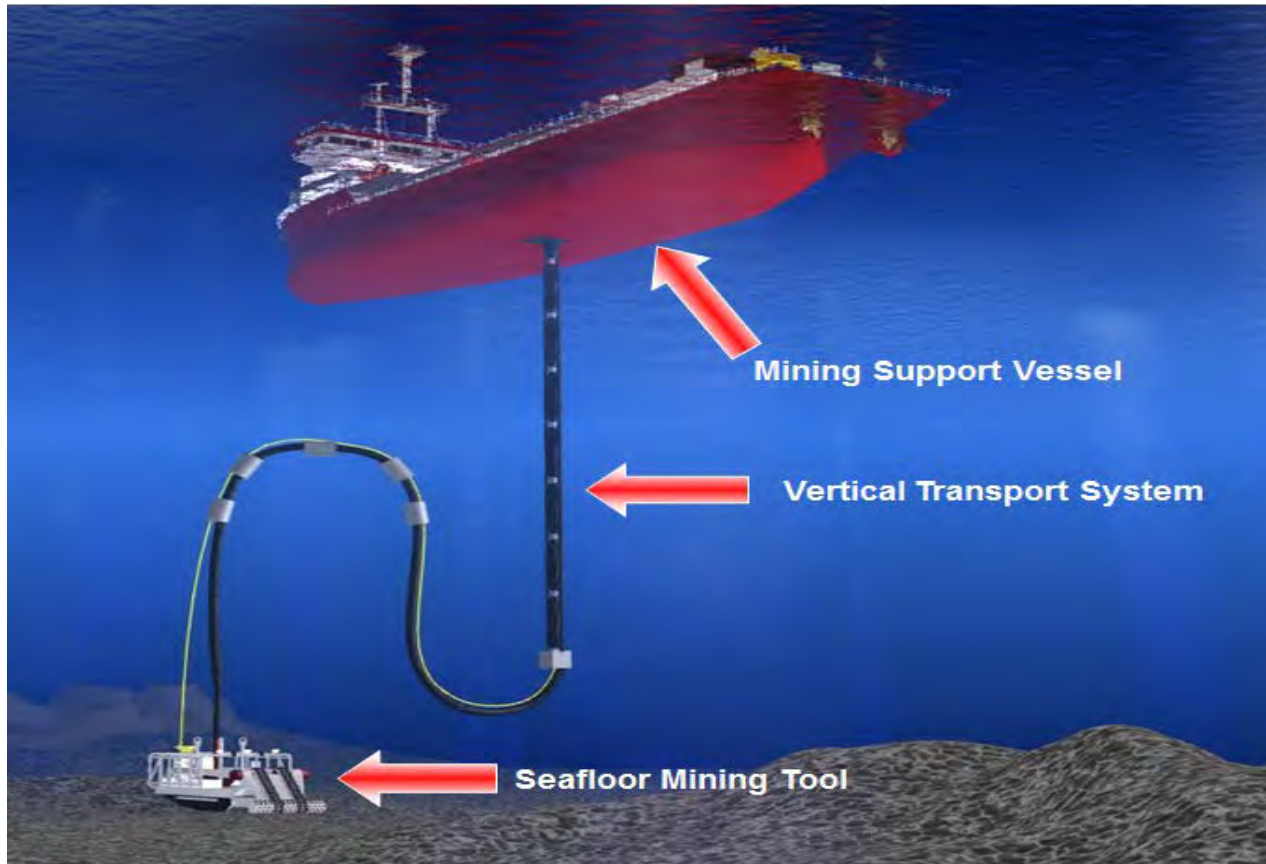


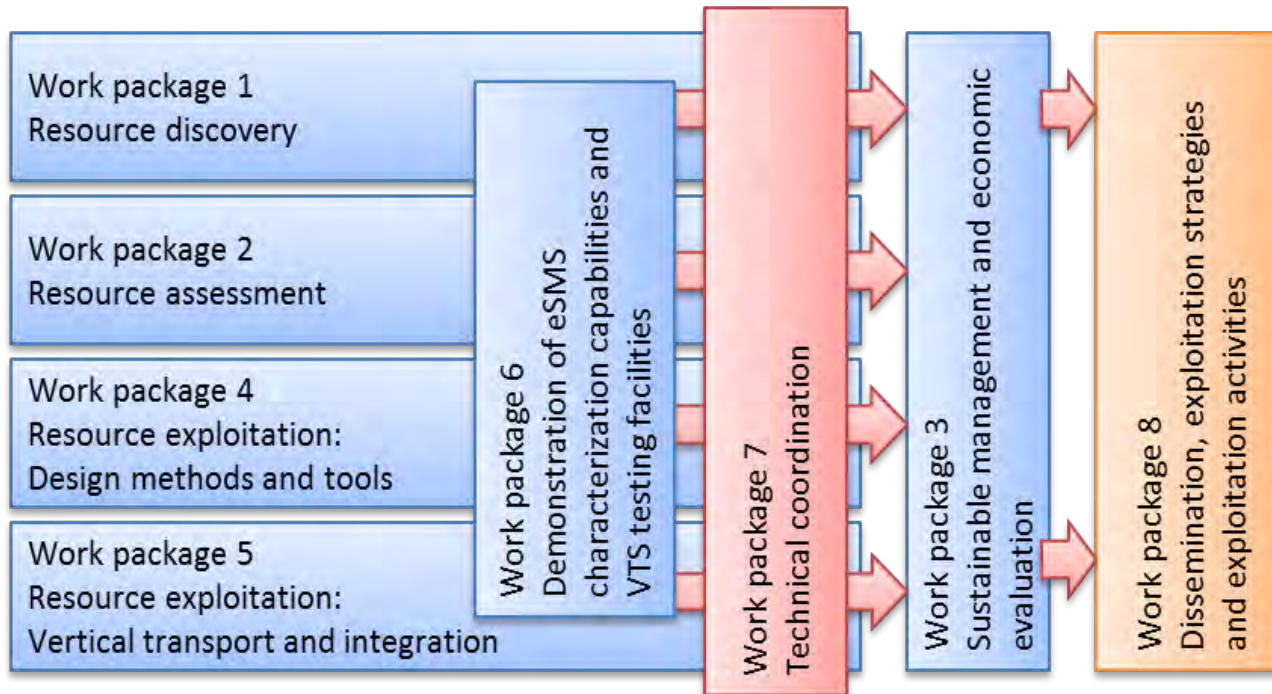
SMnN





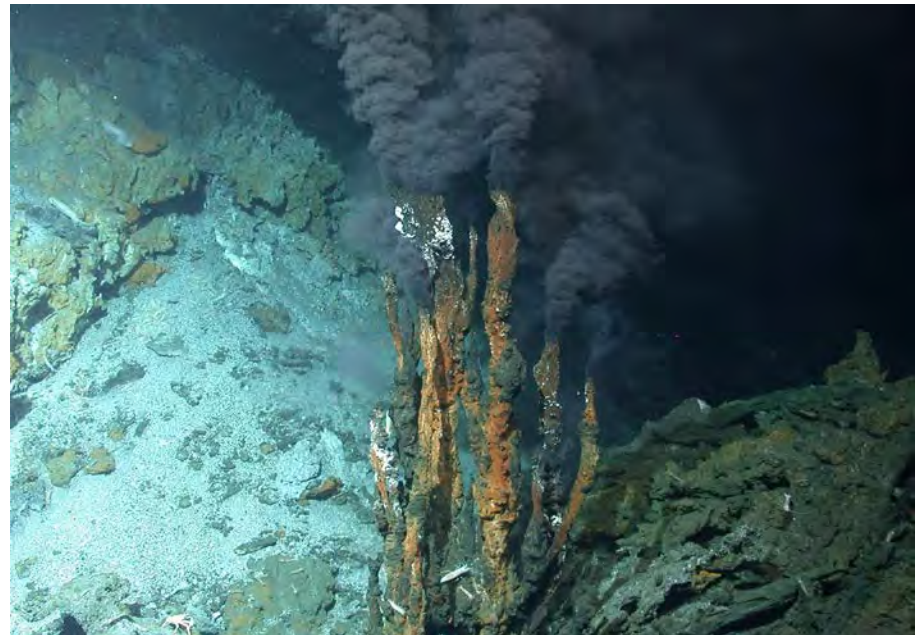
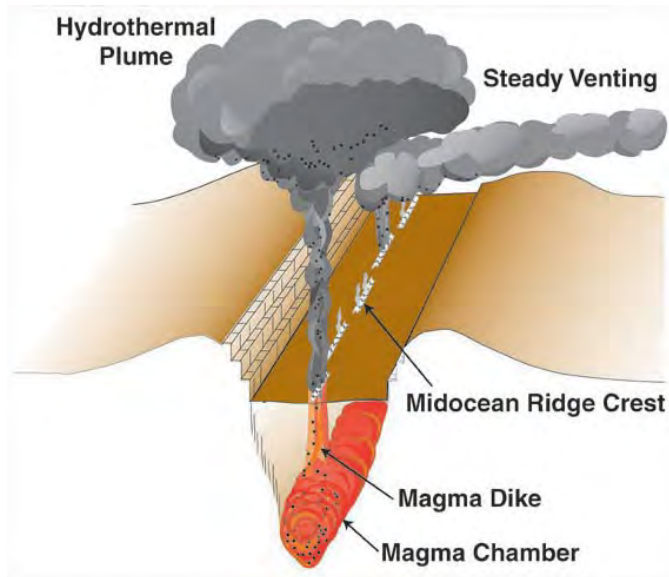
Charles D. Winters/NatureSource/Agentur Focus

Hydraulic design of the Vertical transport system



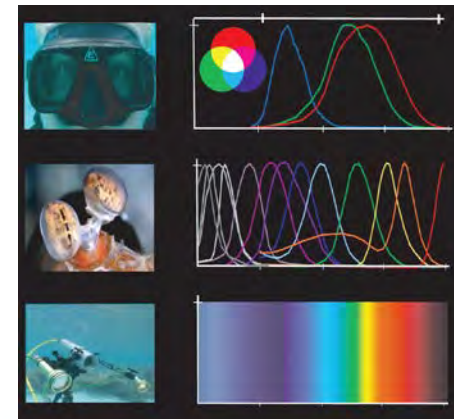
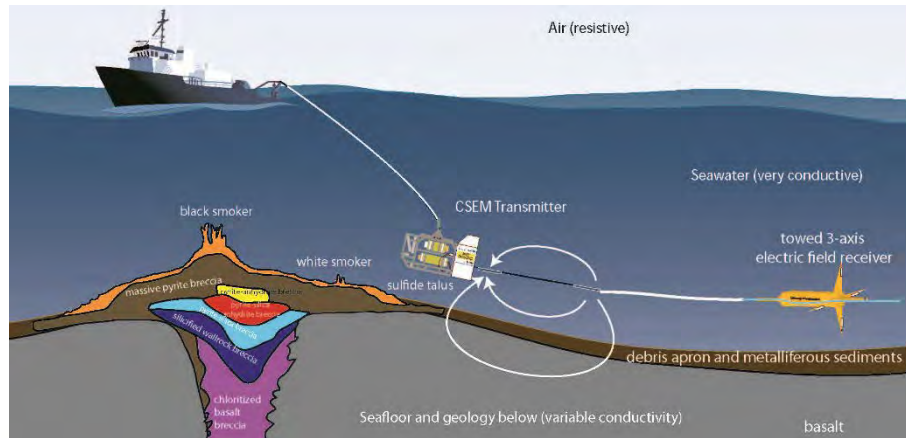


-  Current state-of-the-art
 -  Current exploration is largely based on detecting active deposits via water column anomalies.



Blue Mining objectives

- Fast, reliable, cost-effective discovery of extinct SMS deposits and SMnN using new methods for autonomous or remotely-operated vehicles, towed systems, and analytics

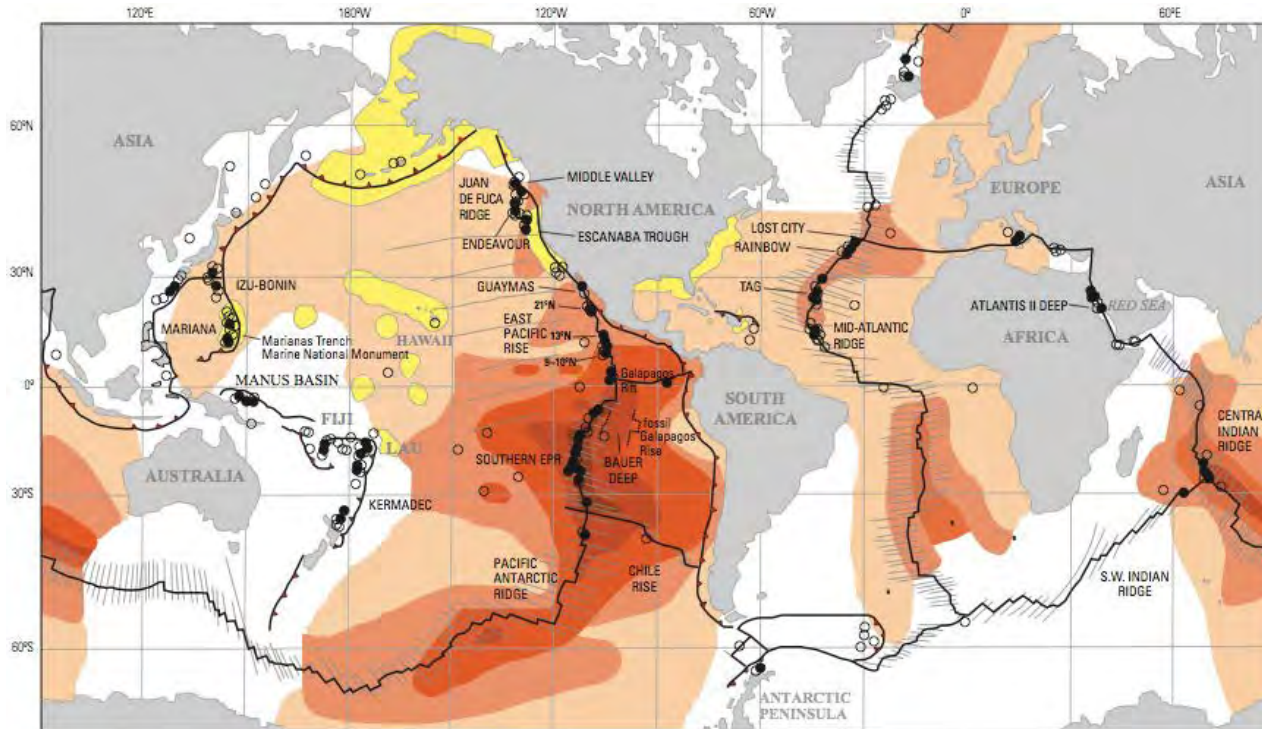




Current state-of-the-art:




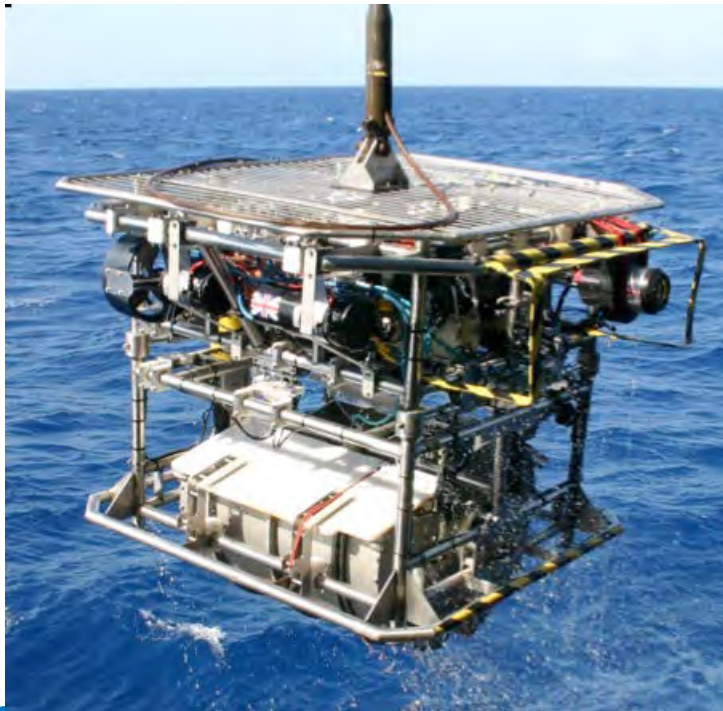
Focus on hydrothermally active systems






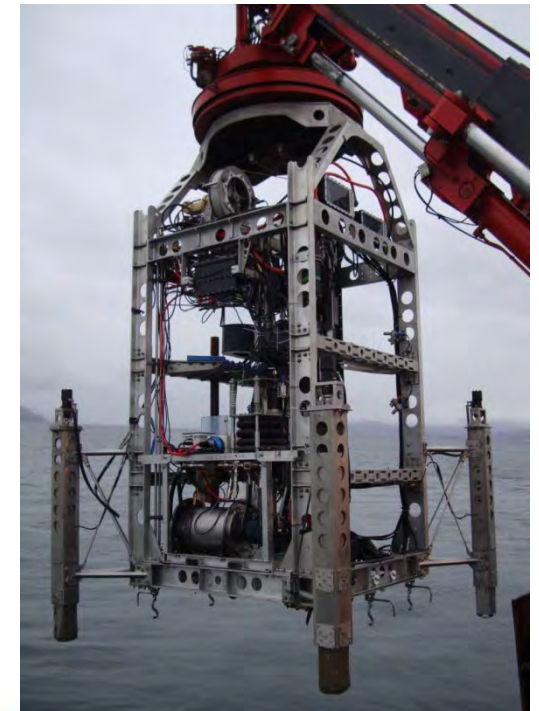
HyBIS

 Characterise mineralogical and chemical composition of eSMS



RD2

 Core samples to determine morphology, composition and extent of eSMS





Resource Sustainable Management and Economic Evaluation



"Use of discounted cash flow analysis as a first tool in the economics of the mining industry in the last 30 years, it has become common to define an ore reserve as that part of a mineral resource whose exploitation can generate maximum net present value (NPV) or return on investment."

ILOIU SORIN, ILOIU MIRELA: ORE RESERVE ESTIMATION AND PROJECT PROFITABILITY, 2008.

"The main objective of each optimization of mining operation is to maximize the net present value of the whole mining project, but this approach without consideration of environmental issues during planning is not really an optimum design."

F.Rashidinejad, M. Osanloo, B. Rezai: CUTOFF GRADES OPTIMIZATION WITH ENVIRONMENTAL MANAGEMENT, 2008.



Economic feasibility (max. NPV, IRR) is a **key aspect** in any mining project



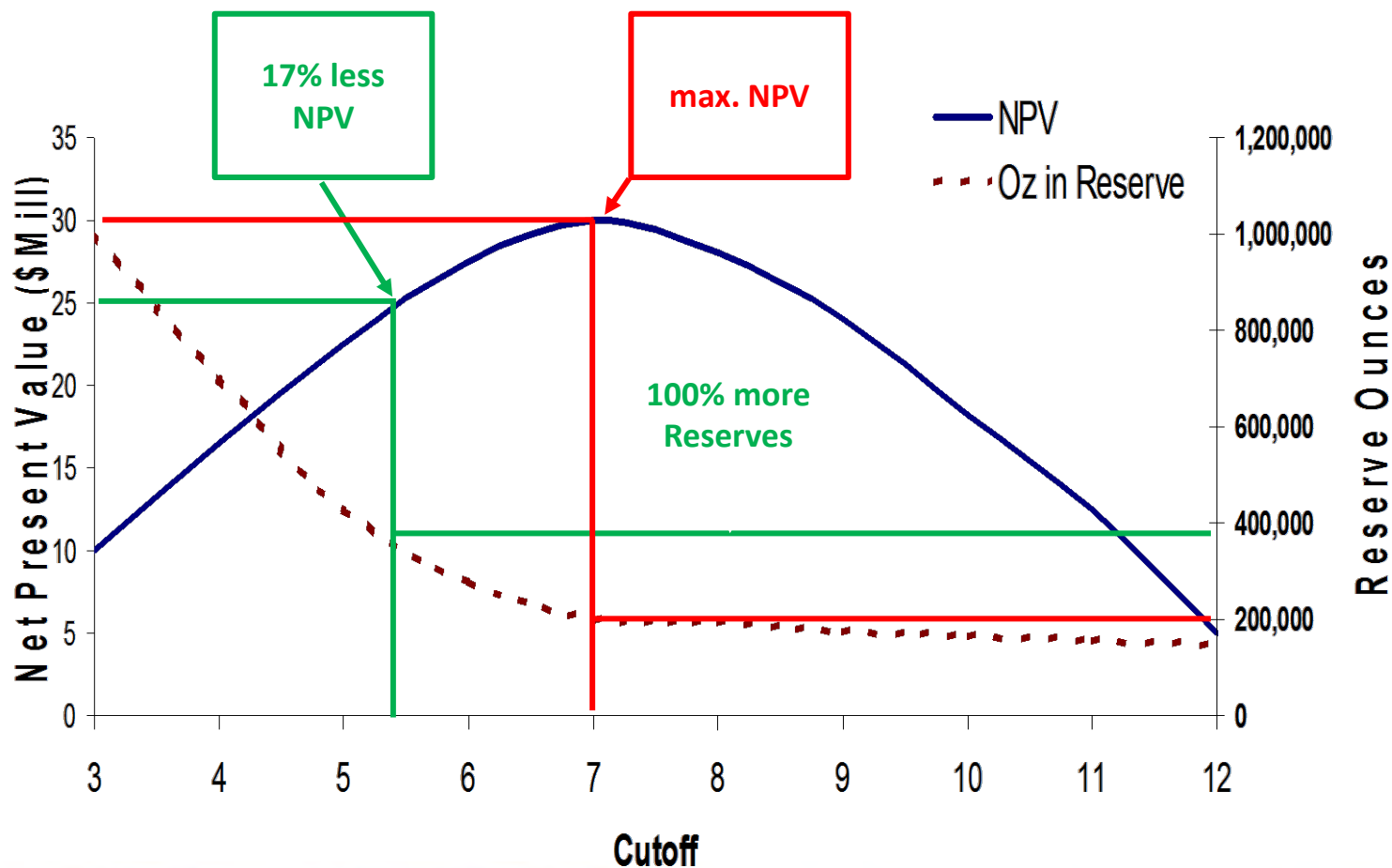
Sustainability aspects not yet considered appropriately



Fiscal Incentives hold larger potential **for improvement**




Resource Sustainable Management and Economic Evaluation





Resource Exploitation: Design Methods and Tools

 Development of design methods and tools related to the dynamics of vertical transport, using numeric and experimental methods



Partners involved:

Industry

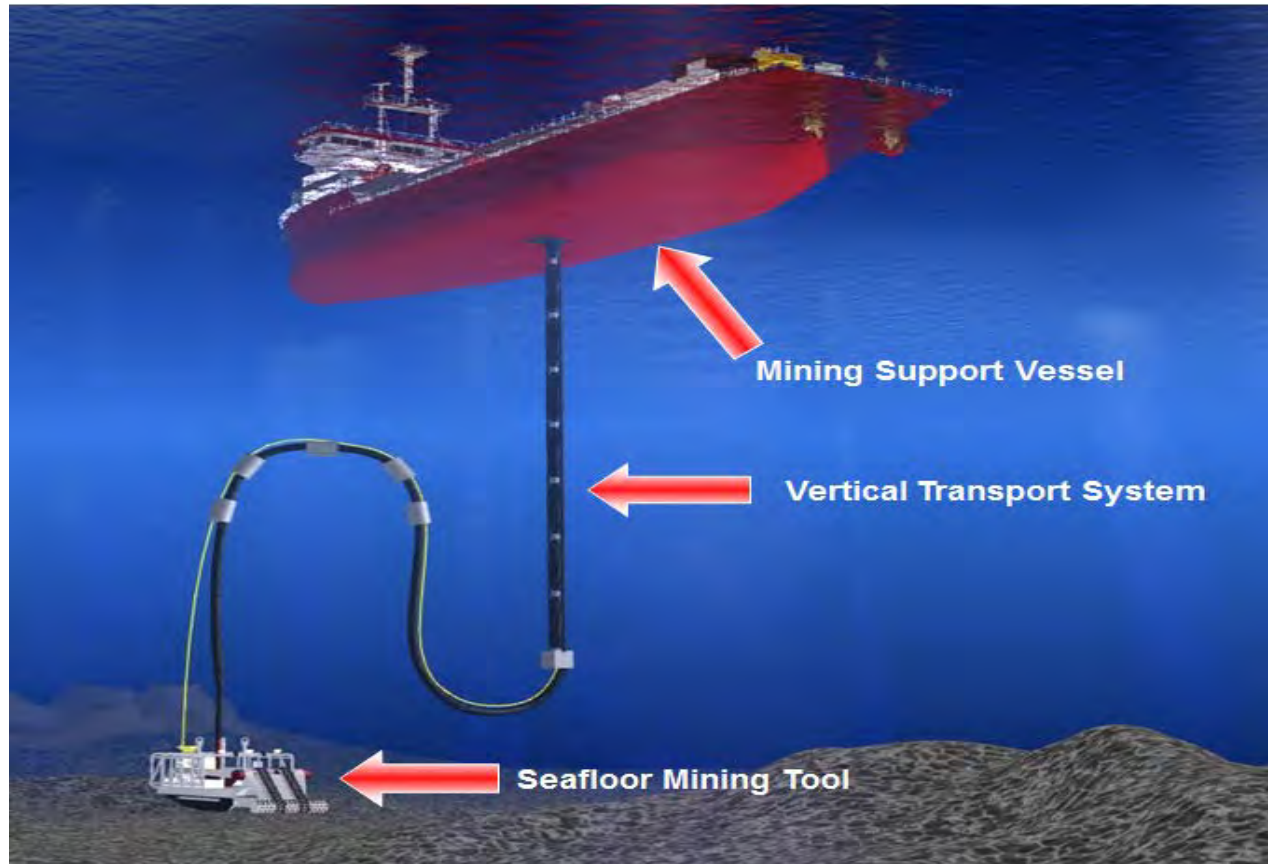


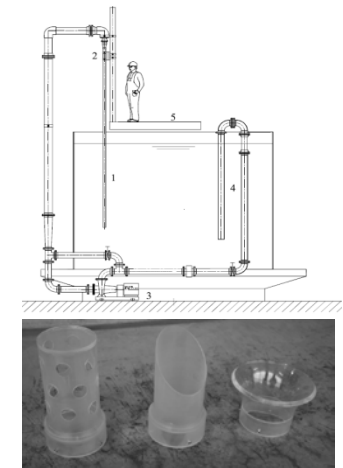
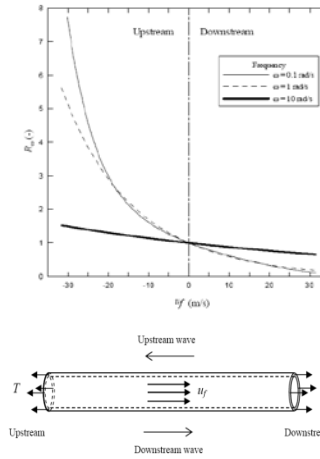
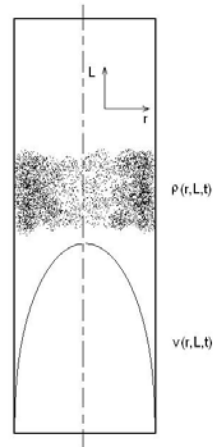
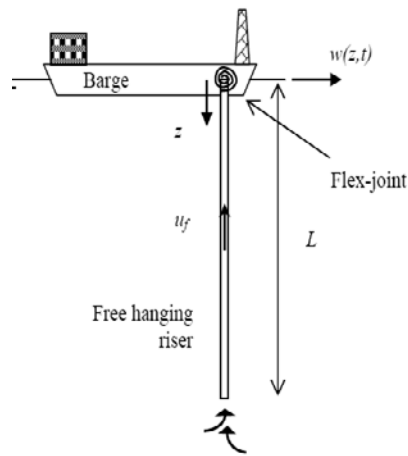
Research Institutes



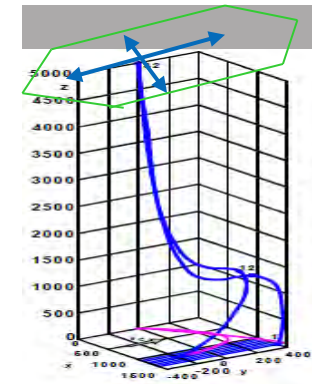
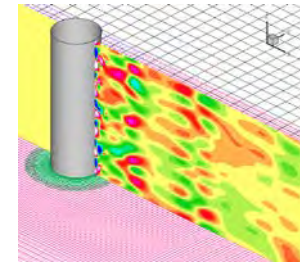
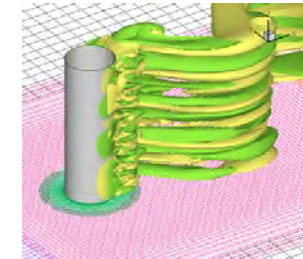
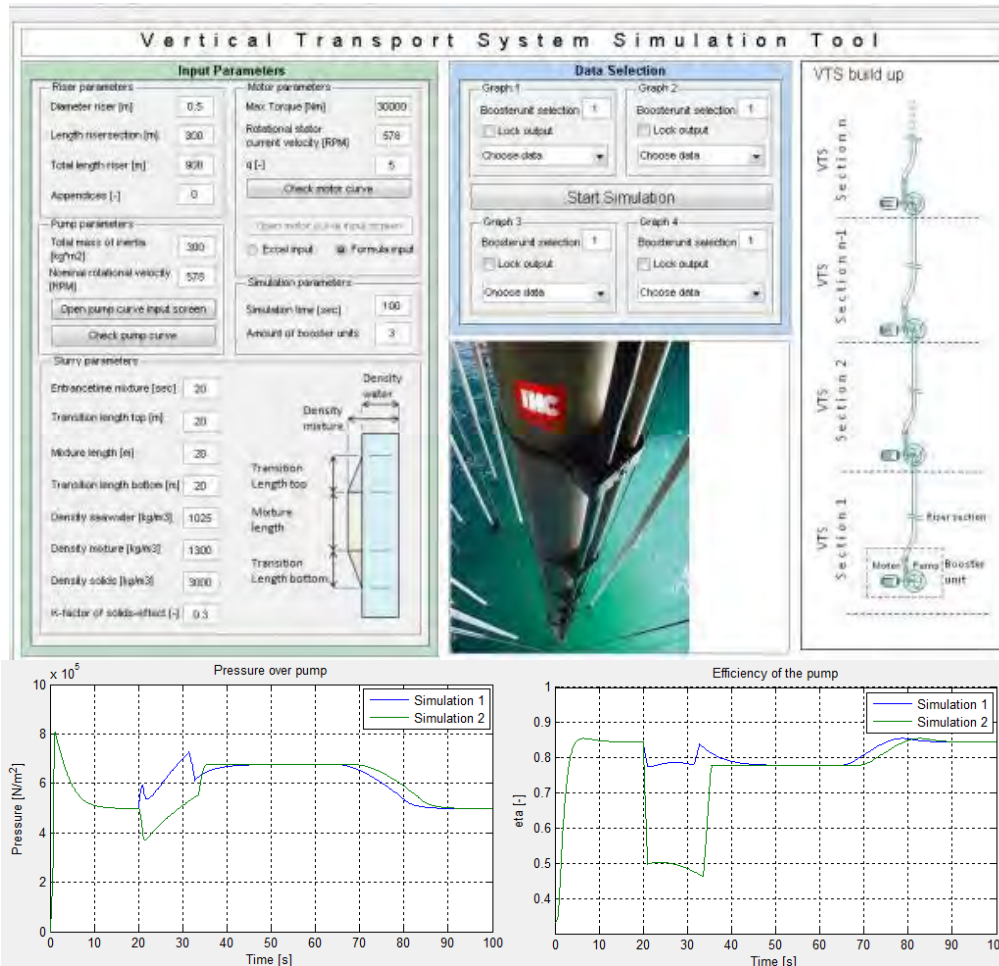
Service Supplier

Resource Exploitation: Design Methods and Tools





Resource Exploitation: Design Methods and Tools












Resource Exploitation: Design Methods and Tools



Focus on:

-  Dynamics of vertical transport
-  Ship-to-ship transfer
-  Numeric and experimental methods

Done by:

-  Software suite for VTS and slurry dynamics
-  Validation by model tests
-  Integration of models
-  Technologies for monitoring and control of VTS



Resource Exploitation: Vertical Transport and Systems Integration



To acquire the technical knowhow and develop advanced models, design methodologies and technologies for a clog-free reliable vertical transport solution

Partners involved:

Industry

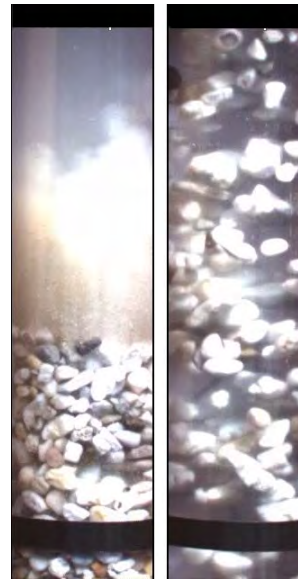
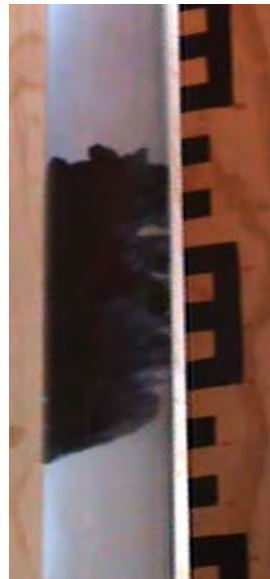
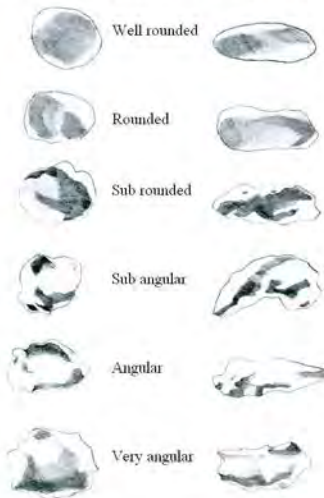


Research Institutes






Service Supplier

High Sphericity Low Sphericity







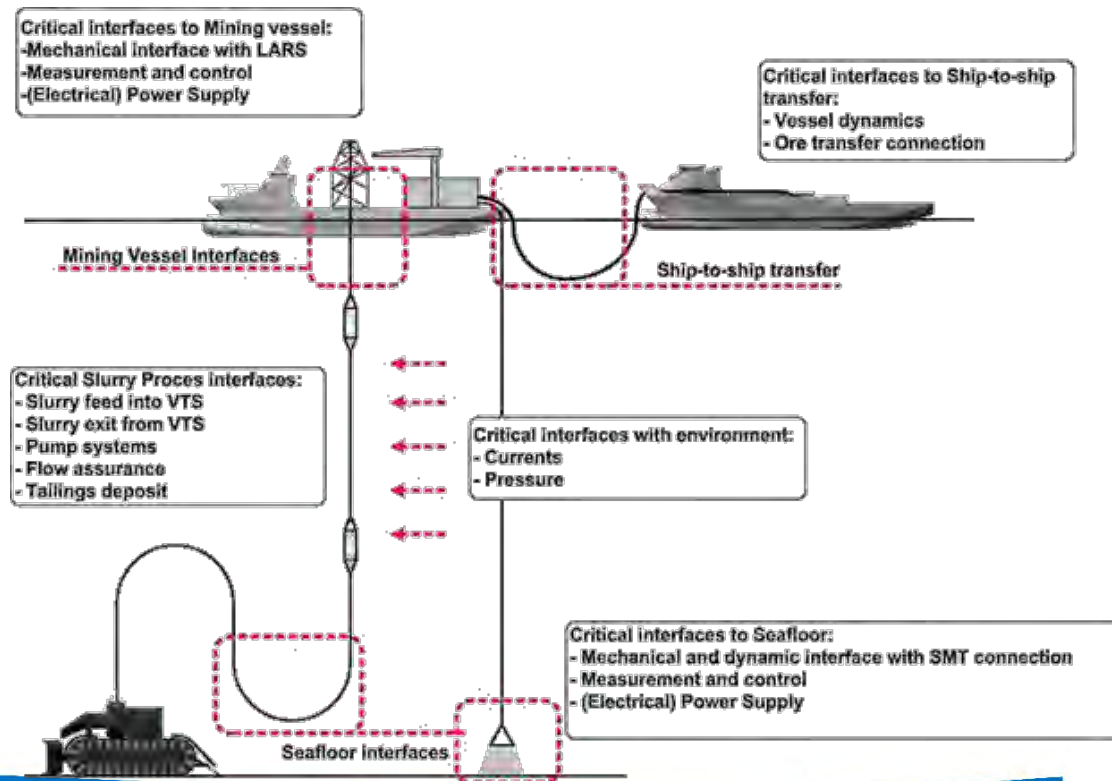
Resource Exploitation: Vertical Transport and Systems Integration

Focus on:

-  Clog-free vertical transport
-  Wear and tear
-  Critical interfaces

Done by:

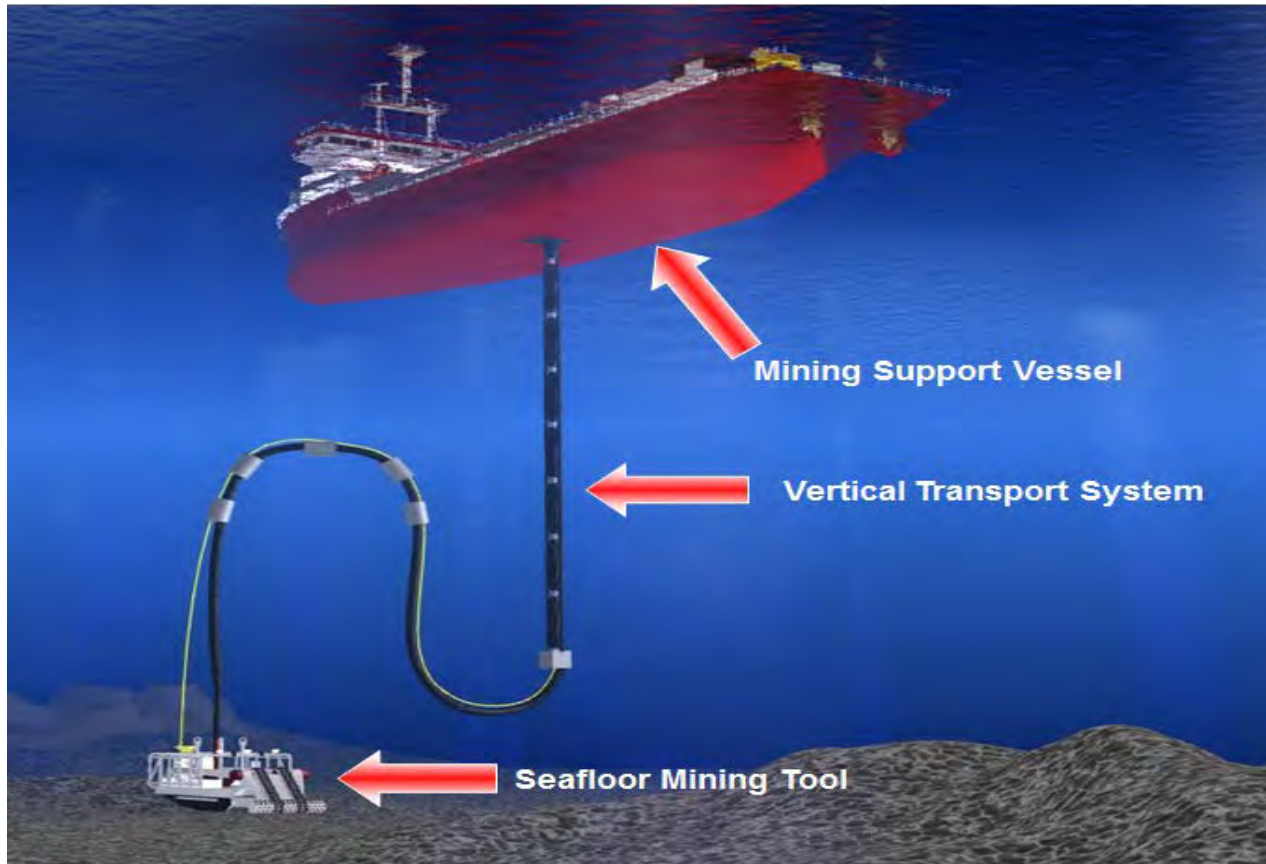
-  Investigation of airlift and subsea pump system
-  Conceptual VTS design
-  Testing under realistic conditions
-  Integration in complete system design





Hydraulic design of the Vertical transport system

Hydraulic design of the Vertical transport system





Hydraulic design of the Vertical transport system










Type	Specification
Water Depth	5000 m
Density water	1,025 kg/m ³
Density solids	2,500 kg/m ³
In situ density	2,150 kg/m ³
Dry density	1900 kg/m ³
Average Production dry solids per operational hour	400 tds/OH
Maximum nodule diameter	120 mm



Hydraulic design approach









-  Low specific energy consumption
-  Centrifugal pumps running close to their best efficiency point (BEP)
-  Pump impeller tip speeds below a certain threshold
-  Acceptable pump ball passages
-  Acceptable under- and over pressures in the system during pump failures
-  Low weight of the booster stations (including pump and drive)
-  Low weight of the riser system



Hydraulic design approach



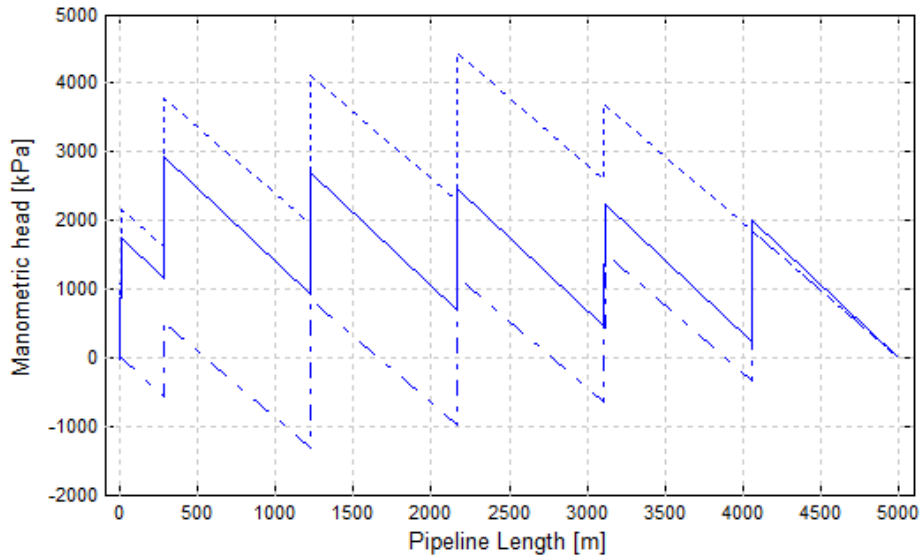
-  Mixture density
-  Riser diameter
-  Centrifugal pump suction diameter
-  Booster stations positioning
-  Number of booster stations
-  Drive/motor for the pumps (power and rotational speed)



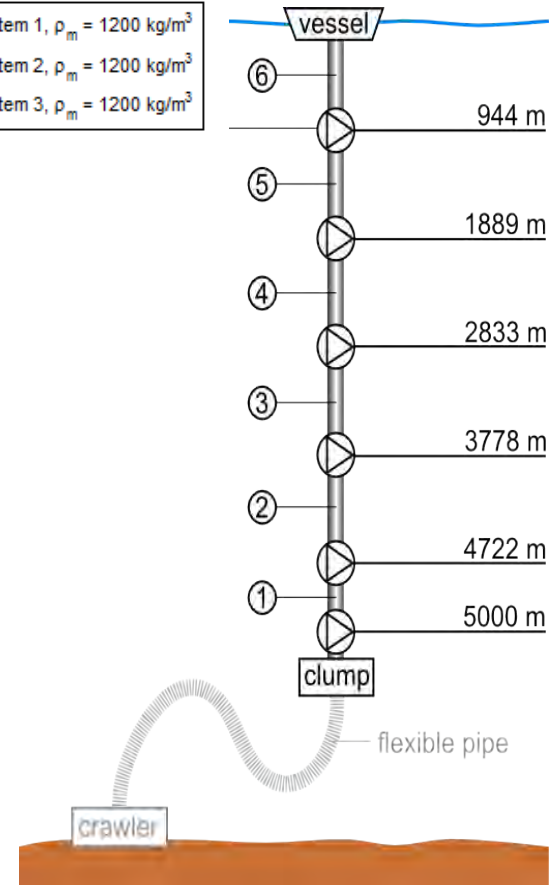
Hydraulic design approach

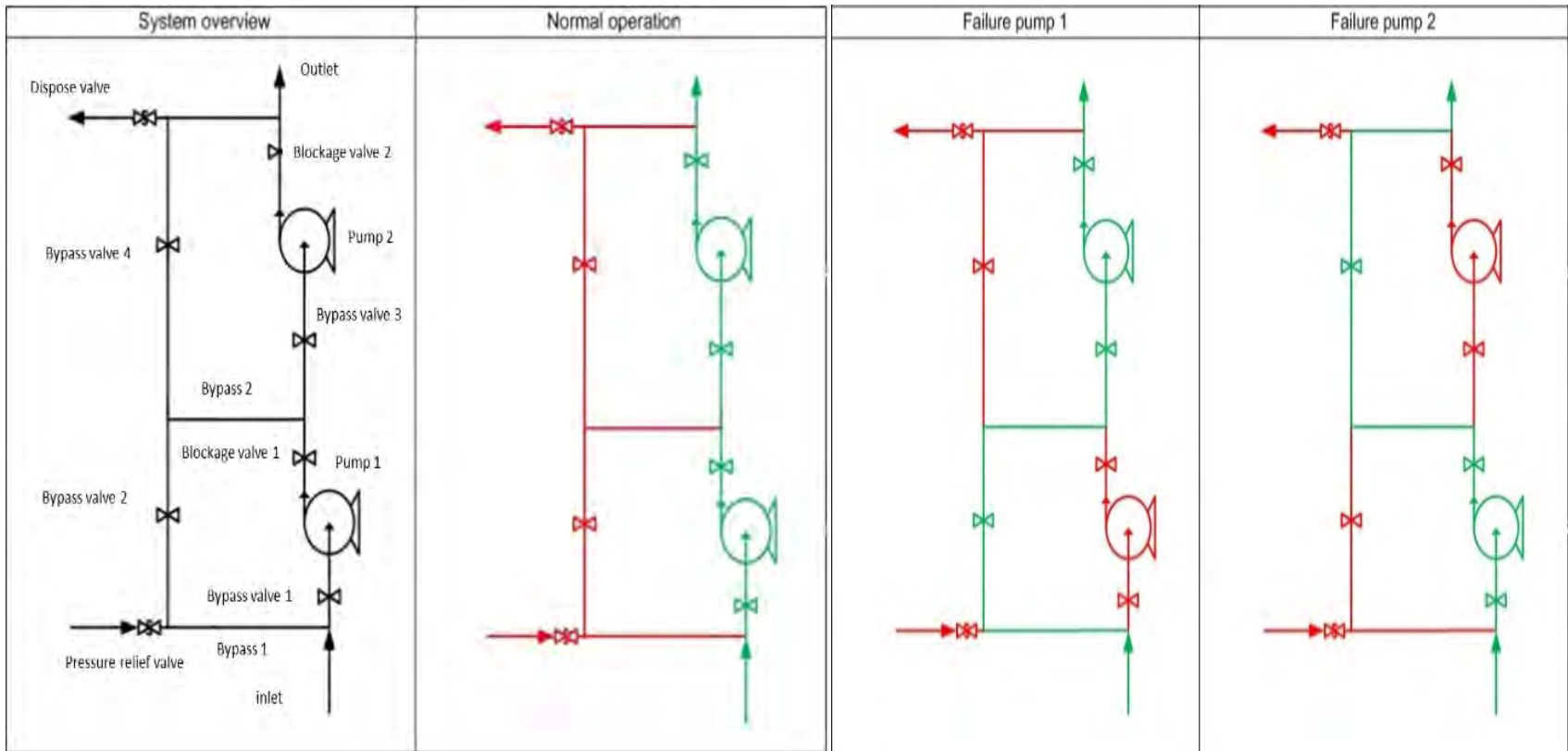


system parameter	specification
riser inner diameter (constant)	14" (356 mm)
centrifugal pumps	12 (6x2) HRHD 78-13-30, 3 bl.
electrical drives for 12 pumps (6x2)	506 kW @ 931 rpm
slurry density (design)	1200 kg/m ³
slurry velocity	4 m/s
max under-/over pressure	-6 / 39.1 bar

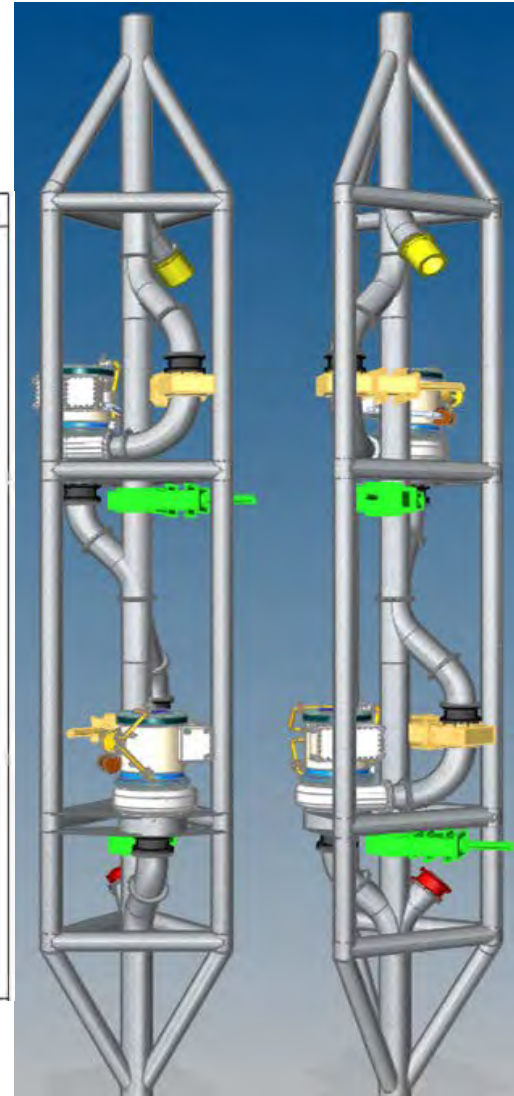
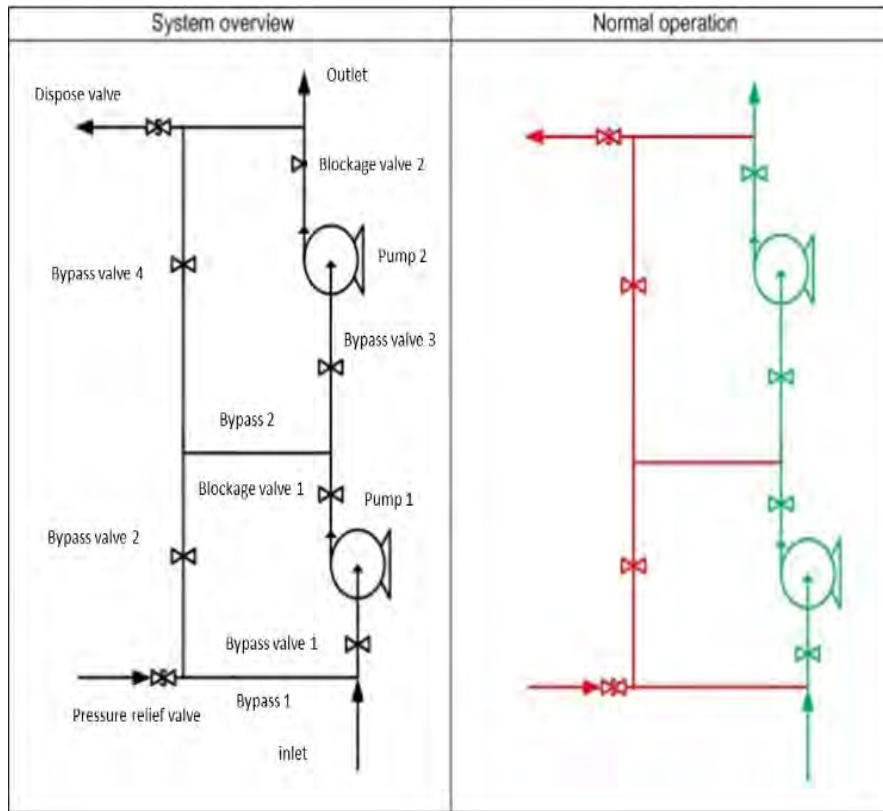


— system 1, $\rho_m = 1200 \text{ kg/m}^3$
 - - - system 2, $\rho_m = 1200 \text{ kg/m}^3$
 ····· system 3, $\rho_m = 1200 \text{ kg/m}^3$





Hydraulic design





Development of Deep Sea Special Motor



Development of Deep Sea Special Motor



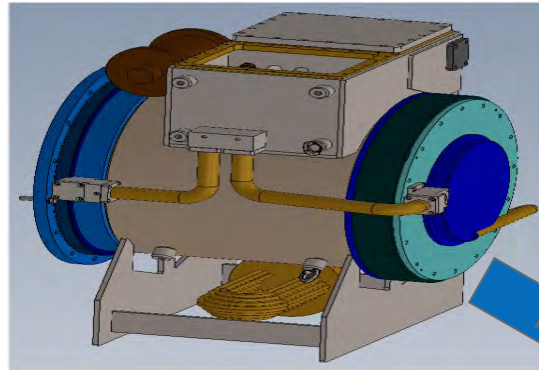
Design Requirements

- Water filled(no enclosed air pockets).
- Water cooled (ambient salt water).
- Water lubricated(no additional lubrication).
- Compact with built on pump
- Minimal maintenance during operational period.
- No environmental impact (not even in fault conditions).
- High efficiency
- Built with proven components in a unique innovative combination.

Development of Deep Sea Special Motor



First Concept



From the drawing board



Deep Sea Special Motor
at Motor test facility

Testing the Deep Sea Special Motor



Testing the Deep Sea Special Motor



Testing the Deep Sea Special Motor



Testing the Deep Sea Special Motor





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End of Presentation

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Industry



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