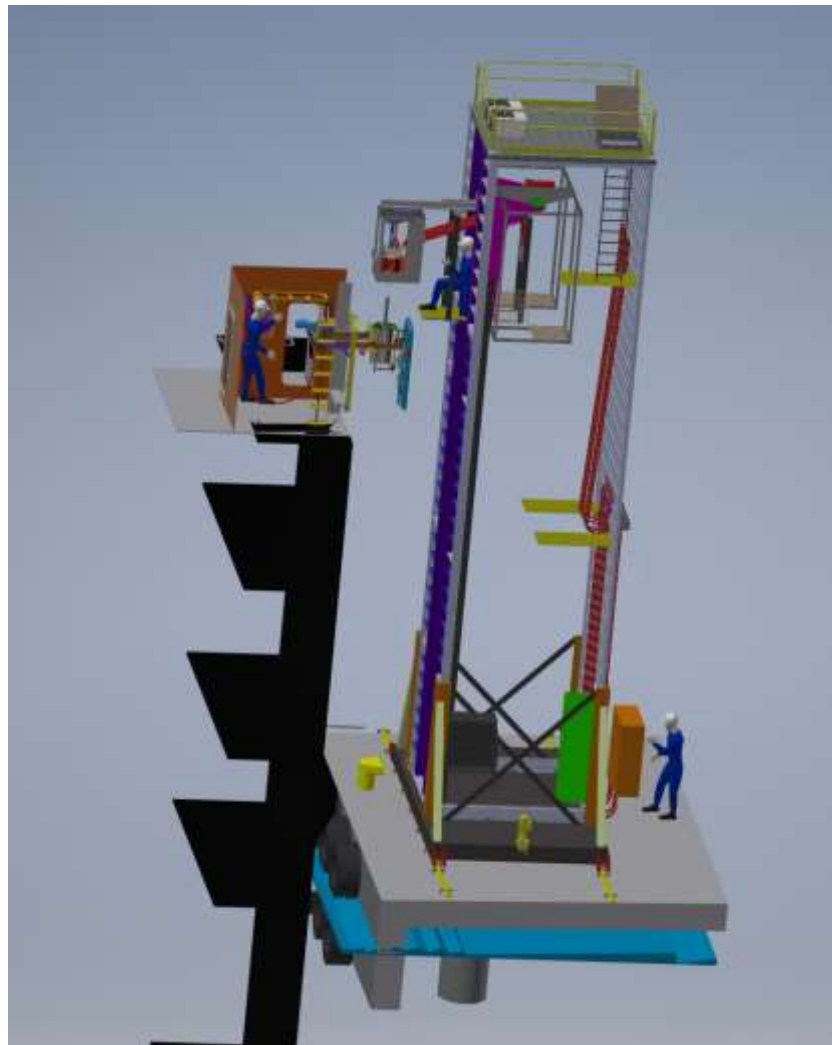


Kysruten route PLUG shore connection Quay interface proposal



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1 Introduction

Port authorities along the Kysruten route, wish to implement a shore power solution to allow calling vessels to connect to their terminals local power grid in order to get power from the shore, as a way to reduce emissions and fuel consumption.

For this purpose, NG3 is proposing, through its agent Scanvi- Interyard, its PLUG (acronym for **P**ower **G**eneration during **L**oading & **U**nloading) technology to provide a low voltage / high amperage quick and mechanized connection.

The purpose of this document is to present the PLUG solution NG3 is proposing for these project, knowing that such solution has been already ordered to allow several vessels to connect to shore power at the Hurtigruten terminal in the port of Bergen.

2 Understanding of the requirements

The main requirements for this PLUG solution are understood to be:

- “Hands out” operations avoiding direct handling of power cables and connectors by crew;
- 1500 amps, power exchange capability under 690 V, -15/25°C ambient still air, continuous;
- Connection / disconnection within 2 minutes after / prior the ship is docking/undocking;
- Ship side and quay side control modes, semi automated;
- Cost of ownership and maintenance to be minimized;
- High reliability and maintainability and safety shall be considered as a key design driver to guaranty the safety and operational efficiency of operation;
- Footprint and mass to be minimized on the vessel and the quay side;
- The system shall be compatible with ship side PLUG interfaces already installed on Hurtigruten and Havila Ropax with a ship side shore power room located between deck 3 (Polarlys RoPax) to 4 (Spitsbergen RoPax)
- The system shall be compatible 20 years tide and vessel draft variation;
- The system shall be compatible with a 0,5 m thick quay side (tires) and 0,35 m thick ship side hull fenders;
- The system shall be compatible with longitudinal alignment variation of +/- 0,5 m
- Speed of operations and user friendliness compatible with short duration calls
- System shall be compatible with weather conditions according to Eurocode /norwegian annex (ice/snow...)
- System shall be compliant with EC machine directive.

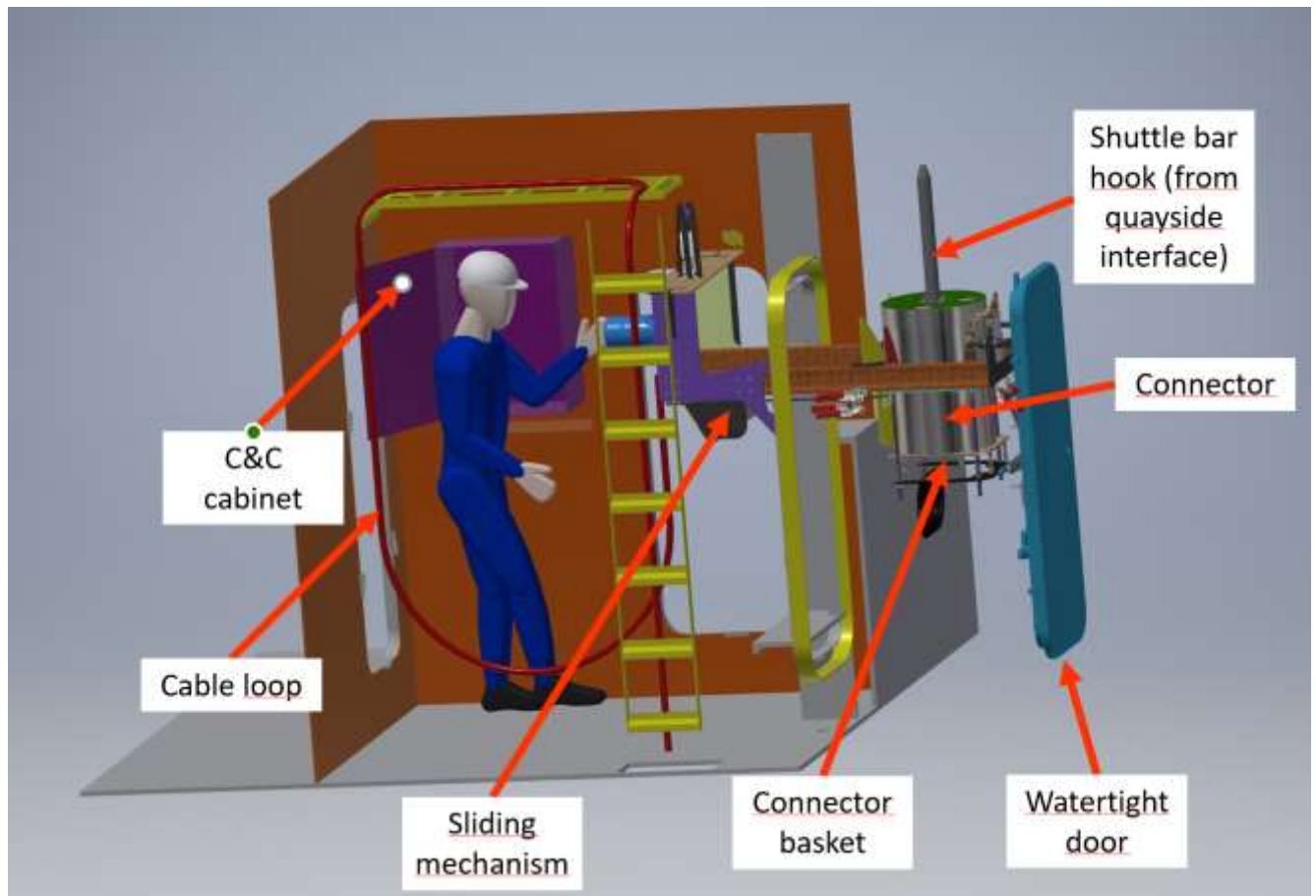
2.1 Main design features

The proposed solution is based on PLUG unique connector and socket patented technology which provides a self mating /de mating connection / disconnection based on simples, reliable, mechanisms.

In the ship side the PLUG main components are:

- a connector linked by a set of flexible cables to the ship side electrical power system;

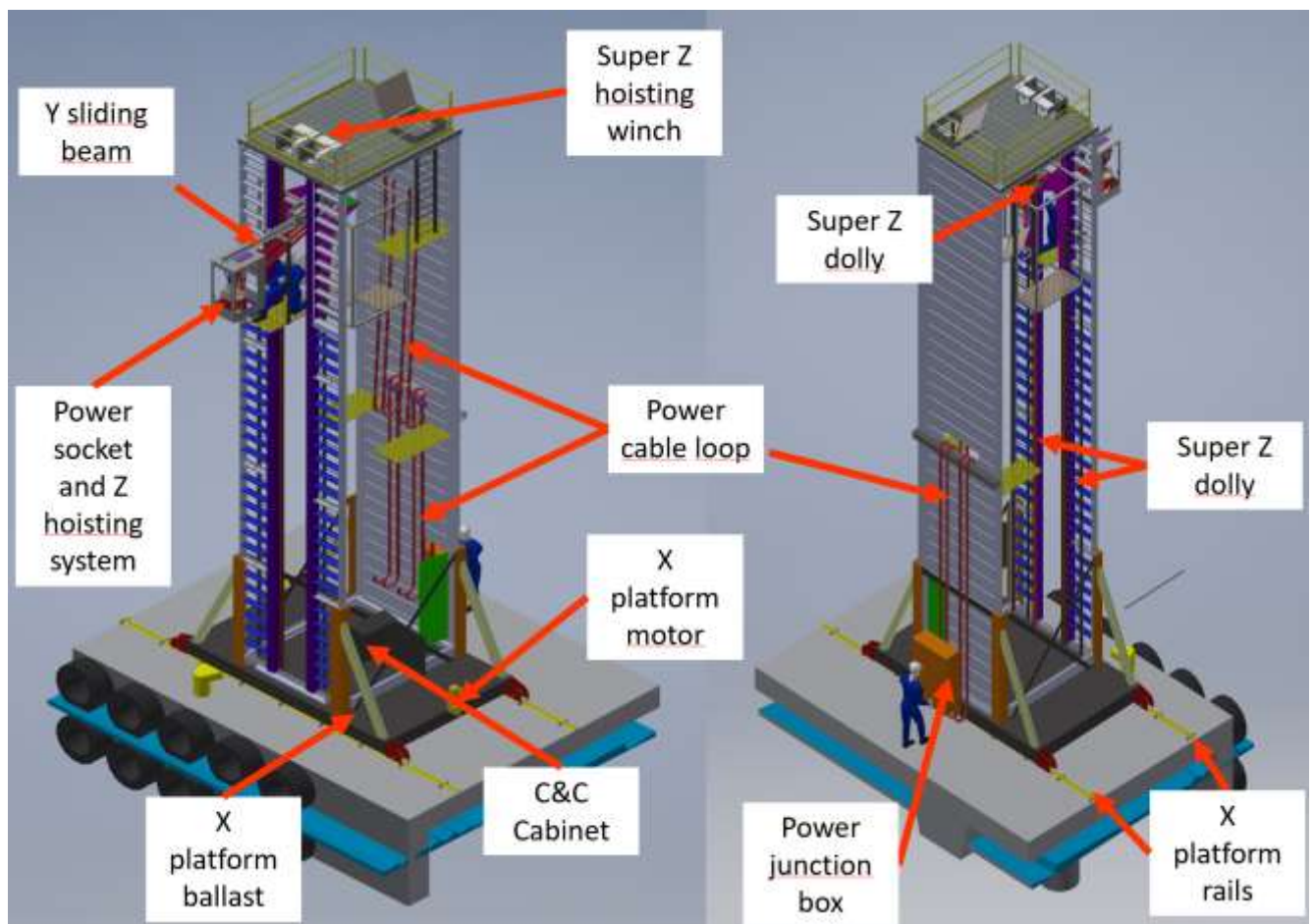
- a connector basket supported by a motorized sliding mechanism (SY axis);
- a watertight door attached to the end of the sliding beams.



PLUG ship side interface main components

On the quay side, the PLUG main components are :

- a connector hoisting system equipped with a “shuttle bar” hook to “fish” the ship side connector and lift it up (z axis) towards a receiving power socket, locator inside a rain proof “fish tank” enclosure;
- this fish tank is attached to a sliding beam (Y axis) which allows to pull it out and drive it above the ship side connector basket
- this sliding beam is moving up and down on a vertical sliding dolly (SZ axis) which adjusts the fish tank position with regard to the ship side deck location and to compensate draft/tide variations
- this sliding dolly is installed in a container 40 feet container structure which support it and provide weather protection;
- to align longitudinally the fish tank with the connector basket and provide stability this container structure is bolted to a reinforced concrete base which moves (X axis) on a set of rails bolted to the quay.



PLUG quay side interface main components (typical)

Basically, this quay side unit is similar to the one already in use in Hurtigruten Bergen terminal except that the moving part of the unit are enclosed in a container shape structure for weather protection and easier access for maintenance and troubleshooting.

No direct handling of the power cables and connector is required.

Thanks to PLUG unique guiding and locking system, these connection /disconnection sequences will be performed by simple, reliable, mechanical effects.

See the principle on: https://www.youtube.com/watch?v=sYW_dkT_EZk

The “shuttle bar” conical lower end is designed to self-center itself into the connector as soon as it gets into it, within, typically, a 10 cm diameter alignment uncertainty. It is then locked with the connector by a jaw mechanism.

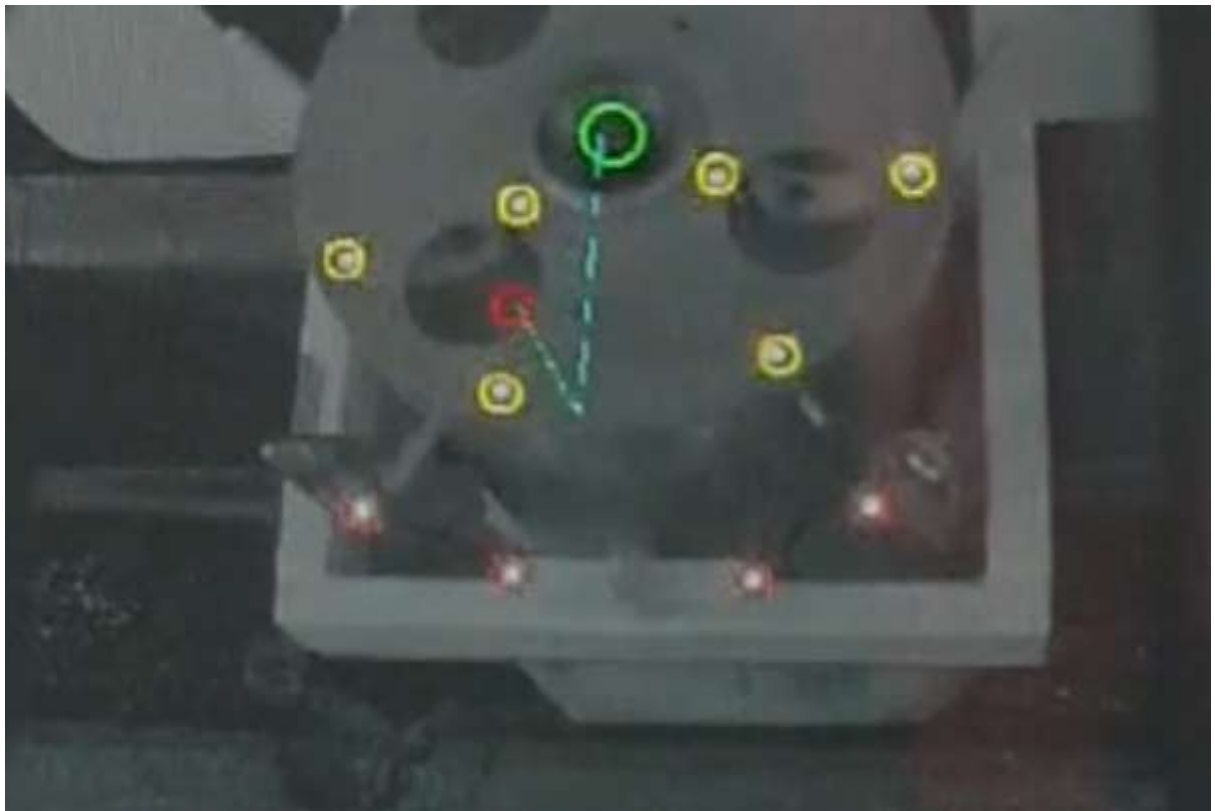
Operations can be driven remotely by the crew using a portable tablet and can be, as well, partly automated thanks to, among other sensors, a set of video tracking cameras installed in the fish tank to monitor the position of both the connector and the connector basket. For this purpose, the connector and the connector basket are equipped with a set of Leds lights which are detected by the camera software to accurately monitor the position of these two items.



*Bergen Hurtigruten terminal PLUG quay side interface during
first power exchange test*



Target Leds



Example of Camera image treatments

The typical connection sequence is the following:

1. sequence starts when the ship arrives within reach, as soon as wifi communication is established between the quay and ship side interfaces, allowing remote control of the quay side unit by the crew;
2. crew using the tablet crew unlocks the door and slid out the connect basket until it reaches its end stop
3. crew operate the quay side X, Y and SZ motors to unpark and position the fish tank above the connector;
4. crew hoist down with the Z motor the shuttle bar into the connector so that it gets engaged in the connector locking mechanism;
5. crew hoist up with the Z motor the shuttle bar into the socket, until it reaches its end stop and activate the “PLUG connected” signals,
6. crew adjust the fish tank position so it is around 20 cm from the ship side hull and 1 meter above the basket, PLUG is then ready for power exchange;
7. once both the ship and the quay electrical systems are ready for power exchanges, the two pilot lines are activated and power exchange can start;
8. During power exchange, due to the flexibility of the ship side cable loop, the vessel small movement will be compensated without any action, for larger movements,



- such as tide or draft variation, the crew operates the SZ axis motor to keep the fish tank in its relative position above the connector basket;
9. Once power exchange is completed, the above sequence is performed in reverse order to bring back the connector into its baskets
 10. Crew open up the jaw locking mechanism holding the shuttle bar into the connector and using the Z motor hoist it up until it reach its parked position end stop;
 11. Crew operate the X,Y and SZ motors to park the quay side interface;
 12. Crew slide in the basket until it reaches its endstop and lock the watertight door, the ship is then ready for departure;
 13. The cycle ends when the ships moves away and the wifi link is lost.

All these operations can be perform as well in semi automated mode using the video tracking system to “fish” the connector, compensate the tide and draft variation once connected, and disconnect the system at the end of the power exchange.

These cameras will be used as well to issue an alarm if there is a risk of mechanical tension on the power cables.

To provide a backup solution, once connected, to release the connector and free the vessel from the quay interface, in case for example of inverter failure, the Z axis hoisting motor offers a power drill interface to operate it to lower the connector back into the ship side basket.

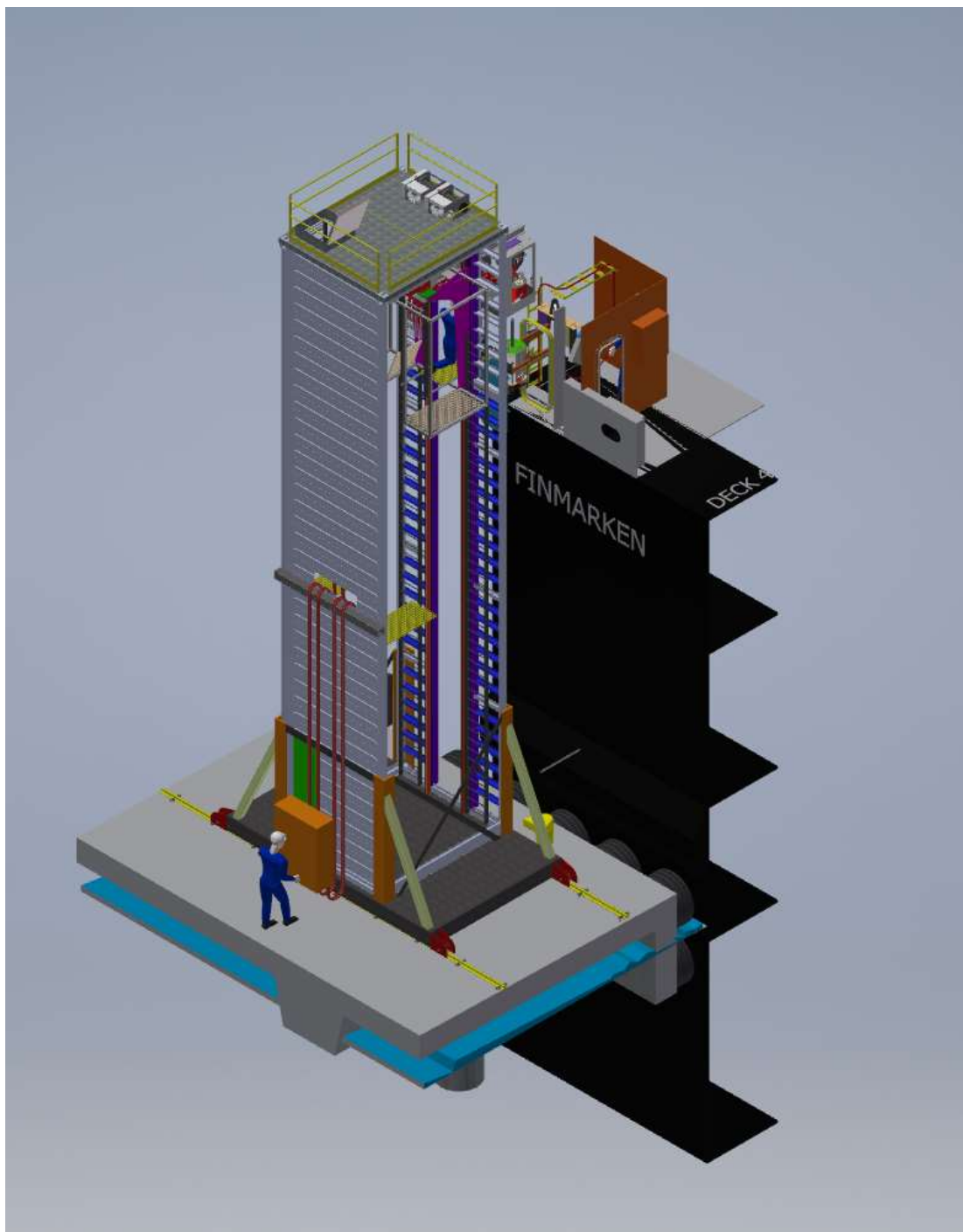
3 Implementation

To simplify logistics and on-site installation, the unit main structure is built within a 40 feet container envelope which provide both a structural support and protection from the weather. This containerized PLUG unit will therefore be brought to the site on a standard truck. It will be then raised up and installed on a moving reinforced concrete platform to provide stability. The following pictures illustrate this configuration.

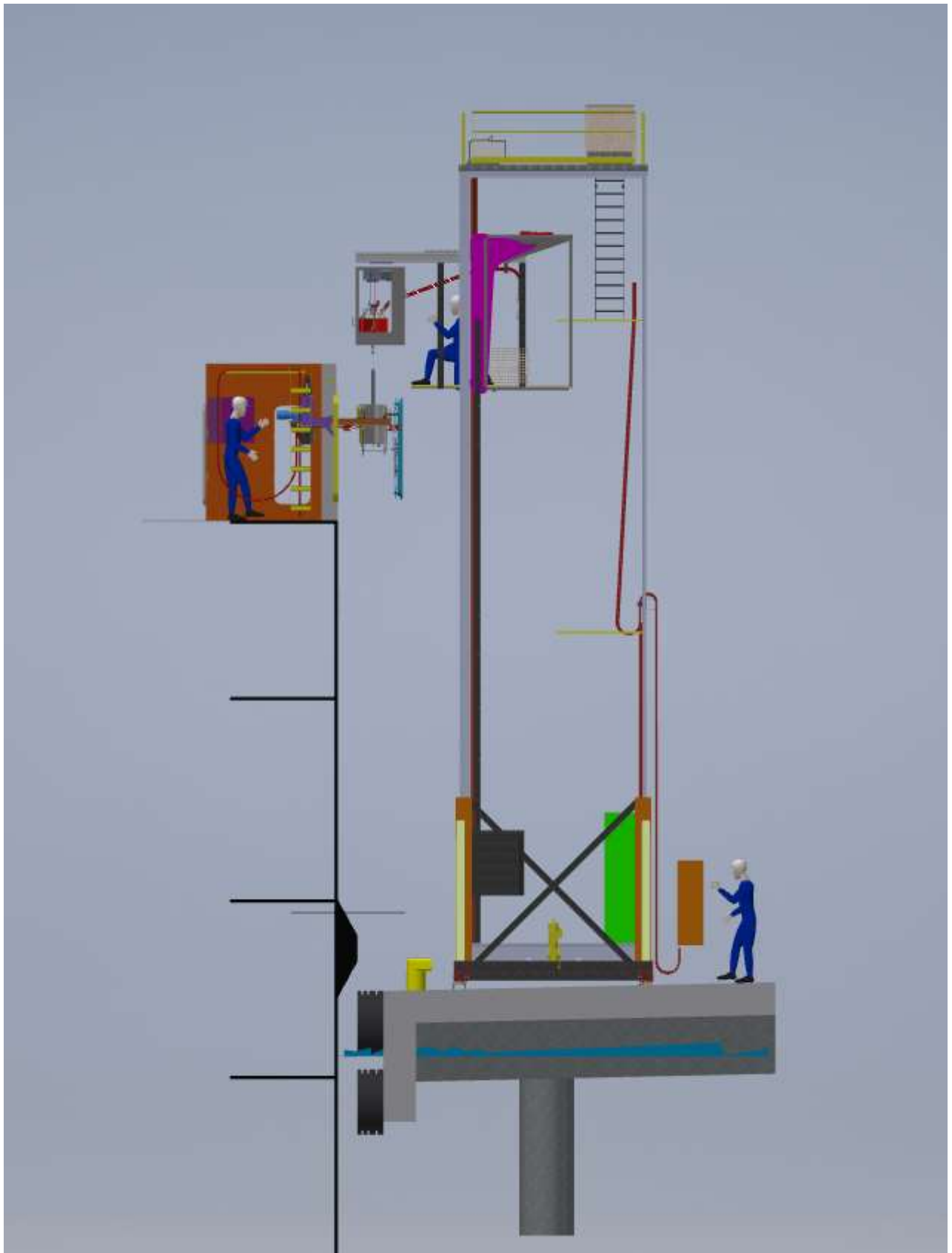
The concrete platform mold and its reenforcements and anchoring points will be provided aside, with all other loose components to be loaded ex work on a standard 12 feet container.

To reduce the visual impact of the system, we propose to paint the external faces of the container structure in “Norwegian” red brown color (RAL 3003 typically).

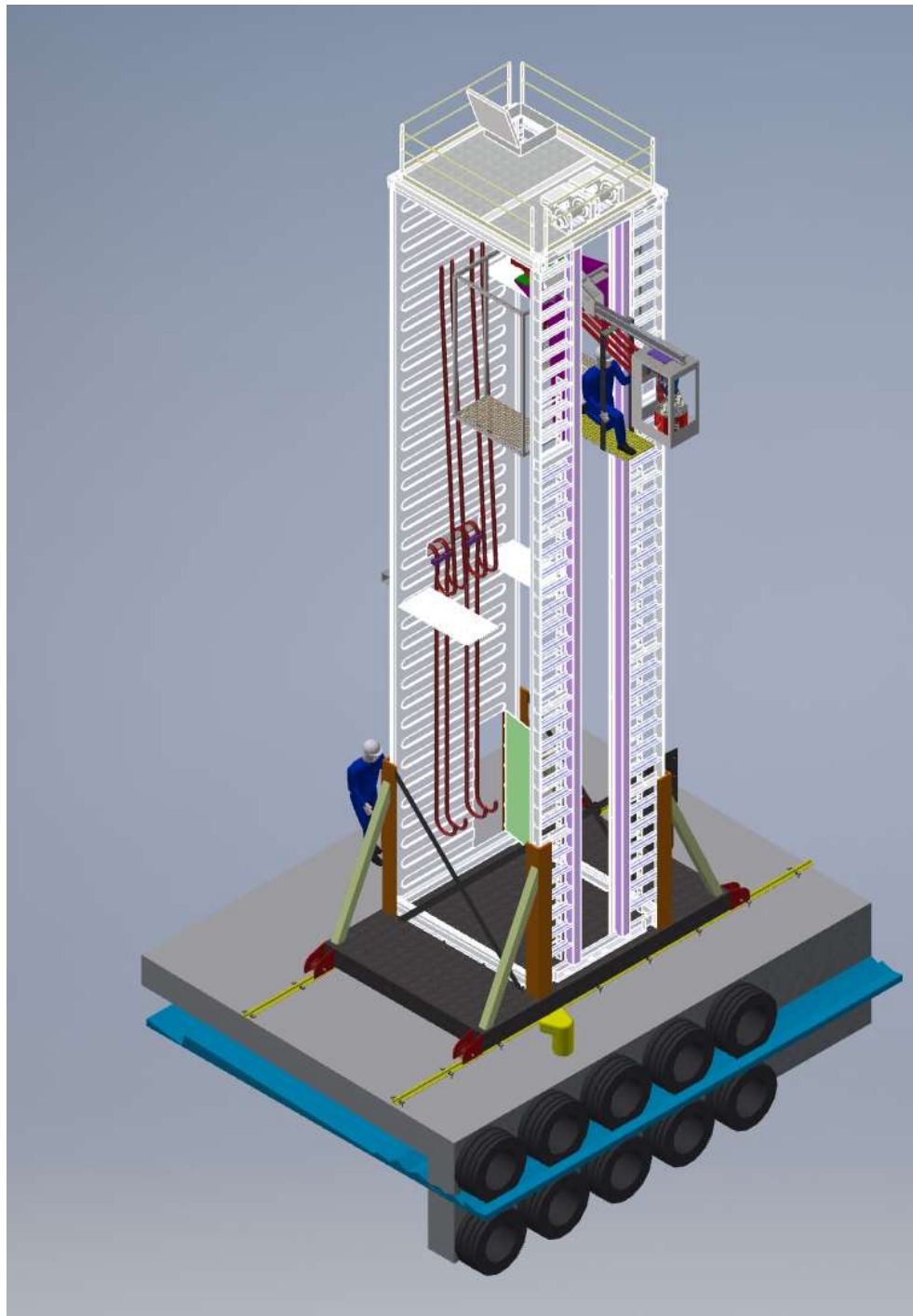
A set of ladders and grid platform provides access to all key components for maintenance and back up disconnection operations so that the ship can disconnect and leave the terminal even in case of some quay side system major failure, such as a power or C&C black out.



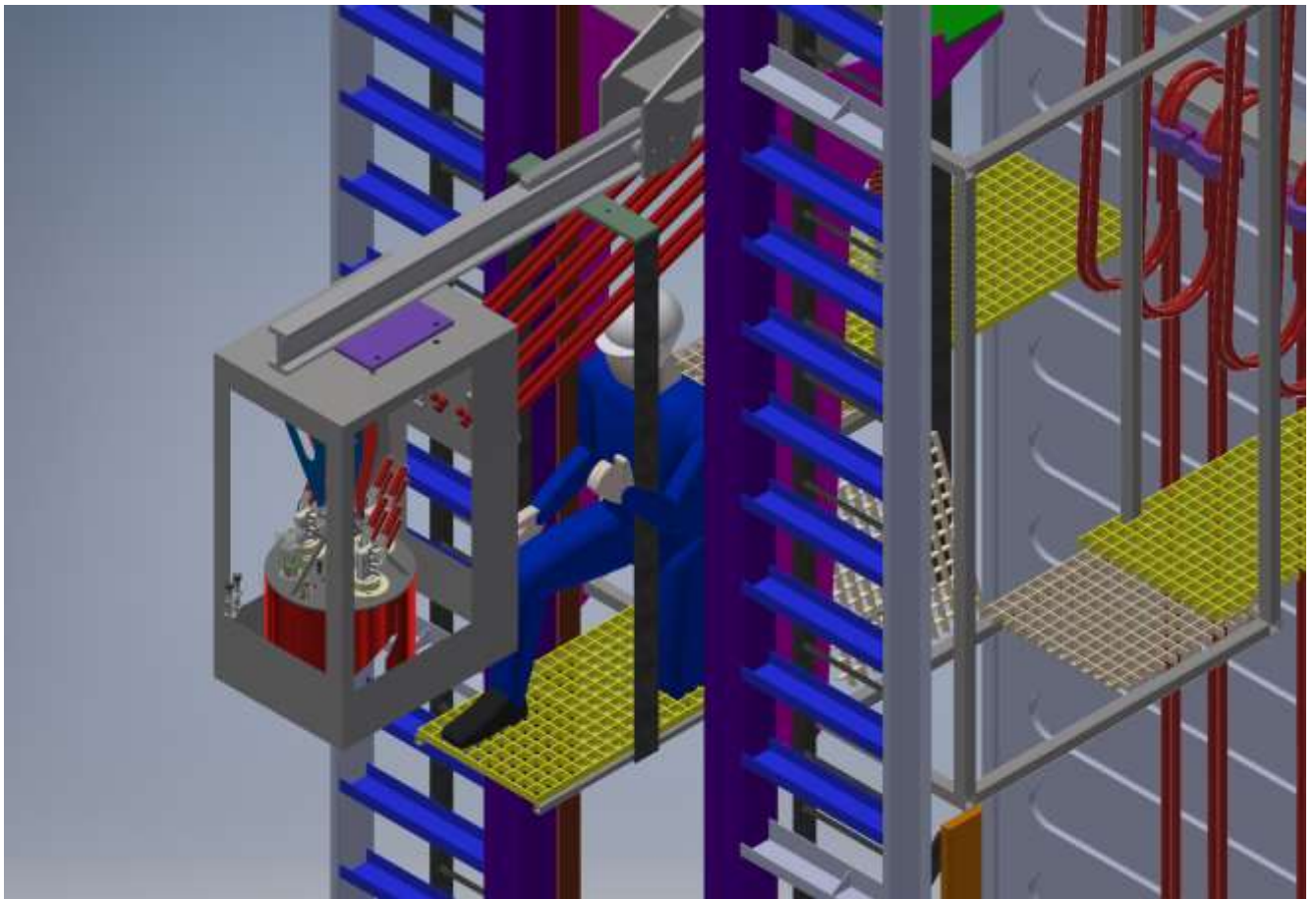
PLUG in operation general view



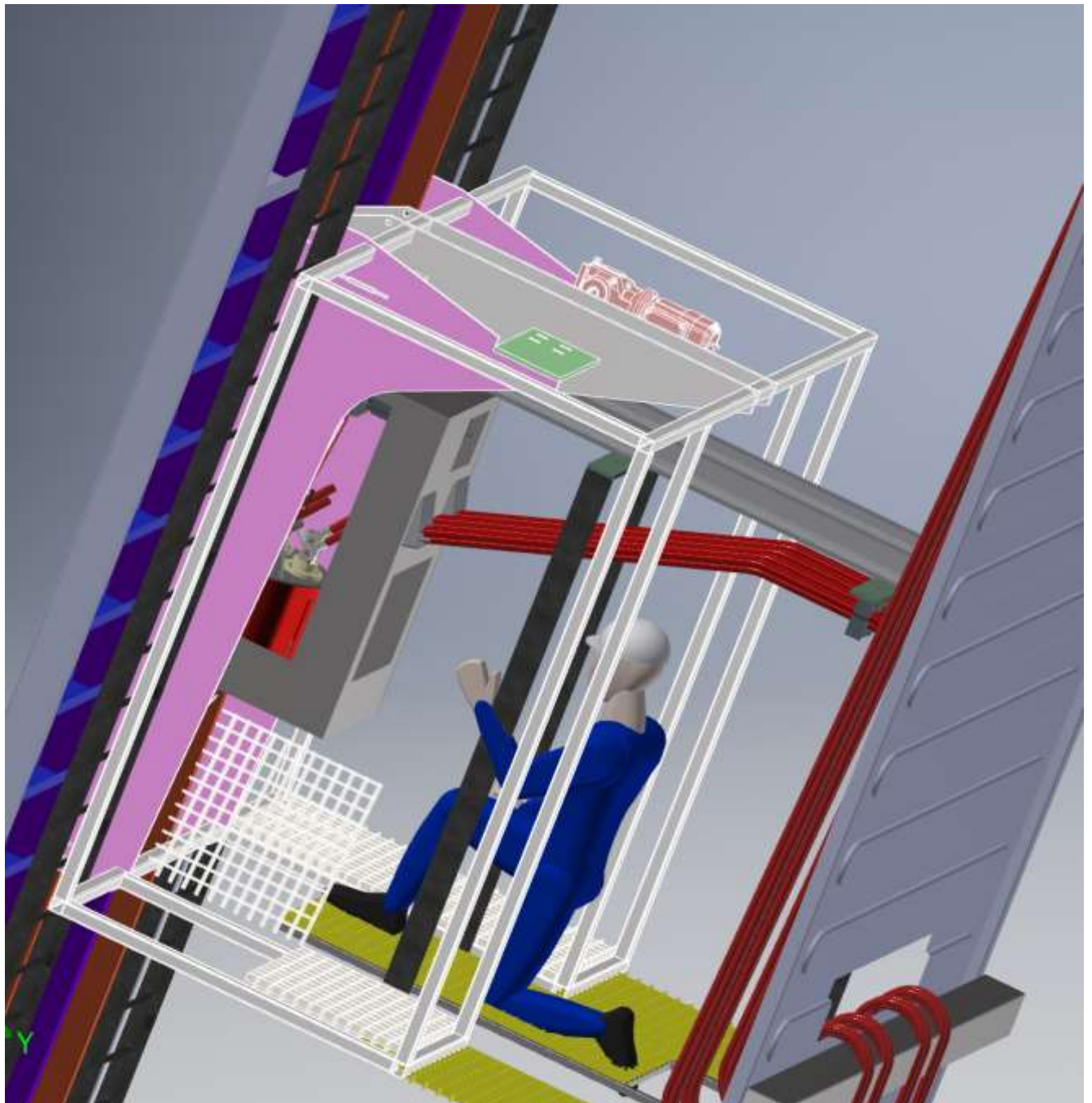
PLUG in operation side view



Modified Container structure

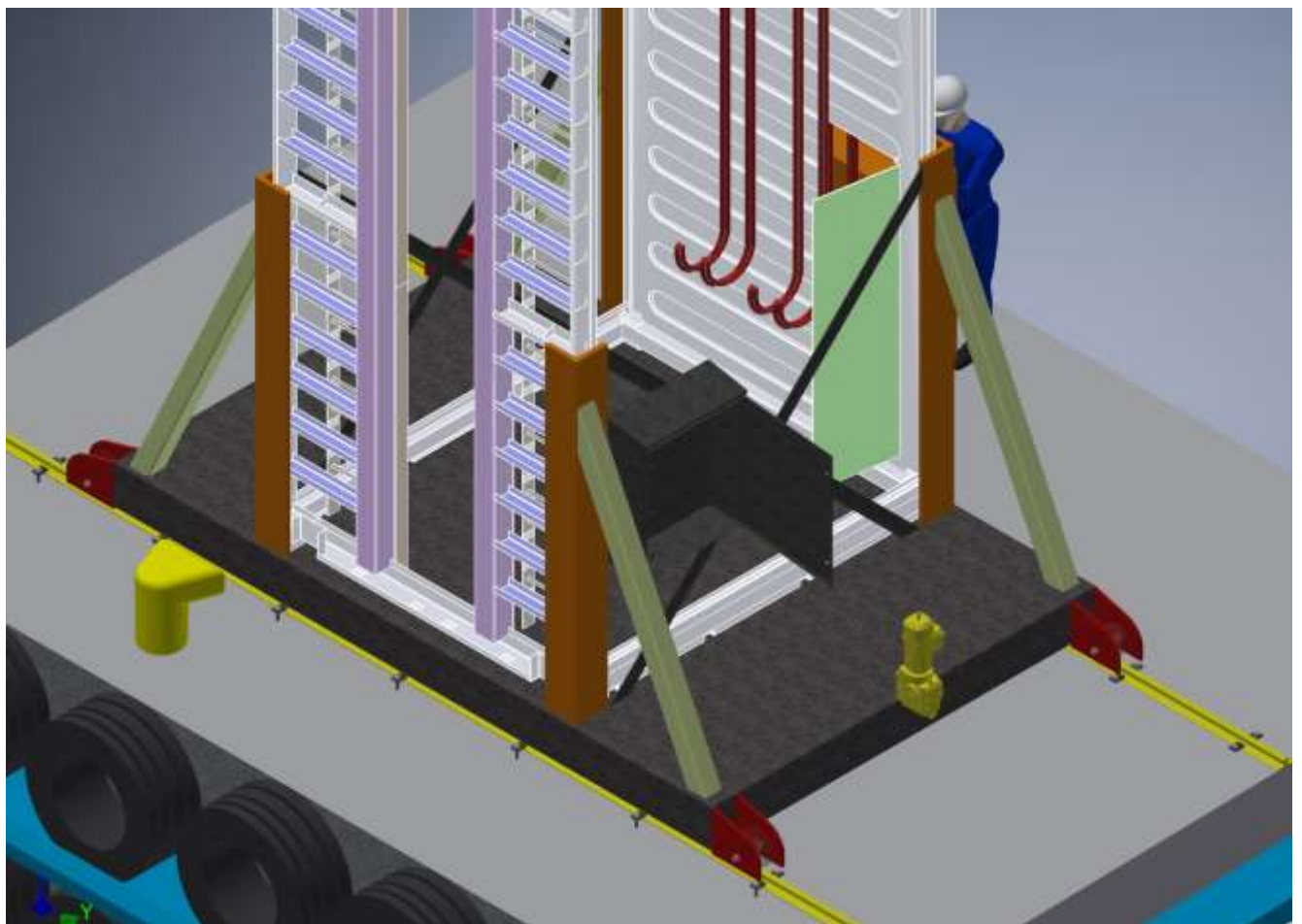


Y Sliding beam and fishtank with access to the Z hoisting winch motor



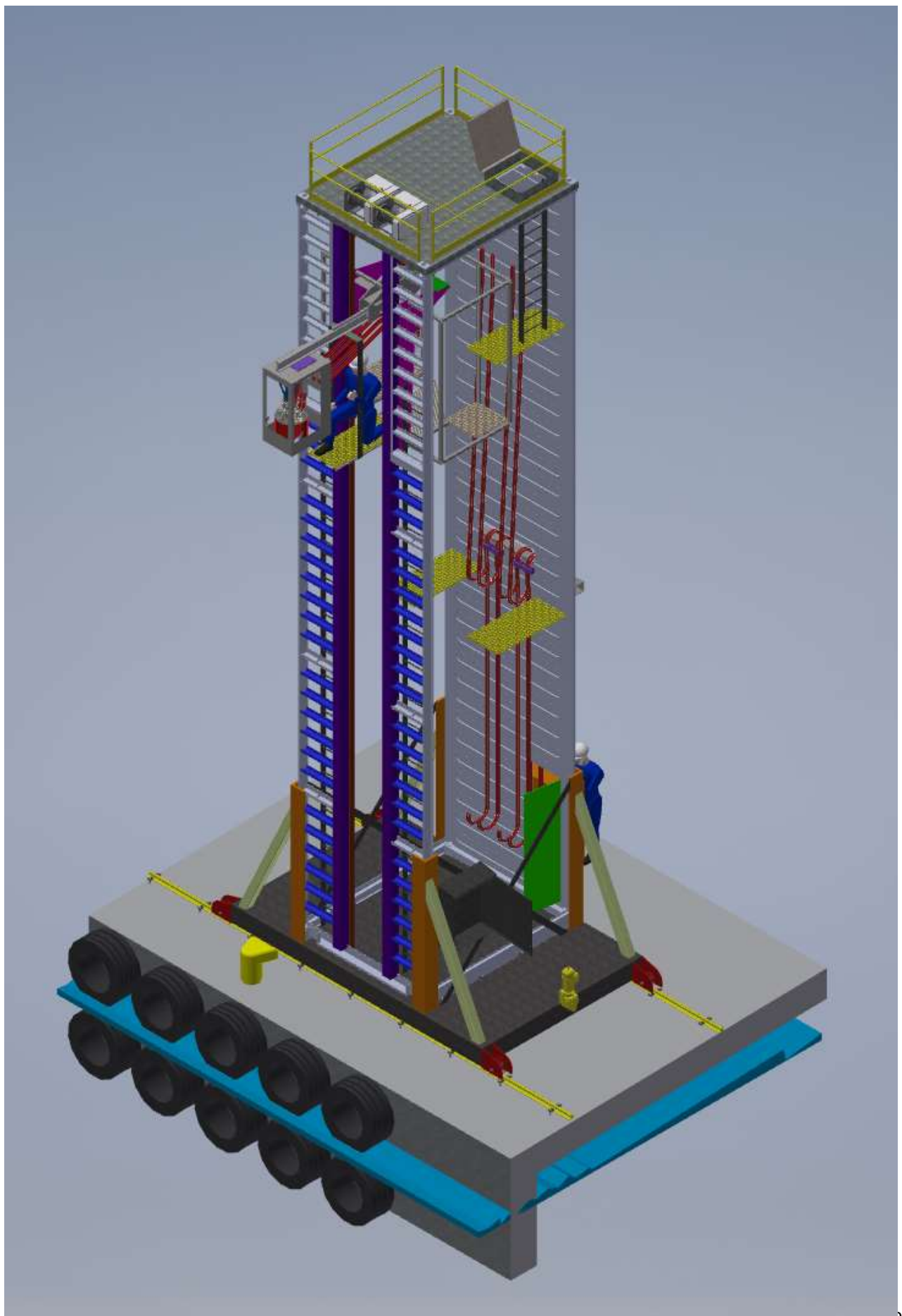
Z dolly moving along the container front face with grid platform

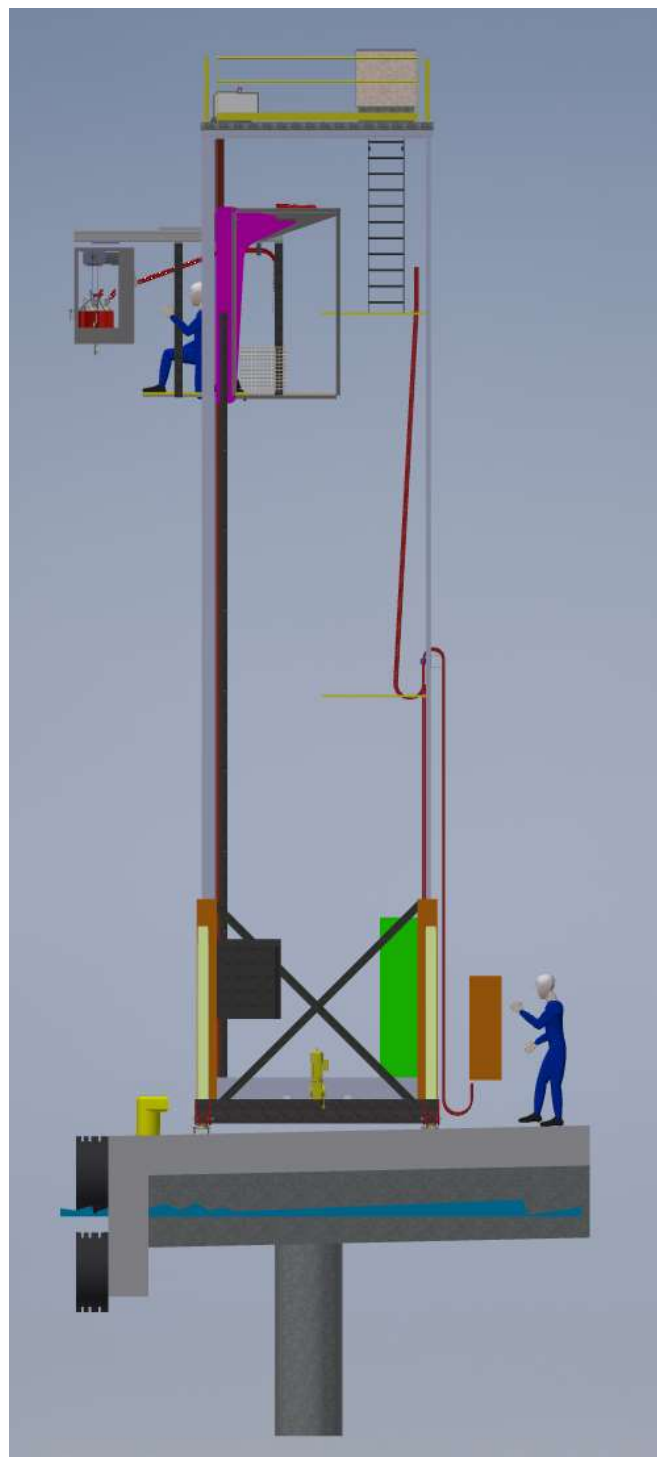
Due to its size the X platform could be built locally.



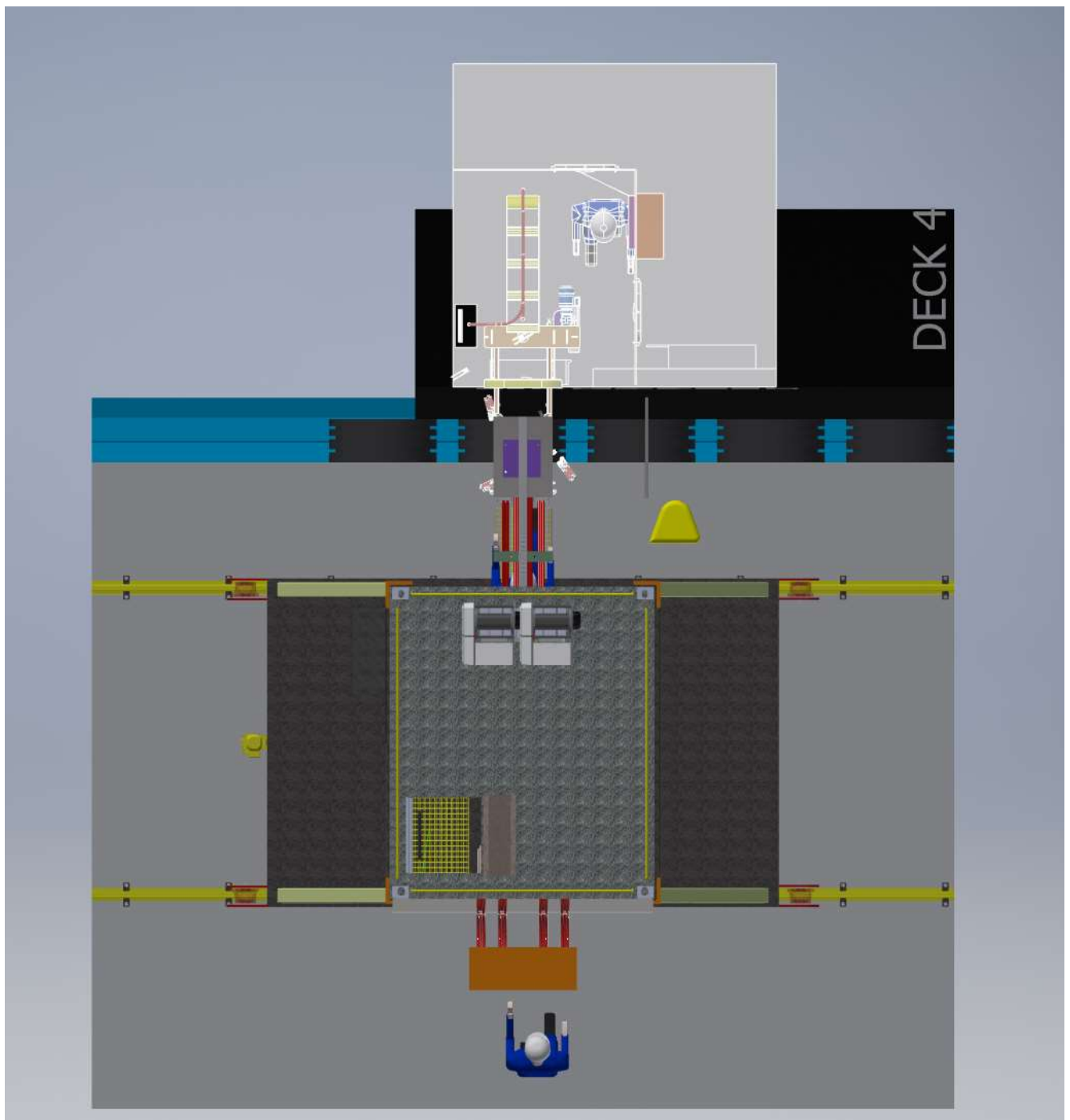
Motorized X reinforced concrete platform

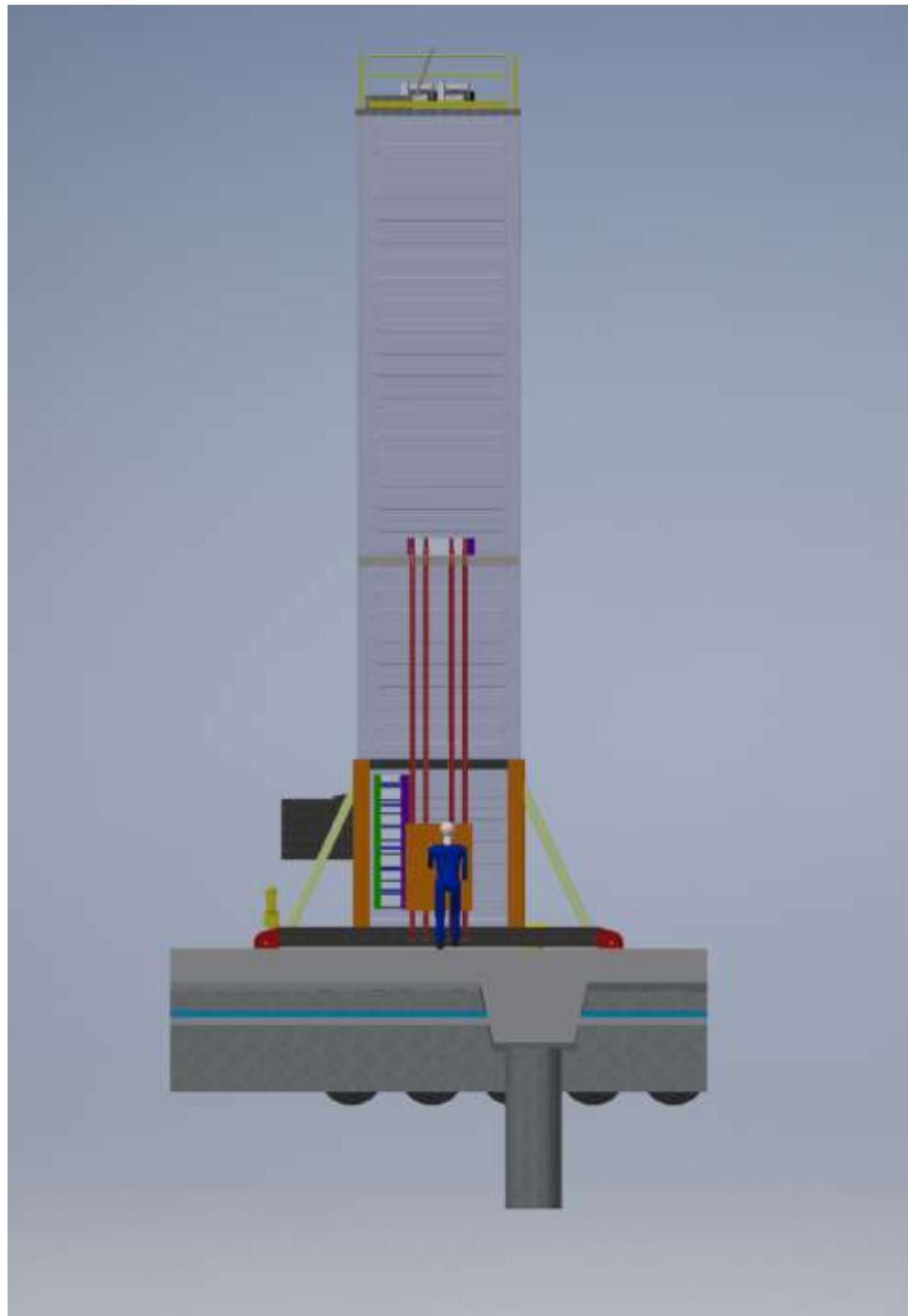


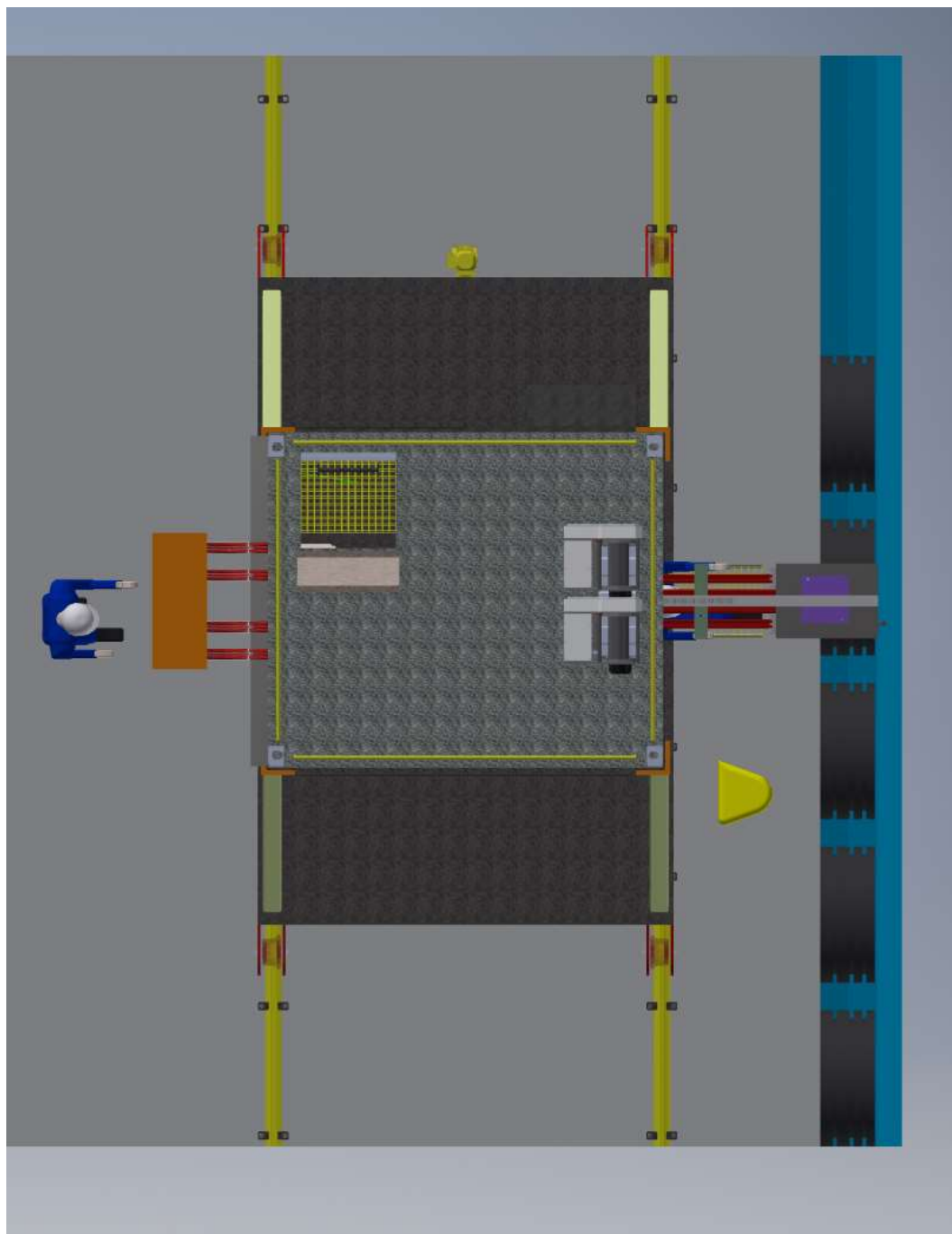


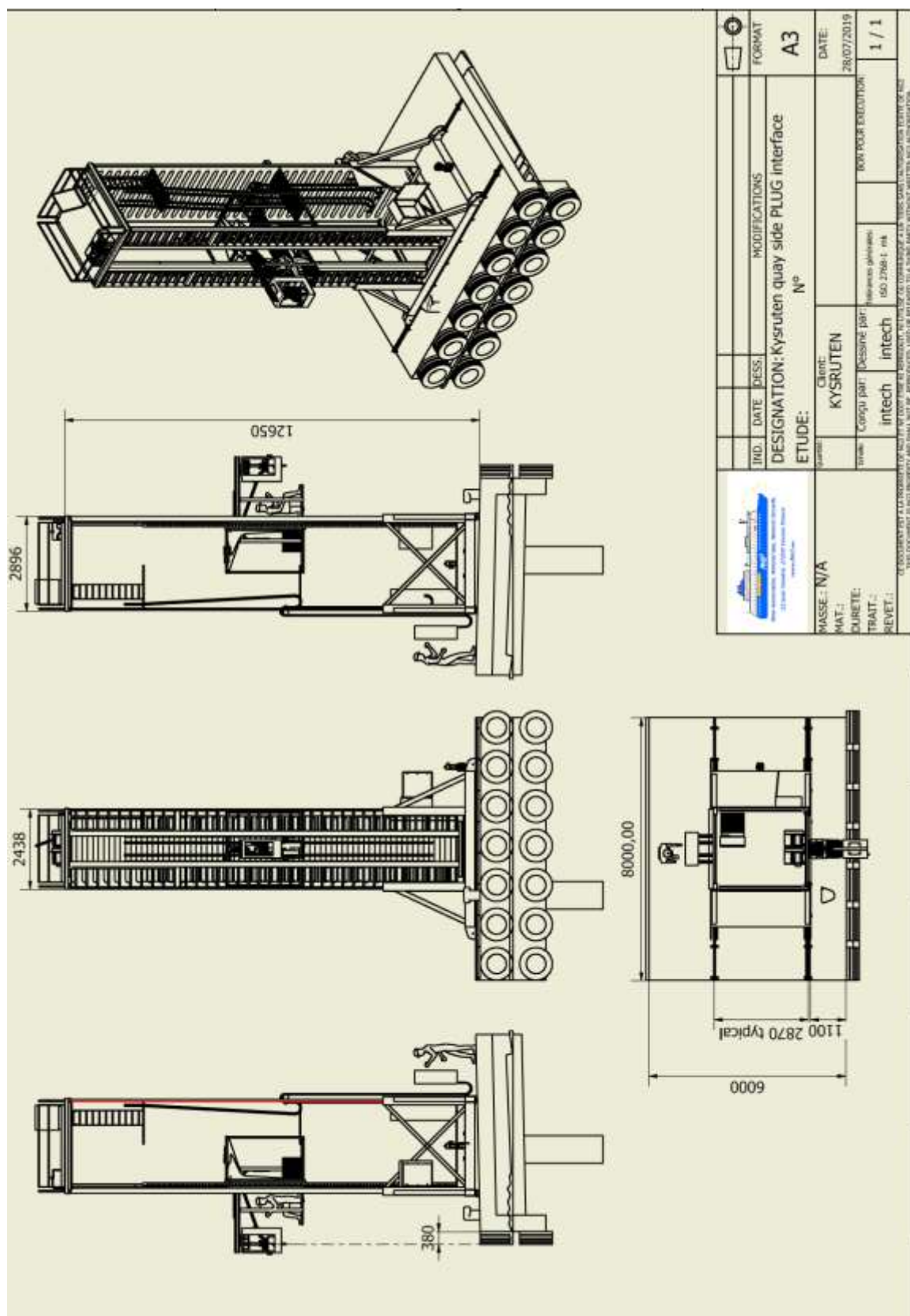












PLUG quay side interface GA



3.1 Interfaces

3.1.1 Mechanical interfaces

On the quay side, the mechanical interface will be by M 22 bolted anchoring in the existing concrete quay structure.

3.1.2 Electrical interfaces

Power Exchange	Three 240 mm ² 1 KV cables per phases the corresponding lugs, bolt and nuts for connection with the quay side junction box to be provided by customer .
Grounding	50 mm ² cable, M12 cable shoes
Power supply	230 V /50 Hz /5000 W

3.1.3 C&C interfaces

C&C input/output between PLUG system and Ship or shore power supply station IAS will be routed by dry contacts, 24 V relays or Ethernet Modbus TPIIP interface for additional non safety related item, such as vessel IMO number, shore power supply name, etc...

To allow remote trouble shooting and maintenance, a permanent internet access shall be provided to the PLUG interface.

4 Deliverables

4.1 Deliverables

We propose to deliver, as described below:

One side PLUG interfaces to be installed in Norway west coast harbour terminal.

4.2 Main Technical Features for quay side PLUG interface

- 1 Self mating / de mating AC 1 kV / 1 kV socket with Three male contacts to be interfaced each with 3 240 mm ² cables per phases	Included
- 1 hoisting system with 2 m long chain and 230 V winch	Included
-1 rain proof fish tank cover	Included
- motor driven platform moving on two rails (X axis)	Included
- Two rail tracks	Included
1 control cabinet with: PLC, Wi Fi interface, Local back up buttons interface and video tracking system	Included
2 sliding beam end stops sensors (Y axis)	Included
2 Pilots lines	Included
40 feet container structure with motorized (SZ) platform dolly	Included
20 meters long 6 x 240 mm ² 1 kV cable loop from socket to customer provided quay side junction box	Included
20 meters long 50 mm ² Earth cable from socket to customer provided quay side junction box	Included
- Power cable Junction box with power exchange management system	Excluded
- Unloading at destination	Excluded
- Hot work and Installation on site, including rail track installation	Excluded
1 kV cable from quay side customer, provided junction box to charging station breaker	Included
-Crane and access lift for on site installation	Excluded
- Quay side power exchange breaker	Excluded
- Earth cable in interface with charging station	Excluded
- Quay and fender modifications	Excluded
- Public access restriction around the interface	Excluded

5 Customer provided equipment's

5.1 Quay side junction box

The shore junction box between the quay side fish tank cable loop and the power supply cables coming from the station are to be provided and installed on the quay side cable loop fixed point structure by the customer.

6 Technical documentation:

- General Assembly drawings;
- Single line diagram and logic chart
- User's Manual

7 On site Engineering support

To support the customer, NG3 will provide the following onsite support activities within this proposal.

7.1 Ship side and quay side installation

To support customer project in the installation and tests on site , NG3 will provide two engineers on site for two periods of 5 week days.

7.2 Power exchange system commissioning

To support customer in the commissioning of the whole power exchange system, NG3 will provide an engineer on site for another period of 5 week days.

7.3 Post commissioning maintenance support

Following commissioning, NG3 and its subcontractors offer maintenance support that will be charged as indicated in annex 1.

8 Exclusions

8.1 Quay side main component's installation

NG3 involvement for the installation on board and on the quay side of PLUG's main components will be limited to:

- guide and support these operations to be performed by customer employees or subcontractors
- perform the detailed integration work of PLUG sub components.

In particular anchoring of the rail track on the quay is to performed by customer employees or subcontractors

8.2 High Amperage tests

Low voltage and/or High amperage laboratory or factory test by NG3 are excluded, but may be offered as an option.



8.3 Terminal and harbour engineering

The terminal modification relevant to the implementation of the quay side PLUG interface and its approval by authorities are excluded. In the same way, Harbour engineering tasks, such as the implementation or removal of bumper tires or fenders, or quay reinforcement, if needed, are excluded.

8.4 Public access restrictions

Public access restrictions, such as fencing around (typically a 6 x 8 m area) the unit are excluded.

8.5 Power Contacts and cable resizing

The proposed contacts solution is designed for a 1500 Amp continuous AC 690 V power exchange capability in 25°C ambient still air. To address this requirement, with margins, we propose contacts designed for 2000 Amp.

We expect that the proposed solution will meet customer requirement without modifications.

If this is not the case, corrective actions such as resizing of the contacts and cables, although possible, are, nevertheless, excluded from the present proposal.

8.6 Electrical safety barriers

Hazard Control barriers preventing the crew or personnel to have access to energized live parts during nominal operations and maintenance activities on the PLUG interfaces (such as access restriction unless power breakers are open and lines are safely, and visibly, grounded) will have to be implemented by the customer. These barriers are excluded from the present proposal.

8.7 Travel and accommodation

Travel and accommodation expenses in Norway and travel expenses between France and Norway made within this project will be charged to customer as described in annex 1.

8.8 Additional safety measures

As defined in the present document, the PLUG solution is understood to meet customer and relevant class and authorities' safety requirements, therefore, additional safety measures and barriers not mentioned in the present proposal are excluded.

8.9 Additional engineering loop

As defined in the present document, the PLUG solution general configuration is understood to meet customer project operational requirements, and remaining engineering effort will be focused on detailed design only. Therefore, additional engineering loop to modify the PLUG solution configuration is excluded.

9 Condition of sales

9.1 Execution of the Contract

NG3 General Terms and Conditions of sales shall govern this purchase.



The Customer's acceptance of the offer shall be deemed an acceptance of these Conditions of Sale. The parties shall be bound by this contract only when NG3 has given its approval in writing ("Acknowledgment of Receipt") for the Customer's order and is fully in line with customer order (hereinafter referred to as the "Order").

The Supply includes, precisely and exclusively, the equipment or the services specified in the Order. Any extra Supply or any change to the Supply shall be specified in an amendment or give rise to a new Order by and between NG3 and the Customer. Any change to the Order shall be specified in a written amendment signed by the authorized representatives of the Parties.

9.2 Price and Terms of Payment

The price, in Euros, excluding tax and duties and the applicable terms for payment shall be as indicated in Annex 1.

9.2.1 Delivery and schedule

Prices for a Supply are Ex work north of France, according to Incoterm 2010 , 8 months after order.

9.3 Liquidated damages

Liquidated damages are limited as described in annex 1.

9.4 Intellectual Property

NG3 fully reserves the intellectual property rights relevant to the proposed shore connection, id est, all the hardware and software technologies respectively located between the ship and quay side breakers.