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Pre-Feasibility Study (PFS) 12931 Qc Ship Unloading Hold Covers

Québec, September 12, 2025

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Report of Pre-Feasibility Study
Our file: 704503-0000-40ER-0001_B02

Dear Mr. Seguin,

We are pleased to submit this Report of Pre-Feasibility Study for the Quebec Ship Unloading Hold Covers.

Do not hesitate to communicate with the undersigned should you have further questions regarding the content of this report.

Yours truly,

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1. Introduction

1.1 Context

Glencore Sudbury Integrated Nickel Operations (Sudbury INO) operates a ship unloading facility at the Port of Québec. Raglan concentrate (FeNiCuS) is received in bulk eight times per year from the MV Arvik bulk carrier. Of the five cargo holds on the ship, four are used to carry the bulk material. These cargo holds are unloaded by a Siwertell Ship unloader installed in 2021. This new piece of equipment increased the overall operational efficiency and reduced dust emissions. The unloader was incorporated with a fog and radar-based vision system to help mitigate dust emissions.

Although the new unloading system is highly efficient to mitigate dust emissions during operations, Glencore Sudbury INO wants to evaluate with this pre-feasibility study the possibility to enclose the unloading process with a ship hold cover. The ship hold cover is intended to minimize the escape of dust-laden air trapped within the ship hold. If feasible, the ship hold cover would limit dust emission even further by not allowing air to come out of the holds during the unloading process.



Figure 1-1: Ship Unloading at Quebec's Port

1.2 Mandate

The study aims to evaluate the feasibility of covering the ship holds in any way.

In the context of the requested mandate, the following methodology is implemented to ensure a structured and effective approach to the process:

- Information collection
 - Collect all necessary technical information such as existing plans and relevant documents, and
 - Survey the ship and the site of the current unloader.
- Concept development
 - Review of the existing solutions from similar applications;
 - Generate potential solutions applied to this mandate;
 - Compare the solutions with a decision matrix to recommend one of the options, and
 - Assess the feasibility of the selected option.

1.3 Objectives

The methodology described in **Section 1.2** aims to ensure a methodical approach through the study process.

It should be noted that the proposed engineering will consider the following elements:

- Preliminary 2D drawings and sketches for the generated options;
- Decision matrix to evaluate the options;
- Feasibility review of the major components;
- Risk assessment for the selected option, and
- Cost estimate at an accuracy of $\pm 50\%$ for the selected option.



2. General Information

2.1 Definitions

For the purposes of this document, the following definitions are used:

Table 2-1: Definitions

Expression	Definition
OWNER:	GLENCORE
CONSULTANT OR ENGINEER:	ATKINSRÉALIS
QSL:	QUÉBEC STEVEDORING LIMITED, THE LOCAL MAINTAINER AND OPERATOR OF THE SITE.
SHALL / MUST:	A MANDATORY REQUIREMENT.
SHOULD / COULD / WILL / MAY BE:	A RECOMMENDATION OR SUGGESTION.

2.2 Units

In general, the SI system will be used for this project.

2.3 Language

All communication, report and studies between client and AtkinsRéalis Canada Inc. (AtkinsRéalis) were to be done in English.

This final report is to be done in English and translated in French upon the client's final approval.



2.4 Documents Provided by Glencore Sudbury INO

The following documents were made available to AtkinsRéalis at the beginning of the project:

Table 2-2: List of Documents

Document Number	Description	Revision
BMH TARP ASSEMBLY INSTRUCTION.PDF	BMH TARP ASSEMBLY INSTRUCTION	N/A
FB 98601.PDF	COUVERT ANTIPOUSSIERE, PHASE 1	N/A
FB 98602.PDF	COUVERT ANTIPOUSSIERE, PHASE 1	N/A
3990ISKM001.PDF	N/A	N/A
H346069-2087-50-124-0001.PDF	SUDBURY INTEGRATED NICKEL OPERATIONS 11764 – QC PORT SHIP UNLOADER REPLACEMENT ZERO DUST EMISSIONS REPORT	C
VLC-RECORD-2025-04-08-11H37M28S-2025-03-21 HOLD5.MP4-	UNLOADING VIDEO	N/A
ATTACHMENT-1B UPPER DECK ARRANGEMENT 0524.DWG	UPPER DECK ARRANGEMENT	N/A
PXL_20210421_233810935.JPG	N/A	N/A
PXL_20210421_234012763.JPG	N/A	N/A
PXL_20210421_234529553.JPG	N/A	N/A
PXL_20210423_153828206.JPG	N/A	N/A
PXL_20210423_153855049.JPG	N/A	N/A
SIWERTELL O&M MANUAL SPEC MOTION SPEEDS.PDF	SIWERTELL O&M MANUAL SPEC MOTION SPEEDS	N/A

These drawings can be found in **Appendix A**.



3. Study Criteria

The following presents the study criteria as set out during the project's kick-off meeting.

- The solution must be a hold cover concept. It cannot in any way focus on changing the unloader or the overall unloading process as part of the solution in order to protect the efficiency of the new ship unloader and its recent upgrades regarding the operation process and dust emission mitigation;
- The solution should focus on keeping the “S” shape unloading pattern over the bulk material surface. This pattern is essential for maintaining an even surface, thereby reducing the occurrence of material free fall. For information, these material free falls are a primary source of dust generation;
- The solution must allow for a greasing of the screw after every four (4) hours of operation. This is a mandatory maintenance procedure. This operation is done a few times during the unloading of every hold;
- The solution must allow for a loader to be placed into the hold while the material is low. This loader is necessary to recuperate the remaining bulk material that the screw can not reach in the bottom of the hold;
- There are current climate constraints including wind, rain, snow, hail, and any mix of the listed that impact unloading protocols;
- The solution should aim to allow for a closing of the hold in 30 minutes. If the solution to cover the hold also helps to prevent contamination of the concentrate from the weather, then the timeline for hold closing could be extended;
- The bulk material cannot be mixed with water to a concentration of more than two (2) percent. Hence, the solution must not allow water, in any form, to discharge or accumulate in the hold;
- The solution must avoid any major modifications on the unloading arm;
- The solution must avoid any modifications inside or outside of the holds since the holds are used to carry other types of cargo that could be affected by changes inside and outside of the hold, and
- The solution must ensure means of egress accessibility.



4. Existing Technology Research

The first step is to research if there is any existing technology for this type of application. This research included a review of similar projects done within AtkinsRéalis for various port facilities. Most of the projects were with clients from the agri-food industry which used dust control on their unloading system (conveyors, silo, etc.). Through all the recent and past projects related to dust control in port facilities analysed, none of them included a dust control system focusing on covering the hold.

Although the internal research did not provide any similar solutions from past project, it did point to some existing companies with potential solutions. The following presents these existing technologies.

4.1 Tarp Cover

The tarp cover system uses a flexible tarp that is unfolded over the whole hold surface to minimize the open area. A version of this system was tried inhouse by Glencore Sudbury INO with their old unloader system. The details of this concept can be found in Appendix B. The main idea was to form a “tent” over the hold that could cover most of the hold during the unloading operations. This system was static since the unloader itself did not allow for movement during the operation. The tarp cover eventually failed due to its lack of resistance to harsh climate constraints.

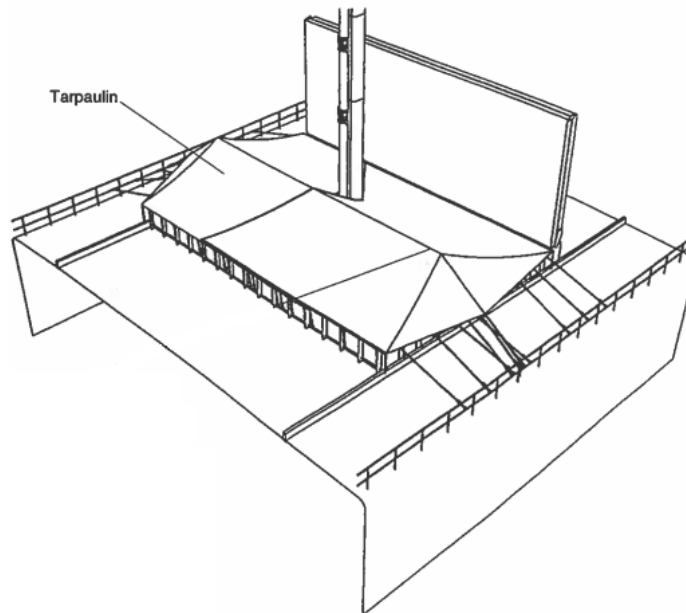


Figure 4-1: Siwertell Dust and Drizzle Protection

This tarp cover approach is not commercially available. There is a company that promotes a similar solution on a case-by-case design. The ECOloading system from Global Rain Protector is an R&D product with prototypes tested on a 1:1 scale with selected clients. Their prototypes were designed for static loading applications with the tarp system being fixed on the loading arm. They used a system of ropes to unfold the tarp to its open position. Once deployed, the tarp could be placed over hold and attached to the ship manually. The company dismantled their prototypes during the Covid-19 pandemic and is now looking for partners to develop their product.





Figure 4-2: ECOloading from Global Rain Protector

4.2 Retractable Rigid Panels

The retractable rigid panels cover is a tried and tested roof type system. Its range of application goes from small gazebo-like roof to large stadium size roofing systems. Although these systems will vary depending on the application, they usually involve a set of rigid panels sliding into one another. The size of the panels and their number is chosen depending on the surface area to cover and the structural resistance needed.

Some niche companies have adapted these systems to fit specific applications, including in the maritime industry. The company Blommaert based in Belgium has developed a sliding rigid panels system adapted for barges. This system was not adapted for a singular ship hold as of today. The company's brochure can be found in **Appendix C**.

This solution is evaluated later in **Section 6.1**.



Figure 4-3: Blommaert Sliding Cover

4.3 Dust Suppression System

Dust suppression systems are widely available and used on many different applications. These systems often use a water-based fluid to mitigate dust propagation. The fluid can be applied directly to the material forming a heavier layer on the surface that limits its volatility. If the dry properties of the material are important, a water atomisation system can produce a fog over the bulk material to have water particles in the air to “catch” the dust particles and bring them down by gravity. These solutions come in various combinations from using a chemical mix in the water-based fluid to adjusting the size of the atomized particles in the fog depending on the application and the material compatibility with water.

The demand for these systems is very high. Their field of application range from mining sites to general construction sites with some specialized manufacturer developing products for specific needs. ENVEX is an example of a company that developed products for targeted fields. They have a range of dust suppression systems with a product line that is specifically designed for port infrastructures. Their product catalog can be found in **Appendix D**.



Figure 4-4: Envex Fog Cannon

These dust suppression technologies have evolved during the last years and companies keep innovating with new and better adapted designs. This development is driven by the high efficiency of the atomisation technology in terms of cost and dust emission control, making the solution commercially available. This solution is used in many ports and is even cited as “the only practical method of suppressing airborne dust in outdoor operations” from bulk handling experts in the Port Technology International journal (Lesch, 2017).

This technology is also quite interesting for minerals applications. Many minerals concentrate have a water incompatibility for various reasons. Therefore, the atomization can be controlled to have small and located water droplets in the air to make sure that it does not wet the material. The U.S. Environmental Protection Agency even declared the Fogging Systems as Best Demonstrated Technology (BDT) for coal handling equipment used on sub-bituminous and lignite coals as reported in the Port Technology International journal (Gilroy, 2011).

These articles can be found in **Appendix E**. This solution was not further investigated because it does not cover the hold as requested and Glencore Sudbury INO is currently utilising a similar fog system during their unloading operation.



4.4 Summary of Existing Technologies

The key takeaway of this review is that there are no existing technologies available on the market that are appropriate for the application.

There were attempts to develop a cover solution for an unloading process like the Tarp Cover from **Section 4.1** but the known prototypes are not in service anymore due to the many problems encountered.

Other ship cover systems are available on the market like the Retractable Rigid Panels from **Section 4.2**, however, these solutions are designed for a specific barge ship type and are not suitable for a hold ship type. This technology can not be transferred to the hold unloading application without a complete re-engineering of the solution.

The most available solution on the market for dust control on ship unloading applications is the water atomization system. There are many companies that offer this dust suppression solution on the market. The market seems to have focused on developing this technology for ship loading and unloading applications. As said previously, a fog system is already being used by Glencore Sudbury INO on the ship during the unloading operation.



5. Conceptual Approach

AtkinsRéalis studied several conceptual designs that were presented to Glencore Sudbury INO throughout the project's progress presentation. These presentations can be found in **Appendix F**.

The various conceptual approaches are divided into the three (3) categories: Static Cover, Tent Tarp, and Dynamic Cover. These different approaches were reviewed with Glencore Sudbury INO to assess against the stated criteria.

5.1 Static Cover

The static cover option relies on using any arrangement of panels to cover partly the hold surface area. This approach is the first studied since it is set to be cost effective and simple to put in place.

This option has already been analysed in two previous studies done on the old unloader. These studies can be found in **Appendix G**.

One of the past studies looked at the effectiveness of a static cover with a computerized fluid dynamic (CFD) simulation. The study did not recommend using a static cover to manage dust emissions due to the operational, cover cleanup and resistance to snow constraints of such a solution.

Any static cover solutions would require a lot of manipulation during the unloading. Each cover would need to be moved by the crane to allow full access of the hold surface area. Every manipulation of the static cover is at risk of releasing dust that stuck to the cover during the unloading operation. This could increase dust events if the covers are not cleaned every time before moving them.

This solution would not allow any fluidity of movement for the unloader's arm unless it leaves a lot of open surface area. The open area would require a lot of dedusting capability to manage a negative pressure in the hold.

Considering the impact on the unloading process, the low effectiveness of this solution, and the required dedusting capacity, this concept is discarded.

5.2 Tent Tarp

Covering the hold with a tarp is a potential solution that can take form in many ways. **Section 4.1** summarized an unsuccessful solution using a "tent-like" tarp system that was static and fixed to the ship. This solution was attempted with the previous generation (stationary) ship unloader. The new ship unloader has more movement axis compared to the previous one. A tarp fixed solely to the ship would not allow the unloader to move thus making the static tarp a non-viable solution for Glencore Sudbury INO operations.

The tarp system would need a few movements axis to follow the unloader unloading in its "S" shape pattern. These movements axis can either be done by a system of ropes, a tarp attached to a moving structure or have the tarp directly attached to the unloading arm.



The moving tarp with ropes and structure concept is not discarded up to this point. It is however a much more complex concept and will be presented in the **Section 5.3**. Up to this point, the study analyses only non-dynamic covers to evaluate a large variety of potential concepts.

Attaching the tarp to the unloader arm is a potential solution that would allow for certain movement axis. **Section 4.1** presented a company offering an R&D product with a tarp concept attached to a fixed loader's arm. This solution is in direct conflict with a Study Criteria asking not to have any major modifications on the unloader. Any modifications to the unloading arm to attach such a concept represent a major technical risk, mainly because the unloader was not designed for this. As an example, the added weight and the required wind resistance of this solution might not be compatible with the actual structural and mechanical design.

The major benefit of this concept is the full covering of the hold open surface.

Figure 5-1 and **Figure 5-2** present sketches of the tarp system with and without a retaining rope system. The tarp would need to allow for the unloading arm's movement. The tarp would be massive considering the 16-metre (m) long side hold. It would require a dynamic set of ropes to fold the tarp whenever it moves. Without such a system, the tarp would fold itself inside the hold up to about 8 m down (half the hold length). This rope system would need to be fixed to the hold side as an anchor point to generate the retaining force for the cable folding the tarp.

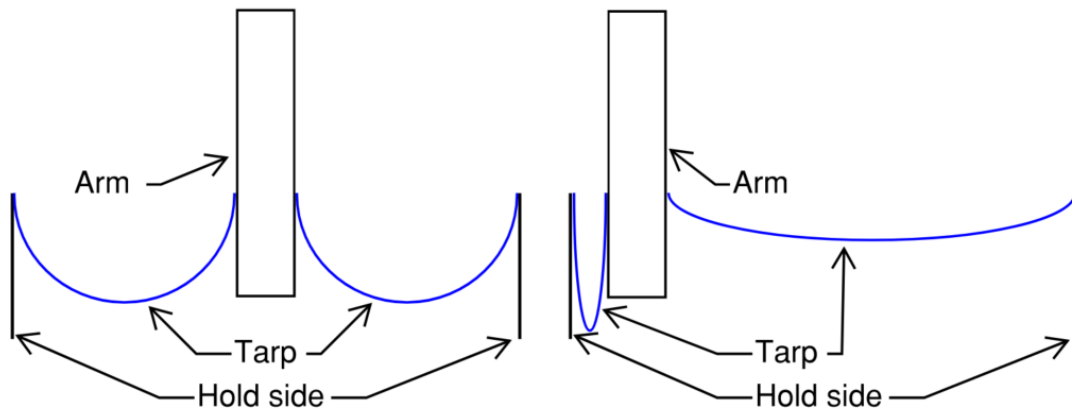


Figure 5-1: Tarp Fixed to the Unloading Arm without a Retaining Rope System Fixed to the Hold

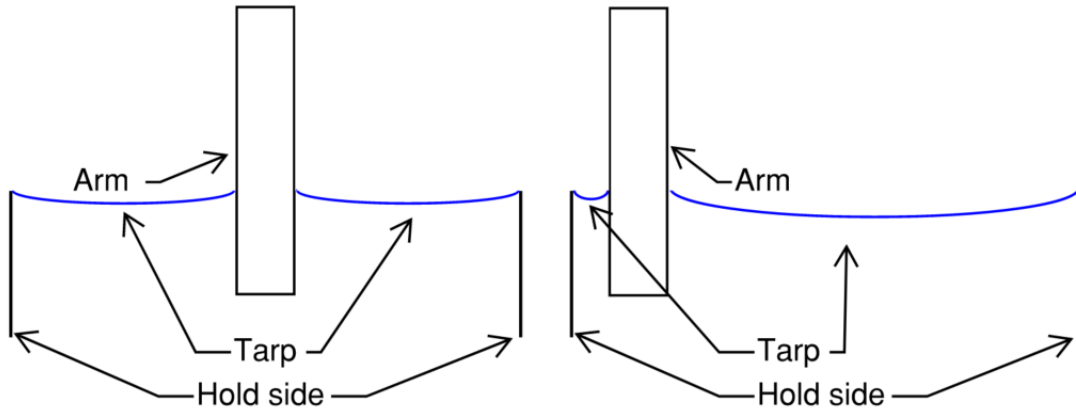


Figure 5-2: Tarp Fixed to the Unloading Arm with a Retaining Rope System Fixed to the Hold

The tarp itself would need to be designed with an irregular shape to manage the arm movement in all X, Y, and Z axis. The system of rope would be complex with many anchor points on the hold to accommodate the movement in all direction.

The operation of the unloading arm would be highly affected mostly because its screw requires greasing every 4 hours as pointed in the Study Criteria. This would result in many openings and closings of the tarp system. The hold would remain open during the greasing sequence allowing for dust to escape. Any leftover dust that would tend to stick to the tarp or on the screw as it is lifted above the plane of the open hold could be released in the air during the many open and close sequences.

Considering that this option does not meet the Study Criteria (required modifications on the unloader, major disturbance on the unloading process for the greasing of the screw) and the lack of proof of concept available on the market, this option is discarded.

5.3 Dynamic Cover

Any dynamic system would need fixed anchors on the ship to allow for the dynamic forces of the movement. There is not a lot of space available on the ship to allow any easy anchoring. The existing hold cover and the crane towers are obstacle for any anchoring system to install on the sides of the hold. The following figure presents the deck configuration, these obstacles and the possible available area to install a support system.

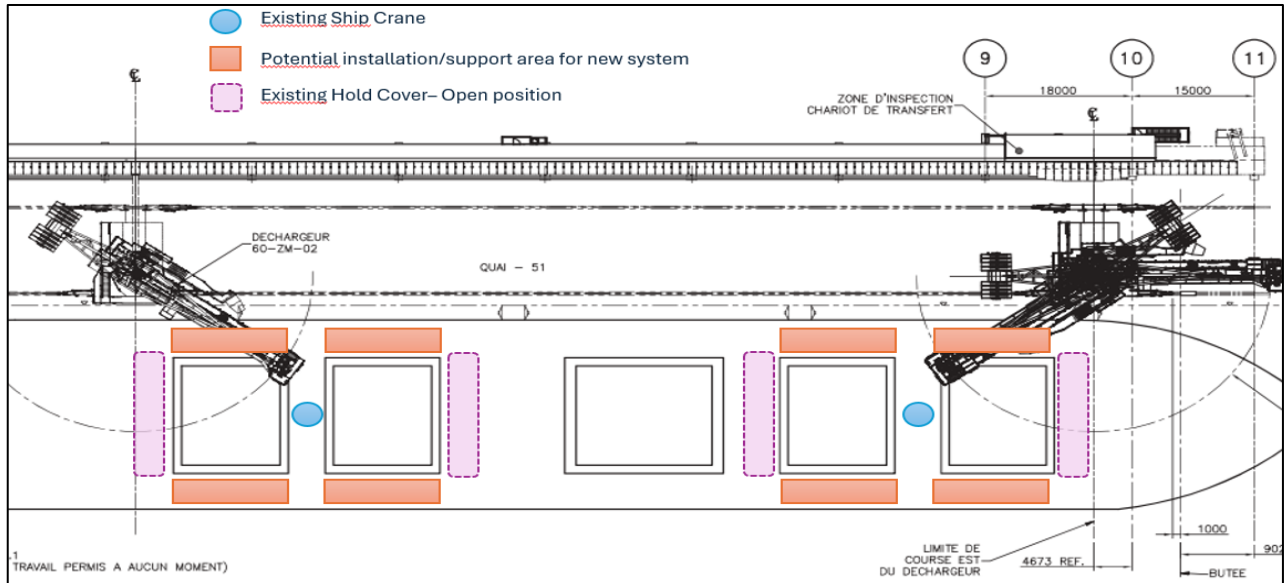


Figure 5-3: Obstacles on the Ship's Deck

The following figure presents the clearance on the existing hold cover side and the crane tower side.



Figure 5-4: Clearance on the Existing Hold Cover and Crane Side

The hold's sides have a railway used by the existing hold cover for its opening and closing system. This railway has a slope at its end where the hold cover rests while open making it uneven. Any anchor system on these rails would have to manage this uneven surface. The following figure presents this rail slope.



Figure 5-5: Existing Hold Rail

This leaves the two walkways as most optimal positions to install any anchor system.

5.3.1 Supported on One Side

The next logical approach is to cover the hold with a dynamic cover that would be able to follow the unloader's arm movement. This has been a critical criterion that almost all other concepts did not meet. The dynamic approach offers a much better solution to ease the impact on the operations if it can minimize the impact on the arm's movement.

The first approach is to evaluate how this system can be supported on one side only. This would provide a major advantage since the system must assure means of egress on the ship. Having a support only on one walkway would leave the other one clear for circulation.

The technical feasibility of the one side support is difficult mostly due to the important lever force from the large hold opening. Any dynamic system using multiple rigid panels to open and close some area would need to manage the lever force of almost 16 m. It would be very impacted by climate constraint, especially wind. The following figure presents a conceptual sketch for this approach.



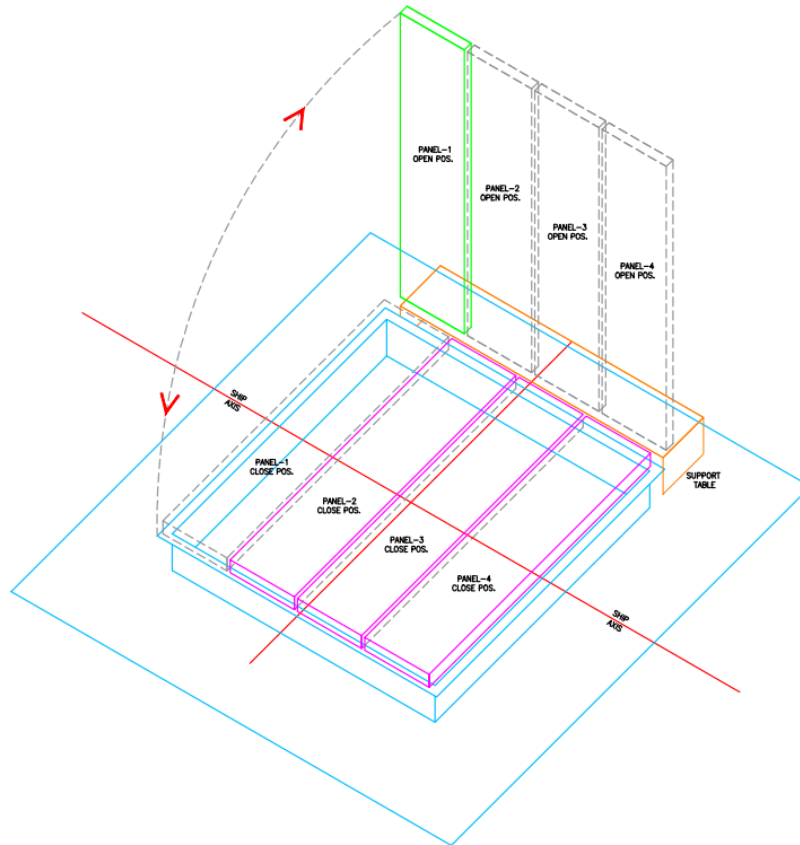


Figure 5-6: Dynamic System Supported on One Side

Having multiple panels would also require many separate systems which would add more complexity to the overall concept. The left open area would also require dedusting. More surface area left open means more dedusting power required. Thus, the concept would need to find the right balance between minimizing the left open area and the number of separate panels with their own opening system. The unloader's arm would also be restricted to the long opening for its primary movement of the unloading "S" pattern. The open and close movement of each panel would also have a major impact on the unloading time and process.

The open panels would also be exposed to wind. It could allow the dust that stuck to the panel to be released to the environment.

Given that this option does not meet the Study Criteria (vulnerable to wind, "S" unloading pattern affected, major impact on unloading time and process) and the significant technical limitations of the solution, this concept is discarded.

5.3.2 Supported on two sides

Supporting the system on more than one side would result in using both walkways to anchor down. Any solution using this approach would need to manage means of egress for workers on the ship. Having walkways obstructed would limit the ability to move around the hold areas, which is a safety risk and would need to be addressed.



A two sides support approach can allow for a sliding mechanism using a moving structure. Such a mechanism can be designed to move with the unloader's arm to minimize any impact on the unloading process. The idea is to have an opening small enough to allow the arm in the hold and move this opening as the unloader's arm is moving. The rest of the hold area would be covered.

Before looking at the covering solution, it is important to first evaluate how the whole mechanism would move. There is two ways to move the mechanism to obtain the desired effect. The first strategy is moving the primary movement along the ship's axis and the second strategy is moving the primary movement across the ship's axis. The primary movement is defined as how the mechanism that covers most of the hold's area moves. The following figures show sketches of these movements.

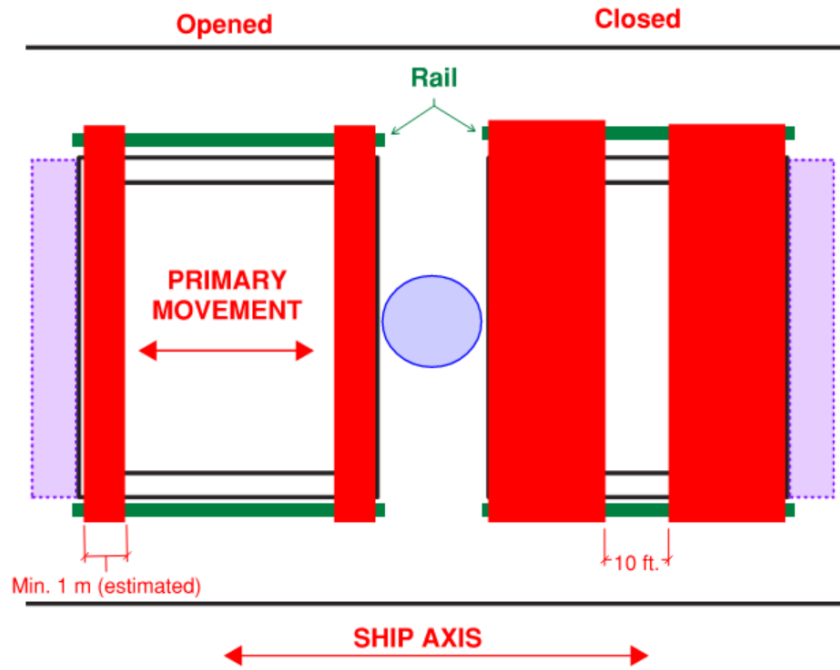


Figure 5-7: Primary Movement Along the Ship's Axis



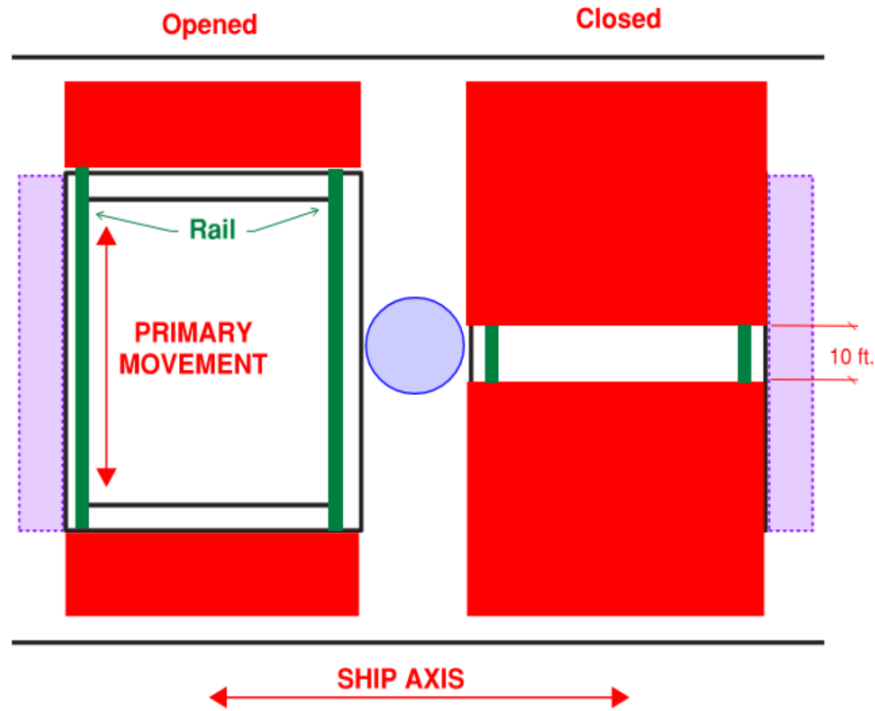


Figure 5-8: Primary Movement Across the Ship's Axis

Both approaches use rails to support the sliding movement. These rails are then anchored down to the ship's walkways. Both these options must not interfere with the crane (Figure 5-8, shown in blue) and the hold existing doors (Figure 5-8, shown in purple).

The primary movement along the ship's axis offers less flexibility to the unloader's arm since it would take more surface area whenever the system is at its open position. This is an issue because it would affect the unloading pattern by not allowing the unloader to even out the material's surface across the hold. It is impossible to know at this point how much space the system would take, but it was estimated at a minimum of 1 m from the hold side as presented in the figure. This system also does not allow for the existing hold doors to close while it is in place. The ship's crew would have to disassemble the system to close the door.

The primary movement across the ship's axis can allow for the unloader's arm to access almost all the hold area. This is possible if the system is designed to retract all the way outside of the hold area and over the walkways. In this case, there would only be the rails left over the hold area. This provides much more flexibility for the unloader to even out the material surface and minimize this risk of having material free falls. The system design could also allow for a quick removal of the rails while still leaving the supports on the walkways. This would facilitate the closing of the existing hold door. The main con of this approach is that the walkways would be more obstructed thus needing a more complex design of the supports to allow for means of egress.

Both approaches can use a secondary movement to help close the remaining area and achieve a square opening. The 10 feet (ft) wide opening presented in the figures is hypothetical and would be reevaluated during a design phase.

Considering the presented pros and cons of the two approaches, the dynamic concept using a primary movement across the ship's axis will be evaluated further.



6. Dynamic Concept Comparison

6.1 Concepts

The proposed concepts are the following:

- Concept 1: Foldable Tarp System,
- Concept 2: Retractable Rigid Roof (Panels) System,
- Concept 3: Rolled Tarp System.

The sketches for these concepts can be found in **Appendix H**.

The proposed concepts share the same base lines. The following figure presents the principal components that are described as follow:

- Two **Base Table**, one on each side of the hold, to support the retractable systems and their components. They allow an easy and quick fixing of the system on the ship through its existing anchor points usually used to anchor ship containers. They would provide a fixed support to anchor the rails that would go from one walkway to another. These tables would also be equipped with portion of rails allowing movement during deployment phases (retraction/extension). With these portions of rails, the covering system can retract itself over the walkways, all the way out of the hold area.
- Two **Rail Beam**, one on the crane side and one on the existing hold cover side, acting as railway to allow for the deployment of the retractable systems all along the Hold width (primary movement). These beams should be latticing girder type to provide rigidity and long span without being too heavy. These beams would connect to the Base Table on each side with a quick connect fixture to allow for a quick fixing of the system.
- Two **Square Beam** systems, one per Base Table, that would move on the Rail Beam of allow for the extension and retraction of the covering system. These Square Beam are the structures on which the covering systems are attached to act as the primary movement. The two Square Beam would move simultaneously in the same direction to follow the unloader's arm position during the unloading process. Note that the Square Beam would differ on the Concept 2 due to the existing rigidity of the panels.
- Two **Travelling Trolleys**, one on each Rail Beam, associated to four **Winches**, two for each trolley, to ensure the primary movement of the retractable systems. With the help of these winches, the trolleys would move simultaneously in the same direction and in perfect alignment with each other. The Travelling Trolleys would allow the movement of the Square Beam while these are mainly used to attach the covering system.
- Two **Roll-up Door** systems, one on each Travelling Trolleys, that would ensure the coverage of the remaining hold open area. This system would close the gap to 10 ft by 10 ft open area. These systems would act as the secondary movement as presented before.

The following figure presents a general view of the concept with these items.



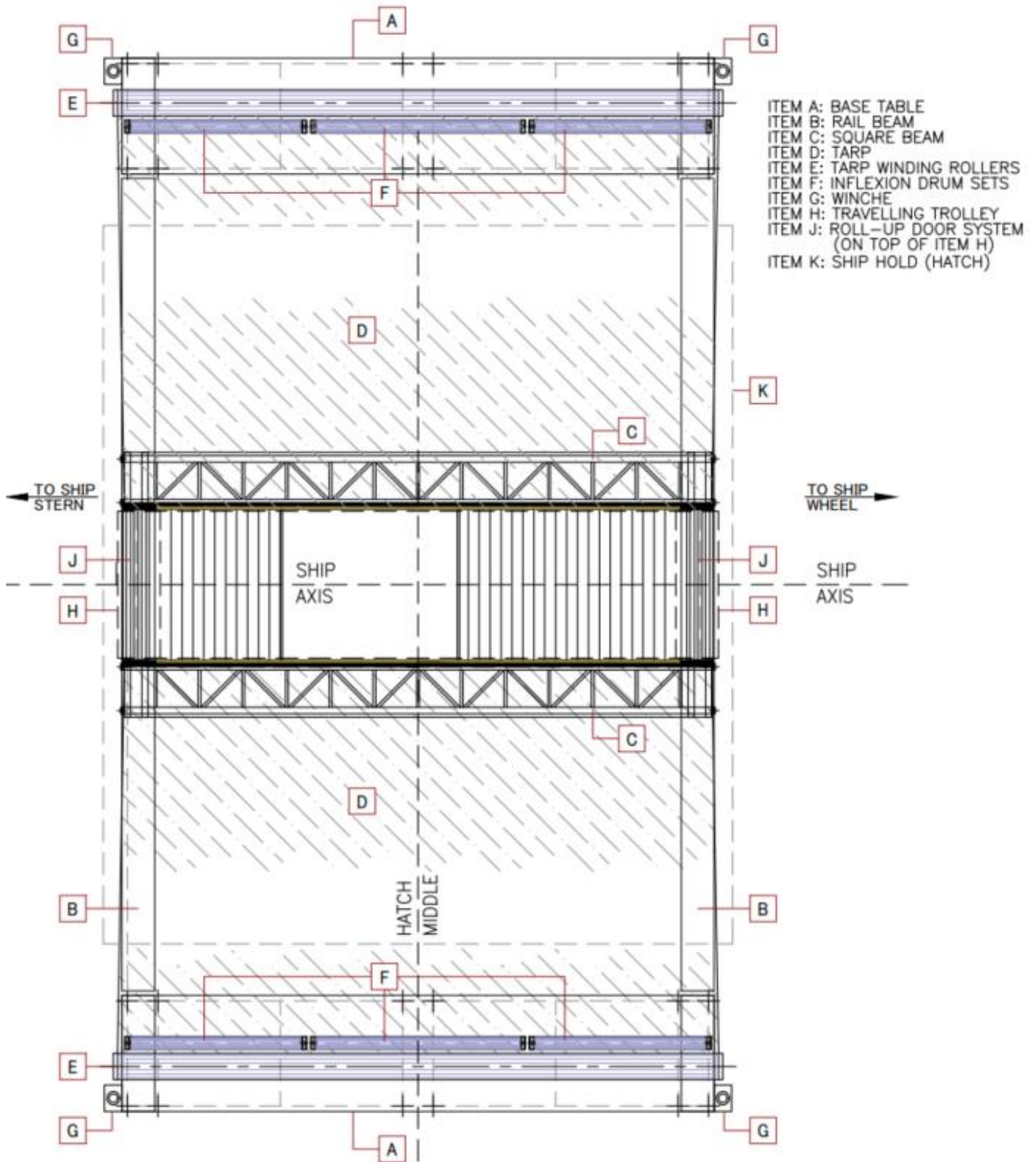


Figure 6-1: Rolled Tarp Components Location

6.2 Comparison Matrix

A comparison matrix is established to list and compare the respective advantages and disadvantages of the three concepts listed above. The matrix is based on certain objectives to satisfy that are directly related to the current unloader and unloading process.

The main objectives are defined as follow: Environment, Operability, HSE, and CAPEX. These objectives are then developed into criteria with a specific definition.

Not all criteria have the same impact. The criteria are weighted to reflect their importance and criticality on scale of one (1) to five (5), five (5) being the most important.

The matrix was presented to Glencore Sudbury INO to discuss the criteria and weight factors.

Each concept is given a score from 1 to 10 based how they perform on the criterion, 10 being the best score. The score is justified with notes explaining the reason behind this evaluation. The scores are then weighed with the weight factor of the criterion.

The weighted scores are then summed for each concept to obtain the total score.

The comparison matrix can be found in Appendix I.

6.3 Recommendation

Based on the comparison matrix results, AtkinsRéalis recommend the “Rolled Tarp” as the most suited hold covering concept to assess the needs and constraints of the current unloading process. The feasibility of this concept shall be further investigated in the following sections.



7. Rolled Tarp Concept Feasibility

7.1 Mechanical

Each subset of the Rolled Tarp concept listed in **Section 6.1**, is equipped with several mechanical components. Their combined and coordinated actions allow the system to perform its main function with reliability and great flexibility.

Note that at this pre-feasibility study phase, the mechanical components proposed herein are only for reference and could be replaced by others during next phases.

The following criteria guided the component's choice:

- The use of known and reliable technologies/components tested in similar operating environments and conditions (weather) must be favored;
- As much as possible, parts must be standard and available on the market (spare parts needed for maintenance), and
- The number of mechanical components must be kept at a minimum to prevent possible failures.

The main mechanical components are described in the following paragraphs.

The **Tarp** is specifically designed to meet the requirements of the unloading process. It shall have the following characteristics:

- 1) Made from light, strong and anti static fabric flexible material (ex. PCV). This would limit dust fumes from sticking to the inner wall of the canvas and at the same time offer great rigidity and minimize weight.
- 2) Reinforced with cables uniformly distributed over the entire tarp width acting as stiffeners to provide the best resistance to applied loads. This is necessary to allow the tarp to resist weather constraints, its own weight, and the tension applied to minimize the deflection.
- 3) Designed for extreme industrial environment with operation conditions being hot, cold, dusty, etc.
- 4) Shall offer long service life, durability, tightness and operational reliability combined with minimal maintenance.

The tarp **Winding Roller** is installed on the Base Tables, one per table. Refer to Figure 6-1 for its location. It consists of a main shaft supported at its ends with pillow blocks. Refer to **Section 7.2** for the sizing of these elements. It would be equipped with a continuous canvas tensioning system, either motorized or spring loaded. At this point in the study, it is considered motorized to allow for a torque control roller. This would prevent deflection in the tarp under the effect of its own weight and the loads of climatic elements like rain and snow.

The **Inflection Drum** is installed on the Base Tables, one per table. It helps to keep the tarp under tension and allow to adapt its direction depending on the Square Beam's position on the Rail Beam. Refer to **Section 7.2** for the sizing of these elements.



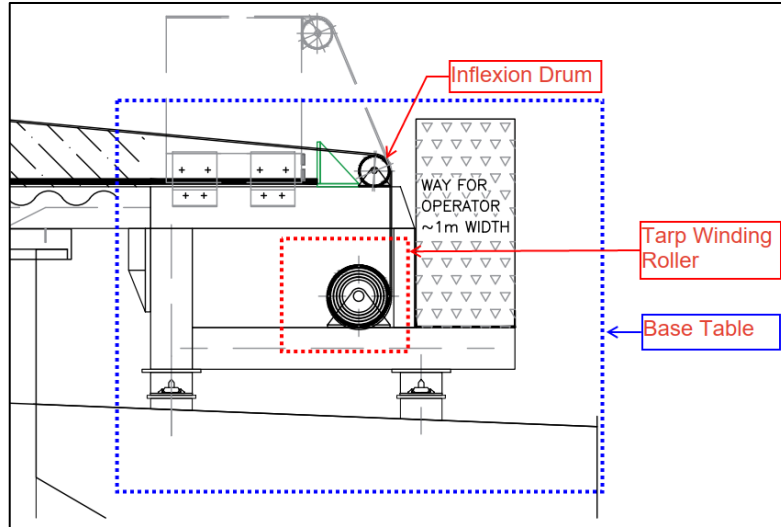


Figure 7-1: Base Table Sketch with the Winding Roller and Inflection Drum

The **Wheels**, located under the Square Beams and Travelling Trolleys, ensure supporting, sliding and guidance of the cover system along the Rail Beams and Base Tables.

The **Rollers**, located under the Square Beams and Travelling Trolleys, act as an anti-uplift device of the Square Beams and Travelling Trolleys.

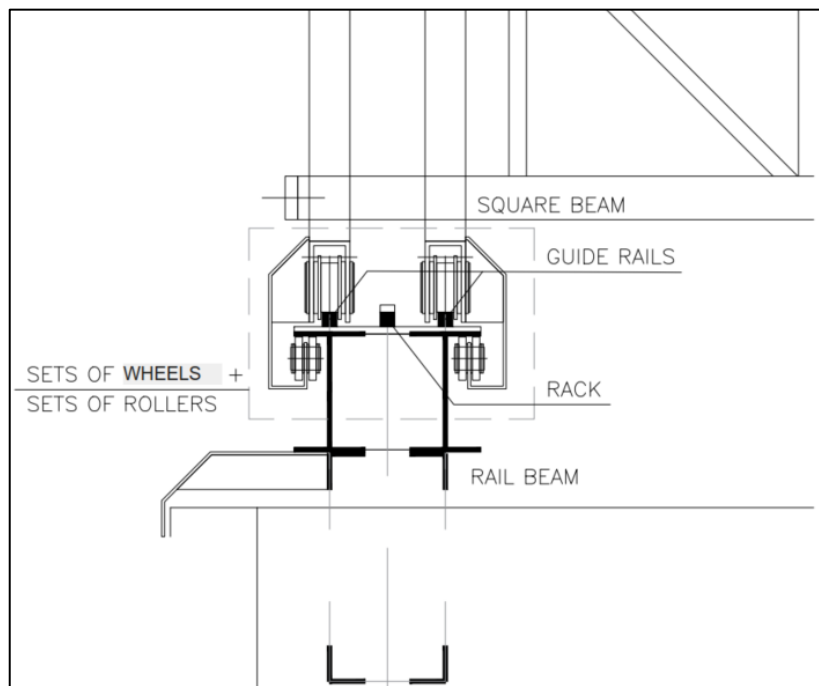


Figure 7-2: Wheels and Rollers Typical Assembly on the Rail Beam

The Industrial **Winches**, one on each side of the Base Tables, should be constructed to withstand industrial environment and designed to handle heavy-duty tasks ensuring consistent performance under heavy loads with

ease while maintaining a compact, efficient footprint. They should be designed with efficient torque transfer, high capacity and quick and easy cable deployment for operational efficiency. The winches would perform two main functions:

- 1) Ensure an easy and coordinated movement for Travelling Trolleys and Square Beams assemblies once attached together and adapt its travelling speed to the unloader's arm movement.
- 2) Secure the travelling assembly (Travelling Trolleys and Squares beams) since they must withstand and compensate for the tension applied in the tarp to minimize its deflection.

Two **Travelling Trolleys**, one on each Rail Beam, would assure the connection of the Square Beams and support the secondary movement system. The movement during the unloader operations would be done with the Winches on the Base Tables attached to the Travelling Trolleys. It shall also have a driving unit controlled by VFD associated to a rack and pinion system, the rack would be installed on rail beam between the guidance rails. This would allow the trolley to move along the rail beam during the installation and removal phase to attach the Square Beams with the Travelling Trolleys. It shall have the Wheel and Roller system as described above. It shall have the Roll-up Door system attached on its top to generate the secondary movement.

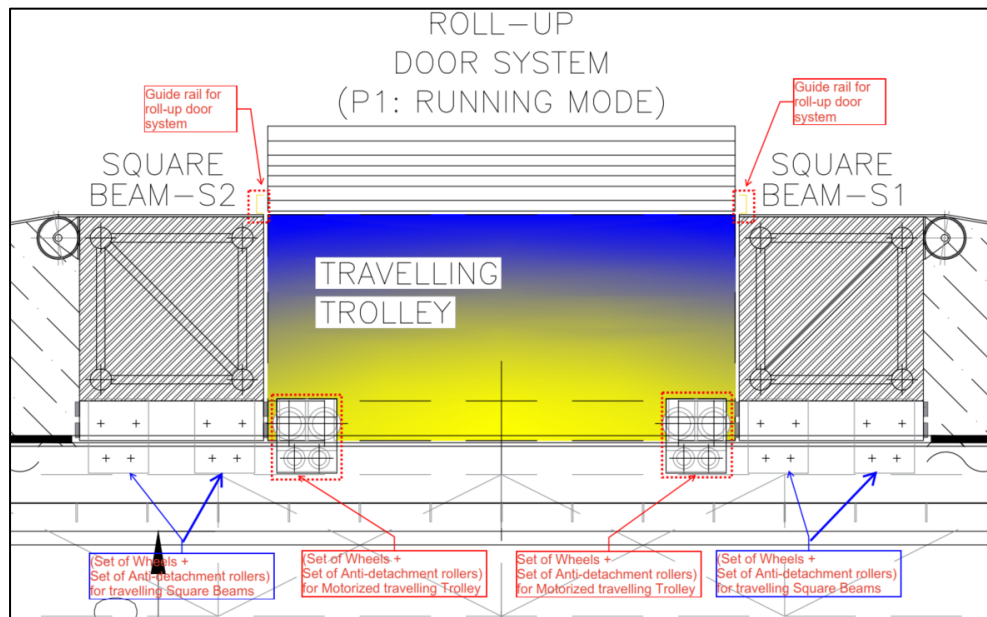


Figure 7-3: Travelling Trolley Side View Sketch

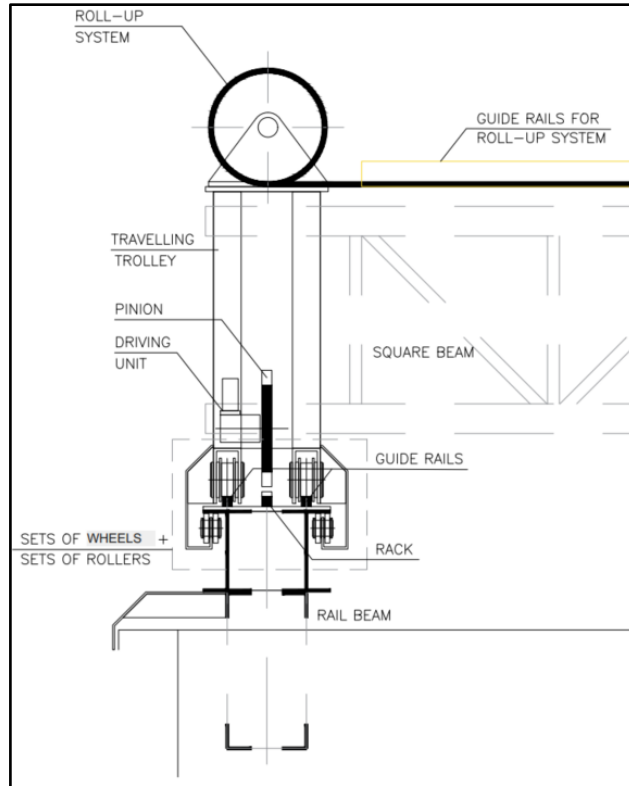


Figure 7-4: Travelling Trolley Front View Sketch

The **Roll-up Door** system is installed on top of travelling trolley, one per Travelling Trolley. This mechanism ensures the secondary movement. Its construction can be made from fabric material, tarp-like, or aluminium alloy roof roller shutters. The use of a standard and existing Roll-up Door system is recommended. The Square Beam would include a guiding system to guide the Roll-up Door on each side. Each Roll-up Door system would be motorized and shall be equipped with remote controller and proximity detectors to adjust the shift of shutter depending on unloader's arm location. The following figure are for reference only and show a typical Roll-up Door system available on the market.

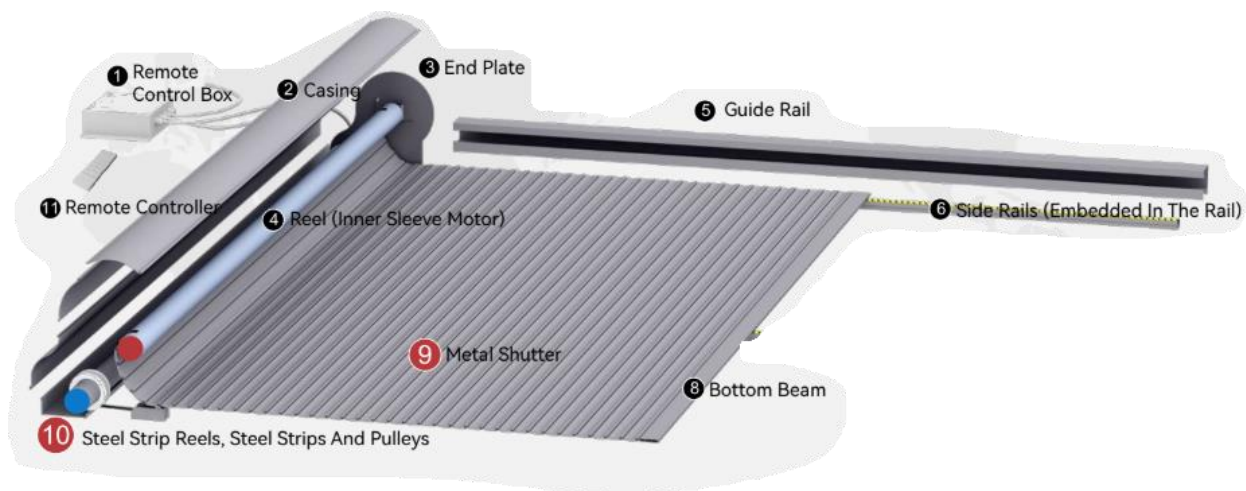


Figure 7-5: Typical Roll-up Door System

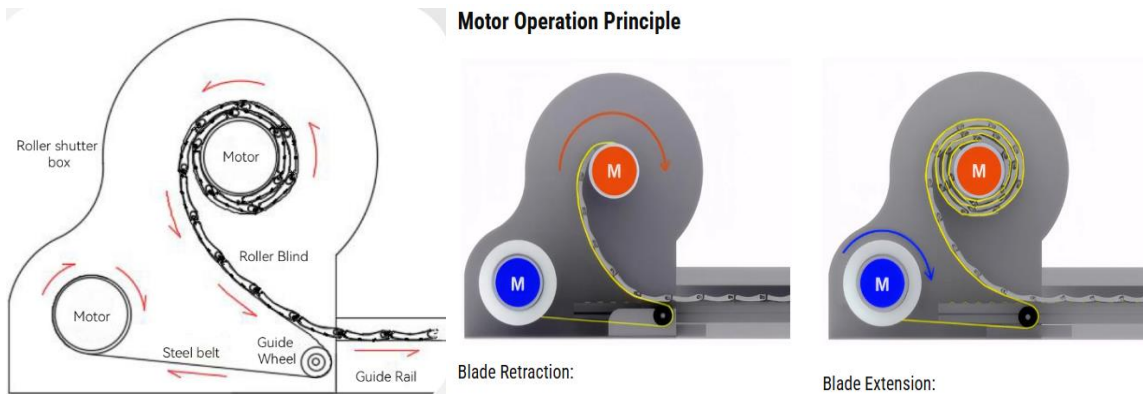


Figure 7-6: Typical Roll-up Door Motorisation

The approximative dimensions of the shutter box, see previous figure for localisation, would depend on the door length. The fully deployed length should be at least ~10.5 m considering the open area for the unloader's arm. This system dimensions would need to be further developed in the detailed engineering phase with the help of existing suppliers. The following figure presents the door length.

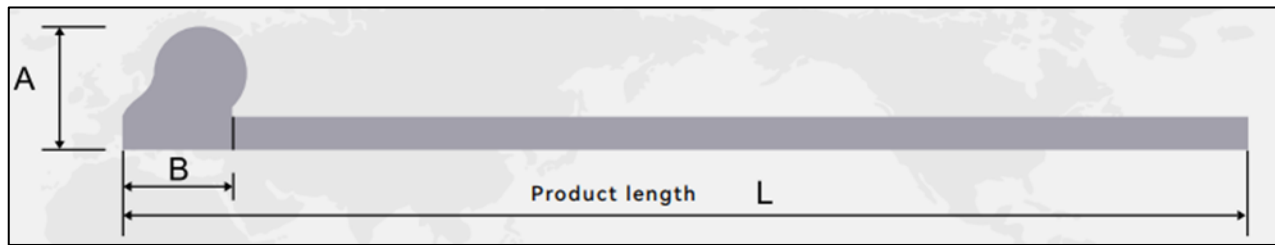


Figure 7-7: Roll-up Door Length

7.2 Structural

The following structural components are studied to assess the feasibility of the Rolled Tarp concept:

- Square Beam;
- Rail Beam;
- Tarp Winding Roller, and
- Inflection Drum.

In general, the structural steel should be made from hollow sections for trusses and drums and from beams for the other structural parts. The use of galvanised steel or stainless steel should be considered in the detailed engineering phase to avoid rust and maintenance issues.

The technical complexity in this concept resides in the tension needed in the tarp to minimize its deflection. The following figure shows the deflection of the tarp in a simplified sketch.



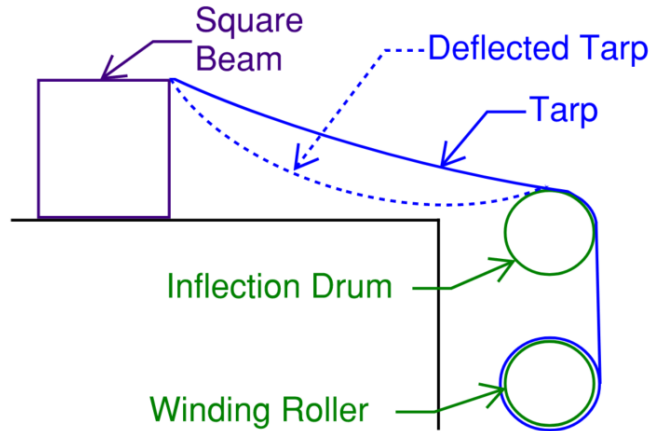


Figure 7-8: Tarp Deflection

The tension needed to minimize the deflection would influence the sizing of the Square Beam, Inflection Drum and Winding Roller. The tension in the tarp is calculated to resist rainwater, snow, and wind while keeping the hold covered efficiently.

The **Square Beam**, as described in **Section 6.1**, would be a 3D truss of ± 14 m long to allow the tarp to cover the whole hold length. The dimensions are evaluated to be 1.2 m high per side to allow sufficient height for the tarp slope and provide structural rigidity. Note that this structural element must resist the tension from the tarp attached on its highest point. This structural element would be made from hollow sections (HSS) to minimize its weight while keeping the structural integrity. It could be possible to split this beam in two sections to facilitate the handling and storage in a future detailed engineering phase. The following figure shows a conceptual Square Beam.

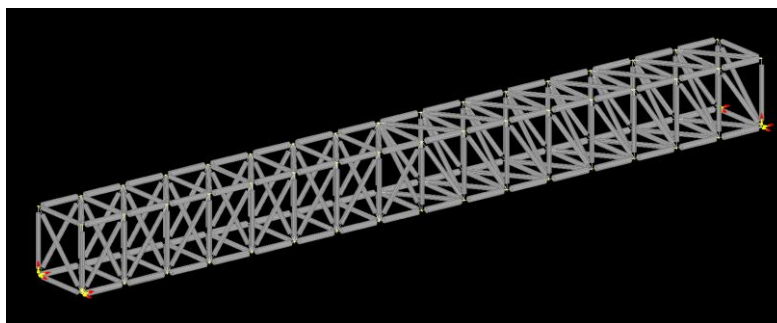


Figure 7-9: Square Beam

The tarp **Winding Roller** would need to resist the necessary torque to generate the tension in the tarp. This structural element would also need to resist the weight of the tarp once rolled on it. It should be made of one piece of ± 14 m long to allow for a continuous tarp. It could be made of more than one piece if the tarp has more than one section. This would need to be further analysed in a future detailed engineering phase. It is evaluated to be a round hollow section of 356 millimeters (mm).

The **Inflection Drum** act as roller to redirect the tarp in the wanted position. It would be affected by the tarp tension but not as much as the other structural components. It can be made in more than one section if needed. It is considered as one continuous ± 14 m long round hollow section of 356 mm for this study.

The **Rail Beam**, as described in **Section 6.1**, would be a 3D truss of ± 21 m long attached to both Base Table. The dimensions are evaluated to be 0.6 m wide and ± 1 m high. This structural element would be made from hollow sections (HSS) to minimize its weight while keeping the structural integrity. A crane rail and a system of rack and pinion would be added to allow the displacement of the Square Beam and Travelling Trolley.

The secondary structure would need to be designed in a future detailed engineering phase. At this moment, the design of these components does not represent a significant threat for this feasibility study. The secondary structure would include elements like the Base Table, Traveling Trolley, guiding members, and other smaller components.

7.3 Electricity and Instrumentation

7.3.1 Motorisation

7.3.1.1 General

All motors shall be totally enclosed, fan-cooled (TEFC or TENV), IP55, NEMA Premium efficiency or equivalent with a service factor of 1.15 and shall be supplied by the Mechanical Equipment Supplier, unless otherwise specified.

All motors shall have a HP (horsepower) rating based on continuous operation at rated load without impairing the service factor and without exceeding the temperature rise determined by the enclosure and insulation at a maximum ambient temperature of 40°C and an altitude of 1,000 m.

The insulation system must be class F for a class B operating temperature rise.

1. Motors of less than $\frac{1}{2}$ HP must be specified at 115 volts, single-phase, 60 Hz.
2. Motors of $\frac{1}{2}$ HP and over, must be specified at 440/460 volts, 3 phase, 60 Hz, unless a voltage transformer is supplied by the manufacturer.
3. Motors with variable-frequency drives must be specified at 440/460 volts, 3 phases, 60 HZ and Inverter Duty type per NEMA MG-1, Part 31.
4. Motors shall be supplied with a braking system for a fixed/stable position when motor is not powered.

7.3.1.2 Travelling Trolley Motorization

As per **Section 7.1**, the center trolley should be moved using a motorized winch system installed on each end of the hold. These motors would be asynchronous type. They would move the Travelling Trolley along the Rail Beam, pulling the tension by the winch system on one end and releasing the tension on the other end.

As the four (4) winch motors would be designed as independent, a master-slave configuration should be implemented for motors on the same Base Table, wharf and seaside. In normal operation, the Travelling Trolley would be linked on both side with the winch hook allowing the pulling and releasing to work in synchronicity.



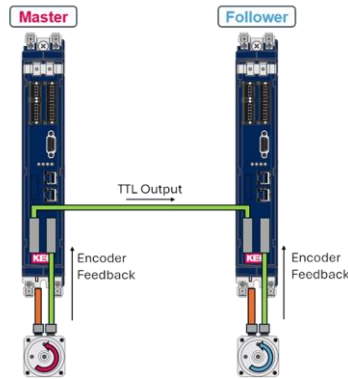


Figure 7-10: Master-Slave Motor Configuration

In maintenance mode, the Travelling Trolley would use a motorized rack and pinion system for the movement to its end location. This manoeuvre would only be done for linking and unlinking the winch systems.

The winch motors would be driven by VFD. An absolute encoder would be required for the position of the Travelling Trolleys on the Rail Beams. Linear encoder could also be used along the Rail Beam for better precision but would be subject to more wear and nickel dust.

7.3.1.3 Tarp Winding Rollers

The Winding Roller motor shall maintain a variable tension on the tarp, wherever the position of the Travelling Trolleys is on the hold. The recommendation is to use synchronous motorisation with encoder feedback or a servo motor. These would allow a precise positioning and speed control, and a dedicated control loop to maintain tension on the tarp. Specific weight cells could be added on the tarp or on the inflexion drum to read the mean tension. A tension control system similar to paper mill winding machine could be studied for the tarp tensioning.

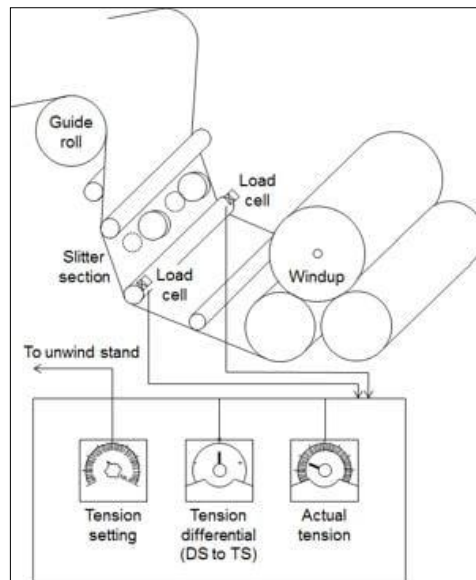


Figure 7-11: Typical Tensioning System.

7.3.1.4 Roll-up Door

Each Roll-up Door system would use two (2) motors as per the contacted supplier's concept, see Figure 7-6: Typical Roll-up Door Motorisation Motorization and control system could be included in the Roll-up Door system. The hold covering system should have all the motorization programming centralised in a single control panel to operate it. Following this recommendation, the Roll-up Door control should be in this panel too. Linear encoders on the Square Beam side rails, refer to **Section 7.2**, would be required for the exact position of the doors.

7.3.1.5 Auxiliaries

Cable reel systems are suggested for the moving equipment (motor, instruments, controls, etc.). These could be motorized or equipped with a retractable mechanism allowing deployment or winding of the power supply and instrument cables depending on the Travelling Trolleys position.



Figure 7-12: Example of Standard Cable Reel

These cable reel systems are typically supplied as fully working equipment. Otherwise, for custom cable reels, the motor and VFD would be driven by the main control panel of the hold cover system.

7.3.2 Electrical Availability

The following information was collected during the ship visit.

The ship is equipped with two (2) main electrical power supply on the deck of 440Vac 60Hz-3p fused at 60A with a screw clamp connection.

- The first connection located at the stern side of hold #2, and
- The second connection located on the port side of hold #4.





Figure 7-13: 440Vac 60Hz-3p Fused at 60A

If Glencore Sudbury INO want to keep using the dry fog system or industrial ventilation powered from the ship, it must be considered that one of these connections would be used for this purpose.

The ship is also equipped with 440Vac 60Hz-3p fused at 30A typically used to supply the container during the travel. As nickel concentrate unloading is done without any container loaded, these connections should be available. However, preference is to use the 60A connection mentioned above in the first case.



Figure 7-14: 440Vac 60Hz-3p Fused at 30A

For higher power requirement, it would be possible to derive power to the deck from the crane #1 located on the stern side of hold #4. The deck crane is currently powered with 440Vac breaker at 630A from the electrical room. While possible, this work would require modifications to intercept the 2x 50MM²x3C cables entering the crane at the deck level. This work would require electrical modifications like an addition of a manual transfer switch and an additional electrical switch with a lower fused protection to fit the needs of the skid equipment. Any modifications to the ship electrical or mechanical require an intensive review and approval from the ship owner.



The motor control center (MCC) located inside the main electrical room and at the ship's bow could possibly provide electrical power, but the passage of cable inside conduits along the deck and holds makes it quite difficult and would again require modifications to the ship's structure. While still being an option, this is not the preferred solution due to its complexity.

Other options remain available like bringing power from the Glencore E-room on the wharf. It should be noted that cabling along the wharf up to the ship has a certain logistic complexity to allow the unloading's operation and passage on the wharf.

7.3.3 Control Panel

A combined control panel could be designed to integrate the power distribution, VFD, motor starters and controllers (i.e. PLC) to minimize the number on components and easy its transportability. The control panel shall use an embedded transformer for internal control voltage (120Vac).

The control panel shall manage all the motors operation, sensors on the Winding Rollers and Tarp system, security and exchange with the unloader to control the position of the tarps.

Quick lock connectors could be used for any remote electrical equipment to ease maintenance and transport operations. Cables could be designed to be rolled and stored with the control panel skid or disconnected and stored elsewhere.

Special consideration needs to be made for the nickel dust and ventilation of the control panel (or electrical panel). As transformers, VFD and other electrical component tend to dissipate heat, a ventilation system using proper filtration and panel design avoiding infiltration is essential. Material of the panel shall be SS316, or epoxy coated steel, as per Glencore Sudbury INO requirements.

7.3.4 Tarp Position Control

To facilitate the interaction of the cover system with the unloader's arm position, the tarp position shall be designed as a controlled X-Y fixed hole area moving on the hold full area. All independent motorisations (travelling Trolleys, Roll-up Door, Winding Roller) would work synchronously with the control system to provide a X-Y hole centred with the unloader's arm actual (or next) position.

The unloader's arm position could be recorded in two (2) different ways:

- Exchange of position with the unloader using wireless antennas with the unloader's operator cabin, and
- Radars scanners located on each corner of the hold providing the actual X-Y position of the boom over the hold.

For these options, Glencore Sudbury INO would require the support from Siwertell and a dedicated radar system provider (i.e., Indurad GmbH) for the implementation and exchange of the boom position over the hold.

7.3.5 Radar System

The existing 3D radar, designed by Indurad GmbH and Glencore, has a radar sensor installed underneath the unloader's arm. The new tarp system might cause inoperability of the 3D radar since only a portion of the hold would be visible. One way to resolve this issue could be the possibility to install 3D radar sensor inside the hold below the tarp system, thus providing visibility underneath the tarps. This option would need to be studied with the support



from Indurad GmbH. The new positioning of the radar system can be integrated in the design of the cover system in the feasibility engineering phase.

7.4 Industrial Ventilation

A bag house would be necessary to create a negative pressure in the hold to manage the remaining openings and fugitives of the system.

The goal is to create a negative pressure to assure that the air flows in the hold and not out. This would prevent any dust particles in the hold air to escape. A bag house must be used to achieve this result since it would filter the air as it creates the negative pressure. The bag house would not be used to operate dedusting at a specific point close to the unloader's arm.

The opening for the unloader is set to be 10 ft by 10 ft as a hypothesis for this study. This hypothesis was determined with the Glencore Sudbury INO team during the kickoff meeting.

It is impossible to know at this point how much fugitives the design would have. Another hypothesis is done to have an order of magnitude of the required CFM for the bag house. At this moment, it is considered that there would be 1 ft-high fugitive all around the hold perimeter. This hypothesis is conservative and would need to be reviewed during detailed design.

The *Industrial Ventilation – A Manual of Recommended Practice for Design 27th Edition* is used to choose the required air velocity for the openings. The chosen value is set at 100 ft per minute since the energy of dispersion would be low when the particles arrive at the hold opening. The following figure shows the recommended capture velocities from the cited manual.

Energy of dispersion	Examples	V, ft/min
Little motion	Evaporation from tanks, degreasing	75–100
Average motion	Intermittent container filling; low speed conveyor transfers; welding; plating; pickling	100–200
High	Barrel filling; conveyor loading; crushers	200–500
Very high	Grinding; abrasive blasting; tumbling	500–2000

Factors affecting choices within ranges	
Strength of cross-drafts due to makeup air, traffic, etc.	
Need for effectiveness in collection:	
toxicity of contaminants produced by the source exposures from other sources, which reduces acceptable exposure from this source quantity of air contaminants generated – production rate, volatility, time generated	
* see also ANSI Z9.2–1979	

Figure 7-15: Industrial Ventilation Recommended Capture Velocities

The required air flow is calculated at 30 000 CFM using the set values of area and air velocity.

A baghouse with this airflow would require a significant amount of space. The system should use a cartridge filtering technique to minimize the total volume of the equipment. It is unclear at this point where the baghouse would need to be placed. It can either be on the deck or on a closed ship hold. The baghouse should then be on a frame to install on the ship or on a trailer on the deck.

Filtrartech was contacted to evaluate this equipment. The company is well known for their custom baghouse projects and worked with Glencore Sudbury INO before. They were able to provide an estimate for a baghouse to fit the needs of the project. Their estimate and drawing example can be found in **Appendix J**.

The baghouse would benefit from an existing manhole to connect its duct. This manhole is close to the hold and offers a sufficient opening area to allow for large flow of air. Its location is high enough in the hold so that the material would not go over it when filled. The following figure shows the opening inside and outside of the hold.



Figure 7-16: Manhole for Baghouse Ductwork Connection

8. Project Constraints and Risks

Here are the main constraints and risks related to the hold cover system. These constraints and risks were discussed internally with the team and Glencore Sudbury INO. Further HAZOP would be required for a complete risk analysis.

8.1 General Constraints and Risks

8.1.1 R&D Prototype

At this point, the type of system described above is not available as an “off-the-shelf” product. The development of such a solution would need to follow a rigid R&D plan to ensure its success. This would impact the workload needed to develop the system as it would require more engineering than it would with integrating an existing solution. This system would require engineering on both its development and integration.

The first product fabricated would act as a prototype for this system. It would require testing before it is used on the ship. There are many ways to approach these testing phases, the two most common being the “scaled down” version prototype and the “bench test”. A scaled-down version of this product can be manufactured for testing purposes. It would require less investment than a full-size prototype and represents a smaller financial risk if there are corrections needed. The other approach is to manufacture a full-size prototype and design a bench test to have a testing phase. The bench test would require a lot of space due to the system size. It would need to recreate the operating environment to simulate the prototype in real time. This way of testing represents a financial risk due to the size of the bench test and the potential correction needed on a full-scale cover system.

8.1.2 Cost (CapEx)

The previous section presented the testing constraint related to an R&D product. This approach to product development has a major impact on the capital expenditure (CapEx) required compared to integrating an off-the-shelf product. **Section 9** presents a preliminary cost estimate of the preferred solution at the PFS phase. It must be noted that the engineering cost and fabrication cost present risks for the unknown amount of R&D work needed.

8.1.3 Environmental Emissions

The hold cover system aims to limit dust emission with a physical barrier between the material and the environment. This approach is different from the existing dust suppression system using a dry fog. The hold cover system can have dust particles stick to its Tarp during the unloading operation due to its proximity to the material. The Tarp cannot be protected from the material with a dry fog because it would allow the hold to accumulate moisture.

The Tarp being at risk of having particles that sticks on it, the winding and unwinding movement could eventually transfer the particles stuck on the inside of the tarp to its outside face. These particles stuck on the outside face could eventually be released into the environment if they are exposed to wind conditions.

The number of particles stuck on the system could be significant depending on how much the cover interferes with the operations, affecting the manoeuvrability and material free falls. A cover system would not act at the source of the dust emission, meaning at the surface of the material, like a water atomization (dry fog) system can. The material free falls could potentially lift more dust and affect the effectiveness of the solution. The system would need to rely



on its sealing ability and industrial ventilation to manage the fugitives. Given the limited amount of information on the solution at this pre-feasibility study level, it must be pointed out that there is a risk of not achieving the desired outcome in terms of environmental emissions with a cover system.

The removal and transportation of the system are also at risk of letting go of some particles that stuck on the system.

There is no planned means of mitigation for the removal and transportation of the system. These particles present an environmental emission risk during the removal and transportation of the system that cannot be quantified at this study phase.

Due to the health and safety constraints around the installation on the ship, the dust fugitives that stick on the system would only be fully removed when cleaning the hold cover at the storage site or another cleaning site.

8.2 Installation and Removal Constraints and Risks

8.2.1 Design Error

The cover system must be adapted to use over every hold on the ship. The design would require precise measurement and positioning of existing ship components to adapt for all possible interference and connection point. On-site surveys should be conducted to obtain the necessary measurements. They can be used together with the ship's drawing to set a design base model. If the model is not precise enough, dimensional errors could occur in the fabrication of the hold cover system. Those dimensional errors would only be discovered on site during the installation on the ship and could require modification on the cover system that would have an impact on the project's cost.

8.2.2 Installation and Removal Time

The cover system scale is massive due to the dimensions of the hold being almost sixteen (16) meters long on each side. The system component's weight would require major lifting operations to install and uninstall. It must be known that the lifting operations would require maneuvering large and heavy components. The time for a complete installation and removal of the hold cover system is unknown and cannot be evaluated at this study phase. It can have a major impact on the unloading schedule and thus require more ship's docking time.

8.2.3 Partial Removal Time

A partial removal sequence is considered in the design to allow for a closing of the hold within a set amount of time. The removal of the Rail Beam with the Travelling Trolley is necessary to close the hold. The rest of the system can stay in place if required for an emergency closing of the hold. The criterion of a thirty (30) minutes complete hold closing procedure comes from the removal time of the existing fogging system. This amount of time is set to avoid any moisture accumulation in the hold whenever the weather conditions are not favourable.

There is a risk that the partial removal time cannot meet the criterion due to the number of components to disassemble and their complex manoeuvrability.

The set-time can always be reviewed and adapted with the weather conditions tolerance. It would, however, impact the unloading procedure and impact the overall unloading time whenever the weather conditions are not favourable.



8.3 Operational Constraints and Risks

8.3.1 System Failure

There are some single points of failure in this system that can have a major impact on the unloading of the hold. Some of these can put the bulk material at risk if they were to happen during a harsh weather event.

Any internal or external communication failure could impact the ability of the cover system to move. The cover system is dependent on a continuous communication between its different moving components to allow for a synchronized and fluid movement. An internal communication failure of any electro-mechanical component can result in a complete movement stop.

The external communication is necessary to allow the cover system to follow the unloader's arm. An external communication failure can result in a collision between the two systems. A collision could lead to complete stop of the system and affect the removal time if some parts are too heavily damaged.

Redundancy of the communication and/or with the unloader's arm physical position should be considered to avoid any impact and physical damages.

The system's design cannot be weatherproof for all weather events to limit its maximum weight. The light structure would have certain limitations to its ability to resist wind and snow weight. If a structural failure occurs, like a torn Tarp or beam failure, the bulk material could be subject to the weather events.

8.3.2 Maintenance Access

The limited space on the ship would not allow for a major maintenance operation on the cover system. The Base Tables would take much of the walkway's space and might not allow for any repair on their internal components when they are installed on the ship. The Rail Beam and Travelling Trolley would be installed over the hold. It is not recommended to have any maintenance procedures on these components when they are on their unloading positions. Any failure on these components can require a removal procedure and impact the unloading schedule.

8.3.3 Confined Space Management

The existing unloading procedure already requires a man-operated unloader's assistance to collect the last part of the material. The equipment is lifted in the hold using the ship's crane. The crane then stays ready to provide support to the team down the hold in case of emergency. During this operation, the hold itself is considered a confined space, and the crew must take the necessary precaution to finish unloading the material.

The hold cover system would limit the surface area available to maneuver the crane. If the cover is removed for this operation, it would be subject to dust emission. This risk would require further investigation during a detailed engineering to establish the best unloading procedure to mitigate dust emission and ensure a safe operation.



8.3.4 Means of Egress

The ship's walkways on the deck are used as means of egress. The hold cover system must consider them in the design as specified in the study criteria. The Base Tables would require much of the walkway's space so the design should include a platform to allow for a passage. This constraint must be considered in the detail design phase.

8.3.5 Safety Around Live Machinery

The hold cover system would have a lot of moving parts that are accessible from their surroundings. Some of the components might not be able to be fully protected as required by the usual norms concerning the safety around live machinery.

It must be noted that the existing hold cover does not have guarding to prevent their access during their opening or closing sequence. The hold cover for the unloading sequence would require a thorough risk assessment to mitigate the operational risks associated with access to live machinery in a further detail engineering phase.



9. Cost Estimate

A **venture level cost estimate** is presented in this section given the available information and R&D nature of the concept.

The following assumptions were made for this estimate:

- All the prices are in Canadian Dollars;
- The costs given in this section are direct costs only;
- Indirect costs to be determined by the Owner;
- CAPEX total accuracy is $\pm 50\%$;
- The estimated concept is the Rolled Tarp;
- The estimated cost is for one (1) system;
- No ship modifications included;
- No OPEX cost included;
- Engineering cost covers the equipment and its test bench, and
- Storage and Cleaning Building cost based on Glencore Sudbury INO Loader Shed Feasibility Study.

The following table summarizes the estimated costs.

Table 9-1 : Cost Estimate

Item	Estimated Cost
Equipment Manufacture	
40 - General	75 000,00 \$
43 - Structural Steel	811 700,00 \$
45 - Mechanical	450 000,00 \$
47 - Electrical	335 000,00 \$
48 - Automation, I&C	880 000,00 \$
4B - Industrial Ventilation	142 000,00 \$
Sub-Total	2 693 700,00 \$
Test bench and Testing (50%)	1 346 850,00 \$
Tooling and Spare Parts (2% + 3%)	134 685,00 \$
Engineering (25%)	1 010 137,50 \$
Commissioning	100 000,00 \$
Storage & Cleaning Building	1 300 000,00 \$
Total Without Contingency	6 585 372,50 \$
Contingency (20%)	1 317 074,50 \$
Total	7 902 447,00 \$

A detailed version of the estimated cost can be found in **Appendix K**.

10. Preliminary Timeline

A Gantt chart of the engineering and production phase of the project was created in MS Project. The following are some of the assumptions that were made:

- The estimated time is approximated to the best of the study team's knowledge;
- The engineering of an R&D prototype product would need thorough analysis;
- The Feasibility phase of the project would be done in close collaboration with the client and equipment manufacturers;
- The ship's necessary drawings would be available for the Feasibility and Detailed Engineering phases;
- The product would need to undergo a testing phase, which has not yet been established, and
- No review/approval time is considered between each phase.

The Gantt chart can be found in **Appendix L**.



11. Conclusion

This report presented the pre-feasibility analysis of an eventual hold cover system. The methodological approach used sets out a conceptual solution allowing Glencore Sudbury INO to cover the hold while considering the impact of the cover system on their operation.

The research on existing technologies showed that there are no technical solutions on the market that are suitable for the hold cover application meeting the Study Criteria.

The proposed cover application would require a custom dynamic system as explained in the **Section 5**. The Rolled Tarp concept is the preferred solution to minimize the impact on the unloading operations while maintaining a certain cover over the hold.

However, the efficiency of the overall unloading operation would be highly affected. The installation and removal of the system would impact on the docking time and the unloading schedule. The cover itself would affect the maneuverability of the unloader and its ability to limit material free falls.

Also, there is also no guarantee of the effectiveness of this solution. A cover system would not act at the source of the dust emission like the actual fog system can. The risks of having multiple fugitives and sealing problems make it impossible to assess the performance of the system at this moment.

At this study level, it is impossible to determine if this solution would allow Glencore Sudbury INO to better control the dust emission during the overall unloading operation compared to the actual installed fog system.



References

Gilroy, D. (2011). Tried and tested systems to control fugitive dust. *Port Technology International*, 47th Edition, p.25 – 27.

Lesch, J. (2017). Dust mitigation for bulk cargo using atomized mist technology. *Port Technology International*, 76th Edition, p.114 – 117.



APPENDICES



Appendix A. : Shared Glencore Sudbury INO Documents

Appendix B. : Siwertell Tarp



Appendix C. : Blommaert Catalog



Appendix D. : ENVEX Catalog



Appendix E. : Port Dust Suppression Literature



Appendix F. : Project Progress Presentation

Appendix G.: Old Unloader Studies



Appendix H. : Concepts Sketches



Appendix I. : Comparison Matrix



Appendix J. : Bag House Estimate



Appendix K. : Cost Estimate



Appendix L. : Preliminary Timeline (Gantt)

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