Transportation Safety Board of Canada
Bureau de la sécurité des transports du Canada

MARINE TRANSPORTATION SAFETY INVESTIGATION REPORT M23C0305

PERSON OVERBOARD AND LOSS OF CARGO

Cargo vessel *Sivumut*
Frobisher Bay, Nunavut
27 October 2023

Canada

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Summary

On 27 October 2023, the cargo vessel *Sivumut* was anchored in Frobisher Bay, Nunavut, while transshipping cargo to Iqaluit, Nunavut, using barges and tugs. During transshipment operations, the tug *Qimmiq* departed the *Sivumut* while towing the *Tasijuaq* barge in an alongside tow. The barge carried 24 shipping containers with 1 crew member stationed atop the containers. Shortly after the tug's departure, the barge listed to port and began to capsize, causing the crew member and 23 containers to fall overboard. Eight minutes later, the crew member was retrieved from the water by the *Sivumut* crew and then transported to Iqaluit for medical attention. Sixteen containers were later retrieved.

1.0 FACTUAL INFORMATION

1.1 Particulars of the vessels and barges

Table 1. Particulars of the vessels and barges

Vessel name	*Sivumut*	*Qimmiq*	*Tasijuaq I*	*Tasijuaq II*
Transport Canada official number	846709	840817	842815	842816
International Maritime Organization number	9501253	N/A	N/A	N/A
Flag	Canada*	Canada	Canada	Canada
Port of registry	Montreal**	Montreal	Montreal	Montreal
Type	General cargo ship	Tug	Barge	Barge
Gross tonnage	9618	13.47	49.39	49.39
Length (m)	138.5	10.28	15.68	15.68

Breadth (m)	21.34	3.81	8.56	8.56
Depth (m)	11.00	2.15	1.84	1.84
Year built	2010	2017	2019	2019
Propulsion	1 diesel engine of 7372 hp, driving 1 controllable-pitch propeller	2 diesel engines of 494 hp (total),	No propulsion	No propulsion
Crew complement	20	2	N/A	N/A
Registered owner and authorized representative	Transport Sivumut Inc.	Transport Umialarik Inc.	Transport Nunalik Inc.	Transport Nunalik Inc.
Managing company (the charterer)	NEAS Inc.	NEAS Inc.	NEAS Inc.	NEAS Inc.
Classification society and recognized organization	Lloyd's Register	N/A	N/A	N/A

* This indicates the flag at the time of the occurrence. Details about the *Sivumut*'s flag can be found in section 1.8, Vessel certification.
** This indicates the port of registry at the time of the occurrence.

1.2 Description of the vessels

1.2.1 *Sivumut*

The *Sivumut* (Figure 1) is a general cargo vessel built in 2010 and purchased by Transport Sivumut Inc. in 2023. The bridge, accommodations, and engine room are located aft. The bridge is equipped with all of the required navigational and communications equipment. The *Sivumut* has 2 deck cranes located on its port side; each crane has a safe working load of 150 metric tonnes (t). The vessel has 3 cargo holds with a removable tweendeck. From forward to aft, the holds are numbered as No. 1, No. 2, and No. 3. The vessel's total cargo capacity is 15 953 m^3, or 661 twenty foot equivalent units (TEU).[1]

When engaged in Arctic sealift operations, the *Sivumut* carries the tugs *Qimmiq* and *Ukaliq*, as well as barges *Tasijuaq I*, *Tasijuaq II*, *Arviat I*, and *Arviat II*.

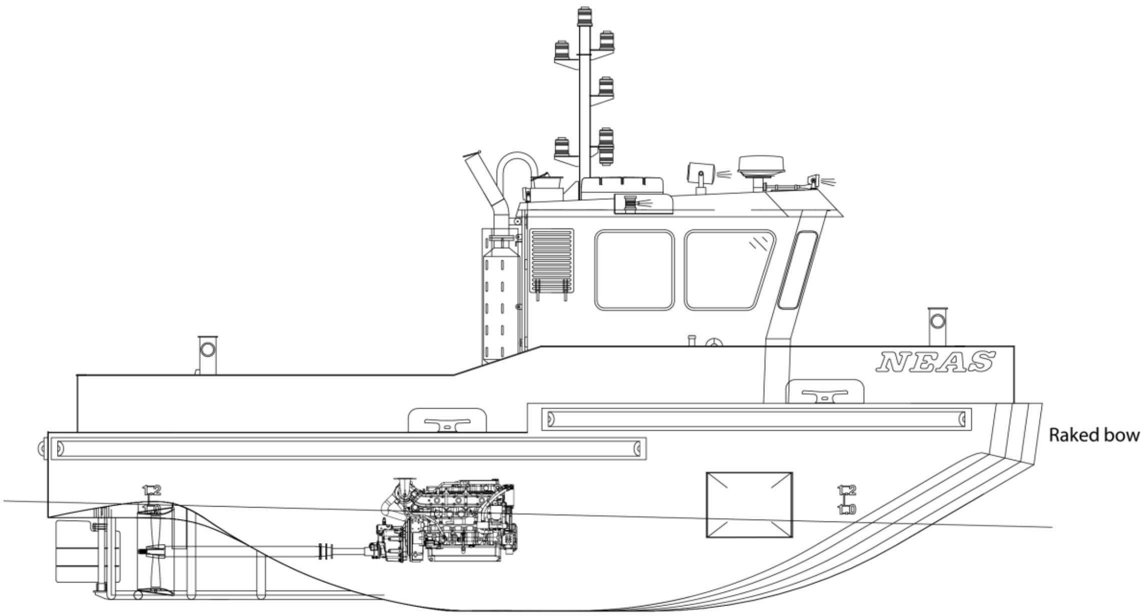
1 TEU (twenty-foot equivalent unit) is a measure of cargo-carrying capacity that uses 20-foot containers as a measure of volume. The dimensions of the containers used in this occurrence were 6.06 m x 2.44 m x 2.59 m (20 ft x 8 ft x 8.50 ft).

Figure 1. The *Sivumut* anchored in Frobisher Bay, just off the shore of Iqaluit, Nunavut, with tug *Qimmiq* and the *Tasijuaq* barge, composed of the *Tasijuaq I* and *Tasijuaq II,* alongside (Source: Mathieu Durocher)

1.2.2 *Qimmiq*

The *Qimmiq* is 1 of 12 tugs operated by NEAS Inc. that were built specifically for cargo transshipment operations in the Canadian Arctic. The tug is of steel construction and has a raked bow (Figure 2). The tug carries navigation and safety equipment, including a gaff, a very high frequency (VHF) radiotelephone, and an ultra high frequency (UHF) radiotelephone. The tug also has a stern bollard with a quick-release towing hook.

Figure 2. Diagram showing a profile view of the *Qimmiq* tug and the raked bow (Source: NEAS Inc., with TSB annotations)



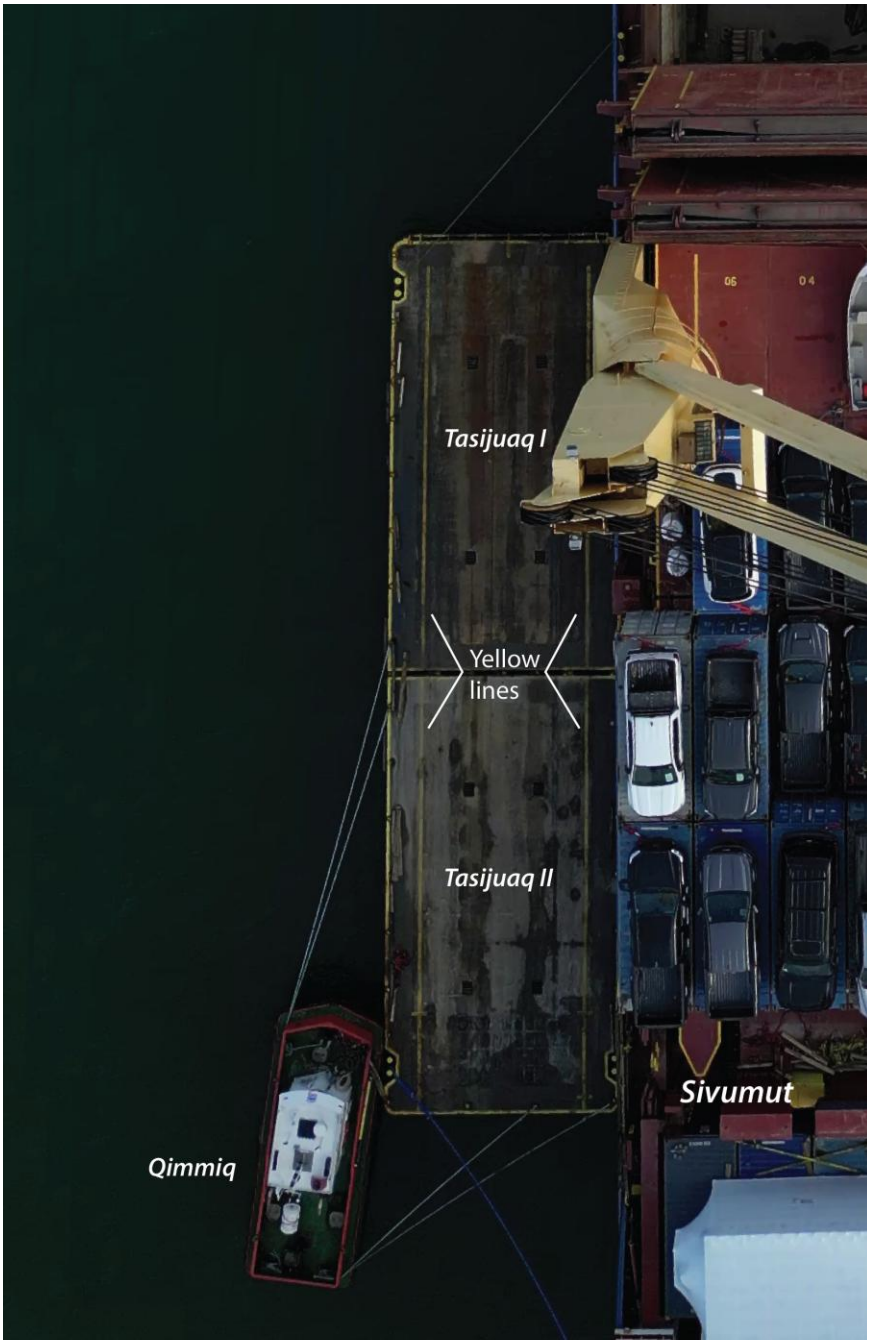
1.2.3 *Tasijuaq I* and *Tasijuaq II*

Tasijuaq I and *Tasijuaq II* are flat-decked, non-propelled barges of steel construction that can be connected together to form a single barge (known as the *Tasijuaq*), with *Tasijuaq I* comprising the forward section and *Tasijuaq II* comprising the aft. Each barge is subdivided by 2 longitudinal bulkheads and 1 transverse bulkhead, creating 6 watertight compartments. Each barge is registered as a vessel with Transport Canada (TC).

When the *Sivumut* reaches its 1st Arctic community of the season, the cargo crew launch the barges and connect them together with rigid connexions made up of rods, hooks and cleats. The barges then remain connected and are operated as a single barge throughout the season. The *Tasijuaq*'s total length is 31.56 m and the maximum cargo capacity is 210 t. Throughout the occurrence, as usual, the barges were connected and operated as 1; the report will therefore make reference to the *Tasijuaq* or the barge.

Every spring, in preparation for the Arctic sealift season, *Tasijuaq I* and *Tasijuaq II* are painted with 2 yellow lines that run the length of the deck from aft to forward. Each line is 1.22 m inboard from the port and starboard sides, and is used to indicate the limits of where containers should be placed (Figure 3).

Figure 3. The *Tasijuaq I* and *Tasijuaq II*, connected and operating as a single barge (*Tasijuaq*), painted with yellow lines along the length of its deck. The *Tasijuaq* is moored along the *Sivumut*'s port side, with the *Qimmiq* attached to the barge in an alongside towing arrangement. (Source: Mathieu Durocher, with TSB annotations)



1.3 Ownership and corporate structure

The *Sivumut*, *Qimmiq*, and *Tasijuaq* are owned by Transport Sivumut Inc., Transport Umialarik Inc., and Transport Nunalik Inc., respectively. These entities share the same business address. Transport Umialarik Inc. and Transport Nunalik Inc. are owned by NEAS Group Inc. (NEAS), which is in turn partly owned by Transport Nanuk Inc, and by the Makivvik corporation.

While Transport Nanuk Inc. fulfilled the role of crew manager and technical operator at the time of the occurrence, some procedures and policies were under the letterhead of NEAS entities. This is because NEAS, the ship's charterer, fulfilled a commercial role in the booking and contracting of cargoes to be delivered as part of the Arctic sealift.

1.4 Arctic sealift operations

Arctic sealift (sealift) involves delivering fuel, building materials, foodstuffs, vehicles, and other goods to remote communities in the Canadian Arctic via cargo vessels and barges. A few shipping companies specialize in sealift operations in Canada. Given the cost of shipping these goods by plane, sealift is the most affordable way for people living in the region to obtain their re-supply for the year. The sealift season runs from about the end of June to the end of October, or beginning of November, depending on ice coverage.

Typically, cargo vessels such as the *Sivumut* are loaded to capacity in southern ports (e.g., Bécancour, Quebec), with cargo destined for several Arctic communities. The vessel travels from 1 community to another until all cargo has been delivered. When a cargo vessel arrives at an Arctic community, it usually anchors offshore and transships the cargo to shore using tugs and barges. Using the vessel's deck cranes, the cargo crew will offload tugs and barges onto the water alongside the vessel. Barges are then moored to the vessel, and tugs are made fast to the barges. The barges are loaded with cargo using the vessel's deck cranes. Due to the short transit, either in sheltered waters or near costal, Class 2, cargo is not secured on the barges in fair weather. Moreover, wood dunnage is sometimes used to reduce the possibility of the cargo and containers sliding on the barge deck.

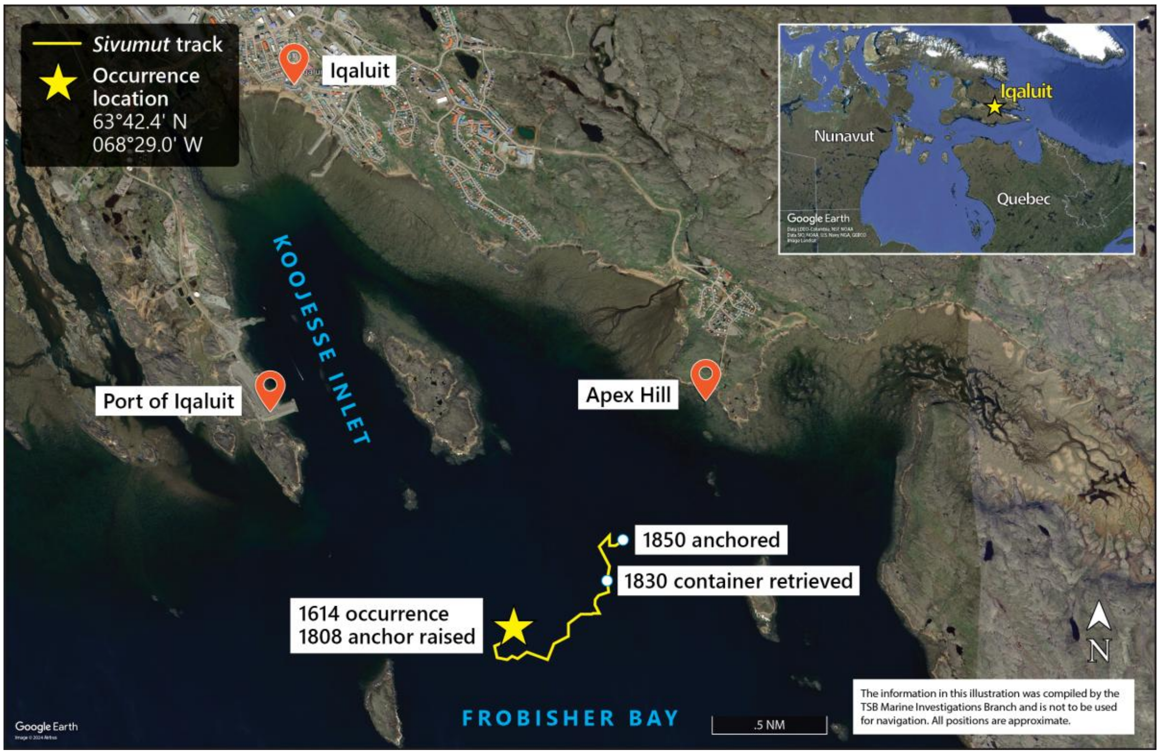
When a barge is fully loaded, a tug departs the vessel with the barge in tow, or in an alongside tow, and proceeds to shore. There, the barge is beached and the cargo is offloaded onto the shore using machinery such as forklifts and loaders before the tug and barge return to the vessel for another load. Because barges have to be beached before cargo is offloaded, transshipment operations may be limited during and around low tide.

Unlike other Arctic communities, Iqaluit, Nunavut, has a deep-sea port that includes a dock that can accommodate 1 vessel at a time, and a ramp that can be accessed by barges at all times regardless of the tide cycle.

1.5 History of the voyage

On 18 October 2023, the *Sivumut* departed Bécancour carrying approximately 14 995 m³ of cargo bound for Iqaluit, and 240 m³ of cargo bound for Saglek, Newfoundland and Labrador. On 23 October 2023, the *Sivumut* anchored in Frobisher Bay, Nunavut, less than 2 nautical miles (NM) from the port of Iqaluit while another sealift vessel occupied the dock (Figure 4).

Figure 4. Map showing the occurrence location and the vessel track to the *Sivumut*'s anchorage positions, with inset image of map showing Iqaluit (Source of both images: Google Earth, with TSB annotations)



On 24 October, the cargo crew started to offload cargo to shore. Between 24 October and 26 October, the cargo crew offloaded approximately 9735 m³ of cargo.

On 27 October, around 1437,[2] the crew loaded containers directly onto the *Tasijuaq* barge's deck, steel on steel. The 1st container was loaded on the aft deck, just outside of the yellow line on the port side.

At around 1534, the *Ukaliq* tug returned to the *Sivumut* with NEAS' new chief executive officer on board. The chief executive officer then headed to the *Sivumut* bridge to observe and discuss the ongoing transshipment operations with the master.

Once the 1st tier of 12 containers had been loaded, the cargo crew began loading a 2nd tier of containers directly on top of the 1st tier. The *Qimmiq* tug operator and tug assistant used

2 All times are Eastern Daylight Time (Coordinated Universal Time minus 4 hours).

a ladder to climb on top of the 2nd tier to remove the lifting slings and help position the remaining containers.

When the barge was fully loaded, the tug assistant removed the lifting slings and remained on top of the containers as a lookout. The *Tasijuaq* was loaded with 24 containers with a total weight of 342 t, and was listing slightly to port with a freeboard of about 0.08 m.

At 1608, the chief cargo[3] exited the hold and helped the *Qimmiq* tug operator release the barge from the *Sivumut*; the tug operator then boarded the *Qimmiq* and departed with the *Tasijuaq* in an alongside tow.

When the tug and barge were near the *Sivumut*'s aft starboard quarter, water washed onto the barge deck, displacing unused wood dunnage[4] into the water. At 1612, the tug operator stopped the *Qimmiq* and went on the *Tasijuaq* deck to retrieve the floating dunnage. As the tug operator retrieved the dunnage, the tug and barge drifted until the barge was perpendicular to the wind and waves. Once all dunnage had been retrieved the tug operator returned to the *Qimmiq* to resume the transit.

At 1613:50, the tug operator put the helm to starboard and pushed the throttle forward. As the *Qimmiq* and *Tasijuaq* turned to starboard, the tug's bow rode onto the barge and water washed onto the barge deck again. The barge slowly heeled to port before righting.

At 1614:29, the barge heeled to port a 2nd time and began to capsize. As the heel to port increased, containers began sliding off the deck and into the water. The tug assistant ran across the tops of the falling containers toward the barge's starboard side. At least 1 container fell onto the *Qimmiq*'s wheelhouse and then into the water, submerging the tug's bow and thrusting its stern upward in the process. The tug operator held on to the stern bollard and side of the tug to remain on board. Most of the lines between the *Qimmiq* and *Tasijuaq* broke as the tug assistant and 23 containers fell into the water.

At 1614:30, the crane operator informed the chief cargo via radiotelephone that the barge was capsizing.

Once the containers had fallen, the *Tasijuaq*'s stability improved and the barge righted itself. The *Qimmiq* tug operator then made his way onto the barge deck to look for the tug assistant. He then detached the remaining lines between the tug and barge, returned to the *Qimmiq*, and proceeded to search for the tug assistant amidst the floating containers.

At 1615, the master of the *Sivumut* ordered crew to lower the rescue boat onto the water while the chief cargo boarded the *Ukaliq.* The *Ukaliq* began navigating among the floating

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3 According to Transport Nanuk Inc.'s *Vessel Management Manual*, the chief cargo supervises barge operations, crane operations and procedures, cargo operations, and docking and undocking operations, among other duties.

4 Wood dunnage was used to secure non-containerized cargo and was also placed between the barges to avoid steel-on-steel contact as they were transported on board the *Sivumut*.

containers as the tug operator and chief cargo searched for the *Qimmiq* tug assistant in the water.

At about 1619, the *Qimmiq* tug operator located the tug assistant in the water. He was unconscious, and his personal flotation device (PFD) was inflated. The *Qimmiq* tug operator notified the *Sivumut* bridge team of the situation before he stopped the tug, grabbed the tug gaff, and jumped on top of a floating container next to the tug assistant. The container had a freeboard of about 1.2 m to 1.4 m. The tug operator used the gaff to bring the tug assistant alongside the container.

Moments later, the *Ukaliq* was manoeuvred alongside the floating container and the chief cargo jumped onto the container to help haul the tug assistant out of the water. Eventually, the *Ukaliq* tug operator also went onto the shipping container to help retrieve the tug assistant.

By 1623, the chief cargo and *Ukaliq* tug operator had managed to haul the tug assistant from the water onto the floating container; the tug assistant had been in the water for about 8 minutes. The tug assistant began to regain consciousness.

By 1628, the tug assistant and chief cargo had transferred to a local vessel and were in transit to shore. They arrived at the Iqaluit port ramp a few minutes later. The tug assistant was transferred to the local hospital where he was treated for hypothermia and other injuries. He was later flown to a hospital in Ottawa for further treatment. The *Sivumut* rescue boat, which had been launched for the rescue, returned the *Qimmiq* and *Ukalik* tug operators to their respective tug. All 3 vessels then returned to the *Sivumut*.

1.5.1 History of the container salvage operations

Given the urgency of the situation, the *Sivumut* crew prioritized recovering the containers as soon as possible before the containers drifted away in Frobisher Bay or sank.

On 27 October, at about 1635, both tugs left the *Sivumut* to retrieve the *Tasijuaq*, which had drifted during the rescue operation. Meanwhile, the *Sivumut* master advised NEAS's vice president of operations about the incident, and of his intention to retrieve the containers at sea (Figure 5).

Figure 5. Image of several shipping containers floating on the water, with the *Sivumut* in the background (Source: CCGS *Henry Larsen*)

At about 1700, the master came down to the deck to briefly meet with the chief cargo in order to establish a preliminary container recovery plan. The master then went back up to join the officer of the watch and the chief executive officer on the bridge. After that, members of the cargo crew shared various ideas for retrieving the containers. The idea chosen was that tugs would retrieve 1 container from the water at a time, towing each container to the cargo vessel so it could be lifted onto 1 of the moored barges. A tug would approach a container in the water, and the chief cargo or a deckhand would transfer from the tug to the top of the container and attach the tug's quick release towing hook to the container. Once the hook was attached, the chief cargo or deckhand would return to the tug. The tug would then tow the container to 1 of the barges moored alongside the cargo vessel.

At 1705, the tugs *Qimmiq* and *Ukaliq* departed the *Sivumut* with their respective tug operators; the chief cargo was on board the *Qimmiq* and a deckhand was on board the *Ukaliq*.

By 1711, the sun had set and the *Sivumut* had turned on its search lights to allow the salvage operation to continue. Given the time it would take to bring the containers to the barges, the master asked the chief cargo via radiotelephone if moving the *Sivumut* next to a floating container to heave it on board would expedite retrieval. The chief cargo asked the master to wait until the 1st container had been loaded before taking action, and then they could discuss next steps. Soon after, the *Qimmiq* began towing the 1st container to the *Sivumut* at low speed.

At 1722, the master ordered crew to raise the anchor and move the *Sivumut* to meet the *Qimmiq,* then load the towed container onto a barge that was moored alongside the vessel in order to limit some of the risks associated with the container recovery operations.

At 1737, as the *Sivumut* was still in the process of raising the anchor and the *Qimmiq* approached with a container in tow, the chief cargo instructed the *Sivumut*'s on-board cargo team, via radiotelephone, how to load the retrieved container onto 1 of the barges. The chief cargo ordered that the *Qimmiq* tow the container parallel to the barges, then release the container using the tug's quick-release towing hook. The *Ukaliq* would then push the container against 1 of the barges to stabilize it while a member of the cargo crew climbed or jumped from 1 of the barge decks onto the container, to attach slings to the container so it could be lifted by 1 of the vessel cranes.

By 1752, the 1st container was removed from the water and loaded onto a barge. The tugs then departed to retrieve more containers.

At 1808, the crew finished raising the *Sivumut*'s anchor and the vessel began moving closer to the containers that had drifted northeast, toward Apex Hill, Nunavut, so it could meet the tugs as they towed containers to the vessel.

At 1828, the *Qimmiq* tug operator asked the master to anchor the *Sivumut* and reassess the method for container retrieval due to concerns about the safety of the operation. The master agreed. The tug operator then asked the master if the container in tow would be loaded after the vessel had anchored at its new position; the master informed the tug operator that the container would be loaded onto a barge before the anchor was dropped.

At 1830, the master notified the *Qimmiq* tug operator that the *Sivumut* was at 0 knots over the water. As the *Sivumut* drifted with its engine running, pitch at 0, and its propeller turning, the *Qimmiq* approached the vessel and the cargo crew proceeded to load the container onto 1 of the barges as previously described. Once the container was loaded, the *Sivumut* continued to move northeast toward the containers still afloat in the water.

At 1850, the *Sivumut* anchored at its new position near Apex Hill and the salvage operation continued, with tugs retrieving and loading 4 more containers onto the barges. The tugs then pushed several of the remaining containers ashore so they would remain in place during low tide, with the intention of retrieving them at high tide.

At some point during the container recovery operation, the chief executive officer left the *Sivumut* to go back to shore.

At 2200, the operation stopped for the night, with a total of 6 containers retrieved.

On 28 October, before beginning the day's recovery operation, the master and cargo crew members met to establish an action plan to limit the risks to the environment, life, and property.

On 28 October and 29 October, the helicopter of the Canadian Coast Guard Ship *Henry Larsen* and an aircraft from TC's National Aerial Surveillance Program helped the *Sivumut's* crew locate the remaining containers in the water, 10 of which were recovered. On 29 October, Transport Nanuk Inc.'s Arctic Operations & Health and Safety Manager boarded the *Sivumut* to conduct an internal audit, and a TC marine safety inspector boarded the vessel to conduct a conformity inspection.

Because it was the *Sivumut*'s last trip of the 2023 sealift season, and due to the incoming winter conditions, including the formation of sea ice in Frobisher Bay, 7 of the containers could not be recovered during the 2023 sealift season.

1.6 Damage to the vessels

The *Qimmiq* sustained damage to the starboard side of the wheelhouse and starboard fenders. The tug's radar antenna, search light, and navigation lights were also broken.

The *Tasijuaq* sustained minor damage to its deck plating.

1.7 Environmental conditions

At the time of the occurrence, the sky was clear with winds averaging 10 knots from the southwest. The wave height averaged 0.3 m. The air temperature was −2 °C and the water temperature (recorded by the *Sivumut)* was 2 °C. The tide was flooding; high tide occurred at 1843 (10.7 m) and low tide occurred at 0055 (1 m).

Sunset occurred at 1635 and it was dark by 1726. Freezing spray developed during the evening.

1.8 Vessel certification

1.8.1 *Sivumut*

Transport Nanuk Inc. acquired the *Sivumut* in June 2023, making it the 6th vessel in the company fleet that specializes in sealift operations. The vessel was then registered as a domestic vessel under Canadian legislation.[5] The *Sivumut* held a Safety inspection certificate valid for near coastal voyage, Class 1, limited home-trade, Class II voyages.

The *Sivumut* was classed with Lloyd's Register and inspected by the same under TC's Delegated Statutory Inspection Program.

On 20 June 2023, as part of the vessel's registration under the Canadian flag, TC conducted a flag state inspection. Several deficiencies were noted, mostly regarding the *Maritime Occupational Health and Safety Regulations* and the *Vessel Fire Safety Regulations*. The deficiencies were rectified, in short order, so that the *Sivumut* met Canadian requirements before it set sail for the 2023 season in the Arctic.

5 Vessels operated by NEAS Inc., with the exception of tugs and barges, change flag twice a year. They sail under the Canadian flag during the Arctic sealift season (June to November) and then they are chartered out and sail under the Netherlands flag as a convention vessel for the remainder of the year.

1.8.2 *Qimmiq*

As a commercially operated vessel of 15 gross tonnage (GT) or less, the *Qimmiq* was required to be registered with TC but was not required to have a certificate of inspection to operate, nor was it required to undergo periodic inspections by TC.

The *Qimmiq* was registered with TC and was part of the Small Vessel Compliance Program (SVCP). The investigation determined that there was no record that TC had ever inspected the *Qimmiq* before this occurrence.

1.8.3 *Tasijuaq I* and *Tasijuaq II*

Tasijuaq I and *Tasijuaq II* are uncertified vessels of 49.39 GT each, registered with TC. There is no record that TC had ever inspected the barges before the occurrence.

The *Vessel Safety Certificates Regulations* apply to vessels of 15 GT or less that carry more than 12 passengers, or vessels of more than 15 GT. There are a few exceptions to this, including vessels that do not have a mechanical means of propulsion and do not transport people. The *Life Saving Equipment Regulations* apply to the barge if a person remains on board. If the barges are rigidly connected and measure more than 24 m, the *Load Line Regulations* then apply for voyages other than in sheltered waters.

Although the barges weren't certified for transporting people, it was common practice for tug assistants to remain on board the barges to assist with navigation while transiting from the *Sivumut* to shore.

1.9 Personnel certification and experience

The master of the *Sivumut* held a Master Mariner certificate of competency. The master was hired by Transport Nanuk Inc. in 2012 as a deckhand and began working as master in 2018.

The chief officer held a Master Mariner certificate of competency. He had been employed by Transport Nanuk Inc. since 2020. He was master of the *Sivumut* for the vessel's 2nd voyage of the 2023 sealift season. During the occurrence voyage, the chief officer was also acting as chief cargo; it was his 3rd time holding both positions on board a Transport Nanuk Inc. vessel.

The officer of the watch was the second mate on board the *Sivumut* and held a Chief Mate Near Coastal certificate. He had been employed by Transport Nanuk Inc. since 2010, and had previously worked as chief cargo. He was the chief officer on board the *Sivumut* during the vessel's 2nd voyage of the 2023 sealift season.

The *Qimmiq* tug operator was also the third officer on board the *Sivumut*, and held a Watchkeeping Mate certificate as well as a Master 150 Gross Tonnage, Domestic certificate. He had been employed by Transport Nanuk Inc. since 2021. He was chief cargo for the vessel's 2nd voyage of the 2023 sealift season. The occurrence voyage marked his 2nd season as a tug operator in the Arctic.

The *Qimmiq* tug assistant also worked as a deckhand and had been employed by Transport Nanuk Inc. since June 2023. He did not hold any certifications and had not taken any training endorsed by TC, nor was he required to.

The crane operator had worked with Transport Nanuk Inc. for more than 15 sealift seasons, 10 of which he had also worked as bosun.

1.10 Crewing

According to the safe manning document issued by TC, the *Sivumut* is required to have on board at minimum 13 crew members, including the following certified positions:

- a master;
- a chief mate;
- a watchkeeping mate;
- a chief engineer;
- a second engineer; and,
- 2 bridge watch ratings.

To fulfill the operational needs for each of its vessels, Transport Nanuk Inc. provides a complement higher than what is required by each vessel's safe manning document. It is common practice for Transport Nanuk Inc. to crew its vessels with 22 crew members each. However, the *Sivumut*'s lifeboat capacity is 20 persons, which limits the crew complement to 20, i.e. the crew complement at the time of the occurrence.

1.10.1 Crewing for Arctic cargo operations

In addition to duties of operating a cargo vessel in the Arctic, some *Sivumut* crew members engage in Arctic cargo operations. The additional tasks associated with cargo operations are assigned to crew members who assume different roles once the vessel arrives in the Arctic. While 15 of the typical 22 crew complement usually participate in cargo operations on other Transport Nanuk Inc. vessels, the company's *Vessel Management Manual* identifies, "[a]s per a normal unloading operation",[6] a minimum of 14 positions within the cargo team that must be filled by crew members:

- one Chief Cargo (Chief Officer), in charge
- two Officers on Watch, on bridge
- one Beach Operator
- one Loader Operator
- one Cargo Checker
- two Tug Operators

6 Transport Nanuk Inc., (OPE.06/Rev. 2023) "Arctic", Vessel Management Manual (updated March 2023), p. 14.

- two Tug Assistants
- one Lift Operator
- one Crane Driver (or two in tandem)
- two Slings[7]

On the *Sivumut*, 13 crew members participate in cargo operations with 1 crew member usually fulfilling the sling position. The chief cargo can request the participation of someone from the bridge team or engine crew during cargo operations, as needed. However, the remaining crew members on board the *Sivumut* must fulfill other duties during the cargo operations. Since performing cargo operations with 13 crew members is considered typical, the participation of other crew members is rarely requested.

According to Transport Nanuk Inc.'s *Vessel Management Manual*, the chief cargo supervises barge operations, crane operations and procedures, cargo operations, as well as docking and undocking operations, among others. In this occurrence, the chief cargo also took an active role in cargo handling; he was often in the cargo hold to fulfill the second sling position. The *Vessel Management Manual* states that the tug operator reports to the chief cargo when he is near the vessel and reports to the beach operator when he is near the beach. During the loading of the barge, he must record the cargo loaded and help place it on the barge. There is no mention of the tug operator's responsibility during the loading of the barge, including stability management.

1.11 Stability

The stability of a vessel, including a barge, is its ability to return to an upright position when influenced by external forces such as wind and waves. Understanding how different factors affect stability is important for estimating risks. For example, how the wind, current, and waves affect the vessel's stability depends on their direction relative to the heading of the vessel. The location and magnitude of weight on a vessel also affects stability (e.g., when weight is placed low in the vessel, stability improves).

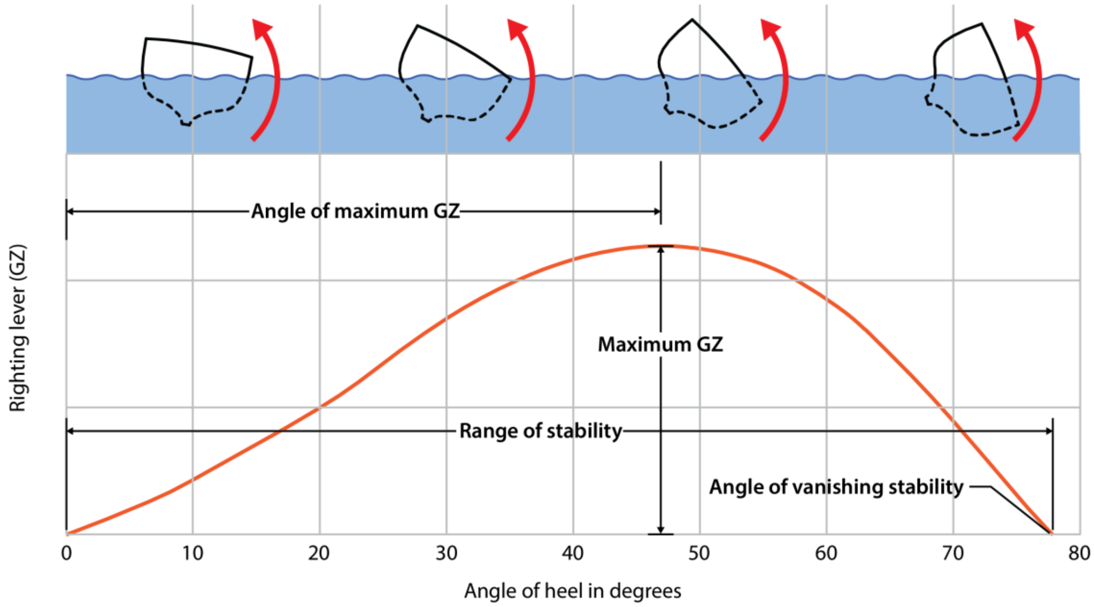
A curve of statical stability (figures 6 and 7) — sometimes called the stability curve, righting arm curve, or righting lever (GZ) curve — is obtained by plotting the righting levers (vertical axis GZ in metres) against angles of heel (horizontal axis in degrees). The smaller the area under the GZ curve, the less a vessel is able to absorb energy when under the influence of external forces.

A perpendicular line drawn from the highest point on the curve onto the heel scale (horizontal axis) indicates the angle at which the maximum GZ is present (i.e., to return a vessel to its upright position). The point where the curve meets the horizontal axis is the angle of vanishing stability (Figure 6). The vessel's stability is 0 at this point, and at any heel

7 Ibid.

angle beyond this point the vessel is said to have negative stability and the vessel will capsize.

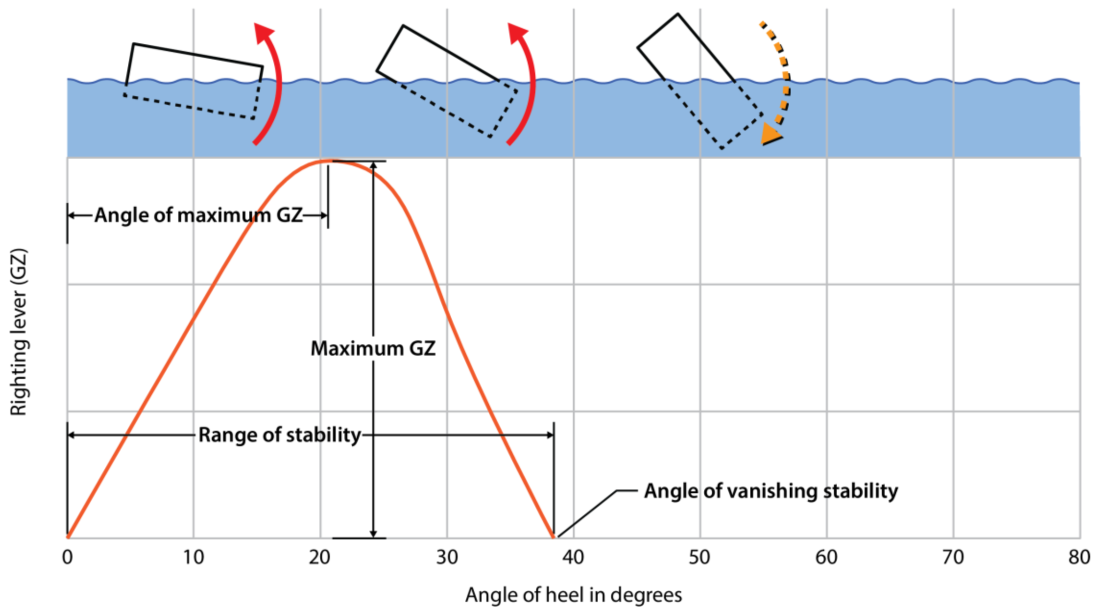
Figure 6. Graph depicting a typical GZ curve with the angle of maximum GZ, maximum GZ, range of stability, and angle of vanishing stability of a traditional vessel shape, accompanied by 4 illustrations showing said vessel shape at various angles of heel with arrows representing the direction of the righting force (Source: TSB)



Metacentric height (GM) is an important measurement of initial stability. The characteristics of the GZ curve, namely the minimum angle at which the curve peaks, the angle of vanishing stability, and the area under the curve, are also important measurements of initial stability.

Vessels such as barges, with relatively wide hulls and flat bottoms, typically have a higher initial GM and the GZ curve is steep. The range of stability for a flat-bottomed vessel (Figure 7) is much smaller than the range of stability for a traditional vessel shape.

Figure 7. Graph depicting a typical GZ curve with the angle of maximum GZ, maximum GZ, range of stability, and angle of vanishing stability of a flat-bottomed vessel, accompanied by 2 illustrations showing said vessel shape at different angles of heel within the range of stability, and 1 illustration showing the vessel shape at an angle of heel higher than the point of vanishing stability, with arrows representing the direction of the righting force (Source: TSB)



1.11.1 Barge loading plan

The loading plans for the barges involved in this occurrence are informal, based on previous experience, and adjusted as the transshipment operation progresses. NEAS Inc. has an informal rule that loaded barges must have a minimum freeboard of 0.3 m.[8] The cargo crew had no information on the dimensions, weight, or capacity of the *Tasijuaq* and *Arviat* barges, and there were no load lines. Based on their experience, cargo crew members believed that as long as the load was centred, the barge was stable and could be operated safely.

1.11.2 Barge stability requirements

The *Vessel Construction and Equipment Regulations*[9] require that vessels that do not have a means of propulsion, and that are 24 m or more in length, comply with the *International Code on Intact Stability, 2008* and with the *Canadian Modifications to the International Code on Intact Stability, 2008* (TP 7301).[10] The Code does not stipulate a value for GM but it does

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8 NEAS Group Inc., "Incident report: NEAS Containers fallen from barge – VVV. Sivumut" (October 2024).

9 Transport Canada, SOR/2023-257, *Vessel Construction and Equipment Regulations* (as amended 20 December 2023), subsection 101(2).

10 Transport Canada, TP 7301, *Canadian Modifications to the International Code on Intact Stability* (2008).

stipulate a minimum area under the GZ curve from 0° heel to the curve's peak. This minimum area cannot be less than 0.08 metre-radians. There is also a minimum angle of vanishing stability of 20° for barges of 100 m or less.

Under the *Canada Shipping Act, 2001*, masters and authorized representatives are responsible for ensuring that a vessel is seaworthy for its intended voyage, which includes ensuring its stability. The stability requirements of the Code do not apply to deck barges of less than 24 m in length, such as the *Tasijuaq I* and *Tasijuaq II*.

1.11.3 Stability assessment and stability information

The underlying purpose of any stability assessment is to determine whether a vessel has sufficient reserve stability to carry out normal operations. A stability assessment is calculated for a stationary vessel in completely calm water (known as static stability). An intact stability assessment sets safety margins for operating a vessel, such as minimum GM and area under the GZ curve, and is a valuable tool to guide vessel operators. However, passing a stability assessment does not guarantee protection from capsizing.

In a standard operating state (dynamic state), external forces act on a vessel, such as the wind, the waves, the current and water on the deck. With a barge-tug combination, there are also external forces such as the thrust produced by the tug and the downward force from the contact between the tug and the barge.

The *Tasijuaq* had not undergone a stability assessment, nor were they required to. However, their structural arrangement plan, which was created by a marine engineering and naval architecture firm, includes a drawing of the 2 barges, information about how the barges are connected, and notes that identify some stability limits. Although the hydrostatic characteristics are not required by regulation, the plan identifies hydrostatic characteristics and notes a maximum draft of 1.18 m (freeboard of 0.65 m) and a maximum cargo weight of 210 t. The structural arrangement plan was stored at the company's shore office.

On 28 October, as part of the company's post-occurrence incident report, the master and the chief cargo of the *Sivumut* calculated roughly the GM of the *Tasijuaq* at the time of the occurrence, with the incomplete information they had, and determined that the GM was 1.35 m. On 02 November, when cargo operations for the port of Iqaluit were complete and the *Tasijuaq* was loaded on board the *Sivumut*, the chief cargo discovered a hole in the *Tasijuaq I*'s forward bottom plating. It was then assumed that water had entered 1 hull compartment, compromising the barge's stability. On 08 November, the TSB investigators and the members of the *Sivumut's* crew found one hole in each barge.

Transport Nanuk Inc.'s post-occurrence incident report cited a GM of at least 1.12 m. Its incident report determined that, among other factors, water was present in 2 of the barge's hull compartments, which created a free surface effect and caused the barge to capsize. The company also commissioned a third party to conduct a post-occurrence investigation.

The TSB conducted a photo analysis to assess the possibility of free surface effect caused by water ingress in the *Tasijuaq*. The TSB determined that the freeboard of the *Tasijuaq* at the time of the occurrence was about 0.08 m on the port side, with an estimated initial port side list of 1° caused by the offset containers. Overall, according to the TSB's assessment, there was likely not a significant amount of water in the hull of the barge; therefore, water ingress did not have a significant impact on the barge's stability.

To investigate the role stability may have played in the occurrence, the TSB performed a stability assessment on the *Tasijuaq* using information from the structural arrangement plan and measurements taken by the TSB during an examination of the barge. The assessment was completed using relevant criteria set out in the *International Code on Intact Stability*, *2008* and calculated the barge's stability under 3 operating conditions (see Appendix A for the assessment).

The TSB stability assessment produced a GM of 0.67 m and an angle of vanishing stability of 2.66° and found that the *Tasijuaq* failed by a significant margin to meet minimum stability criteria in each of the operating conditions examined. Although failing to meet these stability criteria does not necessarily mean that a vessel will suddenly capsize when actually operating in those conditions, it does mean that, in this occurrence, the barge was operating with a greatly reduced ability to right itself after being heeled by external forces and was at an increased risk of capsizing.

1.12 Container loss monitoring and salvage efforts

According to the World Shipping Council's annual survey, 221 containers were lost at sea in 2023. In comparison, there was an average annual loss of 1061 shipping containers between 2021 and 2023. It is estimated that about 33% of the lost containers in 2023 have been recovered.[11]

Since 2016, 3 occurrences of container loss have been reported to the TSB, including this occurrence involving the *Sivumut*. The other 2 occurrences took place in Canadian waters off the west coast of Canada. In November 2016, the *Hanjin Seattle* lost 35 containers, and in October 2021, the *Zim Kingston* lost 109 containers. The *Sivumut* is the first reported occurrence where several containers were lost at once in the Canadian Arctic region, with a total of 23 containers overboard.

Sealift goods are of vital importance to Canadian Arctic communities. The occurrence voyage was the last trip of the 2023 sealift season; it was the last opportunity that year for Arctic communities to receive their goods, and for the *Sivumut* to retrieve the lost containers, before the ice formed and before the vessel and crew had to return south.

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11 World Shipping Council, "World Shipping Council Releases Containers Lost as Sea report – 2024 Update" (June 2024) at https://www.worldshipping.org/news/world-shipping-council-releases-containers-lost-at-sea-report-2024-update (last accessed 05 September 2025).

Container cleanup is a complex operation that can span years, or even decades. Salvage operations are affected by a variety of factors, such as whether the containers and contents can be located, how far the containers and contents have drifted, and whether the containers and contents have sunk or remain floating. The depth of the water in which the containers have sunk also affect salvage operations.[12] The complexities of salvage operations are exacerbated by conditions in the Canadian Arctic, where resources are limited.

During the 2024 sealift season, the following salvage efforts took place:

- A third party was hired to locate the missing containers using a remotely operated underwater vehicle.
- The coordinates of some of the containers located by the remotely operated underwater vehicle were given to Transport Nanuk Inc.
- One of the 7 missing containers was found at the coordinates given and was recovered by a marine salvage contractor.

Transport Nanuk Inc. plans to continue salvage operations in August 2025.

1.12.1 *Wrecked, Abandoned or Hazardous Vessels Act*

In Canada, the *Wrecked, Abandoned or Hazardous Vessels Act*, which came into force on 30 July 2019, provides the federal government with the power to make vessel owners clean up containers that have been lost overboard and their contents, once a hazard has been determined to exist. The Act incorporates the *Nairobi International Convention on the Removal of Wrecks, 2007*[13] into Canadian law. According to the Act, wrecks include "equipment, stores, cargo or any other thing that is or was on board a vessel and that is sunk, partially sunk, adrift, stranded or grounded, including on the shore."[14] This definition is consistent with the definition of a wreck according to the Convention.

Within Canada's exclusive economic zone,[15] vessel owners are liable for the costs of removing wrecks that pose a hazard to the environment; infrastructure; the health, safety,

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[12] Survey results from the Australian Maritime Safety Authority indicate that the depth at which containers can be recovered varies depending on several factors. Following a container loss from the *YM Efficiency* off the coast of Australia, containers were recovered from depths ranging from 100 m to 130 m. (Source: Australian Maritime Safety Authority, "MV YM EFFICIENCY - final survey results" (30 July 2018), at https://www.amsa.gov.au/sites/default/files/2023-11/sd1004544197_mv_ym_efficiency_containers_30072018_1100_survey_results_fi.pdf (last accessed on 05 September 2025).

[13] Transport Canada, "Overview of the Nairobi International Convention on the Removal of Wrecks, 2007," at https://tc.canada.ca/en/corporate-services/policies/overview-nairobi-international-convention-removal-wrecks-2007 (last accessed 05 September 2025).

[14] Transport Canada, S.C. 2019, c. 1, *Wrecked, Abandoned or Hazardous Vessels Act* (as amended 28 August 2019), Part 2, section 27.

[15] Canada's exclusive economic zone generally extends 200 NM beyond Canada's territorial sea.

or well-being of the public; and safe navigation. Vessel owners must also handle any costs of remedial action taken by federal officers. The liability period extends to 3 years from the date that the wreck is determined to be a hazard, and up to a maximum of 6 years from the maritime occurrence that caused the wreck.[16] Vessel owners also have certain duties related to reporting, locating, and marking wrecks.[17]

TC's Navigation Protection Program manages obstructions in navigable waters, and protects navigable waters and shoreline communities from wrecks.

Part 1 of the *Wrecked, Abandoned or Hazardous Vessels Act* requires vessels of 300 GT or more, that are in Canadian waters and in Canada's exclusive economic zone, to have a Wreck Removal Convention Certificate on board.[18] The certificate is proof that the vessel is insured, or has financial security in place, for wreck removal costs. TC Marine Safety and Security is responsible for issuing these certificates to Canadian vessels and foreign ships that are registered in countries where the Convention is not in force. Vessels without a valid certificate are not allowed to enter or leave ports in Canadian waters and may be subject to enforcement action, including vessel detention and fines.

The *Sivumut* held a valid Wreck Removal Convention Certificate. Because the *Qimmiq* and *Tasijuaq* are each under 300 GT, they are not required to have a Wreck Removal Convention Certificate. However, according to Part 2 of the *Wrecked, Abandoned or Hazardous Vessels Act*, the containers that fell from the *Tasijuaq* qualify as wrecks.[19] Therefore, the owner of the wrecks is responsible for the salvage and all the associated costs incurred.

1.12.2 Canadian Coast Guard

The Canadian Coast Guard (CCG) "is the lead federal agency responsible for ensuring an appropriate response to all ship-source […] pollution incidents in Canadian waters […]."[20]

The CCG is responsible for ensuring that vessels and owners are responding in accordance with the CSA 2001 and *Wrecked, Abandoned or Hazardous Vessels Act*. As part of its mandate, the CCG can direct vessel owners to take action and hold owners liable for the

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16 The *Nairobi International Convention on the Removal of Wrecks* is incorporated into the *Wrecked, Abandoned or Hazardous Vessels Act* under Schedule 1. With respect to the liability period, section 23 of the *Wrecked, Abandoned or Hazardous Vessels Act* references the limits set out in the *Marine Liability Act*, Part 6, Division 2, Section 77, paragraph 6(a).

17 Transport Canada, S.C. 2019, c. 1, *Wrecked, Abandoned or Hazardous Vessels Act* (as amended 28 August 2019), Part 1, sections 19, 20, and 21.

18 Ibid., Part 1, section 24.

19 Ibid., Part 2, section 27.

20 "Canadian Coast Guard 2024 Levels of Service," at https://waves-vagues.dfo-mpo.gc.ca/library-bibliotheque/4122436x.pdf (last accessed on 08 September 2025).

costs of managing their hazardous vessels.[21] However, the CCG mandate does not include the identification and evaluation of safety hazards for the crew involved in the management of hazardous vessels. The CCG can also ensures compliance and can issue an Administrative Monetary Penalty to owners who do not fulfill their obligations according to the CSA 2001 and *Wrecked, Abandoned or Hazardous Vessels Act*.[22]

On 28 October, the master of the *Sivumut* was sent a formal Notice/Request of Intent from the CCG, that included a detailed description of the required actions to recover the containers per the CSA 2001 and *Wrecked, Abandoned or Hazardous Vessels Act*. Because the crew were already retrieving containers, the CCG was satisfied with the actions being taken. By 29 October, when 16 containers had been recovered from the water and 7 containers remained within Frobisher Bay, the CCG requested a salvage plan for the 7 sunken containers from the company.

On 10 November, NEAS submitted its final salvage plan for the 2024 sealift season to the CCG, which was approved.

Other finding

The CCG was monitoring the *Sivumut*'s salvage operation only as the operation pertained to the protection of the environment as its mandate does not include the identification and evaluation of safety hazards for the crew.

1.13 Safety management system

A safety management system (SMS) is an internationally recognized framework that allows companies to identify hazards, manage risks, and make operations safer—ideally before an accident occurs. An SMS involves individuals at all levels of an organization and promotes a logical approach to hazard identification and risk assessment and mitigation. It includes a set of documents that a vessel owner or AR prepares with their masters and crew to establish:

- procedures for identifying hazards and managing risks;
- procedures and checklists for the vessel's operations;
- maintenance procedures for the vessel and its associated equipment;
- documentation and record-keeping procedures;
- procedures to prepare for and respond to emergency situations; and
- drills, training, and familiarization for the vessel's crew.

Risk management within an SMS is an ongoing cycle that helps companies and vessel operators in identifying hazards and assessing, mitigating, and following up on existing and

[21] Canadian Coast Guard, "Penalties for non-compliance," at https://www.ccg-gcc.gc.ca/awah-ienad/owner-responsibility-responsabilite-proprietaire-eng.html (last accessed on 23 September 2025).

[22] Ibid.

potential risks. One of the main objectives of an SMS is to ensure safe operations for a vessel, which can be achieved by assessing all identified risks to the vessel, personnel, and the environment, and by establishing appropriate safeguards. The quality of risk management depends on the completeness of hazard identification. The ability to detect and identify hazards depends particularly on the communication of safety-related information between the operational level (master and crew) and the organizational level (management) within an organization.[23]

For an SMS to be effective, it must be vessel-specific. Measures must be in place for the company to respond at all times to hazards, accidents and emergency situations involving their vessels.[24,25]

The *International Safety Management Code* (the ISM Code) provides an international standard for the safe operation of ships and prevention of pollution. The *International Convention for the Safety of Life at Sea, 1974* requires all ships subject to the Convention to adopt an SMS that complies with the ISM Code. The ISM Code requires that, before crew engage in any activity, all hazards are identified, evaluated, and mitigated via procedures. This is especially critical when dealing with emergency situations or non-routine tasks such as container salvage operations.

1.13.1 Safety management within Transport Nanuk Inc.

At the time of the occurrence, an SMS was not required for domestic vessels such as the *Sivumut* and the *Qimmiq* tug.[26]

Although it was not required by regulation, Transport Nanuk Inc. had an SMS in place for its vessels that was certified and audited by Lloyd’s Register. The company also held a document of compliance that was issued by Lloyd’s Register on 03 May 2023.

At the time of the occurrence, the *Sivumut* held an interim safety management certificate,[27] valid for 6 months, that was issued by Lloyd’s Register on 17 June 2023 following an interim audit. An interim audit is a preliminary audit during which an auditor boards a vessel and confirms that a SMS exists and is available, digitally or in print, to all crew members. The interim audit does not include any review or verification of the contents of the SMS. Cargo transshipment operations were not within the scope of the interim audit.

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23 J. Reason, *Managing the Risks of Organizational Accidents* (Ashgate, 1997), p. 197.

24 C. Kuo, *Safety Management and its Maritime Application* (Nautical Institute, 2007), p. 93.

25 International Maritime Organization, *International Safety Management Code* (2018), Part A, Section 8: Emergency preparedness.

26 The *Marine Safety Management System Regulations* were published in July 2024. Part 6 of the regulations details when the regulations will come into force for vessels such as the *Qimmiq* and *Sivumut*.

27 An interim safety management certificate was issued because the *Sivumut* was a new Canadian vessel.

1.13.1.1 Transport Nanuk Inc.'s safety management manuals

The SMS for Transport Nanuk Inc. consists of several manuals: the *Safety Management Manual*, the *Vessel Management Manual*, the *Operating Procedure Manual*, the *Health and Safety Manual,* the *Safety Training Manual*, and the *Polar Water Operational Manual*.

To facilitate the *Sivumut*'s bi-annual change of flag, Transport Nanuk Inc.'s *Safety Management Manual* is based on the SMS manual from the vessel's winter charterer, Spliethoff, and therefore includes many of the ISM Code requirements, including a procedure for cargo operations and associated risk assessments. The SMS does not cover the cargo transshipment that is unique to Arctic sealift operations, although it does include 3 checklists that cover safety equipment verification and maintenance items for tugs and barges, including loading cargo on a barge (see Appendix B).

Transport Nanuk Inc.'s SMS does not have documented procedures or established guidelines specifically on the salvage of shipping containers, nor does it incorporate a risk assessment document addressing the potential hazards associated with salvage operations.

1.13.1.2 NEAS hazard identification and risk assessment

NEAS has in place a hazard prevention program that is detailed in a document entitled *Occupational Health and Safety Hazard Prevention Program- SHIPS*. The program and associated document are produced by NEAS' Department of Ship Operations (Arctic) to assist managers and crew aboard Transport Nanuk Inc.'s vessels in complying with the requirements of the *Canada Labour Code*, Part II, and all associated regulations.

The document includes a list of hazards and a list of corrective measures for some of those hazards. The section identifies 180 hazards; 45 of the identified hazards are described directly in the document, and 135 are in separate job safety analysis documents that are accessible via hyperlinks that redirect the users to an interactive program for risk analysis called Cloud Fleet.

Fewer than 10 of the identified hazards are about sealift operations. Job safety analysis document entitled *JSA 177 - Ship/shore tugs and barge transit* (JSA 177), which is accessible only via a hyperlink, identifies in checklist format the risk of a tug and/or barge colliding with another vessel or object due to the loaded barge restricting the tug operator's visibility. The defences listed include posting a tug assistant forward of the cargo on the barge to maintain a lookout when needed and communicate relevant information to the tug operator for navigation.

JSA 177 also identifies the risk of a person falling in the water during tug and barge transit, and mentions installing an automatic identification system (AIS) man overboard beacon on a life jacket as a defence.

Tug and barge capsizing are also identified in JSA 177 as a hazard during transit. Defences against this risk include tug inspection and maintenance, wearing an AIS man overboard beacon, and knowing the weather forecast.

NEAS's hazard prevention program does not provide guidance to crew on how to detect and assess hazards that are not identified in the program's document. The investigation was unable to identify the process for developing a new job safety analysis.

The *Sivumut* crew conducted a risk assessment for loading cargo onto the barges and documented it; the risk assessment matrix was reviewed by the master on 23 October 2023. The assessment was not done according to NEAS' hazard prevention program; however, it identified hazards such as damage to cargo, the vessel, or other assets, or injury to personnel while handling equipment, and insufficient familiarization of the cargo crew. The risk assessment did not include available freeboard or barge stability.

1.14 Cargo securing manual

A cargo securing manual provides guidance for proper use of the container securing system and for evaluating forces acting on containers. Cargo securing manuals are developed individually for each vessel by specialist companies and are then reviewed and approved by classification societies. Cargo securing manuals are required on all types of vessels engaged in the carriage of cargoes other than solid and liquid bulk cargoes.[28] This requirement is incorporated into and enforced through Canada's *Cargo, Fumigation and Tackle Regulations*.[29]

Cargo securing manuals should be developed by taking into account the International Maritime Organization's *Code of Safe Practice for Cargo Stowage and Securing* (CSS Code), which provides an international standard for the safe stowage and securing of cargoes. The CSS Code provides guidance for stowing and securing containers carried on the deck of vessels not specially designed for that purpose, such as the *Tasijuaq*. The CSS Code recommends that the 1st tier of containers, when not resting on stacking devices, should be stowed on wood timbers (dunnage). It also recommends using locking devices when stacking containers, such as cones or a similar stacking aid. For securing cargo, the CSS Code recommends various lashing techniques with wires, ropes, or chains.[30]

In accordance with Canada's *Cargo, Fumigation and Tackle Regulations,* the *Sivumut* carries an approved cargo securing manual on board. The *Tasijuaq* does not have a cargo securing manual, nor is it required by regulation because it makes voyages in sheltered waters or near coastal, class 2 voyages.

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28 International Maritime Organization, MSC.1/Circ. 1353/Rev. 2, *Revised guidelines for the preparation of the Cargo Securing Manual* (07 December 2020), paragraph 3.

29 Transport Canada, SOR-128, *Cargo, Fumigation and Tackle Regulations* (as amended on 31 October 2021), Part 1, Division 1, section 105.

30 International Maritime Organization, Resolution A.714(17), *Code of Safe Practice for Cargo Stowage and Securing* (1991), Chapter 5.

During transshipment operations, it was routine, in fair weather, for the *cargo* crew to place cargo on the barges without securing it, without placing wood dunnage under the containers, and without using stacking cones between tiers of containers.

1.15 Practical drift and risks

Practical drift can be defined as the gap between "work as imagined" and "work as actually done."[31] It represents the divergence between the expected baseline performance and actual operational performance. This drift reduces safety margins and increases operational risks. Monitoring operations as part of SMS is key for identifying and addressing practical drift before safety margins are compromised.

Risk is a function of likelihood and consequences. Risk perception is the recognition of the risk inherent in a situation. Risk perception can be altered from previous experiences, and situations that present a high level of risk for 1 person may appear low risk for another.[32] Additionally, individuals who experienced more hazardous events tend to have a lower perception of risks.[33] Likewise, those who repeatedly perform dangerous activities with no, or few, negative repercussions may become desensitized or habituated to the high level of risk. Problems arise when perceived risks no longer match the actual risks associated with an activity.

Transport Nanuk Inc. did not have written procedures specifying the maximum cargo weight and the minimum freeboard of its barges, or directives regarding the loading of the barges. Shore management relied on the cargo crews' experience, expecting they would apply best maritime practices. However, over time, several unsafe practices developed: the number of containers loaded on each barge increased, which sometimes reduced the barge freeboard until it was flush with the waterline; a tug assistant was positioned on top of the cargo while a barge was in transit; and dunnage under the containers was only rarely used.

When unsafe practices continue with no negative outcomes, and often yield positive outcomes, such as successful voyages or satisfied customers, those practices may be perceived as rational and eventually become normalized.

1.16 Supervision

Supervision is an administrative control that supports or reinforces using notions taught during training, following procedures, setting priorities, maintaining an adequate workload, preventing a high level of fatigue, as well as fostering engagement and motivation.

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31 D. Maurino, "Why SMS: An Introduction and Overview of Safety Management Systems," Discussion Paper 2017-16, prepared for OECD International Transport Forum (August 2017), pp. 13 and 14.

32 M. Martinussen and D.R. Hunter, *Aviation Psychology and Human Factors*, 2nd Edition (Taylor & Francis Group, 2018), pp. 297–301.

33 Ibid.

Supervision can have a significant impact on many factors that influence workplace behaviours.

Even though supervision is a key aspect of safety, its effectiveness can be compromised if a supervisor takes on an active role in ongoing operations. This limits the supervisor's ability to effectively monitor operations as a whole, since their attention is directed to the tasks they are performing.

Because a great deal of information is available in the work environment and information is continuously being processed, less important information will be deprioritized in favour of information that is essential to the task at hand. In addition, although it is possible to quickly shift attention from one source of information to the other, only one source of information can be processed at a time. Performing several tasks at the same time reduces performance on each individual task.

The TSB has investigated other occurrences[34] involving workplace supervision.

1.17 Survivability

Cold water immersion can rapidly become fatal. The first danger is cold shock, which occurs when the skin temperature suddenly drops upon immersion in cold water. This sudden exposure, especially to the face, triggers an inspiratory gasp reflex, hyperventilation, and involuntary water intake. In conjunction with this, the heart rate increases to dangerous levels, potentially causing cardiac arrest or arrhythmia.[35,36,37] Incapacitation follows as muscles and nerves progressively cool up to a point that it is not possible to use the limbs.[38]

Hypothermia sets in when the body's core temperature drops below its normal 37 °C, with mild hypothermia ranging from 32 °C to 35 °C, moderate hypothermia ranging from 28 °C to 32 °C, and severe hypothermia occurring below 28 °C.[39] The combined dangers of cold shock, incapacitation, and hypothermia increase the risk of inhaling water and drowning. A person immersed in water below 5 °C without protective clothing can typically survive for less than an hour.[40]

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34 TSB Marine Transportation Safety Investigation Reports M22C0005, M21C0265, M20C0101 and M18P0257.

35 J. Brooks on behalf of Transport Canada, TP13822E, *Survival in Cold Waters: Staying Alive* (2003).

36 F. Golden and M. J. Tipton, "Essentials of Sea Survival" (Human Kinetics, 2002).

37 M. J. Tipton, C. Eglin, M. Gennser, and F. Golden, "Immersion Deaths and Deterioration in Swimming Performance in Cold Water," *Lancet*, Vol. 354, No. 9179 (1999), pp. 626–629.

38 National Center for Cold Water Safety, "Stage 2: Physical Incapacitation," at https://www.coldwatersafety.org/physical-incapacitation (last accessed on 11 August 2025).

39 H. Duong, G. Patel, "Hypothermia," StatPearls Publishing, PMID: 31424823 (2023)

40 J. Brooks on behalf of Transport Canada, TP13822E, *Survival in Cold Waters: Staying Alive* (2003).

A PFD acts as a flotation and buoyancy aid, facilitates self-righting, reduces the risk of exertion, and significantly reduces the risk of drowning.[41] Retrieving a person from the water is physically demanding, particularly if the person is unconscious; wearing a PFD can assist in recovering a person from the water.

In this occurrence, the water temperature registered by the vessel was approximately 2 °C. About 20 minutes after being rescued, while in the ambulance, the tug assistant's body temperature was measured at 35.4 °C. The tug assistant had spent about 8 minutes in the water before being retrieved. His self-inflating PFD had inflated and he was wearing several layers of working clothes.

Finding: Other

Wearing a PFD reduced the tug assistant's risk of drowning and facilitated his retrieval from the cold water. The timely retrieval (within about 8 minutes), prevented the tug assistant from experiencing severe and life-threatening hypothermia.

Neither the tug operators nor the tug assistants wore an AIS man overboard beacon, although the company's job safety analysis indicates that cargo crew members should wear an AIS man overboard beacon during ship to shore transit. The investigation was unable to determine whether AIS man overboard beacons were available to the cargo crew at the time of the occurrence. The same job safety analysis document indicates that the company must provide cargo crew members with clothing that is protective against hypothermia and frostbite. While flotation jackets, which provide buoyancy and thermal protection, were available on other vessels in the fleet, they were not available on the *Sivumut*.

1.18 Related occurrences

In addition to this occurrence, the TSB is aware of 25 others occurrences involving cargo operations that have taken place in the Canadian Arctic since 2000. Some of these occurrences had persons go overboard, some were collisions, and some involved barge operations.

Since 2003, 31 incidents involving barges capsizing have been reported to the TSB. This occurrence involving the *Tasijuaq* is the 1st reported instance of a barge capsizing in the Canadian Arctic region.

1.19 TSB Watchlist

The TSB Watchlist identifies the key safety issues that need to be addressed to make Canada's transportation system even safer.

Safety management is a Watchlist 2022 issue. As this occurrence demonstrates, operations that are not covered by an SMS are at a higher risk of incurring operational

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41 Ibid.

issues and accidents. The SMS did not cover the specific hazards and issues identified in this occurrence and was ineffective for Arctic sealift operations.

To ensure the safety of crew, the vessel, and the environment, it is imperative that regulators, recognized organizations, authorized representatives, and vessel operators recognize the critical nature of safety management and take steps to ensure it is implemented effectively at all levels.

ACTION REQUIRED

The issue of **safety management in marine transportation** will remain on the Watchlist until

- TC implements regulations requiring all commercial operators to have formal safety management processes; and
- operators that do have an SMS demonstrate to TC that it is working—that hazards are being identified and effective risk-mitigation measures are being implemented.

1.20 TSB laboratory reports

The TSB completed the following laboratory report in support of this investigation:

- LP010-2024 – Photo Analysis

2.0 ANALYSIS

On 27 October 2023, the barges *Tasijuaq I* and *Tasijuaq II*, connected together and operating as a single barge (*Tasijuaq*), were being used for transshipping cargo from the cargo vessel *Sivumut* to the port of Iqaluit, Nunavut. The *Tasijuaq* capsized, resulting in 1 crew member and 23 containers falling into the water. The crew member was recovered, transported to a local hospital, and treated for hypothermia and other injuries. This analysis will examine the stability of the *Tasijuaq*, cargo transshipment operations and safety management in the Arctic, hazard identification and risk assessment, as well as survivability.

2.1 Stability of the barge

Stability is the ability of a vessel to right itself. Under the *Canada Shipping Act, 2001*, masters and authorized representatives are responsible for ensuring that a vessel is seaworthy for its intended voyage, which includes ensuring its stability. Although deck barges like the *Tasijuaq I* and *Tasijuaq II* are not required to undergo stability assessments, like all vessels they must have suitable stability to undertake their intended operations. Stability limits are determined by a stability assessment. The assessment measures the vessel against certain stability criteria to provide guidance to crew on how to determine the vessel's maximum load and acceptable freeboard.

The TSB performed a stability assessment on the *Tasijuaq* using the relevant criteria contained within the *International Code on Intact Stability*, *2008.* The TSB's assessment showed that the overall barge assembly, when loaded with 24 containers weighing a total of 342 t, was operating outside of the stability limits established by the Code (i.e., it was loaded beyond its capacity of 210 t) and the ability to right itself was compromised (Appendix A).

The TSB's stability assessment examined the vessel under different operating conditions in a static state. With an estimated initial port side list of 1° caused by the offset containers, the assessment produced a metacentric height (GM) of 0.67 m and an angle of vanishing stability of 2.66°. These results indicate that the *Tasijuaq* had a significantly limited range of stability, where a heel of 2.66° would likely result in capsizing. In contrast, the *International Code on Intact Stability, 2008* indicates that barge of 100 m in length or less must maintain a range of stability of at least 20°.

At the time of the occurrence, the *Tasijuaq* was operating in a dynamic state, under the influence of external forces such as wind, waves, current, the thrust produced by the *Qimmiq* tug, and water washing on deck due to the low freeboard. With such a limited range of stability, the barge's capacity to withstand the cumulative effects of the external forces present at the time was compromised.

Finding as to causes and contributing factors

Overloading compromised the *Tasijuaq* barge's capacity to withstand external forces; consequently, when operated in a dynamic state, the barge began to capsize, causing the tug assistant and multiple containers to fall into the water.

Because it was not required by regulation, the *Tasijuaq* had not undergone a stability assessment. Although Transport Nanuk Inc. did not have a stability assessment for the *Tasijuaq*, the company had a structural arrangement plan indicating that the maximum weight allowed on the barge deck was 210 t.

There is no regulatory requirement for a domestic vessel to carry its structural arrangement plan on board and it is not common practice to do so on small vessels, especially for vessels such as barges. The plan for the *Tasijuaq* was therefore kept on file at the onshore company office and was not available to the *Sivumut* crew; as a result, the master and members of the cargo crew were not aware of the limitations that were included in the plan notes.

Finding as to causes and contributing factors

The master and cargo crew of the cargo vessel *Sivumut* were not aware of the barge's loading limits and consequently the barge was loaded beyond its capacity.

Without a stability assessment, or access to the structural arrangement plan, the cargo crew were unaware of the barge's stability limits. The cargo crew therefore relied solely on previous experience to make decisions about the barge's safe operating limits.

Finding as to risk

If deck barges are operated without having undergone a stability assessment, there is a risk that those barges will be operated outside of their stability limits.

2.2 Barge stability characteristics and safety

Vessels with relatively wide hulls and flat bottoms, such as barges, typically have a higher initial GM and a steep righting lever (GZ) curve (peaks at smaller angles), and the range of stability is much less than a traditionally shaped vessel. It is therefore important to ensure that the stability characteristics and loading limits are established and that the cargo crew are familiar with them.

Following the occurrence, in an attempt to understand how the loading of the *Tasijuaq* may have contributed to the occurrence, the master and chief cargo of the *Sivumut* calculated the barge's GM and found it to be positive. Given that a positive GM typically indicates that a vessel is capable of righting itself, this result alone could not explain why the barge capsized. In the absence of comprehensive information to perform a stability assessment, the full impact of the loaded conditions of the barge, including the impact on the GZ curve, were not assessed. Several days later, crew discovered holes in the barge's hull; it was then assumed that water entered 2 hull compartments and created a free surface effect that, when combined with dynamic external forces, reduced the barge's stability. The findings of a third-party post-occurrence investigation, that did not include stability calculations, supported this assumption.

The TSB investigation could not determine exactly when the holes were made. However, according to the TSB's stability assessment, the approximate freeboard of the *Tasijuaq* at the time of the occurrence was about 0.08 m on the port side, which is consistent with the results of a photo analysis of the draft just before the occurrence. Water in the barge at the time of the occurrence would have produced a significantly smaller freeboard than the results of the photo analysis. Furthermore, the barge's multiple subdivisions greatly reduced free surface effect. If water was present in large quantity in the 2 holed compartments at the time of the occurrence, the barge's list or trim likely would have been more noticeable on the photos analyzed. The results of the TSB's analysis indicate that if water was present in the barge, it was a minimal amount and had no appreciable impact on the occurrence.

The TSB's stability assessment highlights the importance of having a complete understanding of a barge's stability characteristics, and not just the GM. Without this knowledge, mariners working with barges may not be aware of the differences in the range of stability of a barge and a traditionally shaped vessel, which may result in overloading and capsizing. In this occurrence, the master and cargo crew of the *Sivumut* were not aware of the *Tasijuaq*'s stability characteristics, including its limited range of stability. They were therefore unaware of the degree of heel the barge could sustain before capsizing, and were under the impression that as long as the load was centred and the GM was positive, the barge was being operated safely.

Finding as to risk

If the members of a cargo crew working with barges have an incomplete understanding of barge stability characteristics (including the hull shape) and associated limits, there is a risk that the stability will not be fully assessed for the barge operation.

2.3 Cargo transshipment operations and safety management in the Arctic

A safety management system (SMS) is a formal, documented, and systemic approach to help vessel operators and crew members manage risk. To be effective, an SMS must be vessel-specific and cover all vessel operations.

Transport Nanuk Inc. specializes in Arctic sealift (sealift) operations; its entire fleet is dedicated to this task, and using barges to transship cargo from vessels to shore is an essential part of its operation. However, the investigation found that procedures for cargo transshipment contained within the company's SMS at the time of the occurrence were limited in number and detail. For example, there were no procedures for container handling, loading the barges, and securing cargo on the barges. As well, the SMS was large and complex, and the few procedures relevant to transshipment operations were spread across multiple documents, making them difficult to retrieve.

The company had conducted transshipment operations in the Arctic for several years without adverse consequences. Loading and offloading barges was a routine part of operations, which likely diminished the perceived need for formal written procedures. The company therefore relied almost entirely on the experience of the crew members that were part of the cargo crews. However, in the absence of procedures, there was an increased risk of variability in practices and the potential for unsafe practices to develop without the cargo crew being aware.

Finding as to risk

The absence of detailed procedures specific to cargo handling operations can lead to variability in practice, which can increase the likelihood that crew will develop unsafe practices.

2.3.1 Barge operational practices

In absence of written procedures for transshipment operations, crews working throughout Transport Nanuk Inc.'s fleet developed vessel-specific work practices that, over time, became normalized on board those vessels.

The crew members on board the *Sivumut* who were in charge of cargo operations had several years' experience working on other vessels within Transport Nanuk Inc.'s fleet, and applied their vessel-specific work practices to the occurrence vessel. Therefore, even before the *Sivumut* was added to the fleet, several operational practices began to drift from the expected baseline. For example, barges were sometimes loaded to the point where they had minimal freeboard, and the upper edge of the barge deck was flush with the waterline. The use of dunnage under the containers and stacking cones between tiers of containers was discontinued. This practical drift represented a departure from existing best practices, which reduced safety margins and increased operational risk for transshipment operations.

Practical drift eventually led to practices that compromised the safety of cargo crew members. For example, because a tug operator's view could be restricted by the barge load, the company's job safety analysis allowed for a tug assistant to be stationed on the barge deck to assist with navigation. Over time it became acceptable for a tug assistant to be stationed on top of the load during transit to shore, further compromising crew member safety. Without negative consequences, the crew's perception of the risks diminished, and this practice became normalized.

Finding as to causes and contributing factors

Over time, the practices of the *Sivumut*'s crew drifted, their perception of the risks diminished, and unsafe practices became normalized. This led the cargo crew to load the barge in an unsafe manner during operations, resulting in reduced safety margins during dynamic operating conditions.

2.3.2 Operational requirements and crewing

The company's *Vessel Management Manual*, based on the needs of a typical transhipment in the Arctic, lists 14 cargo crew members. Most of the vessels operated by the company are crewed with a total of 22 persons, including 15 crew members for cargo handling operations. However, the *Sivumut*'s lifeboat capacity (20 persons, or the complement at the time of the occurrence) limits the number of crew members who can work on board the vessel, and some crew members are needed for shipboard operations such as those required on the bridge, in the engine room, and in the galley. Consequently, the *Sivumut*'s transshipment operations are conducted with 13 cargo crew members, which is 1 less cargo crew member than required, and 2 less cargo crew members than personnel were accustomed to working with on other vessels in the company's fleet.

Because of the reduced cargo crew capacity, the chief cargo involved in this occurrence took an active role in cargo handling. As a result, the chief cargo was in the hold to help crew sling shipping containers as the *Tasijuaq* was being loaded. The chief cargo could not see how the shipping containers were being positioned on the barge or supervise cargo crew members working on the barge, and therefore was unable to detect whether the containers were being loaded off-centre.

Recent TSB investigations have identified other situations where supervisors were taking an active role impacting operational safety.

Finding as to risk

If supervisors play an active role during a safety-critical task, their attention will be divided and they will have less capacity to oversee all aspects of the task, increasing the risk that safety-critical issues will not be detected in time to prevent an accident.

Although the chief cargo can request assistance from bridge officers or machinery assistants if needed, the work undertaken during transshipment operations on the day of the occurrence was regarded by crew as routine. The chief cargo therefore did not perceive the need to have an additional crew member assist in the cargo hold.

When the *Sivumut* was introduced to the fleet, the company's *Vessel Management Manual* was not amended to take into account the *Sivumut*'s reduced crew capacity, and there were no written procedures, guidance, or other measures in place to mitigate the risks associated with the resulting increased workload.

Finding as to risk

If an SMS does not reflect the actual working conditions on a vessel, crew may be left without guidance to mitigate the risks associated with an increased workload.

2.4 Hazard identification and risk assessment

In accordance with the *International Safety Management Code*, before undertaking any new task, all potential hazards must be taken into account and procedures established, including for emergency situations. However, Transport Nanuk Inc.'s SMS did not address salvage operations in the Arctic, nor did it include an assessment for the hazards specific to these operations.

The cargo crew of the *Sivumut* operated without any formalized risk assessment or structured procedural framework for the challenges posed by container salvage operations in the Canadian Arctic. Instead, crew members applied their previous experience with routine sealift operations to the container salvage operation.

After crew members of the *Sivumut* successfully retrieved the tug assistant and transferred him to emergency services ashore, they proceeded with container recovery. They understood the vital importance of the goods they were transporting to the communities, especially because the occurrence voyage was the last trip of the season. If the containers were not retrieved before they sank, the ice formed, or the vessel and crew had to return south, the opportunity would be lost until July of the following year, which would pose a risk for navigation and the environment. Aware of the limited availability of resources in the region for an immediate salvage operation, crew members recognized that they needed to take initiative and act quickly.

Given the urgency of the situation, the crew prioritized recovering the containers as soon as possible. Crew members drew on their operational experience with sealift operations and adapted their approach to the situation. Although the master was in communication with company management and the chief executive officer had some discussions with the master about the container salvage operations, no specific instructions on how to proceed with the container recovery were requested and none were provided. Given the crew's experience with sealift operations, and the urgency of the situation, the company accepted the crew's approach.

The urgency to retrieve the containers prevented the crew from effectively identifying the hazards and manage the risks associated with such a complex salvage operation. Although the chief cargo, master, and crew members communicated their proposals to each other for container retrieval via radiotelephone, no formal hazard identification or coordinated planning took place. Methods for retrieval were briefly addressed and changed as the situation unfolded, without a common understanding among all crew members of how to proceed. Additionally, there were often discrepancies between crew member proposals and actions.

The absence of formal hazard identification and coordinated planning increased the risk of further accident and injury. Crew members worked until 2200 to retrieve the containers, with only the *Sivumut*'s search light and the lights from tugs to assist them, impacting their ability to detect hazards while working. Crew members also boarded containers while the containers were afloat to secure them for towing and retrieval, which increased crew members' risk of falling overboard and incurring injury. At least 1 container was retrieved while the *Sivumut*'s propeller was turning, which posed a risk of injury or death to any crew member who fell into the water.

Finding as to risk

If new operations are conducted without thorough hazard identification and risk assessment, risk mitigation measures might not be taken, which would increase the risk that crew members will conduct the operation in unsafe conditions.

2.5 Survivability

After falling into the water, the tug assistant's personal flotation device (PFD) inflated, which helped him stay afloat, facilitated self-righting, and reduced the risk of drowning. The tug assistant remained in the water for about 8 minutes before being retrieved. When his body temperature was measured about 20 minutes after retrieval, it was recorded at 35.4 °C. His body temperature was lower at the time of recovery, in the range of mild to moderate hypothermia.

At the time of the occurrence, the tugs *Qimmiq* and *Ukaliq* were each equipped with life rings and a gaff, but were not equipped with devices to assist and facilitate the retrieval of an unconscious person overboard. Life rings and gaffs can assist a conscious person to return to a vessel, but will not assist a single rescuer in the timely and effective retrieval of an unconscious person from the water. Retrieving a person from the water is physically demanding, particularly if the person is unconscious. In this occurrence, even though the tug assistant's PFD was inflated, it took 3 crew members to haul the unconscious tug assistant onto a container as the container floated on the water with a freeboard of approximately 1.2 to 1.4 m. The PFD facilitated the tug assistant's retrieval.

The tug assistant was wearing several layers of work clothing that helped him retain body heat but added a lot of weight once they became wet. A flotation suit, or flotation jacket and pants, would have offered buoyancy in addition to thermal protection, but none were available at the time of the occurrence. Despite Transport Nanuk Inc.'s requirement to provide tug and barge operators with protective clothing to prevent hypothermia, neither the tug operators nor the tug assistants involved in this occurrence were provided with such clothing. Additionally, Transport Nanuk Inc. requires that crew members always wear an automatic identification system (AIS) man overboard beacon during ship to shore tug and barge transits, but none of the tug operators or tug assistants involved in this occurrence were provided with AIS man overboard beacons.

In this occurrence, the absence of a retrieval device, flotation clothing offering thermal protection, and AIS man overboard beacons increased the tug assistant's risk of severe and life-threatening hypothermia.

Finding as to risk

Crew members who are not provided with appropriate personal protective equipment, such as flotation clothing offering thermal protection, person overboard retrieval equipment, and locator devices, may be severely or fatally injured when falling overboard.

3.0 FINDINGS

3.1 Findings as to causes and contributing factors

These are conditions, acts or safety deficiencies that were found to have caused or contributed to this occurrence.

1. Overloading compromised the *Tasijuaq* barge's capacity to withstand external forces; consequently, when operated in a dynamic state, the barge began to capsize, causing the tug assistant and multiple containers to fall into the water.

2. The master and cargo crew of the cargo vessel *Sivumut* were not aware of the barge's loading limits; consequently, the barge was loaded beyond its capacity.

3. Over time, the practices of the *Sivumut*'s crew drifted, their perception of the risks diminished, and unsafe practices became normalized. This led the cargo crew to load the barge in an unsafe manner during operations, resulting in reduced safety margins during dynamic operating conditions.

3.2 Findings as to risk

These are conditions, unsafe acts or safety deficiencies that were found not to be a factor in this occurrence but could have adverse consequences in future occurrences.

1. If deck barges are operated without having undergone a stability assessment, there is a risk that those barges will be operated outside of their stability limits.

2. If the members of a cargo crew working with barges have an incomplete understanding of barge stability characteristics (including the hull shape) and associated limits, there is a risk that the stability will not be fully assessed for the barge operation.

3. The absence of detailed procedures specific to cargo handling operations can lead to variability in practice, which can increase the likelihood that crew will develop unsafe practices.

4. If supervisors play an active role during a safety-critical task, their attention will be divided and they will have less capacity to oversee all aspects of the task, increasing the risk that safety-critical issues will not be detected in time to prevent an accident.

5. If a safety management system does not reflect the actual working conditions on a vessel, crew may be left without guidance to mitigate the risks associated with an increased workload.

6. If new operations are conducted without thorough hazard identification and risk assessment, risk mitigation measures might not be taken, which would increase the risk that crew members will conduct the operation in unsafe conditions.

7. Crew members who are not provided with appropriate personal protective equipment, such as thermal protective clothing, person overboard retrieval equipment, and locator devices, may be severely or fatally injured when falling overboard.

3.3 Other findings

These items could enhance safety, resolve an issue of controversy, or provide a data point for future safety studies.

1. The Canadian Coast Guard was monitoring the *Sivumut*'s salvage operation only as the operation pertained to the protection of the environment as its mandate does not include the identification and evaluation of safety hazards for the crew.

2. Wearing a personal flotation device reduced the tug assistant's risk of drowning and facilitated his retrieval from the cold water. The timely retrieval (within about 8 minutes), prevented the tug assistant from experiencing severe and life-threatening hypothermia.

4.0 SAFETY ACTION

4.1 Safety action taken

4.1.1 NEAS Inc. and Transport Nanuk Inc.

Following the occurrence, NEAS Inc. and Transport Nanuk Inc. took the following safety action:

- On 27 March 2024, as requested by NEAS Inc., a third party created a loading guide specifically for the company's barges, to meet acceptable stability criteria.
- In June 2024, a new manual, *Arctic Sealift Operations Safety Manual*, was added to Transport Nanuk Inc.'s safety management system. This manual provides transshipment procedures to be followed by the crew.
- In the spring of 2024, a recovery device (Jason's Cradle) was installed on each tug.
- A minimum freeboard line is painted in white on both sides of all barges operated by NEAS inc.

4.1.2 Transport Canada

Transport Canada proceeded with a compliance inspection following the occurrence in Iqaluit, on 29 October 2023 for the *Tasijuaq I* and *Tasijuaq II* barges, the *Qimmiq* tug, and the cargo vessel *Sivumut.* It was the 1st time Transport Canada proceeded with a flag state inspection in the Arctic of a sealift vessel at the transshipment site.

Some deficiencies were noted and had to be rectified before the *Sivumut* was allowed to resume cargo transshipments. Most deficiencies were regarding safe operating procedures according to the *Canada Shipping Act, 2001*, subsection 106(1).

4.1.3 Canadian Coast Guard

Canadian Coast Guard issued navigational warnings on 03 July 2024 about shipping containers that may have been drifting or submerged in shallow waters in Koojesse Inlet, Nunavut, and surrounding areas.

In September and October 2024, the Canadian Coast Guard Marine Environmental and Hazard Response branch (CCG-MEHR) monitored the salvage operation in Frobisher Bay, Nunavut, and Koojesse Inlet.

This report concludes the Transportation Safety Board of Canada's investigation into this occurrence. The Board authorized the release of this report on 16 July 2025. It was officially released on 07 October 2025.

Visit the Transportation Safety Board of Canada's website (www.tsb.gc.ca) for information about the TSB and its products and services. You will also find the Watchlist, which identifies the key safety issues that need to be addressed to make Canada's transportation system even safer. In each case, the TSB has found that actions taken to date are inadequate, and that industry and regulators need to take additional concrete measures to eliminate the risks.

APPENDICES

Appendix A – TSB stability assessment of the *Tasijuaq* barge

Although existing barges of less than 24 m in length, such as the *Tasijuaq I* and *Tasijuaq II*, are not required to undergo a stability assessment, a new barge of more than 24 m in length is required to comply with the recommendations of the International Maritime Organization's *International Code on Intact Stability, 2008*.[42] In the absence of requirements for a stability assessment for barges of less than 24 m in length, the TSB carried out an assessment on the *Tasijuaq* using information contained within the barge's technical arrangement plan and the relevant criteria contained within the Code.

For the TSB's stability assessment, interviews and documentation were used to determine the loading conditions at the moment of the occurrence, including the location of the containers on the barge and their respective weights. The center of the container was used as a center of gravity reference point , since the distribution of the weight inside the containers was not known. The barge's static stability was evaluated under the following loading conditions:

1. 342 metric tonnes (t) of cargo, no list on departure
2. 342 t of cargo, port side list of 1° on departure
3. 342 t of cargo, maximum calculated potential port side list of 2.27° on departure

The TSB's assessment determined that the *Tasijuaq* failed at least 2 stability criteria in each of the operating conditions examined (Table 2).

Table 2. Calculated values for load conditions of the *Tasijuaq* barge on the occurrence voyage, measured against relevant stability criteria of the *International Code on Intact Stability, 2008* (Source: TSB)

Stability criterion	Minimum value to meet stability criterion	Calculated value for loading condition 1 (342 t of cargo, no list on departure)	Calculated value for loading condition 2 (342 t of cargo, port side list of 1° on departure)	Calculated value for loading condition 3 (342 t of cargo, maximum calculated potential port side list of 2.27° on departure)
(1) Righting area for maximum righting lever*	0.08 metre-radians	0.0006 metre-radians (fail)	0.0002 metre-radians (fail)	0.0000 metre-radians (fail)
(2) Minimum range of stability*	20°	4.17° (fail)	2.66° (fail)	Negligible (fail)

42 Transport Canada, SOR/2023-257 *Vessel Construction and Equipment Regulations* (as amended 20 December 2023), section 101, referring to International Maritime Organization, *International Code on Intact Stability, 2008* (last amended 01 January 2020).

(3) Static angle of heel (windage)*	Angle corresponding to half the freeboard	Not calculated**	Not calculated**	Not calculated**
(4) Initial metacentric height	Criterion not applicable to barges	0.664 m	0.666 m	Negligible
(5) Angle of maximum righting lever	Criterion not applicable to barges	2.50°	1.51°	0.19°

* These criteria are from the *International Code on Intact Stability, 2008*.
** These values were not calculated because they are not relevant to this occurrence.

Appendix B – NEAS Inc. work assessment checklist for loading cargo on barge

Checklist

Report exported on:
05.11.2023

Loading cargo on barge

01 Personnel (001 to 049)

18 Unawareness of the hazardous environment and surrounding dangers
- ☐ Onboard training carried out
- ☐ Unfamiliar crewmember to be supervised by officer/experienced seamen
- ☐ Crew members situational awareness verified during Toolbox meeting.
- ☐ Aware of surroundings

27 Insufficient familiarization/lack of training
- ☐ New or unexperienced crewmember to be supervised by experienced person
- ☐ Familiarization/on board training to be completed.
- ☐ Toolbox meeting carried out

30 Inappropriate technique of lifting/handling equipment
- ☐ Onboard training
- ☐ Unfamiliar crewmembers to be supervised by officer/experienced seamen
- ☐ Crewmembers/officers with key position to receive training with lifting equipment and techniques
- ☐ Toolbox meeting carried out

34 Falling cargo/object (ship)
- ☐ Onboard training/familiarization
- ☐ Toolbox meeting system in place
- ☐ Hazard prevention program in place to increase awareness of risk related to each job position onboard
- ☐ Crewmembers to wear PPE during deck operations
- ☐ Awareness of all crew to keep focus on operations and position of the moving cargo around them

02 Ship (050 to 099)

81 Unexpected/uncontrolled movement of equipment during lifting operation
- ☐ Onboard training
- ☐ Unfamiliar crewmembers to be supervised by officer/experienced seamen
- ☐ Awareness of crane operator and use of adapted technique to prevailing conditions
- ☐ Awareness of crewmember on movement of equipment and associated risks
- ☐ Techniques adapted to prevailing conditions and use of extra lines as needed to control movement of equipment during lifting operations
- ☐ At no time, crewmembers shall be in an area where crushing by unanticipated movement of equipment can occur (onboard enforcement supervised by officer)

82 Inadequate/damage/worn out lifting equipment
- ☐ Inspections of lifting appliance to be carried out as per regulations
- ☐ No operation will be done using damage/worn out lifting equipment

Checklist

Report exported on:
05.11.2023

03 Cargo (100 to 149)

111 Manipulation of hook/lifting gear under strong tension

- ☐ Onboard training to ensure proper manipulation of equipment
- ☐ Unfamiliar crewmembers to be supervised by officer/experienced seamen
- ☐ Awareness of crane operator and use of adapted technique to prevailing conditions

Report exported on:
11/5/2023

Cloud Fleet Manager

Page
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Source: NEAS Inc., Checklist: Loading cargo on barge (report exported on 05 November 2023).