Incident Investigation Report

Kicking Horse Gondola

TECHNICAL SAFETY BC

February 2026

Summary

Incident Description

On March 10, 2025, just before 9:30 am, a hanger arm from the Golden Eagle Express (GEE) Gondola broke just after it left the bottom station at the Kicking Horse Mountain Resort (KHMR) (Images 1 and 2). The gondola cabin fell to the ground from a height of approximately 1 to 1.5 m and the gondola was stopped by operations staff. The eight passengers inside were able to exit the cabin and were attended to by local ski patrol with only minor injuries reported.

Following the failure, KHMR personnel began procedures to evacuate the passengers in the other cabins. Initially, an attempt was made to remove the failed portion of the gondola arm that was still connected to the haul rope so the drive could be used to evacuate passengers (Image 3). However, the hanger arm section that was broken became stuck in the tower sheaves (Image 4) and at approximately 11:20 am a decision was made to switch to manual evacuation. Evacuations via manual rope rescue, including ground and helicopter operations, were used to evacuate patrons from the remaining cabins. All guests were safely cleared from the GEE Gondola by 4:22 pm (approximately seven hours after the failure).

Technical Safety BC's Role and Jurisdiction

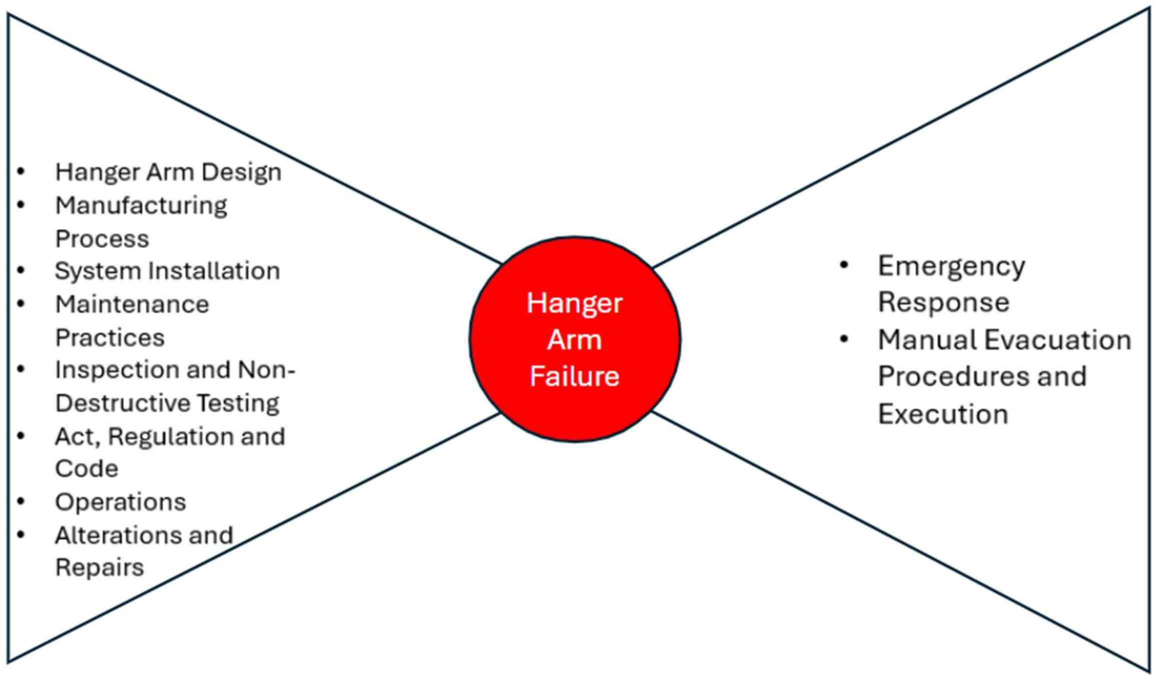
Technical Safety BC administers the Safety Standards Act and the Elevating Devices Safety Regulation which applies to Passenger Ropeways in BC, including gondolas.

Following an incident, Technical Safety BC may investigate to learn from the incident and inform the prevention of similar incidents in the future. Additional details regarding jurisdiction and role can be found in Appendix A.

Scope of Investigation

The content and findings in this report are based upon the evidence presented and available at the time of Technical Safety BC's investigation, conducted between March – November 2025.

The investigation sought to understand the causes and contributing factors to the gondola arm failure, as well as the effectiveness of the emergency response that followed. The following was included as part of the investigation:



Failure Scenario

The GEE Gondola was constructed in the year 2000, with hanger arms manufactured from ASTM A500 B Steel using a manufacturing process that was extensively used for hanger arms at the time. Shortly after installation in 2000, the GEE Gondola began experiencing some operational issues. The station design, setup (alignment), and operation (adverse conditions) resulted in mis-captures (the grip was missing the guide (or lateral) rails in the station) leading to impacts between the top of the hanger arm and the station structure, especially during high wind conditions. This resulted in damage to both the top station and the hanger arms. The operator working with the manufacturer attempted various operational and alignment fixes to inhibit these impacts including a service bulletin issued by the manufacturer in 2002 regarding proper adjustment of the lateral rails.

In response to the mis-captures the GEE Gondola was experiencing, the manufacturer issued another service bulletin in 2006 that required modifications to the lateral rail to reduce the possibility of mis-capture. The modifications were implemented but did not fully resolve the issue. An additional guide assembly to prevent impacts was developed by the manufacturer around 2003, but it was not referenced in a formal service bulletin, and the guide assembly was never installed on the GEE Gondola drive station prior to the incident. In addition, some components used to align and support the guide rails were not in place on the arrival side of the return and drive stations. Without these components in place, impacts continued to occur.

At some point during the GEE Gondola lifecycle, several years before the incident, the hanger arm for cabin 15 (the failed arm) struck the station (possibly multiple times), resulting in damage to a heavy steel gusset at the top of the arm. The impact also created high levels of stress in the bend of the arm where it was brittle from a combination of the material selected and the manufacturing process used. At this point, the crack was exposed and began to progress slowly during operation.

Prior to the failure, the GEE Gondola went through various visual and non-destructive test cycles. In addition to daily and 500h visual inspections, the failed arm was checked three times with Magnetic Particle Inspection (MPI) in the last five years (2020, 2021, and 2023) and no crack was identified.

On the morning of the incident, the KHMR staff completed all the daily checks on the GEE Gondola and began its operation. At 8:32am the first passenger in cabin number 15 was a staff member who was transported to the top of the mountain for a day at work. The cabin remained empty until the lift was open to the public and at 9:27am 8 patrons (the maximum capacity) were loaded into the cabin along with their ski gear in the outer equipment holder. The cabin then passed through the station, the grip reattached to the haul rope, and the fully loaded cabin accelerated out of the station until the hanger reached its critical failure point and snapped. The cabin broke free and landed on the ground approximately 1-1.5 meter below coming to rest on its side.

Findings

Cause

The investigation found that the cause of the incident was an unidentified crack that developed from conditions introduced through the manufacturing process, coupled with short duration, high-magnitude forces that occurred during operation.

Contributing Factors

1. The selected material and manufacturing process resulted in low material toughness and brittleness; properties that were conducive to a crack initiating in the arm.
2. Station setup allowed for impacts between the hanger arm and station structure resulting in high stresses in the carrier structure.
3. Major impacts to the hanger arm during operation very likely triggered the progression of the crack.
4. The inspection regime intended to identify and respond to cracks before failure did not identify the crack prior to it reaching a critical size.

Additional Considerations

5. Through additional testing of numerous other hanger arms from the GEE Gondola, as well as other similar gondolas, the investigation determined that the failure was the result of the unlikely convergence of several abnormal conditions, as opposed to a single risk factor.

6. Once the manual evacuation began, favourable conditions and well-trained personnel resulted in all gondola passengers being successfully rescued.

Recommendations

Recommendations made by Technical Safety BC pursuant to this investigation and the rationale are located at the end of the report on Page 29.

Site, System, and Components

Definitions

Definitions pertinent to this report are included in Appendix B

Act, Regulation, and Code

Passenger ropeways, including gondolas, are subject to the Elevating Devices Safety Regulation (the Regulation), as enacted by the Safety Standards Act (the Act). The Regulation sets out requirements for the design, operation, ownership, maintenance, and alteration of Passenger Ropeways in British Columbia and adopts the applicable code, in this case, CSA Z98 (2014 edition), Passenger Ropeways and Passenger Conveyors (the Code, Appendix C).

Gondola Overview

KHMR is located near Golden, BC and operates a variety of passenger ropeways including chairlifts, passenger conveyors, and gondolas. A gondola is an enclosed aerial lift system where cabins are suspended from a moving cable, powered by a large drive motor at the top station. At KHMR, the GEE Gondola starts at the valley station at 1,150 m elevation and climbs 1,260 m over a 3.7 km span to the mountain station near 2,350 m of elevation (Image 5). It operates with up to 55 cabins seating up to 8 passengers per cabin (Image 6). The GEE Gondola was manufactured by Leitner Poma of America (LPOA) and was installed in the year 2000. The GEE Gondola serves as the main access to top of the mountain and provides access to several other lifts on the mountain during both the winter ski season, and the summer season where it provides access for tourism, weddings and other summer activities.

Site and Environment

Temperatures, especially at the top of the mountain, can range from around 20 °C in the summer to -40 °C in the winter. In addition to extreme temperatures, the top of the mountain experiences frequent and sustained high wind events. According to staff, the bottom, or return station, also experiences strong crosswinds.

CCTV Footage

On the day of the incident, at 8:32 am, cabin 15 first came through the lower (return) station (Image 7). At that time, one member of the operations staff boarded the cabin and was successfully brought to the top of the mountain. The cabin went around again several times before the first passengers entered cabin 15 at approximately 9:27 am (Image 8). At that time eight passengers entered the gondola and three snowboards, and five pairs of skis were placed in the cargo compartments on the doors (Image 9). Cabin 15, and a few cabins on either side of it, were covered in snow. The area on the hanger where the crack existed was also coated in snow and/or ice, obscuring any view of the crack. A few seconds later, as the gondola left the station, it fell to the ground. (image 10).

Hanger Arm Design and Manufacture

The GEE Gondola used eight-person detachable hanger arms (part number US4076.601) manufactured by LPOA. This type of hanger arm was used for a variety of other chairlifts and gondolas. The hanger arm is considered a critical gondola component as it represents a single path to failure. In other words, there is no redundancy in the design and failure of the arm will result in the gondola cabin falling. This is addressed in the code and, as a critical component, requires a static factor of safety of at least 3 in the design (Appendix C).

Design Drawing

LPOA's design drawings for the GEE Gondola hanger arms indicate the arms were manufactured with 5-inch diameter ASTM A500 Grade B steel with 3/8 inch wall thickness. The design drawings show that a single piece of welded tube was bent into the desired shape and then assembled with gussets, connections and other component parts. The lower bend was approximately 60 degrees, the upper bend only 12 degrees. A note *stated "NOTE SEAM LOCATION"* referring to the weld seam on the tubing. It showed the weld on the inside face of the tubing, in line with the bend.

The gondola cabins were connected via a steel *"h-frame"* to the hanger arm with two bolted connections with bushings for dampening on the bottom of the arms. This created a relatively fixed connection between the gondola cabin and the hanger arm. It is important to note that this design differs from some other gondola cabin to hanger arm systems installed in BC, which typically use a dampened single bolt or hinged connection that allows for more movement of the cabin relative to the hanger. The ability for the cabin to move independently of the hanger arm typically lessens the effect of wind and impacts to the hanger arm.

Material Standard and Specification

The ASTM A500 standard for steel is specified for cold-bent tubing for structural applications. The tubing is typically cold rolled from plate and welded. To qualify as ASTM A500 Grade B steel, the material's chemical composition and material properties must fall into specific ranges. For example, carbon content must be below 0.3%. Even when these requirements are met, acceptable materials may still exhibit a range of properties, particularly for characteristics not explicitly defined by the standard. The standard states:

> *“Note 1 – Products manufactured to this specification may not be suitable for those applications such as dynamically loaded elements in welded structures etc., where low-temperature notch-toughness properties may be important.”*

The specification for ASTM A500 steel does not include a cold weather toughness requirement. When deemed necessary for the application, it would have to be separately specified by the purchaser and either verified or produced in a custom run by the mill. This would typically increase costs and lead times for the steel.

There are currently other available material specifications in production, including A501 steel (similar to A500 except it is for hot-rolled steel) or ASTM 1085 (a more recently developed steel for dynamic applications, including amusement rides). Some of these materials were less available at the time of the GEE Gondola construction.

Around the time of the GEE Gondola construction, documentation from the European counterparts of LPOA identified minimum cold weather toughness requirements for hanger arms (see excerpt from a POMA (France) specification from 2000 below):

NUMERO MÉCANIQUES OUTILLAGE	NUMÉRO PIECE POMA	DÉSIGNATION	NUMÉRO DE PLAN DE CONTROLE MAGNÉTO	DIMENSIONNEL	NUANCE	CARACTÉRISTIQUES
17 205	8 900 085	Mors fixe TA	8 001 224	(*) ET 8111819		Dureté HB = 250 - 285
C7307 ambiante	8 900 119	BRAS SUSP. TC 12	8 001 345	(*)		34 Cr Mo 4 Traction à température
C7284	8 900 109	Tête susp. TC 6	8 001 346	(*)		Rp 0,2 • 670 MPa Rm = 830 - 980 MPa
63 542	8 900 116	Bras susp. TC 6	8 001 345	(*)		Allongement A % • 13 % Energie de rupture au choc KVL • 27 Joules à - 20° C en moy. sur 3 essais, aucune valeur individuelle • 21 Joules

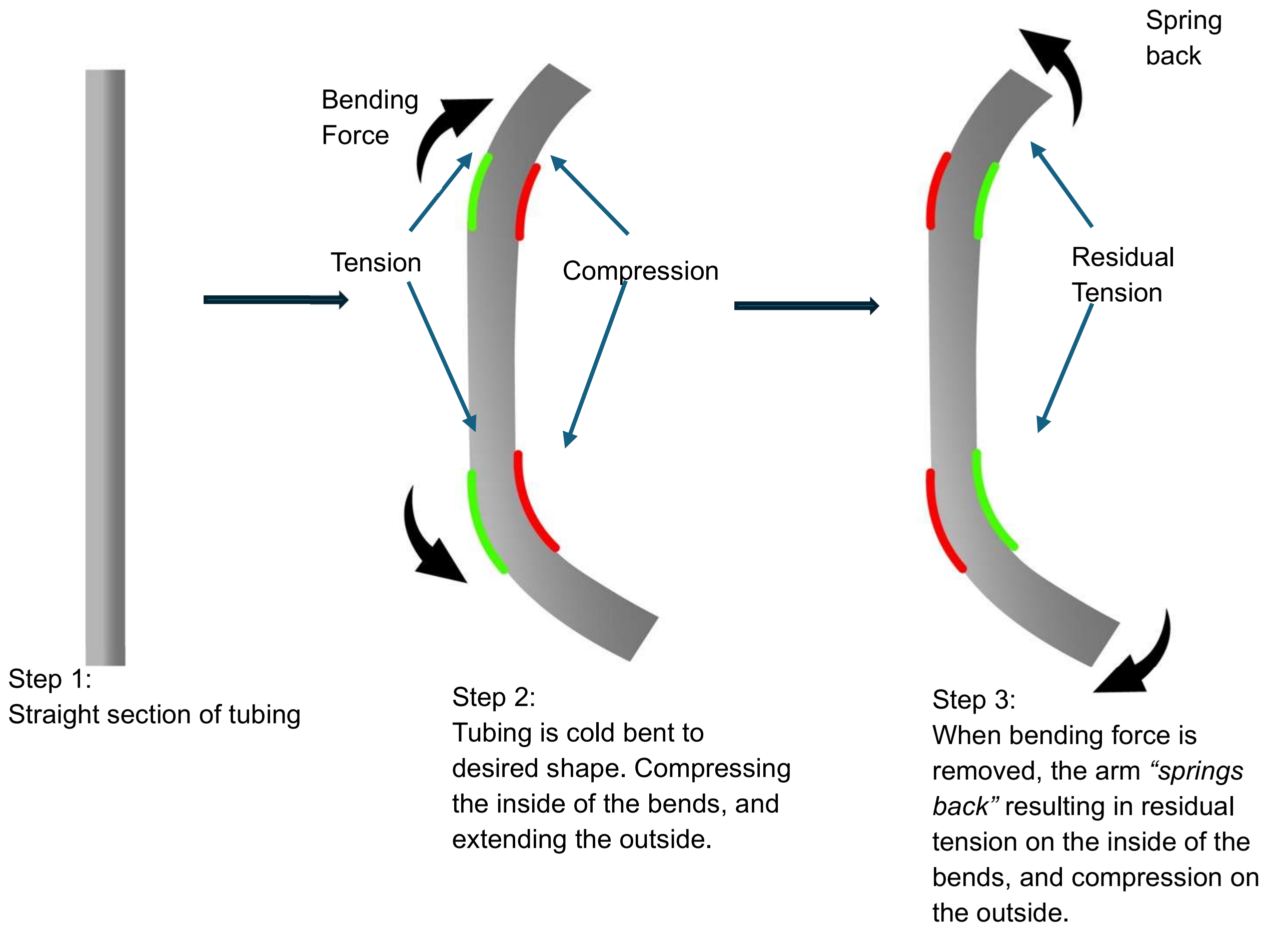
Figure 1 - Poma specification for hanger arms and grips (Translation: Hanger Arm TC 12, 27 Joules at -20 C on average over 3 tests with no single value below 21 J)

Manufacturing Process and Sequence

LPOA had limited records relating to the manufacture of the GEE Gondola hanger arms due to the length of time passed, and because records were kept in paper copies at the time of manufacture. However, based on typical procedures they use for manufacturing, they indicated the following general sequence would have been followed:

1. The tubing was ordered from a third-party supplier. Mill test reports (MTR) would have been requested and reviewed to ensure the metal met the specification for A500 Grade B steel. It was rare that MTRs would include Charpy impact results, which measure a material’s ability to absorb energy before breaking at a given temperature (see Appendix B for more details).
2. The tubing was shipped to a third-party contractor (specific contractor unknown) in order to bend the tubing as LPOA does not have the capability in house to complete bending on a tube of that size. The tubing was cold bent. This would result in residual tensile stresses at the interior of the bend (See figure 2 below).
3. The bent tubing would return to LPOA’s Grand Junction facility to complete fit up and assembly including the addition of connection points, gussets, etc.
4. The complete assembly would then be shipped to another third party for galvanizing.
5. The completed part would return to LPOA’s facility for final quality control and preparation for shipment.

Figure 2 - Manufacturing Process for bending the gondola arms to the desired shape



LPOA indicated that because they use mild steels, with limited cold work the notch toughness (or Charpy impact) properties had never been a problem. However, for about the last decade LPOA has been more specific regarding required impact testing in order to confirm the virgin materials used had adequate impact resistance.

Testing and Quality Control

Throughout the manufacturing process for the GEE Gondola, LPOA completed various forms of quality control including regular visual and dimensional checks. In addition, the hanger arm designs were required to be certified according to the CSA Z98 code for fatigue by performing cyclic testing under load on a sample arm. LPOA has a custom fatigue testing machine which is used to create a simulated cyclic load for five million cycles in both loaded (with passengers) and unloaded (weight of the arm and cabin alone) states. The hanger arm design was originally certified in September 1999 for use for up to eight persons. It was later re-certified in 2001 and 2006 for 10-person applications and for use as a freight carrier. At each of those times, an additional fatigue test was conducted on the arm with the additional expected weight. It was not documented if these tests were done pre or post galvanizing, and LPOA representatives indicated they did not have a consistent practice at the time. However, images that were included in the testing reports from 2001 showed the arm had external corrosion, indicating it was not galvanized at the time of the test. This was confirmed in an interview with LPOA's senior design engineer. Photographs of the hanger arms during other tests completed in 2006 did not have corrosion, indicating they may have already been galvanized.

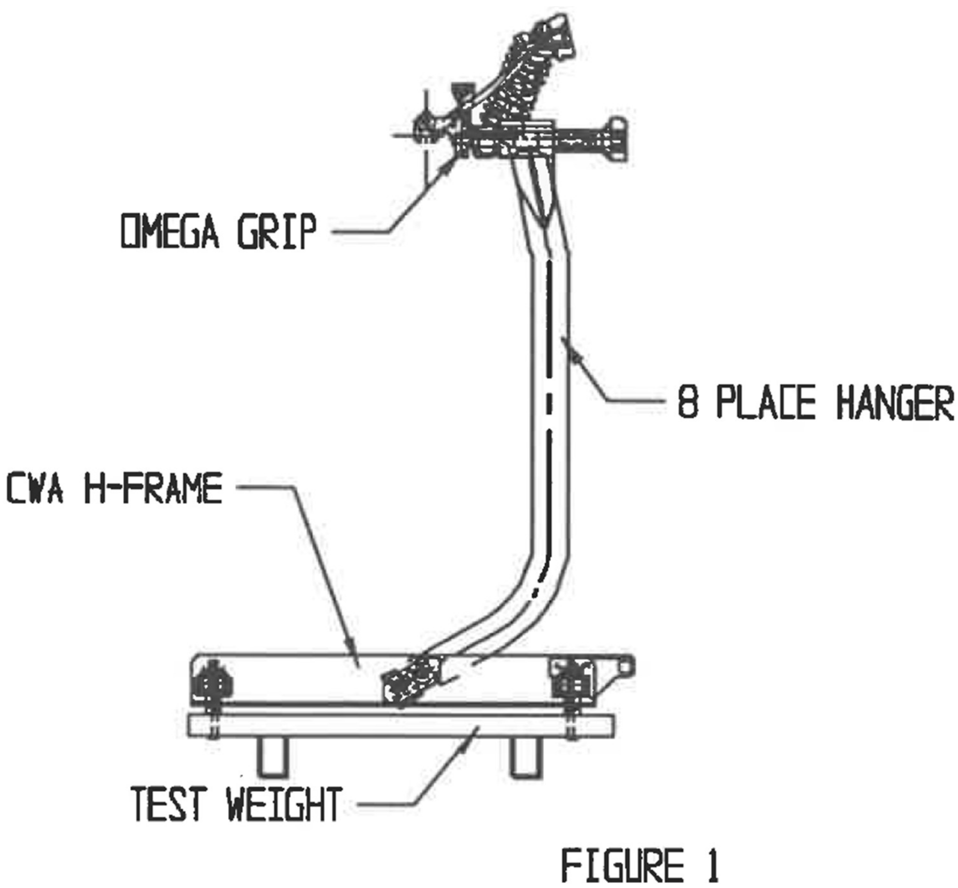


Figure 3 - Diagram of fatigue test apparatus for the GEE Gondola hanger arm (from 1999 LPOA Omega Hanger Arm fatigue test report)

After each of the loaded and unloaded fatigue tests, the tested arm was visually inspected and no cracks were identified. After completion of the entirety of the tests regiment, the arm was subject to MPI testing. No cracks or failure indications were identified and the arm was noted to have successfully passed the required tests (Appendix D).

LPOA also provided a letter dated September 22, 2000, which stated that *"100% of the gondola hangers supplied for the GEE Gondola at the KHMR have been nondestructively tested by visual examination."* (Appendix E).

Gondola Operation and History

Overview

In 2000, the GEE Gondola was installed in 2000 with 29 cabins (Appendix F) and was designed to allow for a future increase in capacity to a total of 55 cabins. In 2006, the additional 26 cabins were ordered and installed, bringing the GEE Gondola to full capacity. The GEE Gondola features a return station at the base of the mountain and a drive station located at the top of the mountain.

The drive and return stations incorporate several features essential to the safe operation of the GEE Gondola. The drive station houses the main drive that spins the bull wheel to rotate the haul rope and carry passengers up the mountain. It also incorporates a diesel powered auxiliary drive, to be used during extended power outages, and the evacuation drive, a secondary, redundant diesel power system. The evacuation drive is typically used to evacuate patrons from the gondola when the other drives are inoperable.

In addition, the stations incorporate both lateral (or guide) and primary rails which *"catch"* the gondola cabins as they enter the station to ensure it runs along a dedicated track and engages the mechanism to remove the detachable grip. In general, the primary rail is responsible for bearing the weight of the cabin and the lateral rail assists with cabin alignment as it enters the station. The grips incorporate rollers that run along each rail while in the station.

The lateral (or guide) rails are supported by a combination of springs and/or dampers mounted to the station structure. Adjustable rubber cylinders on threaded rods are used for adjustment of the lateral rails and are intended to absorb impacts and vibrations. Additional oil shocks, located just behind them assist in dampening.

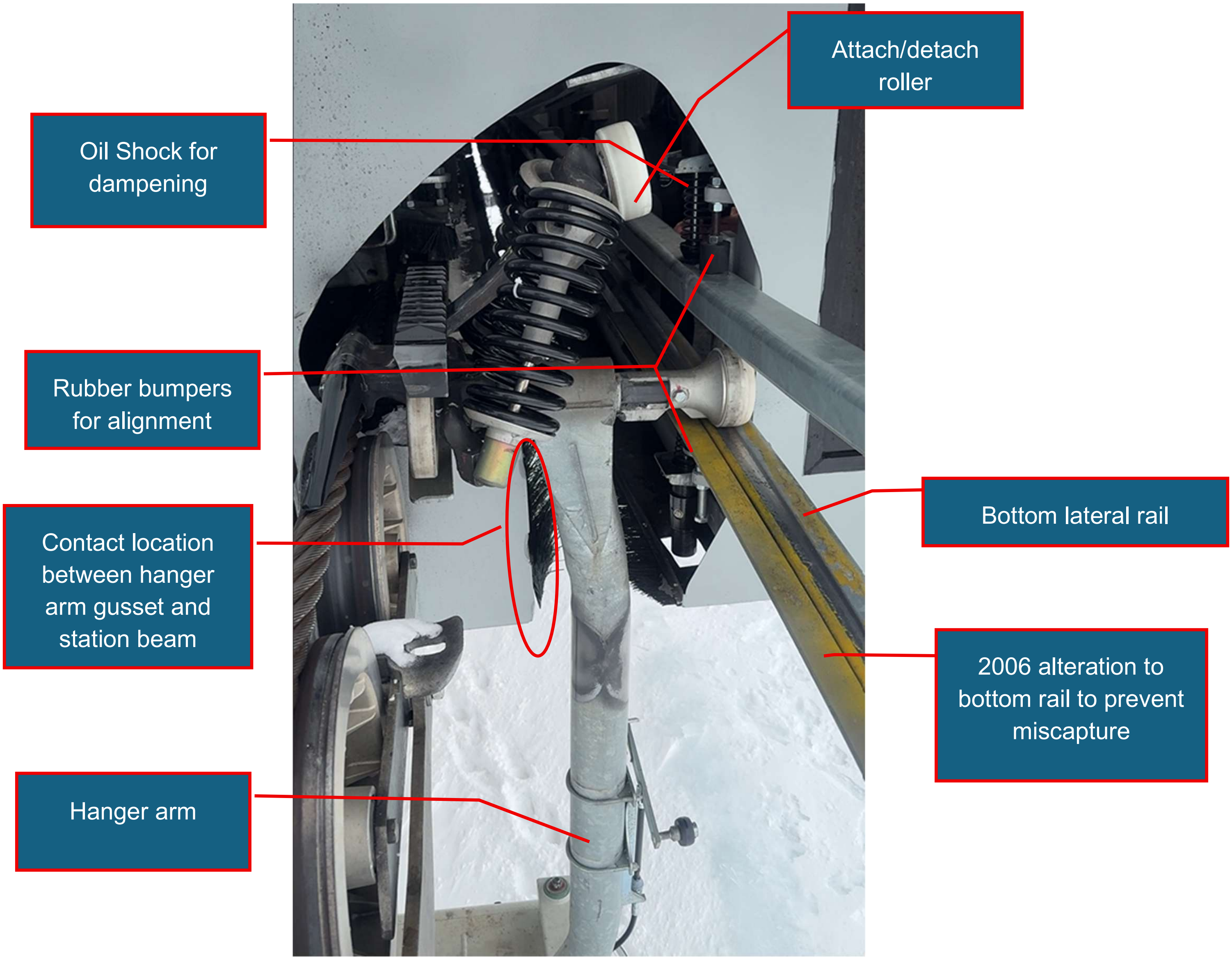


Figure 4 - Lateral rails and associated dampening and modifications for GEE Gondola.

Gondola Lateral Rail Assembly

The lateral rails of the GEE Gondola are the components that stabilize and align the gondola cabin as it enters the top and bottom stations. Several factors, including wind or asymmetrical loading (e.g. all passengers sat on one side), can cause gondola cabins to come into the station at an angle. When this happens, the lateral rails exert force on a grip mounted roller to push the cabin back into alignment. This creates forces on both the hanger arm and lateral rail. The amount of force transmitted through the hanger arms is directly affected by the alignment and dampening of the lateral rails accomplished through the rubber bumpers and shocks described above.

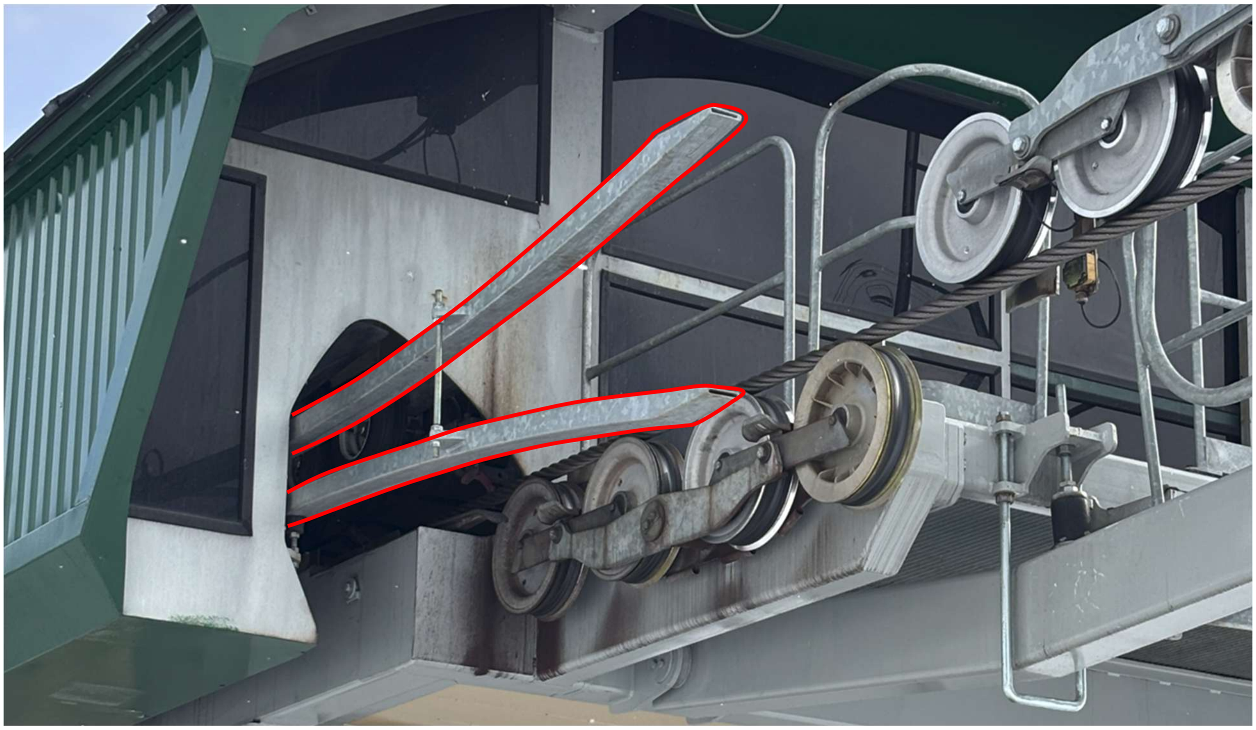


Figure 5 - The guide (lateral) rails on the GEE Gondola Return Station

Gondola Alterations and Service Bulletins

The forces experienced by the gondola hanger arms are also a function of how the GEE Gondola cabins enter the drive and return stations located at the top and bottom of the hill. Smooth entries result in little to no additional force on the hanger arms, whereas rough entries can multiply the force or result in impacts. Several modifications were made to the GEE Gondola through its lifespan to alter or improve how the cabins were captured.

Shortly after the GEE Gondola was installed, an incident at another resort in Canada occurred when a cabin coming into the station at an angle missed the lateral rail and fell to the ground at the station. In response, in 2002 LPOA issued a service bulletin to adjust the distance between the haul rope and lateral rail assembly (Appendix G). This did not fully resolve the issue as impacts continued to occur. Then later, in 2006, an additional service bulletin was issued to add an angle bracket to the lateral rail (Appendix G) (See figures 4 and 5 above). LPOA also became aware that the hanger arms of gondola cabins that enter the station swinging occasionally impacted the station structure, an issue that was occurring frequently at KHMR on the GEE Gondola. An additional *"entry guide assembly"* was shipped to applicable owners for installation but was not included in the lateral rail modification service bulletin and therefore was not considered a requirement (Appendix H). The additional guide bracket was installed on the lower return station but was never installed on the drive station for unknown reasons (See

"Correspondence between LPOA and KHMR" below). Around the same time, wind sensors and operational guidelines for windy conditions were implemented to reduce the risk of impact with the station. According to tenured KHMR staff, following the installation of wind sensors and rail adjustments, impacts with the station were less frequent which may have factored into the decision not to install the additional guide bracket on the drive station.

Technical Safety BC obtained a number of historical station photographs. Photographs from 2017 and 2018 showed that the drive station did not have rubber bumpers in place on the incoming side of the oil shocks (Images 11 and 12). Brackets where the bumpers were intended to be (according to LPOA documentation) were empty. Inclusion of the rubber bumpers was inconsistent across separate drawings for the system (See Image 13).

Without the rubber bumpers' support and dampening, the lateral rails could experience deflection and would also be more challenging to align correctly in the vertical direction. If a cabin came into the station at a sufficient angle, this could allow the rails to deflect far enough to allow for contact between the upper gusset on the hanger arm and the primary structural rail of the station. Therefore, it's probable that impact between the hanger arms and station could have continued to occur between 2017 and 2024.

Correspondence between LPOA and KHMR

In December of 2017, LPOA indicated in an email that they had an *"entry guide"* for Omega Terminals that could be used to *"help prevent hanger arms from contacting the main frame."* In a response from KHMR to LPOA, they indicated discussions were had between LPOA and KHMR years previously, but no action was taken. The conversation was restarted in 2020 (Appendix I). However, at the time of the incident, there was still no guide installed on the arrival side of the upper (drive) station.

Regulatory Inspection History and TSBC Documentation

Inspections

Regulatory inspection history for the GEE Gondola from 2000 to 2025 was reviewed. Rough entries and impacts at the stations were identified over several years starting in 2000 during the gondola acceptance inspection. Additional notes relating to reducing impacts, introducing wind procedures and monitoring, and improving cabin entries into stations were recorded at various points including in 2001, 2005, 2008, 2015 and 2017 (See Appendix J – Regulatory Inspection History).

GEE Gondola Incidents Reported to TSBC

There were 11 incidents reported between 2018 and 2025 (including the subject incident). The following incidents described impacts that occurred during operation between the hanger or cabin and a fixed object:

March 20, 2018 – A cabin struck and broke a bumper railing. The following cabin struck the broken bumper rail resulting in the passenger having a sore back. The cabin numbers are not noted.

April 5, 2020 – Cabin 30 *"derailed out of the rail system"* and *"tagged a bracket"* which stopped the lift. The grip was removed from service for testing, but the hanger was not. The haul rope showed some scuffing.

February 5, 2024 – Cabin 29 struck a raised piece of snowmaking equipment on startup, damaging the cabin and knocking the snowmaking equipment to the ground.

In-Service Testing and Inspection

Code Requirements

The Code requires that daily visual inspections be conducted as part of the pre-operational start-up. These inspections include inspection of the carrier, but do not address the hangers specifically. In discussions with staff at KHMR who perform these visual inspections, the hangers were not typically points of concern prior to the incident. Problem areas that often warranted further attention were door closing mechanisms, grips, and wear components such as rollers. As a result of the location of the crack, the myriad of things that have to be looked at each day, and the possibility for any visual indicators to be obscured by snow, ice, or other debris, it is unlikely that a visual inspection would have reliably identified this crack until it was a major defect.

The Code also required manufacturer's instructions to be followed which included more in-depth non-destructive testing including regular visual and Magnetic Particle Inspection (MPI) of the hanger arms while in service. The minimum required standard was to complete a rotating inspection and testing of 20% of the arms each year (such that 100% of the arms would be covered in a five-year period). See Appendix C – Code Requirements for more information.

Gondola Manual

In addition to code requirements, the manufacturer manual provided NDT protocols and required inspection procedures for the hanger arms (section 13). This manual was updated in 2006 by the manufacturer and was sent to the resort.

These updated inspection procedures indicated the desired test method and test locations. However, different pages in the manual were contradictory, with some indicating to check specific points, and others indicating the entire part should be checked (a note below the drawing stated "Repeat Steps 1 and 2 for entire part"). The manual had the following specific requirements:

1. A rotating minimum test sample of 20% of the hangers had to be tested using MPI each year (which means each hanger would be required to be checked at least once every five years).
2. Visual inspections of every hanger were required once per year.
3. Testing had to be done in accordance with drawings provided (shown below).

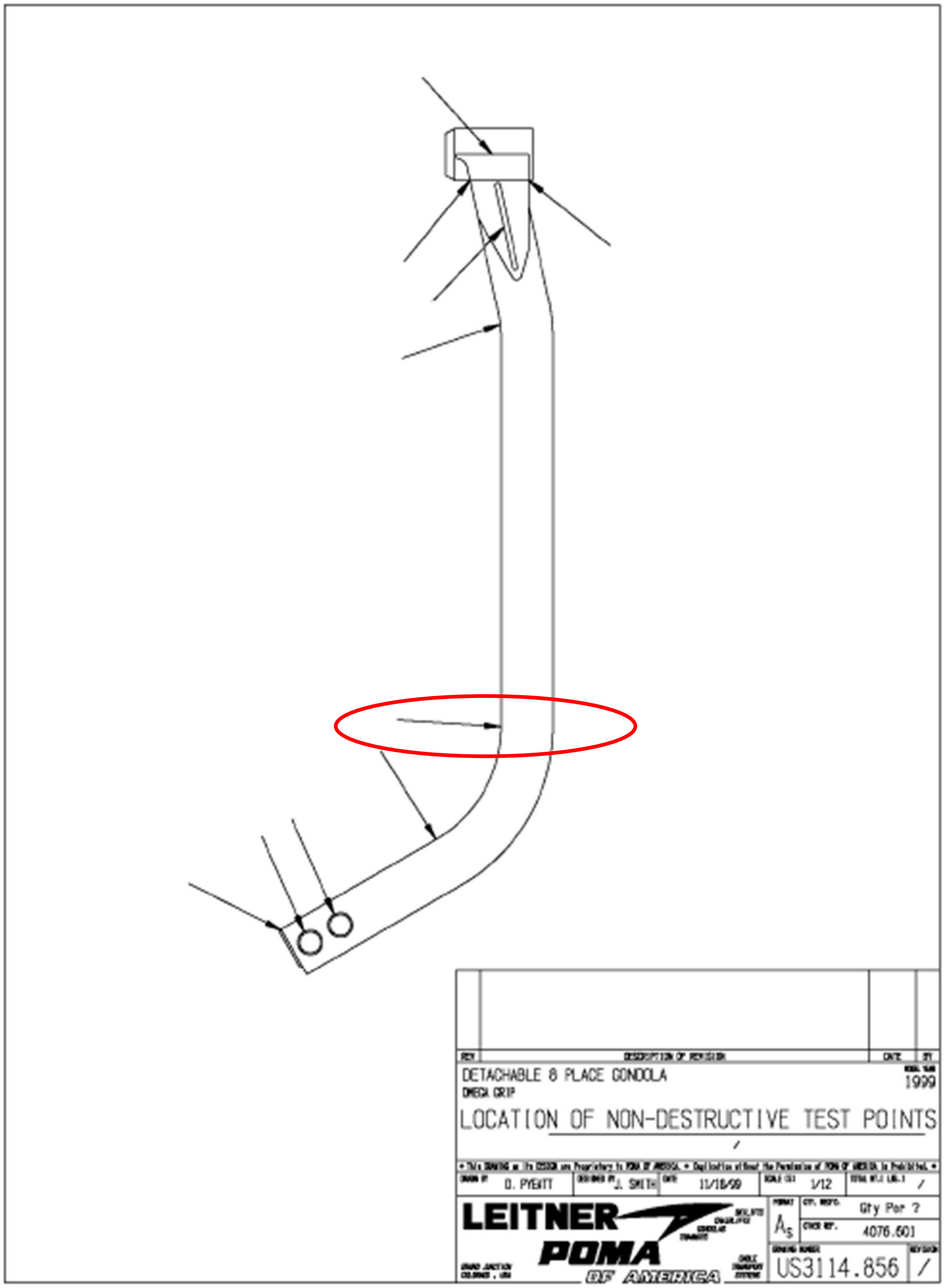


Figure 6 - Manufacturer's NDT Diagram for the hanger arm. The area of the failure was near a noted check point and is highlighted.

Maintenance Staff Interviews

Technical Safety BC interviewed maintenance staff at KHMR regarding in-service inspections. They indicated that typically members of the maintenance staff, usually millwrights, perform the visual inspections including the 500h inspection (which they do approximately monthly) and the pre-operational checks. They indicated that the primary concern of the visual checks is the grips as they have had issues in the past. During pre-operational visual inspections in the mornings, staff typically would not climb up onto the cabin. They would be watching to make sure the cabin doors close and wear components (such as rollers) were not worn through. They also check tires, rails, and belts in the stations at that time. Typical items that would be found would be misaligned doors, broken windows, odd sounds or other obvious operational issues. Monthly checks would be more in depth, they would typically use a ladder and get up close to check for things like missing nuts or pins. They have found cracks in the rails and stations and other places that don't typically go through the more in-depth independent NDT.

When discussing signs of impacts, they indicated that they often would repaint the station and monitor for scuffing. They did not recall seeing scuffing the season prior to the incident, but there was scuffing the summer before. They indicated that in order to prevent impacts they work on alignment consistently. This includes shock absorber and trumpet rail adjustments. However, photographs indicated that as late as 2024, there were brackets to place additional rubber dampers, but the dampers were not installed.

A millwright is typically present alongside the NDT technicians during MPI testing. It was indicated that the NDT technician generally spends approximately 5 minutes per hanger arm. To date, no indications have been identified other than some weld cracks near the gusset. They also noted that visual inspection of the hangers is challenging due to numerous surface inconsistencies, which can obscure or complicate visual inspection.

GEE Gondola Hanger Arm Testing Records

An independent testing company was hired by KHMR to complete the manufacturer and code required testing each year (Appendix K). Testing was typically performed with the arms removed and sitting on pallets outside. The NDT team, typically consisting of a technician, and a skilled labourer, would be on site for about two days at a time, and were responsible for checking grips, cabins, and arms. Reports were received for each year and showed that since 2021, 50% of the hanger arms for the gondola were tested each year. Over that time, the hanger arm for cabin 15 was checked three times (2020, 2021, and 2023). There were no issues or indications of cracks identified in any of the inspections for the hanger arm for cabin 15. Reports that were for the catamount chair described the work as *"hanger and carrier weld areas."* In 2021, the description of work was less specific and just stated hanger arms and H-frames for the GEE Gondola were inspected. Of all inspection records reviewed, the only cracks identified were weld cracks that were repaired. No lateral cracks in any hanger arm were identified in any records reviewed.

The NDT reports were also reviewed against invoices for the work completed from 2020 to 2024. Earlier invoices did not list hours spent; however, letters accompanying the testing report indicated the number of days that testing was completed. In all cases, 1 or 2 days were spent on site. The last two invoices (2023 and 2024) listed the hours spent testing. Due to discrepancies in how the invoices were presented, the NDT company provided an additional summary of the number of parts tested, and the hours spent on site in each year. They are summarized below:

Invoice Date	Description of work	# of components tested	Hanger Arms Checked	Time spent on NDT (hours)
11/20/2021	GEE Grips, Hangers, Cabins	620 (28 Hangers)	31	18
5/6/2022	GEE Cabins and Grips and Hangers x 28	540 (28 Hangers)	27	14
5/9/2023	GEE Grips, Cabins, and Hangers	560 (28 Hangers)	28	14
5/7/2024	Catamount and Gondola	540 for Gondola (27 Hangers)	27	17

*Yellow highlights indicate the failed hanger arm was checked

Statements from Independent Testing Company

The owner of the NDT company typically used by KHMR was interviewed immediately following the incident and again on August 13, 2025 regarding inspection practices on the GEE Gondola. The NDT company had been hired almost exclusively over the previous decade, to complete nondestructive testing of grip, hanger and cabin components of the GEE Gondola. On average, the NDT technicians leading the work at KHMR had over 10 years of experience doing these types of inspections. The owner stated the industry is tight with budgets and they have had to maximize efficiency to keep costs low including developing faster procedures (such as using coil magnetization for small parts).

Despite time pressures, the NDT company stated they follow the procedures and instructions of the manufacturer for performing NDT. The test procedures are provided by KHMR and are reviewed before starting to confirm whether there were any updates since the last time they were there. The company works within the ski industry and keeps up to date with changes in test procedures.

The steps followed to complete the NDT were as follows:

1. They set up their equipment near where the parts are located.
2. The parts are generally cleaned and laid out on a pallet prior to their arrival.
3. The grips are separately taken into a shop and cleaned for NDT.
4. The H-frame and hanger arms are too large so they are left outside.
5. For the hanger arms they use dry powder magnetic particle inspection specified by the manufacturer. The owner indicated a typical inspection of a hanger arm could take as little as 5 minutes per, or much longer, depending on how well the arm is prepared.
6. If any defects are identified they are indicated with red paint marker and noted on reports. They are also separately flagged directly with the customer.

In general in industry, indications (or areas of interest that could be defects) are fairly rare and the NDT company has never found an indication of this nature on a hanger arm. In 2017, the NDT company was hired to do inspections of the gusset welds specifically where the impacts had previously occurred, but not to check the remainder of the arms.

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Across their testing in industry, they have never identified a crack in the bend area and they indicated It would be odd and treated seriously if one were to be found. Welds are typically where cracks have been seen in the past and therefore; warranted special care when checking the parts.

Post Incident Inspection, Testing and Analysis

Following the incident, arms were documented and tested in several ways including in-situ testing and laboratory investigation. The investigation included arms from the GEE Gondola, as well as a similar gondola incorporating the same hanger arm design from the United States, and a review of testing records for a third gondola located outside of BC. No additional cracks were identified in any arms reviewed despite detailed destructive and non-destructive testing.

On Site Arm Inspection Documentation

Following the incident, all hanger arms at KHMR were inspected by KHMR staff. Observations were documented and are shown in Appendix L. Approximately 60% of the arms had damage to the gusset at the top of the arm where they had struck the station during operation (image 14). The extent of damage varied from small scuffs to 27 mm (~1 inch) of gusset deflection. For reference, the gusset of hanger arm 15 (the failed arm) was deflected approximately 18 mm (~¾ inch) (Image 15).

As part of the regulatory investigation, Technical Safety BC hired Acuren Group Inc. (Acuren) to perform non-destructive testing of hanger arms. 25 hanger arms were checked in situ on the gondola using a magnetic particle inspection or shear wave ultrasonic inspection (a method capable of identifying defects below the galvanizing layer). No cracking on any arms was identified using those inspection methods. The inspection reports are included in Appendix M – Acuren Report.

Technical Safety BC also inspected the arms while on site with Acuren NDT technicians. In addition to the gusset damage, irregularities and lines in the galvanizing were also noted on many arms (Images 16 and 17). The types of irregularities identified (including wrinkles, horizontal lines in the spangling, scratches, and dings) could contribute to making it more difficult to recognize a crack during visual inspections or even some NDT inspections.

Laboratory Hanger Arm Testing

In addition to the in-situ testing, the failed hanger arm (15), as well as several exemplar arms (3, 16, 21, and 47) were brought to the Acuren labratory for a more in depth and controlled analysis (Image 18). Acuren performed a full suite of tests including (Image 19):

1. Visual examination and fractography
2. Stereo microscope examination
3. Tensile strength and chemistry analysis
4. Sectioning and mounting a cross section for microstructure analysis
5. Scanning electron microscope examination of the fracture origin
6. Charpy V-notch material toughness analysis

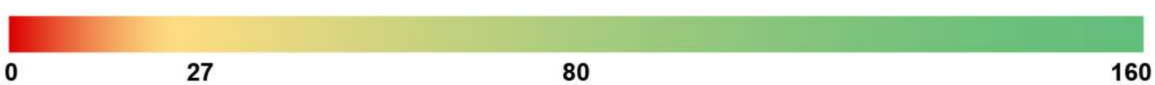
Inspection of these arms did not identify any cracks (aside from the failure in hanger arm 15). However, there were significant differences in bend characteristics in the arms (Image 20). Certain bends were found to have visual deformities in the bends with bulges and narrowing. In addition, measurements of ovality found significant differences between the x and y dimensions of up to 12 mm (0.5 inches). Finally, the seam location for the pipe varied between hanger arms and was not controlled in the manufacturing process. Using clock positions as directional indicators, the original drawing for the hanger arms specifies that the seam be located at the intrados of the bend in the 12 o’clock position. The seam for arm 47 was located at the 12 o’clock position, but the other arms had varying seam locations, including the 3, 5, 7, and 8 o’clock positions.

The serial numbers for each arm were also documented. One arm was missing a serial number, while others had very different serial numbers, both on top and under the galvanizing (image 21), indicating it is likely they came from different batches of steel.

Analysis of the testing for the failed arm indicated that the initial crack had occurred progressively, over an extended period of time before fracturing suddenly on the day of the incident. The analysis also showed that the material had undergone significant changes during the manufacturing process which had resulted in the metal on the inside of the failed bend becoming extremely brittle. Comparisons with other arms showed a general reduction of cold weather fracture toughness in that area, but not to the same extent as the failed arm. Reduction in cold weather fracture toughness also reduces the size of the crack necessary before final brittle fracture occurs (known as critical crack length). The table below provides a visual representation of the difference between the failed arm and others tested. Note that all tests were conducted at 10 deg C or above which is well above typical operating temperatures for the GEE Gondola. Tests at lower temperatures were not conducted since it was clear the material was already breaking in the lower shelf area of the Charpy curve for the material and was unlikely to drop further at lower temperatures.

Table 1 - Charpy V-Notch Impact Test Results from Bent areas of Hanger Arm.

Sample	Energy (Failed Arm)*	Energy (Arm 16)*	Energy (Arm 21)*
1	10	97	53
2	11	52	79
3	7	106	22
4	6	93	12
5	143	19	72
6	150	112	56
7	155	90	63
8	129	53	59
9	7	105	20



Note: All tests between 10 and 30 deg C.

**Energy values to be used for comparison between tested arms. Absolute values not adjusted for reduced sample size relative to standard.*

Acuren's analysis also found that the cold bending of the failed arm during manufacturing introduced significant residual stress at the inside of the bend that was not relieved using a stress relieving process. When the arm was galvanized, strain ageing occurred resulting in a significant drop in ductility and cold weather fracture toughness. This low ductility at expected operating temperatures contributed to the conditions needed for a fracture to occur. These conditions likely resulted in a subsurface crack (below the galvanizing) during or shortly after manufacturing under initial loading conditions. The importance of material toughness and following manufacturing processes that supports resistance to brittle fracture is further discussed in Appendix N.

This low ductility at expected operating temperatures contributed to the conditions needed for a fracture to occur.

Examination of the fracture surface in the failed hanger arm identified a *"thumbnail"* shaped origin which had progressed in several phases. It began with two separate brittle progressions, followed by alternating fatigue, and brittle progression. Acuren's analysis determined that the crack likely progressed through a combination of the initial residual stress and materials properties, combined short term, high magnitude forces (such as the impact between the hanger arm gusset and station structure). The critical size of the thumbnail prior to the first large brittle fracture event was approximately 18 mm.

Figure 7 - Overview of the fracture face. Circle – "thumbnail" initiation site. Arrow – Approximate length of the crack present during operation leading up to the incident. Note the colour differences from corrosion products between the "thumbnail", the first large progression (noted by the arrow), and the bright silver of the fresh fracture face.

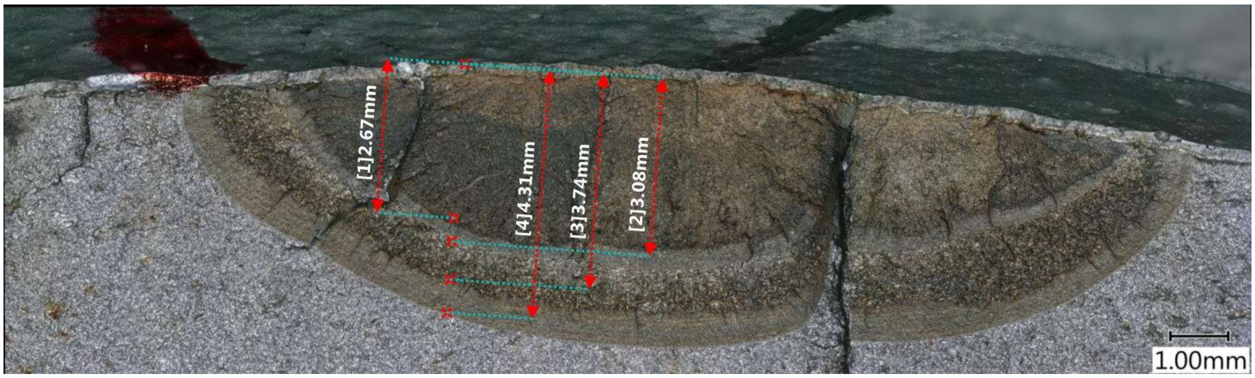


Figure 8 - Keyence Microscope image of the initiation site showing the areas of progression (Acuren Inc.) The initial brittle progressions were small and were followed by long term, high cycle fatigue that progressed over thousands of cycles.

Acuren's report concludes that corrosion products and zinc oxide on the surface of the *"thumbnail"* initiation site provided evidence that the crack had been open to atmosphere (i.e. exposed), likely through several seasons.

Similarly, the area between the thumbnail, and additional fatigue cracking located in the weld metal heat affected zone (see arrow in Figure 7) displayed a rust discolouration indicating it had also been open to atmosphere for some time, albeit less than the thumbnail area.

The complete Acuren Report is included in Appendix M.

American Resort Hanger Testing

A ski resort located in the United States, had a very similar gondola to the GEE Gondola and was of a similar vintage. In 2024, the resort underwent an upgrade whereby hanger arms were entirely replaced with a new design. The manufacturer was able to obtain some of the original arms and contracted an independent company to inspect and perform Charpy v-notch impact testing on three of them. None of the arms were serialized for comparison to GEE Gondola arms. The results were as follows:

1. Prior to visual and magnetic particle inspection, the arms were sandblasted to remove the galvanizing layer and expose the substrate. None of the arms had visible impact damage. No cracks were identified in the tubular section of any of the arms tested. Some minor indications were observed on gusset welds at the top of the arm.
2. Two of the arms were sectioned for Charpy impact testing at various locations including on the straight areas, and bent areas. Note that these tests were completed at -20 deg C.

3. Results in the first arm were highly variable, with some energy values as low at 9 Joules (not adjusted for sample size) up to 136 J.
4. The second arm tested was considerably lower in all tests conducted with most averages below 15 J even after adjustment for the smaller sample size.

The report prepared from this examination is included in Appendix O.

Mechanical Engineering Analysis

McElhanney Ltd. were hired to complete an assessment of the stresses endured by a hanger arm during operation of the GEE Gondola. The following was noted from their analysis:

1. Static stresses in the hanger arm could reach up to 90 MPa. Given the typical yield stress for this steel, this provides a factor of safety higher than three, above the minimum code requirement.
2. A heat map of relative stress is shown in figure 9. The inside of the bend is among the highest stresses experienced in the hanger.
3. Dynamic stresses in the hanger arm could reach values of up to 126 MPa from passing over towers under normal operation. These stresses are still well below the yield stress, and the fatigue limit (estimated at 165 MPa for this steel).
4. Higher short duration forces were likely experienced in two circumstances
    a. Impact between the hanger arm and terminal, main beam.
    b. Entry of the gondola into a terminal while swinging at angles of 8 deg, or more.
5. These peak loadings, though rare, could have been sufficient to initiate a crack in the hanger arm through a local, brittle fracture. It would have been more likely if they occurred during cold weather conditions. Once a crack is present, operational loads could have been sufficient to propagate the crack.

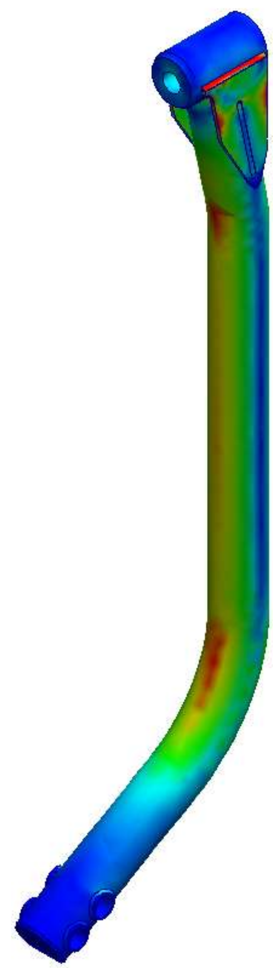


Figure 9 - Heat map showing relative stress concentrations in the hanger arm during static loading. The intrados of the bend experiences elevated stress levels.

These findings highlight two very important features of passenger ropeway safety, station setup, and proper operational practices. Proper station set-up can greatly affect the forces transferred down the arm when coming in at angle. They can also ensure ropeway safeties such as proximity sensors operate as intended. Finally, good operational practices, including limiting speed or shutting down the gondola during high wind events, can reduce the likelihood of high forces from carriers entering the terminals at high angles.

The complete McElhanney Report is included in Appendix P.

Evacuation and Emergency Response

The investigation also looked at the emergency response to evacuate patrons after the incident. The CSA Z90 Code (adopted in BC) requires that a manual evacuation plan be included in the operations manual and must contain all the provisions to evacuate passengers in a *"reasonable amount of time."* Although *"reasonable"* is not defined, the code does require inclusion of an estimate of when an evacuation should begin in the event of that the passenger ropeway becomes inoperable, as well as an estimate for the time necessary for a complete evacuation of the passenger ropeway. It also must consider probable operating and evacuation conditions and areas of the lift above difficult or unusual terrain (Appendix C).

Following the hanger arm breaking, there was an attempt to restart the gondola in order to evacuate patrons as quickly as possible. This resulted in the remaining section of hanger arm and grip becoming lodged in the sheaves on the first tower, preventing further movement of the gondola and requiring manual or *"rope"* evacuation. The decision process to start the manual evacuation took about two hours and the rope evacuation took approximately five and a half hours. Therefore, some guests were stuck in gondola cabins for a total of approximately seven and a half hours.

For a complete evaluation of evacuation and emergency response activities, please see Appendix Q.

Findings

Preamble

The hanger for a gondola cabin is a critical structural element. The hanger forms the only structural connection between the haul rope, and gondola cabin carrying passengers that are travelling, at times, dozens of meters in the air. In light of the potentially catastrophic consequences of a failure at elevation, the safety system designed around such an element aims to provide a very high degree of reliability. This is realized through a combination of structural design with an inherent *"buffer"* (or safety factor), in combination with a high inspection frequency. The safety factor required by the Code in this design is three (indicating it must be three times stronger than the expected static load). In comparison, some structural components, for example in elevators, can have much higher safety factors, between 5 and 10. In each case, the factor of safety is meant to account for any deviations that can't be predicted by the design and are commensurate with the risk of failure. Factors that can't always be predicted by the theoretical design could include deviations in the manufacturing or operating conditions from what is expected. One of the reasons for the selected safety factor in the gondola hanger arm is that it is also inspected regularly through both in-service visual inspections and using more advanced techniques such as MPI. Lower factors of safety often also support other design considerations including weight and size. The factor of safety and inspection frequency are intended to work in tandem to prevent cracks or catch them before they result in a complete failure. Resistance to brittle fracture is an equally important characteristic as it slows down the rate of failure, increasing the opportunity for defects to be caught prior to complete failure.

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Cause

The investigation found that the cause of the incident was an unidentified crack that developed from conditions introduced through the manufacturing process, coupled with short duration, high-magnitude forces that occurred during operation.

Reliability of a critical component such as a hanger arm is established through a combination of design, inspection, and good operational practices. The investigation found that each of these factors contributed to increasing the probability of a crack initiating, and progressing until the failure occurred.

During manufacture, virgin and introduced material properties resulted in the failed portion of the hanger arm having very low toughness. This resulted in the failed portion of the hanger arm being susceptible to rapid onset forces, such as impacts.

During operation, a large dent to the failed hanger arm gusset suggests it was subject to one or more large impacts with the station structure during operation. It is likely these major impacts played a critical role in the propagation of the crack. Station setup, including support of the guide (lateral) rails used to align the gondola cabins as they enter the station, contributed to the repeated impacts between cabins and the station's structural rail. Station impacts were a common occurrence on the GEE Gondola with nearly 60% of the arms having experienced an impact through the lifespan.

Although exact timelines cannot be identified, fracture face analysis indicates it is likely that the crack would have been at some stage of progression during previous non-destructive testing cycles. The Acuren report details that the most likely scenario, based on analysis of the fracture face indicates that a minute crack initiated at or shortly after manufacturing and progressed in steps in response to high impact events. Despite manufacturer's instructions to check this area, none of the records for these inspections identified a concern with this arm, or more broadly with any circumferential crack in any hanger inspected.

Contributing Factors

Crack Initiation and Propagation

The selected material and manufacturing process resulted in low material toughness and brittleness; properties that were conducive to a crack initiating in the arm.

The hanger arms for the GEE Gondola were made from ASTM A500-B steel, a material standard that does not prescribe minimum toughness requirements at cold temperatures. No additional toughness requirements were specified during the original manufacturing. As a result, material properties across the arms showed a large variability in ductility and toughness. The failed arm had low material toughness values in both the straight (unbent) sections, as well as the bent areas of the tube.

In addition to base material properties, the manufacturing process employed cold bending followed by galvanizing without intermediary stress relief, which is likely to alter the material properties of the metal used in the manufacturing of the arm. This process can reduce the ductility and material toughness significantly through a material change known as strain age embrittlement (See Appendix B). Testing of the arm in the location of the failure found that toughness values were exceedingly low (virtually 100% brittle at room temperature) leaving the arm susceptible to future impact loading. Material properties in the tube in areas far away from the bent sections were much better than those in the bent areas. The Code requires that for hanger arm materials, due attention must be paid to resistance to brittle fracture in the range of expected operating temperatures. This includes consideration of how the material properties may be altered by the manufacturing process so that the final product will behave as expected in the field.

Station setup allowed for impacts between the hanger arm and station structure resulting in high stresses in the carrier structure.

Under proper operation, a gondola carrier will enter smoothly into a station resulting in minimal forces being translated through the hanger arm. However, achieving this smooth entry relies on many factors including proper adjustment of various components, support and dampening in the guide (lateral) rail system, and the angle of entry of the gondola cabin. The investigation found that the original trumpet rail design and positioning allowed the cabins to enter the station with enough angle for an impact between the hanger arm and station structure to occur. Small changes and alterations over time likely reduced the probability of this occurring; however, inconsistent documentation from the manufacturer and inconsistent follow-through by the resort resulted in missing components that were critical to supporting the guide (lateral) rails and preventing impacts until as late as 2024. These included rubber support dampers for the guide (lateral) rails, and an entry rail deflector developed by LPOA to redirect cabins that were at risk of striking the station.

The failed hanger arm had evidence of multiple impacts to the top of the hanger arm on the reinforcing gusset. Fracture analysis indicated that the early brittle progressions of the crack were likely the result of a temporary, high force event such as one of these impacts.

Major impacts to the hanger arm during operation very likely triggered the progression of the crack.

Although conditions for the crack to occur were present since manufacture, it likely didn't progress until sufficient stress from a large impact occurred. The analysis of the thumbnail found that the first two stages of progression were brittle in nature, indicating that a momentary, high force was applied to the hanger arm. The failed hanger arm had evidence of at least one large impact where the gusset at the top of the hanger arm had struck the main structural beam of the station.

The investigation was unable to determine exactly when the major impact(s) to the failed arm occurred. Regardless, contact between a carrier hanger arm and the station is a serious event that is likely not contemplated in initial structural design. In addition, the forces experienced in such an event can be difficult to assess and, therefore, so are the potential consequences of the impact. Variables such as the extent of impact, the temperature on the day, the material properties of the arm, and gondola loading could all contribute to whether the impact would damage the integrity of the arm. Inspection of the arms after the incident showed that approximately 60% of the hanger arms of the GEE gondola had experienced an impact with the station but did not exhibit the same cracking that caused the failure of hanger arm 15. It's likely that a combination of aggravating factors, such as a rather severe impact (resulting in some of the most pronounced gusset deformation), cold temperatures and a heavily loaded cabin at the time of the impact, and the arm having the lowest material toughness in the area of the failure of all the arms examined, resulted in this arm experiencing a rare crack, while others were able to endure any impacts without failure.

Following these impacts, additional inspections were performed and often resulted in changes to station set-up, or adjustments to procedures for operating in windy conditions. In some cases, specific checks of the gusset areas were performed and cracks in the welds were identified and repaired, but these specialized checks did not extend to the full hanger or carrier assembly.

NDT and Inspection

The inspection regime intended to identify and respond to cracks before failure did not identify the crack prior to it reaching a critical size.

The ability for inspections to identify the emergence of cracks is a critical safety feature for passenger ropeways. Both the timing and effectiveness of the inspections have to be sufficient such that cracks are identified and responded to prior to a critical failure occurring. In this instance, neither visual nor MPI inspections identified a crack in this hanger arm leading up to the incident. The analysis of the available evidence could not fully explain the reason for this, but offers some insight into various factors that likely limited the effectiveness of the inspections.

Evidence indicates that the crack initiated at or shortly after manufacture at the intrados of the cold bent section of the hanger arm and remained small for an extended period while propagating intermittently under high magnitude loading events. For much of its early life, the crack was likely subsurface or partially masked by the galvanizing layer, limiting its detectability using visual inspection and MPI techniques. While analysis can tell us the initial crack grew slowly over time, and was likely exposed for several years, the exact time period between the crack becoming reliably detectable and complete failure could not be accurately determined. Fracture analysis indicates that as a result of the low fracture toughness in the area of the failure the crack was only approximately 18 mm (¾") prior to reaching a critical length and progressing rapidly. The low fracture toughness also increases the rate of crack propagation under sufficient load. These factors narrowed the window between reliable detectability of the crack and complete failure, reducing the probability that the crack would be identified during scheduled inspection intervals, even though inspections in this case exceeded the minimum frequency required by code.

The failed arm was inspected in 2020, 2021, and 2023. The non-destructive testing company that performed the tests indicated that manufacturer's instructions were followed, which included a required inspection point near the location of the failure. However, the majority of inspection points were located near the top and bottom of the arm, where welds were located. In addition, industry experience and historical results likely reinforced expectations that any cracking would occur at welds, or near the damaged gussets, rather than in the parent tube material. Under time and environmental constraints inherent to field based nondestructive testing, it's possible that area of the failure received comparatively less scrutiny than others.

Visual inspections are also required every 500 hours, and, in a much less detailed manner, every day before operation. Visual inspections, without the assistance of crack detection technology such as ultrasound, MPI, or liquid penetrant are inherently less precise and less reliable. They are generally intended to capture large and obvious defects. The location of the crack (above the cabin and facing inward) would have been difficult to visually observe and this area is often covered in snow and ice buildup during morning inspections. Staff stated the hanger arms were not the primary focus of visual inspections and there was an expectation that cracks of this nature would be identified by the more detailed magnetic particle inspection practices.

Additional Considerations

> **Through additional testing of numerous other hanger arms from the GEE Gondola, as well as other similar gondolas, the investigation determined that the failure was the result of the unlikely convergence of several abnormal conditions, as opposed to a single risk factor.**

The materials and manufacturing process used for the GEE Gondola were commonly used in the industry at the time of construction. Historically, hanger arms built in this manner have operated successfully for thousands of hours, across several hanger arm designs, and in certain cases, were even subject to impacts or miscapture events. Despite this, no other cracks were identified on the 39 additional arms inspected using multiple methods of non-destructive testing, including a procedure specifically developed for the investigation to look beneath the protective galvanizing layer. Arms from other facilities that are similar age, and design also underwent rigorous non-destructive testing following the incident and no cracks of this nature were identified, despite some other arms also exhibiting low toughness values. This demonstrates that the crack was likely the result of a rare convergence of material properties, environmental conditions, and operational stresses (such as impacts) rather than a single risk factor.

> **Once the manual evacuation began, favourable conditions and well-trained personnel resulted in all gondola passengers being successfully rescued.**

Once the decision to perform a manual evacuation was made, all passengers were successfully rescued in a time period of five and a half hours. This is approximately in line with expectations that management at KHMR had for the full evacuation of the GEE Gondola. Manual rope evacuations are complex and slow, especially when it comes to a gondola with enclosed cabins. The GEE Gondola in particular has additional challenges with a grizzly bear refuge below certain areas of the lift, and steep, rocky terrain below the upper third. In addition to active staff members, many off duty employees and search and rescue personnel from the town of Golden were brought in to assist. In this case, the entire evacuation was done in relatively favourable conditions with no significant adverse weather, daylight, and no passenger medical emergencies. Personnel were set-up to use various types of evacuation techniques to deal with the terrain challenges of the GEE Gondola.

Recommendations

Recommendation #1: To manufacturers of above surface ropeways and ropeway components

> **It is recommended that manufacturers utilize materials with specified low temperature fracture toughness properties for the manufacturing of critical carrier components (such as hangers and grips) and, where applicable, the procedures and guidelines established in ASTM A143 are used to ensure those properties are maintained in the final product.**

The investigation found that materials used in the construction of failed arm had extremely low toughness properties, even at room temperature, and this contributed to the failure. Manufacturers are reminded that under the Code, due attention must be given to ensure their final product is fit for use at all expected operating temperatures, especially as it relates to resistance to brittle fracture. In order to accomplish this, manufacturers should specify toughness properties for materials used in construction of critical components. This is already done in some cases, and has been widely adopted in Europe for decades where minimum fracture toughness of 27 J at -20 C is typically required. Manufacturers also need to be aware of the risks of introducing brittleness through cold bending, followed by galvanizing. It is recommended that for any component where fracture toughness is important and cold bending is utilized, manufacturing processes be updated to reflect the guidance provided in ASTM A143– Standard Practice for Safeguarding Against Embrittlement of Hot-Dip Galvanized Structural Steel Products and Procedure for Detecting Embrittlement.

Recommendation #2: To manufacturers of above surface passenger ropeways.

It is recommended that manufacturers:

1. **Identify where critical carrier components were manufactured with cold bent, galvanized steel** where adequate cold weather toughness properties and resistance to brittle fracture cannot be confirmed.
2. For all components manufactured in this manner**, assess whether revised guidance for safe operation including NDT testing intervals and procedures is required.** Shortened intervals between inspections should be considered to account for the possibility of cracks that may progress more rapidly than anticipated, and procedures updated to reflect additional scrutiny in cold bent areas where lower toughness is expected.

The GEE Gondola incident highlights that the hanger arm is a critical structural element such that if a failure occurs, it results in cabin detachment and potential severe consequences. The investigation found cold bending, and galvanizing the selected steel for these hangers could result in brittle areas in the cold bent section of the arm. Fracture analysis indicates a crack likely existed for years in the bent area of the arm but went undetected during regular inspection and periodic nondestructive testing. The intent behind the requirement for resistance to brittle fracture in the code is to ensure that no failure can occur without pre-warning by large, and visible cracks, and to justify the code required inspection interval. Without adequate resistance to brittle fracture, the justification for code required inspection intervals could be undermined.

Repeated carrier impacts with station structures introduced additional impact loading that likely accelerated crack growth and were not adequately investigated or resolved. Standard inspection practices and intervals did not address how the bent areas with low material toughness could be affected by these events. Manufacturers are reminded that owners and operators rely on the technical guidance manufacturers provide to manage known issues.

Given the critical nature of these components and the potential for accelerated failure, manufacturers should identify affected components and assess whether updated guidance is required to mitigate risk.

Recommendation #3: To owners and operators of passenger ropeways in BC.

It is recommended that owners and operators:

Respond to all carrier impact or miscapture incidents proactively. For any impact where there is reason to suspect the carrier has been subject to severe loading or there is reason to question critical component integrity, the affected carrier should be removed from service until all critical components are subject to additional nondestructive testing in accordance with up-to-date manufacturer's instructions.

The investigation found that impacts between gondola carriers and station structures occurred repeatedly over the operational life of the Golden Eagle Express Gondola and were a significant contributing factor to the incident. Fracture analysis showed that one or more severe impact events likely propagated the crack in the failed hanger arm by introducing short-duration, high-magnitude forces. Approximately 60% of hanger arms showed evidence of past impacts, demonstrating that such events were not isolated. Owners are reminded that for any repairs, or modifications, the manufacturer's instruction (or in the absence of, a professional engineer's direction) must be followed.

Assessing and removing affected carriers from service following impacts or similar severe loading events until non-destructive testing of all critical components is completed is an important measure to ensure ongoing reliability of the components. This is especially important for components that may have reduced capability of withstanding these types of unexpected events as a result of low material toughness characteristics.

Additional Images

Image 1 – Aftermath of the gondola cabin falling (Photograph Provided by Resorts of the Canadian Rockies)

Image 2 – The fallen gondola cabin after evacuation (Photograph provided by Resorts of the Canadian Rockies)

Image 3 - The remaining portion of the hanger arm and grip still connected to the lift line after the incident (Photograph provided by Resorts of the Canadian Rockies)

Image 4 – The remaining portion of the hanger arm lodged in the sheaves of tower 1, resulting in the need for a manual evacuation.

Image 5 – Overview of the return station of the GEE Gondola

Image 6 – A carrier making its way through the return station


EXIT
LEFT

Image 7 – The first time that cabin 15 (the incident cabin) was loaded with a staff member on the day of the incident. Snow covered the inside of the hanger arm. (From resort CCTV footage)

Image 8 – Cabin 15 going around the station prior to the first load of customers. Note the inside of the hanger arm is still covered in snow (from resort CCTV footage).

Image 9 – The fully loaded cabin with 8 adult passengers and equipment, just prior to failure (from resort CCTV footage).

Image 10 – A different camera angle showing the hanger arm fracturing and the cabin falling as it passed under the compression sheaves leading to tower 1 (from resort CCTV footage).

Image 11 – Photograph taken by a Safety Officer in 2017 showing the missing rubber bumper dampers on the guide rails (red allow). Impact marks to the station rail can also be seen (blue arrows).

Image 12 – A similar photograph taken by a Safety Officer in 2018, approximately 1 year later. The rubber bumpers are still missing.

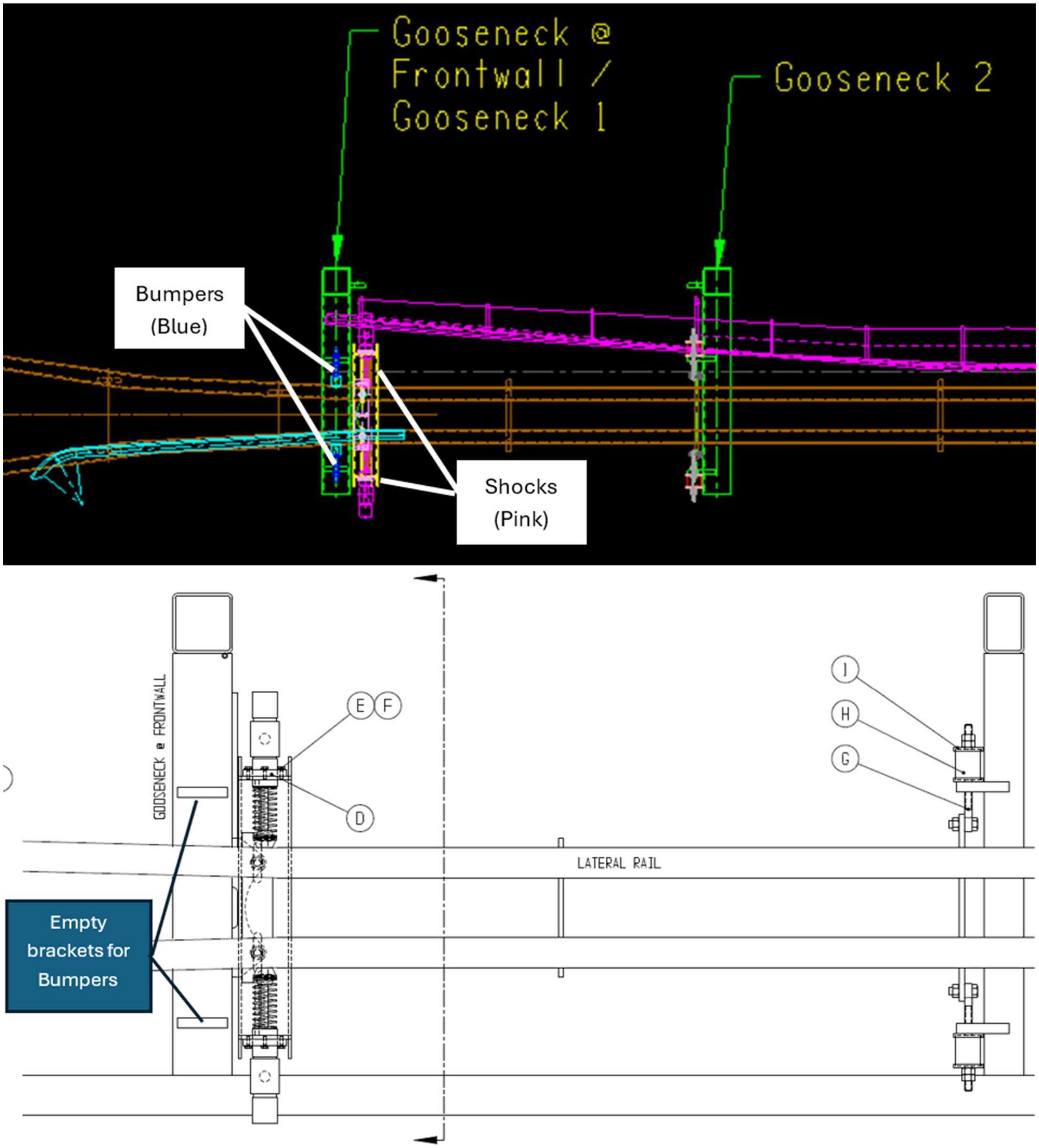

Image 13 - Manufacturer diagrams showing discrepancy in guide rail supports.

Image 14 – A compilation of severely bent gussets on various GEE gondola hanger arms taken during investigation after the incident.

Image 15 - A close up the deformation and damage to the gusset on the failed hanger arm for cabin 15.

Image 16 – A view of a hanger arm during inspection. Irregularities in the surface including lines, marks, and scrapes are highlighted.

Image 17 – A close up of wrinkling and horizontal lines on another hanger arm during post-incident testing.

Image 18 – Example of an arm located I the Acuren facility after undergoing extensive MPI testing and documentation.

Image 19 – Comparison of the variation of smoothness of the interior bend geometries between two arms from the GEE Gondola.

Image 20 – The bottom portion of the failed arm after being sectioned for various tests including metal chemistry, tensile tests, and fracture analysis.

Image 21 – Three arms from the GEE gondola. One with no serial number. One with the serial number stamped on top of the galvanizing. One with the serial number stamped beneath the galvanizing. The arms with numbers were not close to being sequential.