ACCIDENT REPORT

Report on the investigation of

the fatal accident to a deckhand on board the beam trawler

Cornishman (PZ 512)

44 nautical miles south-south-west of the Isles of Scilly, England

on 6 February 2021

VERY SERIOUS MARINE CASUALTY REPORT NO 8/2025 JUNE 2025

MAIB
MARINE ACCIDENT INVESTIGATION BRANCH

The United Kingdom Merchant Shipping

(Accident Reporting and Investigation)

Regulations 2012 – Regulation 5:

"The sole objective of the investigation of an accident under the Merchant Shipping (Accident Reporting and Investigation) Regulations 2012 shall be the prevention of future accidents through the ascertainment of its causes and circumstances. It shall not be the purpose of an investigation to determine liability nor, except so far as is necessary to achieve its objective, to apportion blame."

NOTE

This report is not written with litigation in mind and, pursuant to Regulation 14(14) of the Merchant Shipping (Accident Reporting and Investigation) Regulations 2012, shall be inadmissible in any judicial proceedings whose purpose, or one of whose purposes is to attribute or apportion liability or blame.

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Image courtesy of Devon & Cornwall Police

Cornishman

GLOSSARY OF ABBREVIATIONS AND ACRONYMS

°	-	degrees
AHTS	-	anchor handling tug supply
BF	-	breaking force, the minimum force that chain or its components must withstand before failure
c.	-	circa
cm	-	centimetre
DNV	-	Det Norske Veritas
ductility	-	the degree of extension (in %) before failure of a material in tension
elastic strain	-	is reversible and disappears when the stress is removed
embrittlement	-	is the partial or complete loss of a material's ductility
EN 818-2	-	European Norm (EN) 818-2 Short link chain for lifting purposes – Safety – Part 2: Medium tolerance chain for chain slings – Grade 8
FASING	-	Capital Group FASING S.A., Poland
FSM Code	-	Fishing Safety Management Code
Gilson	-	a generic term for winches, blocks and ropes used to lift and move fishing gear around the deck of a fishing vessel
Hardness	-	the resistance of a material to localised plastic deformation. Hard materials tend to have low toughness and can easily fracture
HB	-	Brinell Hardness scale, a measure of resistance to indentation using a hardened steel ball to indent the material
HE	-	hydrogen embrittlement
HRC	-	Hardness Rockwell C scale, a measure of resistance to indentation using a diamond cone to indent the material
HSE	-	Health and Safety Executive
HV	-	Vickers Hardness scale, a measure of resistance to indentation
ISO	-	International Organization for Standardization
kN	-	kilonewton
LEEA	-	Lifting Equipment Engineers Association
LOLER	-	Statutory Instrument 2006 No.2184, The Merchant Shipping and Fishing Vessels (Lifting Operations and Lifting Equipment) Regulations 2006
LR Code	-	Lloyd's Register Code
LSA	-	lifesaving appliance
m	-	metre

MCA	-	Maritime and Coastguard Agency
MGN	-	Marine Guidance Note
MGN 332 (M+F)	-	Amendment 1 The Merchant Shipping and Fishing Vessels (Lifting Operations and Lifting Equipment) Regulation
MGN 619 (F)	-	Amendment 1 The application of the lifting operations and lifting equipment regulations 2006 (LOLER) and provision and use of work equipment regulations 2006 (PUWER) to fishing vessels regulations
MJA/4	-	DNV identification code for the chain examined during the second contract
mm	-	millimetre
Mn	-	manganese
MPF	-	manufacturing proof force, the test to which chain or its components are subjected during manufacture
MSN	-	Merchant Shipping Notice
N/mm^2	-	Newtons per square millimetre (pressure or tension measurement)
nm	-	nautical mile
OTC	-	Offshore Technology Conference
plastic deformation	-	is a permanent deformation or change in shape of a solid body without fracture under the action of a sustained force
plastic strain	-	occurs when a material is stressed to the extent where its elastic limit is exceeded. When the stress is removed, the elastic strain disappears and any plastic strain (i.e. deformation) remains
proof load	-	the amount of force a fastener must be able to withstand without permanent deformation
PUWER	-	The Merchant Shipping and Fishing Vessels (Provision and Use of Work Equipment) Regulations 2006
SICC	-	stress-induced corrosion cracking
Stevenson	-	W. Stevenson & Sons Limited
SWL	-	safe working load
t	-	tonnes
tensile strength	-	the ability of a material to resist deformation under tension, measured as force per unit area
UTC	-	universal time coordinated
UTS	-	ultimate tensile strength
WLL	-	working load limit, the maximum load that a chain or its components are designed to handle

TIMES: all times used in this report are UTC unless otherwise stated.

SYNOPSIS

At 0630 on 6 February 2021, a deckhand/cook on board the beam trawler *Cornishman*, was fatally injured when a suspended heavy steel trawl beam fell to the deck, striking and trapping him. A second deckhand was also struck and sustained minor injuries. The deckhands had been repairing the port trawl gear between fishing operations, 44 nautical miles south-south-west of the Isles of Scilly, England. The skipper contacted the coastguard and a rescue helicopter and lifeboat were dispatched. The deckhand was declared deceased by the attending helicopter paramedic. The second deckhand was evacuated to hospital and discharged later that day following treatment.

The investigation established that the deckhands were working beneath suspended equipment when a chain link fractured, allowing the trawl beam to fall. The chain section formed part of the port trawl gear's quick-release gear that supported the port beam and was operated over a fixed steel pin at the top of the derrick. The quick-release chain links were found to be worn, corroded and cracked.

Despite a previous incident where a similar quick-release chain was found to have cracked, the safety regime within the company and on board had not recognised the design flaw in operating chains over fixed pins on *Cornishman*. The lifting gear inspection regime had not identified the deterioration of the chain, and the requirements of the lifting and equipment regulations for fishing vessels and guidance on the use and inspection of chains was not strictly followed.

The chain was made from a low ductile steel with a high hardness value, which was detrimental to its longevity and not recommended for use in corrosive marine environments. There was potential for material embrittlement and sudden failure to occur. Hardness was not a specified parameter in the standard to which the chain was manufactured and was not considered in the purchase of the chain.

In May 2022, the MAIB published an interim report highlighting that the design of *Cornishman*'s quick-release gear made it difficult to calculate its working load limit. It stated that the chain over pin arrangement was susceptible to failure, and that the need for regular inspections and replacement of these types of gear and derrick head pins was imperative.

The Maritime and Coastguard Agency has been recommended to update: its guidance on the training requirements of competent persons carrying out lifting equipment inspections and examinations; and, its instructions to surveyors regarding their monitoring of compliance with the lifting operations and lifting equipment regulations during surveys. Capital Group FASING S.A., Poland has been recommended to review and amend its chain quenching and tempering process and offer customers a hardness test certificate for its lifting chains. W. Stevenson & Sons Limited has been recommended to ensure compliance with the lifting equipment regulations; liaise more closely with chain suppliers; and implement the Fishing Safety Management Code.

SECTION 1 – FACTUAL INFORMATION

1.1 PARTICULARS OF *CORNISHMAN* AND ACCIDENT

VESSEL PARTICULARS	
Vessel's name	*Cornishman*
Flag	UK
Classification society	Not applicable
IMO/Fishing numbers	7102558/PZ 512
Type	Beam trawler
Registered owner	W. Stevenson & Sons Limited
Manager	W. Stevenson & Sons Limited
Construction	Steel
Year of build	1971
Length overall	32.82m
Registered length	29.37m
Gross tonnage	208.20
Minimum safe manning	4
Authorised cargo	Fish

VOYAGE PARTICULARS	
Port of departure	Newlyn, Cornwall
Port of arrival	Newlyn, Cornwall
Type of voyage	Fishing
Cargo information	Fish
Manning	6

MARINE CASUALTY INFORMATION	
Date and time	06 February 2021 at about 0630
Type of marine casualty or incident	Very Serious Marine Casualty
Location of incident	44nm south-south-west of the Isles of Scilly, England
Place on board	Main deck
Injuries/fatalities	1 injury, 1 fatality
Damage/environmental impact	Failure of quick-release gear
Vessel operation	On passage
Voyage segment	Mid-water
External & internal environment	Calm seas with slight swell, north-westerly wind force 3 to 4, fine and clear weather, good visibility but dark
Persons on board	6

1.2 NARRATIVE

At 1830 on 31 January 2021, the beam trawler *Cornishman* **(Figure 1)** departed Newlyn, England and proceeded to its fishing grounds approximately 44 nautical miles south-south-west of the Isles of Scilly, England. The six crew on board experienced heavy weather for the first 3 days, but conditions gradually improved towards the end of the week and, by 6 February, the weather was clear and dry and the sea was calm with a slight swell.

Figure 1: *Cornishman*

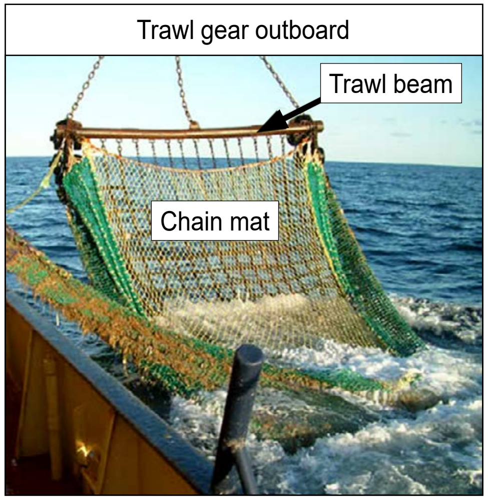
At 0545 on 6 February, the four deckhands started hauling in the nets. The mate had just taken over the watch in the wheelhouse and the skipper was resting at the back of the wheelhouse. Two deckhands worked on each side of the vessel and the starboard net was emptied. The rest of the starboard gear, including the beam but excluding the cod end, remained in the hauling position with the derrick suspended at about 45°. When the port trawl gear was retrieved, one of the deckhands (deckhand 1) noticed that a shackle was missing on the third row of the chain mat below the beam **(Figure 2)**. Deckhand 1 discussed it with the mate and, having been instructed to replace the shackle, was assisted by two other deckhands to secure the port trawl beam using the safety chains at either end of it **(Figure 3)**.

At about 0620, the mate raised the port derrick to ensure the safety chains held the trawl beam taut alongside the vessel at between 3m to 3.5m above the deck and about 10° from the vertical so that the trawl gear, including the chain mat, was hanging slightly outboard **(Figure 4)**. The third row of the chain mat was positioned at about bulwark level. One of the deckhands collected a pneumatic spanner (air gun) from the engine room and handed it to deckhand 1 while the other deckhand brought the compressed airline from forward of the gantry. The vessel was rolling steadily in the sea conditions.

At around 0630, and without warning, the quick-release chain supporting the port trawl beam failed **(Figure 5)** and the beam fell, striking deckhand 1 and landing inboard **(Figure 6)** with the net and remaining trawl gear overboard. The beam trapped deckhand 1 and injured one of the other two deckhands who had been assisting with the port trawl beam. The skipper was awoken by the sound of the beam hitting the deck and sent the mate down to help. The crew used the Gilson winch to lift the beam clear of the deck and pulled deckhand 1 out from beneath the fishing gear. After some initial difficulties with radio communication, the skipper contacted Falmouth coastguard via *Cornishman*'s satellite telephone to raise the alarm and was in turn connected to a doctor to discuss the extent of the injuries. The doctor requested immediate evacuation of deckhand 1 and advised the crew to start cardiopulmonary resuscitation (CPR). Deckhand 1 was bleeding heavily from his ears, nose and mouth, one of his legs was broken and his pulse was very faint. The crew moved him to the crew companionway and cut off his oilskins. They began CPR, attached a finger heart rate monitor, which initially gave an output, and prepared the vessel's defibrillator.

Image courtesy of and Devon & Cornwall Police

Image courtesy of W. Stevenson & Sons Limited



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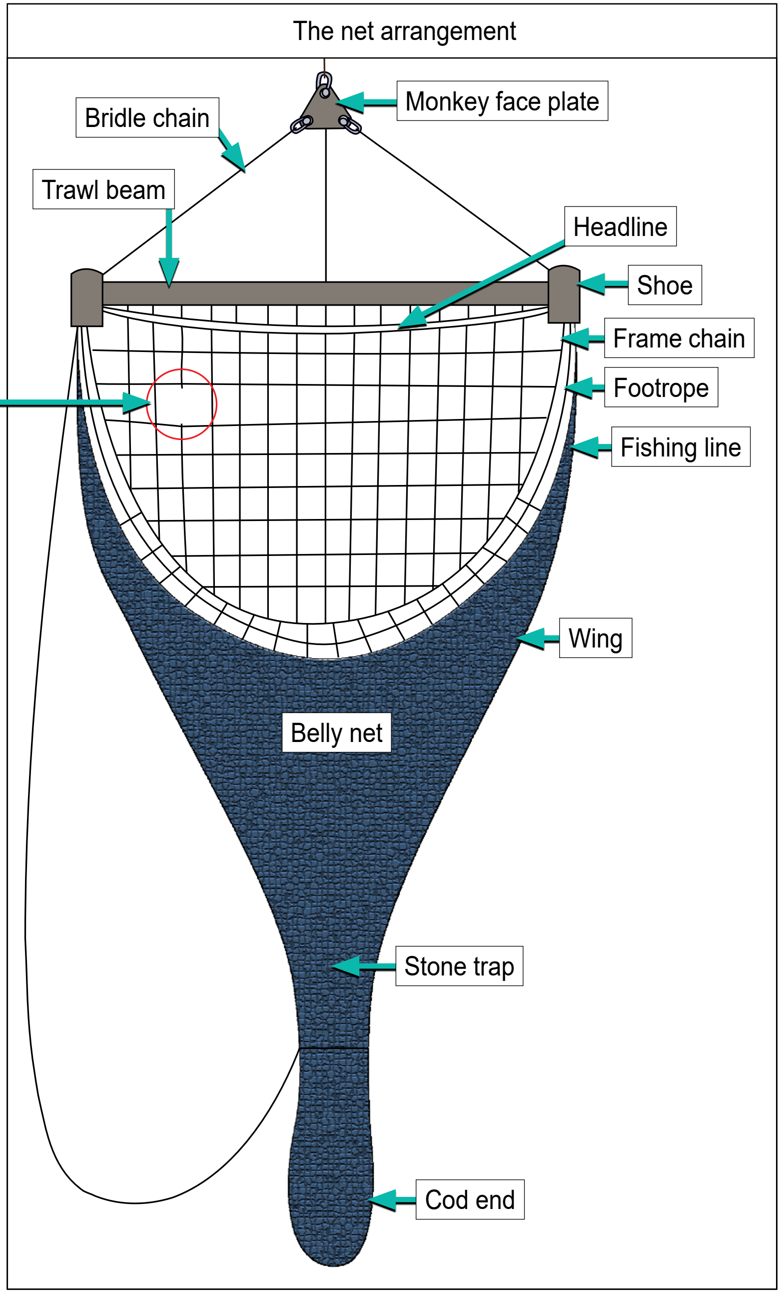


Figure 2: *Cornishman*'s net arrangement

Figure 3: Port trawl beam and forward safety chain

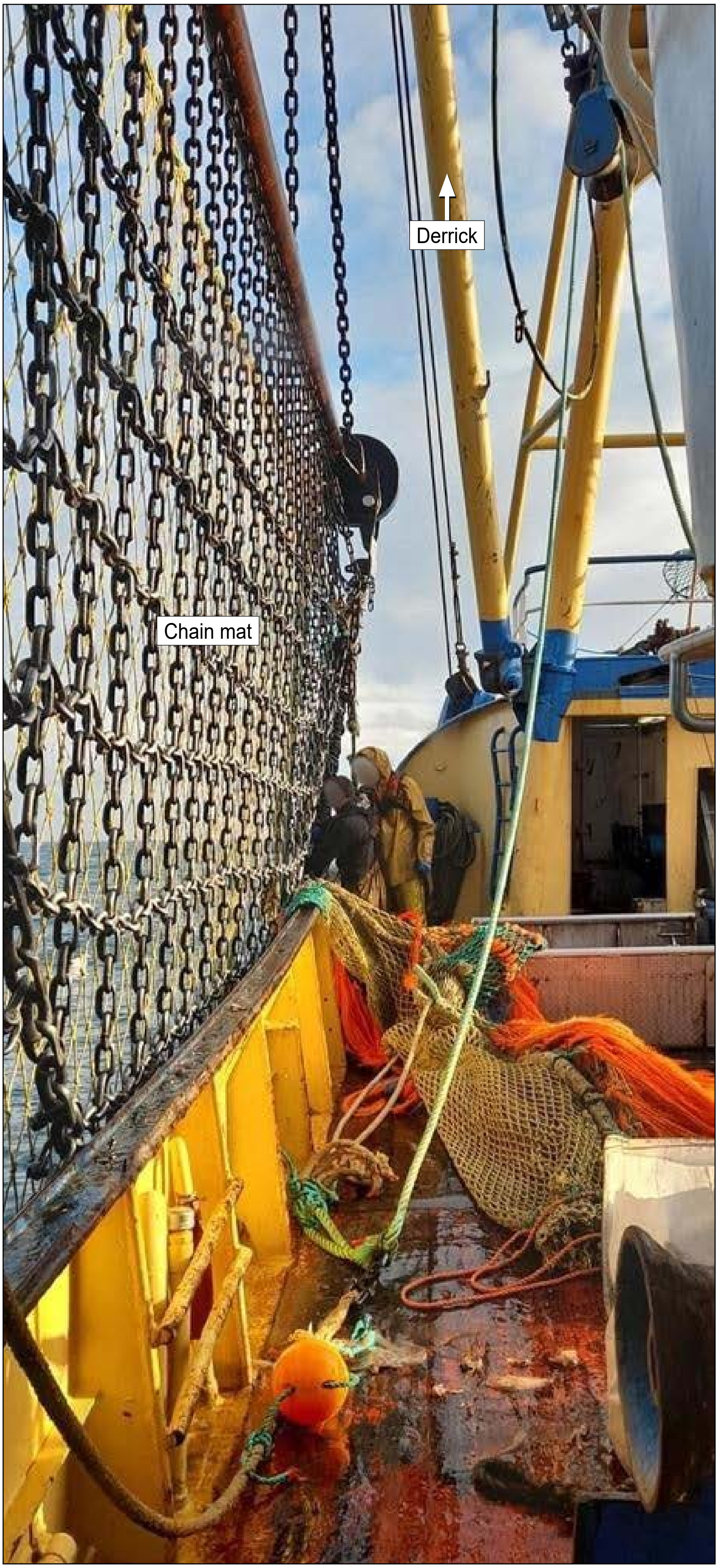


Figure 4: Port chain mat suspended outboard

Figure 5: Port derrick broken quick-release chain

Image courtesy of [W. Stevenson & Sons Limited]

Figure 6: Port trawl beam on port deck after quick-release chain failure

At 0641, a coastguard helicopter was tasked. Around 45 minutes later, the St Mary's RNLI[1] lifeboat was dispatched from the Isles of Scilly. At 0800, rescue helicopter *R924* arrived on scene and a paramedic was winched down to *Cornishman* to attend to deckhand 1. At 0816, the paramedic declared deckhand 1 deceased. The other injured deckhand was winched into the helicopter and transferred to a hospital in Newquay, Cornwall where they were treated for minor injuries and discharged the same day.

By 1100, the fishing gear that had gone overboard on the port side of *Cornishman* had been retrieved and the vessel set sail for Newlyn. The coastguard requested the St Mary's lifeboat, which was still on its way to the vessel, to return to its Isles of Scilly base. At 1840, *Cornishman* arrived in Newlyn where the body of deckhand 1 was disembarked and transferred to the mortuary.

1.3 ENVIRONMENTAL CONDITIONS

The sea conditions at the time of the accident were calm, with a slight swell on the vessel's port side. The wind was north-westerly force 3 to 4 and the weather was fine and clear with good visibility, but dark.

1.4 POST-ACCIDENT EVENTS

1.4.1 Postmortem examination

The postmortem examination of deckhand 1, Leigh Spencer, identified the primary cause of his death as a head injury and the report stated:

> *The head injury would have resulted in instant unconsciousness with death following very rapidly thereafter if not instantly. He would have been unaware of what had happened. This represents a non-survivable injury; it follows that there was nothing that could have been done to save his life.*

The toxicological examination report concluded that:

> *There is no analytical evidence to suggest that Leigh SPENCER had used alcohol or any other drugs within the scope of the testing, in the hours prior to death. For reference, most drugs are detected for up to approximately 12 to 24 hours in blood and 24 to 48 hours in urine, following last use.* [sic]

1.4.2 Detention

Following the accident, the Maritime and Coastguard Agency (MCA) issued prohibition notices to 14 vessels owned by the W. Stevenson & Sons Limited (Stevenson) fleet with instructions to the company to check if these vessels complied with all statutory requirements. Five vessels, including *Cornishman*, were subsequently issued with detention notices. Of the nine separate breaches recorded for *Cornishman*, three related to lifting equipment:

> *2. Ropes and wires:* *Blocks not identified, blocks significantly corroded, SWL plates not identifiable, significant grooving, shackles not secured*

[1] Royal National Lifeboat Institution.

4. Other: Competent person not identified. Competent person inspection regime not available.

5. Ship's occupational safety and health policies and programmes:

Health and Safety Policies indicate previous Chief Executive Officer as responsible person. No direction from the Owner to the Skipper with respect to the operation and control of operations on board. No evidence of Safe Operating Procedures for all reasonably foreseeable circumstances. [sic]

Three of the five vessels were released from detention between 12 and 26 February 2021. *Cornishman* and the fourth vessel were released from detention in June 2021.

1.5 *CORNISHMAN*

1.5.1 Crew

The six crew on board *Cornishman* at the time of the accident comprised the skipper, mate and four deckhands: the skipper, mate and deckhand 1, who was also the vessel's cook, were UK nationals; two deckhands were Ghanaian nationals; and one deckhand, who was also the vessel's engineer, was a Latvian.

The skipper had been employed by Stevenson since 1979 and had been *Cornishman*'s full-time skipper for 7 years until October 2020, working part-time thereafter. The skipper held a fishing vessel skipper's Second Hand (Special) certificate of competency, issued in 1985. The skipper's training record, including from Seafish, showed the skipper held four of the five[2] mandatory Seafish qualifications, of which the basic health and safety training requirement was missing.

The mate was a career fisherman and had been employed by Stevenson for about 12 years. The mate held a Class II skipper's certificate issued in 1995, and the same four qualifications as the skipper.

The deceased deckhand, Leigh Spencer (deckhand 1) was a 49-year-old career fisherman. He had been employed by Stevenson since 2014 and had worked on board *Cornishman* since 2017. He also held four of the five mandatory Seafish qualifications, excluding the basic health and safety requirement.

The two Ghanaian deckhands had joined *Cornishman* in November 2020 and December 2020, respectively. Both had completed a familiarisation and basic safety training course[3] in Ghana. Records of this were not listed in the Seafish training database.

The Latvian deckhand had been employed by Stevenson for about 11 years, including 2 years on board *Cornishman*. The deckhand had an able seaman's qualification issued by Latvia. The deckhand had not completed the five mandatory Seafish qualifications or equivalents.

[2] Basic sea survival; basic firefighting; basic first aid; basic health and safety; and, for fishermen with more than two years' experience, safety awareness and risk assessment. MGN 411 (M+F) – Training and Certification Requirements for the Crew of Fishing Vessels and their Applicability to Small Commercial Vessels and Large Yachts – sets out the requirements.

[3] This training comprised personal survival techniques; fire prevention and firefighting; elementary first aid and personal safety and social responsibilities.

1.5.2 Certification

Cornishman held the required International Fishing Vessel Certificate for fishing vessels over 24m registered length, which had been issued by the MCA on 10 October 2019 and was valid until 22 June 2023. The certificate was to be renewed every 4 years, with vessels subject to a system of annual, intermediate, renewal and additional surveys on a rolling basis. The last intermediate survey of *Cornishman* before the accident was conducted on 20 October 2020.

1.5.3 Fishing gear

Cornishman was a twin beam trawler that used port and starboard derricks to operate the vessel's trawl beams and fishing nets. The derrick heads were free to rotate by approximately 60° in the horizontal plane to accommodate the movements of the trawl gear **(Figure 7)**. Both derricks were lowered to a near horizontal position just above sea level during trawling, when it was normal for the top portion of the derricks, including the chain of the quick-release gear, pulley block, shackles and fixed pin, to frequently dip into the water as the vessel rolled to either side **(Figure 8)**.

The head of the fishing net mouth was attached directly to the beam. The bottom of the fishing net mouth was attached to a chain mat via the footrope, the ends of which were also then attached to the beam. The chain mat was a series of linked chains connected by further chain links and shackles **(**see **Figure 2)**.

Image courtesy of Devon & Cornwall Police

Figure 7: Overhead view of *Cornishman*'s derricks

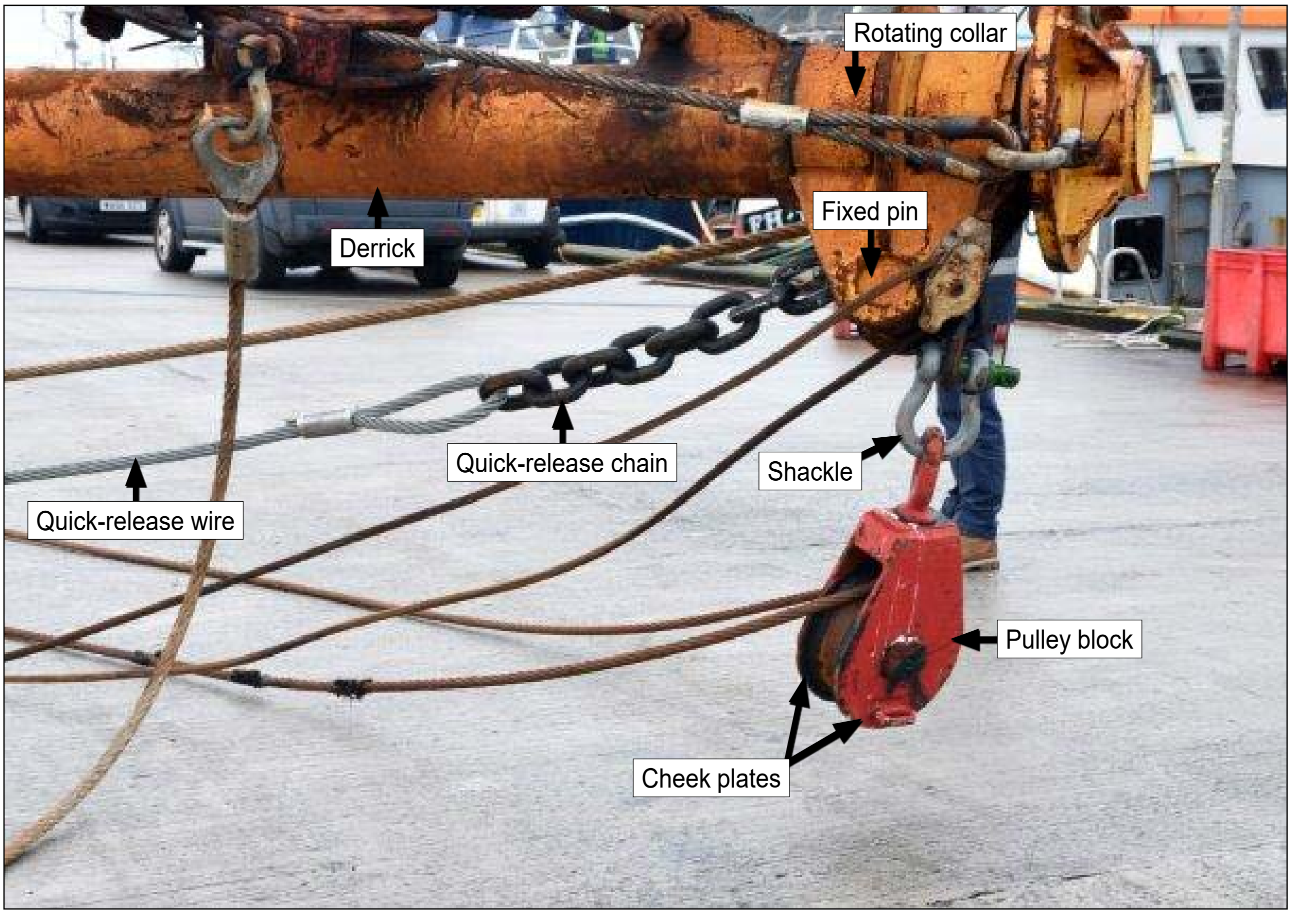


Figure 8: *Cornishman*'s starboard quick-release gear in lowered position

1.5.4 Survey

The MCA conducted annual surveys of *Cornishman* as required by The Fishing Vessels (Codes of Practice) Regulations 2017 (SI[4] 2017/943).

MCA fishing vessel surveys focused on the hull, propulsion machinery, lifesaving appliances (LSA) and crew accommodation. There were no specific instructions for surveying the rigging and lifting gear, such as shackles. MCA surveyor training did not include the inspection of lifting equipment, and MCA surveyors did not consider themselves subject matter experts on the inspection of lifting gear.

The survey procedures for derricks and other lifting equipment on board *Cornishman* remained the same each year, whether a renewal, intermediate or annual survey was being conducted. The visual inspection of both derricks was cursory, and examination of the on board greasing records and maintenance notes were the only survey activities undertaken for the derricks. No checks were made of Stevenson's lifting block register and there were no requests to see the lifting plan. The derricks were not lowered so surveyors could examine the derrick heads and chain for the quick-release gear.

[4] Statutory Instrument.

1.6 W. STEVENSON & SONS LIMITED

1.6.1 General

Cornishman was one of a fleet of nine beam trawlers owned and operated by Stevenson. A shore-based team comprising 14 employees was responsible for maintenance of the Stevenson fleet under the management of the head of operations. A site manager was responsible for the management of MCA surveys, communicating regulatory requirements to the skippers and acting as liaison between the crew and the MCA. In 2017, a health and safety manager was employed to oversee safe systems of work, occupational health and safety and the maintenance of all lifesaving, firefighting and lifting equipment.

Crew on Stevenson vessels were issued with safety equipment that included ‘bump’ caps intended for use while working alongside in harbour, lifejackets, high-visibility jackets, safety goggles and ear defenders. Head impact protection was not commonly used on board.

From February 2021, and as a result of the accident on board *Cornishman*, Stevenson engaged an external specialist marine consultant to advise on crew training, risk assessments, safe methods of work, safety and maintenance standards and vessel lifting plans.

1.6.2 Safety management manual

Stevenson’s 2019 safety management manual stated:

> *This manual is part of the Safety Management System for the safety of our vessels, crews and the environment. This SMS is the main management document for the company. Whilst this document is for the purpose of managing the vessel’s operations in their entirety, individual vessels are issued with and shall comply to the onboard Safety Folder. Common procedures and policies are issued to each vessel in their safety folder in compliance with the Fishing SMS Code. It is necessary for the safety, health and welfare of the crew and protection of the environment to manage the vessel in compliance with the SMS.* [sic]

And, that the:

> *Safety Folder – is the document aboard each vessel which shall structure the running of the vessels with regard to health and safety.*

On lifting operations and the use of lifting equipment, the safety management manual stated that:

> *The Safety Folder has a specific section for managing LOLER and PUWER equipment. This includes a register and a record with a schedule. The vessels should each have these documents within their safety folders and completed copies shall be kept as company records in between MCA surveys.*

Further the safety management manual stated that the vessel skipper(s) were *Responsible for operating vessel in compliance with safety management system*. [sic]

1.6.3 Safety folder

Cornishman's safety folder contained the:

- health and safety policy
- PFD wear policy
- environmental policy
- alcohol and drugs policy and procedures
- "Mayday" procedure
- emergency and drills checklist
- accident record for the vessel.

1.6.4 Lifting equipment safety

Stevenson's health and safety manager kept a lifting block register detailing the lifting blocks carried on board each vessel and including the type, number in use, maximum permitted load, wire diameter and price. The items listed for *Cornishman* were *Derrick End block*; *Shoulder block (rebuild fixed sheaves)*; and *Topping Lift and Topping Left (double)*. Refurbished blocks were allocated to various vessels after they had been tested and certified by an external company. The spare fishing gear and stores required for the day-to-day running of the vessels were kept in a dedicated store at Newlyn. The skipper, crew and relevant members of the shore-based team were responsible for maintenance and record-keeping in relation to the component parts of the quick-release arrangement.

The skippers fulfilled the role of competent person as required by the LOLER[5] lifting regulations. Stevenson also considered that knowledge was gained through experience and did not provide instructions on the application of LOLER for those working on board the company's vessels.

1.6.5 Risk assessment

There were risk assessments on board *Cornishman* that identified risks and proposed mitigations for them. The *Maintenance Work* (RA-007) health and safety risk assessment form for *Cornishman* had last been reviewed on 24 July 2020, with a next review date of 23 July 2021. For lifting operations, two risks had been identified:

- *Lifting equipment not meeting good standards (faulty equipment)*
- *Crews unaware of lifting procedures*

The requisite controls to mitigate these risks were:

- *All equipment used for lifting will be tested to meet the requirements of the regulations*

[5] Statutory Instrument 2006 No.2184, The Merchant Shipping and Fishing Vessels (Lifting Operations and Lifting Equipment) Regulations 2006.

- *All such equipment will be recorded in a register*

The documented risk outcomes (if controls were not in place) were:

- *Crushing injuries*
- *Death*
- *Damage to equipment*

The *Handling on Deck* (RA-009) health and safety risk assessment form had identified two risk areas/activities:

1. *Being struck by the heavy mass of gear swinging as it is lifted*
2. *Hands/limbs trapped by gear*

The associated risks included strops failing and a lack of clear instruction, for which the mitigation controls were:

- *The gear is to be stropped in poor weather conditions, and whenever it is lifted inboard*
- *The crew are instructed to stand well clear*
- *Crew are not to place their hands/limbs between the gear and the rail unless for maintenance/repair purposes when the gear is to be secured to prevent injury.*

1.7 FISHING ARRANGEMENT

1.7.1 Configuration and operation

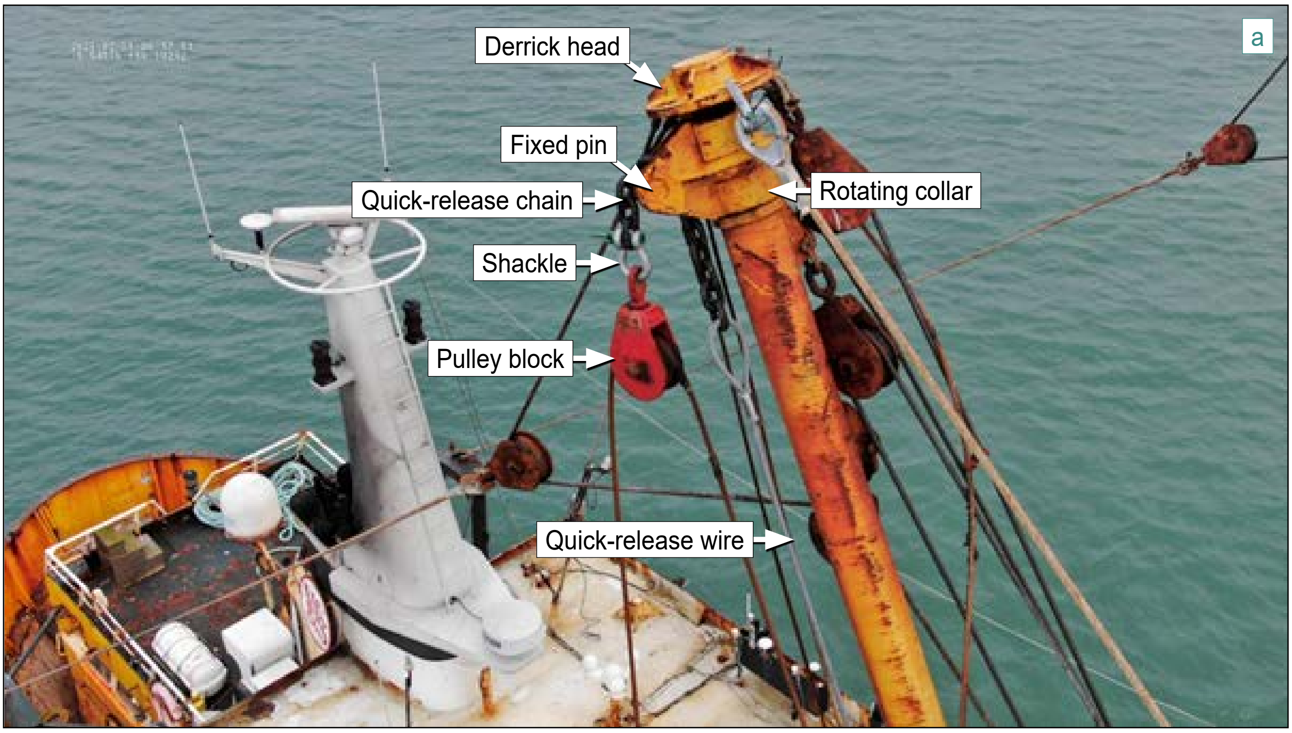
Cornishman's port and starboard fishing arrangement **(Figure 9)** consisted of a trawl beam suspended from a pulley block, which was connected by a shackle to the quick-release chain passed over the derrick head[6] fixed pin. The trawl warp was fed from the trawl winch through the pulley block to the monkey face plate, which was in turn connected to the trawl beam with bridle chains. The trawl winch enabled the beam to be lowered into the sea so that the trawl gear could be payed out to the required trawling length on the seabed.

A quick-release system was incorporated to prevent the vessel capsizing if the net came fast on the seabed during trawling. Activating the quick-release mechanism reduced the capsize force on the vessel by moving the trawl beam towing force from the top of the derrick to low down on the vessel's side. This gave time for the crew to take further action.

Cornishman's quick-release gear design originated in the Netherlands and was similar to that used on other UK beam and scallop dredgers. It comprised a length of steel wire rope, one end of which was attached to a quick-release pelican hook at the lower end of the derrick. The upper end of the wire was fitted to a 10-link length of 32mm steel chain, which ran over a 150mm diameter fixed steel pin welded

[6] Also known as a horse's head.

Image courtesy of Devon & Cornwall Police



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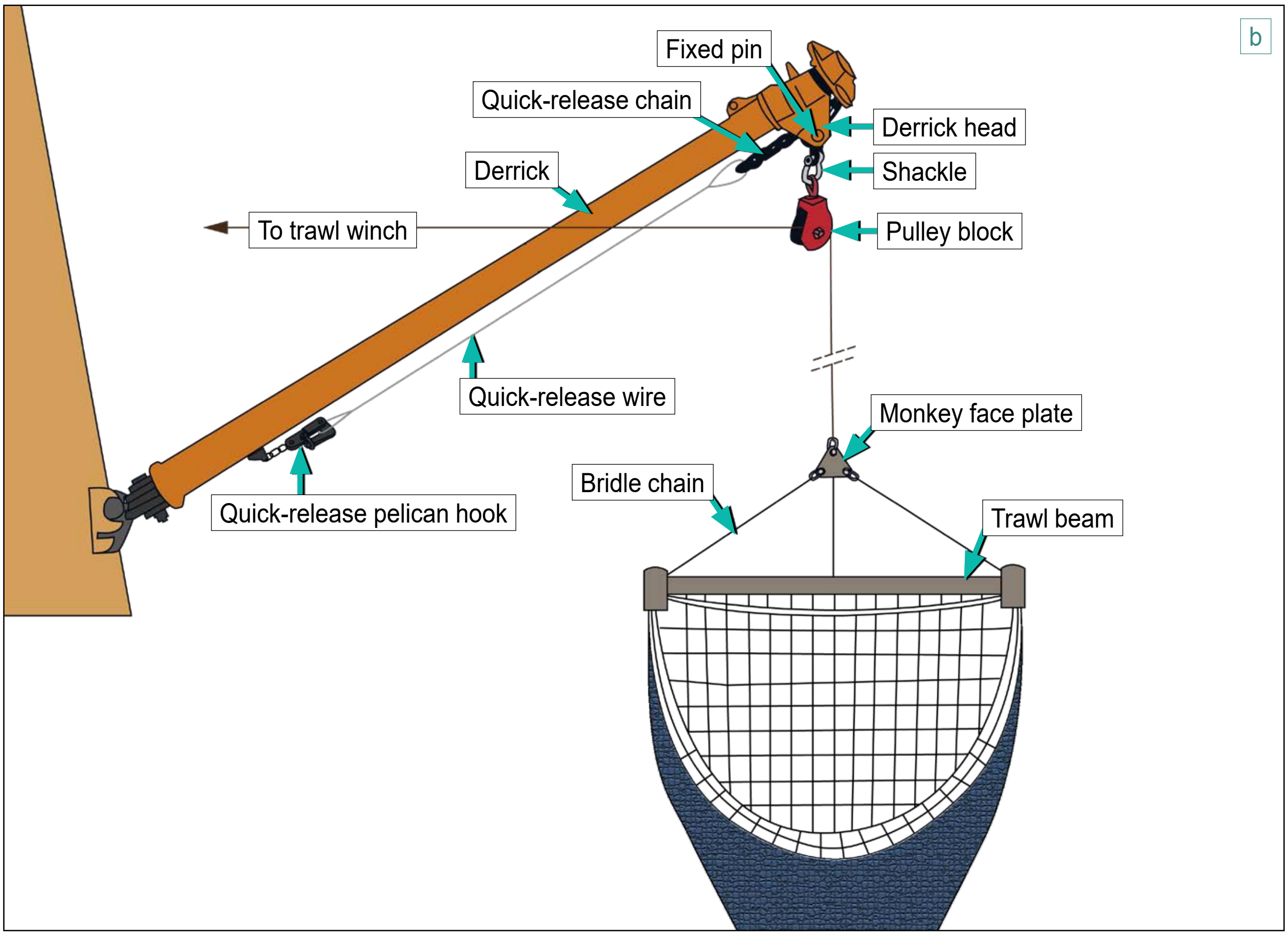


Figure 9: *Cornishman*'s starboard quick-release system, showing the derrick head (a) and illustration of the quick-release mechanism (b)

between the steel cheek plates of the derrick head and connected to the shackle at the top of the pulley block to support the trawl beam. The D/d ratio[7] of the 150mm fixed pin (D) and 32mm 10-link chain (d) was 4.68 (150/32) when new.

The fixed steel pin became grooved **(Figure 10)** during use by wear from the chain links as they laid at angles to the pin **(Figures 10** and **11)**, alternately lying to one side and then the other, effectively reducing the D/d ratio to a measured value of between 3.0 to 3.5 to 1.

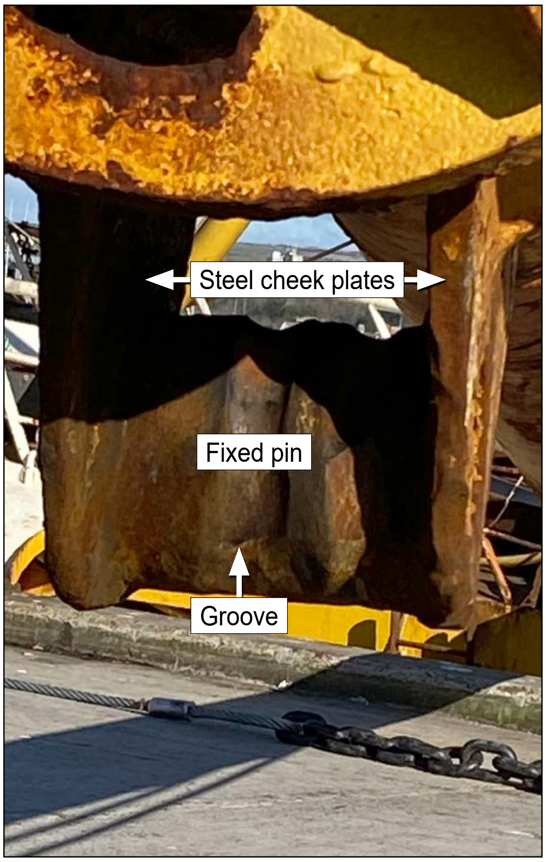


Figure 10: Derrick head quick-release fixed pin grooving

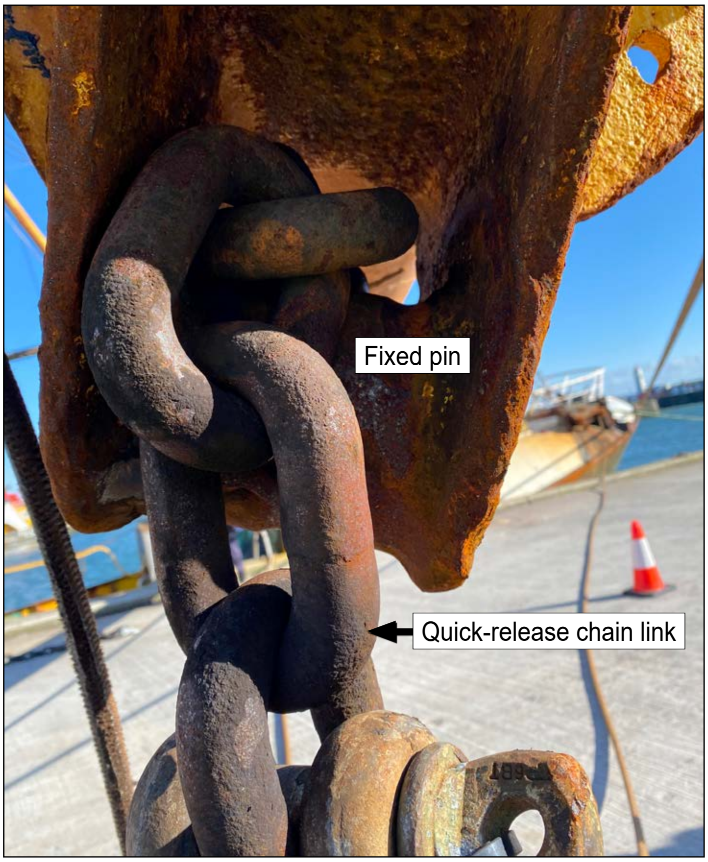


Figure 11: Quick-release chain links lying at alternating angles on the fixed pin

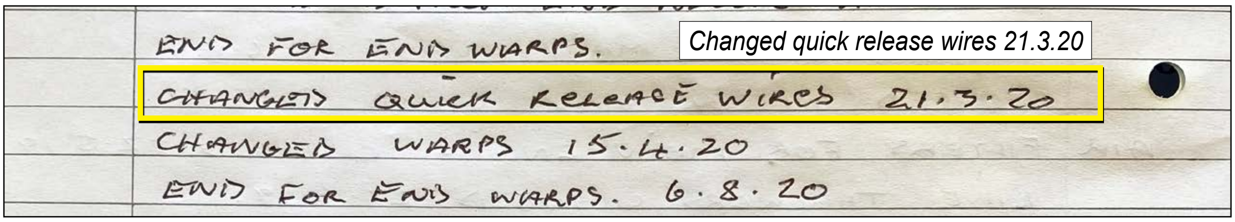
1.7.2 Maintenance

The effects of the harsh operating conditions required frequent running repairs to *Cornishman*, including the replacement of various components such as corroded links **(Figure 12)**, to keep the gear in working order. Excessive grooves in the fixed steel pin were filled in with weld and then ground smooth by the shore-based maintenance team. The quick-release chain was replaced approximately annually. Previous failures while at sea had involved chains, wires and shackles on the quick-release gear and had usually resulted in the trawl gear falling overboard.

There was no formal planned maintenance schedule for fishing gear on *Cornishman*, but the skipper maintained a handwritten record of the maintenance activities carried out on board. The maintenance record stated the quick-release wires were last changed on 21 March 2020 **(Figure 13)**.

[7] Ratio of the diameter (D) around the object that the chain is running over, divided by the chain link's bar diameter (d).

Figure 12: Corroded chain



END FOR END WARPS.
CHANGED QUICK RELEASE WIRES 21.3.20
CHANGED WARPS 15.4.20
END FOR END WARPS. 6.8.20

Figure 13: Skipper's record of vessel maintenance activities

The pulley blocks were routinely greased before starting a fishing trip when a general appreciation of the condition of the quick-release chain could be achieved. A thorough assessment of either the section of the chain that went around the derrick head's fixed pin or the condition of the derrick head fixed pin with the chain in place was impractical **(Figures 11** and **14)**. Close inspection of the quick-release gear required *Cornishman* to be berthed alongside and for the derrick on the vessel's shore side to be lowered until the component parts rested on the quayside; the vessel was then turned and the inspection process repeated for the quick-release gear on the opposite side **(**see **Figure 8)**.

Cornishman's engineer had inspected the equipment at the derrick heads on 30 January 2021, in readiness for the fishing trip. No faults with the quick-release chain were identified.

Figure 14: Limited access of quick-release chain and derrick head fixed pin

1.7.3 Alternative quick-release designs

Other methods of quickly releasing the towing point from the derrick head if the fishing gear became fouled had been developed. These included the Van Damme quick-release system **(Figure 15)**. This arrangement used a wire running over a sheave instead of a chain over a pin and worked on a swivel system on the end of the derrick. The release wire connected to a hinged arm at the derrick head and, when released, enabled the trawl beam and fishing gear to move inboard, reducing the capsize forces.

On more recent vessels the fixed pin at the derrick head, as used on *Cornishman*, was replaced with a sheave for use with wires instead of chains. This system required a different winch arrangement to incorporate the quick-release wire arrangement, passing the operation of the quick-release system to the wheelhouse to enable controlled lowering of the trawl beam[8].

Image courtesy of the Maritime and Coastguard Agency

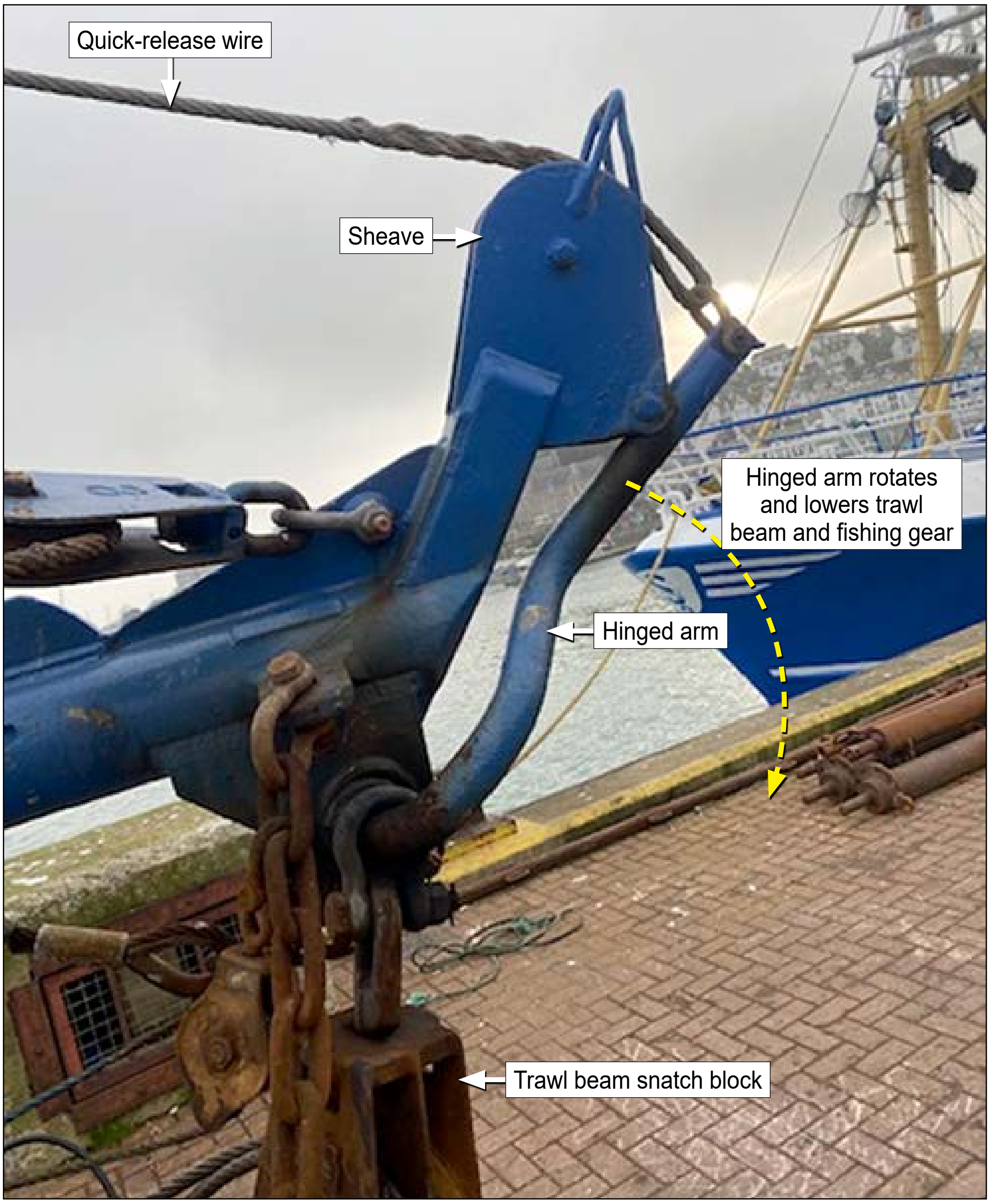


Figure 15: Van Damme quick-release arrangement

[8] For further details refer to **Annex D**.

1.7.4 Quick-release gear chain history

The 32mm x 96mm chain used for both the port and starboard side trawl gear quick releases on *Cornishman* was 8m long and part of a 100m length of chain manufactured by Capital Group FASING S.A., Poland (FASING) in March 2019.

On 23 April 2019, the 100m chain was supplied to a UK chain supplier. On 23 September 2019, 8m of the chain was purchased by Stevenson and stored on a pallet at its Newlyn store. The chain certificate stated the chain's distinguishing mark as *HS2-8 3/9* and detailed it as a *GRADE 8 SHORT LINK CHAIN 32MM DIA – G8C32 – TO BS EN 818-2 – SAFETY FACTOR 4 TO 1 – MIN ELONGATION 20%* with a proof load of 804 kilonewtons (kN) and a working load limit (WLL)[9] of 31.5 tonnes (t). The order neither specified a material hardness limit for the chain nor detailed its purpose or arrangement when used as part of the quick-release gear. The chain supplier's user information included:

- *Grade 8 alloy chain slings should not be used in hazardous conditions which would include offshore applications*[10]*,…*
- *If a Grade 8 alloy chain sling is being used against sharp edges or corners, the W.L.L. will be affected and should be referred to the supplier to establish a safe load limit.*

In March 2020, Stevenson supplied a sub-contractor with a length of the 8m chain as part of an order to manufacture the chain and wire quick-release system for the two derricks on board *Cornishman*. The order was completed on 13 March 2020. Each chain and wire assembly comprised 13 links of chain connected to 10m of 6 x 36 fibre core galvanised steel wire rope. The WLL of the wire rope was 8.4t[11].

On 21 March 2020, after reducing the overall length by three links, the assembled quick-release chains and release wires replaced the existing *Cornishman* arrangement, on which corrosion had been identified. The WLL for the complete trawl beam lifting equipment was unspecified.

1.8 CHAIN MANUFACTURE

1.8.1 Chain specification and manufacture

FASING began as a mining and smelting company in 1913. The company eventually became the largest chain manufacturer in central Europe and one of the largest in the world supplying industries in the mining, marine and fishing, power, sugar, cement and timber sectors.

FASING produced a range of chains for different markets and material specifications to meet customer requirements and comply with applicable standards. The various types included wear-resistant chains and those used for lifting and hoisting.

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[9] The WLL for a chain is based on the maximum weight the chain can lift vertically. If the chain is used to drag a load up a 45° platform, the WLL of the chain needs to be lower to allow for the additional forces exerted on the load.

[10] This information had been updated after the HSE published information about hydrogen embrittlement on Grade 8 chains in 2014 (see section 1.11.1).

[11] 8.4 tonnes-force (tf) = 82.37kN.

The FASING product catalogue for *Lifting chains, chains for hoists* described the range as:

> *The group of special, short-link chains with high hardness value and free of any production tension, of standard precision, applied in chain slings, used in lifting and carrying the loads.* [sic]

The chemical analysis of the 32mm round steel bar used in the manufacture of *Cornishman*'s chain is summarised in **Table 1**. The material certificate provided to FASING by the steel manufacturer included a hardness level of 270 to 272 Brinell Hardness (HB)[12].

	Carbon [%]	Silicon [%]	Manganese [%]	Chromium [%]	Molybdenum [%]	Nickel [%]
Chain steel	0.23	0.22	1.25	0.56	0.258	0.51

Table 1: Chemical analysis of the round steel bar supplied to the chain

The UK chain supplier guided customers to the chains' safety information and user instructions detailed on its website. This was done via individual customer delivery notes, invoices and on the supplier's declarations and certification.

1.8.2 Technical standard

FASING used the round steel bar to manufacture lifting chain that complied with technical standard *European Norm (EN) 818-2 Short link chain for lifting purposes – Safety – Part 2: Medium tolerance chain for chain slings – Grade 8 (EN 818-2)* and the equivalent ASTM[13] International standard 319/A.

Section 4 of the EN 818-2 technical standard identified the following risk with lifting chains:

> *Accidental release of a load, or release of a load due to failure of lifting accessories such as slings or their component parts puts at risk either directly or indirectly the safety or health or health* [sic] *of those persons within the danger zone of lifting equipment.*

Section 5 instructed that:

> *The steel shall contain alloying elements in sufficient quantities so that the finished chain, when heat treated in accordance with 5.3.2 complies not only with the mechanical properties specified in this Part of EN 818 but also possesses adequate low temperature ductility and toughness to provide resistance to impact loading.* [sic]

[12] Equivalent to a hardness of circa 273 to 275 Vickers Hardness (HV).

[13] American Society for Testing and Materials.

On heat treatment, the standard required that:

> *The tempering[14] conditions shall be at least as effective as a temperature of 400°C maintained for a period of 1 h. This requirement is the responsibility of the chain manufacturer. When proposed for verification, sample chains shall be tested after they have been reheated to and maintained for 1 h at 400°C and then cooled to room temperature; they shall comply with the requirements of 5.4.2 and 5.4.3.* [sic]

For each nominal size of chain the EN 818-2 technical standard stipulated the required dimensions and permitted variations, chemical composition, WLL, manufacturing proof force (MPF) and breaking force (BF). The expected compliance properties for a nominal chain size of 32mm were:

WLL (t)	MPF (kN)	BF[15] (kN)
31.5	804	1,290

In its *Instructions for use of short link chains for lifting purposes and chain slings* FASING provided the required strength ratios for lifting chains to comply with EN 818-2:

WLL (t)	MPF (kN)	BF (kN)
1.0	2.5	4.0

The ratio of 4:1 between the BF and the WLL provided a factor of safety of about four, i.e. a WLL of 31.5t equated to a BF of 131.5t (1,290kN).

The EN 818-2 chemical composition requirements were limited to minimum percentage by mass of the alloying elements of nickel, chromium, molybdenum and aluminium, and the maximum percentages by mass of sulphur and phosphor. There was no requirement for maximum manganese (Mn) content but the presence of Mn can result in material hardness.

A minimum elongation[16] of 20% was required when the BF was applied. The material's hardness[17] and tensile strength[18] were not part of the EN818-2 requirements for Grade 8 steel short link chain.

[14] A heat treatment technique applied to a ferrous alloy such as steel or cast iron to increase its toughness by decreasing its hardness. Tempering is usually performed after quenching, which is rapid cooling of the metal to put it in its hardest state. Steel is also sometimes toughened through a process called normalising, leaving the steel only partially softened.

[15] The BF mean stress was specified as 800N/mm². Mean stress is the average of the maximum and minimum stresses in a strain cycle.

[16] The stretch that occurs when a force is applied to a chain.

[17] The ability to withstand indentation and deformation.

[18] The ability of a material to resist deformation under tension, measured as force (newtons) per unit area (mm) of two cross sections of a single chain link. The grade is 0.1 of the actual ultimate strength so the ultimate breaking strength for Grade 80 (Grade 8) chain is 800N/mm².

1.8.3 Quality standard

FASING's integrated quality and environmental management systems complied with the requirements of International Organization for Standardization (ISO) 9001:2015 and ISO 14001:2015 (valid until August 2024). FASING's manufacturing process included testing the 32mm round steel bar to verify its compliance with various standards and the specification agreed between FASING and the steel bar manufacturer. The steel used in the production of *Cornishman*'s chain had a hydrogen content of 1.3%, which was within FASING's maximum 2% requirement.

FASING's chain production included a mechanical cleaning method (shot blasting), rather than acid solutions, and two heat treatment processes involving quenching, tempering and stress relief annealing[19] in line with an appropriate standard to improve resistance to brittle cracking in a corrosive environment.

The results of subsequent post-production tests were analysed by FASING to confirm the chain's quality and EN 818-2 compliance. The batch of 32mm x 96mm chain, part of which was supplied for use on board *Cornishman*, was certified with no inconsistencies and met the Grade 8/Grade 9 chain specifications.

The generally available information and a technical leaflet for FASING lifting chain advised that:

> *Before each use of the lifting chain, it is recommended to check whether there is any visible damage or deterioration of quality. It is important that such assessments are carried out cyclically and that records of the assessment with authorization are kept. This is important if the chain has not been used for some time and has been in corrosive conditions, so that it is to be checked.* [sic]

The leaflet further guided that:

> *If chain slings are to be used in exceptionally hazardous conditions i.e. offshore activities, the lifting of persons and lifting of potentially dangerous loads …. the degree of hazard should be assessed by a competent person and the working load limit adjusted and consulted with the manufacturer.* [sic]

FASING provided the test certificate[20] **(Annex A)** for the batch of chain that formed part of *Cornishman*'s quick-release arrangement, including the failed chain on the port side, the in-service chain on the starboard side and a sample of the spare chain supplied by Stevenson. The Mn content was stated to be 0.215% by weight and this was later advised to be a typing error. The actual Mn content was 1.25% in line with the original value quoted in the material specification **(Table 1)** of the round bar used to make the chain. The hardness number was not included in the test certificate, although FASING provided a separate document during the investigation indicating a hardness of 373 HB[21] and an elongation of 38% during break load testing.

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19 To minimise the residual stresses that occur in a material during the production process.

20 The certificate contained a typographical error that indicated a manganese chemical composition of 0.215%, which was later confirmed to be 1.25%.

21 Equivalent to c.388 HV10 (using a 10kg force).

1.9 EVIDENCE TESTING

1.9.1 Component tests

In September 2021, Det Norske Veritas AS (DNV) Technology Centre Materials and Corrosion in Bergen, Norway was contracted to examine and test *Cornishman*'s trawl beam components, including:

- five links of the failed port side chain connected to 1m of steel wire rope (BJC/1)
- unused sample of chain comprising nine links sourced from Stevenson's stores (BJC/2)
- intact starboard side chain comprising ten links (BJC/3)
- part of the fractured number 6 link from the port side chain, counting from the wire (BJC/4) **(Figure 16)**
- four links of the port side chain, towards the trawl beam (BJC/5)
- the port side derrick head (MPH/CM/PORT/3); and
- the starboard side derrick head (MPH/CM/SB/1)

The report produced by DNV **(Annex B)** established that:

> *The fractured link has been identified as the sixth link when counting from the steel wire rope end. According to the received images*[22]*, the fractured link is positioned close to the pin of the derrick head, most likely experiencing some bending moment against the pin.* **(**see **Figure 14)**

It further identified that:

> *Crack-like indications in a significant number of links is found, up to five cracks in one link. Cracks are found both in links that have been bent over the derrick heads and links that are considered to have been loaded along the main length direction. Examination of samples from break load testing showed that, in addition to the fractured chain link, at least one chain link has a crack that have propagated through the link thickness.* [sic] **(Figure 17)**

And concluded:

> *A large number of cracks and crack-like indications have been detected, both in the portside chain that fractured, but also in the starboard chain used in parallel to the portside one. The large number of cracks are believed to be related to environmentally induced cracking, most likely related to hydrogen embrittlement. This has induced crack growth in multiple positions.*
>
> *The underlying cause of fracture is a high hardness and low ductility*[23] *chain material in a corrosive environment, in combination with tensile stress. Hydrogen introduced during the steel chain manufacturing process may also have contributed to the material embrittlement.* [sic]

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[22] This refers to photographs taken by MAIB investigators during the investigation.

[23] High ductility indicates that a material will be likely to deform and not break whereas low ductility indicates that a material is brittle and will fracture before deforming under a tensile load.

Image courtesy of Det Norske Veritas

Figure 16: Extract from the DNV BJC report, showing part of the fractured number 6 link in the port side chain

Image courtesy of Det Norske Veritas

Figure 17: Extract from the DNV BJC report, showing cracks identified in one link of the port side chain

On chain loading, the DNV report stated:

> *The examination of the pins in the derrick heads shows severe deformation/ wear, caused by the contact with a chain…It is however considered likely that the significant deformation/wear can influence on the load distribution in the chain,…* [sic] **(Figure 18)**

Image courtesy of Det Norske Veritas

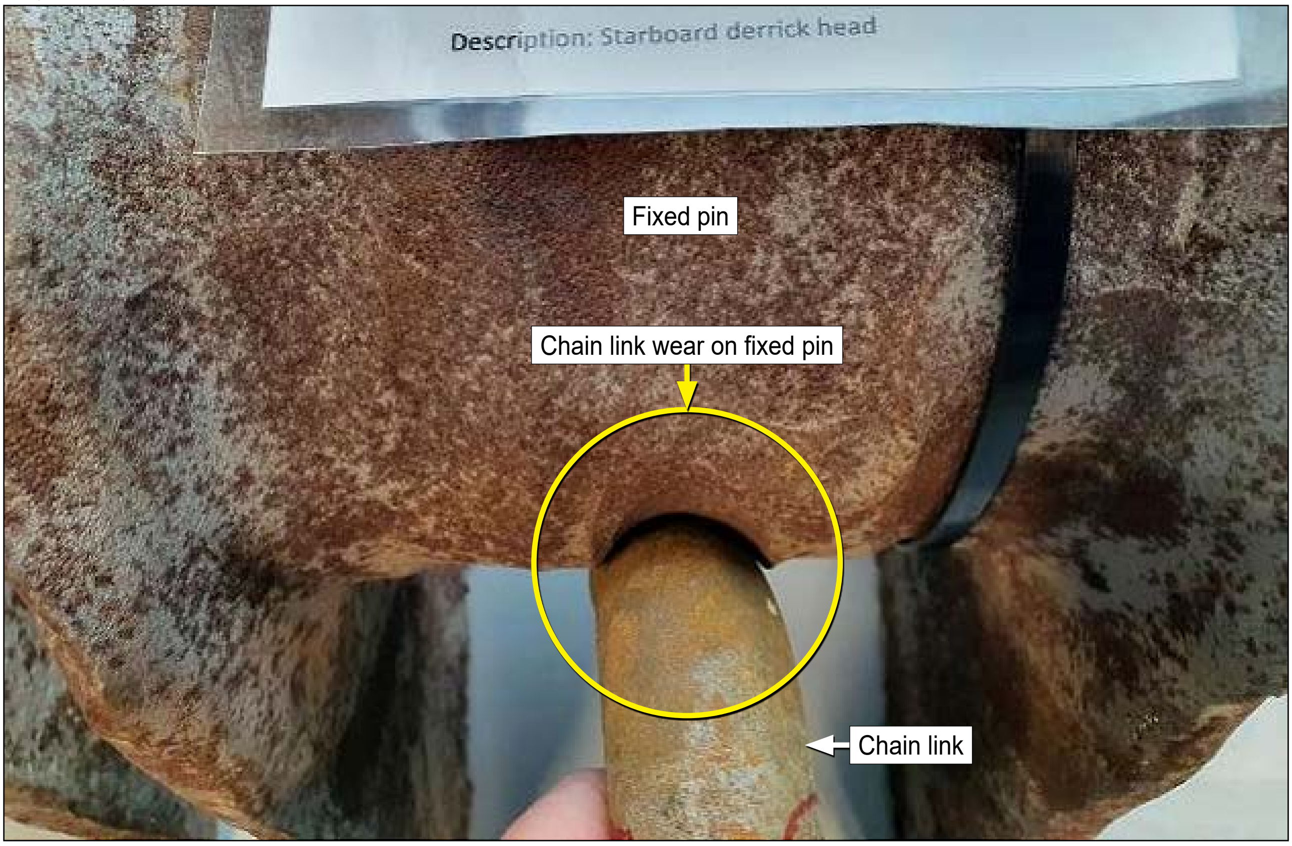

Figure 18: Extract from the DNV BJC report, showing chain link wear (grooving) on the fixed pin

And:

> *The geometry of the system also gives bending loading of the chain links that are supported over the pin, and not pure tension/tension loading as a lifting chain will normally experience. This would decrease the capacity of the chain part bent over the pin.* [sic]

On the breaking load of the chain, it identified that:

> *The break load testing shows the break load of the reference sample* (BJC/2) *is low compared to the requirements, the result is 994kN, i.e. 77% of the MBL*[24]*. The used chain has significantly a lower break load, 223kN compared to the required 1290kN…This indicates that during use, even the chain with a crack through the diameter has some remaining capacity, at least without additional bending moment. Hence, it is not expected the loading from normal use would have overloaded the chain without cracks or other weaknesses.* [sic]

[24] Minimum Breaking Load.

The DNV report also stated that, although Grade 8 chains were considered appropriate for lifting applications in marine environments, materials with hardness greater than 350 HV10 were susceptible to hydrogen embrittlement.

Dimensional checks of the links from both sections of the failed port side (BJC/1 and BJC/5) chain showed that their outside lengths were similar to that of the links from the unused sections of chains (BJC/2 and MJA/4[25]) and the starboard chain (BJC/3).

The report further explained that the material of the chain had a yield to tensile strength ratio of 0.99[26], implying very low ductility and therefore increased susceptibility to environmentally induced cracking. In this respect, the report stated:

> *Generally a higher hardness corresponds to a higher break load, which is desired, however a higher hardness also increase the probability of environmentally induced cracking, hence should also not be too high.* [sic]
>
> And:
>
> *… Grade 8 quality requirements do not include requirements to ensure good ductility of the chain material, for instance yield to tensile strength ratio. The extremely high yield to tensile strength ratio of the chain is assumed to have large influence on the susceptibility of hydrogen-induced cracking and hence contribute to the failure.* [sic]

The report concluded that:

> *Low actual break load is not expected based on the high hardness of the material, as tensile strength and hardness are more or less proportional properties, hence properties as ductility, yield to tensile strength ratio, etc. are believed to explain the low break load, not a low tensile strength.* [sic]

1.9.2 New reference chain testing

In November 2022, DNV was further contracted to conduct the same tests on a section of unused chain that had been identified in the UK chain supplier's warehouse as being from the same batch as *Cornishman*'s failed chain and had been reportedly dry stored. The new chain section was identified as MJA/4.

The summary of findings in the DNV report[27] on the MJA/4 reference chain sample included **(Annex B)**:

- *Tensile testing showed results somewhat lower compared to previously tested chain samples /1/* [28]*, and with a lower yield-to-tensile strength ratio.*
- *Hardness testing has shown hardness results somewhat higher than results reported from the manufacturer…and somewhat lower compared to previously tested chain samples /1/. Tensile strength converted from hardness measurements shows good correspondence with the actual tensile testing.*

[25] See section 1.9.2

[26] The range is from 0 to 1. The greater the ratio the smaller the difference between the yield strength and tensile strength, resulting in lower ductility and increased brittleness.

[27] DNV – Report No. 2023-5163, Rev. 0.

[28] This refers to the first set of DNV tests conducted under the BJC reference code.

- *The chemical composition corresponds to the certificate and results from previously tested chain samples /1/.*

- *The actual break load shows good correspondence to previous testing /1/, however, is significantly lower compared to the value given in the certificate, and requirements given in the relevant standards /2-3/.*[29]

- *Fractographic examination of sample from break load testing shows brittle fracture topography in the inner part of the fracture surface, with areas of intergranular crack propagation.* [sic]

The report also provided an assessment of various factors that might have contributed to the actual break load of 1011kN:

Ductility

> *Previous tensile tests have shown a very high yield strength to tensile strength ratio, 0.998 and 0.99 /1/. In the current test, a yield to tensile strength ratio of 0.94 was achieved, which is more as expected for the material…The low actual break load could be related to the high yield to tensile strength ratio; however it is then not clear why the current sample, with yield to tensile strength ratio of 0.94, have a similar actual break load as the previously tested reference chain… It cannot be excluded that there are large local differences between the chain link that fractured in break load testing and the link used for tensile testing.* [sic]

Residual stresses

> *During cutting of chain links for characterization of chain link material, it was noted compressive residual stresses, as the saw blade got caught in the chain link as soon as the link was cut through. The residual stresses are likely to be formed during production (forming), however has not been released during heat treatment. When compressive stresses are found on some part of the chain, it is likely to have tensile residual stresses in other parts of the chain. The residual stresses will, when not released prior to testing, influence break load, by adding to (positively or negatively) the stresses inflicted on the chain from the tensile test machine. For the tensile testing, less influence from the residual stresses is expected, due to the machined samples.*

Variation in properties

> *Testing has shown actual break load and hardness that does not correspond to the certificate values. Differences in tensile test results between different links are also seen. The mechanical properties of the chain are generally related to the heat treatment of the chain. The material has been through a quench and temper heating process. The* [high hardness and varying ductility properties] *indicate that the tempering part of the quench and temper heating process has not been successful. This is also supported by the somewhat lower hardness close to the surface compared to the higher values in the core/main part of the cross section, i.e., better tempering on the outside. The visual appearance of*

[29] This refers to the first set of DNV tests conducted under the BJC reference code.

the microstructure is as expected, a quenched and tempered microstructure, however large differences in mechanical properties can be found without a clear difference in the visual appearance of the microstructure. This indicates that there are high variations in the properties of the chain, which has not been identified by the quality control of the manufacturer. [sic]

Hydrogen embrittlement

Based on an assessment of all the three factors [presence of hydrogen, tensile stress and a susceptible material] *it is not very likely that hydrogen is a contributing cause for the low actual break load. The areas of intergranular crack growth can also be a direct result of the high strength material.*

DNV's report summarised that *all the effects believed to be contributing to the observed low actual break load are considered to be related to production and not storage of the chain. The chain samples have not been in use; hence this is not considered relevant.*

The report further recommended that FASING should *initiate actions with regard to qualification of the fabrication process, to ensure a consistent quality of lifting chain. The large variation in chain properties indicate variation in the fabrication*.

A summary of the FASING chain specification and DNV's BJC chain analysis results compared with the EN 818-2 minimum standard is shown in **Table 2**.

Hardness	Test result[30]	Comments
FASING	373 HB	= c.388 HV10 = c.40 HRC Estimated tensile strength c.1,260N/mm² (MPa)
EN 818-2	Not applicable	No requirement
DNV (BJC/1 – 5)	426 to 431 HV10 Total average values (surface/core)	= c.420 to 425 HB = c.44 to 45 HRC Total average tensile strength c.1340N/mm² (MPa) Higher than manufacturer specification
DNV (MJA/4)	406 HV10 Total average value	c.401 HB Tensile strength 1269N/mm² (MPa)

Elongation	Test result	Comments
FASING	38%	
EN 818-2	Not applicable	20% minimum standard
Test on section sample taken from DNV (BJC/1) chain link	17%	Test showed elongation of material sample not elongation of link/complete chain
Test on section sample taken from DNV (BJC/2) chain link	13.5%	Test showed elongation of material sample not elongation of link/complete chain
Test on section sample taken from DNV (MJA/4) chain link	16.5%	Test showed elongation of material sample not elongation of link/complete chain

Breaking load/force	Test result	Comments
FASING	1,480kN	
EN818-2	Not applicable	1,290kN minimum standard
DNV (BJC/2) unused sample	994kN	77% of minimum BL
DNV (BJC/3) intact starboard chain	223kN	17% of minimum BL
DNV (MJA/4)	1011kN	78.4% of minimum BL

Table 2: BJC chain specification and DNV chain analysis comparison with EN 818-2

[30] FASING used the HB method and DNV used the HV method to measure hardness. The comments column shows the approximate equivalent HB/HV and Hardness Rockwell C scale (HRC) value.

A comparison of the DNV results of the breaking force and the associated working load limits for the BJC and MJA tests is in **Table 3**.

Test piece	Breaking force (kN)	Working Load Limit (kN)	Working Load Limit (T)
BJC/2 unused	994	248.5	25.33
BJC/3 starboard	223	55.75	5.68
MJA/4 unused	1011	252.75	25.76

Table 3: Comparison of breaking test results and associated working load limits

1.10 REGULATIONS AND GUIDANCE

1.10.1 Health and safety

The Merchant Shipping and Fishing Vessels (Health and Safety at Work) Regulations 1997 (S.I. 1997/2962) laid down the framework governing health and safety on board ships. It required that shipowners and employers protected the health and safety of seafarers by adopting work process which included risk avoidance and safety training.

Further, Marine Guidance Note 587 (F) Amendment 1 The International Labour Organization Work in Fishing Convention (No.188), Health and Safety: responsibilities of fishing vessel owners, managers, skippers and fishermen provided guidance, which included:

- *A documented risk assessment is required, and safety measures put in place.*
- *For vessels over 24m, there must be documented safety procedures.*
- *All fishermen must have enough training so that they can work safely on board, including familiarization with on-board equipment and procedures.* [sic]

1.10.2 Lifting operations and equipment

MGN 332 (M+F) Amendment 1 The Merchant Shipping and Fishing Vessels (Lifting Operations and Lifting Equipment) Regulations provided shipowners and employers with general legal obligations regarding lifting operations and equipment. It included information regarding maintenance, training of operators and lifting registers. It also stated:

The majority of injuries to crew involving lifting equipment occur as a result of persons being struck, crushed or caught in moving parts and equipment. The cause is often attributed to incorrect practices or to errors of judgement. Other types of serious accident are caused by the failure of lifting equipment or single point failures of equipment.

Accidents can be avoided through careful design and selection of lifting equipment. In this respect shipowners and employers may wish to consider the use of a suitable design code, with survey and certification carried out by a competent authority. Corrosion, metal fatigue, inappropriate repairs or modifications and poor maintenance can all contribute to reduced safety margins.

MGN 619 (F) Amendment 1, The application of the lifting operations and lifting equipment regulations 2006 (LOLER)[31], provided guidance to fishing vessel operators on the application of the LOLER and PUWER regulations. It stated:

> *The fishing vessel owner and any employer of the fishermen working on board have a duty to ensure the health and safety of anyone working on their fishing vessel or affected by their undertaking – for example, anyone on the quayside when the fish is being unloaded. This includes*
>
> - *ensuring that equipment on the vessel is fit for purpose and safe to use;*
> - *having a maintenance and inspection regime to ensure that it remains in a safe condition; and*
> - *having a system to ensure that the maintenance inspection regime is being followed.*

Annex 2 of MGN 619 (F) recommended monthly work equipment inspections and an annual lifting equipment thorough examination of trawl blocks, gantries and lifting points. For derricks, it recommended a monthly interval for both the work equipment inspection and lifting equipment thorough examination.

1.10.3 Conduct of surveys

The MCA provided a leaflet for vessel owners/skippers titled *Fishing Vessel Surveys and Inspections: How to prepare for your next MCA visit*. On fishing and lifting gear, it stated:

> *PUWER[32] and LOLER regulations apply. See MGN 619, MGN 331[33] and MGN 332[34]. This affects all equipment on a fishing vessel. The legislation is risk-based legislation; there is no prescriptive way of doing this. What is reasonably expected is that:*
>
> - *All work equipment and lifting gear should be maintained in good repair and working order*
> - *All work equipment and lifting gear should be tested and examined at regular intervals and a written record maintained of all tests and examinations*

[31] To be read in conjunction with MGN 331 (M+F) Amendment 1 and MGN 332 (M+F) Amendment 1. Replaced in May 2024 with MGN 619 (F) Amendment 2: the application of the LOLER and PUWER Regulations 2006 to fishing vessels.

[32] The Merchant Shipping and Fishing Vessels (Provision and Use of Work Equipment) Regulations 2006.

[33] Marine Guidance Note 331 (M+F) The Merchant Shipping and Fishing vessels (Provision and Use of Work Equipment) Regulations 2006 Amendment 1.

[34] Marine Guidance Note 332 (M+F) The Merchant Shipping and Fishing vessels (Lifting Operations and Lifting Equipment) Regulations 2006 Amendment 1.

On winches, tackles and hoisting gear and the application of LOLER and PUWER the MCA *Instructions for the Guidance of Surveyors on Protection of the Crew* (MSIS[35] 27.9) stated:

> *9.3.10.7 Owners and skippers should be reminded that this is risk based legislation; there is no prescribed method or way of meeting the requirements. It is up to owners/skippers to demonstrate compliance. As with Risk Assessments, this is difficult to do unless written records of tests and inspections are maintained.*
>
> *9.3.10.8 …The MCA takes the view that all lifting equipment on fishing vessels is subject to conditions causing deterioration. Therefore, lifting equipment should be load tested at least 5 yearly, and thoroughly examined at least annually by a third party and monthly by a competent person*

MSIS 27. Chapter 1 Annex 17 *Fishing vessel aide-memoire – 24m and over survey (for unclassed vessels)* Doc No. MSF 5552 Revision 04/18 included a tick box item for:

> *Safety of operation of fishing gear, winches, wires, blocks, nets, lines etc (LOLER/PUWER Regs).*

1.10.4 Fishermen's Safety Guide

Published by the MCA, the Fishermen's Safety Guide was intended to help fishermen identify and assess risks and implement control measures.

The *General considerations for working and lifting equipment* asked several questions, including:

Is the equipment you work with:

- *Suitable for use and for the purpose and conditions in which it is used?*
- *Maintained in a safe condition so that health and safety is not at risk?*
- *Inspected to ensure that it is, and continues to be, safe for use? Inspections should be carried out by a competent person and a record kept until the next inspection.*

Is the lifting equipment you work with:

- *Sufficiently strong, stable and suitable for the proposed use?*
- *Positioned or installed to prevent the risk of injury? For example, from the load falling or striking people*
- *Visibly marked with any appropriate information to be taken into account for its safe use. For example, safe working loads.*

[35] Marine Survey Instructions for the Guidance of Surveyors. MSIS represent MCA policy and the applicable regulations for MCA surveyors to follow during vessel surveys.

Also:

- *Has a suitable Risk Assessment been carried out before the operation begins?*

- *Is defective equipment taken out of service immediately?*

The *Winches, haulers, cranes, ropes and lifting tackle* section noted the risk of *ropes or lifting tackle breaking under load* and included a *do not stand underneath a suspended load* control measure for crew.

1.10.5 Competent person

MGN 332 (M+F) stated that *a "competent person" might obtain the necessary knowledge through training provided by the manufacturer of equipment or by "inhouse" or "on the job" training provided within the organisation or on the vessel.* [sic]

MGN 619 (F) defined a competent person as *a person possessing the knowledge or experience necessary for the performance of the duties under these Regulations* and advised:

> *The Regulations require that a competent person carries out inspection, thorough examination and testing and determining the frequency of thorough examination. The level of competence required for each of these duties should be determined by risk assessment taking into account the complexity of the equipment. It should not be assumed that possession of a certificate of competency automatically means that person is a "competent person" for every duty under these regulations. The competent person in each case could be the skipper or a crew member or a shore-based person with the appropriate knowledge or experience. However, in respect of inspection and ILO testing, the competent person should be sufficiently independent and impartial to allow objective decisions to be made.*

1.10.6 Fishing Safety Management Code

Published in November 2018, MGN 596 (F) *Fishing Safety Management Code: Helping to improve the management of safety on Fishing Vessels* (FSM Code) assisted with compliance of the International Labour Organization Work in Fishing Convention and the associated Merchant Shipping Notice (MSN) codes of practice[36].

The FSM Code was defined as being for *the safe operation of fishing vessels and for pollution prevention as proposed by the UK fishing industry and developed by the Fishing Industry Safety Group (FISG). This code is based on* the *ISM Code 2014*[37].

On the benefits of the FSM Code, MGN 596 (F) affirmed that:

- *The FSM itself will help you keep on top of the documentation required and to ensure that when you need to take action to check equipment, service it or to carry out maintenance, the system can remind you of what is needed.*

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[36] MSN 1871 (F) – The Code of Practice for the Safety of Small Fishing Vessels of less than 15m Length Overall; MSN 1872 (F) – The Code of Safe Working Practice for the Construction and Use of Fishing Vessels of 15m Length Overall to less than 24m Registered Length; and MSN 1873 (F) – The Code of Practice for the Construction and Safe Operation of Fishing Vessels of 24m Registered Length and Over.

[37] The Merchant Shipping (International Safety Management (ISM) Code) Regulations 2014.

- *This FSM provides guidance to owners and skippers to improve the safety of their vessels, the maintenance and servicing of safety equipment that relates to the vessel and the operation of the vessel. FV owners and skippers will find that if they implement such a system it will greatly assist in complying with their statutory safety obligations.*

The FSM Code expected a safety management system to include:

1. *a safety and environmental protection policy;*

2. *instructions and procedures to ensure safe operation of vessels and protection of the environment in compliance with relevant legislation;*

3. *defined levels of authority and lines of communication between, and amongst, crew on board and, if appropriate, shore personnel;*

4. *procedures for reporting accidents and non-conformities with the provisions of legislation;*

5. *procedures to prepare for and respond to emergency situations; and*

6. *procedures for internal reviews and self-assessments.* [sic]

On vessel maintenance and equipment, the FSM Code advised the owner to:

> *…identify equipment and technical systems the sudden operational failure of which may result in hazardous situations. The safety management system should provide for specific measures aimed at promoting the reliability of such equipment or systems.*

On company verification, review and evaluation, the FSM Code advised that:

> *The Company should carry out internal self-audits on board and ashore at intervals not exceeding twelve months to verify whether safety and pollution-prevention activities comply with the safety management system.* [sic]

1.11 REFERENCE INFORMATION

1.11.1 Use of chains

The Health and Safety Executive (HSE) *Hydrogen cracking of grade T*[38] *and grade 8 chain and components Guidance Note PM39 (Third edition)* published in 2014 stated:

> *Incidents reported to the Health and Safety Executive indicate that grade T and grade 8 chain and components are still being used in corrosive environments, despite advice from manufacturers.* [sic]

[38] Also known as Grade 8 or 80 steel chain.

The guidance note's recommendations included:

> *If the regular use of lifting equipment in corrosive environments is unavoidable, a lower tensile grade should be used, e.g. grade 4 to BS EN 818-3 or BS EN 818-5[39]. Its use should be accompanied by a comprehensive risk assessment which should establish an effective inspection regime.* [sic]

Part 6 of the BS EN 818 standard provided information on acceptable interlink chain wear limits and proposed that a reduction to 90% of the nominal chain diameter *may be tolerated*.

In May 1980, a technical paper[40] analysing 32mm[41] and 35mm Grade 2 stud link welded chain failure over both grooved and ungrooved surfaces was presented at the Offshore Technology Conference (OTC).

Analysis of the stresses under different conditions highlighted their complexity: when operating on an ungrooved curved surface with a larger diameter, the chain links were lying at alternating angles to the surface; when the chain was operating over an ungrooved surface with a smaller diameter and only one or several of its links were in contact, the alternating links might lie flat and upright to the surface **(Figure 19)**. On surfaces with a very small diameter, only one chain link might be in contact.

Image courtesy of [Tension Technology International]

Chain links on grooved and ungrooved curved surfaces, with links on ungrooved surfaces lying at alternating angles to surface

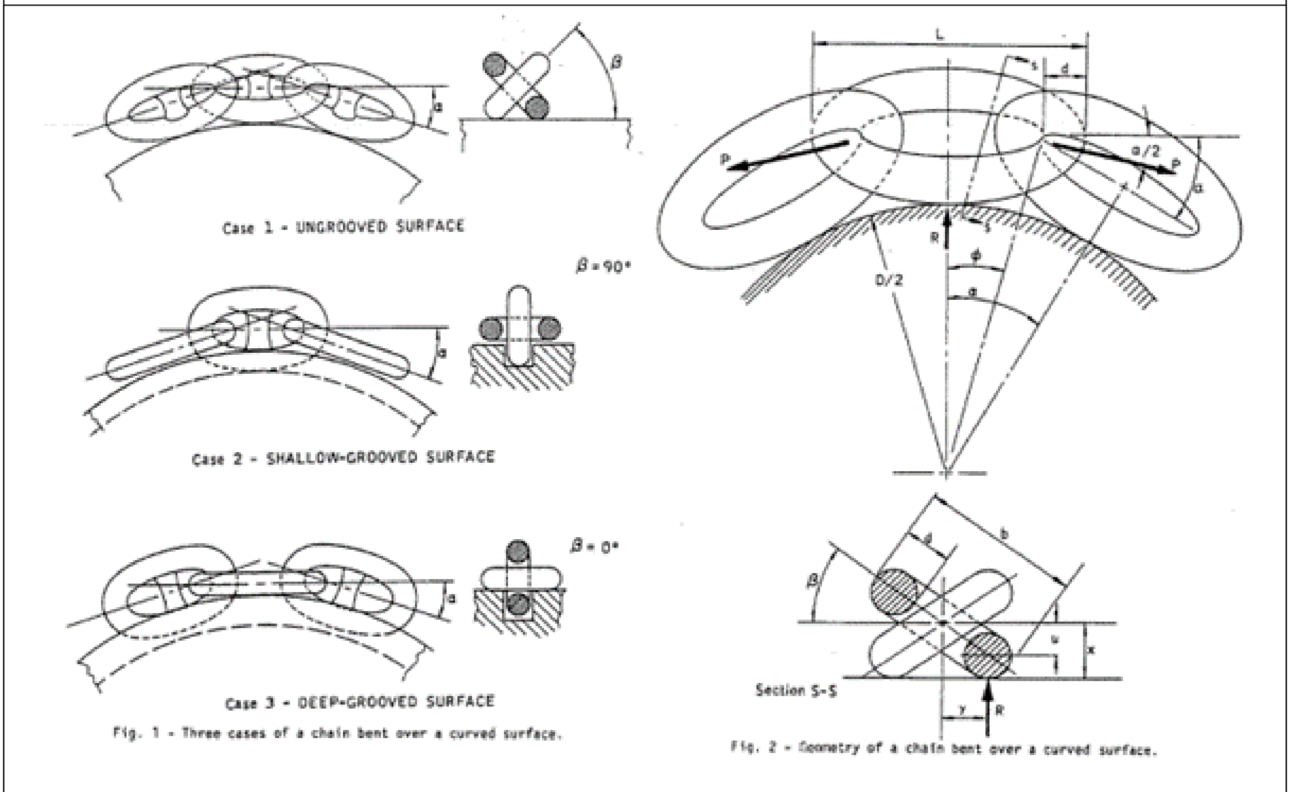

Figure 19: Extract from the Offshore Technology Conference technical paper

39 Short link chain for lifting purposes – Safety – Part 5: Chain slings – Grade 4.

40 Strength of Chain Tensioned Over a Curved Surface, John F. Flory and Steven P. Woehleke.

41 Actual break load 700kN; ultimate strength 555,000 kilopascals; 84 Hardness Rockwell B scale.

The study showed that the D/d ratio of curved surface to chain link diameters should be 7 or greater so that the maximum stresses over a curved surface did not exceed those achieved under straight line tension. The D/d ratio therefore affected strength reduction.

An example of the use of a chain over a roller was an anchor handling tug supply (AHTS) vessel, which was used to supply and relocate oil installation platforms. The platform's anchor chains had to be recovered and repositioned by the AHTS vessel to relocate an anchored platform. The anchor and chain were brought on board over the vessel's stern roller. The dimensions of a roller on a 65m, 90t bollard pull AHTS vessel could be 5m length, 2m diameter, and a 300t safe working load (SWL). The outside link length of a 300t SWL anchor chain was typically about 380mm, with a chain link diameter of about 63mm. The D/d ratio of the roller (2m) to chain (63mm) was about 31 to 1.

1.11.2 Use of lifting appliances

The Lifting Equipment Engineers Association (LEEA) promoted enhanced standards for the worldwide lifting and height safety industries through educating, influencing and enabling to embed best practice as the normal practice.

On the safe use of chain slings, the LEEA *Code of Practice for Safe Use of Lifting Equipment* (9th edition) advised that several points should be observed in addition to *any specific instructions relating to the safe use of the chain sling issued by the manufacturer*, including:

> *Chain is designed to support a load in a straight line. Therefore, chain should never be loaded when twisted or worse, knotted. Where chain is tensioned across an edge or corner, adequate packing must be used.*

The third edition[42] of the Stage Rigging Handbook, published in 2007, stated that *Side loading reduces a chain-link strength by 50%*.

Where a chain was required to change direction, for example at an anchor windlass, a device such as a chain lifter or anchor windlass gypsy was used to reduce side loading and bending stress.

1.11.3 Failure mechanisms

Hydrogen embrittlement (HE) can lead to hardening of steel alloys and stress-induced corrosion cracking (SICC) can lead to failure mechanisms, which pose an extreme risk to the integrity of alloy lifting chain such as those of Grade 8 and above.

An embrittled product fails by fracture without deforming and can be associated with strain ageing in steel, commonly known as strain hardening or work hardening, which can cause a delayed increase in strength and hardness, impact resistance and loss of ductility.

HE is defined as a metal's loss of ductility and reduction in load-bearing capability due to its absorption of hydrogen atoms or molecules, which can cause components to crack and fracture at stresses below the yield strength of the metal. Hydrogen

[42] Stage Rigging Handbook, Third Edition, Jay O Glerum. ISBN: 9780809387649

can enter and diffuse through steel even at room temperature. It can occur during various manufacturing and assembly operations or operational use, anywhere that the metal comes into contact with atomic or molecular hydrogen. Hydrogen absorption can also happen when a component is in service if the steel is exposed to acids or corrodes. HE becomes an issue when steel exceeds an ultimate tensile strength of approximately 1100N/mm².

Intergranular cracking occurs when cracks form and grow along weakened grain boundaries in a metal. If HE occurs, the hydrogen bubbles at the grain boundaries weaken the metal.

Tensile residual stress[43] within a component can be enough to cause failure of an embrittled material, particularly in an offshore environment.

In October 2020, William Hackett Ltd issued technical guidance[44] on the effects of HE. The guidance identified that the risk of HE increased as material hardness exceeded 38 HRC. Section 1 of the guidelines cautioned:

> ***Stressing the importance of Lifting Appliances being Fit for Purpose***
>
> *Whilst chain and link products may be fully compliant with the relevant International Standards, the reality is that at the same time they may be unsuitable for use in the offshore environment.* [sic]
>
> *If a high-Grade alloy steel-lifting product does not have the correct material attributes for offshore lifting applications, the risks of its failure due to hydrogen embrittlement and stress induced corrosion cracking increases because the material becomes inherently susceptible to these degradation mechanisms.* [sic]
>
> *Typically, when a product fails due to hydrogen embrittlement it is instantaneous and therefore the risks are severe.*
>
> *Meeting the specific International standards should not therefore, be seen as a guarantee that specific equipment is fit for purpose in an offshore environment. Specific environmental and performance considerations for equipment used in the offshore industry needs to be an important consideration as part of the specification and selection process.* [sic]

The guidelines advised that, as a general guide, *the lower the hardness of the steel the less its susceptibility to hydrogen embrittlement and we recommend hardness is always considered in product selection offshore*.

1.11.4 Safety bulletins

On 5 October 2020, following a number of incidents and one fatality, the MCA published *Safety Bulletin 17: Safety concern over lifting operations on fishing vessels* to remind those involved in the operation of UK fishing vessels of their responsibilities towards health and safety during lifting operations and the requirement to comply with the LOLER regulations.

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[43] An undesirable side effect of production that can also be introduced with shrinking, fitting, bending or twisting. The outcome is decreased fatigue strength and fatigue life, increased crack propagation and lower resistance to environmentally induced cracking.

[44] Website: www.williamhackett.co.uk

On 20 August 2021, the MCA published *Safety Bulletin 20: Safety concern over lifting equipment inspections on fishing vessels* to remind those involved in lifting operations of their responsibilities for lifting equipment inspections. The safety bulletin highlighted fractured chain links found during inspections as an example of faults that had been identified before failure. The bulletin defined a competent person as *someone who is appropriately trained…to undertake the requirements of the Regulations*.

1.12 SIMILAR ACCIDENTS

1.12.1 Stevenson quick-release chain fracture

In 2015, a fracture was identified in a chain link crown **(Figure 20)** for the quick-release gear on board a Stevenson beam trawler. The link was part of a 32mm short link Grade 8 chain manufactured by FASING to the EN 818-2 standard. The information was sent to the chain supplier, which provided Stevenson with feedback that included:

Image courtesy of Devon & Cornwall Police

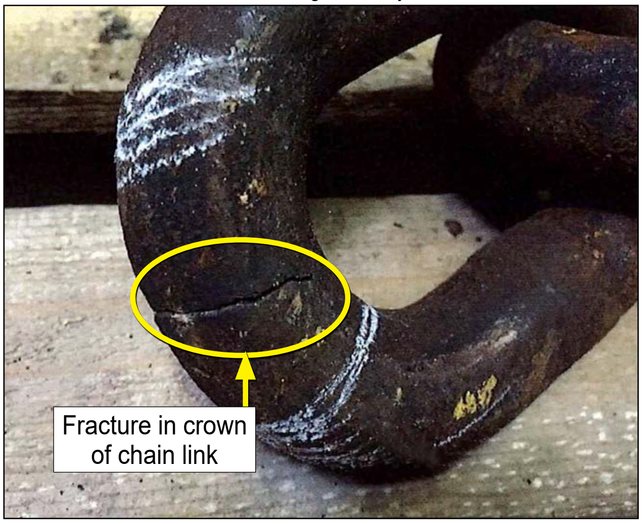


Figure 20: Previous Stevenson quick-release chain link fracture

> *For a crack to appear in the crown of the link, it would from experience show a very different type of usage issue. This crack could come from possibly uneven loading application or fatigue under duress.*
>
> *… in any non standard lifting application where the parameters of knowing what load has been put on any one link and how it is applied to a fishing vessel/net chain is most difficult to assess.* [sic]
>
> *The people who I know have to use chain in a use that is outside the normal have grown to assess the product after almost each use to check for any stress cracks due to the shock loading and have to replace products very regularly to avoid a full crack appear.* [sic]
>
> *The problem is a chain is not designed for that type of impact so therefore any chain manufacturer does not class it as an acceptable complaint.*
>
> *If the material of batch was ever found to be defective they would have to do an international recall in line with the ISO norms and the Homologated manufacturers formal requirements. I can confirm that they have not issued any recall to us in any of the chains we have bought to date.* [sic]
>
> *From the batches of Grade 8 chains we have had from them over the years, I have only ever had one reported link issue and that broke at an area where their was continual abrasion and shock loading. That link of chain was used in a towing application, which would be well outside the norms of EN lifting usage..* [sic]

The failed link was not analysed to determine the cause of the cracks.

1.12.2 *Van Dijck* – quick-release chain connection failure

In January 2017, two crew members working on a beam trawler were injured when they were struck by the vessel's falling beam and associated gear.

The accident occurred while the port trawl beam crew were stowing the trawl gear after the vessel's last tow. The safety chains were connected at either end of the beam and the beam was raised until the chains were taut. Three crew members climbed on board the conveyor belt to tie a strop around the net to bring it inboard and, as two of them stepped off the belt, the beam, bridle chains and pulley block fell onto the conveyor belt and deck. Two crew members were struck by the falling parts and were eventually taken to hospital, where they were treated for broken bones.

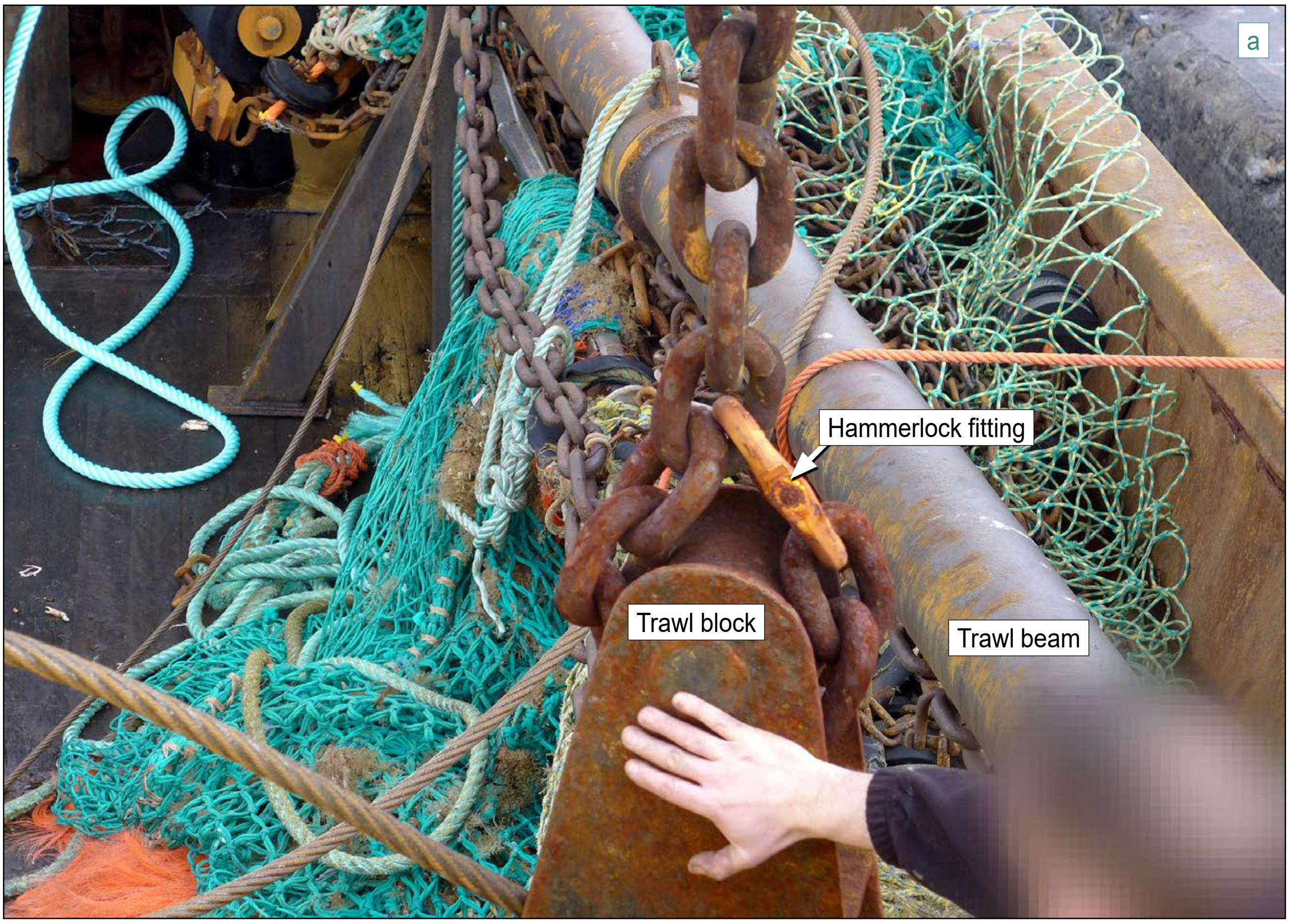
The port side quick-release arrangement included a steel wire rope connected to a short length of steel chain. The chain supported the trawl block by passing it over a fixed pin in the horse's head at the top of the derrick and joining it back onto the chain using a hammerlock fitting **(Figure 21)**. The chain links connected by the hammerlock were twisted and not in the same plane. This resulted in a twisting force on the links and led to the failure of one of the links.

1.12.3 *Llanddwyn Island* – parting of hawser

On 1 March 2010, a deckhand on board the UK registered workboat *Llanddwyn Island* was fatally struck by a towing hawser when it parted during a towing operation (MAIB report 14/2010[45]). The workboat was moving a dredger in Roscoff, France and the deckhand had moved into the snapback zone of the hawser while it was under tension. The failed element was identified as a Grade 8 chain connected to the stern of the dredger. The chain had not been provided by the vessel's owner and its use in the hawser was not in line with best practice.

The parted steel chain was recovered and sent to Tension Technology International Ltd for inspection and testing. The test report identified that, around the pad eye at the chain connection, there was a 25% reduction in strength of the doubling up of the chain **(Figure 22)** compared to a straight chain length. This had significantly reduced the chain's breaking load and ability to absorb energy.

[45] https://www.gov.uk/maib-reports/parting-of-hawser-during-towing-operation-on-workboat-llanddwyn-island-at-roscoff-france-with-loss-of-1-life



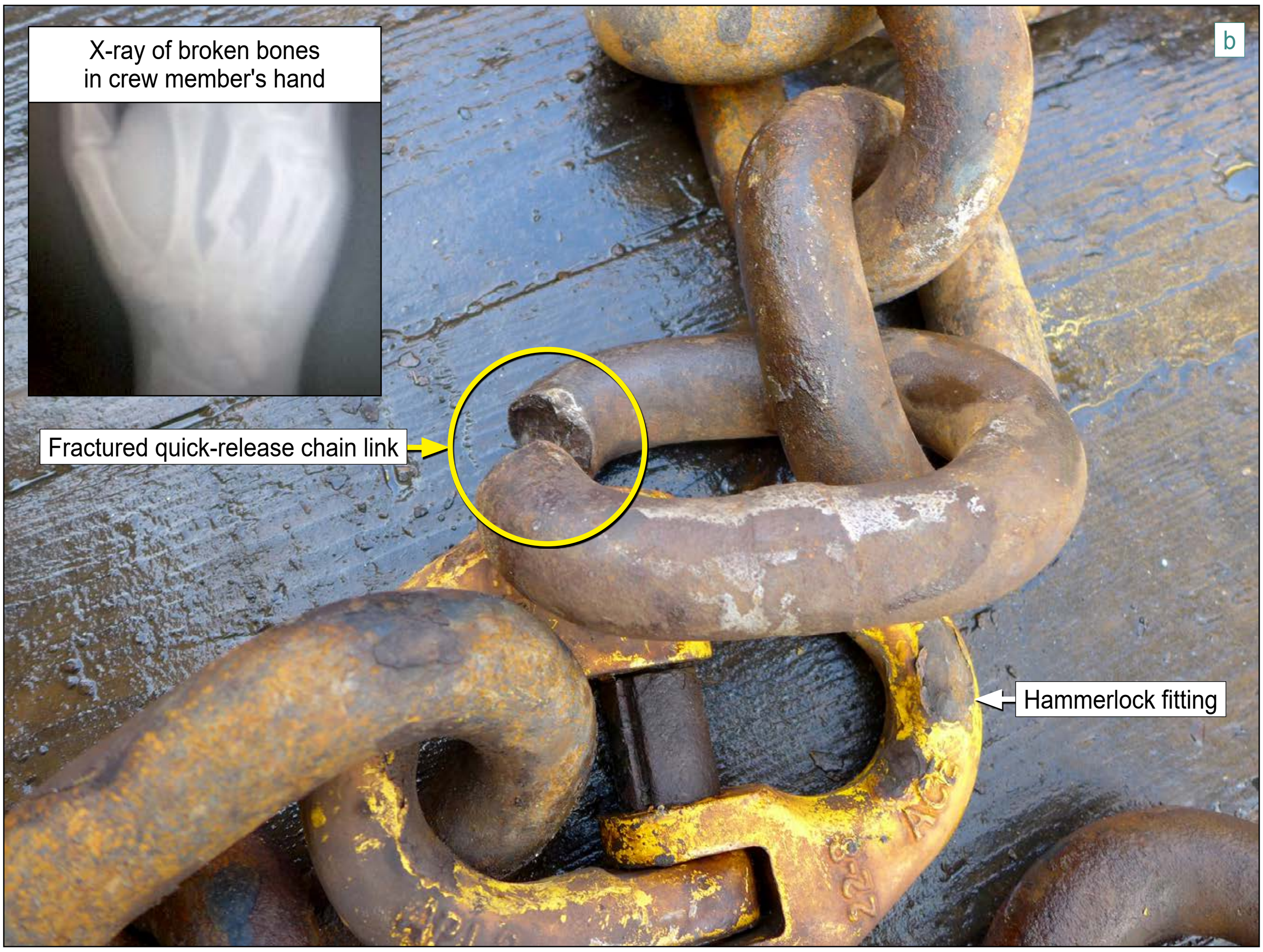


Figure 21: The fallen port side gear (a), quick-release chain connection failure (b) and (inset) X-ray of the crew member's broken hand

Image courtesy of [Tension Technology International]

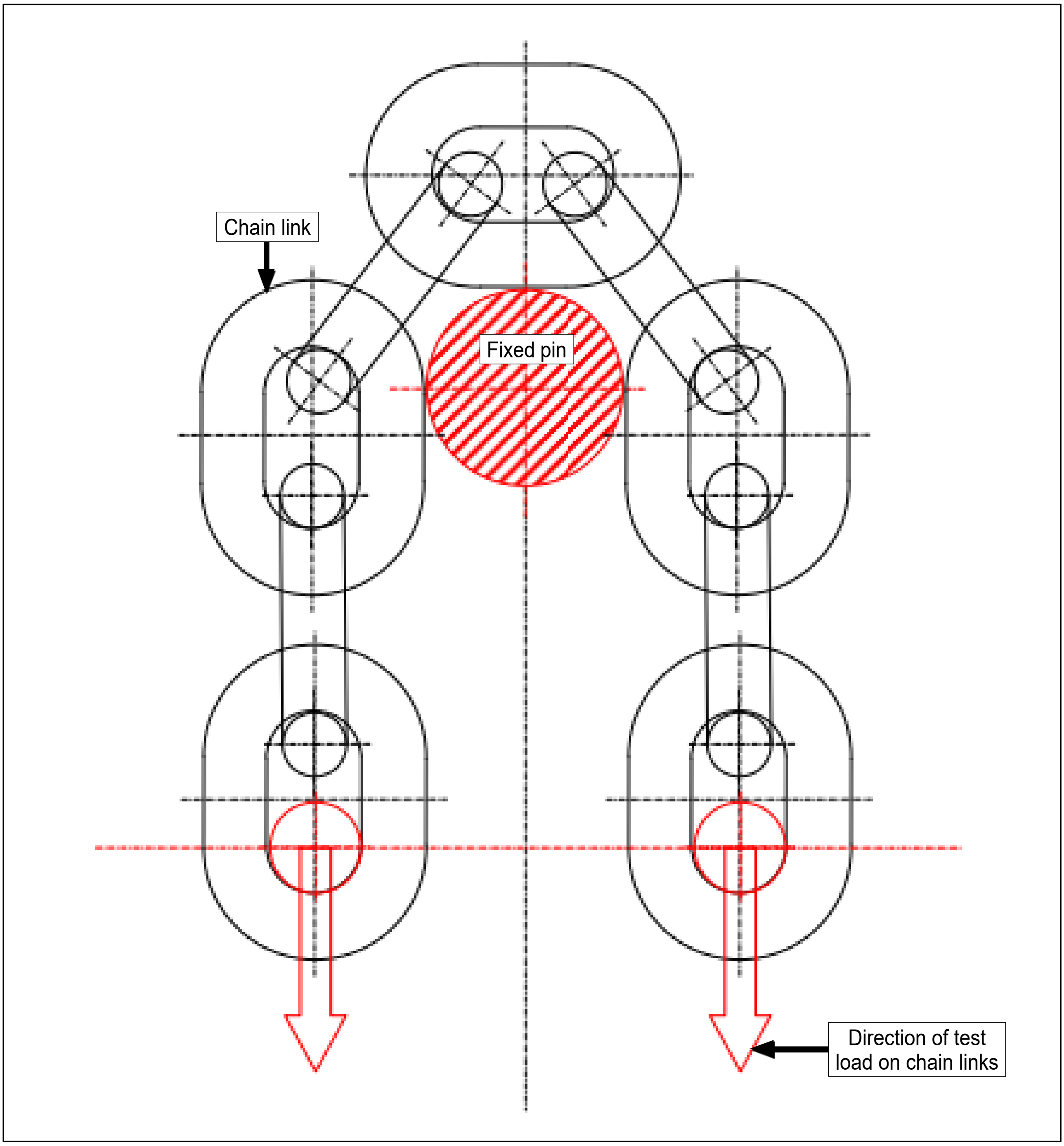


Figure 22: Extract from the *Llanddwyn Island* chain failure test report

1.12.4 *Honeybourne III* – fishing gear failure

At about 2345 on 6 October 2023, the lifting arrangement for the dredging gear that was suspended from the raised port derrick on the UK registered scallop dredger *Honeybourne III* (PD905) fell to the deck without warning. The gear struck a deckhand working below, causing serious head injuries.

The crew of *Honeybourne III* alerted His Majesty's Coastguard and administered first aid to the unconscious deckhand. The coastguard tasked a search and rescue helicopter and a Royal National Lifeboat Institution lifeboat to assist, but the deckhand was declared deceased by the attending helicopter paramedic.

The ongoing MAIB investigation has found that a section of chain in the port dredging gear quick-release assembly failed as the gear was being retrieved. A 32mm chain link, which was led over a static steel pin at the derrick head, parted and allowed the towing block, monkey face block and associated gear to fall to the deck below. On 7 February 2024, the MAIB issued Safety Bulletin 1/2024 **(Annex C)** with a recommendation made to the MCA.

1.12.5 *Olivia Jean* – parted trawl wire

On 10 October 2009, a fisherman was injured by a falling bridle chain on board the fishing vessel *Olivia Jean* when the port side main trawl wire parted as the trawl beam was lifted inboard (MAIB report 10/2010[46]). The fisherman sustained chest injuries and was airlifted to hospital.

The safety issues identified in the investigation included poorly maintained fishing equipment and no evidence of systematic planned maintenance. Documentation, records and evidence of risk assessment were also missing.

[46] https://www.gov.uk/maib-reports/parting-of-trawl-wire-on-converted-scallop-dredger-olivia-jean-off-beachy-head-england-with-1-person-injured

SECTION 2 – ANALYSIS

2.1 AIM

The purpose of the analysis is to determine the contributory causes and circumstances of the accident as a basis for making recommendations to prevent similar accidents occurring in the future.

2.2 OVERVIEW

Deckhand 1 died and another deckhand was injured because the heavy port trawl beam fell on them as they worked under it to repair the steel chain mat. The weight of the trawl gear had been supported solely from the derrick by the quick-release gear, which included a length of chain. A chain link fractured where the chain passed over the derrick head fixed pin, allowing the port trawl gear to fall to the deck. The analysis considers working under suspended loads, the chain link failure and the inspection and maintenance of lifting equipment.

2.3 SAFETY

2.3.1 Working under a suspended load

Cornishman's deckhands were working under suspended equipment (effectively a suspended load) while repairing the steel chain mat. This working practice put them at risk of harm in the event of a failure and was discouraged in guidance such as the Fishermen's Safety Guide. The suspended loads were considerable and were supported by gear that included potential single points of failure. As seen in the quick-release chain failure on board a beam trawler in January 2017, and in the fatal *Honeybourne III* accident, the normal operation of the fishing gear similarly put the crew at risk.

The risks of working with suspended loads or a load falling can be mitigated by safe systems of work, including documented risk assessments, and having appropriate precautions in place. Often the most effective mitigation is to change the working method so that working near the suspended load is not required.

2.3.2 Risk assessment

The Merchant Shipping and Fishing Vessels (Health and Safety at Work) Regulations 1997 and MGN 587 required that on board risks are assessed and managed.

Cornishman had risk assessments that included mitigations. The *Handling on Deck* (RA-009) risk assessment required the fishing gear *to be stropped in poor weather conditions, and whenever it is lifted inboard*, and instructed the crew to *stand well back*. When the deckhands were repairing the chain mat the trawl beam was not secured from above to prevent it falling if a component failed, and the process involved manual handling that placed the deckhands in the impact zone should the load fall.

The *Maintenance Work* (RA-007) risk assessment stated mitigations for faulty lifting equipment were testing to *meet the required standards*, and the equipment *will be recorded in a register*. Although rudimentary inspection of the quick-release arrangement was carried out, it was not tested. Since the quick-release was an integral part of the trawl beam arrangement it is possible that *Cornishman*'s crew did not identify this as *lifting equipment* and RA-007 was not used.

It is apparent that the onboard risk assessments applicable to maintenance of the chain mat were not followed and their stated risk mitigations were probably unrealistic. Consequently, risk assessments RA-007 and RA-009 were insufficiently effective and did not offer the required protection to help keep the crew safe at work.

2.3.3 Crew training

Although *Cornishman*'s crew had many years of fishing experience, the Seafish records showed that none had completed all the mandatory Seafish training courses. Mandatory training included basic health and safety and safety awareness and risk assessment (required for fishermen with more than 2 years' experience).

It is possible the lack of some safety-related training affected the crew's ability to assess and implement their on board risk assessments.

2.3.4 Management of safety

Stevenson had a safety management manual that stated: *Common procedures and policies are issued to each vessel in their safety folder in compliance with the Fishing SMS Code*.

Cornishman's safety folder contained generic policy statements but lacked specific procedures such as the management of LOLER (which was a stated requirement in the company's safety management manual). The risk assessments, maintenance and inspection processes and procedures for the trawl quick-release gear were rudimentary at best. The on board records of maintenance were basic with no detail about work undertaken, and no records of the condition of equipment. Given that a chain crack had previously been identified on a Stevenson beam trawler quick-release gear, it is apparent that lessons were not learned from that near miss and did not result in a change of maintenance, inspections, or risk assessment. Although the company had employed a health and safety manager, the safe operation of the vessel was delegated to the skipper.

Stevenson's safety management manual contained elements of the FSM Code, such as policy statements, but specific safety procedures were either missing or lacked detail. The MCA's post-accident detention notice stated that there was *No evidence of Safe Operating Procedures for all reasonably foreseeable circumstances*. [sic]

At the time of the accident, the management of safety on board *Cornishman* was not fully effective. The implementation of the FSM Code and development of a comprehensive safety management system would likely improve the safety of the vessel's crew.

2.4 QUICK-RELEASE GEAR

2.4.1 Arrangement

The quick-release gear on board *Cornishman* passed a 10-link length of 32mm Grade 8 steel chain over a 150mm diameter fixed steel pin.

Chains are primarily intended to be loaded in a point-to-point straight line. When a change in direction is required, a chain lifter or anchor windlass gypsy could be used. Also, chains are sometimes led over large rollers, for example on AHTS vessels with large D/d ratios. Both methods reduce side loads acting on each chain link.

The D/d ratio of pin to chain link on *Cornishman* was nominally about 4.68 to 1 (150mm/32mm). The in-service movement of the chain over the pin had caused wear to individual links and grooving in the pin, which reduced the D/d ratio to between 3.0 and 3.5 to 1. This was considerably lower than the minimum ratio of 7 to 1 defined in the OTC paper to achieve approximate parity in terms of chain break load strength compared with the chain's straight tensile break load.

Previous accidents such as the quick-release gear failure on board the beam trawler *Van Dijck* highlight the inherent risk of loading a chain around a fixed pin. In the fatal *Llanddwyn Island* accident, when a chain failed where it was doubled around a pad eye, testing showed a 25% reduction in strength. Also, the LEEA's Stage Rigging Handbook stated that *side loading reduces a chain-link strength by 50%*. It is therefore apparent that loading a chain over relatively small diameters leads to a reduction in breaking strength compared to a straight pull and makes it challenging to assign a WLL for trawl gear that includes a chain over pin quick-release arrangement.

The design of *Cornishman*'s chain over fixed pin arrangement of the quick-release gear resulted in the side loading and bending of individual chain links and heavy wear of the pin, both of which made the chain susceptible to failure.

2.4.2 Chain usage and material properties

Use of Grade 8 chain

A Grade 8 short link chain was used in the quick-release gear on board *Cornishman* and was commonly used for a variety of lifting applications across the fishing sector.

Reference material, such as the 2014 HSE guidance, recommended the use of lower tensile (Grade 4, for example) chains in the harsh corrosive environments experienced offshore. This usage was to be subject to a risk assessment and frequent inspection. Following this guidance, *Cornishman*'s chain supplier signposted customers to user information that included warnings about the use of Grade 8 chain in offshore applications and where a chain was not being used in a straight line.

The chain supplier's feedback to Stevenson about the previous quick-release gear chain link crack on one of its beam trawlers suggested that inappropriate use had contributed to the formation of the crack.

Since Grade 8 chains were unsuitable for use in corrosive environments the application of a Grade 8 chain in the quick-release gear was inappropriate and increased the risk of material degradation and failure.

Hardness

The EN818-2 standard did not include specifications for maximum hardness or yield tensile strength ratio to ensure ductility. *Cornishman*'s Grade 8 chain hardness (when new, as advised by the chain supplier) was 373 HB (40 HRC). Testing of the unused section of the same batch of chain that failed in the accident showed the hardness to be considerably higher at 401 HB The testing also showed that both the port and starboard chain hardness had increased while in service to between 420 HB and 425 HB. Lifting industry guidance advised that the risk of failure because of HE and SICC increased at material hardness above 353 HB (38 HRC) and an ultimate tensile strength of approximately 1100N/mm². It is highly likely that the increase in hardness can be attributed to environmental factors caused by using the chain in a highly corrosive environment.

A detailed material specification requested by and provided to the customer before purchase might have determined that the quick-release lifting chain as supplied was unsuitable for its intended use. Although the Grade 8 chain when new was likely harder than expected by the manufacturer and its use was undesirable in a corrosive environment, its hardness did not contravene EN818-2 since this was not a specified criteria.

Elongation

The tensile tests carried out by DNV on material samples cut from the used and unused chain links all showed that elongation of the material was possible. However, the dimensional checks of the links from the failed port side chain showed no evidence of permanent elongation. Although the actual loading of the port side chain while in service and at the time of failure is not known, it is possible that the chain's elongation properties did not meet the minimum in the EN818-2 standard (20%) or that claimed by the manufacturer (38%). A greater propensity to elongation reduces the likelihood of sudden failure due to fracture. Evidence of permanent elongation can provide a visual indication that the chain has been subjected to excessive loads before failure occurs.

Breaking load and ductility

When tested, neither the used starboard chain (BJC/3) nor unused chains (BJC/2 and MJA/4) met the EN818-2 minimum breaking load requirement of 1290kN and were all considerably lower than the manufacturer's quoted 1,480kN. The low actual break load was attributed to the low ductility and yield tensile strength ratio, not a low tensile strength. The in-use starboard chain had a breaking load of 223kN (equivalent to a WLL of just 55.75kN) when tested and was therefore also at high risk of failure while in operation.

The manufacturer was unable to identify the reasons for the reduced breaking load values of the used and unused sections of the chains. The storage conditions for the unused chain were considered a possibility for degradation due to corrosion;

however, this was unlikely for MJA/4 as this chain had reportedly been dry stored. Some strength loss could occur over time after manufacture and that was mitigated by applying a factor of safety to the chain.

It is evident that the Grade 8 chains used on *Cornishman* did not meet the required standard due to a low breaking load value, which apparently worsened while in service. However, DNV concluded that the low actual break load was not considered a direct cause of the failure of *Cornishman*'s quick-release chain.

Heat treatment

Post-manufacture heat treatment processes such as tempering were intended to relieve material stresses and reduce hardness, improving the ductility of the finished chain.

During preparations for the testing of the unused section of the chain (MJA/4), cutting of the links indicated the presence of residual stress. The testing of all samples also revealed high hardness values, possibly due to the 1.25% Mn content of the parent round steel bar material as the presence of Mn can impede tempering processes.

The high hardness values, low ductility and low break load strength indicated that the post fabrication tempering process of the chain was unsuccessful.

Chain failure

The port quick-release gear chain failed at link six, which was tensioned adjacent to the fixed pin. The chain when new had a hardness value in excess of the recommended value of 350 HV10 for use in a corrosive environment, making it susceptible to HE. The declared hydrogen content of the chain material when new was within manufacturer's tolerance and the post-manufacturing cleaning method was shot blasting, rather than acid solutions, and heat treatment. It is therefore likely that the hydrogen formation was due to contact with salt water in the harsh operating environment.

The chain's material hardness apparently increased in service and cracks started to form. It is likely that the load of the trawl beam pulled up against the safety chains acted on the chain links bent around the fixed pin with a low D/d ratio. This introduced a high bending stress, which coincided with an existing crack. The crack fractured, which was followed by a second fracture (likely immediately) in way of another crack, and the lower part of the chain detached, causing the connected equipment to fall to the deck and strike the deckhands.

Alternative systems

Cornishman's quick-release arrangement had its roots in the Netherlands fishing industry that was introduced to the UK when Dutch fishing vessels were transferred to the UK flag. Vessel operators are required to comply with LOLER to ensure lifting equipment is fit for purpose and safe to use. Yet the chain over fixed pin design resulted in wear, complex loading and the risk of failure. The continued operation of these older quick-release designs therefore perpetuated the risk of injuries and fatalities due to a trawl beam falling without warning, as also tragically happened on board *Honeybourne III*.

Since the alternative quick-release designs, such as the Van Damme, do not use a chain over fixed pin, the chain link failure mode is removed. It is likely that the use of alternative quick-release systems compared to the chain over fixed pin arrangement would reduce the risk of failure.

2.5 MAINTENANCE REGIME

2.5.1 Operating conditions

Fishing vessels generally operate in a harsh environment; the salt-laden atmosphere causes corrosion to ferrous components and exposes them to HE. *Cornishman*'s derricks were lowered during fishing operations and the quick-release arrangement was often immersed in sea water as the vessel rolled from side to side. It was also subjected to fluctuating loads as the trawl gear was dragged along the seabed, including shock loads when the gear became snagged on an obstruction. As noted by the chain supplier in its report after the Stevenson quick-release chain link fracture in 2015, the dynamic environment meant that, unlike a static loading condition, it was difficult to assess either the loading or fatigue life of the components. Consequently, regular inspection and maintenance was required to mitigate against unexpected failure.

2.5.2 Routine inspection and maintenance

MGN 619 (F) required that lifting equipment was inspected every 12 months; Annex 2 required monthly examinations of derricks. The MCA's guidance to surveyors (MSIS 27) stated that lifting equipment should be load tested at least 5-yearly and thoroughly examined at least annually by a *third party*, but these requirements were not stated in the MGNs.

Since access to the quick-release gear was restricted when raised, *Cornishman*'s derricks were lowered when in port so that the chains and fixed gear could be inspected from the quayside. The chain and wire combinations were normally changed on a time interval basis of approximately one year. The selection of this time interval was probably based on previous experience and had no correlation as to the amount of work and stress the wire-chain combination had experienced while in service. The port side chain failed after just over 10 months in service.

Both port and starboard quick-release gear chains were corroded and worn with corresponding grooving to the fixed pins. The chains also had numerous cracks, which would have been invisible until after cleaning had been carried out.

It is therefore evident that the inspection regime was not informing the decision to change the chains and repair the wear to the fixed pins. *Cornishman*'s onboard record of inspection of lifting equipment was limited. The post-accident findings of the MCA, which led to the detention of many of the company's vessels, indicate that there were deficiencies to other lifting equipment that were also missed by the inspection and maintenance routine.

Previous accidents, such as that on *Olivia Jean*, show that poorly maintained fishing gear can result in an accident. Similarly, with *Cornishman*'s fatal accident the maintenance and inspection regime did not identify faults in the quick-release gear and instigate repairs, which therefore left the gear at risk of failure.

2.5.3 Competent person

The role of the competent person regarding lifting equipment was to ensure effective inspections and examinations were carried out to help assure that equipment was fit for purpose and the risk of failures reduced.

Stevenson had delegated the responsibilities of the competent person to *Cornishman*'s skipper, who in turn delegated lifting equipment inspections to crew members. However, MGN 619 (F) stated that *It should not be assumed that possession of a certificate of competency automatically means that person is a "competent person" for every duty under these regulations*. It is likely that the skipper was delegated the role of competent person based solely on their maritime experience and therefore had *on the job training* as stated in MGN 322 (M+F).

As seen from the post-accident testing of *Cornishman*'s quick-release gear chains, the failure mechanism of chains can be complex. The inspection and assessment of *Cornishman*'s quick-release gear's condition required an understanding of chain loading, the effects of corrosion, and wear limits that none of the crew possessed. Furthermore, it was probably unrealistic to expect any crew member to be sufficiently independent or impartial enough to identify and condemn equipment that might delay the vessel sailing and incur additional costs. However, this was required by MGN 619 (F) and other industry guidance.

On *Cornishman*, the competent person did not possess the requisite knowledge to carry out effective inspections of the quick-release gear, which led to the defective chains remaining in service.

2.5.4 Training

The MCA's *Safety Bulletin 20* issued after the *Cornishman* fatal accident stated a competent person was *someone who is appropriately trained*. MGN 332 (M+F) stated that a competent person might acquire the knowledge or experience to perform the duties required by the regulation via equipment manufacturer or in-house/on the job training.

The *Cornishman* accident and others suggest that the training of lifting equipment competent persons is ineffective and industry guidance lacks clarity as to the knowledge and competency requirements need to carry out effective monthly and yearly inspections and examinations.

2.5.5 Survey

Cornishman was last surveyed before the accident in October 2020 and the survey aide-mémoire included a tick box pertaining to *Safety of operation of fishing gear, winches, wires, blocks net, lines etc. (LOLER & PUWER)*.

MCA surveyors were not required to be trained in the inspection of lifting gear. Guidance to surveyors regarding lifting gear, such as MSIS27.9, provided little detail about the survey requirements, though it did allude to checking maintenance records. It is therefore possible that there is uncertainty about what surveyors are required to check at time of survey.

The MCA's post-accident inspection of *Cornishman* and other company vessels resulted in vessel detentions; some of the defects were related to lifting gear. This, combined with the similar accidents due to failure of chain over pin lifting arrangements, indicates that MCA oversight of compliance with LOLER, as examined through survey, is insufficiently effective.

It is likely that additional guidance on the inspection aide-mémoire and training for MCA surveyors on the acceptance of LOLER-related equipment would be beneficial.

SECTION 3 – CONCLUSIONS

3.1 SAFETY ISSUES DIRECTLY CONTRIBUTING TO THE ACCIDENT THAT HAVE BEEN ADDRESSED OR RESULTED IN RECOMMENDATIONS

1. The deckhand died when he was struck by the port trawl beam falling on him as he repaired the trawl chain mat when a chain link from the quick-release gear fractured. [2.2]

2. The risk assessments applicable to the repair were not followed and the stated risk mitigations were ineffective. Consequently, the crew were at risk from a failure while working under a suspended load. [2.3.1, 2.3.2]

3. At the time of the accident, the management of safety on board *Cornishman* was not fully effective. The implementation of the FSM Code and development of a comprehensive safety management system would likely improve the safety of the vessel's crew. [2.3.4]

4. The design of the chain over fixed pin arrangement of the quick-release gear resulted in side loading and bending of individual chain links and heavy wear of the pin, both of which made the chain susceptible to failure. [2.4.1]

5. Since Grade 8 chains were unsuitable for use in corrosive environments the application of a Grade 8 chain in the quick-release gear was inappropriate and increased the risk of material degradation and failure. [2.4.2]

6. The Grade 8 chain supplied did not meet the required standard for minimum breaking strain, but this was not considered a direct cause of the port side chain's failure. [2.4.2]

7. The Grade 8 chain's high hardness values, apparent lack of elongation, low ductility and low break load strength indicated that the post-manufacture tempering process was unsuccessful. [2.4.2]

8. Hydrogen embrittlement caused by operating the hard chain, in a salt water environment caused cracks to form. The bending stress from loading the chain over the fixed pin coincided with an existing crack, and a chain link fractured in two positions. [2.4.2]

9. It is likely that the use of an alternative quick-release system as opposed to a chain over fixed pin arranged would reduce the risk of component failure and the trawl beam dropping. [2.4.2]

10. The chain was used in a corrosive environment, and it was difficult to assess its loading and fatigue life. Regular inspection and maintenance was required to mitigate against unexpected failure. [2.5.1]

11. The maintenance and inspection regime did not identify faults and degradation in the quick-release gear and did not instigate repairs, which therefore left it at risk of failure. [2.5.2]

12. *Cornishman*'s competent person did not possess the requisite knowledge to carry out an effective inspection of the quick-release gear, which led to the defective chains remaining in service. [2.5.3]

13. The *Cornishman* accident and others suggest that the training of lifting equipment competent persons is ineffective, and industry guidance lacks clarity on the knowledge and competency requirements needed to carry out effective monthly and yearly inspections and examinations. [2.5.4]

3.2 SAFETY ISSUES NOT DIRECTLY CONTRIBUTING TO THE ACCIDENT THAT HAVE BEEN ADDRESSED OR RESULTED IN RECOMMENDATIONS

1. It is possible the lack of some safety-related training affected the crew's ability to assess and implement their onboard risk assessments. [2.3.3]

2. It is likely that additional guidance on the inspection aide-mémoire and training for MCA surveyors on the acceptance of LOLER-related equipment would be beneficial. [2.5.5]

SECTION 4 – ACTION TAKEN

4.1 MAIB ACTIONS

The **MAIB** has:

- Issued a safety bulletin **(Annex D)** urging owners and operators of beam and scallop trawlers to inspect their vessels' quick-release arrangements and to make any necessary changes to the equipment or its operation to ensure the safety of crew working on deck.

- Issued a safety flyer to the fishing industry **(Annex E)** to highlight the effect of side loading on a chain link over a fixed pin design and how to make safety improvements to minimise the opportunity for sudden failure.

4.2 ACTIONS TAKEN BY OTHER ORGANISATIONS

The **Maritime and Coastguard Agency** has undertaken a focused inspection campaign of scallop dredgers and beam trawlers to assess the condition of quick-release gear.

W. Stevenson & Sons Limited has:

- Employed an external specialist marine consultant to advise on the measures required to ensure compliance with the lifting regulations.

- Replaced the existing quick-release arrangement on its fleet of vessels with a Van Damme system that does not involve using chains over fixed pins.

- Introduced vessel-specific lifting plans across its fleet to clarify the requirements for lifting equipment inspections and thorough examinations.

SECTION 5 – RECOMMENDATIONS

The **Maritime and Coastguard Agency** is recommended to:

2025/114 Update The Merchant Shipping and Fishing Vessels (Lifting Operations and Lifting Equipment) Regulations 2006 guidance to state the training requirements and accreditation of competent persons carrying out lifting equipment inspections, including:

- monthly and yearly company inspections
- annual third party inspections
- 5-yearly load testing

2025/115 Update its training and guidance to surveyors to improve their ability to check compliance with The Merchant Shipping and Fishing Vessels (Lifting Operations and Lifting Equipment) Regulations 2006 during surveys.

W. Stevenson & Sons Limited is recommended to:

2025/116 Ensure the maintenance of lifting equipment, including thorough examinations and inspections by competent and independent personnel, is suitable and sufficient to control the risks of failure and complies with The Merchant Shipping and Fishing Vessels (Lifting Operations and Lifting Equipment) Regulations 2006.

2025/117 Review and update its risk assessments to ensure that all loads are properly secured from falling while work is undertaken on or in proximity to suspended heavy equipment.

2025/118 Before purchase, confirm with chain suppliers and/or chain manufacturers that the selected chains are suitable for their intended use.

2025/119 Ensure that its crews hold complete and up-to-date mandatory training qualifications in compliance with MCA Marine Guidance Note 411 (M+F) *Training and Certification Requirements for the Crew of Fishing Vessels and their Applicability to Small Commercial Vessels and Large Yachts*.

2025/120 Implement the Fishing Safety Management Code for its fleet and develop an effective safety management system.

Capital Group FASING S.A., Poland is recommended to:

2025/121 Review and amend as necessary its chain quenching and tempering processes to ensure the resulting hardness levels are consistent throughout the steel and do not make the chain susceptible to embrittlement.

2025/122 Offer its customers hardness test certificates for the lifting chains it manufactures to assist them to select the most appropriate chain for the intended purpose.

Safety recommendations shall in no case create a presumption of blame or liability

Marine Accident Report

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