s. 17, s. 21, s. 22

Page redacted

s. 17, s. 21

Page redacted

Rasmussen, Shauna

From: Adams, James W
Sent: February 02, 2022 3:22 PM
To: David Mietla - 3GA Marine Ltd. (dmietla@3gamarine.com)
Cc: Cennon, Quentin; Jones, Gary
Subject: BSC Cables - Option #2 - 1.5 dia 9x40
Attachments: 2022022 - BC Ferries 1.625 6x25 FS guide rope replacements.pdf; 2022022A - BC Ferries 1.50 9x40 Constructex emergency replacement.pdf; Constructex.jpg

Hi David,

See attached and below for option #2. The current in-service cable, 1-5/8" dia, 6x25 FS, is also attached for reference.

Thanks,

James Adams, P.Eng.
Project Manager, Terminal Construction ss. 15, 19
British Columbia Ferry Services Inc.
T: 250-978-1317 [redacted] **F:** 250-361-4922
james.adams@bcferries.com
bcferries.com

s. 21, s. 17

[redacted]

s. 21, s. 17

s. 21, s. 17

Page redacted

Rasmussen, Shauna

From: Adams, James W
Sent: February 02, 2022 3:23 PM
To: David Mietla - 3GA Marine Ltd. (dmietla@3gamarine.com)
Cc: Cennon, Quentin; Jones, Gary
Subject: BSC Cables - Option #3
Attachments: 20220202132349827.pdf

Hi David,

See attached for option #3.

Thanks,

James

James Adams, P.Eng.
Project Manager, Terminal Construction
British Columbia Ferry Services Inc. ss. 15, 19
T: 250-978-1317 [redacted] F: 250-361-4922 james.adams@bcferries.com bcferries.com

-----Original Message-----
From: Jones, Gary <Gary.Jones@bcferries.com>
Sent: February 02, 2022 2:23 PM
To: Adams, James W <James.Adams@bcferries.com>
Subject: FW: [EXTERNAL] FW: Baynes Sound ferry

One wire rope option

Gary Jones
Little River Terminal Maintenance
British Columbia Ferry Services Inc.
1300 Ellenor Road Comox, BC V9M 4B3
Gary.jones@bcferries.com
Office: 250-339-2229
Phone: 250-890-7851 ss. 15, 19
[redacted]

-----Original Message-----
From: Kevin Clarke <k.clarke@wribc.com>
Sent: February 02,2022 1:29 PM
To: Jones, Gary <Gary.Jones@bcferries.com>
Cc: r.cote@wribc.com
Subject: [EXTERNAL] FW: Baynes Sound ferry

CAUTION: This email originated from outside of BC Ferries. Do not click links or open attachments unless you recognize the sender and know the content is safe.

s. 21, s. 17

Page redacted

Rasmussen, Shauna

From: Adams, James W
Sent: February 03, 2022 11:57 AM
To: David Mietla
Cc: Cennon, Quentin; Paterson, Bruce; Shaun Wallis
Subject: RE: BSC Cable Review

Hi David,

Thanks for the estimate. We'll prepare a Services Contract. Can you provide your rate sheet and insurance?

Quentin will send you a PO; work will be carried on a T&M basis to an upset limit of $10k.

See answers to your questions below in red.

Thanks,

James Adams, P.Eng.
Project Manager, Terminal Construction
British Columbia Ferry Services Inc.
T: 250-978-1317 [redacted] **F:** 250-361-4922
james.adams@bcferries.com
bcferries.com

ss. 15, 19

s. 13

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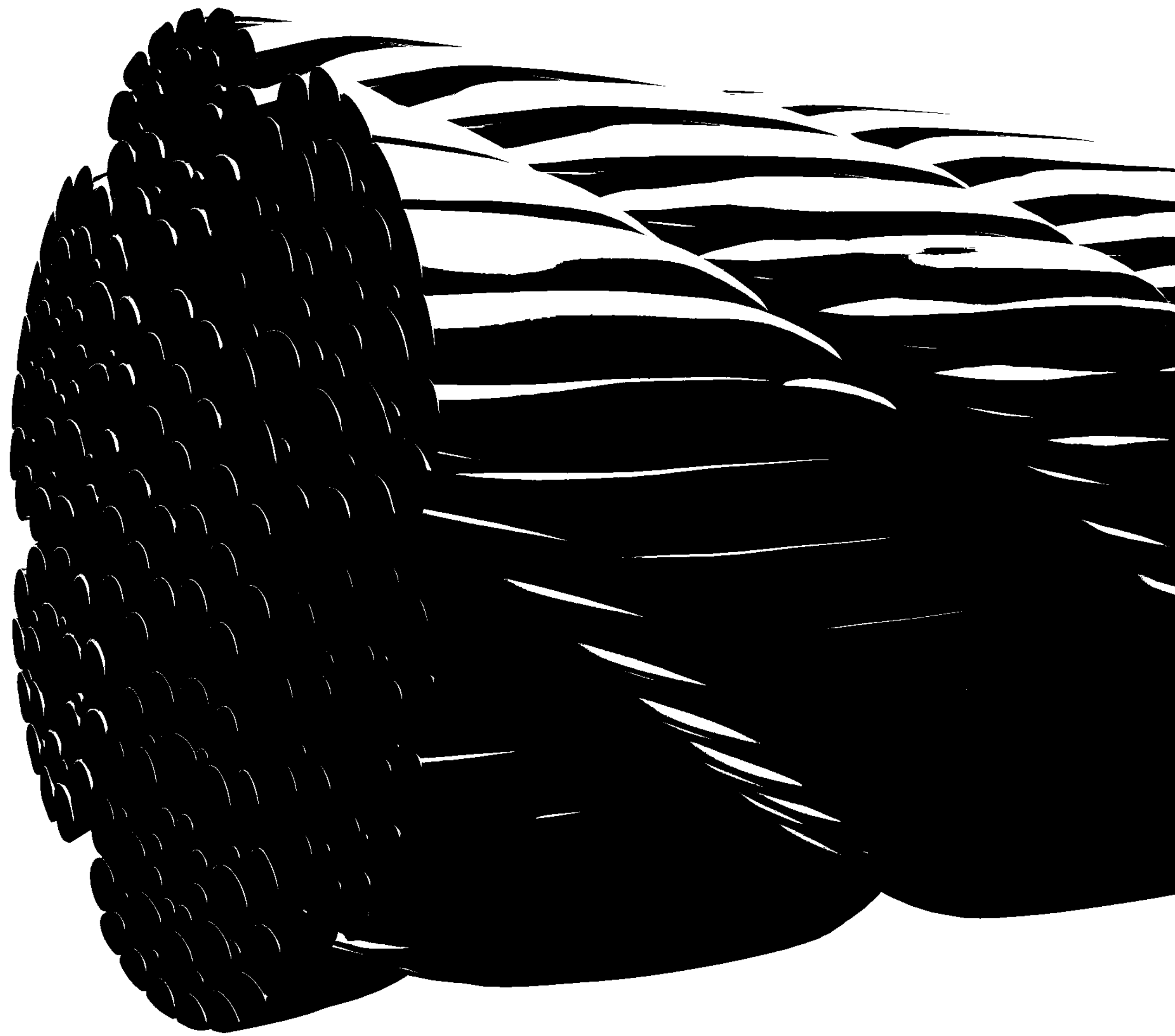


Designation: A1023/A1023M – 09$^{\varepsilon 1}$

Standard Specification for Stranded Carbon Steel Wire Ropes for General Purposes[1]

This standard is issued under the fixed designation A1023/A1023M; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

ε^1 NOTE—Section 4.1 was changed editorially in September 2012.

1. Scope*

1.1 This specification covers the general requirements for the more common types of stranded steel wire ropes. Included in this specification are wire ropes in various grades and constructions from ¼ in. [6 mm] to 2⅜ in. [60 mm] manufactured from uncoated or metallic coated wire. Also included are cord products from 1⁄32 in. [0.8 mm] to ⅜ in. [10 mm] manufactured from metallic coated wire. For specific applications, additional or alternative requirements may apply.

1.2 The values stated in either inch-pounds or SI units are to be regarded separately as standard. Within the text, the SI units are shown in brackets. The values stated in each system are not exact equivalents; therefore, each system shall be used independently of the other. Combining values from the two systems may result in nonconformance with the specification.

2. Referenced Documents

2.1 *ASTM Standards:*[2]

A931 Test Method for Tension Testing of Wire Ropes and Strand

A1007 Specification for Carbon Steel Wire for Wire Rope

2.2 *ISO Standards:*[3]

ISO 2232 Round Drawn Wire for General-Purpose Non-alloy Steel Wire Ropes

ISO 3108 Steel Wire Ropes for General Purposes—Determination of Actual Breaking

3. Terminology

Description of Terms Specific to this Specification

3.1 *inserts, n*—fiber or solid polymer so positioned as to separate adjacent strands or wires in the same or overlying layers or to fill interstices of the rope.

3.2 *Lubrication:*

3.2.1 *impregnating compound, n*—material used in the manufacture of natural fiber cores, covers, or inserts for the purpose of providing protection against rotting and decay of the fiber material.

3.2.2 *preservation compound, n*—material, usually containing some form of blocking agent, applied during, after, or both during and after manufacture of the rope to fiber inserts, fillers, and coverings for the purpose of providing protection against corrosion.

3.2.3 *rope lubricant, n*—general term used to signify material applied during the manufacture of a strand, core, or rope for the purpose of reducing internal friction, providing protection against corrosion, or both.

3.3 *rope cores, n*—central element, usually of fiber or steel (but may be a combination of both), of a round rope around which are laid helically the strands of a stranded rope or the unit ropes of a cable-laid rope (Fig. 1).

3.3.1 *fiber core (FC), n*—an element made from either natural or synthetic fibers.

3.3.2 *solid polymer core, n*—a single element of solid polymer material that is either cylindrical or shaped (grooved). It may also include an element or elements of wire or fiber.

3.3.3 *steel core, n*—a stranded rope (IWRC), or a round strand (WSC) construction. The round strand or the stranded rope core or its outer strands, or both, may also be covered or filled with either fiber or solid polymer. Steel cores are normally made as a separate independent element, the exception being rope with a stranded rope core closed parallel with the outer strands.

[1] This specification is under the jurisdiction of ASTM Committee A01 on Steel, Stainless Steel and Related Alloysand is the direct responsibility of Subcommittee A01.03 on Steel Rod and Wire.

Current edition approved Oct. 1, 2009. Published December 2009. Originally approved in 2002. Last previous edition approved in 2007 as A1023/A1023M – 07. DOI: 10.1520/A1023_A1023M-09.

[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

[3] Available from International Organization for Standardization (ISO), 1 rue de Varembé, Case postale 56, CH-1211, Geneva 20, Switzerland, http://www.iso.ch.

***A Summary of Changes section appears at the end of this standard**

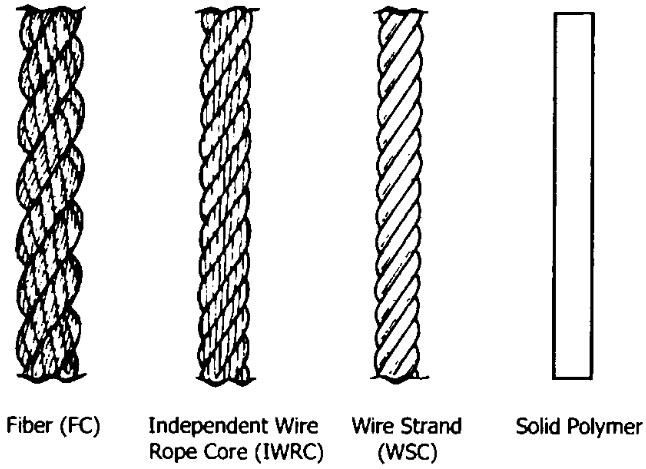


FIG. 1 Examples of Cores

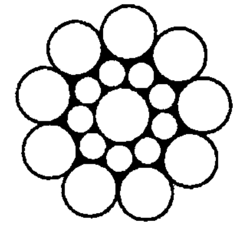


FIG. 3 Round Strand

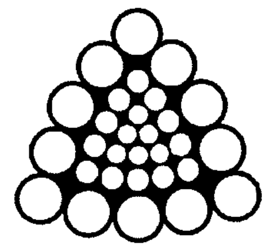


FIG. 4 Triangular Strand

3.4 *strand, n*—an element of rope normally consisting of an assembly of wires of appropriate shape and dimensions laid helically in one or more layers around a center. The center may consist of one round or shaped wire, of several round wires forming a built-up center, or of fiber or some other material. If multiple wires are used in a strand center, they may be counted as one wire.

3.4.1 *Cross-Section Shape:*

3.4.1.1 *compacted strand, n*—a strand that has been subjected to a compacting process such as drawing, rolling, or swaging (Fig. 2).

3.4.1.2 *round strand, n*—strand having a perpendicular cross-section that is approximately the shape of a circle (Fig. 3).

3.4.1.3 *triangular strand, n*—strand having a perpendicular cross-section that is approximately the shape of a triangle (formerly referred to as flattened strand) (Fig. 4).

(a) Style B—Solid center wire
(b) Style G—3×2 or 3×2+3F center
(c) Style H—3 or 3+3F center
(d) Style V—1×7 center

3.4.2 *strand lay direction, n*—the direction right (z) or left (s) corresponding to the direction of lay of the outer wires in relation to the longitudinal axis of the strand (Fig. 5).

3.4.3 *Type and Constructions:*

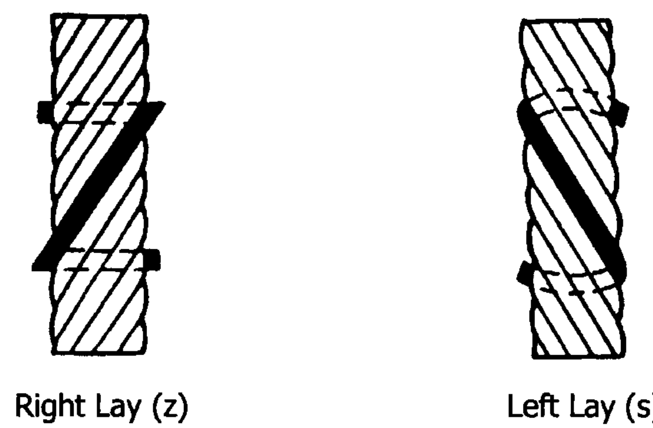


FIG. 5 Lay Direction of Strands for Stranded Ropes

3.4.3.1 *multiple operation lay, n*—construction containing at least two layers of wires in which successive layers are laid in more than one operation, with different lay lengths. There are two basic types of multiple operation strand:

(a) compound lay, n—strand that contains a minimum of three layers of wires where a minimum of one layer is laid in a separate operation, but in the same direction, over a parallel lay center.

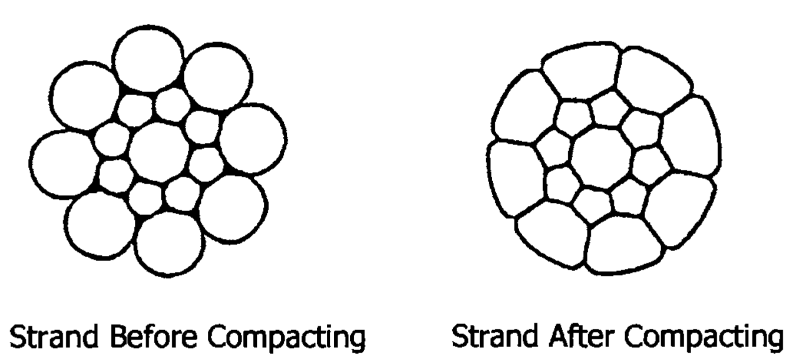


FIG. 2 Compacted Round Strand–Before and After

(b) *cross-lay, n*—strand in which the wires are laid in the same direction. The wires of superimposed wire layers cross one another and make point contact.

3.4.3.2 *parallel lay, n*—strand that contains at least two layers of wires, all of which are laid in one operation (in the same direction). The lay length of all the wire layers is equal, and the wires of any two superimposed layers are parallel to each other, resulting in linear contact. There are four types of parallel lay constructions:

(a) *combined, adj*—describes a parallel lay construction having three or more layers laid in one operation and formed from a combination of the above, for example, Warrington-Seale construction (Fig. 6a).

(b) *filler (F), adj*—describes a construction having outer layer containing twice the number of wires than the inner layer, with filler wires laid in the interstices between the layers. Filler wires are designated with the letter "F" (Fig. 6b).

(c) *Seale (S), adj*—describes a construction having same number of wires in each layer, for example, 9-9-1 (Fig. 6c).

(d) *Warrington (W), adj*—describes a construction having outer (Warrington) layer containing alternately large and small wires and twice the number of wires as the inner layer. Warrington layers are designated by listing the number of large and small wires with a + sign in between and bracketing ( ) the layer, for example, (6+6) (Fig. 6d).

Note 1—Strand construction is designated by listing the number of wires, beginning with the outer wires, with each layer separated by a hyphen.

3.4.3.3 *single lay, n*—strand that contains only one layer of wires.

3.5 *stranded wire rope, n*—an assembly of strands laid helically in one or more layers around a core. Exceptions are stranded wire ropes consisting of three or four outer strands that may or may not be laid around a core. Elements of stranded wire rope are shown in Fig. 7.

3.6 *Wires:*

3.6.1 *finish and quality of coating, n*—the condition of the surface finish of the wire, that is, uncoated or metallic coated (zinc or zinc alloy).

3.6.1.1 *metallic coated wire, n*—carbon steel wire that has a metallic coating.

(a) *drawn-galvanized wire, n*—coated carbon steel wire with a zinc coating applied prior to the final wire drawing operation, that is, galvanized in process.

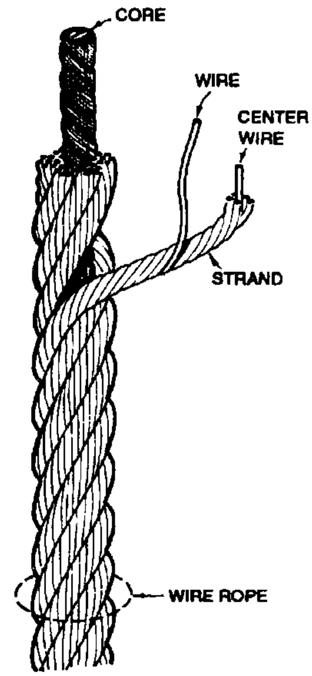


FIG. 7 Elements of Stranded Wire Rope

(b) *drawn-Zn5/Al-MM wire, n*—coated carbon steel wire with a zinc-aluminum alloy (mischmetal) coating applied prior to the final wire drawing operation.

(c) *final-coated Zn5/Al-MM wire, n*—coated carbon steel wire with a zinc-aluminum alloy (mischmetal) coating applied after the final wire drawing operation.

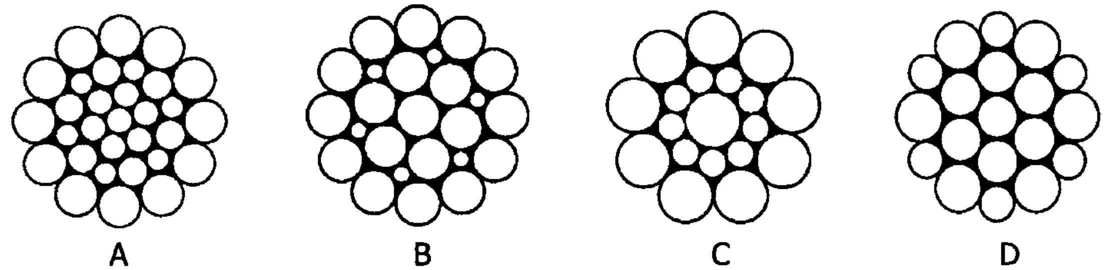
(d) *final-galvanized wire, n*—coated carbon steel wire with a zinc coating applied after the final wire drawing operation, that is, galvanized at finished size.

3.6.1.2 *uncoated wire, n*—carbon steel wire that does not have a metallic coating. Commonly referred to as bright wire.

3.6.2 *Function:*

3.6.2.1 *filler wires, n*—comparatively small wires used in certain constructions of parallel lay ropes to create the necessary number of interstices for supporting the next layer of covering wires.

3.6.2.2 *load-bearing wires (main wires), n*—those wires in a rope that are considered as contributing toward the breaking force of the rope.



A—Example of Combined Parallel Lay ex. 31WS, 12-(6+6)-6-1
B—Filler Construction ex. 25F, 12-6F-6-1
C—Seale Construction ex. 19S, 9-9-1
D—Warrington Construction ex. 19W, (6+6)-6-1

FIG. 6 Parallel Lay Constructions

3.6.2.3 *non-load-bearing wires, n*—those wires in a rope that are considered as not contributing toward the breaking force of the rope.

3.6.2.4 *seizing (serving) wires or strands, n*—single wires or strands used for making a close-wound helical serving to retain the elements of a rope in their assembled position.

3.6.3 *layer of wires, n*—an assembly of wires having one pitch diameter. The exception is a Warrington layer comprising large and small wires where the smaller wires are positioned on a larger pitch circle than the larger wires. The first layer of wires is that which is laid over the strand center. Filler wires do not constitute a separate layer.

3.6.4 *Position:*

3.6.4.1 *center wires, n*—wires positioned at the center of a strand of a stranded rope.

3.6.4.2 *core wires, n*—all wires comprising the core of a stranded rope.

3.6.4.3 *inner wires, n*—all wires except center, filler, core, and outer wires in a stranded rope.

3.6.4.4 *outer wires, n*—all wires in the outer layer of the outer strands of a stranded rope.

Dimensional Characteristics

3.7 *Diameter of Rope:*

3.7.1 *diameter of plastic-coated rope, n*—the diameter that circumscribes the overall rope cross-section including the cover followed by the diameter, which circumscribes the underlying rope (for example, ¾ × ⅝ in.).

3.7.2 *diameter of round rope, n*—the diameter (*d*) that circumscribes the rope cross-section. Diameter is expressed in inches or millimeters (Fig. 8).

3.8 *Lay Length:*

3.8.1 *rope lay length, n*—that distance measured parallel to the longitudinal rope axis in which the outer strands of a stranded rope or the component ropes of a cable-laid rope make one complete turn (or helix) about the axis of the rope (Fig. 9).

3.8.2 *strand lay length, n*—that distance measured parallel to the longitudinal strand axis, in which the wire in the strand makes one complete turn (or helix) about the axis of the strand. The lay length of a strand is that corresponding to the outer layers of wires (Fig. 9).

Manufacture (Rope)

3.9 *Preformation:*

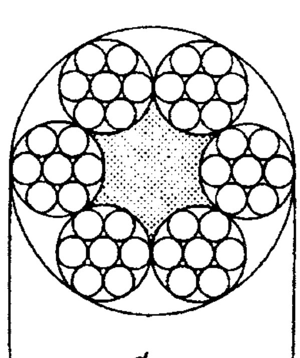


FIG. 8 Diameter of Round Rope

3.9.1 *non-preformed rope, n*—rope in which the wires and strands in the rope will, after removal of any seizing (serving), spring out of the rope formation.

3.9.2 *preformed rope, n*—rope in which the wires and strands in the rope will not, after removal of any seizing (serving), spring out of the rope formation.

3.10 *prestretching, n*—the name given to a process that results in the removal of a limited amount of constructional stretch.

Mechanical Properties

3.11 *Rope:*

3.11.1 *actual (measured) breaking force, n*—breaking force obtained using the prescribed test method in Test Method A931 or ISO 3108.

3.11.2 *calculated breaking force, n*—value of breaking force obtained from the sum of the measured breaking forces of the wires in the rope, before rope making, multiplied by the measured spinning loss factor as determined by the rope manufacturer's design.

3.11.3 *measured spinning loss factor, n*—ratio between the measured breaking force of the rope and the sum of the measured breaking forces of the wires, before rope making.

3.11.4 *minimum breaking force, n*—specified value that the actual (measured) breaking force must meet or exceed in a prescribed test.

3.12 *Rope Stretch (Extension):*

3.12.1 *constructional stretch (extension), n*—amount of extension that is attributed to the initial bedding down of wires within the strands and the strands within the rope due to loading. Initial extension cannot be determined by calculation.

3.12.2 *elastic stretch (extension), n*—amount of recoverable extension that follows Hooke's law within certain limits due to application of a load.

3.12.3 *permanent stretch (extension), n*—non-elastic extension.

3.13 *Wire:*

3.13.1 *torsions, n*—a measure of wire ductility normally expressed as the number of 360° revolutions that a wire can withstand before breakage occurs, using a prescribed test method. Torsion requirements are based on the wire diameter and either the wire level, as specified in Specification A1007, or the tensile strength grade, as specified in ISO 2232.

3.13.2 *wire tensile strength, n*—ratio between the maximum force obtained in a tensile test and the nominal cross-sectional area of the test piece. Requirements for wire tensile strength are determined by either the wire level, as specified in Specification A1007, or by the tensile strength grade, as specified in ISO 2232.

3.13.2.1 *tensile strength grade, n*—a level of requirement for tensile strength based on the SI system of units. It is designated by a value according to the lower limit of tensile strength and is used when specifying wire. Values are expressed in N/mm^2 (for example, 1960).

3.13.2.2 *wire level, n*—a level of requirement for tensile strength based on the inch-pound system of units (for example, Level 3).

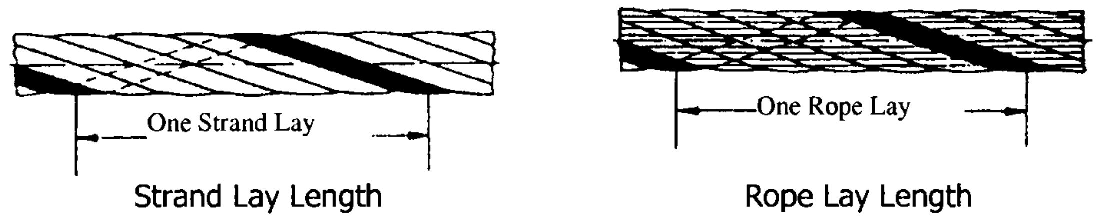


FIG. 9 Lay Lengths

TABLE 1 Wire Tensile Strength Grades or Levels for Given Rope Grades

Rope Grade	Wire Tensile Strength Grade or Level	
	Minimum	Maximum
IPS	Level 2 / 1570	Level 4 / 1960
EIP	Level 3 / 1770	Level 5 / 2160
EEIP	Level 4 / 1960	Level 5 / 2160
1770	1570 / Level 2	1960 / Level 4
1960	1770 / Level 3	2160 / Level 5
2160	1960 / Level 4	2160 / Level 5

Terminology Relating to Ropes

3.14 *Rope Classification and Construction:*

3.14.1 *rope classification, n*—a grouping of ropes of similar characteristics on the basis of, for stranded ropes, the number of strands and their shape, the number of strand layers, the number of wires in one strand, the number of outer wires in one strand, and the number of wire layers in one strand. For classification details, refer to Table 2.

TABLE 2 Classification

Classification	Table		Diameter (in.)	Diameter [mm]
	SC	FC		
6x7	9	10	¼ –1½	6–36
6x19	11	12	¼ –2⅜	6–60
6x36	13	14	¼ –2⅜	6–60
7x19	15		¼ –2⅜	6–60
7x36	16		¼ –2⅜	6–60
8x19	17		¼ –2⅜	6–60
8x36	18		¼ –2⅜	8–60
8x19 SR	19		½ –1½	12–38
19x7	20		¼ –1½	6–38
34x7	21		¼ –1⅝	8–40
35x7	22		⅜ –1⅝	8–40
6x12		23	5⁄16 –1	8–25
6x24		24	⅜ –2	9.5–51
6x25 TS	25	26	½ –2⅜	12–60
6x19 CS	27		⅜ –2¼	10–56
6x36 CS	28		⅜ –2¼	10–56
6x19 SW	29		½ –1½	12–38
6x36 SW	30		½ –1½	12–38
19x7 CS	31		¼ –1	6–24
19x19	32		⅜ –1⅝	10–40
35x7 CS	33		7⁄16 –1⅝	10–40
3x7 CORD	34		1⁄32	0.8
7x7 CORD	34		3⁄64 –⅜	1.2–9.5
7x19 CORD	34		1⁄16 –⅜	1.6–9.5

Designation key:
SR = spin resistant
TS = triangular strand
CS = compacted strand
SW = swaged rope
CORD = small diameter specialty wire rope
SC = steel core
FC = fiber core

TABLE 3 Weight of Coating for Final-Galvanized or Final-Coated Zn-5Al-MM Rope Wire

Diameter of Wire		Minimum Weight of Coating	
in.	[mm]	oz/ft²	[kg/m²]
0.025 to 0.047 incl	0.64 to 1.19 incl	0.20	0.06
over 0.047 to 0.054 incl	over 1.19 to 1.37 incl	0.40	0.12
over 0.054 to 0.063 incl	over 1.37 to 1.60 incl	0.50	0.15
over 0.083 to 0.079 incl	over 1.80 to 2.01 incl	0.60	0.18
over 0.079 to 0.092 incl	over 2.01 to 2.34 incl	0.70	0.21
over 0.092 to 0.192 incl	over 2.34 to 4.88 incl	0.80	0.24

TABLE 4 Weight of Coating for Drawn-Galvanized or Drawn Zn-5Al-MM Rope Wire

Diameter of Wire		Minimum Weight of Coating	
in.	[mm]	oz/ft²	[kg/m²]
0.0045 to 0.010 incl	0.11 to 0.25 incl	0.03	0.009
Over 0.010 to 0.017 incl	Over 0.25 to 0.43 incl	0.05	0.015
over 0.017 to 0.028 incl	over 0.43 to 0.71 incl	0.10	0.03
over 0.028 to 0.060 incl	over 0.71 to 1.52 incl	0.20	0.06
over 0.060 to 0.090 incl	over 1.52 to 2.29 incl	0.30	0.09
over 0.090 to 0.140 incl	over 2.29 to 3.56 incl	0.40	0.12

TABLE 5 Tolerances on Rope Diameter (Stranded Rope) (Inch-Pound Units)

Nominal Rope Diameter (*d*), in.	Diameter Tolerancesas a Percentage of Nominal Diameter
thru ⅛	-0, +8 %
over ⅛ thru 3⁄16	-0, +7 %
over 3⁄16 thru 5⁄16	-0, +6 %
over 5⁄16 and larger[A]	-0, +5 %

[A] 6x12 and 6x24 classifications -0, +7 % (Tables 24 and 25)

TABLE 6 Tolerances on Rope Diameter (Stranded Rope) [SI Units]

Nominal Rope Diameter (*d*), [mm]	Diameter Tolerances as a Percentage of Nominal Diameter
from 2 to <4	-0, +8 %
from 4 to <6	-0, +7 %
from 6 to <8	-0, +6 %
8 and greater	-0, +5 %

3.14.2 *rope construction, n*—detail and arrangement of the various elements of the rope, taking into account the number of strands, and the number of wires in the strand. For construction details, refer to Tables 9–34.

3.14.2.1 *Discussion*—Rope construction is designated by listing the number of outer strands followed by the number of

TABLE 7 Permissible Differences in Rope Diameter (Inch-Pound Units)

Nominal Rope Diameter (*d*), in.	Percentage Allowable Difference (%)
1/8 and smaller	7
over 1/8 thru 3/16	6
over 3/16 thru 5/16	5
over 5/16 and larger	4

TABLE 8 Permissible Differences in Rope Diameter [SI Units]

Nominal Rope Diameter (d), [mm]	Percentage Allowable Difference (%)
from 2 to <4	7
from 4 to <6	6
from 6 to <6	5
8 and greater	4

wires in each strand and the designation for the type of construction, for example, 6×25F. The "×" symbol is read as "by."

3.15 *rope grade, n*—a level of requirement for breaking force that is designated either by a number (for example, 1770, 1960) or a series of letters (for example, IPS, EIP). See 6.3. Rope grade does not imply that the actual tensile strength of the wires in the rope is necessarily of this grade.

3.16 *Rope Lay:*

3.16.1 *lay direction of rope, n*—the direction right (Z) or left (S) corresponding to the direction of lay of the outer strands in a stranded rope or the unit ropes in a cable laid rope in relation to the longitudinal axis of the rope.

3.16.2 *Lay Types:*

3.16.2.1 *alternate lay, adj*—describes stranded rope in which the type of lay of the outer strands is alternately regular (ordinary) lay followed by lang lay such that half of the outer strands are regular (ordinary) lay and the other half are lang lay. The lay direction of the rope will be either right (AZ) or left (AS). Alternate lay can also be supplied with two lang lay strands followed by one regular (ordinary) lay strand in a repeating pattern.

3.16.2.2 *contra-lay, adj*—describes rope in which at least one layer of strands is laid in the opposite direction to the other layers.

3.16.2.3 *lang lay, adj*—describes stranded rope in which the direction of lay of the wires in the outer strands is the same direction as that of the outer wires in the rope (Fig. 10).

3.16.2.4 *regular (ordinary), adj*—describes stranded rope in which the direction of lay of the wires in the outer strands is in the opposite direction to the lay of the outer strands in the rope.

3.16.2.5 *Discussion*—The lower case letter denotes strand direction; the upper case letter denotes rope direction.

3.17 *Rope Types:*

3.17.1 *cable-laid rope, n*—an assembly of several (usually six) round stranded ropes laid helically over a core (usually a seventh rope). Requirements for cable-laid rope are not covered in this standard.

3.17.2 Ropes incorporating filling and covering materials:

3.17.2.1 *cushioned rope, n*—rope in which the inner layers, inner strands or core strands are covered with solid polymers or fibers to form a cushion between adjacent strands or overlying layers.

3.17.2.2 *plastic-coated core rope, n*—rope in which the core is covered, or filled and covered, with a solid polymer.

3.17.2.3 *plastic-coated rope, n*—rope in which the exterior surface is coated (covered) with a solid polymer.

3.17.2.4 *plastic-filled rope, n*—rope in which the free spaces up to the diameter of the rope are filled with a solid polymer.

3.17.3 *rotation-resistant rope, n*—stranded ropes designed to generate reduced levels of torque and rotation when loaded

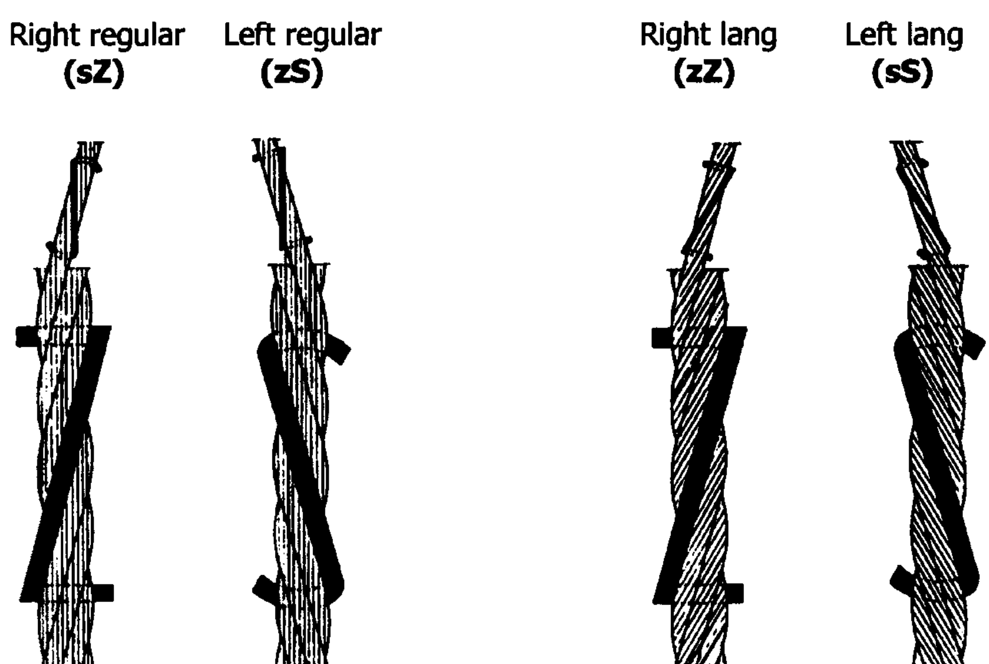


FIG. 10 Regular (Ordinary Lay) and Lang Lay

and comprising an assembly of two or more layers of strands laid helically around a center, the direction of lay of the outer strands being opposite to that of the underlying layer. There are three categories of rotation-resistant rope:

3.17.3.1 *category 1, adj*—describes stranded rope constructed in such a manner that it displays little or no tendency to rotate, or, if guided, transmits little or no torque, has at least fifteen outer strands and comprises an assembly of at least three layers of strands laid helically over a center in two operations, the direction of lay of the outer strands being opposite to that of the underlying layer.

3.17.3.2 *category 2, adj*—stranded rope constructed in such a manner that it has significant resistance to rotation, has at least ten outer strands, and comprises an assembly of two or more layers of strands laid helically over a center in two or three operations, the direction of lay of the outer strands being opposite to that of the underlying layer.

3.17.3.3 *category 3, adj*—stranded rope constructed in such a manner that it has limited resistance to rotation, has no more than nine outer strands, and comprises an assembly of two layers of strands laid helically over a center in two operations, the direction of lay of the outer strands being opposite to that of the underlying layer.

3.17.3.4 *Discussion*—Rotation resistant ropes have previously been referred to as multi-strand and non-rotating ropes.

3.17.3.5 *Discussion*—Ropes having three or four strands can also be designed to exhibit rotational resistant properties.

3.17.4 *Stranded Rope Types:*

3.17.4.1 *compacted strand rope, n*—rope in which the strands, prior to closing of the rope, are subjected to a compacting process such as drawing, rolling, or swaging.

3.17.4.2 *multi-layer, adj*—describes an assembly of two or more layers of strands laid helically around a core, the direction of the lay of the outer strands being opposite (that is, contra-lay) to that of the underlying layer.

3.17.4.3 *single layer, adj*—describes rope consisting of one layer of strands laid helically around a core.

3.17.4.4 *swaged (compacted) rope, n*—rope that is subjected to a compacting process after closing the rope, thus reducing its diameter.

Values

3.18 *actual (measured) value, n*—value derived from direct measurement in a prescribed manner.

3.19 *maximum value, n*—specified value that an actual value must not exceed.

3.20 *minimum value, n*—specified value that an actual value must meet or exceed.

3.21 *nominal value, n*—the conventional value by which a physical characteristic is designated.

4. Ordering Information

4.1 It is the responsibility of the purchaser to specify all requirements that are necessary for material ordered under this specification. Such requirements may include, but are not limited to, the following:

Item	Examples inch-pound	[SI]
Length	500 ft	175 m
Size (diameter)	¾ in.	16 mm
Rope classification or construction (if known)	6x36	6x36
Preformed or non-preformed	Preformed	Preformed
Lay direction and type	Right regular	sZ
Wire finish (uncoated or metallic coated and type)	uncoated	drawn-galvanized
Rope Grade	EIP	1960
Core Type	FC (fiber)	SC
Applicable specification	ASTM A1023	ASTM A1023
Special requirements		
Termination of rope ends		
Special length tolerance		
Type of certificate		
Special packaging and identification		
Lubrication, other than as noted in 5.3		
Prestretching		

4.2 *Certification of Conformance and Test:*

4.2.1 A certificate of conformance and test shall confirm compliance with this standard. It shall contain the following information items:

4.2.1.1 Certificate number,

4.2.1.2 Purchaser's name and address,

4.2.1.3 Purchaser's order number,

4.2.1.4 Rope supplier's name and address,

4.2.1.5 Supplier's order number,

4.2.1.6 Number traceable to manufacturer's production length,

4.2.1.7 Nominal length(s) of rope,

4.2.1.8 Rope designation (nominal diameter, construction and core, lay and grade), and

4.2.1.9 Minimum breaking force in tons (short tons) or kilonewtons.

4.2.2 *Tests on Wires and Rope*—If wire tests are required, indicate if the wire samples are taken before the rope fabrication or if they are taken from a completed rope. The following additional information can be supplied under agreement between purchaser and supplier. These items shall be completed as agreed between the supplier and the purchaser.

4.2.2.1 Quality system registration number of the rope manufacturer, if applicable;

4.2.2.2 Approximate mass in lb/ft [kg/m];

4.2.2.3 Wire standard used;

4.2.2.4 Number of wires tested;

4.2.2.5 Nominal dimensions of wire;

4.2.2.6 Measured dimensions of wire;

4.2.2.7 Breaking force of wire;

4.2.2.8 Tensile strength of wire;

4.2.2.9 Number of torsions completed (and test length);

4.2.2.10 Mass of zinc (or zinc alloy);

4.2.2.11 Actual (measured) diameter of rope; and

4.2.2.12 Actual (measured) breaking force of rope.

4.2.3 *Additional Information and Certification:*

4.2.3.1 Space for additional information, and

4.2.3.2 Space for certification with provision for certifying the foregoing, name and position held, signature, and date.

5. Material

5.1 *Wire*—The wires used in rope making shall comply with the appropriate requirements of Specification A1007 or ISO 2232. The manufacturer, subject to the limits in Table 1, shall determine the tensile strength grade so that the minimum breaking force of the rope is achieved.

5.1.1 Wire tensile limitations in Table 1 do not apply to center, filler, and core wires.

5.1.2 Wire tensile limitations do not apply to compacted ropes, or compacted strand ropes.

5.1.3 The manufacturer shall have the option to adopt a single wire level or tensile strength grade throughout the rope, or decide on a combination of wire levels or tensile strength grades.

5.1.4 Wire diameters shall be selected by the manufacturer in accordance with applicable wire rope design requirements.

5.2 *Core*—Cores of stranded ropes shall normally be either steel or fiber composition.

5.2.1 *Fiber Core*—All fiber cores shall be natural fiber (for example, sisal), polypropylene, or other suitable synthetic fiber. The cores shall be of uniform hardness, effectively supporting the strands. Natural fiber cores shall be treated with an impregnating compound free from acid. Fiber cores larger than 5⁄32-in. (4-mm) diameter shall be doubly closed.

5.2.2 *Steel Core*—Steel main cores shall be either an independent wire rope (IWRC) or a wire strand (WSC). Steel cores of single layer ropes larger than 7⁄16-in. (12-mm) diameter shall be independent wire ropes (IWRC), unless specified otherwise. Steel cores shall be lubricated. Cores closed in one operation (parallel lay) with the outer strands of the rope may be specified by agreement between the supplier and the purchaser.

5.3 *Lubricant*—All wire rope, unless otherwise specified, shall be lubricated and impregnated in the manufacturing process with a suitable lubricant selected by the manufacturer. Stranding lubricants used for fiber core ropes shall be compatible with the impregnating compound of the fiber core.

6. Rope Properties and Tolerances

6.1 *Classification*—The rope classification shall be specified by the purchaser and shall normally be one of those covered in Table 2 although other classifications and constructions are available by agreement between the supplier and purchaser.

NOTE 2—Where only the rope classification is specified by the purchaser, the manufacturer shall determine the construction.

6.2 *Rope Core*—Steel core (SC) shall be supplied unless otherwise specified. The manufacturer shall determine core construction. Cores with inserts or solid polymer cores are subject to agreement between the supplier and purchaser.

6.3 *Rope Grade*—The rope grade shall be one of the following although other grades are available by agreement between the supplier and purchaser.

6.3.1 The listed rope grades for the following inch-pound units are shown in the indicated tables:

6.3.1.1 *IPS*—Tables 10–21, Tables 24–27

6.3.1.2 *EIP*—Tables 10–21, Tables 26–33

6.3.1.3 *EEIP*—Tables 12–20, Tables 26–29, Tables 32 and 33

6.3.2 Rope Grades for the following SI units are shown in the indicated tables:

6.3.2.1 *1770*—Table 10–19, Tables 21–23

6.3.2.2 *1960*—Tables 10–19, Tables 21–23, Tables 28 and 29, Tables 32–34

6.3.2.3 *2160*—Tables 12–19, Table 23, Tables 28 and 29, Tables 32–34

6.4 *Wire Finish*—Unless otherwise specified, wire ropes will be furnished with uncoated wires. For wire ropes requested with metallic coated wires, the wires shall be galvanized unless otherwise specified by the purchaser.

6.4.1 *Final-Galvanized Rope*—All outer wires shall be supplied as final-galvanized. Inner, filler, and center wires shall be supplied as final-galvanized or drawn-galvanized. Minimum weight of coating for galvanized wire shall be as specified in Tables 3 and 4.

6.4.1.1 Final-galvanized rope shall be supplied with minimum breaking forces 10 % lower than those listed in Tables 9–34, except for Table 21 and Table 22.

6.4.1.2 *Final-Coated Zn-5Al-MM*—Wires of final-coated Zn-5Al-MM may be substituted for final-galvanized wire at the option of the manufacturer. Minimum weight of coating shall be as specified in Table 3.

6.4.2 *Drawn-Galvanized (Zinc Coated) Rope*—All the wires shall be galvanized (zinc coated), including those of any steel core. Minimum weight of coating shall be as specified in Table 4.

6.4.2.1 Drawn galvanized rope shall be supplied with minimum breaking forces no less than those listed in Tables 9–34.

6.4.2.2 *Drawn-Zn-5Al-MM*—Wires of drawn-Zn-5Al-MM may be substituted for drawn-galvanized wire at the option of the manufacturer. Minimum weight of coating shall be as specified in Table 4.

6.5 *Direction and Type of Rope Lay*—The direction and type of rope lay shall be as specified by the purchaser and shall be one of the following:

Right regular (ordinary) lay (sZ)
Left regular (ordinary) lay (zS)
Right lang lay (zZ)
Left lang lay (sS)
Right alternate lay (AZ)
Left alternate lay (AS)

Right regular (ordinary) lay will be supplied for six, seven, and eight-strand constructions unless otherwise specified by the purchaser.

6.6 *Dimensions:*

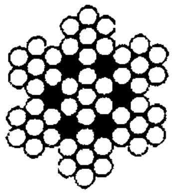
6.6.1 *Rope Diameter*—The nominal diameter shall be as specified by the purchaser and shall be the dimension by which the rope is designated.

6.6.1.1 *Tolerance on Rope Diameter*—When measured in accordance with 8.6.1, the actual diameter shall not vary from the nominal diameter by more than the tolerances specified in Table 5 or Table 6. For small diameter specialty cord with diameters from 1⁄32 in. [0.8 mm] to 3⁄8 in. [10 mm] inclusive, diameter tolerances shall be as specified in Table 9.

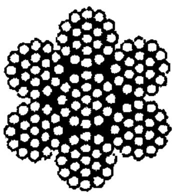
6.6.1.2 *Permissible Differences in Diameter*—The difference between any two of the four measurements taken in

TABLE 9 Classification 7×7 and 7×19 Small Diameter (Galvanized) Specialty Cord

Cross Section Examples	Construction of Rope		Construction of Strand	
	Item	Quantity	Item	Quantity
	Strands[A]	7	Wires	7 or 19
	Outer Strands	6	Outer Wires	6 or 12
	Layer of Strands	2	Layer of Wires	1 or 2
	Wires in Rope[A] (excluding core strand)	42 or 114		



7×7



7×19

Typical Examples		Number of Outer Wires	
Rope	Strand	Total	Per Strand
3×7	1–6	18	6
7×7	1–6	36	6
7×19	1–6/12	72	12

Diameter		Approx. Mass				Minimum Breaking Force[A]				Diameter Range	
		7×7		7×19		7×7		7×19		Min.	Max.
in.	[mm]	lb/100 ft	[kg/30.5 m]	lb/100 ft	[kg/30.5 m]	lbs	[kN]	lbs	[kN]	in.	in.
1/32 [A]	0.79	0.16	0.07			110	0.49			0.031	0.037
3/64	1.19	0.42	0.19			270	1.2			0.047	0.055
1/16	1.59	0.75	0.34	0.75	0.34	480	2.1	480	2.1	0.083	0.073
5/64	1.98	1.1	0.50			650	2.9			0.078	0.089
3/32	2.38	1.6	0.73	1.7	0.77	920	4.1	1000	4.4	0.094	0.106
7/64	2.78	2.2	1.0			1260	5.6			0.109	0.122
1/8	3.18	2.8	1.3	2.9	1.3	1700	7.8	2000	8.9	0.125	0.139
5/32	3.97	4.3	2.0	4.5	2.0	2600	11.6	2800	12.5	0.156	0.172
3/16	4.76	6.2	2.8	6.5	3.0	3700	16.5	4200	18.7	0.188	0.206
7/32	5.56	8.3	3.8	8.6	3.9	4800	21.4	5600	24.9	0.219	0.237
1/4	8.35	10.6	4.8	11.0	5.0	8100	27.1	7000	31.1	0.250	0.268
9/32	7.14	13.4	6.1	13.9	6.3	7600	33.8	8000	35.6	0.281	0.301
5/16	7.94	16.7	7.6	17.3	7.9	9200	40.9	9800	43.6	0.313	0.335
11/32	8.73	20.1	9.1	20.7	9.4	11 100	49.4	12 500	55.8	0.344	0.368
3/8	9.53	23.6	10.7	24.3	11.0	13 100	58.3	14 400	64.1	0.375	0.401

[A] 1/32 construction is 3×7.

accordance with 8.6.1, and expressed as a percentage of the nominal diameter, shall not exceed the values given in Table 7 or Table 8.

6.6.2 *Lay Length:*

6.6.2.1 For single layer ropes of 6×7 class, the lay length of the finish rope shall not exceed 8 times the nominal rope diameter.

6.6.2.2 For other single layer ropes with round strands, except for 3 or 4 strand ropes, and multi-layer ropes with round or shaped strands, the length of lay of the finished rope shall not exceed 7.25 times the nominal rope diameter.

6.6.2.3 For single layer ropes with shaped strands, for example, flattened (triangular) strand, the length of lay of the finished rope shall not exceed 10 times the nominal rope diameter.

6.7 *Mechanical Properties:*

6.7.1 *Breaking Force*—Values for minimum breaking force for the more common classes of rope are specified in Tables 9–34 of this standard.

6.7.1.1 The minimum breaking force for other classes and constructions not covered by the tables, shall be agreed upon by the manufacturer and the purchaser.

6.7.1.2 Wire ropes with minimum breaking forces less than those allowed in this specification may be accepted by prior agreement between the supplier and purchaser and shall be regarded as beyond the scope of this specification.

6.7.2 *Mass*—The (approximate) nominal rope mass shall be as given in Tables 9–34 or as specified by the manufacturer.

6.7.3 *Length*—The actual length of rope supplied, expressed in feet or meters, shall be the specified length subject to the following limits of tolerance:

(a) Up to and including 1300 ft [400 m]: +5.0 % of specified length,

(b) Over 1300 ft up to 3280 ft [400 m to 1000 m]: +66 ft [20 m], and

(c) Over 3280 ft [1000 m]: +2.0 % of specified length.

NOTE 3—The rope shall be measured under no load. Ropes required with more restrictive length tolerance shall be agreed upon by the supplier and purchaser.

7. Rope Workmanship and Finish

7.1 *Strand:*

7.1.1 Strand wires shall be tight and uniform. All the wire layers in a strand shall have the same direction of lay. The lay lengths of corresponding wire layers in strands of the same size shall be uniform.

7.1.2 Center wires and fiber centers of strands shall be of a size to provide sufficient support to enable the covering wires to be evenly laid.

7.2 *Rope*—The rope shall be uniformly made and the strands shall lie tightly on the core or the underlying strands.

7.2.1 The core of a stranded rope, except for swaged (compacted) ropes, shall be designed so that in a new rope under no load there is clearance between the outer strands.

7.2.2 Rope ends that have no end fittings shall be so secured as to maintain the integrity of the rope and prevent its unraveling.

7.3 *Wire Joints:*

7.3.1 Wires over 0.015 in. [0.4 mm] in diameter shall have their ends joined by soldering, brazing, or welding.

7.3.2 Wires up to and including 0.015 in. [0.4 mm] diameter may be joined by soldering, brazing, welding, twisting, or by ends being simply inserted into the strand's formation.

7.3.3 The minimum distance between joints in a strand shall be 18 times the nominal rope diameter.

7.4 *Preformation*—Stranded ropes shall be preformed unless otherwise specified, except that multi-layer ropes, including rotation-resistant and low-rotation ropes, may be non-preformed.

7.5 *Prestretching*—Stranded ropes are not prestretched unless otherwise specified. When specified, ropes may be prestretched using either a process of static or dynamic loading. Prestretch loads shall not exceed 55 % of the minimum breaking force for the rope.

NOTE 4—Example of static prestretching practice: Rope is subjected to three cycles of tensile loading to 40 % of the ropes minimum breaking force for 5 min, returning to 5 % of the minimum breaking force between cycles. After the last cycle, the tensile load is completely released.

8. Testing and Compliance

General

8.1 Wire ropes manufactured in accordance with this specification shall be capable of meeting all the appropriate requirements as specified in 8.2. The manufacturer shall be able to demonstrate compliance with this specification by either:

8.1.1 Testing each production length in accordance with 8.2, or

8.1.2 Operating a quality assurance system that includes a sampling program that meets the following requirements as a minimum:

8.1.2.1 For each size and grade of a given rope construction, the manufacturer shall present evidence from testing, if requested by the purchaser, of a minimum of three production lengths representing the current design. The purpose of these tests is to assure the manufacturer's ability to produce a rope that conforms to the minimum requirements as defined in this specification. Periodic acceptance tests are successfully completed on a sample taken from a minimum of every twentieth production length.

8.1.2.2 Manufacturers complying with all requirements of 8.1.2 may use calculated breaking force to verify compliance with requirements for an individual production length not included in sample testing.

8.2 Any change in design requires that the tests specified in 8.1.2 be repeated on the modified rope. However, if the same design, apart from the wire tensile grades, is used for ropes of a lower grade than the one which has successfully passed the tests specified in 8.1.2, it shall not be necessary to repeat the tests on the lower grade rope(s).

8.3 For the purposes of this specification, a production length is regarded as that length of rope manufactured in one continuous operation from one loading of the closing machine comprising strands, each of which has been produced in one continuous operation on the stranding machine. A production length may comprise one or more reels of rope.

NOTE 5—Examples of quality assurance systems are API Q1, ANSI/ASQC Q9002 and ISO 9002.

Acceptance Tests

8.4 *Test Piece*—When required by 8.1, one test piece shall be taken from each production length.

8.5 *Test Verification*—When requested, the manufacturer shall allow the purchaser or his representative the opportunity to witness acceptance tests (when these are performed), or to examine test records, to verify compliance with this specification. Test lengths required by the purchaser should be ordered as additional lengths.

8.6 *Rope:*

8.6.1 *Diameter*—Measurements for diameter shall be taken on a straight portion of the rope without tension, at two positions spaced at least three feet (or one meter) apart, and at each position two diameters at right angles shall be measured. The average of these four measurements shall be within the tolerances given in Tables 5 and 6 of this specification. The permissible differences between any two individual diameter measurements are given in Tables 7 and 8.

NOTE 6—In case of dispute concerning oversize diameter, the rope shall be measured under a tension not exceeding 20 % of the minimum breaking force. If the measurements from this test are within the specified tolerances, the rope shall be deemed to be within the specified size.

8.6.2 *Breaking Force*—When measured in accordance with the method specified in Test Method A931 or ISO 3108, the actual (measured) breaking force obtained shall be equal to or greater than the minimum breaking force required by this specification. If the minimum breaking force is not achieved, up to three additional tests shall be permitted. At least one of the additional tests shall achieve the minimum breaking force specified. Tables 9–34 show the minimum breaking forces of the more common classes, sizes, and grades of ropes:

8.6.2.1 Minimum breaking forces listed apply to uncoated or drawn-galvanized ropes.

8.6.2.2 Minimum breaking forces for final-galvanized ropes are 10 % lower than values listed, except for Tables 21 and 22.

8.6.2.3 Minimum breaking force values for IPS, EIP and EEIP are given in short tons of 2000 pounds.

8.7 *Rope Wires:*

8.7.1 *General*—Wires shall be tested for diameter, tensile strength, torsions, and, where applicable, metallic coating in accordance with the methods in Specification A1007 or ISO 2232. The manufacturer shall have the option to test wires either before or after fabrication of the rope.

NOTE 7—After fabrication wire testing is not applicable to compacted strand ropes or swaged (compacted) ropes.

8.7.2 *Sampling*—All main wires from the equivalent of one complete strand of each layer, strand diameter and strand construction, including steel rope core, shall be tested. If there are more than eight strands of one diameter in one layer, then two strands of that diameter shall be tested.

8.7.3 For the purpose of evaluating the test results, the rope manufacturer shall record the nominal diameters and tensile grades of the wires.

8.7.3.1 The sample selected shall be of sufficient length to allow for retest.

8.7.3.2 The wires shall be selected at random.

8.7.3.3 Filler wires and center wires shall be excluded from this test.

8.7.4 *Levels of Acceptance:*

8.7.4.1 *Wire before Fabrication*—Wire samples tested before fabrication shall meet the requirements for the size and grade (level) specified by the supplier and as found in the appropriate wire specification.

8.7.4.2 *Wire after Fabrication*—For each requirement, a maximum of 5 % of wires tested is permitted to lie outside the values specified, rounded to the nearest whole number of wires. Failure of the same wire to satisfy more than one requirement shall be considered as a single failure.

(a) Diameter—The diameter of 5 % of the wires may exceed, by up to 50 %, the specified tolerance for the nominal diameter.

(b) Tensile Strength—When tested in accordance with the requirements of Specification A1007, the measured values shall be within the tolerance specified with an additional tolerance of 7000 psi [50 N/mm^2] below the minimum value. The measured value of wire diameters less than 0.020 in. [0.5 mm] shall be greater than the minimum values specified in the appropriate wire specification.

(c) Torsion—When tested in accordance with the requirements of Specification A1007, the measured values of wires of 0.020 in. [0.5 mm] diameter and greater shall be at least 85 % of the values specified, rounded down to the next whole number. The measured value of wire diameters less than 0.020 in. [0.5 mm] shall be greater than the minimum values specified.

9. Packaging and Identification

9.1 *Packaging*—Unless otherwise specified by the purchaser, ropes shall be supplied in coils or on reels at the discretion of the manufacturer.

9.2 *Identification*—Each package of rope shall be legibly identified with the following information, as a minimum:

9.2.1 Rope supplier and address,

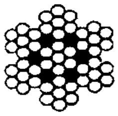
9.2.2 Rope length and description, and

9.2.3 Number traceable to manufacturer's production length.

10. Keywords

10.1 aircraft cable; cable; steel cable; steel rope; utility cable; wire rope

TABLE 10 Classification 6x7 Steel Core

Cross Section Examples	Construction of Rope: Item	Construction of Rope: Quantity	Construction of Strand: Item	Construction of Strand: Quantity
	Strands	6	Wires	5 to 9
	Outer Strands	6	Outer Wires	4 to 8
	Layer of Strands	1	Layer of Wires	1
	Wires in Rope	30 to 54		

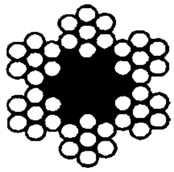
	Typical Examples: Rope	Typical Examples: Strand	Number of Outer Wires: Total	Number of Outer Wires: Per Strand
6x7 SC	6x7	1–6	36	6

Diameter in.	Diameter [mm]	Approx. Mass lb/ft	Approx. Mass [kg/m]	Minimum Breaking Force[A] IPS Tons	Minimum Breaking Force[A] 1770 [kN]	Minimum Breaking Force[A] EIP Tons	Minimum Breaking Force[A] 1960 [kN]	Diameter Range Min. in.	Diameter Range Max. in.
	6	0.10	0.144		22.9		25.3	0.236	0.250
1/4		0.11	0.161	2.84		3.12		0.250	0.265
	7	0.13	0.196		31.1		34.5	0.276	0.292
5/16		0.17	0.252	4.41		4.85		0.313	0.331
	8	0.17	0.256		40.7		45.0	0.315	0.331
	9	0.22	0.324		51.5		57.0	0.354	0.372
3/8		0.24	0.363	6.30		6.93		0.375	0.394
	10	0.27	0.400		63.5		70.4	0.394	0.413
	11	0.33	0.484		76.9		85.1	0.433	0.455
7/16		0.33	0.494	8.52		9.37		0.438	0.459
	12	0.39	0.576		91.5		101	0.472	0.496
1/2		0.43	0.645	11.1		12.2		0.500	0.525
	13	0.45	0.676		107		119	0.512	0.537
	14	0.53	0.784		125		138	0.551	0.579
9/16		0.55	0.817	14.0		15.4		0.563	0.591
5/8		0.68	1.008	17.1		18.8		0.625	0.656
	16	0.69	1.024		163		180	0.630	0.661
	18	0.87	1.296		206		228	0.709	0.744
	19	0.97	1.444		229		254	0.748	0.785
3/4		0.98	1.452	24.4		26.8		0.750	0.788
	20	1.08	1.600		254		281	0.787	0.827
	22	1.30	1.936		308		341	0.866	0.909
7/8		1.33	1.976	33.0		36.3		0.875	0.919
	24	1.55	2.304		366		405	0.945	0.992
1		1.73	2.581	42.7		47.0		1.000	1.050
	26	1.82	2.704		430		476	1.024	1.075
	28	2.11	3.136		498		552	1.102	1.157
1 1/8		2.19	3.266	53.5		58.9		1.125	1.181
1 1/4		2.71	4.032	65.6		72.2		1.250	1.313
	32	2.75	4.096		651		721	1.260	1.323
1 3/8		3.28	4.879	78.6		86.5		1.375	1.444
	36	3.48	5.184		824		912	1.417	1.488
1 1/2		3.90	5.808	92.7		102		1.500	1.575

[A] Minimum breaking force for final-galvanized ropes 10 % lower than values listed.

Note—To convert to kilonewtons (kN), multiply tons by 8.896.

TABLE 11 Classification 6×7 Fiber Core

Cross Section Examples	Construction of Rope		Construction of Strand	
	Item	Quantity	Item	Quantity
	Strands	6	Wires	5 to 9
	Outer Strands	6	Outer Wires	4 to 8
	Layer of Strands	1	Layer of Wires	1
	Wires in Rope	30 to 54		
6×7 FC	Typical Examples		Number of Outer Wires	
	Rope	Strand	Total	Per Strand
	6×7	1–6	36	6

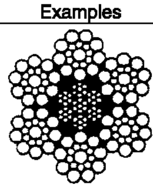
Diameter		Approx. Mass		Minimum Breaking Force[A]				Diameter Range	
in.	[mm]	lb/ft	[kg/m]	IPS Tons	1770 [kN]	EIP Tons	1960 [kN]	Min. in.	Max. in.
	6	0.08	0.124		21.2		23.4	0.236	0.248
¼		0.09	0.139	2.64		2.90		0.250	0.263
	7	0.11	0.169		28.8		31.9	0.276	0.289
5⁄16		0.15	0.217	4.10		4.51		0.313	0.328
	8	0.15	0.221		37.8		41.6	0.315	0.331
	9	0.19	0.279		47.6		52.7	0.354	0.372
⅜		0.21	0.313	5.86		6.45		0.375	0.394
	10	0.23	0.345		58.8		65.1	0.394	0.413
	11	0.28	0.417		71.1		78.7	0.433	0.455
7⁄16		0.29	0.426	7.93		8.72		0.438	0.459
	12	0.33	0.497		84.6		93.7	0.472	0.496
½		0.37	0.556	10.3		11.3		0.500	0.525
	13	0.39	0.583		99.3		110	0.512	0.537
	14	0.45	0.676		115		128	0.551	0.579
9⁄16		0.47	0.704	13.0		14.3		0.563	0.591
⅝		0.58	0.869	15.9				0.825	0.858
	16	0.59	0.883		150		167	0.630	0.661
	18	0.75	1.118		190		211	0.709	0.744
	19	0.84	1.245		212		235	0.748	0.785
¾		0.84	1.252	22.7		25.0		0.750	0.788
	20	0.93	1.380		235		260	0.787	0.827
	22	1.12	1.670		284		315	0.866	0.909
⅞		1.15	1.704	30.7		33.8		0.875	0.919
	24	1.34	1.987		338		375	0.945	0.992
1		1.50	2.226	39.7		43.7		1.000	1.050
	26	1.57	2.332		397		440	1.024	1.075
	28	1.82	2.705		461		510	1.102	1.157
1⅛		1.89	2.817	49.8		54.8		1.125	1.181
1¼		2.34	3.478	61.0		67.1		1.250	1.313
	32	2.37	3.533		602		666	1.260	1.323
1⅜		2.83	4.208	73.1		80.4		1.375	1.444
	36	3.00	4.471		762		843	1.417	1.488
1½		3.37	5.008	86.2		94.8		1.500	1.575

[A] Minimum breaking force for final-galvanized ropes 10 % lower than values listed.

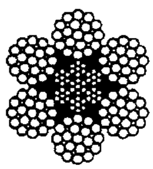
Note—To convert to kilonewtons (kN), multiply tons by 8.896.

TABLE 12 Classification 6x19 Steel Core

Cross Section Examples



6x19 Seale
IWRC



6x25 filler wire
IWRC

Construction of Rope: Item	Quantity	Construction of Strand: Item	Quantity
Strands	6	Wires	15 to 26
Outer Strands	6	Outer Wires	7 to 12
Layer of Strands	1	Layer of Wires	2 to 3
Wires in Rope	90 to 156		

Typical Examples: Rope	Strand	Number of Outer Wires: Total	Per Strand
6x19S	1–9–9	54	9
6x21F	1–5–5F–10	60	10
6x26WS	1–5–(5+5)–10	60	10
6x19W	1–6–(6+6)	72	12
6x25F	1–6–6F–12	72	12

Diameter		Approx. Mass		Minimum Breaking Force[A]						Diameter Range	
in.	[mm]	lb/ft	[kg/m]	IPS Tons	1770 [kN]	EIP Tons	1960 [kN]	EEIP Tons	2160 [kN]	Min. in.	Max. in.
	6	0.10	0.153		22.7		25.1		27.7	0.236	0.250
¼		0.12	0.172	2.94		3.40				0.250	0.265
	7	0.14	0.209		30.9		34.2		37.7	0.276	0.292
5⁄16		0.18	0.268	4.58		5.27				0.313	0.331
	8	0.18	0.273		40.3		44.7		49.2	0.315	0.331
	9	0.23	0.345		51.0		56.5		62.3	0.354	0.372
⅜		0.26	0.388	6.56		7.55		8.30		0.375	0.394
	10	0.29	0.426		63.0		69.8		76.9	0.394	0.413
	11	0.35	0.515		76.2		84.4		93.0	0.433	0.455
7⁄16		0.35	0.526	8.89		10.2		11.2		0.438	0.459
	12	0.41	0.613		90.7		100		111	0.472	0.498
½		0.46	0.687	11.5		13.3		14.6		0.500	0.525
	13	0.48	0.720		106		118		130	0.512	0.537
	14	0.56	0.835		124		137		151	0.551	0.579
9⁄16		0.58	0.870	14.5		16.8		18.5		0.563	0.591
⅝		0.72	1.074	17.7		20.6		22.7		0.625	0.656
	16	0.73	1.091		161		179		197	0.630	0.661
	18	0.93	1.380		204		228		249	0.709	0.744
	19	1.03	1.538		227		252		278	0.748	0.785
¾		1.04	1.546	25.6		29.4		32.4		0.750	0.788
	20	1.15	1.704		252		279		308	0.787	0.827
	22	1.39	2.062		305		338		372	0.866	0.909
⅞		1.41	2.104	34.6		39.8		43.8		0.875	0.919
	24	1.65	2.454		363		402		443	0.945	0.992
1		1.85	2.748	44.9		51.7		56.9		1.000	1.050
	26	1.94	2.880		426		472		520	1.024	1.075
	28	2.24	3.340		494		547		603	1.102	1.157
1⅛		2.34	3.478	56.5		65.0		71.5		1.125	1.181
1¼		2.89	4.294	69.4		79.9		87.9		1.250	1.313
	32	2.93	4.362		645		715		787	1.260	1.323
1⅜		3.49	5.196	83.5		96.0		106		1.375	1.444
	36	3.71	5.521		817		904		997	1.417	1.488
1½		4.16	6.184	98.9		114		125		1.500	1.575
	40	4.58	6.816		1008		1116		1230	1.575	1.654
1⅝		4.88	7.257	115		132		146		1.625	1.706
	44	5.54	8.247		1220		1351		1489	1.732	1.819
1¾		5.66	8.417	133		153		169		1.750	1.838
1⅞		6.49	9.662	152		174		192		1.875	1.969
	48	6.60	9.815		1452		1608		1772	1.890	1.984
2		7.39	10.994	172		198		217		2.000	2.100
	52	7.74	11.519		1704		1887		2079	2.047	2.150
2⅛		8.34	12.411	192		221		243		2.125	2.231
	56	8.98	13.359		1976		2188		2411	2.205	2.315
2¼		9.35	13.914	215		247		272		2.250	2.363
	60	10.31	15.336		2268		2512		2768	2.362	2.480
2⅜		10.42	15.503	239		274		301		2.375	2.494
2½		11.6	17.261	282		302		332		2.500	2.625
2⅝		12.8	19.046	288		331		364		2.625	2.756

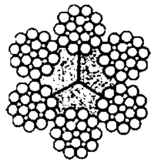
TABLE 12 *Continued*

Diameter		Approx. Mass		Minimum Breaking Force[A]						Diameter Range	
in.	[mm]	lb/ft	[kg/m]	IPS Tons	1770 [kN]	EIP Tons	1960 [kN]	EEIP Tons	2160 [kN]	Min. in.	Max. in.
2¾		14.0	20.832	314		361		397		2.750	2.888
2⅞		15.3	22.786	341		392		432		2.875	3.019
3		16.6	24.701	370		425		438		3.000	3.150
3⅛		18.1	26.933	399		458		504		3.125	3.281
3¼		19.5	29.018	429		492		543		3.250	3.413
3⅜		21.0	31.248	459		529		582		3.375	3.544
3½		22.7	33.778	491		564		621		3.500	3.675

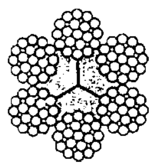
[A] Minimum breaking force for final-galvanized ropes 10 % lower than values listed.

Note—To convert to kilonewtons (kN), multiply tons by 8.896.

TABLE 13 Classification 6x19 Fiber Core



6x21
fiber wire
FC



6x25
fiber wire
FC

Construction of Rope Item	Quantity	Construction of Strand Item	Quantity
Strands	6	Wires	15 to 26
Outer Strands	6	Outer Wires	7 to 12
Layer of Strands	1	Layer of Wires	2 to 3
Wires in Rope	90 to 156		

Typical Examples		Number of Outer Wires	
Rope	Strand	Total	Per Strand
6x19S	1–9–9	54	9
6x21F	1–5–5F–10	60	10
6x26WS	1–5–(5+5)–10	60	10
6x19W	1–6–(6+6)	72	12
6x25F	1–6–6F–12	72	12

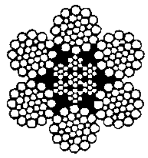
Diameter		Approx. Mass		Minimum Breaking Force[A]						Diameter Range	
in.	[mm]	lb/ft	[kg/m]	IPS Tons	1770 [kN]	EIP Tons	1960 [kN]	EEIP Tons	2160 [kN]	Min. in.	Max. in.
	6	0.09	0.140		21.0		23.3		25.7	0.236	0.250
¼		0.11	0.156	2.74		3.01				0.250	0.265
	7	0.13	0.190		28.8		31.7		34.9	0.276	0.292
5⁄16		0.16	0.244	4.26		4.69				0.313	0.331
	8	0.17	0.248		37.4		41.4		45.6	0.315	0.331
	9	0.21	0.314		47.3		52.4		57.7	0.354	0.372
⅜		0.24	0.352	6.10		6.71		7.38		0.375	0.394
	10	0.26	0.388		58.4		64.7		71.3	0.394	0.413
	11	0.32	0.469		70.7		78.3		86.2	0.433	0.455
7⁄16		0.32	0.479	8.27		9.10		10.0		0.438	0.459
	12	0.38	0.559		84.1		93.1		103	0.472	0.496
½		0.42	0.626	10.7		11.8		12.9		0.500	0.525
	13	0.44	0.656		98.7		109		120	0.512	0.537
	14	0.51	0.760		114		127		140	0.551	0.579
9⁄16		0.53	0.792	13.5		14.9		16.3		0.563	0.591
⅝		0.66	0.978	16.7		18.4		20.2		0.625	0.656
	16	0.67	0.993		150		166		182	0.630	0.861
	18	0.84	1.257		189		210		231	0.709	0.744
	19	0.94	1.401		211		233		257	0.748	0.785
¾		0.95	1.408	23.8		26.2		28.8		0.750	0.788
	20	1.04	1.552		234		259		285	0.787	0.827
	22	1.26	1.878		283		313		345	0.866	0.909
⅞		1.29	1.917	32.2		35.4		39.0		0.875	0.919
	24	1.50	2.235		336		373		411	0.945	0.992
1		1.68	2.503	41.8		48.0		50.8		1.000	1.050
	26	1.76	2.623		395		437		482	1.024	1.075
	28	2.04	3.042		458		507		559	1.102	1.157
1⅛		2.13	3.188	52.6		57.9		63.6		1.125	1.181
1¼		2.63	3.911	64.6		71.1		78.2		1.250	1.313
	32	2.67	3.973		598		662		730	1.260	1.323
1⅜		3.18	4.733	77.7		85.5		94.0		1.375	1.444
	36	3.38	5.028		757		838		924	1.417	1.488
1½		3.78	5.632	92.0		101		111		1.500	1.575
	40	4.17	6.208		935		1035		1140	1.575	1.654
1⅝		4.44	6.610	107		118		129		1.625	1.706
	44	5.05	7.512		1131		1252		1380	1.732	1.819
1¾		5.15	7.666	124		136		150		1.750	1.838
1⅞		5.91	8.800	141		155		171		1.875	1.969
	48	6.01	8.940		1346		1490		1642	1.890	1.984
2		6.73	10.013	160		176		194		2.000	2.100
	52	7.05	10.492		1579		1749		1927	2.047	2.150
2⅛		7.60	11.304	179		197		217		2.125	2.231
	56	8.18	12.188		1832		2028		2235	2.205	2.315
2¼		8.52	12.673	200		220		242		2.250	2.363
	60	9.39	13.968		2103		2328		2566	2.362	2.480

TABLE 13 *Continued*

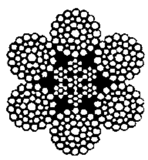
Diameter		Approx. Mass		Minimum Breaking Force[A]						Diameter Range	
in.	[mm]	lb/ft	[kg/m]	IPS Tons	1770 [kN]	EIP Tons	1960 [kN]	EEIP Tons	2160 [kN]	Min. in.	Max. in.
2⅜		9.49	14.120	222		244		269		2.375	2.494
2½		10.5	15.624	244		269		295		2.500	2.625
2⅝		11.8	17.281	288		294		324		2.825	2.758
2¾		12.7	18.898	292		321		353		2.750	2.888
2⅞		13.9	20.683	317		349		384		2.875	3.019
3		15.1	22.489	344		378		416		3.000	3.150
3⅛		16.4	24.403	371		408		448		3.125	3.281
3¼		17.7	26.338	399		438		483		3.250	3.413
3⅜		19.1	28.421	427		470		518		3.375	3.544
3½		20.6	30.653	457		503		552		3.500	3.675

[A] Minimum breaking force for final-galvanized ropes 10 % lower than values listed.
Note—To convert to kilonewtons (kN), multiply tons by 8.896.

TABLE 14 Classification 6x36 Steel Core

Cross Section Examples	Construction of Rope: Item	Quantity	Construction of Strand: Item	Quantity
	Strands	6	Wires	27 to 49
	Outer Strands	6	Outer Wires	12 to 18
	Layer of Strands	1	Layer of Wires	3 to 4
6x31 Warrington Seale IWRC	Wires in Rope (excluding steel core)	156 to 276		

Typical Examples: Rope	Strand	Number of Outer Wires: Total	Per Strand
6x31WS	1–6–(6+6)–12	72	12
6x36WS	1–7–(7+7)–14	84	14
6x41WS	1–8–(8+8)–16	96	16
6x41SF	1–8–8–8F–16	96	16
6x49SWS	1–8–8–(8+8)–16	96	16
6x46WS	1–9–(9+9)–18	108	18



6x41 Warrington Seale IWRC

Diameter		Approx. Mass		Minimum Breaking Force[A]						Diameter Range	
in.	[mm]	lb/ft	[kg/m]	IPS Tons	1770 [kN]	EIP Tons	1960 [kN]	EEIP Tons	2160 [kN]	Min. in.	Max. in.
	6	0.10	0.153		22.7		25.1		27.7	0.236	0.250
¼		0.12	0.172	2.94		3.40				0.250	0.265
	7	0.14	0.209		30.9		34.2		37.7	0.276	0.292
5⁄16		0.18	0.268	4.58		5.27				0.313	0.331
	8	0.18	0.273		40.3		44.7		49.2	0.315	0.331
	9	0.23	0.345		51.0		56.5		62.3	0.354	0.372
⅜		0.26	0.386	6.56		7.55		8.30		0.375	0.394
	10	0.29	0.426		63.0		69.8		76.9	0.394	0.413
	11	0.35	0.515		76.2		84.4		93.0	0.433	0.455
7⁄16		0.35	0.526	8.89		10.2		11.2		0.438	0.459
	12	0.41	0.613		90.7		100		111	0.472	0.496
½		0.46	0.687	11.5		13.3		14.6		0.500	0.525
	13	0.48	0.720		106		118		130	0.512	0.537
	14	0.56	0.835		124		137		151	0.551	0.579
9⁄16		0.58	0.870	14.5		16.8		18.5		0.563	0.591
⅝		0.72	1.074	17.7		20.6		22.7		0.625	0.656
	16	0.73	1.091		161		179		197	0.630	0.661
	18	0.93	1.380		204		226		249	0.709	0.744
	19	1.03	1.538		227		252		278	0.748	0.785
¾		1.04	1.546	25.6		29.4		32.4		0.750	0.788
	20	1.15	1.704		252		279		308	0.787	0.827
	22	1.39	2.062		305		338		372	0.866	0.909
⅞		1.41	2.104	34.6		39.8		43.8		0.875	0.919
	24	1.65	2.454		363		402		443	0.945	0.992
1		1.85	2.748	44.9		51.7		56.9		1.000	1.050
	26	1.94	2.880		426		472		520	1.024	1.075
	28	2.24	3.340		494		547		603	1.102	1.157
1⅛		2.34	3.478	56.5		65.0		71.5		1.125	1.181
1¼		2.89	4.294	69.4		79.9		87.9		1.250	1.313
	32	2.93	4.362		645		715		787	1.260	1.323
1⅜		3.49	5.196	83.5		96.0		106		1.375	1.444
	36	3.71	5.521		817		904		997	1.417	1.488
1½		4.16	6.184	98.9		114		125		1.500	1.575
	40	4.58	6.816		1008		1116		1230	1.575	1.654
1⅝		4.88	7.257	115		132		146		1.625	1.706
	44	5.54	8.247		1220		1351		1489	1.732	1.819
1¾		5.66	8.417	133		153		169		1.750	1.838
1⅞		6.49	9.662	152		174		192		1.875	1.969
	48	6.60	9.815		1452		1608		1772	1.890	1.984
2		7.39	10.994	172		198		217		2.000	2.100
	52	7.74	11.519		1704		1887		2079	2.047	2.150
2⅛		8.34	12.411	192		221		243		2.125	2.231
	56	8.98	13.359		1976		2188		2411	2.205	2.315
2¼		9.35	13.914	215		247		272		2.250	2.363
	60	10.31	15.336		2268		2512		2768	2.362	2.480
2⅜		10.42	15.503	239		274		301		2.375	2.494

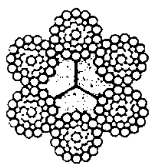
TABLE 14 *Continued*

Diameter		Approx. Mass		Minimum Breaking Force[A]						Diameter Range	
in.	[mm]	lb/ft	[kg/m]	IPS Tons	1770 [kN]	EIP Tons	1960 [kN]	EEIP Tons	2160 [kN]	Min. in.	Max. in.
2½		11.6	17.261	262		302		332		2.500	2.625
2⅝		12.8	19.046	288		331		364		2.625	2.756
2¾		14.0	20.832	314		361		397		2.750	2.888
2⅞		15.3	22.766	341		392		432		2.875	3.019
3		16.6	24.701	370		425		438		3.000	3.150
3⅛		18.1	26.933	399		458		504		3.125	3.281
3¼		19.5	29.016	429		492		543		3.250	3.413
3⅜		21.0	31.248	459		529		582		3.375	3.544
3½		22.7	33.778	491		564		621		3.500	3.675

[A] Minimum breaking force for final-galvanized ropes 10 % lower than values listed.

Note—To convert to kilonewtons (kN), multiply tons by 8.898.

TABLE 15 Classification 6×36 Fiber Core

Cross Section Examples	Construction of Rope: Item	Construction of Rope: Quantity	Construction of Strand: Item	Construction of Strand: Quantity
 6×36 Warrington Seale FC	Strands	6	Wires	27 to 49
	Outer Strands	6	Outer Wires	12 to 18
	Layer of Strands	1	Layer of Wires	3 to 4
	Wires in Rope	156 to 276		

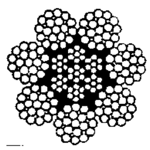
Typical Examples: Rope	Typical Examples: Strand	Number of Outer Wires: Total	Number of Outer Wires: Per Strand
6x31WS	1–6–(6+6)–12	72	12
6x36WS	1–7–(7+7)–14	84	14
6x41WS	1–6–(8+8)–16	96	16
6x41SF	1–8–8–8F–16	96	16
6x49SWS	1–8–8–(8+8)–16	96	16
6x46WS	1–9–(9+9)–18	108	18

Diameter in.	Diameter [mm]	Approx. Mass lb/ft	Approx. Mass [kg/m]	Minimum Breaking Force[A] IPS Tons	1770 [kN]	EIP Tons	1960 [kN]	EEIP Tons	2160 [kN]	Diameter Range Min. in.	Diameter Range Max. in.
	6	0.09	0.140		21.0		23.3		25.7	0.236	0.250
¼		0.11	0.156	2.74		3.01				0.250	0.265
	7	0.13	0.190		28.6		31.7		34.9	0.276	0.292
5⁄16		0.16	0.244	4.26		4.69				0.313	0.331
	8	0.17	0.248		37.4		41.4		45.6	0.315	0.331
	9	0.21	0.314		47.3		52.4		57.7	0.354	0.372
⅜		0.24	0.352	6.10		6.71		7.38		0.375	0.394
	10	0.26	0.388		58.4		64.7		71.3	0.394	0.413
	11	0.32	0.469		70.7		78.3		86.2	0.433	0.455
7⁄16		0.32	0.479	8.27		9.10		10.0		0.438	0.459
	12	0.38	0.559		84.1		93.1		103	0.472	0.496
½		0.42	0.626	10.7		11.8		12.9		0.500	0.525
	13	0.44	0.656		98.7		109		120	0.512	0.537
	14	0.51	0.760		114		127		140	0.551	0.579
9⁄16		0.53	0.792	13.5		14.9		16.3		0.563	0.591
⅝		0.66	0.978	16.7		18.4		20.2		0.625	0.656
	16	0.67	0.993		150		166		182	0.630	0.661
	18	0.84	1.257		189		210		231	0.709	0.744
	19	0.94	1.401		211		233		257	0.748	0.785
¾		0.95	1.408	23.8		26.2		28.8		0.750	0.788
	20	1.04	1.552		234		259		285	0.787	0.827
	22	1.26	1.878		283		313		345	0.866	0.909
⅞		1.29	1.917	32.2		35.4		39.0		0.875	0.919
	24	1.50	2.235		336		373		411	0.945	0.992
1		1.68	2.503	41.8		46.0		50.6		1.000	1.050
	26	1.76	2.623		395		437		482	1.024	1.075
	28	2.04	3.042		458		507		559	1.102	1.157
1⅛		2.13	3.168	52.6		57.9		63.6		1.125	1.181
1¼		2.63	3.911	64.6		71.1		78.2		1.250	1.313
	32	2.67	3.973		598		662		730	1.260	1.323
1⅜		3.18	4.733	77.7		85.5		94.0		1.375	1.444
	36	3.38	5.028		757		838		924	1.417	1.488
1½		3.78	5.632	92.0		101		111		1.500	1.575
	40	4.17	6.208		935		1035		1140	1.575	1.654
1⅝		4.44	6.610	107		118		129		1.625	1.706
	44	5.05	7.512		1131		1252		1380	1.732	1.819
1¾		5.15	7.666	124		136		150		1.750	1.838
1⅞		5.91	8.800	141		155		171		1.875	1.969
	48	6.01	8.940		1346		1490		1642	1.890	1.984
2		6.73	10.013	160		176		194		2.000	2.100
	52	7.05	10.492		1579		1749		1927	2.047	2.150
2⅛		7.60	11.304	179		197		217		2.125	2.231
	56	8.18	12.168		1832		2028		2235	2.205	2.315
2¼		8.52	12.673	200		220		242		2.250	2.363
	60	9.39	13.968		2103		2328		2566	2.362	2.480
2⅜		9.49	14.120	222		244		269		2.375	2.494
2½		10.5	15.624	244		269		295		2.500	2.625
2⅝		11.6	17.261	268		294		324		2.625	2.756
2¾		12.7	18.898	292		321		353		2.750	2.888
2⅞		13.9	20.683	317		349		384		2.875	3.019
3		15.1	22.469	344		378		416		3.000	3.150
3⅛		16.4	24.403	371		408		448		3.125	3.281
3¼		17.7	26.338	399		438		483		3.250	3.413
3⅜		19.1	28.421	427		470		518		3.375	3.544
3½		20.6	30.653	457		503		552		3.500	3.675

[A] Minimum breaking force for final-galvanized ropes 10 % lower than values listed.

Note—To convert to kilonewtons (kN), multiply tons by 8.896.

TABLE 16 Classification 7x19 Steel Core

Cross Section Examples	Construction of Rope		Construction of Strand	
	Item	Quantity	Item	Quantity
	Strands	7	Wires	15 to 26
	Outer Strands	7	Outer Wires	7 to 12
	Layer of Strands	1	Layer of Wires	2 to 3
	Wires in Rope	105 to 182		

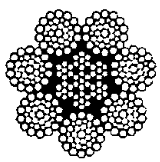
Cross Section Examples	Typical Examples		Number of Outer Wires	
	Rope	Strand	Total	Per Strand
	7x19S	1–9–9	63	9
7x25 filler wire IWRC	7x21F	1–5–5F–10	70	10
	7x26WS	1–5–(5+5)–10	70	10
	7x19W	1–6–(6+6)	84	12
	7x25F	1–6–6F–12	84	12

Diameter		Approx. Mass		Minimum Breaking Force[A]						Diameter Range	
in.	[mm]	lb/ft	[kg/m]	IPS Tons	1770 [kN]	EIP Tons	1960 [kN]	EEIP Tons	2160 [kN]	Min. in.	Max. in.
	6	0.11	0.157		22.7		25.1		27.7	0.236	0.250
¼		0.12	0.176	2.94		3.40				0.250	0.265
	7	0.14	0.214		30.9		34.2		37.7	0.276	0.292
5⁄16		0.19	0.275	4.58		5.27				0.313	0.331
	8	0.19	0.280		40.3		44.7		49.2	0.315	0.331
	9	0.24	0.354		51.0		56.5		62.3	0.354	0.372
⅜		0.27	0.396	6.56		7.55		8.30		0.375	0.394
	10	0.29	0.437		63.0		69.8		76.9	0.394	0.413
	11	0.36	0.529		76.2		84.4		93.0	0.433	0.455
7⁄16		0.36	0.540	8.89		10.2		11.2		0.438	0.459
	12	0.42	0.629		90.7		100		111	0.472	0.496
½		0.47	0.705	11.5		13.3		14.6		0.500	0.525
	13	0.50	0.739		106		118		130	0.512	0.537
	14	0.58	0.857		124		137		151	0.551	0.579
9⁄16		0.60	0.892	14.5		16.8		18.5		0.563	0.591
⅝		0.74	1.101	17.7		20.6		22.7		0.625	0.656
	16	0.75	1.119		161		179		197	0.630	0.661
	18	0.95	1.416		204		226		249	0.709	0.744
	19	1.06	1.578		227		252		278	0.748	0.785
¾		1.07	1.586	25.6		29.4		32.4		0.750	0.788
	20	1.17	1.748		252		279		308	0.787	0.827
	22	1.42	2.115		305		338		372	0.866	0.909
⅞		1.45	2.159	34.6		39.8		43.8		0.875	0.919
	24	1.69	2.517		363		402		443	0.945	0.992
1		1.89	2.819	44.9		51.7		56.9		1.000	1.050
	26	1.99	2.954		426		472		520	1.024	1.075
	28	2.30	3.426		494		547		603	1.102	1.157
1⅛		2.40	3.568	56.5		65.0		71.5		1.125	1.181
1¼		2.96	4.405	69.4		79.9		87.9		1.250	1.313
	32	3.01	4.475		645		715		787	1.260	1.323
1⅜		3.58	5.330	83.5		96.0		106		1.375	1.444
	36	3.81	5.664		817		904		997	1.417	1.488
1½		4.26	6.344	98.9		114		125		1.500	1.575
	40	4.70	6.992		1008		1116		1230	1.575	1.654
1⅝		5.00	7.445	115		132		146		1.625	1.706
	44	5.69	8.460		1220		1351		1489	1.732	1.819
1¾		5.80	8.634	133		153		169		1.750	1.838
1⅞		6.66	9.912	152		174		192		1.875	1.969
	48	6.77	10.068		1452		1606		1772	1.890	1.984
2		7.58	11.277	172		198		217		2.000	2.100
	52	7.94	11.816		1704		1887		2079	2.047	2.150
2⅛		6.56	12.731	192		221		243		2.125	2.231
	56	9.21	13.704		1976		2186		2411	2.205	2.315
2¼		9.59	14.273	215		247		272		2.250	2.363
	80	10.57	15.732		2268		2512		2788	2.362	2.480
2⅜		10.69	15.903	239		274		301		2.375	2.494

[A] Minimum breaking force for final-galvanized ropes 10 % lower than values listed.

Note—To convert to kilonewtons (kN), multiply tons by 8.896.

TABLE 17 Classification 7x36 Steel Core

Cross Section Examples	Construction of Rope: Item	Quantity	Construction of Strand: Item	Quantity
 7x36 Warrington Seale IWRC	Strands	7	Wires	27 to 49
	Outer Strands	7	Outer Wires	12 to 18
	Layer of Strands	1	Layer of Wires	3 to 4
	Wires in Rope	189 to 343		

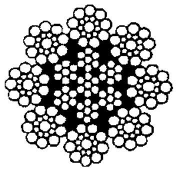
Typical Examples: Rope	Strand	Number of Outer Wires: Total	Per Strand
7x31WS	1–6–(6+6)–12	84	12
7x36WS	1–7–(7+7)–14	98	14
7x41WS	1–6–(8+8)–16	112	16
7x41SF	1–8–8–8F–16	112	16
7x49SWS	1–8–8–(8+8)–16	112	16
7x46WS	1–9–(9+9)–18	126	18

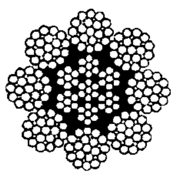
Diameter		Approx. Mass		Minimum Breaking Force[A]						Diameter Range	
in.	[mm]	lb/ft	[kg/m]	IPS Tons	1770 [kN]	EIP Tons	1960 [kN]	EEIP Tons	2160 [kN]	Min. in.	Max. in.
	6	0.11	0.157		22.7		25.1		27.7	0.236	0.250
¼		0.12	0.176	2.94		3.40				0.250	0.265
	7	0.14	0.214		30.9		34.2		37.7	0.276	0.292
5⁄16		0.19	0.275	4.58		5.27				0.313	0.331
	8	0.19	0.280		40.3		44.7		49.2	0.315	0.331
	9	0.24	0.354		51.0		56.5		62.3	0.354	0.372
⅜		0.27	0.396	6.56		7.55		8.30		0.375	0.394
	10	0.29	0.437		63.0		69.8		76.9	0.394	0.413
	11	0.36	0.529		76.2		84.4		93.0	0.433	0.455
7⁄16		0.36	0.540	8.89		10.2		11.2		0.438	0.459
	12	0.42	0.629		90.7		100		111	0.472	0.496
½		0.47	0.705	11.5		13.3		14.6		0.500	0.525
	13	0.50	0.739		106		118		130	0.512	0.537
	14	0.58	0.857		124		137		151	0.551	0.579
9⁄16		0.60	0.892	14.5		16.8		18.5		0.563	0.591
⅝		0.74	1.101	17.7		20.6		22.7		0.625	0.656
	16	0.75	1.119		161		179		197	0.630	0.661
	18	0.95	1.416		204		226		249	0.709	0.744
	19	1.06	1.578		227		252		276	0.748	0.785
¾		1.07	1.586	25.6		29.4		32.4		0.750	0.788
	20	1.17	1.748		252		279		308	0.787	0.827
	22	1.42	2.115		305		338		372	0.866	0.909
⅞		1.45	2.159	34.6		39.8		43.8		0.875	0.919
	24	1.69	2.517		363		402		443	0.945	0.992
1		1.89	2.819	44.9		51.7		56.9		1.000	1.050
	26	1.99	2.954		426		472		520	1.024	1.075
	28	2.30	3.426		494		547		603	1.102	1.157
1⅛		2.40	3.568	56.5		65.0		71.5		1.125	1.181
1¼		2.96	4.405	69.4		79.9		87.9		1.250	1.313
	32	3.01	4.475		645		715		787	1.260	1.323
1⅜		3.58	5.330	83.5		96.0		106		1.375	1.444
	36	3.81	5.664		817		904		997	1.417	1.488
1½		4.26	6.344	98.9		114		125		1.500	1.575
	40	4.70	6.992		1008		1116		1230	1.575	1.654
1⅝		5.00	7.445	115		132		146		1.625	1.706
	44	5.69	8.460		1220		1351		1489	1.732	1.819
1¾		5.80	6.634	133		153		169		1.750	1.838
1⅞		6.66	9.912	152		174		192		1.875	1.969
	48	6.77	10.068		1452		1608		1772	1.890	1.984
2		7.58	11.277	172		198		217		2.000	2.100
	52	7.94	11.816		1704		1887		2079	2.047	2.150
2⅛		8.56	12.731	192		221		243		2.125	2.231
	56	9.21	13.704		1976		2188		2411	2.205	2.315
2¼		9.59	14.273	215		247		272		2.250	2.363
	60	10.57	15.732		2268		2512		2768	2.362	2.480
2⅜		10.69	15.903	239		274		301		2.375	2.494

[A] Minimum breaking force for final-galvanized ropes 10 % lower than values listed.

Note—To convert to kilonewtons (kN), multiply tons by 8.696.

TABLE 18 Classification 8x19 Steel Core

Cross Section Examples	Construction of Rope: Item	Construction of Rope: Quantity	Construction of Strand: Item	Construction of Strand: Quantity
 8x19 Seale IWRC	Strands	8	Wires	15 to 26
	Outer Strands	8	Outer Wires	7 to 12
	Layer of Strands	1	Layer of Wires	2 to 3
	Wires in Rope (excluding steel core)	120 to 232		



8x25 Filler Wire IWRC

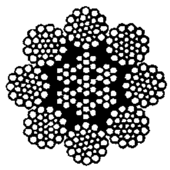
Typical Examples: Rope	Typical Examples: Strand	Number of Outer Wires: Total	Number of Outer Wires: Per Strand
8x19S	1–9–9	72	9
8x21F	1–5–5F–10	80	10
8x26WS	1–5–(5+5)–10	80	10
8x19W	1–6–(6+6)	96	12
8x25F	1–6–6F–12	96	12

Diameter		Approx. Mass		Minimum Breaking Force[A]						Diameter Range	
in.	[mm]	lb/ft	[kg/m]	IPS Tons	1770 [kN]	EIP Tons	1960 [kN]	EEIP Tons	2160 [kN]	Min. in.	Max. in.
	8	0.11	0.181		22.7		25.1		27.7	0.238	0.250
1/4		0.12	0.180	2.94		3.40				0.250	0.265
	7	0.15	0.219		30.9		34.2		37.7	0.276	0.292
5/16		0.19	0.281	4.58		5.27				0.313	0.331
	8	0.19	0.285		40.3		44.7		49.2	0.315	0.331
	9	0.24	0.361		51.0		56.5		62.3	0.354	0.372
3/8		0.27	0.405	6.56		7.55		8.30		0.375	0.394
	10	0.30	0.446		63.0		69.8		76.9	0.394	0.413
	11	0.36	0.540		76.2		84.4		93.0	0.433	0.455
7/16		0.37	0.551	8.89		10.2		11.2		0.438	0.459
	12	0.43	0.642		90.7		100		111	0.472	0.496
1/2		0.48	0.719	11.5		13.3		14.6		0.500	0.525
	13	0.51	0.754		106		118		130	0.512	0.537
	14	0.59	0.874		124		137		151	0.551	0.579
9/16		0.61	0.910	14.5		16.8		18.5		0.563	0.591
5/8		0.76	1.124	17.7		20.8		22.7		0.825	0.858
	16	0.77	1.142		161		179		197	0.630	0.661
	18	0.97	1.445		204		226		249	0.709	0.744
	19	1.08	1.610		227		252		278	0.748	0.785
3/4		1.09	1.619	25.6		29.4		32.4		0.750	0.788
	20	1.20	1.784		252		279		308	0.787	0.827
	22	1.45	2.159		305		338		372	0.866	0.909
7/8		1.48	2.203	34.6		39.8		43.8		0.875	0.919
	24	1.73	2.569		363		402		443	0.945	0.992
1		1.93	2.877	44.9		51.7		56.9		1.000	1.050
	26	2.03	3.015		426		472		520	1.024	1.075
	28	2.35	3.497		494		547		603	1.102	1.157
1 1/8		2.45	3.642	56.5		65.0		71.5		1.125	1.181
1 1/4		3.02	4.496	69.4		79.9		87.9		1.250	1.313
	32	3.07	4.587		845		715		787	1.260	1.323
1 3/8		3.66	5.440	83.5		96.0		106		1.375	1.444
	36	3.88	5.780		817		904		997	1.417	1.488
1 1/2		4.35	6.474	98.9		114		125		1.500	1.575
	40	4.80	7.136		1008		1116		1230	1.575	1.654
1 5/8		5.11	7.598	115		132		146		1.625	1.706
	44	5.80	8.635		1220		1351		1489	1.732	1.819
1 3/4		5.92	8.812	133		153		169		1.750	1.838
1 7/8		6.80	10.116	152		174		192		1.875	1.969
	48	6.91	10.276		1452		1608		1772	1.890	1.984
2		7.73	11.510	172		198		217		2.000	2.100
	52	8.10	12.080		1704		1887		2079	2.047	2.150
2 1/8		8.73	12.993	192		221		243		2.125	2.231
	56	9.40	13.987		1976		2188		2411	2.205	2.315
2 1/4		9.79	14.567	215		247		272		2.250	2.363
	60	10.79	16.058		2288		2512		2788	2.382	2.480
2 3/8		10.91	16.230	239		274		301		2.375	2.494

[A] Minimum breaking force for final-galvanized ropes 10 % lower than values listed.

NOTE—To convert to kilonewtons (kN), multiply tons by 8.896.

TABLE 19 Classification 8x36 Steel Core



8x31
Warrington Seale
IWRC

Construction of Rope: Item	Quantity	Construction of Strand: Item	Quantity
Strands	8	Wires	29 to 57
Outer Strands	8	Outer Wires	12 to 18
Layer of Strands	1	Layer of Wires	3 to 4
Wires in Rope (excluding steel core)	232 to 458		

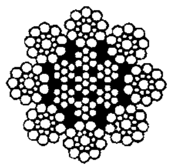
Typical Examples: Rope	Strand	Number of Outer Wires: Total	Per Strand
8x31WS	1–6–(6+6)–12	96	12
8x36WS	1–7–(7+7)–14	112	14
8x41WS	1–8–(8+8)–16	128	16
8x41SF	1–8–8–8F–16	128	16
8x49SWS	1–8–8–(8+8)–16	128	16
8x46WS	1–9–(9+9)–18	144	18

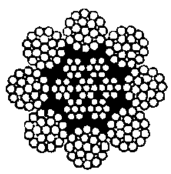
Diameter		Approx. Mass		Minimum Breaking Force[A]						Diameter Range	
in.	[mm]	lb/ft	[kg/m]	IPS Tons	1770 [kN]	EIP Tons	1960 [kN]	EEIP Tons	2160 [kN]	Min. in.	Max. in.
	6	0.11	0.161		22.7		25.1		27.7	0.236	0.250
¼		0.12	0.180	2.94		3.40				0.250	0.265
	7	0.15	0.219		30.9		34.2		37.7	0.276	0.292
5⁄16		0.19	0.281	4.58		5.27				0.313	0.331
	8	0.19	0.285		40.3		44.7		49.2	0.315	0.331
	9	0.24	0.381		51.0		56.5		62.3	0.354	0.372
⅜		0.27	0.405	6.56		7.55		8.30		0.375	0.394
	10	0.30	0.446		63.0		69.8		76.9	0.394	0.413
	11	0.36	0.540		76.2		84.4		93.0	0.433	0.455
7⁄16		0.37	0.551	8.89		10.2		11.2		0.438	0.459
	12	0.43	0.642		90.7		100		111	0.472	0.496
½		0.48	0.719	11.5		13.3		14.6		0.500	0.525
	13	0.51	0.754		106		118		130	0.512	0.537
	14	0.59	0.874		124		137		151	0.551	0.579
9⁄16		0.61	0.910	14.5		16.8		18.5		0.563	0.591
⅝		0.76	1.124	17.7		20.6		22.7		0.625	0.656
	16	0.77	1.142		161		179		197	0.630	0.661
	18	0.97	1.445		204		226		249	0.709	0.744
	19	1.08	1.610		227		252		278	0.748	0.785
¾		1.09	1.619	25.6		29.4		32.4		0.750	0.788
	20	1.20	1.784		252		279		308	0.787	0.827
	22	1.45	2.159		305		338		372	0.866	0.909
⅞		1.48	2.203	34.6		39.8		43.8		0.875	0.919
	24	1.73	2.569		363		402		443	0.945	0.992
1		1.93	2.877	44.9		51.7		56.9		1.000	1.050
	26	2.03	3.015		426		472		520	1.024	1.075
	28	2.35	3.497		494		547		603	1.102	1.157
1⅛		2.45	3.642	56.5		85.0		71.5		1.125	1.181
1¼		3.02	4.496	69.4		79.9		87.9		1.250	1.313
	32	3.07	4.567		645		715		787	1.260	1.323
1⅜		3.66	5.440	83.5		96.0		106		1.375	1.444
	36	3.88	5.780		817		904		997	1.417	1.488
1½		4.35	6.474	98.9		114		125		1.500	1.575
	40	4.80	7.136		1008		1116		1230	1.575	1.654
1⅝		5.11	7.598	115		132		146		1.625	1.706
	44	5.80	8.635		1220		1351		1489	1.732	1.819
1¾		5.92	8.812	133		153		169		1.750	1.838
1⅞		6.80	10.116	152		174		192		1.875	1.969
	48	6.91	10.276		1452		1606		1772	1.890	1.984
2		7.73	11.510	172		198		217		2.000	2.100
	52	8.10	12.060		1704		1887		2079	2.047	2.150
2⅛		8.73	12.993	192		221		243		2.125	2.231
	56	9.40	13.987		1976		2188		2411	2.205	2.315
2¼		9.79	14.567	215		247		272		2.250	2.363
	60	10.79	16.056		2268		2512		2768	2.362	2.480
2⅜		10.91	16.230	239		274		301		2.375	2.494

[A] Minimum breaking force for final-galvanized ropes 10 % lower than values listed.

Note—To convert to kilonewtons (kN), multiply tons by 8.896.

TABLE 20 Classification 8×19 Rotation Resistant—Category 3

Cross Section Examples	Construction of Rope		Construction of Strand	
	Item	Quantity	Item	Quantity
	Strands	8	Wires	15 to 28
	Outer Strands	8	Outer Wires	7 to 12
	Layer of Strands	1	Layer of Wires	2 to 3
8×19 Seale IWRC	Wires in Rope (excluding steel core)	120 to 232		

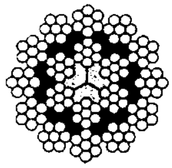
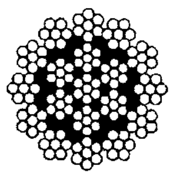
Cross Section Examples	Typical Examples		Number of Outer Wires	
	Rope	Strand	Total	Per Strand
	8×19S	1–9–9	72	9
	8×21F	1–5–5F-10	80	10
	8×26WS	1–5–(5+5)–10	80	10
	8×19W	1–6–(6+6)	96	12
8×25 Filler Wire IWRC	8×25F	1–6–6F–12	98	12

Diameter		Approx. Mass		Minimum Breaking Force[A]			Diameter Range	
in.	[mm]	lb/ft	[kg/m]	IPS Tons	EIP Tons	EEIP Tons	Min. in.	Max. in.
¼	6.3	0.12	0.178	2.8	3.0	3.3	0.250	0.285
5⁄16	7.9	0.18	0.268	4.0	4.6	5.1	0.313	0.331
⅜	9.5	0.26	0.387	5.8	6.6	7.3	0.375	0.394
7⁄16	11.1	0.36	0.536	7.8	9.0	9.9	0.438	0.459
½	12.7	0.47	0.700	10.1	11.6	12.8	0.500	0.525
9⁄16	14.3	0.60	0.886	12.8	14.7	16.2	0.563	0.591
⅝	15.9	0.74	1.094	15.7	18.1	19.9	0.625	0.656
¾	19.1	1.08	1.575	22.5	25.9	28.5	0.750	0.788
⅞	22.2	1.44	2.144	30.5	35.0	38.5	0.875	0.919
1	25.4	1.88	2.800	39.6	45.5	50.1	1.000	1.050
1⅛	28.6	2.38	3.544	49.8	57.3	63.0	1.125	1.181
1¼	31.8	2.94	4.375	81.3	70.5	77.8	1.250	1.313
1⅜	34.9	3.56	5.294	73.8	84.9	93.4	1.375	1.444
1½	38.1	4.23	6.300	87.3	100	110	1.500	1.575

[A] Minimum breaking force for final-galvanized ropes 10 % lower than values listed.

Note—To convert to kilonewtons (kN), multiply tons by 8.896.

TABLE 21 Classification 19x7 Rotation Resistant–Category 2

Cross Section Examples	Construction of Rope		Construction of Strand	
	Item	Quantity	Item	Quantity
 18x7 FC	Strands	17 to 18	Wires	5 to 7
	Outer Strands	10 to 13	Outer Wires	4 to 6
	Layer of Strands	2	Layer of Wires	1
	Wires in Rope (excluding steel core)	85 to 126		
 19x7				

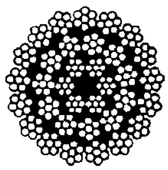
Typical Examples		Number of Outer Wires	
Rope	Strand	Total	Per Strand
17x7	1–6	66	6
18x7	1–6	72	6
19x7	1–6	72	6

Diameter		Approx. Mass				Minimum Breaking Force[A]				Diameter Range	
in.	[mm]	Fiber		WSC		IPS	1770	EIP	1960	Min.	Max.
		lb/ft	[kg/m]	lb/ft	[kg/m]	Tons	[kN]	Tons	[kN]	in.	in.
	6	0.10	0.144	0.10	0.151		20.9		23.1	0.236	0.248
¼		0.11	0.161	0.11	0.169	2.51		2.77		0.250	0.263
	7	0.13	0.196	0.14	0.205		28.4		31.5	0.276	0.289
5⁄16		0.17	0.251	0.18	0.264	3.90		4.30		0.313	0.328
	8	0.17	0.255	0.18	0.268		37.2		41.1	0.315	0.331
	9	0.22	0.323	0.23	0.339		47.0		52.1	0.354	0.372
⅜		0.24	0.362	0.26	0.380	5.59		6.15		0.375	0.394
	10	0.27	0.399	0.28	0.419		58.1		64.3	0.394	0.413
	11	0.32	0.483	0.34	0.507		70.2		77.8	0.433	0.455
7⁄16		0.33	0.493	0.35	0.517	7.58		8.33		0.438	0.459
	12	0.39	0.575	0.41	0.603		83.8		92.6	0.472	0.496
½		0.43	0.644	0.45	0.676	9.85		10.8		0.500	0.525
	13	0.45	0.674	0.48	0.708		98.1		109	0.512	0.537
	14	0.53	0.782	0.55	0.821		114		126	0.551	0.579
9⁄16		0.55	0.814	0.57	0.855	12.4		13.8		0.563	0.591
⅝		0.68	1.006	0.71	1.056	15.3		16.8		0.625	0.656
	16	0.69	1.021	0.72	1.073		149		165	0.630	0.661
	18	0.87	1.293	0.91	1.358		188		208	0.709	0.744
	19	0.97	1.440	1.02	1.513		210		232	0.748	0.785
¾		0.97	1.448	1.02	1.521	21.8		24.0		0.750	0.788
	20	1.07	1.596	1.13	1.676		232		257	0.787	0.827
	22	1.30	1.931	1.36	2.028		281		311	0.868	0.909
⅞		1.32	1.971	1.39	2.070	29.5		32.5		0.875	0.919
	24	1.54	2.298	1.62	2.413		334		370	0.945	0.992
1		1.73	2.574	1.82	2.703	38.3		42.2		1.000	1.050
	28	1.81	2.897	1.90	2.832		392		435	1.024	1.075
	28	2.10	3.128	2.21	3.285		455		504	1.102	1.157
1⅛		2.19	3.258	2.30	3.421	48.2		53.1		1.125	1.181
1¼		2.70	4.022	2.64	4.224	59.2		85.1		1.250	1.313
	32	2.75	4.086	2.88	4.291		594		658	1.260	1.323
1⅜		3.27	4.867	3.43	5.111	71.3		78.4		1.375	1.444
	36	3.47	5.171	3.65	5.430		752		833	1.417	1.488
1½		3.89	5.792	4.09	6.082	84.4		92.8		1.500	1.575
1⅝		4.57	6.800	4.80	7.142	98.4		108.0		1.625	1.706
1¾		5.30	7.886	5.57	8.288	114.0		125.0		1.750	1.838

[A] Minimum breaking force for final-galvanized ropes 10 % lower than values listed.

Note—To convert to kilonewtons (kN), multiply tons by 8.896.

TABLE 22 Classification 34x7 Rotation Resistant—Category 2

Cross Section Examples	Construction of Rope: Item	Quantity	Construction of Strand: Item	Quantity
	Strands	34 to 36	Wires	5 to 9
	Outer Strands	12 to 18	Outer Wires	4 to 8
	Layer of Strands	3	Layer of Wires	1
	Wires in Rope (excluding steel core)	170 to 324		
34x7				

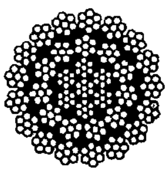
Typical Examples: Rope	Strand	Number of Outer Wires: Total	Per Strand
34x7 17:11/6–C	1–6	102	6
36x7 16:12/6–C	1–6	108	6

Diameter		Approx. Mass				Minimum Breaking Force[A]				Diameter Range	
		Fiber		WSC		1770		1960		Min.	Max.
in.	[mm]	lb/ft	[kg/m]	lb/ft	[kg/m]	Tons	[kN]	Tons	[kN]	in.	in.
	6	0.09	0.140	0.10	0.144		20.3		22.4	0.236	0.250
¼		0.11	0.157	0.11	0.162	2.55		2.83		0.250	0.265
	7	0.13	0.191	0.13	0.196		27.6		30.5	0.276	0.292
5⁄16		0.17	0.246	0.17	0.253	3.99		4.41		0.313	0.331
	8	0.17	0.250	0.17	0.257		36.0		39.9	0.315	0.331
	9	0.21	0.316	0.22	0.325		45.6		50.5	0.354	0.372
⅜		0.24	0.354	0.24	0.364	5.74		6.36		0.375	0.394
	10	0.26	0.390	0.27	0.401		56.3		62.3	0.394	0.413
	11	0.32	0.472	0.33	0.485		68.1		75.4	0.433	0.455
7⁄16		0.32	0.482	0.33	0.495	7.81		8.65		0.438	0.459
	12	0.38	0.562	0.39	0.577		81.1		89.8	0.472	0.496
½		0.42	0.629	0.43	0.647	10.2		11.3		0.500	0.525
	13	0.44	0.659	0.46	0.678		95.1		105.3	0.512	0.537
	14	0.51	0.764	0.53	0.786		110		122	0.551	0.579
9⁄16		0.53	0.796	0.55	0.819	12.9		14.3		0.563	0.591
⅝		0.66	0.983	0.68	1.011	15.9		17.7		0.625	0.656
	16	0.67	0.998	0.69	1.027		144		160	0.630	0.661
	18	0.85	1.264	0.87	1.299		182		202	0.709	0.744
	19	0.95	1.408	0.97	1.448		203		225	0.748	0.785
¾		0.95	1.415	0.98	1.455	23.0		25.4		0.750	0.788
	20	1.05	1.560	1.08	1.604		225		249	0.787	0.827
	22	1.27	1.888	1.30	1.941		272		302	0.866	0.909
⅞		1.29	1.926	1.33	1.981	31.3		34.6		0.875	0.919
	24	1.51	2.246	1.55	2.310		324		359	0.945	0.992
1		1.69	2.516	1.74	2.587	40.8		45.2		1.000	1.050
	26	1.77	2.636	1.82	2.711		380		421	1.024	1.075
	28	2.05	3.058	2.11	3.144		441		489	1.102	1.157
1⅛		2.14	3.184	2.20	3.274	51.7		57.2		1.125	1.181
1¼		2.64	3.931	2.72	4.042	63.8		70.6		1.250	1.313
	32	2.68	3.994	2.76	4.106		576		638	1.260	1.323
1⅜		3.20	4.757	3.29	4.891	77.2		85.5		1.375	1.444
	36	3.40	5.054	3.49	5.197		729		808	1.417	1.488
1½		3.80	5.661	3.91	5.821	91.8		102		1.500	1.575
	40	4.19	6.240	4.31	6.416		901		997	1.575	1.654
1⅝		4.48	6.644	4.59	6.832	108		119		1.625	1.706

[A] Minimum breaking force for final-galvanized ropes 10 % lower than values listed.

Note—To convert to kilonewtons (kN), multiply tons by 8.896.

TABLE 23 Classification 35x7 Rotation Resistant—Category 1

Cross Section Examples	Construction of Rope		Construction of Strand	
	Item	Quantity	Item	Quantity
	Strands	35	Wires	5 to 9
	Outer Strands	16	Outer Wires	4 to 8
	Layer of Strands	3	Layer of Wires	1
	Wires in Rope (excluding steel core)	238		

Typical Examples		Number of Outer Wires	
Rope	Strand	Total	Per Strand
35x7	1–6	96	6

35x7

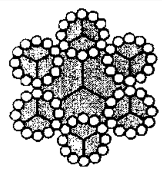
Diameter		Approx. Mass		Minimum Breaking Force[A]						Diameter Range	
in.	[mm]	WSC		1770		1960		2160		Min.	Max.
		lb/ft	[kg/m]	Tons	[kN]	Tons	[kN]	Tons	[kN]	in.	in.
	9	0.25	0.369		55.4		60.2		66.6	0.354	0.372
⅜		0.28	0.413	6.98		7.46		8.22		0.375	0.394
	10	0.31	0.455		69.2		75.4		83.5	0.394	0.413
	11	0.37	0.551		83.1		90.6		100	0.433	0.455
7⁄16		0.38	0.562	9.53		10.1		11.2		0.438	0.459
	12	0.44	0.655		99.9		106		119	0.472	0.496
½		0.49	0.734	12.6		13.6		14.6		0.500	0.525
	13	0.52	0.769		117		127		142	0.512	0.537
	14	0.60	0.892		136		147		165	0.551	0.579
9⁄16		0.62	0.929	15.9		17.3		18.5		0.563	0.591
⅝		0.77	1.147	19.7		21.7		22.8		0.625	0.656
	16	0.78	1.165		178		193		217	0.630	0.661
	18	0.99	1.474		223		241		271	0.709	0.744
	19	1.10	1.643		251		275		308	0.748	0.785
¾		1.11	1.651	28.4		30.9		32.9		0.750	0.788
	20	1.22	1.820		278		299		336	0.787	0.827
	22	1.46	2.202		337		368		413	0.866	0.909
⅞		1.51	2.247	38.7		41.6		44.7		0.875	0.919
	24	1.76	2.621		401		439		493	0.945	0.992
1		1.97	2.935	50.3		54.4		58.4		1.000	1.050
	26	2.07	3.076		469		514		576	1.024	1.075
	28	2.40	3.567		549		596		646	1.102	1.157
1⅛		2.50	3.715	64.3		68.9		73.9		1.125	1.181
1¼		3.08	4.587	78.8		86		91.3		1.250	1.313
	32	3.13	4.659		711		765		829	1.260	1.323
1⅜		3.73	5.550	95.4		106		110		1.375	1.444
	36	3.96	5.897		906		977		1060	1.417	1.488
1½		4.44	6.605	114		120		131		1.500	1.575
	40	4.69	7.260		1112		1200		1300	1.575	1.654
1⅝		5.21	7.752	134		140		154		1.625	1.706

[A] Minimum breaking force for final-galvanized ropes 10 % lower than values listed.

Note—To convert to kilonewtons (kN), multiply tons by 8.896.

TABLE 24 Classification 6x12 Fiber Core

Cross Section Examples



6x12
Running Rope
FC

Construction of Rope: Item	Quantity	Construction of Strand: Item	Quantity
Strands	6	Wires	12
Outer Strands	6	Outer Wires	12
Layer of Strands	1	Layer of Wires	1
Wires in Rope (excluding steel core)	72		

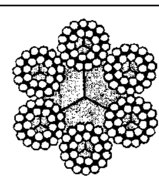
Typical Examples: Rope	Strand	Number of Outer Wires: Total	per Strand
6x12	FC-12	72	12

Diameter		Approx. Mass		Minimum Breaking Force	Diameter Range	
in.	[mm]	lb/ft	[kg/m]	IPS Tons	Min. in.	Max. in.
5/16	7.9	0.10	0.152	2	0.313	0.328
3/8	9.5	0.15	0.219	3.36	0.375	0.394
7/16	11.1	0.20	0.298	4.55	0.438	0.459
1/2	12.7	0.26	0.389	5.91	0.500	0.525
9/16	14.3	0.33	0.492	7.45	0.563	0.591
5/8	15.9	0.41	0.607	9.16	0.625	0.656
3/4	19.1	0.59	0.875	13.1	0.750	0.788
13/16	20.6	0.69	1.026	15.3	0.813	0.853
7/8	22.2	0.80	1.190	17.7	0.875	0.919
1	25.4	1.04	1.555	23.0	1.000	1.050

Note—To convert to kilonewtons (kN), multiply tons by 8.896.

TABLE 25 Classification 6x24 Fiber Core

Cross Section Examples



6x24 (2 operation)
Hawser Rope
FC

Construction of Rope: Item	Quantity	Construction of Strand: Item	Quantity
Strands	6	Wires	24
Outer Strands	6	Outer Wires	12–16
Layer of Strands	1	Layer of Wires	2
Wires in Rope (excluding steel core)	144		

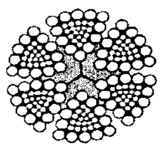
Typical Examples: Rope	Strand	Number of Outer Wires: Total	per Strand
6x24	FC/9/15	90	15
6x24W	FC/8-(8+8)	96	16
6x24S	FC/12-12	72	12

Diameter		Approx. Mass		Minimum Breaking Force	Diameter Range	
in.	[mm]	lb/ft	[kg/m]	IPS Tons	Min. in.	Max. in.
3/8	9.5	0.19	0.289	4.77	0.375	0.394
1/2	12.7	0.34	0.513	8.40	0.500	0.525
9/16	14.3	0.44	0.649	10.6	0.563	0.591
5/8	15.9	0.54	0.801	13.0	0.625	0.656
3/4	19.1	0.78	1.154	18.6	0.750	0.788
7/8	22.2	1.06	1.571	25.2	0.875	0.919
1	25.4	1.38	2.052	32.8	1.000	1.050
1 1/8	28.6	1.74	2.597	41.2	1.125	1.181
1 1/4	31.8	2.15	3.206	50.7	1.250	1.313
1 3/8	34.9	2.61	3.879	61.0	1.375	1.444
1 1/2	38.1	3.10	4.616	72.3	1.500	1.575
1 5/8	41.3	3.64	5.418	84.5	1.625	1.706
1 3/4	44.5	4.22	6.283	97.5	1.750	1.838
1 7/8	47.6	4.85	7.213	111	1.875	1.969
2	50.8	5.51	8.206	126	2.000	2.100
2 1/16	52.4	5.87	8.734	134	2.063	2.166

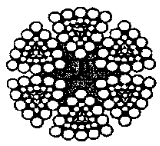
Note—To convert to kilonewtons (kN), multiply tons by 8.896.

TABLE 26 Classification 6x25 Triangular Strand Fiber Core

Cross Section Examples



6x30 Style G
Flattened Strand
(Plaited Center)
FC



6x31
Style V
(Brangle Center)
FC

Construction of Rope		Construction of Strand	
Item	Quantity	Item	Quantity
Strands	6	Wires	144
Outer Strands	6	Outer Wires	72
Layer of Strands	1	Layer of Wires	2
Wires in Rope			

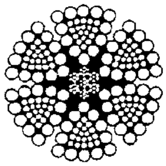
Typical Examples		Number of Outer Wires	
Rope	Strand	Total	Per Strand
6x25B	1/12/12	72	12
6x30G	(3x2)/12/12	72	12
6x27H	3/12/12	72	12
6x31V	1–6/12/12	72	12

Diameter		Approx. Mass		Minimum Breaking Force[A]			Diameter Range	
in.	[mm]	lb/ft	[kg/m]	IPS Tons	EIP Tons	EEIP Tons	Min. in.	Max. in.
3/8	9.5	0.25	0.372	6.7	7.4	8.1	0.325	0.394
1/2	12.7	0.45	0.669	11.8	13.0	14.3	0.500	0.525
9/16	14.3	0.57	0.847	14.9	16.4	18.0	0.563	0.591
5/8	15.9	0.70	1.046	18.3	20.1	22.1	0.625	0.656
3/4	19.1	1.01	1.506	26.2	28.8	31.7	0.750	0.788
7/8	22.2	1.38	2.050	35.4	38.9	42.8	0.875	0.919
1	25.4	1.80	2.677	46.0	50.6	55.7	1.000	1.050
1 1/8	28.6	2.28	3.389	57.9	63.7	70.1	1.125	1.181
1 1/4	31.8	2.81	4.183	71.0	78.1	85.9	1.250	1.313
1 3/8	34.9	3.40	5.062	85.5	94.1	103	1.375	1.444
1 1/2	38.1	4.05	6.024	101	111	122	1.500	1.575
1 5/8	41.3	4.75	7.070	118	130	143	1.625	1.706
1 3/4	44.5	5.51	8.200	138	152	167	1.750	1.838
1 7/8	47.6	6.33	9.413	155	171	188	1.875	1.969
2	50.8	7.20	10.710	176	194	213	2.000	2.100
2 1/8	54.0	8.12	12.090	196	215	237	2.125	2.231
2 1/4	57.2	9.11	13.554	220	240	264	2.250	2.363
2 3/8	60.3	10.15	15.102	241	265	292	2.375	2.494
2 1/2	83.5	11.20	18.665	289	295	325	2.500	2.625
2 3/4	69.8	13.60	20.237	321	354	389	2.750	2.888

[A] Minimum breaking force for final-galvanized ropes 10 % lower than values listed.

Note—To convert to kilonewtons (kN), multiply tons by 8.696.

TABLE 27 Classification 6×25 Triangular Strand Steel Core

Cross Section Examples	Construction of Rope		Construction of Strand	
	Item	Quantity	Item	Quantity
	Strands	6	Wires	144
	Outer Strands	6	Outer Wires	72
	Layer of Strands	1	Layer of Wires	2
	Wires in Rope			

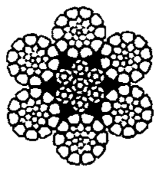
	Typical Examples		Number of Outer Wires	
	Rope	Strand	Total	Per Strand
6×30 Style G Flattened Strand (Plated Center) IWRC	6×25B	1/12/12	72	12
	6×30G	(3×2)/12/12	72	12
	6×27H	3/12/12	72	12
	6×31V	1–6/12/12	72	12

Diameter		Approx. Mass		Minimum Breaking Force[A]			Diameter Range	
in.	[mm]	lb/ft	[kg/m]	IPS Tons	EIP Tons	EEIP Tons	Min. in.	Max. in.
3/8	9.5	0.26	0.387	7.2	7.9	8.7	0.375	0.394
1/2	12.7	0.47	0.703	12.6	14.0	15.4	0.500	0.525
9/16	14.3	0.60	0.890	16.0	17.6	19.4	0.563	0.591
5/8	15.9	0.74	1.099	19.6	21.7	23.9	0.625	0.656
3/4	19.1	1.06	1.582	28.1	31.0	34.1	0.750	0.788
7/8	22.2	1.45	2.154	38.0	41.9	46.1	0.875	0.919
1	25.4	1.89	2.813	49.4	54.4	59.8	1.000	1.050
1 1/8	28.6	2.39	3.560	62.2	68.5	75.4	1.125	1.181
1 1/4	31.8	2.95	4.395	76.3	84.0	92.4	1.250	1.313
1 3/8	34.9	3.57	5.318	91.9	101	111	1.375	1.444
1 1/2	38.1	4.25	6.329	108	119	131	1.500	1.575
1 5/8	41.3	4.99	7.428	127	140	154	1.625	1.706
1 3/4	44.5	5.79	8.615	146	161	177	1.750	1.838
1 7/8	47.6	6.65	9.889	187	184	202	1.875	1.969
2	50.8	7.56	11.252	189	207	228	2.000	2.100
2 1/8	54.0	8.54	12.702	211	232	255	2.125	2.231
2 1/4	57.2	9.57	14.240	237	260	286	2.250	2.363
2 3/8	60.3	10.68	15.867	281	287	318	2.375	2.494
2 1/2	63.5	11.80	17.558	289	318	350	2.500	2.625
2 3/4	69.8	14.30	21.278	345	381	418	2.750	2.888

[A] Minimum breaking force for final-galvanized ropes 10 % lower than values listed.

Note—To convert to kilonewtons (kN), multiply tons by 8.896.

TABLE 28 Classification 6×19 Compacted Strand (CS)

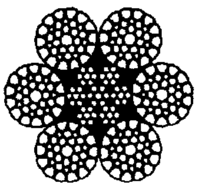
Cross Section Examples	Construction of Rope		Construction of Strand	
	Item	Quantity	Item	Quantity
	Strands	6	Wires	15 to 26
	Outer Strands	6	Outer Wires	7 to 12
	Layer of Strands	1	Layer of Wires	2 to 3
	Wires in Rope	90 to 156		
	Typical Examples		Number of Outer Wires	
	Rope	Strand	Total	Per Strand
	6x19S	1–9–9	54	9
6x26	6x21F	1–5–5F–10	60	10
Warrington Seale	6x26WS	1–5–(5+5)–10	60	10
Compacted Strand	8x19W	1–6–(8+6)	72	12
IWRC	6x25F	1–6–6F–12	72	12

Diameter		Approx. Mass		Minimum Breaking Force				Diameter Range	
in.	[mm]	lb/ft	[kg/m]	EIP Tons	1960 [kN]	EEIP Tons	2160 [kN]	Min. in.	Max. in.
3⁄8		0.282	0.419	8.30		9.13		0.375	0.394
	10	0.310	0.462		85.3		91.5	0.394	0.413
	11	0.376	0.559		98.1		113	0.433	0.455
7⁄16		0.383	0.571	11.2		12.3		0.438	0.459
	12	0.447	0.665		114		127	0.472	0.496
1⁄2		0.501	0.745	14.6		16.1		0.500	0.525
	13	0.525	0.781		147		157	0.512	0.537
	14	0.609	0.906		169		183	0.551	0.579
9⁄16		0.634	0.943	18.5		20.4		0.563	0.591
5⁄8		0.782	1.164	22.7		25.0		0.625	0.656
	16	0.795	1.183		217		228	0.630	0.661
	18	1.006	1.497		275		298	0.709	0.744
	19	1.121	1.668		302		323	0.748	0.785
3⁄4		1.127	1.677	32.4		35.6		0.750	0.788
	20	1.242	1.848		333		355	0.787	0.827
	22	1.503	2.236		398		423	0.866	0.909
7⁄8		1.534	2.282	43.8		48.2		0.875	0.919
	24	1.788	2.661		487		518	0.945	0.992
1		2.003	2.981	56.9		62.6		1.000	1.050
	26	2.099	3.123		576		610	1.024	1.075
	28	2.434	3.822		655		700	1.102	1.157
1 1⁄8		2.535	3.772	71.5		78.7		1.125	1.181
1 1⁄4		3.130	4.657	87.9		96.7		1.250	1.313
	32	3.179	4.731		844		914	1.260	1.323
1 3⁄8		3.787	5.635	108		117		1.375	1.444
	36	4.024	5.988		1060		1120	1.417	1.488
1 1⁄2		4.507	6.706	125		138		1.500	1.575
	40	4.967	7.392		1290		1320	1.575	1.654
1 5⁄8		5.289	7.871	146		161		1.625	1.706
	44	6.011	8.944		1500		1590	1.732	1.819
1 3⁄4		6.134	9.128	169		186		1.750	1.838
1 7⁄8		7.042	10.479	192		211		1.875	1.989
	48	7.153	10.644		1880		1890	1.890	1.984
2		8.012	11.923	217		239		2.000	2.100
	52	8.395	12.492		2130		2220	2.047	2.150
2 1⁄8		9.045	13.460	243		267		2.125	2.231
	56	9.736	14.488		2470		2574	2.205	2.315
2 1⁄4		10.140	15.090	272		299		2.250	2.363

Note—To convert to kilonewtons (kN), multiply tons by 8.896.

TABLE 29 Classification 6x36 Compacted Strand (CS)

Cross Section Examples



6x36
Compacted Strand

Construction of Rope: Item	Quantity	Construction of Strand: Item	Quantity
Strands	6	Wires	27 to 49
Outer Strands	6	Outer Wires	12 to 18
Layer of Strands	1	Layer of Wires	27 to 49
Wires in Rope	156 to 276		

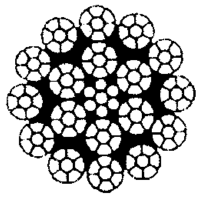
Typical Examples: Rope	Strand	Number of Outer Wires: Total	Per Strand
6x31WS	1–6–(6+6)–12	72	12
8x38WS	1–7–(7+7)–14	84	14
6x41WS	1–8–(8+8)–16	96	16
6x41SF	1–8–8–8F–16	96	16
6x49SWS	1–8–8–(8+8)–16	96	16
6x46WS	1–9–(9+9)–18	108	18

Diameter		Approx. Mass		Minimum Breaking Force				Diameter Range	
in.	[mm]	lb/ft	[kg/m]	EIP Tons	1960 [kN]	EEIP Tons	2160 [kN]	Min. in.	Max. in.
3/8		0.282	0.419	8.30		9.13		0.375	0.394
	10	0.310	0.462		85.3		91.5	0.394	0.413
	11	0.376	0.559		98.1		113	0.433	0.455
7/16		0.383	0.571	11.2		12.3		0.438	0.459
	12	0.447	0.665		114		127	0.472	0.496
1/2		0.501	0.745	14.6		16.1		0.500	0.525
	13	0.525	0.781		147		157	0.512	0.537
	14	0.609	0.906		169		183	0.551	0.579
9/16		0.634	0.943	18.5		20.4		0.563	0.591
5/8		0.782	1.164	22.7		25.0		0.625	0.656
	16	0.795	1.183		217		228	0.630	0.661
	18	1.006	1.497		275		298	0.709	0.744
	19	1.121	1.668		302		323	0.748	0.785
3/4		1.127	1.877	32.4		35.8		0.750	0.788
	20	1.242	1.848		333		355	0.787	0.827
	22	1.503	2.236		398		423	0.866	0.909
7/8		1.534	2.282	43.8		48.2		0.875	0.919
	24	1.788	2.661		487		518	0.945	0.992
1		2.003	2.981	56.9		62.6		1.000	1.050
	26	2.099	3.123		576		610	1.024	1.075
	28	2.434	3.822		655		700	1.102	1.157
1 1/8		2.535	3.772	71.5		78.7		1.125	1.181
1 1/4		3.130	4.657	87.9		96.7		1.250	1.313
	32	3.179	4.731		844		914	1.260	1.323
1 3/8		3.787	5.835	108		117		1.375	1.444
	36	4.024	5.988		1060		1120	1.417	1.488
1 1/2		4.507	6.706	125		138		1.500	1.575
	40	4.967	7.392		1290		1320	1.575	1.654
1 5/8		5.289	7.871	146		161		1.625	1.706
	44	6.011	8.944		1500		1590	1.732	1.819
1 3/4		6.134	9.128	169		186		1.750	1.838
1 7/8		7.042	10.479	192		211		1.875	1.969
	48	7.153	10.644		1880		1890	1.890	1.984
2		8.012	11.923	217		239		2.000	2.100
	52	8.395	12.492		2130		2220	2.047	2.150
2 1/8		9.045	13.480	243		287		2.125	2.231
	56	9.736	14.488		2470		2574	2.205	2.315
2 1/4		10.140	15.090	272		299		2.250	2.363

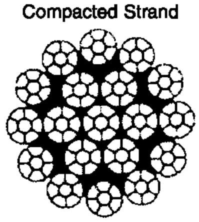
Note—To convert to kilonewtons (kN), multiply tons by 8.896.

TABLE 32 Classification 19×7 Compacted Strand (CS) Rotation Resistant—Category 2

Cross Section Examples



18×7
Compacted Strand



19×7
Compacted Strand

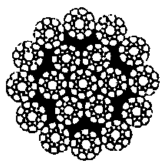
Construction of Rope		Construction of Strand	
Item	Quantity	Item	Quantity
Strands	17 to 18	Wires	5 to 7
Outer Strands	10 to 13	Outer Wires	4 to 6
Layer of Strands	2	Layer of Wires	1
Wires in Rope (excluding steel core)	85 to 126		

Typical Examples		Number of Outer Wires	
Rope	Strand	Total	Per Strand
17×7	1–6	66	6
18×7	1–6	72	6
19×7	1–6	72	6

Diameter		Approx. Mass		Minimum Breaking Force				Diameter Range	
in.	[mm]	lb/ft	[kg/m]	EIP Tons	1960 [kN]	EEIP Tons	2160 [kN]	Min. in.	Max. in.
	6	0.12	0.181		30.7		34.0	0.236	0.248
¼		0.14	0.203	3.74		4.11		0.250	0.263
	7	0.17	0.247		39.8		44.1	0.276	0.289
5⁄16		0.21	0.318	5.80		6.38		0.313	0.328
	8	0.22	0.323		54.2		60.0	0.315	0.331
	9	0.27	0.408		67.6		74.8	0.354	0.372
⅜		0.31	0.457	7.55		8.30		0.375	0.394
	10	0.34	0.504		84.3		93.3	0.394	0.413
	11	0.41	0.610		105		116	0.433	0.455
7⁄16		0.42	0.822	10.2		11.2		0.438	0.459
	12	0.49	0.726		121		133	0.472	0.496
½		0.55	0.813	13.3		14.6		0.500	0.525
	13	0.57	0.852		147		162	0.512	0.537
	14	0.86	0.988		187		165	0.551	0.579
9⁄16		0.69	1.029	16.8		18.5		0.563	0.591
⅝		0.85	1.270	20.6		22.7		0.625	0.656
	16	0.87	1.290		219		243	0.630	0.661
	18	1.10	1.633		278		308	0.709	0.744
	19	1.22	1.819		304		337	0.748	0.785
¾		1.23	1.829	29.4		32.4		0.750	0.768
	20	1.35	2.018		336		372	0.787	0.827
	22	1.64	2.439		412		457	0.866	0.909
⅞		1.67	2.490	39.8		43.8		0.875	0.919
	24	1.95	2.903		476		541	0.945	0.992
1		2.19	3.252	51.7		58.9		1.000	1.050

Note—To convert to kilonewtons (kN), multiply tons by 8.898.

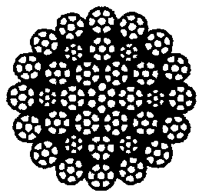
TABLE 33 Classification 19x19 Compacted Strand (CS) Rotation Resistant—Category 2

Cross Section Examples	Construction of Rope		Construction of Strand	
	Item	Quantity	Item	Quantity
	Strands	17 to 18	Wires	15 to 26
	Outer Strands	10 to 13	Outer Wires	7 to 12
	Layer of Strands	2	Layer of Wires	2 to 3
	Wires in Rope (excluding steel core)	255 to 468		
	Typical Examples		Number of Outer Wires	
	Rope	Strand	Total	Per Strand
	17x19S	1–9–9	99	9
	16x19S	1–9–9	108	9
19x19 Seale Compacted Strand	16x26WS	1–5–(5+5)–10	120	10
	19x19S	1–9–9	108	9
	19x26WS	1–5–(5+5)–10	120	10

Diameter		Approx. Mass		Minimum Breaking Force				Diameter Range	
in.	[mm]	lb/ft	[kg/m]	EIP Tons	1960 [kN]	EEIP Tons	2160 [kN]	Min. in.	Max. in.
3⁄8		0.31	0.462	7.55		8.3		0.375	0.394
	10	0.34	0.509		84.3		93.3	0.394	0.413
	11	0.41	0.616		105		116	0.433	0.455
7⁄16		0.42	0.629	10.2		11.2		0.438	0.459
	12	0.49	0.733		121		133	0.472	0.496
1⁄2		0.55	0.821	13.3		14.6		0.500	0.525
	13	0.58	0.860		147		162	0.512	0.537
	14	0.67	0.998		160		180	0.551	0.579
9⁄16		0.70	1.039	16.8		18.5		0.563	0.591
5⁄8		0.86	1.283	20.6		22.7		0.625	0.656
	16	0.88	1.303		215		241	0.630	0.661
	18	1.11	1.649		266		299	0.709	0.744
	19	1.23	1.837		300		337	0.748	0.785
3⁄4		1.24	1.847	29.4		32.4		0.750	0.788
	20	1.37	2.036		335		376	0.787	0.827
	22	1.66	2.464		405		454	0.866	0.909
7⁄8		1.69	2.514	39.8		43.8		0.875	0.919
	24	1.97	2.932		482		540	0.945	0.992
1		2.21	3.284	51.7		56.9		1.000	1.050
	26	2.31	3.441		572		637	1.024	1.075
	28	2.68	3.991		662		743	1.102	1.157
1 1⁄8		2.79	4.156	65.0		71.5		1.125	1.181
1 1⁄4		3.45	5.131	79.9		87.9		1.250	1.313
	32	3.50	5.212		859		964	1.260	1.323
1 3⁄8		4.17	6.209	96.0		106		1.375	1.444
	36	4.43	6.597		1085		1218	1.417	1.488
1 1⁄2		4.97	7.389	114		125		1.500	1.575
	40	5.47	8.144		1340		1503	1.575	1.654
1 5⁄8		5.83	8.671	132		145		1.625	1.706

NOTE—To convert to kilonewtons (kN), multiply tons by 8.896.

TABLE 34 Classification 35×7 Compacted Strand (CS) Rotation Resistant—Category 1

Cross Section Examples	Construction of Rope		Construction of Strand	
	Item	Quantity	Item	Quantity
	Strands	35	Wires	5 to 9
	Outer Strands	16	Outer Wires	4 to 8
	Layer of Strands	3	Layer of Wires	1
	Wires in Rope	238		
	Typical Examples		Number of Outer Wires	
	Rope	Strand	Total	Per Strand
35×7 Compacted Strand	35×7	1–6	98	6

Diameter		Approx. Mass		Minimum Breaking Force				Diameter Range	
				1960		2160		Min.	Max.
in.	[mm]	lb/ft	[kg/m]	Tons	[kN]	Tons	[kN]	in.	in.
	10	0.33	0.497		87.6		98.3	0.394	0.413
	11	0.40	0.601		105		118	0.433	0.455
7⁄16		0.41	0.614	12.1		13.4		0.438	0.459
	12	0.48	0.716		124		140	0.472	0.496
½		0.54	0.802	15.4		17.4		0.500	0.525
	13	0.56	0.840		144		162	0.512	0.537
	14	0.65	0.974		168		188	0.551	0.579
9⁄16		0.68	1.015	19.7		22.0		0.563	0.591
5⁄8		0.84	1.253	25.2		28.2		0.625	0.656
	16	0.85	1.272		224		251	0.630	0.661
	18	1.08	1.610		274		308	0.709	0.744
	19	1.21	1.794		307		344	0.748	0.785
¾		1.21	1.804	34.5		38.7		0.750	0.788
	20	1.34	1.988		341		382	0.787	0.827
	22	1.62	2.405		415		466	0.866	0.909
7⁄8		1.65	2.455	47.2		53.0		0.875	0.919
	24	1.92	2.863		491		555	0.945	0.992
1		2.15	3.206	62.4		70.0		1.000	1.050
	26	2.26	3.360		588		660	1.024	1.075
	28	2.62	3.896		676		758	1.102	1.157
1⅛		2.73	4.058	77.5		86.9		1.125	1.181
1¼		3.37	5.010	98.1		110		1.250	1.313
	32	3.42	5.089		873		980	1.260	1.323
1⅜		4.07	6.062	117		124		1.375	1.444
	36	4.33	6.441		1110		1232	1.417	1.488
1½		4.85	7.215	138		147		1.500	1.575
	40	5.34	7.952		1390		1521	1.575	1.654
1⅝		5.69	8.467	167		182		1.625	1.706

Note—To convert to kilonewtons (kN), multiply tons by 8.896.

SUMMARY OF CHANGES

Committee A01 has identified the location of selected changes to this standard since the last issue (A1023/A1023M – 07) that may impact the use of this standard. (Approved October 1, 2009.)

(1) Revised tables Table 12, Table 13, Table 14, Table 15, Table 20, Table 21, Table 25, Table 26, and Table 27.

(2) Corrected typographical error in heading of Table 18.

Rasmussen, Shauna

From: Adams, James W
Sent: February 08, 2022 9:51 AM
To: David Mietla - 3GA Marine Ltd. (dmietla@3gamarine.com)
Cc: Cennon, Quentin
Subject: FW: BSC Cable - Emergency Spare
Attachments: [redacted] Standard Specification for Stranded Carbon Steel Wire Ropes.pdf; ASTM A1023 Standard Specification for Stranded Carbon Steel Wire Ropes.pdf

s. 21, s. 17

s. 21, s. 17, s. 13

[redacted]

James Adams, P.Eng.
Project Manager, Terminal Construction
British Columbia Ferry Services Inc.
T: 250-978-1317 [redacted] **F:** 250-361-4922
james.adams@bcferries.com
bcferries.com

ss. 15, 19

From: Adams, James W
Sent: February 04, 2022 3:03 PM
To: Cennon, Quentin (Quentin.Cennon@bcferries.com) ; Seitz, Robert ; Jones, Gary (Gary.Jones@bcferries.com)
Cc: Nakano, Leonard ; Bruce Paterson (Bruce.Paterson@bcferries.com) ; Jones, Gary (Gary.Jones@bcferries.com) ; Stahuliak, Marian (Marian.Stahuliak@bcferries.com)
Subject: BSC Cable - Emergency Spare

All,

Just a quick follow up on the emergency spare cable for the BSC. Three vendors have confirmed spares are available in the US. See table below for details.

s. 13, ss. 15, 19, s. 17

Page redacted

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MEMORANDUM

To: James Adams, Bruce Paterson, BC Ferries
From: David Mietla, Vice President
Prepared By: Iain Mill, Senior Naval Architect
Date: 2020-06-30
RE: **MV Baynes Sound Connector – Bullwheel and Sheaves – Site Visit (Rev2)**

3GA Marine visited the vessel on June 17th, 2020 to observe the cable propulsion system in operation. The following is documentation of the observations made. Proposed modifications are presented following this.

Site Observations

Overview

The MV Baynes Sound Connector is a cable ferry operating between Vancouver Island (Buckley Bay Terminal) and Denman Island (Denman West Terminal). The vessel has two guide cables and one drive cable and is driven by a pair of bullwheels installed at midships on the vessel centreline. The drive cable is wrapped 180 degrees around each bullwheel.

Both bullwheels are powered by hydraulic motor. The drive cable enters the vessel at the number one end via fairlead, passes through two pairs of urethane cable rollers, and then wraps around the bullwheels at amidships. The cable exits the number two end in a similar arrangement to the number one end.

The guide cables are arranged on each side of the vessel. The guide cables are each supported by guide cable sheaves at either end and a pair of intermediate guide sheaves in between. The guide cable end sheaves and intermediate guide sheaves are uniformly spaced along the vessel length.

Bullwheels

The bullwheels fabricated by Jeamar Winches, and are machined from 3.75" plate. They have an outer diameter of 1722mm, and a cable centre diameter of (D) 1651mm (which corresponds to a D/d of 40 for 1-5/8" cable (d)). The cable groove is reportedly hardened, though no records are available of the hardening that was applied. Based on the design drawings a groove surface hardening to 35 C (Rockwell) 5 mm thick was done.

The current bullwheels were installed in December 2019. The previous bullwheels were removed after four years in service; however, the groove tolerance was reported to be exceeded after three years.

The bullwheel arrangement drawings show a cable groove with a rounded 'V' profile (i.e. with sides that slope continuously to the cable groove), while on the vessel, the groove profile was observed to be a U-shape with a flare at the top. This suggests that there is possibly some wear on the groove already. However, it is not known what groove profile was actually fabricated on the bullwheels.

The previous bullwheels were observed at the Little River maintenance facility. The bottom of the groove was measured to be approximately 82mm below the rim of the bullwheel. The original groove bottom was 56mm below the bullwheel rim, so the bullwheel has worn by 26mm all around.

The previous bullwheels were also observed to be worn asymmetrically, suggesting that the bullwheels were misaligned and that the cable was applying a lateral load onto the bullwheel.

One of the previous bullwheels was also observed to be worn on the outer face of the bullwheel, for a height approximately the same as the depth of the cable groove. It is assumed that this wear is due to the cable contacting the side of the bullwheel as it passed the bullwheel. It is assumed that the cable did not contact the bullwheel in the original installation, but as the groove wore asymmetrically, the cable path moved closer to the other bullwheel, eventually resulting in contact between the cable and the bullwheel. This also confirms statements by the vessel staff, who stated that the alignment of the new bullwheels was improved.

Onboard the vessel, at the Denman end of the crossing, marks were placed on both bullwheels at the 12 o'clock position. When the vessel had transited from Denman to Buckley Bay, the bullwheel marks were observed to be in different positions relative to each other. The mark on the bullwheel nearest Denman Island (the aft bullwheel in the direction of vessel travel) was observed to be at the 8 o'clock position, while the mark on the other bullwheel was at the 4 o'clock position.

On returning to the Denman end of the crossing, the mark on the Denman Island bullwheel was in the 1 o'clock position, and the mark on the other bullwheel was in the 11 o'clock position.

The following conclusions can be made from this observation:

1. The cable slips on the bullwheels as the vessel travels
2. The cable slips at different rates on each bullwheel.
3. The amount of cable slip on each bullwheel is dependent on the direction of travel of the vessel.

The above observations support basic tension winch theory, which states that for a driven cable wheel, there must be a difference in tension between the infeed and outfeed cables, resulting in different cable elongations (whether due to construction elongation or material stretch) in the infeed and outfeed cables. The change in elongation must occur around the contact surface of the driven cable wheel, resulting in the sliding of cable fibres across the surface of the driven cable wheel.

A mark was also placed on the cable at the Denman end of the crossing, adjacent to the Denman bullwheel. The mark was placed on the top surface of the cable. As the vessel departed the Denman terminal, the cable was video recorded as it entered the other bullwheel for later observation. The cable was observed to rotate very slightly counterclockwise between leaving the Denman bullwheel and entering the Buckley Bay bullwheel.

Both the changing elongation of the cable and the rotation of the cable on the bullwheels will contribute to wear of the bullwheel.

It should be noted that the bullwheel circumference is approximately 5 metres, while the crossing length is approximately 1800 metres. Thus, the wear on the bullwheels can be expected to be 360 times faster (assuming the cable and the bullwheel are of the same hardness).

Bullwheel shafts

The bullwheels are mounted on steel shafts, which are supported by SKF pillow block bearings. The shafts are driven by Hagglunds CA100 motors, which are fitted with Hagglunds brakes.

BCF reported that one of the shafts of the previous bullwheels showed signs of damage. Observation of the shaft damage at the Little River maintenance facility suggest that the damage occurred as a result of slippage between the shaft and the coupling on the motor. The greatest torque generated on the shaft is developed by the brake, so it is likely that this occurred during an emergency braking event.

It is noted that the shaft coupling has a very important and precise connecting procedure, which includes lubricating of bolts and sliding surfaces, correct alignment of the shaft and coupling, and correct bolt torques. If any of these items were missed or carried out incorrectly, the result could be incorrect coupling of the motor/brake assembly and the shaft, with the coupling not being capable of transmitting the full brake torque. 3GA has reviewed the coupling specifications and concluded that the coupling is suitable for transmitting the levels of torque seen in this application.

As this occurred on one shaft only and appears to be the result of a single event, it is concluded that this is possibly the result of poor assembly rather than a design flaw with the arrangement. It is recommended that the manufacturer's instructions are followed very closely during assembly of the motor and brake to the shaft.

It was also noted that the motor specifications require a shaft material of minimum yield strength of 450 MPa for a heavy duty, bidirectional shaft. However, the material specified on the drawings and the vendors material certificates indicated the material used for the shaft is SAE 4140, which has a yield strength of only 415 MPa (only 92% of the required value). It is possible that this material specification may have been a contributing factor to the slipping of the shaft. It is recommended that the motor/brake vendor (Hagglunds) be contacted to verify the suitability of the shaft material, and to provide recommendations for a suitable material grade if the SAE 4140 material is not suitable.

s. 13

Repair of the bullwheel shafts has been proposed by spray welding and re-machining. [redacted]

Motors

The motors driving the shafts are Hagglunds CA100-64 motors, which provide up to 64 Nm/bar of torque, and have a maximum pressure of 350 bar. At maximum pressure, the maximum torque developed is 22.4 kNm. At the system operating pressure on the vessel (296 bar at the motors), the motors develop 18.9 kNm.

The motors are fitted with Haaglunds MDA 14 brakes.

No issues were reported with the motors or brakes (other than the shaft slipping described above).

Cables

The vessel uses identical cables for the drive cables and guide cables. The drive cable is used for one year in the drive position and is then moved to one of the guide cable positions for a further two years. With this arrangement, one cable is replaced each year.

The cable specification is 6x19 IWRC, EIPS, finished with drawn Bezinal 3000, with a minimum breaking strength of 264,000 lbs (1,175 kN).

The existing cables are 1-5/8 inch diameter 6x19S EIPS IWRC plastic filled valley cables, wound right lang lay. The steel wires are bezinal coated. The actual breaking strength is 305,500 lbs (1,359 kN).

BCF have reported that the plastic coating one the cables is being shed during operations, resulting in plastic pollution of the surrounding environment. As a result, BCF are moving to a new cable composition that contains no plastic.

The new cables that have been delivered to BCF are 1-5/8 inch diameter EIPS IWRC 6x25B flattened strand bezinal coated cables. The actual breaking strength is 318,890 lbs (1,419 kN).

All cables have been manufactured by Bridon-Bekaert in Quebec.

It was observed that there is a kink in the drive cable at the Buckley Bay end of the cable. The kink is located very close to the bullwheels, but is not believed to enter the bullwheel. [redacted] s. 13

Drive Cable Fairleads

The drive cable fairleads are fabricated by Smith Berger Marine and are of an unbalanced flagging design that is intended to rotation around the rope axis to match the fleet angle of the wire rope. According to the EYE Wire Rope Selection Report, the fairleads require a minimum of 30 degrees of cable wrap for the fairlead to follow the fleet angle of the wire rope properly. The wrap angle observed on board the vessel is only 10 degrees 'at best'.

The flagging design of fairlead requires a minimum wrap angle around the sheave in order to generate sufficient lateral moment to rotate the fairlead. In an unbalanced design such as this, the lateral moment is fighting against the moment caused by the lateral shift in the center of gravity of the sheave. As a result, the fairlead will flag to an angle where the moment due to the wire rope fleet angle is balanced by the opposing moment due to the offset centre of gravity acting downwards. As a result, whenever the fairlead does flag, the wire rope will be acting on one side of the sheave, resulting in asymmetric wear.

s. 13

[redacted]

<u>Guide Cable Sheaves</u>

The guide cable sheaves are somewhat similar to the drive cable fairleads in that they are of a design that allows flagging of the sheave. However, the same issues are present, namely that the wrap angle (and thus flagging moment) is small, and that the sheave is unbalanced, resulting in side loading on the sheave.

The guide cable sheaves are located significant distance from the ends of the vessel. As such, their function in guiding the vessel to the terminal is somewhat limited when the vessel is very close to the terminal.

Best corrective actions are to be determined.

<u>Guide Cable Intermediate Sheaves</u>

The guide cable intermediate sheaves are of a fixed design, with no capability of flagging. The design drawings show that the underside of the sponson they are attached to is flat with no lateral slope. However, inspection onboard appeared to suggest the underside of the sponson is not flat and has a slight deadrise. If this is the case, the intermediate sheaves would not be oriented vertically, but slightly away from vertical, resulting in a side wear on the sheaves.

It was noted that the sheaves are repositioned every few months to even out any asymmetric wear. This means that any observed wear may not be attributable to the sheave being in that position. All the fairleads and guide sheaves use the same design of sheave, so any sheave could have been in any other sheave position in the past.

<u>Removed Sheaves</u>

A box of removed sheaves was observed at the Little River maintenance facility. Many of these showed signs of asymmetric wear. However, no information was available about which sheave was installed in which location.

One sheave was noted to be coated in a Belzona coating, and the coating was reported to have lasted better than expected.

It was also reported that the tapered roller bearings for the sheaves have not been performing as expected. This lack of performance is perhaps due to lubrication issues associated with the shipboard lubrication system. It was suggested that the tapered roller bearings could be replaced with self lubricating bronze bushings to avoid these issues. It was also noted that the tapered roller bearings must be pre-loaded using the retaining nut that is difficult to service.

Maintenance has tested different pre-load settings but none have improved the service life of the bearings.

Cable Tensions

The cable tensions for the drive and guide cables are high. The tensions are all broadly similar. In many other cable ferry installations, the drive cable tension is lower than the guide cable tensions so that the drive cable is carrying predominantly only propulsion loads, and the loads associated with restraining the vessel in adverse weather are carried by the guide cables.

In the current configuration, the drive cable also carries weather loads. This means that the drive cable is typically higher loaded than the guide cables.

Consideration should be given to reducing the drive cable tension. However, as noted in the EYE cable tensioning report, a minimum tension of 98kN (10 MT) should be maintained in the current configuration to maintain traction on the bullwheels. (It is noted that the EYE calculation assumes 180 degrees of wrap instead of 360 degrees 'to give a margin of safety'. In addition, the EYE calculation uses a friction coefficient of 0.194 for friction between the existing cable and the bullwheel. It is not known what the source of this data is. It is assumed this represents a wet, lubricated plastic filled valley cable on a steel bullwheel).

It is reported that BCF terminal maintenance has reported slippage of the bullwheels when the pre-tension is approximately 10 kip-f to 15 kip-f. The presence of slippage will vary with the acceleration load that is applied (low accelerations may not induce slippage while higher accelerations may). The weather, tide, and current will also influence the slippage.

Wear (mud particles)

It was noted during the site visit that the cables are often dirty in places due to laying in the mud. This mud can become embedded in the cable and transfer to the bullwheel. The mud particles will act as an additional abrasive on the bullwheel and result in increase wear on the bullwheel and cable.

Proposed modifications

BCF have requested the bullwheels be fitted with removable/replaceable sectional liners to improve the maintainability of the system (thus reducing the need to disconnect the propulsion motors and remove the bullwheels).

BCF have also elected to change the cable type from the plastic filled valley cable to a flattened strand all steel cable. This will result in a reduction of friction coefficient between the bullwheels and the cable.

Friction plays a crucial role in the propulsion of the ferry. Too little friction, and the bullwheels may slip on the cable, resulting in a lack of propulsion or stopping power; while too much will lead to increased abrasion wear on components, and increased fatigue of the drive cable, resulting in decreased life of the drivetrain components and cables, and increased operating costs.

As demonstrated above, there is some sliding (albeit small amounts) occurring between the cable and the bullwheel. This movement makes it important to carefully select the appropriate coefficient of friction between the bullwheel and the cable for the cable tension calculations.

Generally speaking, two coefficients of friction are available for a pair of materials – the coefficient of static friction, and the coefficient of dynamic (or kinetic) friction. The first is a result of the force required to make an object begin moving from rest, and is a result of having to break molecular bonds between the two objects (adhesion), and overcome microscopic interlocking between the surface textures of the two objects (abrasion). The second is the result of the force required to continue moving an object that is already in motion. Due to the continuous movement, there is significantly less adhesion (the molecular bonds do not have an opportunity to form due to the motion), and somewhat less abrasion (the peaks of one surface do not get an opportunity to settle in to the crevices in the other surface).

Considering the drive cable acting on the bullwheels, there is some motion between the cable and the cable groove. However, the motion is very slow, so it is most likely that the proper coefficient of friction that should be used lies somewhere between the coefficient of static friction and the coefficient of dynamic/kinetic friction.

In addition, the cables are wet from having just come out of the sea water. The presence of the bezinal coating must also be considered when selecting the coefficient of friction. Both of these considerations reduce the coefficient of friction.

The US Navy Wire Rope Handbook[1] provides coefficients of friction for steel wire ropes on various bullwheel surface materials in the dry, wet, and greasy condition (refer to page 5-16):

Table 1 - Coefficients of friction for steel wire ropes on various materials

Dry	0.120	0.235	0.495
Wet	0.085	0.170	0.400
Greasy	0.070	0.140	0.205

In the EYE cable tensioning report, a coefficient of friction for the plastic filled valley cable on the bullwheels of 0.194 has been assumed. No published information is available to support or dispute this number, but it is assumed that the plastic filled valleys contribute to increasing the coefficient of friction.

For the new steel cables, the coefficient of friction will be somewhere around 0.085. It is difficult to assess the impact of the bezinal coating – this is mostly zinc (95%) and is stated in literature as being a low friction coating. However, no data has been found for wet zinc on steel. With that said, the zinc coating on the steel wire will quickly wear off on the areas that contact the bullwheel, resulting in steel on steel contact after the first few days in service.

The reduction of friction coefficient raises the question of traction on the bullwheels. If there is insufficient traction on the bullwheels, the solutions available are to either increase the pre-tension on the drive cable, or increase the wrap angle around the bullwheels (i.e. introduce a second wrap around the bullwheels, which will require a double groove on the bullwheels).

The relationship between high and low tension sides of the bullwheel drive system is as follows:

[1] AD A955305. "US Navy Wire Rope Handbook". Available here: https://apps.dtic.mil/dtic/tr/fulltext/u2/a955305.pdf

$$\frac{T1}{T2} = e^{fn\pi}$$

Where

T1 = rope high tension (pretension plus driving/braking force)

T2 = rope low tension (pretension)

f = coefficient of friction

n = total number of 180 degree (half wraps) on driving sheaves

This can be rearranged as follows to calculate the required number of half wraps for given tensions and coefficients of friction:

$$\mathrm{n} = \frac{ln\left(\frac{T1}{T2}\right)}{f\pi}$$

As reported by BCF, the bullwheels are known to slip with between 10,000 lb-f and 15,00 lb-f pre-tension during acceleration. Using this information, the friction coefficient of the existing PFV wire rope can be calculated, as show in the table below:

Table 2 - Calculation of existing cable co-efficient of friction at slippage (15,000 lb pre-tension)

Cable Type	**6x19 PFV**	**6x19 PFV**
Pretension (N, lb-f)	66723.3	15000
Driving force (N, lb-f)	45897	10318
T1 (N, lb-f)	112620	25318
T2 (N, lb-f)	66723.3	15000
T1/T2	1.688	1.688
n (no of 180 degree wraps)	2	2
F (coefficient of friction)	0.083	0.083

It is noted that the calculated coefficient of friction is almost exactly that of wet steel on steel. One possible explanation is that when the cable is under high tension, the steel strands are forced to compress, exposing the plastic on the outside, which wears down. When the tension lowers, the cable is able to expand and the steel strands sit proud of the plastic, resulting in only steel on steel contact.

Below are tables of calculations for the required number of wraps in various scenarios. These calculations include the current cable using the EYE friction coefficient for the existing cable, the friction coefficient calculated above for the existing cables, and the assumed friction coefficient for the new cables. In the cases with the lower friction coefficient for the existing cables, a lower cable pre-tension (15,000 lbs) has also been used.

BCF have reported that during operation, the maximum brake torque available when the throttle is at 100% is limited to 30% of the maximum brake torque. However, when the throttle is at 0%, the full 100% of the brake torque is available. Both of these cases are modelled below.

Table 3 - Number of bullwheel wraps required (maximum motor torque)

Cable Type	6x19 PFV	6x19 PFV	6x25 FS
Pretension (N)	196200	66723	196200
Driving force (N)	45897	45897	45897
High side tension, T1 (N)	242097	112620	242097
Low side tension, T2 (N)	196200	66723	196200
T1/T2	1.234	1.688	1.234
Friction coefficient, f	0.194	0.083	0.085
n (180 degree wraps)	0.345	2.000	0.787
No of bullwheel wraps required	1	1	1

Table 4 - No of bullwheel wraps required - normal transit (2/3 of maximum torque)

Cable Type	6x19 PFV	6x19 PFV	6x25 FS
Pretension (N)	196200	66723	196200
Driving force (N)	30598	30598	30598
High side tension, T1 (N)	226798	97321	226798
Low side tension ,T2 (N)	196200	66723	196200
T1/T2	1.156	1.459	1.156
Friction coefficient, f	0.194	0.08333	0.085
n (180 degree wraps)	0.238	1.442	0.543
No of bullwheel wraps required	1	1	1

Table 5 - No of bullwheel wraps required - Maximum emergency braking torque

Cable Type	6x19 PFV	6x19 PFV	6x25 FS
Pretension (N)	196200	66723	196200
Emergency braking tension (N)	158940	158940	158940
High side tension, T1 (N)	355140	225663	355140
Low side tension ,T2 (N)	196200	66723	196200
T1/T2	1.810	3.382	1.810
Friction coefficient, f	0.194	0.08333	0.085
n (180 degree wraps)	0.974	4.654	2.222
No of bullwheel wraps required	1	3	2

Table 6 - No of bullwheel wraps required - 30% of maximum braking torque.

Cable Type	6x19 PFV	6x19 PFV	6x25 FS
Pretension (N)	196200	66723	196200
Emergency braking tension (N)	47682	47682	47682
High side tension, T1 (N)	243882	114405	243882
Low side tension ,T2 (N)	196200	66723	196200
T1/T2	1.243	1.715	1.243
Friction coefficient, f	0.194	0.083	0.085
n (180 degree wraps)	0.357	2.060	0.815
No of bullwheel grooves required	1	2	1

The above tables demonstrate that the vessel will be able to accelerate and transit normally with the new cable and the existing bullwheel arrangement. However, the data also shows that if the vessel was required to execute an emergency stop using the maximum capacity of the installed brakes, the new cable will slip on the bullwheel as 2.2x 180 degree wraps are required around the bullwheels, while there are currently only 2x 180 degree wraps on the bullwheels. Using a double wrap on the bullwheels solves this problem, as there would now be 4x 180-degree wraps.

If the number of wraps around the bullwheels is increased to a double wrap (4x 180-degree wraps), the traction of the bullwheels is increased. As a result, it is possible to reduce the cable tensions. The below tables show the calculated minimum cable tensions required to maintain traction during an emergency braking event:

Table 7 - Minimum pre-tensions required - single wrap on bullwheels

	Emergency Braking			Accelerating		
Friction coefficient, f	0.194	0.083	0.085	0.194	0.083	0.085
No of bullwheel grooves	1	1	1	1	1	1
n (180 degree wraps)	2	2	2	2	2	2
T1/T2	3.38	1.68	1.71	3.38	1.68	1.71
Applied force on cable (N)	158940	158940	158940	45897	45897	45897
Minimum pre-tension required (T2) (N)	66681	232178	225171	19255	67046	65023
Tension on high tension side of winch (T1) (N)	225621	391118	384111	65152	112943	110920
Minimum pre-tension (lbs)	14990	52196	50621	4329	15073	14618

Table 8 - Minimum pre-tensions required - double wrap on bullwheels

	Emergency Braking			Accelerating		
Friction coefficient, f	0.194	0.083	0.085	0.194	0.083	0.085
No of bullwheel grooves	2	2	2	2	2	2
n (180 degree wraps)	4	4	4	4	4	4
T1/T2	11.45	2.84	2.91	11.45	2.84	2.91
Applied force on cable (N)	158940	158940	158940	45897	45897	45897
Minimum pre-tension required (T2) (N)	15211	86487	83216	4393	24975	24030
Tension on high tension side of winch (T1) (N)	174151	245427	242156	50290	70872	69927
Minimum pre-tension (lbs)	3420	19443	18708	987	5615	5402

As can be seen, in the current configuration requires a minimum tension of 66.7 kN (14.99 kip-f)[2] to withstand the braking force. It is currently tensioned to 196kN. Changing the drive cable to the new cable results in a minimum pre-tension of 225 kN (50.6 kip-f). It is noted that this tension is higher than the maximum tension that can be achieved with the existing tensioning equipment, which is 196 kN (44 kip-f).

Changing the bullwheel to a double groove design and providing two wraps of the drive cable around the bullwheel, significantly increases the traction of the bullwheels, and allows the cable tensions to be reduced dramatically. As can be seen, the minimum cable pre-tension for the new cable drops to 83.2 kN (18.7 kip-f) with the double wrap. This is only 43% of the current drive cable tension.

Note that the above does not include any safety factors on bullwheel traction.

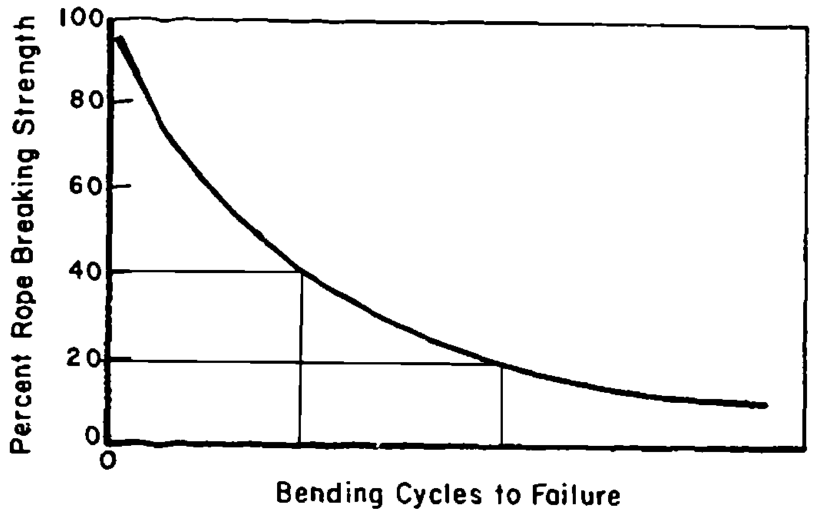
<u>Effects of changing the cable tension</u>

Reducing the cable tension has multiple benefits:

- Wear on the cables and components (sheaves and bullwheels) due to abrasion is reduced significantly. Abrasion is the result of the normal force distributed over the contact area of the wire rope. A new wire rope has a very small contact area, and quickly abrades to develop a slightly flatter area on each wire that is on the exposed surface of the cable, and thus increases the surface contact area. Similar wear occurs on the sheaves and bullwheels. Reducing the tension reduces the normal force, and thus reduces the abrasion that occurs. Increasing the number of cable grooves on the bullwheels also increases the area that the force is distributed over, thus further reducing the wear due to abrasion.

[2] It is noted that the minimum tension reported here is different from that provided in the cable tension report. It should be noted that these calculations are based on the actual wrap angles, and uses the maximum braking tension for design purposes rather than the maximum motor torque. There also appears to be some discrepancy with the method of calculating the minimum tension in that report.

- Bending fatigue of the drive cable is significantly reduced. The US Navy[3] has carried out extensive research on applied load versus bending fatigue life for steel wire ropes, and developed the following chart as a result:



  As can be seen from the above, a 50% reduction in applied load results in a 100% increase in the fatigue life of the rope, so from a wire rope life perspective, it is desirable to reduce the applied load on the drive cable. However, increasing the number of wraps increases the number of fatigue cycles the cable is exposed to. The cable is currently exposed to approximately 44,000 bending fatigue cycles per year (assuming 1 cycle each time the drive cable segment contacts a bullwheel or fairlead, so 4 cycles per crossing, and 30 crossings per day). This figure rises to around 66000 cycles if the bullwheel has a double wrap.
- Assuming the existing cable has a fatigue life of one year (44,000 cycles), the fatigue life of the cable will increase to 88,000 cycles if the cable tension is reduced to 50% (22,000lbs). The cable will be exposed to 66,000 cycles per year instead of 44,000 cycles per year. Based on this, the cable fatigue life will now be (88,000/66,000 =) 1.33 years, or 33% greater than currently.

One concern that has been raised with reduced cable tension is that the vessel may end up further out of alignment at the terminal, as the drive cable is the only practical source of alignment (with the guide cable sheaves being located too far aft on the hull to aid with final alignment). However, all the useful tension in the drive cable between the vessel and the drive cable anchor is developed by the bullwheels, and the available tension from the bullwheels will not change, even if the pre-tension in the cable is changed.

Another consideration is what will happen to the vessel in extreme weather. Currently, all 3 cables are considered to support the vessel in heavy weather, and the failure scenarios consider what happens when one or more of the cables fail or lose a portion of their tension. These studies would have to be revisited to assess the impact of the change in drive cable tension. However, a review of the EYE cable tensioning report shows that they have studied the impact of reducing tension in various cables. In the scenario where the drive cable tension is reduced, it is stated that (for the current configuration) the drive cable tension can be reduced to

[3] AD A955305. "US Navy Wire Rope Handbook". Available here: https://apps.dtic.mil/dtic/tr/fulltext/u2/a955305.pdf

11T (45% reduction) while continuing to meet the defined criteria (minimum safety factor of 3, and maximum drift off the straight line track of 100m).

3GA have reviewed the information in the cable tensioning report and carried out calculations to determine the impact of replacing the PFV cables with the 6x25 FS cable. The results of these calculations are shown in Table 9. The following should be noted:

- Actual cable tension data has been calculated by taking the specified minimum breaking strength of the existing cable and dividing it by the published F.o.S.
- The calculations of cable tension are based on the specified minimum cable breaking strength, and not the actual breaking strength of the existing installed cables.
- Data for drive cable pre-tensions of 9T and less is extrapolated from the EYE published data. Extrapolation was carried out by graphing the EYE published data, fitting a trendline (polynomial, order 2), and using the formula for the trendline to calculate the extrapolated data. (Extrapolated data is highlighted in orange).
- F.o.S. data for the 17T case has been modified slightly to better align it with the surrounding data. (Highlighted in yellow).
- The drift data for the 17T and 16T cases did not correlate with the surrounding data so has been omitted. (Highlighted in red).

The results of these calculations show that the actual factors of safety for the new cables are significantly higher than with the minimum cable specification. In particular, the drive cable tension can be reduced to 5T and the new guide cables will be able to support the vessel with a minimum factor of safety of 3.54.

It is also noted that the vessel drift from the vessel track is not projected to change significantly if the drive cable tension is reduced.

Table 9 - Environmental cable tensions for varying drive cable tensions

Pre-tensions			F.o.S.			Total Cable tensions (Based on existing cable min breaking strength and FoS)			Actual F.o.S. (Based on calculated cable tensions and new cable min breaking strength)				
Drive cable	North Guide cable	South Guide cable	Drive cable	North Guide cable	South Guide cable	Drive cable	North Guide cable	South Guide cable	Drive cable	North Guide cable	South Guide cable	Total load, LBS	Drift, m
20	20	20	3.13	3.14	3.14	84345	84076	84076	3.78	3.79	3.79	252498	82.01
19	20	20	3.20	3.13	3.13	82500	84345	84345	3.87	3.78	3.78	251190	82.33
18	20	20	3.26	3.11	3.11	80982	84887	84887	3.94	3.76	3.76	250757	82.59
17	20	20	3.33	3.09	3.09	79279	85437	85437	4.02	3.73	3.73	250153	
16	20	20	3.42	3.08	3.08	77193	85714	85714	4.13	3.72	3.72	248622	
15	20	20	3.50	3.06	3.06	75429	86275	86275	4.23	3.70	3.70	247978	83.57
14	20	20	3.59	3.05	3.05	73538	86557	86557	4.34	3.68	3.68	246652	83.87
13	20	20	3.67	3.03	3.03	71935	87129	87129	4.43	3.66	3.66	246192	84.17
12	20	20	3.76	3.02	3.02	70213	87417	87417	4.54	3.65	3.65	245047	84.46
11	20	20	3.84	3.01	3.01	68750	87708	87708	4.64	3.64	3.64	244165	84.72
10	20	20	3.94	2.99	2.99	67005	88294	88294	4.76	3.61	3.61	243594	85.00
9	20	20	4.04	2.98	2.98	65324	88605	88605	4.88	3.60	3.60	242533	85.28

8	20	20	4.14	2.97	2.97	63703	88980	88980	5.01	3.58	3.58	241663	85.55
7	20	20	4.25	2.95	2.95	62101	89349	89349	5.14	3.57	3.57	240799	85.81
6	20	20	4.36	2.94	2.94	60519	89711	89711	5.27	3.55	3.55	239941	86.07
5	20	20	4.48	2.93	2.93	58957	90066	90066	5.41	3.54	3.54	239088	86.32

Wear on the bullwheels, cable and other components must also be considered. Currently, the bullwheels are hardened to 35C (Rockwell), while EIPS cables are generally much harder than this (around 45-50C Rockwell). As a result, the cable is able to wear through the bullwheel much faster than the cable wears. Current experience shows that the bullwheels reach their wear limits in under 3 years, while the guide cable is replaced annually and no significant wear is reported to have occurred on any of the cables to date.

Wear on the bullwheels is related to multiple factors:

- Bullwheel hardness
- Drive cable hardness
- Drive cable tension
- Drive cable contact area
- Vessel acceleration/deceleration rates
- Volume of entrained mud/sand

Of these, the cable tension and bullwheel material hardness are the variables with the greatest effect. Increasing the number of wraps of the drive cable around the bullwheels (as discussed previously) will increase the traction, allowing the cable tension to be reduced. This design change will reduce the wear in two ways –reducing the tension reduces the normal force applied to the bullwheels, thus reducing wear, and increasing the number of wraps increases the contact area of the cable, distributing the wear over a larger surface area.

Material hardness plays a significant role. As stated earlier, the two bullwheels have a 5m circumference each, while the drive cable is 1800m long. As a result, the driving force of the ferry is concentrated onto the 10m linear contact surface of the bullwheels, and at the same time distributed over the 1800m of drive cable. As a result, the bullwheels will wear much faster than the cable. In addition, the subtle sliding and twisting motion of the cable on the bullwheels causes the cable to act like a file or saw on the bullwheel groove. Inspection of the old bullwheels shows that the drive cables have worn through the hardened surface of the bullwheel groove, and significantly worn away the softer mild steel below. It is reported that the old bullwheels exceeded their wear limit within the first 2.5 years of service (the cable grooves had worn 0.225” and 0.248” (5.7mm and 6.3mm) after 2.5 years of service, at which point the cable had worn through the 5mm of groove hardening). Between October 2018 and the bullwheels removal in November 2019, the cables had worn through a further 20mm of mild steel. This highlights the importance of a hardened surface on the bullwheels.

In addition, the new all steel cables will lift more mud from the sea bed into the cable trough and
s. 13 bullwheels. This will lead to increased maintenance costs to clean the greater volume of mud, [redacted] The mud will also cause additional wear on the bullwheels and cable. Again, increasing the bullwheel hardness will aid in resisting this additional wear. The cables most likely effect of the mud on the cables is that the mud will wear through the bezinal

coating on the strands inside the cable faster, resulting in increased corrosion rates inside the cable. However, it is not expected that this will materially affect the use and lifespan of the cables – the life of the cable is still anticipated to be dominated by the cable fatigue life.

There is conflicting literature available on traction winch bullwheel hardness. Some manufacturers recommend a softer surface to protect the cable, while others recommend a very hard surface (up to 70 Rockwell C) to maximise bullwheel life. In general, those manufacturers recommending softer surfaces are in the subsurface marine industry, and their winches are used for deploying and recovering ROVs with complex umbilical cables. Those cables are very expensive, the load is comparatively low, and the service rate is also low. In this application, a softer bullwheel surface is understandable to protect the cable. Replacing the traction winch bullwheels in that application is significantly cheaper than replacing the ROV umbilical cable.

Those recommending a hard bullwheel surface are typically in the mining industry, where the traction winches are used for hauling elevator carts up long mine shafts. In this application, the cables are not as expensive (though by no means cheap), the loads are comparatively high, and the service rate is high. In this application, a harder bullwheel surface is used to minimize the wear on the bullwheel, and any wear that does occur on the cable is minimal during the life of the cable (which is limited by fatigue rather than surface wear).

The Baynes Sound Connector application is most similar to that of the mining industry where there are high loads and a high service rate. The cable wear is also not significant during the fatigue life of the cable.

It is recommended that the new bullwheel liners for the vessel are manufactured with hardened steel grooves, the exact hardening level will be determined during the design process. The hardened surface will prolong the life of the bullwheel liners. The depth of hardening should be further evaluated to prevent cracking of the hardened surface, and also to allow the possibility of re-grooving of the bullwheel liners. The hardened surface will offer increase abrasion resistance for the increased quantity of entrained mud particles likely to be present in the new cables.

Conclusions

s. 13

Based on the above information, 3GA recommends the following:

[redacted]

The above will result in prolonging the life of the drive cable as well as reducing stresses on the bullwheels caused by cable tension, therefore reducing bullwheel wear.

Assuming a current wear rate of 2mm/year, it is anticipated that the above changes will result in the following improvements to bullwheel life:

Table 10 - Estimated changes in bullwheel wear rate

Item	Change in wear rate (relative to current wear rate)	Cumulative change	New wear rate (cumulative)	Notes
Current wear rate	-	-	2 mm/year	
Increased bullwheel surface area (doubled)	50%	50%	1 mm/year	Assuming bullwheels are converted to double wrap
Reduced cable tension	50%	25%	0.5 mm/year	Assuming 50% reduction in pretension
Increased bullwheel hardness	50%	12.5%	0.25 mm/year	Difficult to assess, particularly with increase in mud particles. Worst case estimate.

As is shown, it is anticipated that the proposed changes to the bullwheels and the reduction in cable tension result in an increase of bullwheel life of around 4 times the current bullwheel life.

With regards to the vessel alignment in the terminal during inclement weather the repositioning of the guide sheaves should be investigated.

Briefing Note

BCFerries

for **Decision**

PREPARED FOR: Frank Camaraire

SUBJECT: Project 92342 Baynes Sound Connector Cable System Upgrades Bullwheel Design

ACTION REQUIRED: for Decision

PURPOSE: It is requested that the Project Owner provide direction whether it is acceptable to proceed with the detailed design of a two-wrap cable liner system.

ATTACHMENTS:
1. 3GA Site Visit and Design Memo, Rev 2
2. Bullwheel Double Wrap Concept Drawing, Rev 0

s. 13

SUMMARY

[redacted]

s. 17, s. 13

[redacted]

s. 17, s. 13

[redacted]

Rasmussen, Shauna

From:	Peterson, Greg
Sent:	December 05, 2019 11:16 AM
To:	Meyer, Leslie A.
Cc:	Camaraire, Frank; Riis, Daniel; Paterson, Bruce
Subject:	FW: CF BAYNES SOUND CONNECTOR (BSC) - Request to review change in cable type
Attachments:	BSC New Rope.pdf

Leslie,

We should add this document into the MTRB sharepoint database with the original MTRB.

Greg

From: Camaraire, Frank
Sent: December 05,2019 11:10 AM
To: Peterson, Greg; Meyer, Leslie A.; Wills, Stuart; Cennon, Quentin; Adams, James W
Cc: Paterson, Bruce; Riis, Daniel; Joyce, Jeff
Subject: FW: CF BAYNES SOUND CONNECTOR (BSC) - Request to review change in cable type

FYI and for our records, thank you

Frank Camaraire
Executive Director, Engineering
Operations Division ss. 15, 19
British Columbia Ferry Services Inc.
Suite 500 – 1321 Blanshard Street, Victoria, British Columbia, V8W 0B7
T: 250-978-1384 [redacted] **F:** 250-978-1166
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From: Zargham, Reza <Reza.Zargham@lr.org>
Sent: December 04, 2019 1:24 PM
To: Paterson, Bruce <Bruce.Paterson@bcferries.com>; Camaraire, Frank <Frank.Camaraire@bcferries.com>
Cc: Chern, Richard <richard.chern@lr.org>; McDonald, Bruce <Bruce.McDonald@lr.org>; Sovagovic, Zoran <Zoran.Sovagovic@lr.org>; Bulkowski, Jerry <Jerry.Bulkowski@lr.org>
Subject: RE: CF BAYNES SOUND CONNECTOR (BSC) - Request to review change in cable type

Dears Frank and Bruce,
Please find attached the no objection letter as requested.

Kind regards,
Reza

Reza Zargham, Lloyds Register
Area Operations Manager - West of Canada and USA (NAW) , Marine & Offshore

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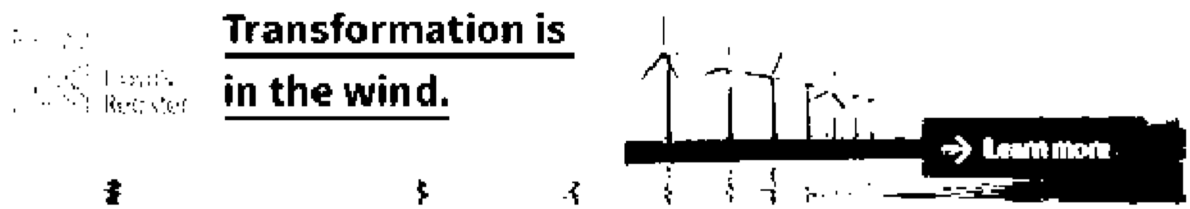

From: Paterson, Bruce <Bruce.Paterson@bcferries.com>
Sent: Monday, 02 December, 2019 4:13 PM
To: Zargham, Reza <Reza.Zargham@lr.org>; Camaraire, Frank <Frank.Camaraire@bcferries.com>
Cc: Chern, Richard <richard.chern@lr.org>; McDonald, Bruce <Bruce.McDonald@lr.org>; Sovagovic, Zoran <Zoran.Sovagovic@lr.org>; Bulkowski, Jerry <Jerry.Bulkowski@lr.org>
Subject: RE: CF BAYNES SOUND CONNECTOR (BSC) - Request to review change in cable type

*** **THIS IS AN EXTERNAL EMAIL:** do not click any links or open any attachments unless you trust the sender and know the content is safe. ***

Thanks Reza,

You can address it to Frank Camaraire, (cc'd), as follows:

Frank Camaraire
Executive Director, Engineering
Operations Division
British Columbia Ferry Services Inc.
Suite 500 – 1321 Blanshard Street, Victoria, British Columbia, V8W 0B7

Bruce Paterson, P.Eng, M.Eng
Director, Naval Architecture, Engineering British Columbia Ferry Services Inc.
Tel: (250) 978-1385
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Safety and Operational Readiness

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From: Zargham, Reza [mailto:Reza.Zargham@lr.org]
Sent: December 02,2019 4:10 PM
To: Paterson, Bruce
Cc: Chern, Richard; McDonald, Bruce; Sovagovic, Zoran; Bulkowski, Jerry
Subject: RE: CF BAYNES SOUND CONNECTOR (BSC) - Request to review change in cable type

Hi Bruce,
Provided all conditions in MTRB 14754 are followed, we will issue a letter of no objection to the proposed wire rope replacement referencing condition "e" of the MTRB.
Please let me know who should this letter be addressed to.

Kind regards,
Reza

Reza Zargham, Lloyds Register
Area Operations Manager - West of Canada and USA (NAW), Marine & Offshore
T +1 604 985 0477 D +1 604 982 2124 M +1 604 857 3206 E reza.zargham@lr.org
Lloyds Register Canada Limited, 502-221 West Esplanade, North Vancouver, BC V7M 3J3, Canada
Visit www.lr.org or follow us on: LinkedIn Facebook Twitter

From: Paterson, Bruce <Bruce.Paterson@bcferries.com>
Sent: Thursday, 28 November, 2019 10:07 AM
To: Zargham, Reza <Reza.Zargham@lr.org>
Cc: Chern, Richard <richard.chern@lr.org>; McDonald, Bruce <Bruce.McDonald@lr.org>; Sovagovic, Zoran <Zoran.Sovagovic@lr.org>
Subject: RE: CF BAYNES SOUND CONNECTOR (BSC) - Request to review change in cable type

***** THIS IS AN EXTERNAL EMAIL:** do not click any links or open any attachments unless you trust the sender and know the content is safe. ***

Thanks Reza et al.

Could we ask for a formal letter stating that "No objection" , an referencing condition "e" of MTRB 14754?

Thank you (in advance),

Bruce Paterson, P.Eng, M.Eng
Director, Naval Architecture, Engineering British Columbia Ferry Services Inc.
Tel: (250) 978-1385
[redacted] ss. 15, 19
Fax: (250) 978-1166
bruce.paterson@bcferries.com
www.bcferries.com
Safety and Operational Readiness

From: Zargham, Reza [mailto:Reza.Zargham@lr.org]
Sent: November 27,2019 8:39 AM
To: Paterson, Bruce
Cc: Chern, Richard; McDonald, Bruce; Sovagovic, Zoran
Subject: RE: CF BAYNES SOUND CONNECTOR (BSC) - Request to review change in cable type

Hi Bruce,
There are no LR standards that can be used for verification of the steel wire rope.
Steel wire ropes were not considered to be a class item during plan appraisal of BAYNES SOUND CONNECTOR (BSC) and consequently ATSO was not involved in the review of ropes.
Steel wire ropes are under the responsibility of the designer and should be selected to be compatible with the equipment (bull wheels, sheaves) fitted on board.
Based on information provided in attached memorandum there is no objection for existing steel wire rope 6x19 IWRC (BS 1174kN) to be replaced with steel wire rope 6x25 IWRC (BS 1335kN).
Considering that steel ropes are not a class item we cannot stamp attached memo however we could issue a statement of no objection.

Kind regards,
Reza

From: Paterson, Bruce <Bruce.Paterson@bcferries.com>
Sent: Tuesday, 26 November, 2019 2:55 PM
To: Zargham, Reza <Reza.Zargham@lr.org>
Cc: Chern, Richard <richard.chern@lr.org>; McDonald, Bruce <Bruce.McDonald@lr.org>
Subject: RE: CF BAYNES SOUND CONNECTOR (BSC) - Request to review change in cable type

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Just to clarify, is the design standard being referenced meant to mean an LR standard? Or could we provide the original cable specification?

Bruce Paterson, P.Eng, M.Eng
Director, Naval Architecture, Engineering British Columbia Ferry Services Inc.
Tel: (250) 978-1385
[redacted] ss. 15, 19
Fax: (250) 978-1166
bruce.paterson@bcferries.com
www.bcferries.com
Safety and Operational Readiness

From: Zargham, Reza [mailto:Reza.Zargham@lr.org]
Sent: November 26,2019 1:54 PM
To: Paterson, Bruce
Cc: Chern, Richard; McDonald, Bruce
Subject: FW: CF BAYNES SOUND CONNECTOR (BSC) - Request to review change in cable type

Hi Bruce
Your email below and attached document refers.
As per our ATSO advise , this case is out of scope and difficult to appraise as there is no design standard.
We could issue a statement of no objection , please let me know if is acceptable.

Kind regards,
Reza

Reza Zargham, Lloyds Register
Area Operations Manager - West of Canada and USA (NAW) , Marine & Offshore
T +1 604 985 0477   D +1 604 982 2124   M +1 604 857 3206 E reza.zargham@lr.org
Lloyds Register Canada Limited, 502-221 West Esplanade, North Vancouver, BC V7M 3J3, Canada
Visit www.lr.org or follow us on: LinkedIn Facebook Twitter

From: Paterson, Bruce <Bruce.Paterson@bcferries.com>
Sent: November 25, 2019 5:07 PM
To: Chern, Richard <richard.chern@lr.org>
Cc: Zargham, Reza <Reza.Zargham@lr.org>; Camaraire, Frank <Frank.Camaraire@bcferries.com>; Johnston, Darren <Darren.Johnston@bcferries.com>; de Koninck, Captain Al <Al.deKoninck@bcferries.com>; Wills, Stuart <Stuart.Wills@bcferries.com>; Meyer, Leslie A. <Leslie.Meyer@bcferries.com>; Adams, James W <James.Adams@bcferries.com>
Subject: CF BAYNES SOUND CONNECTOR - Request to review change in cable type

Richard,

As you are probably aware, we have been investigating a new cable type to address the plastic shedding problem we have experienced on the cable ferry. Please find the attached memo and cover letter that outlines the specs for our proposed replacement cable. To comply with the applicable MTRB, can we get the memo stamped and/or a letter issued indicating LR's acceptance of the proposed change?

We are keen to place an order for the cables, so your prompt attention will be appreciated,

Regards,

Bruce Paterson, P.Eng, M.Eng
Director, Naval Architecture, Engineering British Columbia Ferry Services Inc.
Tel: (250) 978-1385
[redacted] ss. 15, 19
Fax: (250) 978-1166
bruce.paterson@bcferries.com
www.bcferries.com
Safety and Operational Readiness

Rasmussen, Shauna

From:	Adams, James W
Sent:	February 10, 2022 8:39 AM
To:	David Mietla - 3GA Marine Ltd. (dmietla@3gamarine.com)
Cc:	Shaun Wallis
Subject:	FW: BSC Cable - Emergency Spare
Attachments:	CF BAYNES SOUND CONNECTOR - Request to review change in cable type; FW: CF BAYNES SOUND CONNECTOR (BSC) - Request to review change in cable type

Hi David,

FYI - Attached is the documentation from the 2019 cable change. At that time we submitted an EYE memo outlining the specs for the proposed replacement, and LR reviewed and issued a letter of no objection provided that all other conditions in MTRB 14754 are followed.

The following tables show the maximum loads predicted in the EYE Dynamic Analysis Report and the current weather matrix for the BSC. It appears the proposed 1-1/2" cable, with a breaking strength of 259,000 lbs, exceeds min breaking strength requirements for the 55knot condition. However, considering that the cable will wear and lose strength over time, I think we should assess the cable with ~15% section loss and determine if the weather matrix requires modification. The matrix could be modified to restrict sailings above 38 knots for example, which aligns with the 20 m/s 100 year storm. In the 100 year storm scenario, do you believe the damaged condition (two cables only) is the limiting factor for determining the min breaking strength? It appears the damaged condition is based on max loading from the 100 year storm (430kN x 3)/2, though I'm not sure what assumptions EYE and DSA made during their analysis.

Table 8-2 shows the maximum loads predicted during the Time Domain Analysis with the appropriate safety factors and minimum required breaking load.

	Maximum Load kN	Factor of Safety	Minimum Breaking Strength Required kN
Pretension	196	5.0	980
100 Year Storm	429.4	2.0	859
Worst Operation 55 knots	571.7	2.0	1143
Damaged	691	1.33	919

Table 8-2

For Hourly Weather Conditions visit: Comox Airport

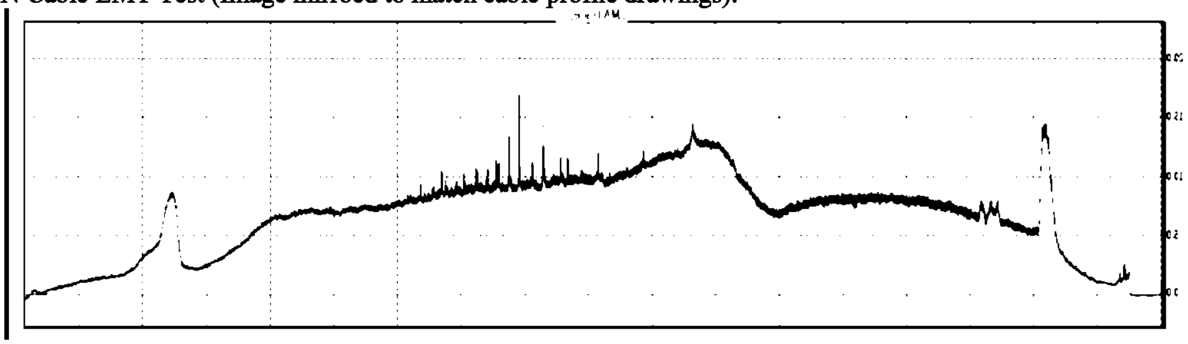
7	Near Gale	28 to 33	Diminishing	YES YES YES YES	OSC to get duty Superintendant if in doubt Complete heavy weather check-lists if sustained winds above 30kts
			Steady	YES YES YES YES	
			Increasing	YES YES YES YES	
8	Gale	34 to 40	Diminishing	YES YES YES YES	OSC to get duty Superintendant if in doubt In addition to the heavy weather chekist hold a weather briefing with the crew prior to departure
			Steady	YES YES YES YES	
			Increasing	YES YES YES YES	
9	Strong Gale	41 to 45	Diminishing	CONSULT CONSULT CONSULT CONSULT	Call OSC to get duty Superintendant In addition to heavy weathr checklist and briefing discuss how the weather is effecting the apron vessel interface and if it is safe to keep transferring traffic
			Steady	CONSULT CONSULT CONSULT CONSULT	
			Increasing	CONSULT CONSULT CONSULT CONSULT	
10	Storm	48 to 55	Diminishing		Call OSC and cancel the sailing if sustained wind is above 45kts
			Steady		
			Increasing		

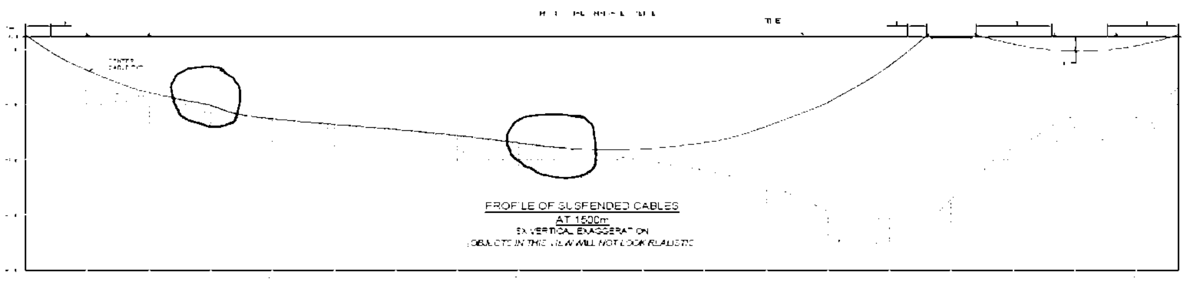
Regards,

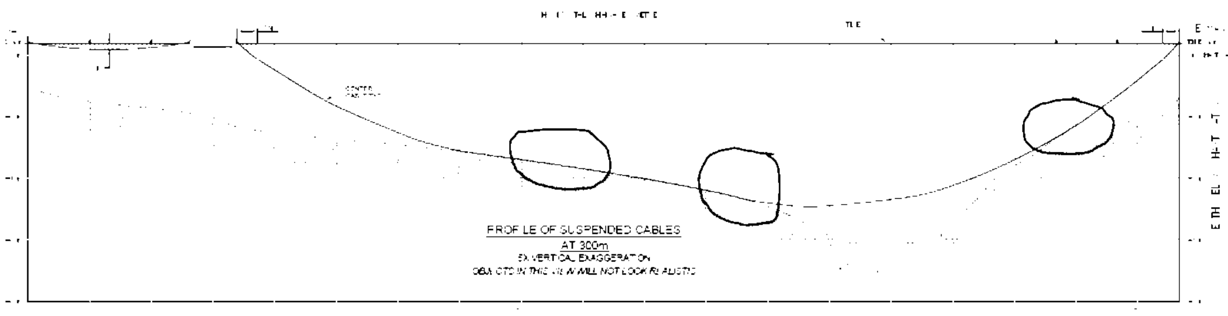
James Adams, P.Eng.
Project Manager, Terminal Construction
British Columbia Ferry Services Inc.
T: 250-978-1317 [redacted] **F:** 250-361-4922
james.adams@bcferries.com
bcferries.com

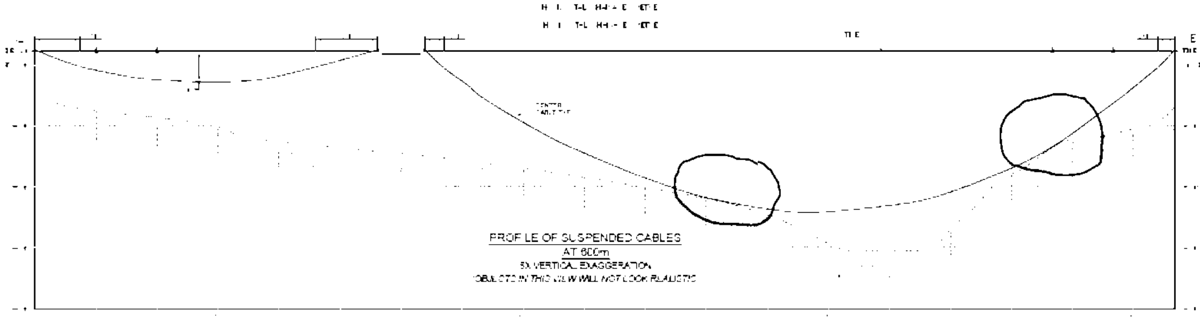
ss. 15, 19

N Cable EMT Test (Image mirroed to match cable profile drawings):

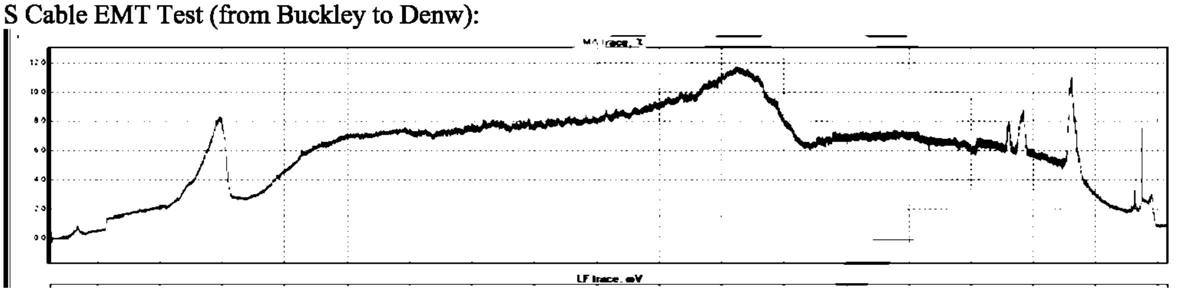








S Cable EMT Test (from Buckley to Denw):



Rasmussen, Shauna

From: Adams, James W
Sent: February 11, 2022 7:17 PM
To: Shaun Wallis
Cc: David Mietla
Subject: Re: [EXTERNAL] RE: BSC Cable - Emergency Spare

Thanks Shaun, we will review and will let you know if we have any questions.

Regards,

James

Sent from my iPhone

On Feb 11, 2022, at 3:42 PM, Shaun Wallis wrote:

James,
Here is the draft letter for our initial findings. I know you are looking for a memo to send to LR, but this memo is more for BC Ferries. The LR memo will be developed once BC Ferries decides on the model parameters, they want us to use, and we develop a new allowable tension matrix.
Cheers,
Shaun Wallis, EIT
Marine Systems Engineer
3GA Marine Ltd.
Work: (250) 920 9992 ext. 1004

From: Adams, James W
Sent: February 11, 2022 12:19 PM
To: Shaun Wallis ; David Mietla
Subject: RE: BSC Cable - Emergency Spare
Yes, agreed. Attached are the cable survey drawings.
James Adams, P.Eng.
Project Manager, Terminal Construction ss. 15, 19
British Columbia Ferry Services Inc.
T: 250-978-1317 [redacted] **F:** 250-361-4922
james.adams@bcferries.com
bcferries.com

From: Shaun Wallis <swallis@3gamarine.com>
Sent: February 11, 2022 12:14 PM
To: Adams, James W <James.Adams@bcferries.com>; David Mietla <dmietla@3gamarine.com>
Subject: [EXTERNAL] RE: BSC Cable - Emergency Spare

Wow that is pretty clear correlation.
Shaun Wallis, EIT
Marine Systems Engineer
3GA Marine Ltd.
Work: (250) 920 9992 ext. 1004

From: Adams, James W <James.Adams@bcferries.com>
Sent: February 11, 2022 11:58 AM
To: David Mietla <dmietla@3gamarine.com>
Cc: Shaun Wallis <swallis@3gamarine.com>
Subject: FW: BSC Cable - Emergency Spare
Hi David and Shaun,
Thanks for the call today. The email below contains preliminary information that may be helpful to include the memo. As discussed, the numbers will likely change since you'll be using the min design breaking strength.
I'd like to make sure BCF is aware of the possible changes to the sailing matrix if we use this cable when new and with 15% section loss.
Also attached is a couple screen shots showing the N and S cable EMT testing and cable profile drawings. Interesting to see the location of the wear areas correspond to seabed features.
Thanks,
James Adams, P.Eng.
Project Manager, Terminal Construction
British Columbia Ferry Services Inc. ss. 15, 19
T: 250-978-1317 [redacted] **F:** 250-361-4922
james.adams@bcferries.com
bcferries.com

From: Adams, James W
Sent: February 10, 2022 9:50 AM
To: Meyer, Leslie A. <Leslie.Meyer@bcferries.com>; Paterson, Bruce <Bruce.Paterson@bcferries.com>; Weigold, Andrew <Andrew.Weigold@bcferries.com>; Seitz, Robert <Robert.Seitz@bcferries.com>; Stahuliak, Marian <Marian.Stahuliak@bcferries.com>
Cc: Nakano, Leonard <Leonard.Nakano@bcferries.com>; Jones, Stephen <Stephen.Jones@bcferries.com>; Jones, Gary <Gary.Jones@bcferries.com>; Cennon, Quentin <Quentin.Cennon@bcferries.com>
Subject: RE: BSC Cable - Emergency Spare
Hi Rob,
3GA Marine has been contracted to review the proposed 1-1/2" emergency spare cable with a breaking strength of 259,000 lbs [1152 kN]. While we are waiting 3GA to complete their review, I have provided the following preliminary information for consideration:
The table below provides the minimum required breaking strength for cables in the 100 year (39 knot sustained winds) and worst case 55 knot storm conditions. The emergency spare cable meets requirements for the 55knot condition but has limited reserve capacity as it becomes worn during standard use. In general, we typically allow a maximum section loss limit of 15% and this equates to 15-20% loss in strength. Using the same section loss limit for the emergency spare cable would reduce its breaking strength to approximately 920 kN. The table below notes that the minimum required breaking strength is 859kN in a 100 year storm and 919kN in the two cable "damaged" condition. Therefore, the sailings may need to be restricted above 39 knots to maintain the minimum required factor of safety in this condition. This aligns with the current sailing matrix with the exception of "Consult" in the Strong Gale condition.
The preliminary calculations noted above will need to be confirmed by 3GA. It should also be noted that the proposed emergency spare cable has the highest available grade of steel. A standard 1-1/2" cable has material that is more common but 10% lower breaking strength.
James Adams, P.Eng.

Project Manager, Terminal Construction
British Columbia Ferry Services Inc.
T: 250-978-1317 [redacted] **F:** 250-361-4922
james.adams@bcferries.com
bcferries.com

ss. 15, 19

Rasmussen, Shauna

From: Adams, James W
Sent: February 14, 2022 11:01 AM
To: Cennon, Quentin; Seitz, Robert
Subject: FW: BSC Cable - Emergency Spare
Attachments: 20-064 Baynes Sound Connector Temporary Cable Replacement Review R0x (Draft).pdf

Hi Rob and Quentin,

Attached is the draft memo from 3GA regarding the emergency spare. Are you both free this afternoon for a brief webex to discus?

I'd like to see additional details on the sailing matrix.

Regards,

James Adams, P.Eng. ss. 15, 19
Project Manager, Terminal Construction
British Columbia Ferry Services Inc.
T: 250-978-1317 [redacted] **F:** 250-361-4922
james.adams@bcferries.com
bcferries.com

From: Adams, James W
Sent: February 10, 2022 9:50 AM
To: Meyer, Leslie A. <Leslie.Meyer@bcferries.com>; Paterson, Bruce <Bruce.Paterson@bcferries.com>; Weigold, Andrew <Andrew.Weigold@bcferries.com>; Seitz, Robert <Robert.Seitz@bcferries.com>; Stahuliak, Marian <Marian.Stahuliak@bcferries.com>
Cc: Nakano, Leonard <Leonard.Nakano@bcferries.com>; Jones, Stephen <Stephen.Jones@bcferries.com>; Jones, Gary <Gary.Jones@bcferries.com>; Cennon, Quentin <Quentin.Cennon@bcferries.com>
Subject: RE: BSC Cable - Emergency Spare

Hi Rob,

3GA Marine has been contracted to review the proposed 1-1/2" emergency spare cable with a breaking strength of 259,000 lbs [1152 kN]. While we are waiting 3GA to complete their review, I have provided the following preliminary information for consideration:

The table below provides the minimum required breaking strength for cables in the 100 year (39 knot sustained winds) and worst case 55 knot storm conditions. The emergency spare cable meets requirements for the 55knot condition but has limited reserve capacity as it becomes worn during standard use. In general, we typically allow a maximum section loss limit of 15% and this equates to 15-20% loss in strength. Using the same section loss limit for the emergency spare cable would reduce its breaking strength to approximately 920 kN. The table below notes that the minimum required breaking strength is 859kN in a 100 year storm and 919kN in the two cable "damaged" condition. Therefore, the sailings may need to be restricted above 39 knots to maintain the minimum required factor of safety in this condition. This aligns with the current sailing matrix with the exception of "Consult" in the Strong Gale condition.

The preliminary calculations noted above will need to be confirmed by 3GA. It should also be noted that the proposed emergency spare cable has the highest available grade of steel. A standard 1-1/2" cable has material that is more common but 10% lower breaking strength.

Table 8-2 shows the maximum loads predicted during the Time Domain Analysis with the appropriate safety factors and minimum required breaking load.

	Maximum Load kN	Factor of Safety	Minimum Breaking Strength Required kN
Pretension	196	5.0	980
100 Year Storm	429.4	2.0	859
Worst Operation 55 knots	571.7	2.0	1143
Damaged	691	1.33	919

Table 8-2

James Adams, P.Eng.
Project Manager, Terminal Construction
British Columbia Ferry Services Inc.
T: 250-978-1317 [redacted] **F:** 250-361-4922
james.adams@bcferries.com
bcferries.com

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Rasmussen, Shauna

From: Adams, James W
Sent: February 16, 2022 8:53 AM
To: Shaun Wallis
Cc: David Mietla - 3GA Marine Ltd. (dmietla@3gamarine.com)
Subject: FW: draft report
Attachments: 3203WRR BC Ferry Services - Baynes Sounds - Wire Rope Report Draft_JA Edits.pdf

Hi Shaun,

s. 13 [redacted]

Thanks,

James Adams, P.Eng.
Project Manager, Terminal Construction
British Columbia Ferry Services Inc.
T: 250-978-1317 [redacted] **F:** 250-361-4922
james.adams@bcferries.com ss. 15, 19
bcferries.com

From: Adams, James W
Sent: February 16, 2022 8:51 AM
To: Parsons, Alex ; 'Ross Muirhead' ; 'Testing'
Cc: 'Cole Iveson' ; Cennon, Quentin ; Latta, Janice ; Thibault, Lisa
Subject: RE: North Rope

Hi Ross,

See attached comments in red for suggested edits. The drive cable asset info should be updated and install date changed.

Please issue the final report to Terminal Maintenance and cc me.

Janice – Thanks for your help reviewing BCF asset information.

Thanks,

James Adams, P.Eng.
Project Manager, Terminal Construction ss. 15, 19
British Columbia Ferry Services Inc.
T: 250-978-1317 [redacted] **F:** 250-361-4922
james.adams@bcferries.com
bcferries.com

From: Adams, James W
Sent: February 16, 2022 8:26 AM
To: Parsons, Alex <Alex.Parsons@bcferries.com>; Ross Muirhead <ross@inter-mtntesting.com>; Testing <testing@inter-mtntesting.com>

Cc: Cole Iveson <cole@inter-mtntesting.com>; Cennon, Quentin <Quentin.Cennon@bcferries.com>; Latta, Janice <Janice.Latta@bcferries.com>; Thibault, Lisa <Lisa.Thibault@bcferries.com>
Subject: RE: North Rope

Hi Alex,

Thanks for looking into this. I'm still not sure if the inter-mtn report is correct. I don't have the asset numbers but I thought the previous drive cable was installed Jan 2021, removed Oct 2021, then installed in North guide Feb 2022? Therefore doesn't the latest drive cable has about 3-4 months of service? The latest inter-mtn report, which was completed Jan 2022, says the drive cable was installed Jan 2021. I don't think this is correct.

Just was to double check for the memo 3GA is preparing.

Thanks,

James Adams, P.Eng.
Project Manager, Terminal Construction ss. 15, 19
British Columbia Ferry Services Inc.
T: 250-978-1317 [redacted] **F:** 250-361-4922
james.adams@bcferries.com
bcferries.com

From: Parsons, Alex <Alex.Parsons@bcferries.com>
Sent: February 16, 2022 7:34 AM
To: Adams, James W <James.Adams@bcferries.com>; Ross Muirhead <ross@inter-mtntesting.com>; Testing <testing@inter-mtntesting.com>
Cc: Cole Iveson <cole@inter-mtntesting.com>; Cennon, Quentin <Quentin.Cennon@bcferries.com>; Latta, Janice <Janice.Latta@bcferries.com>; Thibault, Lisa <Lisa.Thibault@bcferries.com>
Subject: RE: North Rope

All assets are tracked through maximo
Confirm that the drive cable date is accurate
Here is notes for the WO in our CMMS system
Asset 49117 is coming out and new asset 56374 is being installed.
JAN 20 2021 INSTALL DATE

From: Adams, James W <James.Adams@bcferries.com>
Sent: February 15, 2022 2:14 PM
To: Ross Muirhead <ross@inter-mtntesting.com>; Testing <testing@inter-mtntesting.com>; Parsons, Alex <Alex.Parsons@bcferries.com>
Cc: Cole Iveson <cole@inter-mtntesting.com>; Cennon, Quentin <Quentin.Cennon@bcferries.com>
Subject: RE: North Rope

Hi Ross,

I think you've got the wrong in installation date for the drive cable. It was installed around November 2021?

Alex – Can you follow up with Ross on the exact date?

Thanks,

James Adams, P.Eng.
Project Manager, Terminal Construction
British Columbia Ferry Services Inc.
T: 250-978-1317 ss. 15, 19 [redacted] **F:** 250-361-4922
james.adams@bcferries.com
bcferries.com

s. 17, s. 21

[redacted]

<cole@inter-mtntesting.com>; Cennon, Quentin <Quentin.Cennon@bcferries.com>
Subject: RE: North Rope

Thanks Ross.

James Adams, P.Eng.
Project Manager, Terminal Construction
British Columbia Ferry Services Inc.
T: 250-978-1317 [redacted] **F:** 250-361-4922
james.adams@bcferries.com
bcferries.com

ss. 15, 19

From: Testing <testing@inter-mtntesting.com>
Sent: January 28, 2022 4:32 PM
To: Adams, James W <James.Adams@bcferries.com>
Cc: Ross Muirhead <ross@inter-mtntesting.com>; Parsons, Alex <Alex.Parsons@bcferries.com>; Cole Iveson <cole@inter-mtntesting.com>; Cennon, Quentin <Quentin.Cennon@bcferries.com>
Subject: [EXTERNAL] Re: North Rope

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Will have a draft early next week.

Ross Muirhead
Inter-Mtn. Testing Ltd.
C: 250.215.3780
O: 250.491.4250

> On Jan 28, 2022, at 4:13 PM, Adams, James W <James.Adams@bcferries.com> wrote:
>
> Thanks Ross. Looking forward to seeing a draft report next week if possible.
>
> Regards,
>
> James Adams, P.Eng.
> Project Manager, Terminal Construction
> **British Columbia Ferry Services Inc.**
> **T:** 250-978-1317 [redacted] **F:** 250-361-4922
> james.adams@bcferries.com
> **bcferries.com**
>
> ss. 15, 19
>
> **From:** Ross Muirhead <ross@inter-mtntesting.com>
> **Sent:** January 28, 2022 11:05 AM
> **To:** Adams, James W <James.Adams@bcferries.com>
> **Cc:** Parsons, Alex <Alex.Parsons@bcferries.com>; Cole Iveson <cole@inter-mtntesting.com>; Cennon, Quentin <Quentin.Cennon@bcferries.com>; Testing <testing@inter-mtntesting.com>
> **Subject:** [EXTERNAL] Re: North Rope

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s. 13 [redacted]

On Jan 28, 2022, at 8:42 AM, Adams, James W <James.Adams@bcferries.com> wrote:

Thanks Ross, what are the numbers for the south guide? The previous inspection report from Oct 21 notes that both guide cables had max section loss around 8-8.5%.

James Adams, P.Eng.
Project Manager, Terminal Construction
British Columbia Ferry Services Inc.
T: 250-978-1317 ss. 15, 19 [redacted] **F:** 250-361-4922
james.adams@bcferries.com
bcferries.com

From: Parsons, Alex <Alex.Parsons@bcferries.com>
Sent: January 28, 2022 8:30 AM
To: Ross Muirhead <ross@inter-mtntesting.com>; Adams, James W <James.Adams@bcferries.com>
Cc: Testing <testing@inter-mtntesting.com>; Cole Iveson <cole@inter-mtntesting.com>; Cennon, Quentin <Quentin.Cennon@bcferries.com>
Subject: RE: North Rope

Thanks Ross, message received met the crew that was working last night and went over their pictures. We are preparing to replace cable.

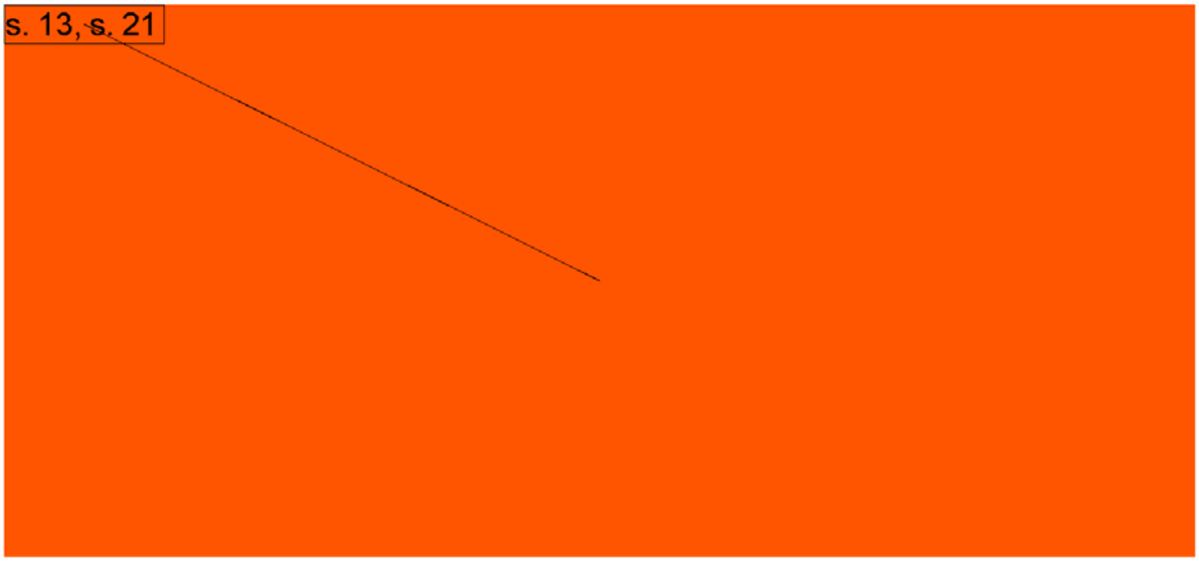
Regards

Alex

From: Ross Muirhead <ross@inter-mtntesting.com>
Sent: January 28, 2022 3:43 AM
To: Adams, James W <James.Adams@bcferries.com>; Parsons, Alex <Alex.Parsons@bcferries.com>
Cc: Testing <testing@inter-mtntesting.com>; Cole Iveson <cole@inter-mtntesting.com>
Subject: [EXTERNAL] North Rope

CAUTION: This email originated from outside of BC Ferries. Do not click links or open attachments unless you recognize the sender and know the content is safe.

James,


s. 13, s. 21

208-1497 Admirals Rd
Victoria, BC V9A 2P8
Canada
+1 250 920 9992
+1 250 483 6301

MEMORANDUM

To: James Adams, P.Eng. Project Manager, British Columbia Ferry Services Inc.
From: David Mietla, P.Eng. President, 3GA Marine Ltd.
Prepared By: Shaun Wallis, EIT Marine Systems Engineer, 3GA Marine Ltd.
Date: 2022-02-07
RE: Baynes Sound Connector Temporary Cable Replacement Review

---

3GA has reviewed INTER-MTN Testing's wire rope inspection report. Additionally, 3GA has reviewed the proposed temporary cable replacement options, provided by BC Ferries.

s. 13, s. 21

[redacted]

Emergency cable replacement options.

Before analysing the options, it should be noted that this system was designed for 1-5/8 inch cable. 3GA does not expect any issues using a 1.5" cable in the guide position. However, the sheave grooves will be oversized, for 1.5" cable. The cable may be subject to additional vibrations, potentially leading to excess noise and accelerated wear. BC ferries must execute quarterly inspections specifically looking for signs of accelerated wear, and any other unforeseen issues, caused by the reduced diameter. This information will be critical for future decision making.

3GA's analysis is to determine the best wire rope, for this emergency situation, selected from the options provided by BC Ferries. The selected rope should not be considered for future rope replacements, without further analysis.

EYE, during the design of this vessel, performed a computational study to determine the required cable strengths. The results of this study have been included in Table 1.

Table 1: EYE report Table 8-2 shows the maximum loads predicted during the Time Domain Analysis

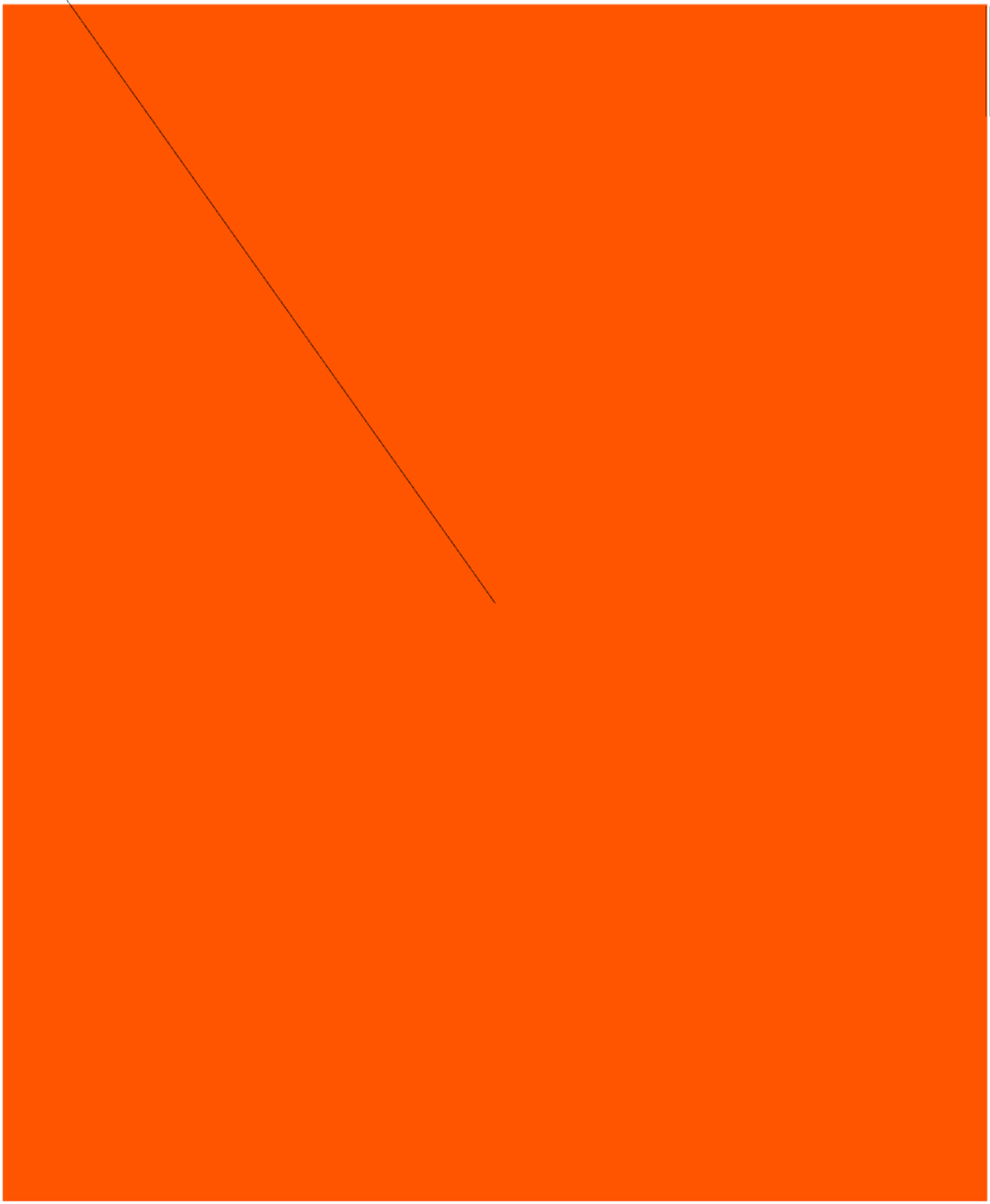
	Maximum Load kN	Factor of Safety	Minimum Breaking Strength Required kN
Pretension	196	5.0	980
100 Year Storm	429.4	2.0	859
Worst Operation 55 knots	571.7	2.0	1143
Damaged	691	1.33	919

For further details on how these values were determined, refer to the EYE report "Dynamic analysis of cable ferry system Buckley Bay to Denman Island, February 2013".

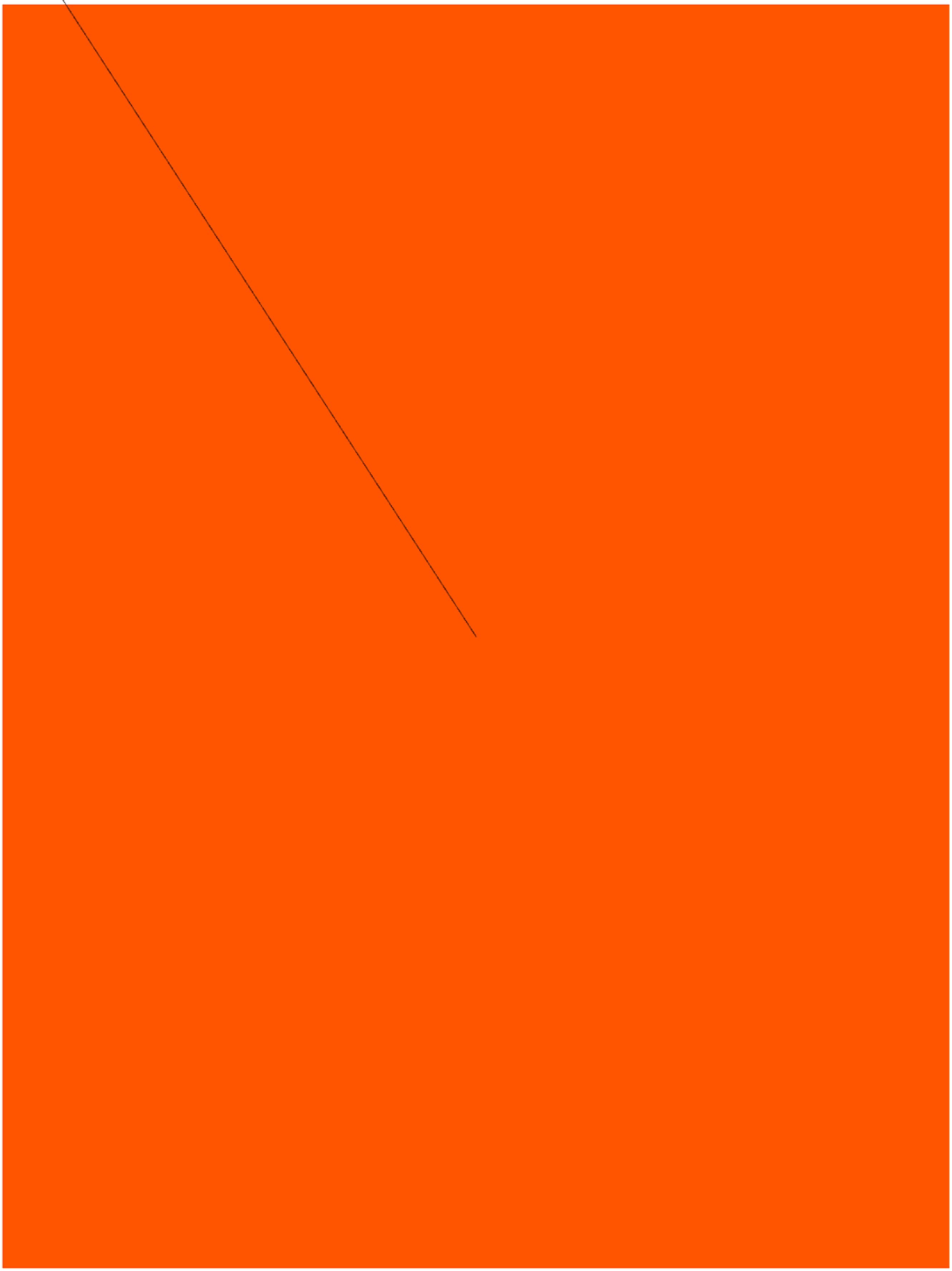
s. 13, s. 17

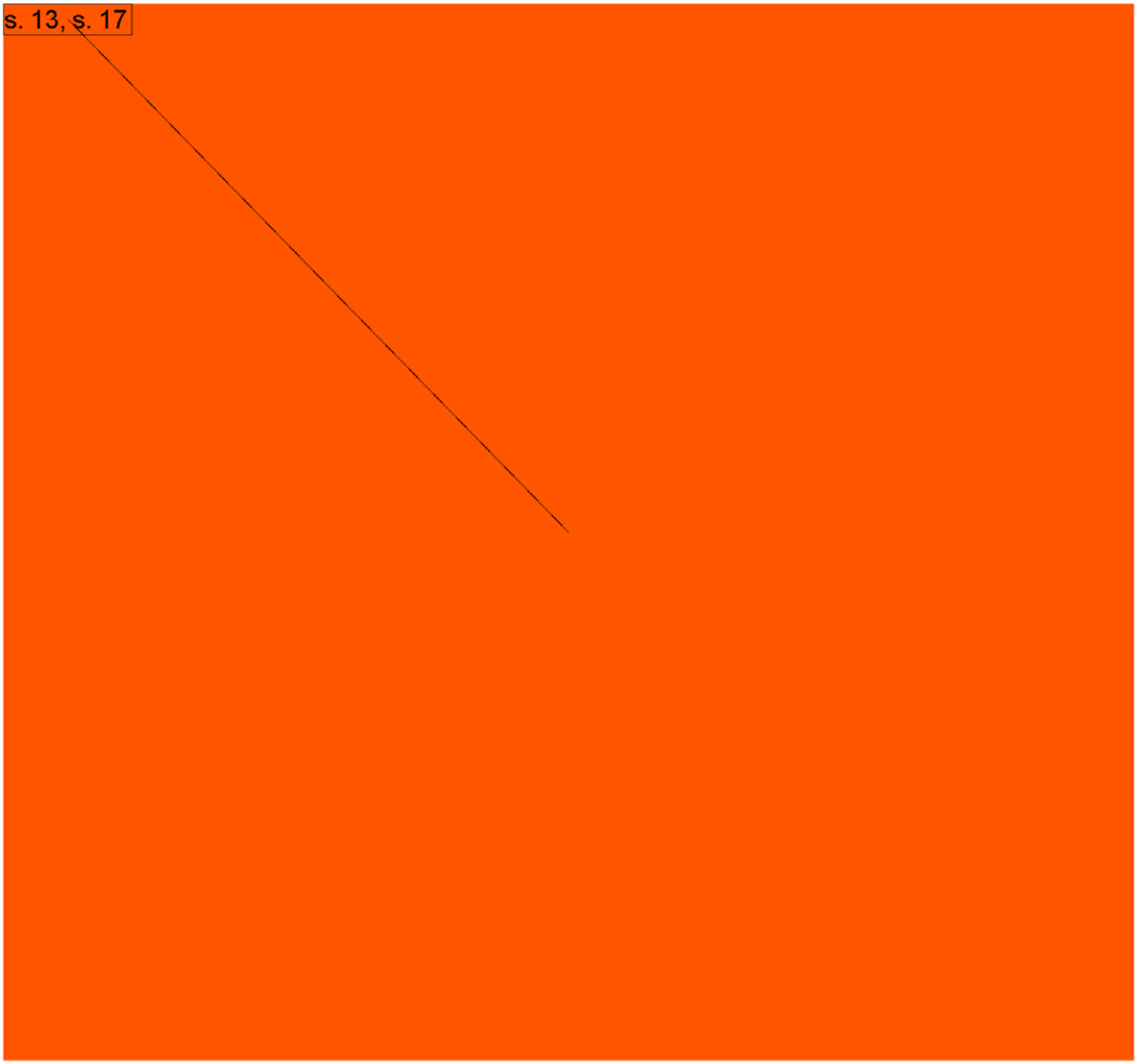
[redacted]

s. 13, s. 17



s. 13, s. 17




s. 13, s. 17

Rasmussen, Shauna

From: Shaun Wallis <swallis@3gamarine.com>
Sent: February 18, 2022 4:34 PM
To: Adams, James; David Mietla
Subject: [EXTERNAL] RE: BSC Cable - Emergency Spare
Attachments: 20-064 Baynes Sound Connector Temporary Cable Replacement Review R0.pdf

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James,

Attached is the updated memo.

Cheers

Shaun Wallis, EIT
Marine Systems Engineer
3GA Marine Ltd.
Work: (250) 920 9992 ext. 1004

From: Adams, James W
Sent: February 18, 2022 1:31 PM
To: David Mietla ; Shaun Wallis
Subject: RE: BSC Cable - Emergency Spare

Hi David,

Perfect, thanks yes that works.

Regards,

James Adams, P.Eng.
Project Manager, Terminal Construction ss. 15, 19
British Columbia Ferry Services Inc.
T: 250-978-1317 [redacted] **:** 250-361-4922
james.adams@bcferries.com
bcferries.com

From: David Mietla <dmietla@3gamarine.com>
Sent: February 18, 2022 1:23 PM
To: Adams, James W <James.Adams@bcferries.com>; Shaun Wallis <swallis@3gamarine.com>
Subject: [EXTERNAL] RE: BSC Cable - Emergency Spare

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Hi James,
We will get it to you later today.

Hopefully that works.

Thank you and kind regards,

David Mietla, P.Eng.
President
3GA Marine Ltd.
Cell: (250) 589 7404

Optimizing Solutions

From: Adams, James W <James.Adams@bcferries.com>
Sent: February 18, 2022 1:15 PM
To: David Mietla <dmietla@3gamarine.com>; Shaun Wallis <swallis@3gamarine.com>
Subject: RE: BSC Cable - Emergency Spare

Hi David,

Just checking in, can you please let me know when you are planning to submit the updated memo?

Thanks,

James Adams, P.Eng.
Project Manager, Terminal Construction ss. 15, 19
British Columbia Ferry Services Inc.
T: 250-978-1317 [redacted] **F:** 250-361-4922
james.adams@bcferries.com
bcferries.com

From: Adams, James W
Sent: February 15, 2022 2:33 PM
To: 'David Mietla' <dmietla@3gamarine.com>; Shaun Wallis <swallis@3gamarine.com>
Subject: RE: BSC Cable - Emergency Spare

Thanks David, appreciate the quick response.

James Adams, P.Eng.

Project Manager, Terminal Construction
British Columbia Ferry Services Inc.
T: 250-978-1317 s. 15, 19 [redacted] **F:** 250-361-4922
james.adams@bcferries.com
bcferries.com

From: David Mietla <dmietla@3gamarine.com>
Sent: February 15, 2022 2:30 PM
To: Adams, James W <James.Adams@bcferries.com>; Shaun Wallis <swallis@3gamarine.com>
Subject: [EXTERNAL] RE: BSC Cable - Emergency Spare

Hi James,
Shaun just told me what you two have discussed and we do not see an issue with updating the report to that effect. So based on our calculations the suggested cable will be suitable for use as a temporary cable for weather up to the 100 year storm.

We will get you the updated memo shortly.

Thank you and kind regards,

David Mietla, P.Eng.
President
3GA Marine Ltd.
Cell: (250) 589 7404

3GA MARINE

Optimizing Solutions

From: Adams, James W <James.Adams@bcferries.com>
Sent: February 15, 2022 12:57 PM
To: Shaun Wallis <swallis@3gamarine.com>
Cc: David Mietla <dmietla@3gamarine.com>
Subject: RE: BSC Cable - Emergency Spare

Hi Shaun,

See attached edits for discussion – Is there a good time we can discuss? I'm free after 1:30 and before 3pm today.

Thanks,

James Adams, P.Eng.
Project Manager, Terminal Construction ss. 15, 19
British Columbia Ferry Services Inc.
T: 250-978-1317[redacted] **F:** 250-361-4922
james.adams@bcferries.com
bcferries.com

From: Shaun Wallis <swallis@3gamarine.com>
Sent: February 11, 2022 3:42 PM
To: Adams, James W <James.Adams@bcferries.com>
Cc: David Mietla <dmietla@3gamarine.com>
Subject: [EXTERNAL] RE: BSC Cable - Emergency Spare

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James,

Here is the draft letter for our initial findings. I know you are looking for a memo to send to LR, but this memo is more for BC Ferries. The LR memo will be developed once BC Ferries decides on the model parameters, they want us to use, and we develop a new allowable tension matrix.

Cheers,

Shaun Wallis, EIT
Marine Systems Engineer
3GA Marine Ltd.
Work: (250) 920 9992 ext. 1004

From: Adams, James W <James.Adams@bcferries.com>
Sent: February 11, 2022 12:19 PM
To: Shaun Wallis <swallis@3gamarine.com>; David Mietla <dmietla@3gamarine.com>
Subject: RE: BSC Cable - Emergency Spare

Yes, agreed. Attached are the cable survey drawings.

James Adams, P.Eng.
Project Manager, Terminal Construction ss. 15, 19
British Columbia Ferry Services Inc.
T: 250-978-131[redacted] **F:** 250-361-4922
james.adams@bcferries.com
bcferries.com

From: Shaun Wallis <swallis@3gamarine.com>
Sent: February 11, 2022 12:14 PM
To: Adams, James W <James.Adams@bcferries.com>; David Mietla <dmietla@3gamarine.com>
Subject: [EXTERNAL] RE: BSC Cable - Emergency Spare

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Wow that is pretty clear correlation.

Shaun Wallis, EIT
Marine Systems Engineer
3GA Marine Ltd.
Work: (250) 920 9992 ext. 1004

From: Adams, James W <James.Adams@bcferries.com>
Sent: February 11, 2022 11:58 AM
To: David Mietla <dmietla@3gamarine.com>
Cc: Shaun Wallis <swallis@3gamarine.com>
Subject: FW: BSC Cable - Emergency Spare

Hi David and Shaun,

Thanks for the call today. The email below contains preliminary information that may be helpful to include the memo. As discussed, the numbers will likely change since you'll be using the min design breaking strength.

I'd like to make sure BCF is aware of the possible changes to the sailing matrix if we use this cable when new and with 15% section loss.

Also attached is a couple screen shots showing the N and S cable EMT testing and cable profile drawings. Interesting to see the location of the wear areas correspond to seabed features.

Thanks,

James Adams, P.Eng.
Project Manager, Terminal Construction
British Columbia Ferry Services Inc.
T: 250-978-1317 ss. 15, 19 [redacted] **F:** 250-361-4922
james.adams@bcferries.com
bcferries.com

From: Adams, James W
Sent: February 10, 2022 9:50 AM
To: Meyer, Leslie A. <Leslie.Meyer@bcferries.com>; Paterson, Bruce <Bruce.Paterson@bcferries.com>; Weigold, Andrew <Andrew.Weigold@bcferries.com>; Seitz, Robert <Robert.Seitz@bcferries.com>; Stahuliak, Marian <Marian.Stahuliak@bcferries.com>
Cc: Nakano, Leonard <Leonard.Nakano@bcferries.com>; Jones, Stephen <Stephen.Jones@bcferries.com>; Jones, Gary <Gary.Jones@bcferries.com>; Cennon, Quentin <Quentin.Cennon@bcferries.com>
Subject: RE: BSC Cable - Emergency Spare

Hi Rob,

3GA Marine has been contracted to review the proposed 1-1/2" emergency spare cable with a breaking strength of 259,000 lbs [1152 kN]. While we are waiting 3GA to complete their review, I have provided the following preliminary information for consideration:

The table below provides the minimum required breaking strength for cables in the 100 year (39 knot sustained winds) and worst case 55 knot storm conditions. The emergency spare cable meets requirements for the 55knot condition but has limited reserve capacity as it becomes worn during standard use. In general, we typically allow a maximum section loss limit of 15% and this equates to 15-20% loss in strength. Using the same section loss limit for the emergency spare cable would reduce its breaking strength to approximately 920 kN. The table below notes that the minimum required breaking strength is 859kN in a 100 year storm and 919kN in the two cable "damaged" condition. Therefore, the sailings may need to be restricted above 39 knots to maintain the minimum required factor of safety in this condition. This aligns with the current sailing matrix with the exception of "Consult" in the Strong Gale condition.

The preliminary calculations noted above will need to be confirmed by 3GA. It should also be noted that the proposed emergency spare cable has the highest available grade of steel. A standard 1-1/2" cable has material that is more common but 10% lower breaking strength.

Table 8-2 shows the maximum loads predicted during the Time Domain Analysis with the appropriate safety factors and minimum required breaking load.

	Maximum Load kN	**Factor of Safety**	**Minimum Breaking Strength Required kN**
Pretension	196	5.0	980
100 Year Storm	429.4	2.0	859
Worst Operation 55 knots	571.7	2.0	1143
Damaged	691	1.33	919

Table 8-2

James Adams, P.Eng.
Project Manager, Terminal Construction
British Columbia Ferry Services Inc.
T: 250-978-1317 [redacted] **F:** 250-361-4922
james.adams@bcferries.com
bcferries.com

ss. 15, 19

Rasmussen, Shauna

From: Adams, James W
Sent: February 19, 2022 9:30 AM
To: Seitz, Robert
Cc: Nakano, Leonard; Paterson, Bruce; Stahuliak, Marian; Weigold, Andrew; Jones, Gary; Jones, Gary; Parsons, Alex; Cennon, Quentin
Subject: RE: BSC Cable - Emergency Spare
Attachments: 20-064 Baynes Sound Connector Temporary Cable Replacement Review R0.pdf

Hi Rob,

Attached is 3GA's final report recommending that the Northern Strands 1-1/2" dia emergency spare cable is safe for temporary use in a guide position for weather up to the 100 year (40 knot) storm. 3GA indicates that the sailing matrix will require a minor adjustment to restrict sailings above 40 knots. They also indicated that the smaller diameter cable is s. 13 not optimized for the sheave groove diameter, which may cause increased noise and accelerated wear s. 13 [redacted]

I suggest we proceed with ordering this cable soon as possible to reduce the risk of service impacts and adhere to the Commissioner's requirement to have one spare cable on-site at all times.

It should also be noted that this cable will require new cable handing equipment.

Please let me know if you have any questions.

Regards,

James Adams, P.Eng.
Project Manager, Terminal Construction
British Columbia Ferry Services Inc.
T: 250-978-1317 [redacted] ss. 15, 19 **F:** 250-361-4922
james.adams@bcferries.com
bcferries.com

From: Adams, James W
Sent: February 15, 2022 2:55 PM
To: Seitz, Robert ; Cennon, Quentin (Quentin.Cennon@bcferries.com)
Cc: Nakano, Leonard ; Bruce Paterson (Bruce.Paterson@bcferries.com) ; Stahuliak, Marian (Marian.Stahuliak@bcferries.com) ; Andrew Weigold (Andrew.Weigold@bcferries.com) ; Jones, Gary (Gary.Jones@bcferries.com)
Subject: FW: BSC Cable - Emergency Spare

Hi Rob and Quentin,

I had a call with 3GA today and they have confirmed the Northern Strands 1-1/2" dia emergency spare cable is safe for temporary use for weather up to the 100 year (40 knot) storm. Once the cable is installed, the sailing matrix may require adjustments to ensure no sailings take place above 40 knots.

While we are waiting for 3GA to revise and issue the memo, did you want to provide direction to Leonard to prepare the PO/Supply Contract? It may take a couple days to add a new vendor and receive approval to sole-source.

3GA will be preparing a separate memo for LR indicating that this cable will be safe for temporary use in weather up to the 100 year storm.

Regards,

James Adams, P.Eng.
Project Manager, Terminal Construction ss. 15, 19
British Columbia Ferry Services Inc.
T: 250-978-1317 [redacted] **F:** 250-361-4922
james.adams@bcferries.com
bcferries.com

From: David Mietla <dmietla@3gamarine.com>
Sent: February 15, 2022 2:30 PM
To: Adams, James W <James.Adams@bcferries.com>; Shaun Wallis <swallis@3gamarine.com>
Subject: [EXTERNAL] RE: BSC Cable - Emergency Spare

Hi James,
Shaun just told me what you two have discussed and we do not see an issue with updating the report to that effect. So based on our calculations the suggested cable will be suitable for use as a temporary cable for weather up to the 100 year storm.

We will get you the updated memo shortly.

Thank you and kind regards,

David Mietla, P.Eng.
President
3GA Marine Ltd.
Cell: (250) 589 7404

Optimizing Solutions

s. 17

Page redacted

SERVICES CONTRACT

BSC Cable Ferry – Cable Assessment

BRITISH COLUMBIA FERRY SERVICES INC **“BC Ferries”** Little River Ferry Terminal Comox, BC	**3GA MARINE LTD** **“Contractor”** 208-1497 Admirals Road Victoria, BC V9A 2P8
Attention: Quentin Cennon Regional Manager Terminal Maintenance Telephone: 250-890-7822 Email: quentin.cennon@bcferries.com	Attention: David Mietla, P. Eng President Telephone: 250-589-7404 Email: dmietla@3gamarine.com
Reference PO # 355208	Date: February 10, 2022

BC FERRIES AND THE CONTRACTOR AGREE TO THE TERMS AND CONDITIONS CONTAINED IN SECTIONS 1 THROUGH 30, INCLUSIVE, IN THIS AGREEMENT AND IN THE SCHEDULES OUTLINED BELOW AND ANY ADDENDUM ATTACHED HEREIN.

SCHEDULE “A” – SERVICES – (full details set out in Addendum to Schedule “A”)

TERM – February 10 – May 3, 2022

SCHEDULE “B” - CONTRACT PRICE

s. 17 [redacted]

d) Billing Date: Invoices shall be submitted upon completion, detailing the Services completed and/or the number of hours/days devoted thereto.

e) Payment Terms: Unless otherwise set out in Schedule "B", upon receipt of an invoice detailing the Services performed, payment shall be made net 30 days after receipt of the invoice.

SCHEDULE “C” – APPROVED SUBCONTRACTOR(S)

As set out in Addendum to Schedule “C” – Approved Subcontractor(s)

SCHEDULE “D” – ADDITIONAL TERMS

As set out in Addendum to Schedule “D” – Additional Terms

SCHEDULE “E” – INSURANCE

As set out in Addendum to Schedule “E” – Insurance

TERMS AND CONDITIONS

THE CONTRACTOR

1. The Contractor will:

(a) provide to BC Ferries the Services listed in Schedule "A" hereto and all other services as are necessarily incidental thereto (the "Services"), during the Term, for the Contract Price established in Schedule "B" in accordance with the terms and conditions of this Agreement, including the Addendum to the Schedules (if any) attached, notwithstanding the date of the execution and delivery of this Agreement;

(b) supply at its own expense all labour, materials and approvals necessary to perform the Services except as specifically set forth herein;

(c) provide BC Ferries with status reports (a “Confirmation of Services Rendered”) regarding the performance of the Services by the Contractor at such intervals as BC Ferries may reasonably direct; the report shall be made up to the end of the period in respect of which it is made, in a form acceptable to BC Ferries and shall contain information as may be reasonably required by BC Ferries from time to time;

(d) comply with all applicable laws, regulations, and requirements of federal, provincial, municipal and other governing authorities;

(e) comply with all statutory occupational health and safety requirements under or in connection with the Workers Compensation Act in performance of the Services and the Contractor represents and warrants to BC Ferries that it is in compliance with all requirements of the Workers Compensation Act, including registration;

(f) comply with BC Ferries’ Standards as outlined in Addendum to Schedule A - Services;

(g) not assign this Agreement nor subcontract any right, duty or obligations hereunder to any person, firm or corporation without the prior written consent of BC Ferries and any attempt to so assign or subcontract without such consent of BC Ferries shall be null and void and of no effect;

(h) at all times maintain a professional standard of care, skill and diligence in performance of the Services, warranting that the Services shall be performed to the standard of experienced professionals in the Contractor's field;

(i) ensure that all persons employed or engaged by it to perform the Services have the qualifications, experience and capabilities necessary to perform the Services taking all reasonable steps to insure that such persons perform the Services to a professional standard of care, skill and diligence of experienced professionals in the Contractor's field;

(j) establish and maintain records, as required by BC Ferries from time to time;

(k) not advertise or otherwise publicize its working relationship under this contract without the prior written consent of BC Ferries;

(l) indemnify and save harmless BC Ferries, its directors, officers, employees, agents, servants and assigns from and against any and all losses, claims, damages, actions, causes of action, costs and expenses that BC Ferries may sustain, incur, suffer or be put to at any time either before or after the expiration or termination of this Agreement, where the same or any of them are based upon, arise out of or occur, directly or indirectly, by reason of any negligent act or omission of the Contractor or any of the Contractor's agents, employees, directors, officers, or subcontractors engaged in connection with the Services, including without limitation, any infringement of copyrights or licence rights by the

Contractor, excepting always liability arising out of the independent wilful acts of BC Ferries. This section 1 (l) shall survive the expiry of the Term or the earlier termination of this Agreement;

(m) during the Term of this Agreement, provide, maintain and pay for insurance in such form and amounts, with such deductibles, and according to the terms and conditions outlined in Schedule "E";

(n) make application for, obtain and remit to BC Ferries any applicable refund or rebate of federal or provincial taxes or duties available with respect to any articles, materials, equipment or services used or provided under this Agreement; and

(o) remedy deficiencies in the services promptly on request of BC Ferries for a period of one year after the Term, at no charge to BC Ferries. This section, 1 (o), shall survive the expiry of the Term or the earlier termination of this Agreement.

2. The Contractor acknowledges and agrees that, at all times, BC Ferries has the right of control, review and prior approval with respect to the performance of the Services and may from time to time impose specific requirements and general procedures with which the Contractor must comply and without restricting the generality of the foregoing, BC Ferries may require that its approval of any particular stage of the Services be obtained before the Contractor continues to the next stage in the performance of the Services and such approval by BC Ferries shall not effect or diminish in any way the obligations and liabilities of the Contractor with respect to the Services set forth herein or otherwise arising, nor shall BC Ferries be deemed by virtue of this paragraph to be entitled to direct the Contractor as to the manner in which the Services are performed.

THE CONTRACT PRICE

3. The amount payable to the Contractor in respect of the Services (for fees, expenses or otherwise) shall not exceed, in the aggregate, the Maximum Contract Price set out in Schedule "B", except if pre-authorized in writing by BC Ferries.

4. Where Schedule “B” provisions (b) and/or (c) apply, the Contractor shall be paid only for actual Services rendered, and, if applicable, approved expenses incurred, up to the Maximum Contract Price pursuant to Schedule "B".
Prices proposed shall be in Canadian dollars and shall include all costs of performing all the Services described herein. BC Ferries is subject to GST & PST.

5. The Contractor will submit written statements of account in the form of an Invoice to BC Ferries commencing on the "Billing Date" and thereafter as specified in Schedule "B". Invoices are to be sent as a PDF attachment in a PLAIN text email (not HTML) directly to apinvoicesonly@bcferries.com and cc the Project Manager. Invoices must reference Purchase Order.
The Contractor will, in addition to the Invoice, submit written statements of account referencing the PO number as noted herein and detailing the work performed, the amount invoiced including holdbacks (if applicable) and other information as may be reasonably required by BC Ferries.

6. BC Ferries may, at its discretion, withhold from the Contract Price sufficient monies to indemnify BC Ferries completely against any lien, claim or deficiency arising under this Agreement.

BC FERRIES

7. BC Ferries will:

   (a) subject to the terms of this Agreement, on approval of an invoice, pay to the Contractor the Contract Price calculated per Schedule "B" and clauses 3 and 4 hereof, in full settlement for the Services and the Contractor will accept same as payment in full for the Services;
   (b) make available to the Contractor all available information considered by BC Ferries to be pertinent to the Services and shall provide the Contractor with access to BC Ferries facilities and equipment as set out in Schedule “A”.

SUSPENSION OF WORK/TERMINATION

8. This Agreement shall automatically terminate upon expiration of the Term.
9. Prior to the expiration of the Term, either party may, at its option, elect to terminate the Agreement, provided that the party electing to terminate provides the other with 10 days notice in writing, or payment in lieu of notice.
10. BC Ferries may terminate this Agreement at any time, without notice or payment in lieu of notice, upon occurrence of any of the following:
    (a) the Contractor fails to comply with any provision of this Agreement or in circumstances where, if the Contractor was an Employee, BC Ferries could terminate this Agreement for just cause; or
    (b) the Contractor becomes bankrupt or insolvent or subject to an assignment for the benefit of creditors of the Contractor.
11. Where the Contractor fails to comply with the provisions of this Agreement, BC Ferries may, in addition to terminating this Agreement, pursue such other remedies as it deems necessary.
12. The parties expressly agree that upon termination of this Agreement at any time and for any reason, there shall be no monies owing or payable by BC Ferries to the Contractor other than monies already accrued and owing to the Contractor up to the date of termination.
13. BC Ferries may, at its option, suspend performance of the Services and payment of the Contract Price in the event of any problem or dispute arising between the Contractor and BC Ferries or for any other reason BC Ferries consider appropriate.

GENERAL

14. The Contractor shall not be the employee or agent of BC Ferries and accordingly shall not purport to enter into any contract or subcontract on behalf of BC Ferries or otherwise act on its behalf. The Contractor hereby acknowledges that BC Ferries shall not be required on behalf of the Contractor to make remittances or payments required by statute of employers and that the Contractor and its employees shall not be entitled to any benefits provided by BC Ferries to its employees.
15. This Agreement is made and shall be interpreted in accordance with the laws of the Province of British Columbia and the laws of Canada applicable therein.
16. Time shall be of the essence of this Agreement.
17. Any notice required to be given hereunder shall be written and may be faxed, delivered by hand or mailed by prepaid registered mail to the addresses on the first page of this Agreement (or at such other British Columbia address as either party may from time to time designate in writing to the other); and any such notice mailed will be deemed to be

received on the third business day after mailing (weekends, statutory holidays and days on which there is postal service disruption excepted).

18. If any provision of this Agreement is unenforceable or invalid for any reason whatsoever, such unenforceability or invalidity shall not affect the enforceability or validity of the remaining provisions of this Agreement and such provisions shall be severable from the remainder of this Agreement.
19. No waiver by either party of any breach of a provision of this Agreement shall be deemed to be a waiver of any other breach of this Agreement.
20. Notwithstanding anything herein to the contrary, neither party hereto shall be deemed in default with respect to the performance of the terms, covenants, and conditions of this Agreement if the same shall be due to any reason beyond the reasonable control of the party including due to any strike, lockout, civil commotion, sabotage, governmental regulations or controls or acts of God. Any party affected by an event of Force Majeure shall give notice of such event to the other as soon as it becomes aware of such event and shall take all reasonable steps to mitigate the effects of such event.
21. All material, documents, manuals, reports, plans, records, specifications, computer programs, computer source codes, computer documentation, concepts, findings, data, drawings, information and processes prepared or produced by or at the discretion of the Contractor directly or indirectly in connection with the Services or otherwise developed or first reduced to practice by the Contractor or its agents, employees or subcontractors in performing the Services (collectively the "Material") shall belong exclusively to BC Ferries which shall be solely entitled to all patents, copyright, trademark and other intellectual property rights in respect thereof; provided that the Contractor is hereby granted a non-exclusive licence during the Term to prepare and use the Material in performing the Services. Such licence shall terminate upon the termination of this Agreement. No copies, extracts, or any other reproduction of any Material shall be made by the Contractor without the express written permission of BC Ferries. The Contractor hereby irrevocably waives all moral rights and rights of authorship or attribution that the Contractor may have in the Materials. The Contractor represents, warrants and covenants that the Materials do not and will not infringe the intellectual property rights of any other party.
22. The Contractor acknowledges that during the Term of this Agreement, the Contractor or any of the Contractor's agents, employees or subcontractors may have access to confidential information (the "Confidential Information") concerning BC Ferries or other third parties dealing with BC Ferries which information is of a special and unique value respecting the operation and affairs of BC Ferries and such third parties. The Contractor agrees that any Confidential Information which has or will come into its possession or knowledge in connection with the Services shall be held in the strictest confidence and that, during the Term of this Agreement or at any time thereafter, the Contractor, or any of the Contractor's agents, employees or subcontractors shall not make use of the Confidential Information other than in the performance of the Services and shall not disclose or release it to any other party. This section shall survive the expiry of the Term or the earlier termination of this Agreement.
23. Upon request of BC Ferries, the Contractor shall permit BC Ferries to inspect, review, retain and/or copy all Material and upon the request of BC Ferries during the Term of this Agreement, or upon termination of this Agreement, the Contractor shall immediately deliver to BC Ferries any or all Materials or Confidential Information, together with all copies thereof and extracts therefrom, which may be in the possession or under the control of the Contractor or its agents, employees or subcontractors.
24. All assets and property provided by BC Ferries to the Contractor or any of the Contractor's agents, employees or subcontractors will be and remain the exclusive property of BC Ferries and shall be delivered by the Contractor to BC Ferries

immediately upon BC Ferries giving notice of such request to the Contractor and shall be returned to BC Ferries forthwith upon the completion of the Services or earlier termination of this Agreement in the same or better condition than they were at the time of delivery to the Contractor or its agents, employees or subcontractors.

25. No alteration or amendment to this Agreement shall be effective unless the same is in writing and duly executed by the parties hereto in the same manner as this Agreement.
26. This Agreement and related local purchase order(s) and any amendment made pursuant to section 25, constitute the entire Agreement between the parties.
27. Any determination by BC Ferries as to its consent shall be in its absolute discretion.
28. Where the Contractor is a limited company, the Contractor hereby represents and warrants to BC Ferries that the signatory has been duly authorized by the Contractor to enter into this Agreement without corporate seal on behalf of the said company.
29. The Contractor acknowledges that BC Ferries is subject to the provisions of the *Freedom of Information and Protection of Privacy Act*, R.S.B.C. 1996, c. 165 ("FOIPPA"). The Contractor will ensure that all personal information that is collected, used, disclosed, retained or created is done so in accordance with FOIPPA.
30. This Agreement may be executed in counterparts, each of which when so executed shall be deemed to be an original and all of which taken together, shall constitute one and the same agreement.

IN WITNESS WHEREOF the parties hereto have duly executed this Agreement the 10 day of February, 2022.

SIGNED AND DELIVERED on behalf of

British Columbia Ferry Services Inc by its

Authorized signatory

Name s. 22 [redacted]

Title: Regional Manager
Terminal Maintenance

SIGNED AND DELIVERED on behalf of

3GA Marine Ltd by its

A s. 22 [redacted]

Name: David Mietla

Title: President

ADDENDUM TO SCHEDULE "A" – SERVICES

Engineering Services shall be undertaken on a T&M basis to upset limit s. 17 [redacted]

Scope of work is as follows:

- Engineering services related to the review and advice on using alternate cable(s) for the Baynes Sound Connector
- Conduct an engineering review and provide a memo, stamped by a professional engineer, indicating if the cable is safe for operational use. The review should include information on the suitability of the cable construction, the location where it is safe for use, and details on whether its breaking strength meets minimum strength requirements and Factors of Safety as noted in the EYE Dynamic Analysis Report, dated February 2013. Provide advice on modifying the current operational sailing matrix if minimum standards are not met.
- Preparation of a memo, stamped by a professional engineer, to Lloyds Register stating the cable is safe for operational use.
- Review of report developed by Inter-mtn detailing areas of historical information on NDT inspections, and provide advice on common wear areas and advice on potential cable wear management solutions

The following standards apply to all services completed under this contract:

Contractor's Guide to the FOIPPA
https://www.bcferries.com/web_image/hd4/hca/8825477005342.pdf

Contractor Safety/Security Requirements and Orientation Booklet
https://www.bcferries.com/web_image/h24/h2e/8844243435550.pdf

BCF Vaccination Requirements for Contractors of BC Ferries
https://www.bcferries.com/our-company/procurement

ADDENDUM TO SCHEDULE "B" - CONTRACT PRICE

s. 17

[redacted]

ADDENDUM TO SCHEDULE "C" - APPROVED SUBCONTRACTORS

NONE

ADDENDUM TO SCHEDULE “D” - ADDITIONAL TERMS

No modifications to the standard Terms and Conditions included herein are permitted. Additional terms included here: Addendum to Schedule “D” – Additional Terms, are subject to BC Ferries review and acceptance.

NONE

ADDENDUM TO SCHEDULE "E" - INSURANCE

GENERAL:

1. The Contractor shall, prior to commencement of the service and at its expense, obtain and maintain, until all conditions of the contract have been fully complied with, insurance coverage in wording and in amounts as hereafter specified unless altered by mutual agreement. Any additional coverage that the Contractor may deem necessary to fulfil its obligations under this contract shall be at the Contractor's own discretion and expense.
2. Payment of any deductible amount shall be the responsibility of the Contractor.
3. General Conditions:
   - Insurance shall be placed with reliable insurers registered and licensed to issue insurance in the Province of British Columbia and acceptable to BC Ferries and shall be in a form acceptable to BC Ferries;
   - Before starting the work under this contract, the Contractor shall give BC Ferries proof of all specified insurance and when requested, within ten working days thereafter, a certificate of insurance evidencing coverage;
   - Insurance shall run continuously from the start of the work to the expiry date, which shall not be less than ten working days after completion of work;
   - The Contractor shall be responsible for all deductibles under policies and insurance provided by the Contractor;
   - Loss or damage covered by an insurance policy shall not affect BC Ferries' or Contractor's rights and obligations under this contract. The Contractor's insurance is Primary;
   - If the Contractor fails to provide the specified insurance, BC Ferries may do so and deduct the costs from the Contract Price.
4. All policies shall state that:
   - BC Ferries shall receive at least thirty working days prior written notice of intended cancellation or material change;
   - The inclusion of more than one Insured shall not affect the rights of any other Insured.
5. The Contractor shall not operate or allow entry onto BC Ferries' property, any unlicensed motor vehicle. Unlicensed mobile equipment will be insured by the Contractor for physical damage and liability.

VEHICLE INSURANCE REQUIREMENT:

1. Automobile insurance coverage shall be arranged with inclusive limits of not less than five million dollar s. 17 [redacted] on a Standard Owners Form Automobile Policy, affording third party liability and accident benefits insurance, as provided by the Insurance Corporation of British Columbia (AUTOPLAN) in accordance with the Automobile Insurance Act for all licensed vehicles owned, leased, rented or used in the performance of this contract.

s. 17

Page redacted

Rasmussen, Shauna

From: David Mietla <dmietla@3gamarine.com>
Sent: February 25, 2022 6:21 AM
To: Adams, James
Cc: Cennon, Quentin; Cavanaugh, Shelley
Subject: [EXTERNAL] RE: Services Contract - Cable Ferry - Cable Assessment
Attachments: 20-064 insurance doc.pdf; Services Contract.pdf

Hi James,
Here is the signed contract and the insurance document as requested.

Thank you and kind regards,

David Mietla, P.Eng.
President
3GA Marine Ltd.
Cell: (250) 589 7404

Optimizing Solutions

From: Adams, James W
Sent: February 23, 2022 12:54 PM
To: David Mietla
Cc: Cennon, Quentin ; Cavanaugh, Shelley
Subject: RE: Services Contract - Cable Ferry - Cable Assessment

Hi David,

Just following-up with attached Services Contract. Can you please review and return a signed copy along with your insurance documents?

Thanks,

James

James Adams, P.Eng.
Project Manager, Terminal Construction
British Columbia Ferry Services Inc. ss. 15, 19
T: 250-978-1317 [redacted]**:** 250-361-4922
james.adams@bcferries.com
bcferries.com

From: Cavanaugh, Shelley <Shelley.Cavanaugh@bcferries.com>
Sent: February 10, 2022 11:56 AM
To: dmietla@3gamarine.com
Cc: Cennon, Quentin <Quentin.Cennon@bcferries.com>; Adams, James W <James.Adams@bcferries.com>
Subject: Services Contract - Cable Ferry - Cable Assessment

Hi David, please sign and return the attached Services Contract along with your insurance documents.

Have a good day!

Shelley Cavanaugh
Contract Administrator
Terminal Engineering ss. 15, 19
British Columbia Ferry Services Inc.
500-1321 Blanshard St, Victoria, BC V8W 0B7
[redacted] **F:** 250-361-4922
Shelley.cavanaugh@bcferries.com
bcferries.com | Facebook | Twitter

Rasmussen, Shauna

From:	Adams, James W
Sent:	February 26, 2022 7:56 AM
To:	Seitz, Robert; Jones, Stephen
Subject:	RE: Draft BN for COO - BSC Cable Issues
Attachments:	Briefing_Note_BSC_Cable_Issues_Feb_25_2022_JA Comments.doc

Hi Rob,

Please see attached track changes for my suggested edits.

Note that I have changed the pricing in Options 1 & 2. TM budgets for 1 cable change annually. If three cables are installed in F23, I believe the variance for Option 1 should include the purchase of two additional FS cables + 1 off-shelf + labour to install 2 additional cables. Please review and let me know if this is correct.

Regards,

James

James Adams, P.Eng.
Project Manager, Terminal Construction
British Columbia Ferry Services Inc.
T: 250-978-1317 [redacted] **F:** 250-361-4922
james.adams@bcferries.com
bcferries.com

ss. 15, 19

From: Seitz, Robert
Sent: February 25, 2022 3:16 PM
To: Jones, Stephen ; Adams, James W
Subject: Draft BN for COO - BSC Cable Issues
Importance: High

Hi Stephen and James,

Apologies for the delay in getting this draft out. Please see the draft BN for your comments.

Regards,
Rob

ss. 15, 19

Rob Seitz, P.Eng
Director, Terminal Maintenance
Operations Division
British Columbia Ferry Services Inc.
Suite 500-1321 Blanshard Street, Victoria, BC V8W 0B7
T: 250-978-1268 [redacted] **F:** 250-361-4922
Robert.Seitz@bcferries.com
bcferries.com | Facebook | Twitter

Rasmussen, Shauna

From: Seitz, Robert
Sent: February 26, 2022 4:01 PM
To: Adams, James
Subject: Briefing_Note_BSC_Cable_Issues_Feb_25_2022_JA Comments (002)
Attachments: Briefing_Note_BSC_Cable_Issues_Feb_25_2022_JA Comments (002).doc

Final touch ups. Please confirm a couple of Stephen's questions...

Is the testing program industry standard?

Permitted by whom?

s. 17

And did I get the savings correct? [redacted]

Thanks,
Rob

Rasmussen, Shauna

From:	Adams, James W
Sent:	March 01, 2022 11:49 AM
To:	Seitz, Robert
Subject:	RE: Briefing Note for Decision: BSC Cable Wear Issues

Hi Rob,

The Flattened Strand Cables are equipped with a corrosion resistant coating that performs well in salt water applications. This has been verified through material testing in Baynes Sound followed by operational data collected from the previous plastic coated cables that used the same wire material. The manufacturer provides a warranty that guarantees the workmanship of their cables. Factory acceptance testing and initial in-service inspections determined that the cables were manufactured to contract specifications. Initial condition assessments found no evidence to suggest this issue is related to a manufacturing defect. The latest condition assessment indicates the pattern of wear on all three in-service cables is consistent and is likely related to metal on metal contact between the sheaves and cables due to removal of the plastic coating. Additional factors contributing to wear include cable contact with the seabed, which occurs each crossing of Baynes Sound and seabed material collecting in the cable and acting as an abrasive wearing down the surface of the cable.

The manufacturer was not able to provide a full 30 month warranty due to the unique application of the cable ferry and number of variables that can impact service life. The Flattened Strand cables were determined to have the best balance of safety, performance, and value for a non-plastic coated cable. It is anticipated that other non-plastic cables will have a similar or worse service life. There are a number of variables that BCF could trial in order to determine if cable service life can be improved. Sheaves with a softer material may extend cable service life. This would increase the frequency of sheave replacements but may provide the lowest overall operating cost. Further review of the seabed may be required to determine if specific locations are contributing to accelerated wear.

Regards,

James Adams, P.Eng.
Project Manager, Terminal Construction
British Columbia Ferry Services Inc.
T: 250-978-1317 [redacted] **F:** 250-361-4922
james.adams@bcferries.com
bcferries.com
ss. 15, 19

From: Seitz, Robert
Sent: February 28, 2022 7:11 PM
To: Adams, James W
Subject: Fwd: Briefing Note for Decision: BSC Cable Wear Issues

Any thoughts or comments to help?

Rob Seitz, P.Eng
Director, Terminal Maintenance
British Columbia Ferry Services Inc.
T: 250-978-1268 [redacted]
Robert.Seitz@bcferries.com
ss. 15, 19

s. 13, ss. 15, 19

Page redacted

s. 13, ss. 15, 19

Page redacted

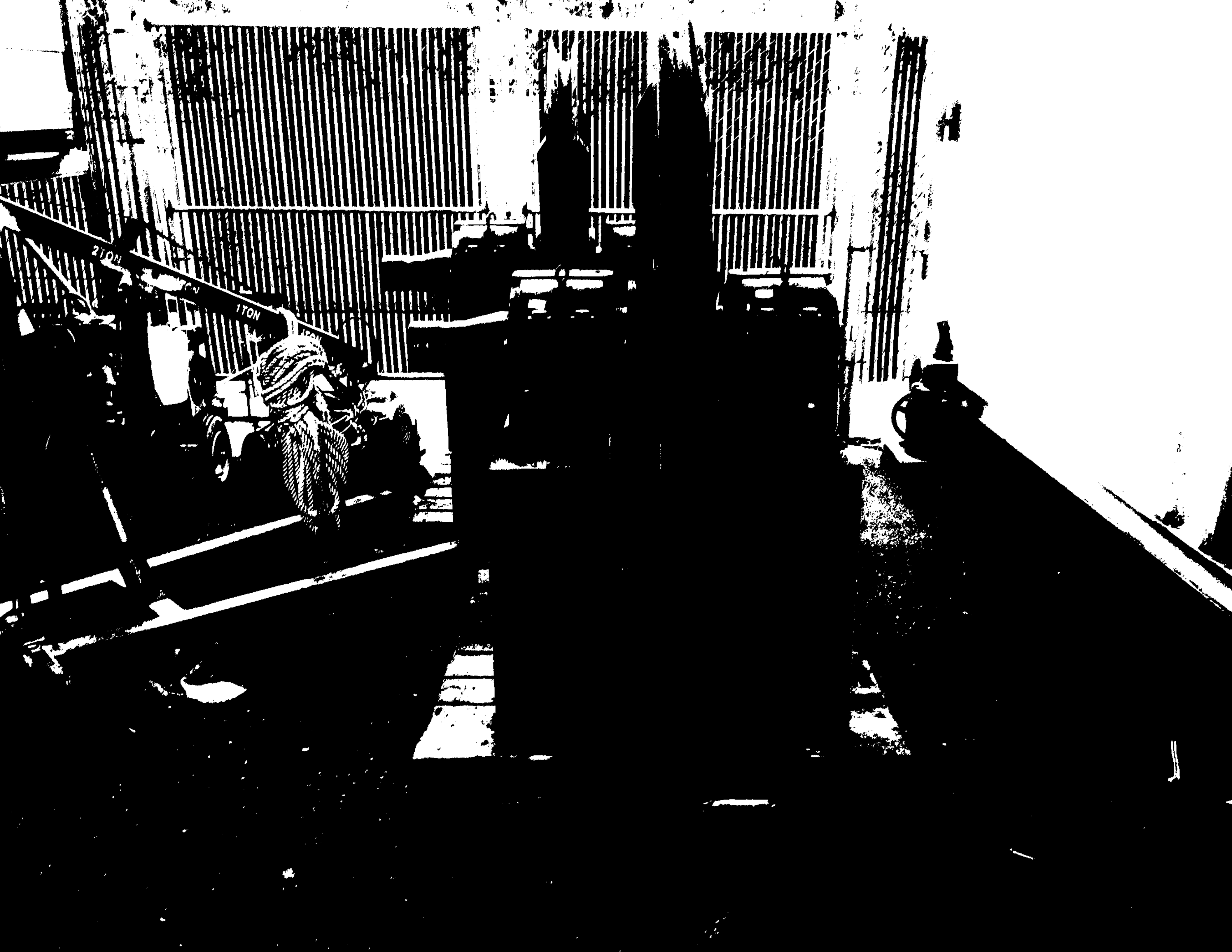
Cc: Wadden, Colleen <Colleen.Wadden@bcferries.com>
Subject: Briefing Note for Decision: BSC Cable Wear Issues

Good morning Corrine,

On behalf of Stephen Jones and Rob Seitz, please see the attached briefing note requiring decision from you. If you have any questions or concerns, kindly direct them to Steve or Rob.

With thanks,
Julie

Julie Lywood
Administrative Assistant to the Executive Director, Engineering
Operations Division
British Columbia Ferry Services Inc.
T: 250-978-2068
julie.lywood@bcferries.com
bcferries.com | Facebook | Twitter


2TON
1TON

Rasmussen, Shauna

From: Adams, James W
Sent: March 02, 2022 8:20 AM
To: Jones, Stephen; Seitz, Robert
Subject: RE: Briefing Note for Decision: BSC Cable Wear Issues
Attachments: IMG_0552.JPG

s. 13

[redacted]

s. 13, ss. 15, 19

Page redacted

Regards,

James

James Adams, P.Eng.
Project Manager, Terminal Construction
British Columbia Ferry Services Inc.
T: 250-978-1317 [redacted] **F:** 250-361-4922
james.adams@bcferries.com
bcferries.com

ss. 15, 19

s. 13, ss. 15, 19

[redacted]

ss. 15, 19, s. 13

Page redacted

ss. 15, 19, s. 13

[redacted]

From: Lywood, Julie <Julie.Lywood@bcferries.com>
Sent: February 28, 2022 11:07 AM
To: Storey, Corrine <Corrine.Storey@bcferries.com>
Cc: Wadden, Colleen <Colleen.Wadden@bcferries.com>
Subject: Briefing Note for Decision: BSC Cable Wear Issues

Good morning Corrine,

On behalf of Stephen Jones and Rob Seitz, please see the attached briefing note requiring decision from you. If you have any questions or concerns, kindly direct them to Steve or Rob.

With thanks,
Julie

Julie Lywood
Administrative Assistant to the Executive Director, Engineering
Operations Division
British Columbia Ferry Services Inc.
T: 250-978-2068
julie.lywood@bcferries.com
bcferries.com | Facebook | Twitter

Rasmussen, Shauna

From: David Mietla <dmietla@3gamarine.com>
Sent: March 04, 2022 10:27 AM
To: Adams, James; Shaun Wallis
Subject: [EXTERNAL] RE: BSC Cable - Emergency Spare

Hi James,
The date is not a problem. We will prepare a draft of it for your review and comments.

Thank you and kind regards,

David Mietla, P.Eng.
President
3GA Marine Ltd.
Cell: (250) 589 7404

Optimizing Solutions

From: Adams, James W
Sent: March 4, 2022 10:16 AM
To: Shaun Wallis ; David Mietla
Subject: RE: BSC Cable - Emergency Spare

Hi David and Shaun,

We have just received approval to order the spare cable from Northern Strands.

The intent is to only use this cable if required; however, we should be prepared to send a letter to LR in case it is needed.

Can you please proceed with preparing the LR memo? Would it be possible to have this complete by March 25? This is not a firm date so let me know if this works for your schedule.

Thanks again for your help with this.

James

James Adams, P.Eng.
Project Manager, Terminal Construction
British Columbia Ferry Services Inc. ss. 15, 19
T: 250-978-1317 [redacted] **F:** 250-361-4922
james.adams@bcferries.com
bcferries.com

From: Shaun Wallis
Sent: February 18, 2022 4:34 PM
To: Adams, James W ; David Mietla
Subject: [EXTERNAL] RE: BSC Cable - Emergency Spare

CAUTION: This email originated from outside of BC Ferries. Do not click links or open attachments unless you recognize the sender and know the content is safe.

James,

Attached is the updated memo.

Cheers

Shaun Wallis, EIT
Marine Systems Engineer
3GA Marine Ltd.
Work: (250) 920 9992 ext. 1004

From: Adams, James W <James.Adams@bcferries.com>
Sent: February 18, 2022 1:31 PM
To: David Mietla <dmietla@3gamarine.com>; Shaun Wallis <swallis@3gamarine.com>
Subject: RE: BSC Cable - Emergency Spare

Hi David,

Perfect, thanks yes that works.

Regards,

James Adams, P.Eng.
Project Manager, Terminal Construction
British Columbia Ferry Services Inc.
T: 250-978-1317 ss. 15, 19 [redacted] **F:** 250-361-4922
james.adams@bcferries.com
bcferries.com

From: David Mietla <dmietla@3gamarine.com>
Sent: February 18, 2022 1:23 PM

To: Adams, James W <James.Adams@bcferries.com>; Shaun Wallis <swallis@3gamarine.com>
Subject: [EXTERNAL] RE: BSC Cable - Emergency Spare

CAUTION: This email originated from outside of BC Ferries. Do not click links or open attachments unless you recognize the sender and know the content is safe.

Hi James,
We will get it to you later today.

Hopefully that works.

Thank you and kind regards,

David Mietla, P.Eng.
President
3GA Marine Ltd.
Cell: (250) 589 7404

Optimizing Solutions

From: Adams, James W <James.Adams@bcferries.com>
Sent: February 18, 2022 1:15 PM
To: David Mietla <dmietla@3gamarine.com>; Shaun Wallis <swallis@3gamarine.com>
Subject: RE: BSC Cable - Emergency Spare

Hi David,

Just checking in, can you please let me know when you are planning to submit the updated memo?

Thanks,

James Adams, P.Eng.
Project Manager, Terminal Construction
British Columbia Ferry Services Inc. ss. ~~15~~, 19
T: 250-978-1317 [redacted] **F:** 250-361-4922
james.adams@bcferries.com
bcferries.com

From: Adams, James W
Sent: February 15, 2022 2:33 PM

To: 'David Mietla' <dmietla@3gamarine.com>; Shaun Wallis <swallis@3gamarine.com>
Subject: RE: BSC Cable - Emergency Spare

Thanks David, appreciate the quick response.

James Adams, P.Eng.
Project Manager, Terminal Construction
British Columbia Ferry Services Inc. ss. ~~15~~, 19
T: 250-978-1317 [redacted] **F:** 250-361-4922
james.adams@bcferries.com
bcferries.com

From: David Mietla <dmietla@3gamarine.com>
Sent: February 15, 2022 2:30 PM
To: Adams, James W <James.Adams@bcferries.com>; Shaun Wallis <swallis@3gamarine.com>
Subject: [EXTERNAL] RE: BSC Cable - Emergency Spare

Hi James,
Shaun just told me what you two have discussed and we do not see an issue with updating the report to that effect. So based on our calculations the suggested cable will be suitable for use as a temporary cable for weather up to the 100 year storm.

We will get you the updated memo shortly.

Thank you and kind regards,

David Mietla, P.Eng.
President
3GA Marine Ltd.
Cell: (250) 589 7404

3GA MARINE
Optimizing Solutions

From: Adams, James W <James.Adams@bcferries.com>
Sent: February 15, 2022 12:57 PM
To: Shaun Wallis <swallis@3gamarine.com>
Cc: David Mietla <dmietla@3gamarine.com>
Subject: RE: BSC Cable - Emergency Spare

Hi Shaun,

See attached edits for discussion – Is there a good time we can discuss? I'm free after 1:30 and before 3pm today.

Thanks,

James Adams, P.Eng.
Project Manager, Terminal Construction
British Columbia Ferry Services Inc. ss. 15, 19
T: 250-978-1317 [redacted] **F:** 250-361-4922
james.adams@bcferries.com
bcferries.com

From: Shaun Wallis <swallis@3gamarine.com>
Sent: February 11, 2022 3:42 PM
To: Adams, James W <James.Adams@bcferries.com>
Cc: David Mietla <dmietla@3gamarine.com>
Subject: [EXTERNAL] RE: BSC Cable - Emergency Spare

James,

Here is the draft letter for our initial findings. I know you are looking for a memo to send to LR, but this memo is more for BC Ferries. The LR memo will be developed once BC Ferries decides on the model parameters, they want us to use, and we develop a new allowable tension matrix.

Cheers,

Shaun Wallis, EIT
Marine Systems Engineer
3GA Marine Ltd.
Work: (250) 920 9992 ext. 1004

From: Adams, James W <James.Adams@bcferries.com>
Sent: February 11, 2022 12:19 PM
To: Shaun Wallis <swallis@3gamarine.com>; David Mietla <dmietla@3gamarine.com>
Subject: RE: BSC Cable - Emergency Spare

Yes, agreed. Attached are the cable survey drawings.

James Adams, P.Eng.
Project Manager, Terminal Construction
British Columbia Ferry Services Inc.
T: 250-978-1317 [redacted] **F:** 250-361-4922
james.adams@bcferries.com
ss. 15, 19

bcferries.com

From: Shaun Wallis <swallis@3gamarine.com>
Sent: February 11, 2022 12:14 PM
To: Adams, James W <James.Adams@bcferries.com>; David Mietla <dmietla@3gamarine.com>
Subject: [EXTERNAL] RE: BSC Cable - Emergency Spare

CAUTION: This email originated from outside of BC Ferries. Do not click links or open attachments unless you recognize the sender and know the content is safe.

Wow that is pretty clear correlation.

Shaun Wallis, EIT
Marine Systems Engineer
3GA Marine Ltd.
Work: (250) 920 9992 ext. 1004

From: Adams, James W <James.Adams@bcferries.com>
Sent: February 11, 2022 11:58 AM
To: David Mietla <dmietla@3gamarine.com>
Cc: Shaun Wallis <swallis@3gamarine.com>
Subject: FW: BSC Cable - Emergency Spare

Hi David and Shaun,

Thanks for the call today. The email below contains preliminary information that may be helpful to include the memo. As discussed, the numbers will likely change since you'll be using the min design breaking strength.

I'd like to make sure BCF is aware of the possible changes to the sailing matrix if we use this cable when new and with 15% section loss.

Also attached is a couple screen shots showing the N and S cable EMT testing and cable profile drawings. Interesting to see the location of the wear areas correspond to seabed features.

Thanks,

James Adams, P.Eng.
Project Manager, Terminal Construction
British Columbia Ferry Services Inc.
T: 250-978-1317 [redacted] **F:** 250-361-4922
james.adams@bcferries.com
bcferries.com ss. 15, 19

From: Adams, James W
Sent: February 10, 2022 9:50 AM
To: Meyer, Leslie A. <Leslie.Meyer@bcferries.com>; Paterson, Bruce <Bruce.Paterson@bcferries.com>; Weigold, Andrew <Andrew.Weigold@bcferries.com>; Seitz, Robert <Robert.Seitz@bcferries.com>; Stahuliak, Marian <Marian.Stahuliak@bcferries.com>

Cc: Nakano, Leonard <Leonard.Nakano@bcferries.com>; Jones, Stephen <Stephen.Jones@bcferries.com>; Jones, Gary <Gary.Jones@bcferries.com>; Cennon, Quentin <Quentin.Cennon@bcferries.com>
Subject: RE: BSC Cable - Emergency Spare

Hi Rob,

3GA Marine has been contracted to review the proposed 1-1/2" emergency spare cable with a breaking strength of 259,000 lbs [1152 kN]. While we are waiting 3GA to complete their review, I have provided the following preliminary information for consideration:

The table below provides the minimum required breaking strength for cables in the 100 year (39 knot sustained winds) and worst case 55 knot storm conditions. The emergency spare cable meets requirements for the 55knot condition but has limited reserve capacity as it becomes worn during standard use. In general, we typically allow a maximum section loss limit of 15% and this equates to 15-20% loss in strength. Using the same section loss limit for the emergency spare cable would reduce its breaking strength to approximately 920 kN. The table below notes that the minimum required breaking strength is 859kN in a 100 year storm and 919kN in the two cable "damaged" condition. Therefore, the sailings may need to be restricted above 39 knots to maintain the minimum required factor of safety in this condition. This aligns with the current sailing matrix with the exception of "Consult" in the Strong Gale condition.

The preliminary calculations noted above will need to be confirmed by 3GA. It should also be noted that the proposed emergency spare cable has the highest available grade of steel. A standard 1-1/2" cable has material that is more common but 10% lower breaking strength.

Table 8-2 shows the maximum loads predicted during the Time Domain Analysis with the appropriate safety factors and minimum required breaking load.

	Maximum Load kN	Factor of Safety	Minimum Breaking Strength Required kN
Pretension	196	5.0	980
100 Year Storm	429.4	2.0	859
Worst Operation 55 knots	571.7	2.0	1143
Damaged	691	1.33	919

Table 8-2

James Adams, P.Eng.
Project Manager, Terminal Construction
British Columbia Ferry Services Inc.
T: 250-978-1317[redacted]**F:** 250-361-4922
james.adams@bcferries.com
bcferries.com ss. 15, 19

Rasmussen, Shauna

From: Peterson, Greg
Sent: December 05, 2019 11:16 AM
To: Meyer, Leslie A.
Cc: Camaraire, Frank; Riis, Daniel; Paterson, Bruce
Subject: FW: CF BAYNES SOUND CONNECTOR (BSC) - Request to review change in cable type
Attachments: BSC New Rope.pdf

Leslie,

We should add this document into the MTRB sharepoint database with the original MTRB.

Greg

From: Camaraire, Frank
Sent: December 05,2019 11:10 AM
To: Peterson, Greg; Meyer, Leslie A.; Wills, Stuart; Cennon, Quentin; Adams, James W
Cc: Paterson, Bruce; Riis, Daniel; Joyce, Jeff
Subject: FW: CF BAYNES SOUND CONNECTOR (BSC) - Request to review change in cable type

FYI and for our records, thank you

Frank Camaraire
Executive Director, Engineering
Operations Division
British Columbia Ferry Services Inc.
Suite 500 – 1321 Blanshard Street, Victoria, British Columbia, V8W 0B7
T: 250-978-1384 [redacted] **F:** 250-978-1166
frank.camaraire@bcferries.com
bcferries.com | Facebook | Twitter

ss. 15, 19

From: Zargham, Reza <Reza.Zargham@lr.org>
Sent: December 04, 2019 1:24 PM
To: Paterson, Bruce <Bruce.Paterson@bcferries.com>; Camaraire, Frank <Frank.Camaraire@bcferries.com>
Cc: Chern, Richard <richard.chern@lr.org>; McDonald, Bruce <Bruce.McDonald@lr.org>; Sovagovic, Zoran <Zoran.Sovagovic@lr.org>; Bulkowski, Jerry <Jerry.Bulkowski@lr.org>
Subject: RE: CF BAYNES SOUND CONNECTOR (BSC) - Request to review change in cable type

Dears Frank and Bruce,
Please find attached the no objection letter as requested.

Kind regards,
Reza

Reza Zargham, Lloyds Register
Area Operations Manager - West of Canada and USA (NAW) , Marine & Offshore

T +1 604 985 0477   D +1 604 982 2124   M +1 604 857 3206 E reza.zargham@lr.org
Lloyds Register Canada Limited, 502-221 West Esplanade, North Vancouver, BC V7M 3J3, Canada
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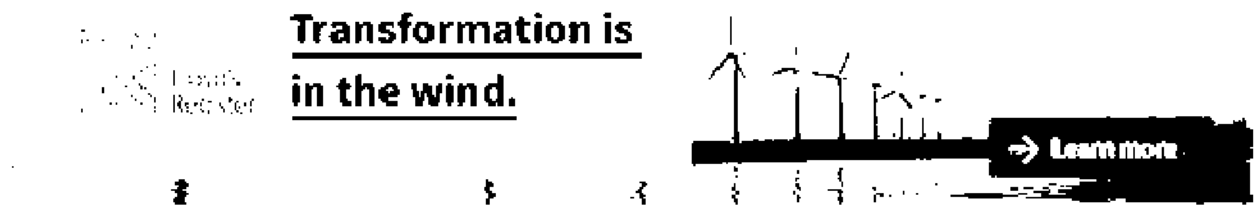

From: Paterson, Bruce <Bruce.Paterson@bcferries.com>
Sent: Monday, 02 December, 2019 4:13 PM
To: Zargham, Reza <Reza.Zargham@lr.org>; Camaraire, Frank <Frank.Camaraire@bcferries.com>
Cc: Chern, Richard <richard.chern@lr.org>; McDonald, Bruce <Bruce.McDonald@lr.org>; Sovagovic, Zoran <Zoran.Sovagovic@lr.org>; Bulkowski, Jerry <Jerry.Bulkowski@lr.org>
Subject: RE: CF BAYNES SOUND CONNECTOR (BSC) - Request to review change in cable type

*** **THIS IS AN EXTERNAL EMAIL:** do not click any links or open any attachments unless you trust the sender and know the content is safe. ***

Thanks Reza,

You can address it to Frank Camaraire, (cc'd), as follows:

Frank Camaraire
Executive Director, Engineering
Operations Division
British Columbia Ferry Services Inc.
Suite 500 – 1321 Blanshard Street, Victoria, British Columbia, V8W 0B7

Bruce Paterson, P.Eng, M.Eng
Director, Naval Architecture, Engineering British Columbia Ferry Services Inc.
Tel: (250) 978-1385
[redacted] ss. 15, 19
Fax: (250) 978-1166
bruce.paterson@bcferries.com
www.bcferries.com
Safety and Operational Readiness

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sender. If you are not an authorized recipient, please notify the sender immediately and permanently destroy all copies of this message and any attachments.

From: Zargham, Reza [mailto:Reza.Zargham@lr.org]
Sent: December 02,2019 4:10 PM
To: Paterson, Bruce
Cc: Chern, Richard; McDonald, Bruce; Sovagovic, Zoran; Bulkowski, Jerry
Subject: RE: CF BAYNES SOUND CONNECTOR (BSC) - Request to review change in cable type

Hi Bruce,
Provided all conditions in MTRB 14754 are followed, we will issue a letter of no objection to the proposed wire rope replacement referencing condition "e" of the MTRB.
Please let me know who should this letter be addressed to.

Kind regards,
Reza

Reza Zargham, Lloyds Register
Area Operations Manager - West of Canada and USA (NAW), Marine & Offshore
T +1 604 985 0477 D +1 604 982 2124 M +1 604 857 3206 E reza.zargham@lr.org
Lloyds Register Canada Limited, 502-221 West Esplanade, North Vancouver, BC V7M 3J3, Canada
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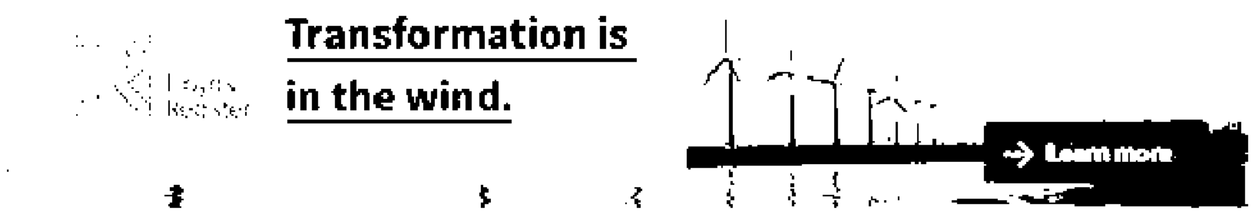

From: Paterson, Bruce <Bruce.Paterson@bcferries.com>
Sent: Thursday, 28 November, 2019 10:07 AM
To: Zargham, Reza <Reza.Zargham@lr.org>
Cc: Chern, Richard <richard.chern@lr.org>; McDonald, Bruce <Bruce.McDonald@lr.org>; Sovagovic, Zoran <Zoran.Sovagovic@lr.org>
Subject: RE: CF BAYNES SOUND CONNECTOR (BSC) - Request to review change in cable type

***** THIS IS AN EXTERNAL EMAIL:** do not click any links or open any attachments unless you trust the sender and know the content is safe. ***

Thanks Reza et al.

Could we ask for a formal letter stating that “No objection” , an referencing condition “e” of MTRB 14754?

Thank you (in advance),

Bruce Paterson, P.Eng, M.Eng
Director, Naval Architecture, Engineering British Columbia Ferry Services Inc.
Tel: (250) 978-1385
[redacted] ss. 15, 19
Fax: (250) 978-1166
bruce.paterson@bcferries.com
www.bcferries.com
Safety and Operational Readiness

From: Zargham, Reza [mailto:Reza.Zargham@lr.org]
Sent: November 27,2019 8:39 AM
To: Paterson, Bruce
Cc: Chern, Richard; McDonald, Bruce; Sovagovic, Zoran
Subject: RE: CF BAYNES SOUND CONNECTOR (BSC) - Request to review change in cable type

Hi Bruce,
There are no LR standards that can be used for verification of the steel wire rope.
Steel wire ropes were not considered to be a class item during plan appraisal of BAYNES SOUND CONNECTOR (BSC) and consequently ATSO was not involved in the review of ropes.
Steel wire ropes are under the responsibility of the designer and should be selected to be compatible with the equipment (bull wheels, sheaves) fitted on board.
Based on information provided in attached memorandum there is no objection for existing steel wire rope 6x19 IWRC (BS 1174kN) to be replaced with steel wire rope 6x25 IWRC (BS 1335kN).
Considering that steel ropes are not a class item we cannot stamp attached memo however we could issue a statement of no objection.

Kind regards,
Reza

From: Paterson, Bruce <Bruce.Paterson@bcferries.com>
Sent: Tuesday, 26 November, 2019 2:55 PM
To: Zargham, Reza <Reza.Zargham@lr.org>
Cc: Chern, Richard <richard.chern@lr.org>; McDonald, Bruce <Bruce.McDonald@lr.org>
Subject: RE: CF BAYNES SOUND CONNECTOR (BSC) - Request to review change in cable type

Just to clarify, is the design standard being referenced meant to mean an LR standard? Or could we provide the original cable specification?

Bruce Paterson, P.Eng, M.Eng
Director, Naval Architecture, Engineering British Columbia Ferry Services Inc.
Tel: (250) 978-1385
[redacted] ss. 15, 19
Fax: (250) 978-1166
bruce.paterson@bcferries.com
www.bcferries.com
Safety and Operational Readiness

From: Zargham, Reza [mailto:Reza.Zargham@lr.org]
Sent: November 26,2019 1:54 PM
To: Paterson, Bruce
Cc: Chern, Richard; McDonald, Bruce
Subject: FW: CF BAYNES SOUND CONNECTOR (BSC) - Request to review change in cable type

Hi Bruce
Your email below and attached document refers.
As per our ATSO advise , this case is out of scope and difficult to appraise as there is no design standard.
We could issue a statement of no objection , please let me know if is acceptable.

Kind regards,
Reza

Reza Zargham, Lloyds Register
Area Operations Manager - West of Canada and USA (NAW) , Marine & Offshore
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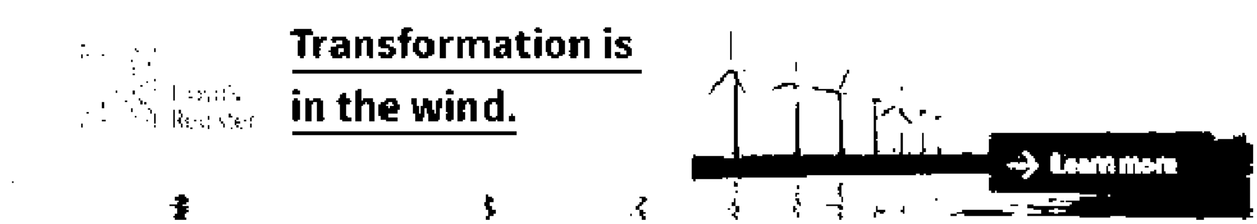

From: Paterson, Bruce <Bruce.Paterson@bcferries.com>
Sent: November 25, 2019 5:07 PM
To: Chern, Richard <richard.chern@lr.org>
Cc: Zargham, Reza <Reza.Zargham@lr.org>; Camaraire, Frank <Frank.Camaraire@bcferries.com>; Johnston, Darren <Darren.Johnston@bcferries.com>; de Koninck, Captain Al <Al.deKoninck@bcferries.com>; Wills, Stuart <Stuart.Wills@bcferries.com>; Meyer, Leslie A. <Leslie.Meyer@bcferries.com>; Adams, James W <James.Adams@bcferries.com>
Subject: CF BAYNES SOUND CONNECTOR - Request to review change in cable type

***** THIS IS AN EXTERNAL EMAIL:** do not click any links or open any attachments unless you trust the sender and know the content is safe. ***

Richard,

As you are probably aware, we have been investigating a new cable type to address the plastic shedding problem we have experienced on the cable ferry. Please find the attached memo and cover letter that outlines the specs for our proposed replacement cable. To comply with the applicable MTRB, can we get the memo stamped and/or a letter issued indicating LR's acceptance of the proposed change?

We are keen to place an order for the cables, so your prompt attention will be appreciated,

Regards,

Bruce Paterson, P.Eng, M.Eng
Director, Naval Architecture, Engineering British Columbia Ferry Services Inc.
Tel: (250) 978-1385
[redacted]
Fax: (250) 978-1166 ss. 15, 19
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Ottawa, Ontario
K1A 0N8

Tour C, Place de Ville
11e étage
330, rue Sparks
Ottawa (Ontario) K1A 0N8

Your file
Votre référence

Our file
Notre référence

Classification 8562-19633

BRITISH COLUMBIA FERRY SERVICES INC.
SUITE 500 - 1321 BLANSHARD ST.
VICTORIA, BRITISH COLUMBIA
V8W 0B7

SUBJECT:
BAYNES SOUND CONNECTOR
MARINE TECHNICAL REVIEW BOARD DECISION NO. M14754

Further to your request to the Marine Technical Review Board (MTRB) regarding the application of the (C.R.C., c. 1431) of Hull Construction Regulations for BAYNES SOUND CONNECTOR, please be advised that the MTRB has granted your request subject to the conditions outlined in the enclosed Record of Decision.

Please keep a copy of this Record of Decision on board of the vessel and for future reference. This Record of Decision will also be made available to the public in a manner that the Chair of the MTRB considers appropriate.

OBJET :
BAYNES SOUND CONNECTOR
DÉCISION N^O M14754 DU BUREAU D'EXAMEN TECHNIQUE EN MATIÈRE MARITIME

Comme suite à votre demande adressée au Bureau d'examen technique en matière maritime (BETMM) concernant l'application du (C.R.C., c. 1431) du Règlement sur la construction de coques pour BAYNES SOUND CONNECTOR, nous vous avisons que le BETMM a accepté votre demande sous réserve des conditions énoncées dans le rapport de décision ci-joint.

Veuillez conserver une copie du rapport de décision à bord du navire pour consultation ultérieure. Le rapport sera aussi rendu public de la manière que le président du BETMM jugera appropriée.

Sincerely,/ Cordialement,

s. 22 [redacted]

Marine Technical Review Board Secretariat |
Secrétariat du Bureau d'examen technique en matière maritime

Enclosure(s): Marine Technical Review Board Decision
Pièce jointe : Décision du Bureau d'examen technique en matière maritime
c.c. *manual entry/saisie manuelle*

Transport Canada / Transports Canada
Safety and Security / Sécurité et sûreté

Marine Safety Directorate
330 Sparks Street
Ottawa, Ontario K1A 0N8

Direction générale de la sécurité maritime
330, rue Sparks
Ottawa (Ontario) K1A 0N8

Marine Technical Review Board Decision / Décision du Bureau d'examen technique en matière maritime

Applicant: **Demandeur :**	BRITISH COLUMBIA FERRY SERVICES INC.
Board Decision No.: **N° de la décision du Bureau :**	M14754
Vessel Name: **Nom du bâtiment :**	BAYNES SOUND CONNECTOR
Official Number: **N° matricule :**	839270
Effective Date: **Date d'effet :**	
Expiry Date:	Valid for life of vessel
Date d'expiration :	Durée de vie du bâtiment

This Marine Technical Review Board Decision authorizes BRITISH COLUMBIA FERRY SERVICES INC. as the authorized representative of the BAYNES SOUND CONNECTOR, to fulfill its obligations under paragraph 106(1)(a) of the *Canada Shipping Act, 2001*, in a manner that does not comply with sections (C.R.C., c. 1431) of Hull Construction Regulations, if:

Cette décision du Bureau d'examen technique en matière maritime autorise BRITISH COLUMBIA FERRY SERVICES INC. en sa capacité de représentant autorisé du BAYNES SOUND CONNECTOR à exécuter ses obligations en vertu de l'alinéa 106(1)a) de la *Loi de 2001 sur la marine marchande du Canada* d'une façon non conforme aux articles (C.R.C., c. 1431) du Règlement sur la construction de coques, si :

Board Decision No.: (M14754) **N° de la décision du Bureau : (M14754)**

CONDITIONS

Please see RDIMS document #12257638 MTRB-BETMM - FINAL CONDITIONS-CONDITIONS FINALE - M14754- BAYNES SOUND CONNECTOR - HULL CONSTRUCTION REGULATIONS-RÈGLEMENT SUR LA CONSTRUCTION DE COQUES

Veuillez voir le document RDIMS #12257638 MTRB-BETMM - FINAL CONDITIONS-CONDITIONS FINALE - M14754- BAYNES SOUND CONNECTOR - HULL CONSTRUCTION REGULATIONS-RÈGLEMENT SUR LA CONSTRUCTION DE COQUES

Note: This Marine Technical Review Board Decision in no way reduces the vessel's, the applicant's or any other person's responsibility to comply with any other requirements of the *Canada Shipping Act, 2001* and regulations made under it that are not specifically addressed in this decision.

Note : La présente décision du Bureau d'examen technique en matière maritime n'exempte en aucune façon le bâtiment, le demandeur ou toute autre personne de l'observation des autres exigences de la *Loi de 2001 sur la marine marchande du Canada* et de ses règlements qui ne sont pas citées explicitement dans cette décision.

s. 22 [redacted]

s. 22 [redacted] Naim Nazha
Chair of the MTRB
Président du BETMM

FINAL CONDITIONS FOR BAYNES SOUND CONNECTOR #M14754	CONDITIONS FINALES POUR BAYNES SOUND CONNECTOR N^{O} M14754
a. The operational profile of the cable ferry remains the same and runs in the sheltered waters between Buckley Bay and Denman Island service;	a. Le profil de fonctionnement du traversier à câble demeure le même et consiste en les eaux abritées séparant la baie Buckley et l'île Denman.
b. The ferry complies with two (2) compartment subdivision stability criteria of the standards TP 10943, and of the bottom damage requirements of SOLAS regulations II-1/9.8 for area not fitted with a double-bottom, based on the Centre of Gravity and Lightship displacement values determined in accordance with the MTRB Decision #M139290 for all loading conditions;	b. Le traversier est conforme aux deux (2) critères de stabilité de la norme TP 10943, pour ce qui est du compartimentage, ainsi qu'aux exigences d'endommagement du fond de la section II-1/9.8 de la SOLAS, en ce qui concerne les parties ne comportant aucun double-fond, si l'on se base sur les valeurs relatives au déplacement de bateau-feu et au centre de gravité qui ont été déterminées conformément à la décision du BETMM n° M139290 pour toutes les conditions de charge.
c. A Letter of Maximum Subdivision Draft is issued by the Recognized Organization specifying the maximum drafts that will comply with the subdivision standards stated in condition b).	c. L'organisme reconnu doit présenter une lettre de tirant d'eau de compartimentage maximal, dans laquelle il indique les tirants d'eau maximaux conformes aux normes de la condition b).
d. The Design methodology and numerical analysis, the Baynes Sound Environmental Characterization Study (Roddan Engineering LTD., Nov 2012) and all other relevant documents are reviewed and accepted by the RO;	d. L'organisme reconnu a étudié et accepté la méthode de conception, l'analyse numérique, l'étude de caractérisation environnementale du détroit de Baynes (Roddan Engineering LTD., nov. 2012), ainsi que tous les autres documents pertinents.
e. The cable ferry working mechanism, cable rope sizes/specifications, design loads, safety factors, maintenance plans and replacement schedule of cables are approved by the RO. BC Ferries' cable maintenance plan is to involve placing a new cable into the drive position annually until such time as a duty cycle can be established for the vessel's route. Subject to cable condition, used drive cables may be utilized in the guide cable positions for two (2) years;	e. L'organisme reconnu approuve le mécanisme de fonctionnement, la taille et les spécifications du câble, les charges nominales, les facteurs de sécurité, les plans d'entretien et le calendrier de remplacement de câble du traversier. Le plan d'entretien de câble de BC Ferries doit prévoir l'installation annuelle d'un nouveau câble à la position d'entraînement, et ce, jusqu'à ce qu'un nouveau cycle d'utilisation puisse être établi pour le circuit du traversier. Les câbles d'entraînement usagés pourront être installés aux positions de câble de guidage pendant deux (2) ans, selon leur état.
f. The vessel is instrumented to monitor and record dynamic motions and cable tensions. Six months	f. Le traversier comporte des instruments conçus pour surveiller et enregistrer les mouvements dynamiques

after the entry in service of the vessel, the authorized representative will submit to the Recognized Organization and Transport Canada an analysis of the motions, loads and related wind and weather conditions with an updated heavy weather matrix.	et les tensions que le câble subit. Un représentant autorisé devra présenter à l'organisme reconnu et à Transports Canada une analyse des mouvements, des charges et des conditions éoliennes et météorologiques, ainsi qu'une matrice des mauvaises conditions météorologiques, après six mois d'exploitation du traversier.
g. The cable ferry operates in compliance with the BC Ferries 'Heavy Weather Precautions Procedures for a Cable Ferry" and will initiate heavy weather precaution above 35 knots of sustained wind speed. Crossing will not be undertaken in sustained wind speed of more than 55 knots, significant wave height of more than 1.03 metres, or current of more than 1.9 knots;	g. Le traversier à câble est exploité conformément aux précautions de BC Ferries relatives à l'exploitation d'un traversier à câble lorsque les conditions météorologiques sont mauvaises (Heavy Weather Precautions Procedures for a Cable Ferry), lesquelles doivent être prises par un vent soutenu supérieur à 35 noeuds. Il ne devra pas être exploité si un vent soutenu souffle à plus de 55 noeuds, si les vagues atteignent plus de 1,03 m et si le courant se chiffre à plus de 1,9 nœud.
h. Crossing is not undertaken when the cable tension exceeds the approved design loads limits. A record of measured cable tension is maintained and provided to TCMSS on request;	h. Le traversier à câble n'est pas exploité si la tension exercée sur le câble dépasse les limites de charges nominales approuvées. Un dossier de mesure de la tension exercée sur le câble est tenu à jour et présenté sur demande à SSMTC;
i. The anchor is sized according to the Equipment Numeral as required by the Classification Rules of the Recognized Organization;	i. La taille de l'ancre est conforme au numéral de l'équipement et aux règles de classification de l'organisme reconnu;
j. Operational / emergency procedures are developed in case of cable system malfunction and incorporated in the Safety Management System (SMS). Crew training and simulation are carried on a periodical basis as per the procedures;	j. Des procédures d'exploitation et d'urgence relatives à une défaillance du système de câble sont élaborées et intégrées au système de gestion de la sécurité. L'équipage suit une formation et participe à des simulations périodiquement et conformément aux procédures pertinentes;
k. Operational readiness with regards to deployment of the anchor is demonstrated. Procedures are incorporated in the Safety Management System (SMS) with regards to periodical crew training and deployment;	k. Une préparation au jet de l'ancre est démontrée. Des procédures de formation de l'équipage et de participation de ce dernier à des exercices sont intégrées au système de gestion de la sécurité;
l. Trials are performed to measure the stopping capability of the ferry. The information is	l. Des essais sont exécutés pour évaluer la capacité d'immobilisation du traversier. Les données d'essai

incorporated in the vessel documentation and made available to the Master;	font partie du ou des documents relatifs au bâtiment et sont présentées au capitaine;
m. The vessel operates / loads vehicle and passengers in accordance with the conditions contained in the approved Loading Manual;	m. L'exploitation du traversier et l'embarquement de véhicules et de passagers à son bord sont conformes aux conditions figurant dans le manuel d'embarquement approuvé;
n. The vessel is fitted with permanent tug mooring arrangement;	n. Le traversier comporte des amarres de remorquage permanents;
o. The vessel meets the fire protection requirements as set out in Part III of the Transport Canada Equivalent Standards for Fire Protection of Passenger Ships (TP 2237E);	o. Le traversier est conforme aux exigences de protection contre les incendies figurant dans la partie III des *Normes équivalentes de protection contre l'incendie des navires à passagers* de Transports Canada (Equivalent Standards for Fire Protection of Passenger Ships - TP 2237E);
p. In addition to the applicable requirements of the Fire Detection and Extinguishing Equipment Regulations for Class E vessels, the vessel is: i. fitted with a water mist fixed fire suppression system, approved as equivalent to a pressure water-spraying system meeting the requirements of Schedule III of the Fire Detection and Extinguishing Equipment Regulations, in the machinery spaces; ii. fitted with a water mist fixed fire suppression system, approved as equivalent to an automatic sprinkler system meeting the requirements if Schedule VI of the Fire Detection and Extinguishing Equipment Regulations, in the crew space and passenger lounge; and iii. fitted with an automated fire monitor system to cover the vehicle deck;	p. Le traversier est conforme aux exigences pertinentes figurant dans le *Règlement sur le matériel de détection et d'extinction d'incendie* en ce qui concerne les bâtiments de classe E, mais il comporte également : i. dans la tranche des machines, un système fixe d'extinction d'incendie par brouillard d'eau qui a été approuvé comme l'équivalent d'un système de projection d'eau sous pression conforme aux exigences de l'annexe III du *Règlement sur le matériel de détection et d'extinction d'incendie*; ii. dans le ou les locaux de l'équipage et le salon des passagers, un système fixe d'extinction d'incendie par brouillard d'eau qui a été approuvé comme l'équivalent d'un extincteur automatique conforme aux exigences de l'annexe VI du *Règlement sur le matériel de détection et d'extinction d'incendie*; iii. un système automatisé de surveillance des incendies sur le pont des véhicules.
q. In addition to the requirements of the Life Saving Equipment Regulations for Class VII vessels, the vessel is:	q. Le traversier est conforme aux exigences du *Règlement sur l'équipement de sauvetage* visant les bâtiments de classe VII, mais il comporte également :

i. fitted with two Marine Evacuation System (MES) stations each with a capacity sufficient for 100% of the persons on board; and ii. fitted with an approved emergency boat meeting the requirement of Schedule VII of the Life Saving Equipment Regulations. The emergency boat is installed under a launching device meeting the requirements of Schedule IX of the Life Saving Equipment Regulations..	i. deux postes d'évacuation maritime d'une capacité équivalant à 100 % des personnes à bord; ii. un bateau d'urgence approuvé qui est conforme à l'exigence figurant à l'annexe VII du *Règlement sur l'équipement de sauvetage* et qui a été installé sous un dispositif de mise à l'eau conforme aux exigences de l'annexe IX dudit règlement.

APPLICATION SUMMARY

DECISION NUMBER (M14754)

PROPOSED EXPIRY DATE: 2500-12-31

OFFICE: Vancouver (502) **DATE:** 2016-06-29

VESSEL NAME:	**IMO NUMBER:**	**OFFICIAL NUMBER:**	**FILE NO.:**
BAYNES SOUND CONNECTOR	839270	839270	19633

VESSEL TYPE: FERRY

RECOGNIZED ORGANIZATION:

GROSS TONNAGE:	**LENGTH:**	**PASSENGERS:**	**CREW:**
753	75.33 m	146	4

CON. MATERIAL:	**BUILT:**	**LAST MAJOR MODIFICATION:**
STEEL	2015	

PROP. TYPE:	**PROP. POWER:**	**PROP. METHOD:**
SELF-PROPELLED	744 KILOWATTS	CABLE

VOYAGE LIMITATION:
Sheltered Waters (Buckley Bay to Denman Island) ** Note: the vessel will operate year-round, therefore the old voyage limitation reference is Minor Waters Voyage Class II.

SUBJECT:
Flip LOA to MTRB. Request for exemption from the requirement for the position of the collision bulkheads. Request for exemption from the requirement for a double bottom.

RDIMS NOs - APPLICATION REQUEST/BACKGROUND:
#12075163: Application Request
#12075139: BAYNES SOUND CONNECTOR - LOAIP - SUBDIVISION DB - CONFIRMATION LETTER PKG
#12075163: BAYNES SOUND CONNECTOR - MTRB-RESUBMIT - SUBDIVISION DOUBLE BOTTOM - EDITABLE - ON 839270
#12075188: BAYNES SOUND CONNECTOR - MTRB-RESUBMIT - SUBDIVISION DOUBLE BOTTOM - SIGNED - ON 839270
#12075228: APPROVED LETTER OF AGREEMENT - VSY HULL 189
#12075243: STABILITY DAD MTES - SLT - WP16235756
#12257638: MTRB - FINAL CONDITIONS -M14754- BAYNES SOUND CONNECTOR - HULL CONSTRUCTION REGULATIONS

REGULATION REFERENCE[1]:
Canada Shipping Act, 2001: Hull Construction Regulations ((C.R.C., c. 1431))

PRECEDENTS:
12046 (Francois Forester, ON 820154).

APPLICATION SUMMARY (M14754)

1. **REVIEW:**
   The Baynes Sound Connector is a 78m cable ferry built by Seaspan Vancouver Shipyards Company Ltd. and delivered on 19 November 2015 for British Columbia Ferry Services Inc. The vessel was built to Lloyd's Register Rules and Regulations for the Classification of Inland Waterways Ships, complying with the class notation: +AT IWW Passenger and Vehicle Ferry, Zone 2, Buckley Bay to Denman Island Service, *IWS MCH Descriptive Note: Cable Operated The vessel operates in Baynes Sound, which is classified as Sheltered Waters. The vessel is a Class VIII passenger ship, as per Hull Construction Regulations, Application, Section 6.(1)(h). The vessel is a Group B ship, as per Hull Construction Regulations, Part II, Section 23.(b). A Letter of Agreement in Principle(LOAIP) with subject title VSY Hull 189 - Agreement in Principle "Request for exemption from the requirement for the position of the collision bulkheads. Request for exemption from the requirement for a double bottom," was issued by Transport Canada on 12 May 2015 based on the original MTRB application submitted on 9 April 2015 stipulated various conditions for compliance. All conditions in the LOAIP has been addressed. BC Ferries letter is attached confirming the status of each of the condition from the LOAIP. (Refer Attachment: 1. BSC-LOAIP-SubdivisionDB-ConfirmationLetter-pkg).

2. **DETAILS OF REGULATORY REQUIREMENTS:**
   Canada Shipping Act, 2001: Hull Construction Regulations ((C.R.C., c. 1431))

   Position of Collision Bulkhead: Hull Construction Regulations Part II, Section 31. The requirements for peak and machinery space bulkheads as specified in Section 10 of Part I apply to ships to which this Part applies, except that the requirements for afterpeak bulkheads specified in subsection 10(2) apply only to ships over 150 tons, gross tonnage. Hull Construction Regulations Part I, Section 10: (1) Subject to subsection (1.1), every ship shall be equipped with a collision bulkhead (a) that is watertight up to the bulkhead deck, and (b) that is fitted at a distance abaft the ship's forward perpendicular of not less than 5%, and not more than 3.05 m + 5%, of the length of the ship. ++++++++++++++++++++++++++++++ Double Bottom: Hull Construction Regulations Part II, Section 30: The requirements for double bottoms as specified in Section 11 of Part I apply to the ships of this Part. Hull Construction Regulations Part I, Section 11: (1) Every ship of 50 m in length or more shall be fitted with a watertight double bottom that: (c) in ships of 76 m or more in length, extends at least from the collision bulkhead to the afterpeak bulkhead, or as near to those bulkheads as is practicable.

3. **ALTERNATIVE PROPOSALS:**
   Collision Bulkhead Position: Locate the collision bulkheads (Peak bulkheads fore and aft) aft of the aft-most allowable position by approx. 52 mm at Frame Nos. 3 and 29 vice Frame Nos. 2 and 30. Section 4 refers. ++++++++++++++++++++++ Double Bottom: Accept the vessel design as a shallow pontoon (2.1m depth) under Hull Construction Regulations Part I, Section 11: (6) The Board may exempt any ship, other than a ship of Class I, from the requirements of a double bottom in any portion of the ship that is subdivided by application of a factor of subdivision not exceeding 0.5 if it is satisfied that the fitting of a double bottom in that

portion of the ship would not be compatible with the design and proper working of the ship. Section 4 refers.

4. **REASON WHY REGULATORY REQUIREMENT CANNOT BE MET OR WHY ALTERNATIVE PROPOSAL IS PREFERABLE:**

Canada Shipping Act, 2001: Hull Construction Regulations ((C.R.C., c. 1431))

Collision Bulkhead Position - reason why the alternative proposal is preferable: The critical compartments for damage stability with two compartments flooded are: Void Nos. 2 (Frame Nos. 3 to 6) and 3 (Frame Nos. 6 to 10) Void Nos. 6 (Frame Nos. 22 to 26) and 7 (Frame Nos. 26 to 29). If the collision bulkheads were located at Frame Nos. 2 and 30 (within the required range), damage stability requirements for two compartment flooding would not be met, as required by Hull Construction Regulations, Part II, Section 24.(3)(c). Two additional bulkheads could have been fitted in the fore / aft ends. However, the additional vessel weight / inertia in yaw and sway motions would have had a negative effect on cable loading with no significant compensating improvement to the capability of the vessel to sustain damage. The end result would have been a marginal reduction in the overall safety of the vessel. ++++++++++++++++++++++++ Double Bottom - reason why the alternative proposal is preferable: The design is typical for many inter-island, inland and cable ferries. Fitting a double bottom in a shallow pontoon would require increasing the depth of the hull which, together with the double bottom structure itself, would substantially increase the weight of the vessel and increase the windage of the vessel. This would in turn require increased winch powering /sizing and cable sizing.

5. **REASON WHY SAFETY AND THE ENVIRONMENT WILL NOT BE COMPROMISED:**

See Section 6. below - Potential Risks to Safety and the Environment. The points following address these risks. Collision Bulkhead Position a. The vessel operates on a fixed, charted route with little commercial traffic. b. The vessel complies with navigational aids that warn of traffic on the route and navigational lighting. c. The vessel has the capability to stop within one vessel length from full operational speed in the event of an obstruction on the route. (For reference, it is noted that MSC.137(76) - Standards for Ship Manoeuvrability, Section 5, Paragraph 5.3.4 (Stopping ability) requires the following: the track reach in the full astern stopping test should not exceed 15 ship lengths. However, this value may be modified by the Administration where ships of large displacement make this criterion impracticable, but should in no case exceed 20 ship lengths.) ++++++++++++++++++++++++ Double Bottom d. The vessel operates on a fixed, charted route where there are no known underwater obstructions. e. The vessel does not need to beach to load / unload, but docks into floating berths with substantial water under the keel. f. The vessel has a three (3) cable system to provide a high level of redundancy in the event of a cable breakage. In addition, a deployable anchor is fitted onboard the vessel. g. Extensive simulation of the performance of the cable system has been undertaken to ensure an acceptable safety factor on the cables. The cables are sized in accordance with the design practice developed by the American Petroleum Institute (API 2SK) for moored offshore structures. See Section 7 f. for cable inspection / monitoring and maintenance. h. The ferry complies with two (2) compartment subdivision stability criteria of the standards TP 10943, and of the bottom damage requirements of SOLAS regulations II-1/9.8 for area not fitted with a double-bottom.(DAD MTES/SLT/WP16235756 para 3.0 refers) The vessel complies with damage stability criteria for two compartment flooding based on estimated centre of gravity and lightship displacement values. The vessel complies with damage stability criteria for three midships compartment flooding based on estimated centre of gravity and lightship displacement values. i. A Letter of Maximum Subdivision Draft issued by LR specifying the maximum drafts(1.078 m) that will comply with a two compartment subdivision standard. j. All compartments below the main deck are voids except the compartment amidships, which contains some independent tanks. All machinery and fuel tanks are located above the main (vehicle) deck. In the event of grounding, no machinery operation is affected which might result in jeopardizing the safety of the vessel or its crew, passengers and cargo.

6. **POTENTIAL RISKS TO SAFETY AND THE ENVIRONMENT:**
   a. Collision with another vessel that crosses the path of the cable ferry. (See Section 5a. to c.) b. Cable breakage, causing the cable ferry to drift and either collide with another vessel or run aground. (See Section 5f. to h.) c. Vessel grounding on route. (Addressed by Section 5d. and e.) d. Pollution incident from machinery spaces as a result of no double bottom. (See Section 5j.)

7. **PROPOSED CONDITIONS[2]:**
   a. The vessel operates in accordance with the requirements of the company's Safety Management System.

   b. The Voyage Limitation of the vessel does not change (i.e. Sheltered Waters, Buckley Bay to Denman Island Service).

   c. The vessel operates in accordance with BC Ferries' Heavy Weather Precautions Procedures in accordance with the Vessel Specific Manual.

   d. The vessel operates / loads vehicles in accordance with the conditions contained in the approved Loading Manual.

   e. In-situ cable inspection / monitoring is carried out and maintenance is completed in accordance with appropriate standards / industry practice. BC Ferries' cable maintenance plan will involve placing a new cable into the drive position annually until such time as a duty cycle can be established for the vessel's route. Subject to cable condition, used drive cables will be utilized in the guide cable positions for two (2) years.

8. **FINAL CONDITIONS[2]:**
   Please see RDIMS document #12257638 MTRB-BETMM - FINAL CONDITIONS-CONDITIONS FINALE -M14754- BAYNES SOUND CONNECTOR - HULL CONSTRUCTION REGULATIONS-RÈGLEMENT SUR LA CONSTRUCTION DE COQUES

REQUIRED NOTIFICATIONS:

☐ IMO Notification required

☑ Delegated Classification Society Notification required

SOMMAIRE DE L'APPLICATION

NUMÉRO DE LA DÉCISION (M14754)

DATE D'EXPIRATION PROPOSÉE: 2500-12-31

BUREAU: Vancouver (502)

DATE: 2016-06-29

NOM DU BÂTIMENT :	N° OMI :	N° MATRICULE :	N° DE DOSSIER :
BAYNES SOUND CONNECTOR	839270	839270	19633

TYPE DE BÂTIMENT : TRAVERSIER

ORGANISATION RECONNUE:

JAUGE BRUTE :	LONGUEUR :	PASSAGERS	ÉQUIPAGE :
753	75.33 m	146	4

MATERIAUX DE CONSTRUCTION :	ANNÉE DE CONSTRUCTION :	DERNIÈRE MODIFICATION MAJEURE :
ACIER	2015	

TYPE DE PROPULSION :	PROPULSION :	MÉTHODE DE PROPULSION :
AUTOPROPULSE	744 KILOWATTS	CABLE

LIMITE DES VOYAGES :

.

OBJET :

.

N°s SDGGI - APPLICATION ET DEMANDE / INFORMATION CONNEXE :
#12075163: Application Request
#12075139: BAYNES SOUND CONNECTOR - LOAIP - SUBDIVISION DB - CONFIRMATION LETTER PKG
#12075163: BAYNES SOUND CONNECTOR - MTRB-RESUBMIT - SUBDIVISION DOUBLE BOTTOM - EDITABLE - ON 839270
#12075188: BAYNES SOUND CONNECTOR - MTRB-RESUBMIT - SUBDIVISION DOUBLE BOTTOM - SIGNED - ON 839270
#12075228: APPROVED LETTER OF AGREEMENT - VSY HULL 189
#12075243: STABILITY DAD MTES - SLT - WP16235756
#12257638: MTRB - FINAL CONDITIONS -M14754- BAYNES SOUND CONNECTOR - HULL CONSTRUCTION REGULATIONS

RÉFÉRENCE RÈGLEMENTAIRE[1] :
Loi de 2001 sur la marine marchande du Canada: Règlement sur la construction de coques ((C.R.C., c. 1431))

PRÉCÉDENTS :

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SOMMAIRE DE L'APPLICATION (M14754)

1. **REVUE :**

2. **DÉTAILS DES EXIGENCES RÉGLEMENTAIRES :**
   Loi de 2001 sur la marine marchande du Canada: Règlement sur la construction de coques ((C.R.C., c. 1431))

3. **SOLUTION PROPOSÉE EN REMPLACEMENT DE L'EXIGENCE RÈGLEMENTAIRE :**

4. **RAISON POUR LAQUELLE L'EXIGENCE RÈGLEMENTAIRE NE PEUT PAS ÊTRE RESPECTÉE OU POUR LAQUELLE LA SOLUTION DE RECHANGE EST JUGÉE PRÉFÉRABLE :**
   Loi de 2001 sur la marine marchande du Canada: Règlement sur la construction de coques ((C.R.C., c. 1431))

5. **RAISON POUR LAQUELLE IL N'Y A PAS DE RISQUE POUR LA SÉCURITÉ ET L'ENVIRONNEMENT**

6. **RISQUES POSSIBLES POUR LA SÉCURITÉ ET L'ENVIRONNEMENT :**

7. **CONDITIONS PROPOSÉES :**

8. **CONDITIONS DÉFINITIVES :**
   Veuillez voir le document RDIMS #12257638 MTRB-BETMM - FINAL CONDITIONS-CONDITIONS FINALE -M14754- BAYNES SOUND CONNECTOR - HULL CONSTRUCTION REGULATIONS-RÈGLEMENT SUR LA CONSTRUCTION DE COQUES

AVIS REQUIS :

☐ Avis requis à l'OMI

☑ Avis requis à la société de classification déléguée

≈BCFerries

British Columbia Ferry Services Inc.
Suite 500, 1321 Blanshard Street
Victoria, BC V8W 0B7
www.bcferries.com

January 14, 2016

Mr. Gordon Macatee
British Columbia Ferries Commissioner
BC Ferry Commission
RPO Hillside P.O. Box 35119
Victoria, BC V8T 5G2

CABLE FERRY PROJECT

Dear Mr. Macatee:

We write in regard to Order 14-01, dated February 20, 2014, by which the British Columbia Ferry Commission (the "Commission") approved the proposed major capital expenditure of British Columbia Ferry Services Inc. ("BC Ferries" or the "Company") for the new cable ferry and associated infrastructure (the "Project"), subject to certain conditions. This correspondence is intended to update the Commissioners on the actions taken and/or planned by the Company to address and satisfy the conditions set out in the Order.

Condition (a): ***The maximum amount of the major capital expenditure for the cable ferry and associated infrastructure is set at the amount stated in the Application which was confirmed by a separate confidential order to BC Ferries.***

BC Ferries confirms its expectation that the major capital expenditures for the Project will be within the amount specified in Order 14-01(A). Execution of the Project is expected to continue through to at least the end of fiscal 2016, with full cost reports expected to be available by the end of May 2016.

Condition (b): ***BC Ferries must advise the commissioner of the actual crewing levels as finally determined, and confirm that the projected life cycle cost savings will be achieved. If the projected life cycle cost savings are less than the projected savings in the Application the commissioner may not allow the increase in operating costs in future price cap determinations.***

BC Ferries has completed the crew safety and emergency drills overseen by Transport Canada, with the result that Transport Canada has set a minimum safe manning ("MSM") level for the vessel of four crew members. BC Ferries confirms that it will crew the vessel at a level not exceeding the MSM level. The Company expects to be in a position to confirm the projected life cycle cost savings of the Project by the end of May 2016. While the MSM level set by Transport Canada has one crew member more than was assumed by BC Ferries in its original filing with the Commissioner for the Project, the business case for the Project remains strong. The Company continues to believe that its decision to proceed with the cable ferry service is in the best interests of taxpayers and fare payers given the opportunity to realize significant savings that will help keep fares across the ferry system as low as possible, without compromising the current high standard of safety and reliability of service that the communities currently receive.

Condition (c): BC Ferries must satisfy the commissioner that standard operating procedures will be developed and refined as operational experience is gained, to include:

(i) a rigorous inspection, testing and replacement protocol of the cable is put in place with an inspection frequency commensurate with loads experienced at site.

A cable maintenance program has been developed to ensure a safe and reliable cable system, which includes installation and change-out procedures, cable load monitoring, cable condition inspections and programed cable replacements commensurate with cable wear and loading experience.

BC Ferries' Terminal Maintenance personnel have been trained in the handling, installation and tensioning of the cables, and have completed successful cable change outs to verify their abilities and to ensure full functionality and reliability of the system. Spare cables are also stored locally for planned preventative maintenance and also in the event of any unplanned cable change-outs.

BC Ferries has developed a rigorous cable inspection process, consisting of three tiers:

- Physical cable stretch measured on a daily basis via load cell pins to detect any potential abnormalities.

- Visual inspection whereby maintenance personnel visually inspect each cable on a weekly basis to observe any potential abnormalities.

- Physical cable monitoring using an electromagnetic testing device whereby the wire rope cables will be inspected on a quarterly basis to detect any potential abnormalities.

Each cable will have a notional operational service life of three years. Initially, the cables will be rotated annually from the center drive cable position to either of the guide cable locations, where the replaced cable would remain for two years. This procedure is considered to be both prudent and safe and may be modified with operational data and experience.

The combination of the above three monitoring techniques forms a comprehensive cable monitoring and inspection system. The inspection procedures noted above may be revised following operational experience with the cable ferry.

(ii) operating limits and protocols based on wave conditions that avoid resonant roll by actual measurements of wind speed, wave period and height.

In addition to developing standard operating procedural limits, such as weather-induced operating restrictions from the design computer simulations, dynamic motion measuring equipment has been procured and installed on the vessel. The resultant data is being used to refine the limiting parameters in the operational matrix.

Additionally a heavy weather operational limitations matrix, applicable to the vessel and based on the current route, will be followed to ensure that the vessel is operated within the approved conditions. A copy of the relevant matrix is attached for reference. This matrix also indicates that the *Baynes Sound Connector* will have the same levels of operational availability as the *Quinitsa* currently has on the route.

Condition (d): Prior deployment of the cable ferry, BC Ferries must satisfy the commissioner that operational reliability will be assured by:

(i) enabling a secondary means of recovering vessel from a propulsion system breakdown within a reasonable period of time.

In the unlikely event that recovery is required, the cable ferry is capable of recovery by two main methods:

- by winching the vessel in to the shore by means of synthetic rope which is stored onboard the vessel, and
- by towing the vessel to shore by tug secured to the vessel's bollards.

BC Ferries' personnel have conducted successful operational trials to confirm the above described recovery methods.

(ii) maintaining inventory, in the province, of non-redundant parts.

An itemized inventory of non-redundant parts has been procured. For example, a spare cable will be held on site at the Little River warehouse in Comox; the reel winder and pre-tensioning gear will be held on site at Buckley Bay; a complete engine/generator mounted assembly is held on site at Little River.

Condition (e): At least one vessel on the minor routes will be retired so that the cable ferry does not result in a net increase in the overall size of the fleet.

BC Ferries confirms that once the cable ferry has been successfully introduced into service, a designated vessel will be retired from its operations and then sold or disposed of as appropriate.

We trust the foregoing is satisfactory. Should you have any questions or require further information regarding this matter, please do not hesitate to contact me.

Sincerely,

s. 22 [redacted]

Dennis M. Dodo, MBA, CPA
Chief Financial Officer

Attach.

Weather Decision Support Matrix

Vessel: *Baynes Sound Connector*

Condition Assessment		***Operational Status***			
	Criteria	***Normal Operation***	***Cautionary Operation***	***Restricted Operation***	[redacted]
Transit	Significant Wave Height	< 0.5 m	0.50 – 0.60 m	0.60 – 0.80 m	[redacted]
	Associated Maximum Roll Angle	< 4°	4 – 5°	5-8°	[redacted]
	Sustained Wind Speed – Mid Channel	< 18m/s	18 - 20 m/s	20 - 28 m/s	[redacted]
Docking	Significant Wave Height	< 0.5 m	> 0.5 m	> 0.60 m	[redacted]

Probability	***Normal Operation***	***Cautionary Operation***	***Restricted Operation***	[redacted]
Average Annual Probability of Occurrence (%)	99.72 %	0.24%	0.04%	[redacted]
Expected Number of Sailings per Year (based on 10,896 sailings in fiscal 2015)	10,865 sailings/yr	26 sailings/yr	5 sailings/yr	[redacted]

Notes & Definitions:

1. All criteria must be met to trigger a change of operational status.
2. Typically only NNW/SSE directions (i.e., "up or down" Baynes Sound) have potential to generate conditions which may trigger a change to operational status. Other directions are generally sheltered.
3. Significant Wave Height: The significant wave height observed in mid channel, where "significant wave height" is the average of the 1/3 highest waves measured in sample. It is the wave height parameter measured and recorded by wave buoys.
4. Sustained Wind Speed: The sustained wind speed observed mid-channel on the vessel. 1 m/s=1.94 Knots.
5. *Cautionary Operation*: No operational measures however a heightened crew awareness and monitoring of shipboard, environmental and operating conditions. Possible slower crossing and dockings.
6. *Restricted Operation*: Continued operations with some operational measures such as announcements to limit unnecessary movement and advisories to remain in vehicles or the passenger lounge during the transit. Also, heightened crew awareness and monitoring of shipboard, environmental and operating conditions. Possible slower crossing and dockings.
7. *Cease Operation*: Vessel operations suspended until conditions allow resumption of service.

January 22, 2016

Mr. Dennis Dodo
Chief Financial Officer
British Columbia Ferry Services Inc.
Suite 500, 1321 Blanshard Street
Victoria BC V8W 0B7

Dear Mr. Dodo,

Re: Compliance with conditions set out in Order 14-01

Thank you for your letter of January 14, 2016. Your letter sets out BC Ferry Services Inc., responses to conditions contained in Order 14-01, concerning the newly constructed cable ferry, named the Baynes Sound Connector (BSC). Our determination on the company's compliance with those conditions is set out and explained in the following discussion.

Condition (a): The maximum amount of the major capital expenditure for the cable ferry and associated infrastructure is set at the amount stated in the Application which was confirmed by a separate confidential order to BC Ferries.

The current status of this condition is based on your expectation that it will be met, subject to some further expenditures which will flow through the end of May, 2016. Please provide a report on the full costs when they have been finalized. Any amount in excess of the approved maximum amount may not be taken into account in the calculation of price caps for the next performance term.

Condition (b): BC Ferries must advise the commissioner of the actual crewing levels as finally determined, and confirm that the projected life cycle cost savings will be achieved. If the projected life cycle cost savings are less than the projected savings in the Application the commissioner may not allow the increase in operating costs in future price cap determinations.

It was understood at the time of your filing that crewing levels would be subject to a decision by Transport Canada, which could not be predicted with certainty at the time of filing. The fact that the final number is higher than anticipated in the business case is noted, ie 4 versus 3. You have indicated that the business case remains strong, despite the additional cost of one extra crew member. We will look for confirmation of the projected life cycle cost savings of the project after the end of May, 2016. We will also want to hear the company's thoughts on how any cost increase will be absorbed without putting pressure on price caps for the next performance term.

Condition (c): BC Ferries must satisfy the commissioner that standard operating procedures will be developed and refined as operational experience is gained, to include:

> ***(i) a rigorous inspection, testing and replacement protocol of the cable is put in place with an inspection frequency commensurate with loads experienced at site.***

The Ferries Commissioner is responsible for overseeing compliance with the Coastal Ferry Services Contract (CFSC), which contains certain requirements pertaining to service reliability. Condition (c)(i) is intended to ensure a robust inspection and maintenance program is in place to minimize the likelihood of service disruptions due to cable failure. The condition includes an expectation that standard operating procedures will be refined as operational experience is gained. The Commissioners are satisfied that the proposed inspection, testing and replacement protocol is reasonable as a starting point, and will expect a report after 12 to 18 months in service to assess the on-going suitability of the operating procedures.

> ***(ii) operating limits and protocols based on wave conditions that avoid resonant roll by actual measurements of wind speed, wave period and height.***

It is noted that the cable ferry will have the same service levels of operational availability as the Quinitsa. After 12 – 18 months of service, we will want to see a report on any refinements to the limiting parameters in the operational matrix, based on data gathered over that period.

Condition (d): Prior to deployment of the cable ferry, BC Ferries must satisfy the commissioner that operational reliability will be assured by:

> ***(i) enabling a secondary means of recovering vessel from a propulsion system breakdown within a reasonable period of time.***

This condition is intended to address operational reliability of the vessel. The Ferries Commissioner is not a safety regulator, and makes no judgment on matters of safety. That responsibility rests with Transport Canada.

On the matter of operational reliability, the condition is intended to ensure that public concerns about a secondary means of recovery from a breakdown have been reasonably addressed. All vessels in the ferry fleet face the possibility of mechanical or propulsion failure, such as an engine breakdown or loss of a propeller. The primary means of recovering any vessel in such circumstances is to call in a tug, and if necessary, to deploy an anchor. The cable ferry is fitted with an anchor and an attachment point for a tug. We understand the vessel is capable of carrying on service to the public with a tug attached, if there are any delays in repairing the propulsion systems.

The cable ferry will be the only vessel in the fleet with an additional means for recovery. The company has installed synthetic ropes at both ends of the route which can be deployed to winch the vessel to shore. There are some members of the public who have conveyed concern with this plan. However, it is noted that this capability is not the primary solution, and is an additional option which is not available to any other vessel in the fleet. Accordingly, the Commissioners are satisfied that operational reliability requirements of the CFSC can be reasonably assured.

(ii) maintaining inventory, in the province, of non-redundant parts.

The Commissioners have visited the inventory storage location and are satisfied that maintaining a supply of non-redundant parts at that location will be sufficient to ensure operational reliability of the vessel in compliance with the CFSC. A copy of the itemized inventory list needs to be provided to the Commissioner, to facilitate an audit in future, at the Commissioner's discretion.

Condition (e): At least one vessel on the minor routes will be retired so that the cable ferry does not result in a net increase in the overall size of the fleet.

It is noted that the decision on a vessel retirement will not be made until the cable ferry has been successfully introduced into service. We will expect confirmation of this decision in due course. This decision will be factored into future price cap determinations.

Conclusion

Noting certain requirements set out above, the Commissioner is satisfied that the conditions set out in Order 14-01 have been sufficiently addressed.

Yours truly,

s. 22

[redacted]

Gord Macatee
BC Ferries Commissioner

BCFerries

British Columbia Ferry Services Inc.
Suite 500, 1321 Blanshard Street
Victoria, BC V8W 0B7
www.bcferries.com

May 31, 2017

Mr. Gordon Macatee
British Columbia Ferries Commissioner
BC Ferry Commission
RPO Hillside P.O. Box 35119
Victoria, BC V8T 5G2

Re: Compliance with conditions set out in Order 14-01

Dear Mr. Macatee:

We write in regard to your letter dated January 22, 2016, which the British Columbia Ferry Commission (the "Commission") addresses BC Ferry Services Inc. ("BC Ferries" or the "Company") compliance with the conditions set out in Order 14-01, concerning the cable ferry and associated infrastructure. This correspondence is intended to update the Commissioner on the actions taken and/or planned by the Company to address and satisfy the requirements set out in the letter.

Condition (c): BC Ferries must satisfy the commissioner that standard operating procedures will be developed and refined as operational experience is gained, to include:

(i) a rigorous inspection, testing and replacement protocol of the cable is put in place with an inspection frequency commensurate with loads experienced at site.

The Ferries Commissioner is responsible for overseeing compliance with the Coastal Ferry Services Contract (CFSC), which contains certain requirements pertaining to service reliability. Condition (c)(i) is intended to ensure a robust inspection and maintenance program is in place to minimize the likelihood of service disruptions due to cable failure. The condition includes an expectation that standard operating procedures will be refined as operational experience is gained. <u>The Commissioners are satisfied that the proposed inspection, testing and replacement protocol is reasonable as a starting point, and will expect a report after 12 to 18 months in service to assess the on-going suitability of the operating procedures.</u>

Cable Maintenance Protocol Update

The comprehensive cable maintenance program has been developed to continue BC Ferries' commitment to maintaining a safe and reliable cable system. The program has been successfully implemented since the Baynes Sound Connector entered into service on February 9, 2016 (15 months of service), and continues to be refined as operational experience is gained. The program presently includes installation and change-out procedures, re-tensioning procedures, cable load monitoring, cable condition inspections and programed cable replacements commensurate with cable wear and loading experience. BC Ferries' Terminal Maintenance personnel have successfully completed three preventative maintenance cable change outs/cable rotations since the ferry entered into service. The change-out procedures and preventive maintenance plans have been refined, ensuring cabling handling equipment is reliable and change-outs are completed without impacting service. Spare cables continue to be stored locally for scheduled change-outs and also in the event of any unplanned cable change-outs.

BC Ferries has further developed a rigorous cable inspection process consisting of the following:

- Cable tension is monitored on a daily basis via load cell pins to detect any potential abnormalities. Protocol has been developed to determine if it is necessary to re-tension a cable to its nominal pretension value, and to ensure cumulative cable re-tensions do not exceed criteria for maximum allowable cable stretch.
- Visual inspections whereby maintenance personnel visually inspect each cable on a weekly basis to observe any potential abnormalities. New visual standards have been developed in order to assess the type and severity of any potential abnormalities.
- Physical cable monitoring by qualified professionals using an electromagnetic testing device whereby the cable will be inspected on a quarterly basis to detect any potential abnormalities. Procedures have been refined to evaluate loss of cross sectional area for condition based assessments.

In a continued effort to assess the condition of the cables and refine the cable inspection process, post-operational assessments are conducted on retired cables. At present, an assessment has been completed on the south guide cable, which was retired as part of the preventative maintenance program. The analysis determined that the length of cable which the cable ferry operates was found to be in good condition, with corrosion pitting isolated only to areas where the cable passes inside the berthing pontoons (as shown in the following diagram).

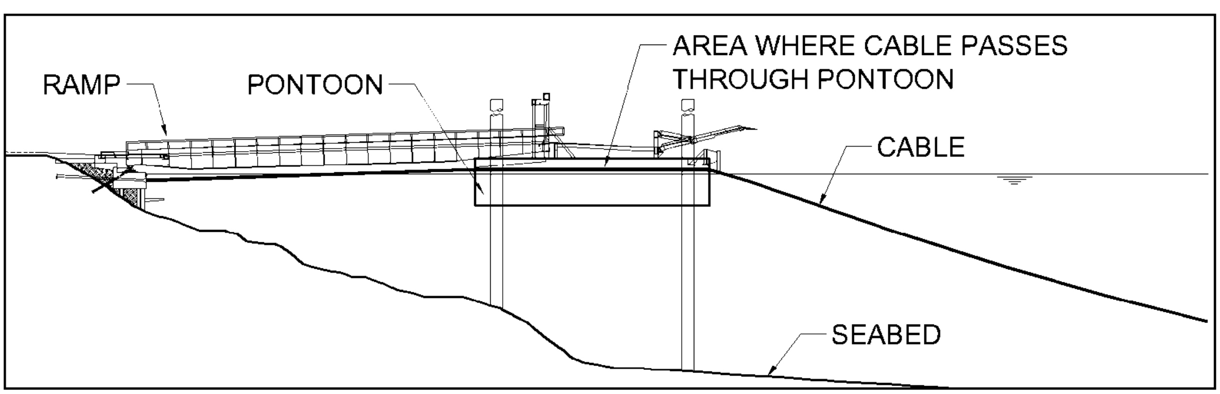

Figure 1 – Diagram of Berthing Pontoon

BC Ferries is currently completing the following actions to ensure that the safety and reliability of the cable system is maintained:

- A bushing system will be installed inside the pontoons to minimize the galvanic corrosion caused by contact between the steel cable and stainless steel hawse pipe inside the pontoon.
- As a result of our cable assessment findings, cables have been procured with sacrificial coatings for improved corrosion resistance. These new cables are the same size and construction to match the existing cables, with an equivalent breaking strength.

BC Ferries will continue to assess the condition of the cables to determine whether the notional operational service life of three years is appropriate or could be extended. Initially, the cables will be rotated annually from the center drive cable position to either of the guide cable locations, where it will remain for two years. This procedure is considered to be both prudent and safe and may be modified with condition assessments, experience and engineering review.

We trust the foregoing is satisfactory. Should you have any questions or required further information regarding this matter, please do not hesitate to contact me.

Sincerely,

Dennis M. Dodo, MBA, CPA
Chief Financial Officer

Rasmussen, Shauna

From:	Adams, James W
Sent:	March 28, 2022 5:07 PM
To:	Meyer, Leslie A.; Paterson, Bruce; Cennon, Quentin
Cc:	Seitz, Robert
Subject:	FW: BSC Cable Documents (Commissioner Response, MTRB, Memo to LR)
Attachments:	2016 01 14 to FC Cable Ferry Order 14-01 Conditions w. Attach.pdf; 2016 01 22 Order 14-01 fr FC conditions letter_final revised.pdf; 2017 05 31 to FC Order 14-01 Conditions Letter DRAFT.docx; 14754 BSC - TC Application Summary.pdf; Briefing Note - Condition (e) of MTRB 14754.pdf; EYE Cable Report, Rev Final, 07 Dec 2016.pdf; 2016 01 14 to FC Cable Ferry Order 14-01 Conditions w. Attach.pdf

Hi Leslie, Bruce, and Quentin,

Further to our discussion today, the attached documents should be useful to reference and/or include in the cable maintenance document.

The document titled 2016 01 14 to FC Cable Ferry Order 14-01 relates to a response issued to the Commissioner regarding BSC operational requirements. Refer to Section c (i) for a good summary of the cable maintenance plans.

The MTRB document with conditions is also attached for reference.

Regards,

James Adams, P.Eng.
Project Manager, Terminal Construction
British Columbia Ferry Services Inc.
T: 250-978-1317 [redacted] **F:** 250-361-4922
james.adams@bcferries.com
bcferries.com

ss. 15, 19

From: Harney, Steven <Steven.Harney@bcferries.com>
Sent: February 14, 2022 2:27 PM
To: Cennon, Quentin <Quentin.Cennon@bcferries.com>
Cc: Seitz, Robert <Robert.Seitz@bcferries.com>
Subject: RE: TM Standard Template

I hoping the attached is what you are after, including a Sewage Maint. Std. example.

Steven

Steven Harney, AScT, PMP
Manager, Terminal Standards
British Columbia Ferry Services Inc.
T: 250 978-2058 [redacted]
steven.harney@bcferries.com
bcferries.com

ss. 15, 19

From: Seitz, Robert <Robert.Seitz@bcferries.com>
Sent: February 14, 2022 2:14 PM
To: Harney, Steven <Steven.Harney@bcferries.com>
Cc: Cennon, Quentin <Quentin.Cennon@bcferries.com>
Subject: TM Standard Template

Hi Steven,

Can you please send Quentin a template for the TM standard. We want to do a brain dump on paper on BSC cable maintenance/inspections.

Rob Seitz, P.Eng
Director, Terminal Maintenance
Operations Division
British Columbia Ferry Services Inc.
Suite 500-1321 Blanshard Street, Victoria, BC V8W 0B7
T: 250-978-1268 [redacted] **F:** 250-361-4922
Robert.Seitz@bcferries.com
bcferries.com | Facebook | Twitter ss. 15, 19

Briefing Note:
OpEx Budget Variance Options
For Decision

PREPARED FOR: Corrine Storey, Vice President & Chief Operating Officer

SUBJECT: BSC Cable Wear – Additional Cables Required

ACTION REQUIRED: Decision on OpEx Budget Variance Options

DATE: February 27, 2022

s. 13

[redacted]

Briefing Note: OpEx Budget Variance Options For Decision

DISCUSSION:

s. 13

[redacted]

OPTIONS:

s. 13, s. 17, s. 22, ss. 15, 19

[redacted]

s. 13, ss. 15, 19

Page redacted

Rasmussen, Shauna

From:	David Mietla <dmietla@3gamarine.com>
Sent:	April 14, 2022 2:04 PM
To:	Adams, James
Cc:	Shaun Wallis
Subject:	[EXTERNAL] replacement of guide cables

Hi James,
As discussed, we had a look at the feasibility of replacing both guide cables with the 1.5" cable (emergency) as stated in our memo and yes, both guide cables can be replaced with the 1.5" cable but as stated in the memo the operating weather window has to be reduced to the hundred year storm.

I hope this helps.

Thank you and kind regards,

David Mietla, P.Eng.
President
3GA Marine Ltd.
Cell: (250) 589 7404

Optimizing Solutions

Rasmussen, Shauna

From:	Meyer, Leslie A.
Sent:	April 14, 2022 3:20 PM
To:	Adams, James W; Weigold, Andrew; Seitz, Robert
Cc:	Stahuliak, Marian; Bliss, Rick; Cennon, Quentin; Paterson, Bruce; Raduta, Captain Claudiu
Subject:	RE: BSC Emergency spare cable
Attachments:	SMD 01-2022 - South Guide Cable.docx; 20220328_LRLtr-BSC_EmergencyCable-Mar2022 DRAFT-v0.3.docx

Thanks Andy and James.

James: I've revised the letter accordingly. Please review and confirm acceptability.

Also, can you confirm that the 39 knots sustained wind speed is a hard stop (i.e. cancel sailings) limit vs. a "consult with Supt/OSC" limit? For consistency (and efficiency for obtaining LR approval), suggest we incorporate similar language as the MTRB into the Sr Master Directive:

> **MTRB 14754**
> g. The cable ferry operates in compliance with the BC Ferries 'Heavy Weather Precautions Procedures for a Cable Ferry" and will initiate heavy weather precaution above 35 knots of sustained wind speed. Crossing will not be undertaken in sustained wind speed of more than 55 knots, significant wave height of more than 1.03 metres, or current of more than 1.9 knots;

While also incorporating the format of the existing heavy weather matrix.

So for example:

> The engineering analysis undertaken by 3GA Marine Consultants confirms the 1-1/2" diameter cable exceeds all safety requirements when the weather matrix is adjusted to 39knots. Due to the south guide cable strength we must reduce the weather matrix to a sustained wind strength of 39kts at Sisters Island land station.
>
> While the new cable type is in place, the following procedures apply:
>
> - Heavy weather precautions are to be initiated above 30 knots of sustained wind speed;
> - Consultation with OSC prior to sailing shall occur for sustained wind speed between xx – xx. [do these limits change for new cable type?];
> - Crossing will not be undertaken in sustained wind speed of more than 39 knots, or significant wave height of more than 1.0 metre [does wave height need to be amended for new cable type?];

Thanks,

Leslie Meyer
Regulatory & Policy Manager
British Columbia Ferry Services Inc.
T: 604-204-2212 [redacted]
leslie.meyer@bcferries.com
bcferries.com

ss. 15, 19

From: Adams, James W <James.Adams@bcferries.com>
Sent: April 14, 2022 2:02 PM

To: Weigold, Andrew <Andrew.Weigold@bcferries.com>; Meyer, Leslie A. <Leslie.Meyer@bcferries.com>; Seitz, Robert <Robert.Seitz@bcferries.com>
Cc: Stahuliak, Marian <Marian.Stahuliak@bcferries.com>; Bliss, Rick <Rick.Bliss@bcferries.com>; Cennon, Quentin <Quentin.Cennon@bcferries.com>; Paterson, Bruce <Bruce.Paterson@bcferries.com>; Raduta, Captain Claudiu <Claudiu.Raduta@bcferries.com>
Subject: RE: BSC Emergency spare cable

Hi Leslie,

Further to my comments below, 3GA has confirmed their analysis covers both guide cables. This cable should not be used in the drive position though since the bull wheel liners are sized for a 1-5/8" dia cable.

As mentioned earlier, it may be difficult to find an equivalent "off the shelf cable" since the Northern Strands cable is constructed with the highest grade material available. Most off the shelf cables use a medium grade steel with a lower breaking strength.

Regards,

James Adams, P.Eng.
Project Manager, Terminal Construction
British Columbia Ferry Services Inc.
T: 250-978-1317 [redacted] **F:** 250-361-4922
james.adams@bcferries.com
bcferries.com

ss. 15, 19

From: Weigold, Andrew <Andrew.Weigold@bcferries.com>
Sent: April 14, 2022 12:57 PM
To: Adams, James W <James.Adams@bcferries.com>; Meyer, Leslie A. <Leslie.Meyer@bcferries.com>; Seitz, Robert <Robert.Seitz@bcferries.com>
Cc: Stahuliak, Marian <Marian.Stahuliak@bcferries.com>; Bliss, Rick <Rick.Bliss@bcferries.com>; Cennon, Quentin <Quentin.Cennon@bcferries.com>; Paterson, Bruce <Bruce.Paterson@bcferries.com>; Raduta, Captain Claudiu <Claudiu.Raduta@bcferries.com>
Subject: RE: BSC Emergency spare cable

See directive for new cable attached

Andy Weigold
Sr. Master, Route 17, Salish Class
Sr. Master, Route 21, Baynes Sound Connector
British Columbia Ferry Services Inc.
1300 Ellenor Rd., Comox, BC, V9M 4B3
[redacted]
Andrew.Weigold@bcferries.com
bcferries.com

ss. 15, 19

From: Adams, James W <James.Adams@bcferries.com>
Sent: April 14, 2022 10:25 AM
To: Weigold, Andrew <Andrew.Weigold@bcferries.com>; Meyer, Leslie A. <Leslie.Meyer@bcferries.com>; Seitz, Robert <Robert.Seitz@bcferries.com>
Cc: Stahuliak, Marian <Marian.Stahuliak@bcferries.com>; Bliss, Rick <Rick.Bliss@bcferries.com>; Cennon, Quentin <Quentin.Cennon@bcferries.com>; Paterson, Bruce <Bruce.Paterson@bcferries.com>
Subject: RE: BSC Emergency spare cable

Hi Andy,

See below for the directive:

What was the agreed wind speed: maximum sustained wind shall not exceed 20m/s [39 knots]
Current in-service cables: 1-5/8”diameter flattened strand steel cable with breaking strength of 285,000 lbs
Emergency spare cable: 1-1/2” diameter steel cable with breaking strength of 249,000 lbs
Note: The engineering analysis undertaken by 3GA Marine Consultants confirms the 1-1/2” diameter cable exceeds all safety requirements when the weather matrix is adjusted to 39knots.
Which cable is it going to replace: South guide cable
Is there anything special for crew to watch for? No, continue with standard visual inspections. LRTM will continue with the standard monitoring program.

Thanks,

James

James Adams, P.Eng.
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British Columbia Ferry Services Inc.
T: 250-978-1317 [redacted] **F:** 250-361-4922
james.adams@bcferries.com ss. 15, 19
bcferries.com

From: Weigold, Andrew <Andrew.Weigold@bcferries.com>
Sent: April 14, 2022 9:35 AM
To: Adams, James W <James.Adams@bcferries.com>; Meyer, Leslie A. <Leslie.Meyer@bcferries.com>; Seitz, Robert <Robert.Seitz@bcferries.com>
Cc: Stahuliak, Marian <Marian.Stahuliak@bcferries.com>; Bliss, Rick <Rick.Bliss@bcferries.com>; Cennon, Quentin <Quentin.Cennon@bcferries.com>; Paterson, Bruce <Bruce.Paterson@bcferries.com>
Subject: RE: BSC Emergency spare cable

What was the agreed wind speed, what is new cable size vs. old, what is the difference in breaking strain, which cable is it going to replace, is there anything special for crew to watch for?

I’ll use this info in the directive.

Regards,

Andy Weigold
Sr. Master, Route 17, Salish Class
Sr. Master, Route 21, Baynes Sound Connector
British Columbia Ferry Services Inc.
1300 Ellenor Rd., Comox, BC, V9M 4B3
[redacted] ss. 15, 19
Andrew.Weigold@bcferries.com
bcferries.com

From: Adams, James W <James.Adams@bcferries.com>
Sent: April 14, 2022 9:14 AM
To: Meyer, Leslie A. <Leslie.Meyer@bcferries.com>; Weigold, Andrew <Andrew.Weigold@bcferries.com>; Seitz, Robert

<Robert.Seitz@bcferries.com>
Cc: Stahuliak, Marian <Marian.Stahuliak@bcferries.com>; Bliss, Rick <Rick.Bliss@bcferries.com>; Cennon, Quentin <Quentin.Cennon@bcferries.com>; Paterson, Bruce <Bruce.Paterson@bcferries.com>
Subject: RE: BSC Emergency spare cable

Hi Leslie,

Thanks again for preparing the letter to LR. See below in red for response to your comments.

It is mentioned in the letter that LR can contact you or myself for further questions. Can you please change the contact to Robert Seitz since this work is maintenance related.

Thanks,

James

James Adams, P.Eng.
Project Manager, Terminal Construction
British Columbia Ferry Services Inc.
T: 250-978-1317 [redacted] **F:** 250-361-4922
james.adams@bcferries.com
bcferries.com

ss. 15, 19

From: Meyer, Leslie A. <Leslie.Meyer@bcferries.com>
Sent: April 13, 2022 4:24 PM
To: Adams, James W <James.Adams@bcferries.com>; Weigold, Andrew <Andrew.Weigold@bcferries.com>; Seitz, Robert <Robert.Seitz@bcferries.com>
Cc: Stahuliak, Marian <Marian.Stahuliak@bcferries.com>; Bliss, Rick <Rick.Bliss@bcferries.com>; Cennon, Quentin <Quentin.Cennon@bcferries.com>; Paterson, Bruce <Bruce.Paterson@bcferries.com>
Subject: RE: BSC Emergency spare cable

Hi James,

Thanks for organizing the meeting today.

I've amended the LR letter based on the discussion today and have attached for your review and comment. Will await your confirmation on the following before finalizing/submitting to LR:

1. Scope of the 3GA memo – does it cover one guide cable or both? (I see the Conclusion refers only to the "proposed Northern Strand", so perhaps it only covers a single cable?). The current revision of the LR letter does not specify the scope of the replacement, but we should modify it to align with the 3GA memo. JA: 3GA believes the analysis should cover both guide cables, though they are double checking their numbers and will provide a response today. This cable should not be used in the drive position since the bull wheel liners are sized for a 1-5/8" dia cable. It should also be noted that it may be difficult to find an equivalent "off the shelf cable" since the Northern Strands cable is constructed with the highest grade material available. Most off the shelf cables use a medium grade steel with a lower breaking strength.

2. Timing of Sr. Master's directive for heavy weather limitations – will this be ready in time to include in LR package (tomorrow or Tuesday), or should we proceed with the LR submission while the Directive is a work in progress? JA: Andy will provide a copy of the directive today.

Thanks,

Leslie Meyer
Regulatory & Policy Manager
British Columbia Ferry Services Inc.
T: 604-204-2212 [redacted] ss. 15, 19
leslie.meyer@bcferries.com
bcferries.com

From: Adams, James W <James.Adams@bcferries.com>
Sent: April 12, 2022 11:37 AM
To: Weigold, Andrew <Andrew.Weigold@bcferries.com>; Seitz, Robert <Robert.Seitz@bcferries.com>
Cc: Stahuliak, Marian <Marian.Stahuliak@bcferries.com>; Bliss, Rick <Rick.Bliss@bcferries.com>; Meyer, Leslie A. <Leslie.Meyer@bcferries.com>; Cennon, Quentin <Quentin.Cennon@bcferries.com>; Paterson, Bruce <Bruce.Paterson@bcferries.com>
Subject: RE: BSC Emergency spare cable

Hi Rob,

Leslie has prepared the attached draft letter (MS Word) to Lloyds regarding the emergency spare cable. The letter is indented to reference the cable maintenance plan, which I understand is now scheduled for completion at the end of June. Unfortunately this creates a conflict since LRTM is currently scheduled to install the spare cable April 28th.

I'll arrange a group conf call to discuss how to finalize and submit the memo in advance of the cable install.

Andy – In terms of the heavy weather matrix, I understand your preference is to issue a directive indicating the heavy weather matrix has been modified for the emergency spare cable. We can discuss this further during the conf call.

Regards,

James Adams, P.Eng.
Project Manager, Terminal Construction ss. 15, 19
British Columbia Ferry Services Inc.
T: 250-978-1317 [redacted]**:** 250-361-4922
james.adams@bcferries.com
bcferries.com

From: Meyer, Leslie A. <Leslie.Meyer@bcferries.com>
Sent: April 04, 2022 10:19 AM
To: Adams, James W <James.Adams@bcferries.com>; Weigold, Andrew <Andrew.Weigold@bcferries.com>; Cennon, Quentin <Quentin.Cennon@bcferries.com>; Paterson, Bruce <Bruce.Paterson@bcferries.com>
Cc: Stahuliak, Marian <Marian.Stahuliak@bcferries.com>; Bliss, Rick <Rick.Bliss@bcferries.com>; Seitz, Robert <Robert.Seitz@bcferries.com>
Subject: RE: BSC Emergency spare cable

Morning James and all,

Attached is the draft LR letter for review and comment by the group. Since the proposal is to leave the new cable type installed for its lifespan (rather than a short term fix), I've proposed within the letter that the heavy weather matrix be amended and a copy included with the submission to LR:

https://sms.bcferries.corp/eFleetReader/eFleetPublishedDocuments/07.10.30.120G_HeavyWeatherFleetSummaryTable_FOM.pdf

Perhaps the "cancel sailing" threshold could be amended to the new limit with a footnote referencing the new cable type.

Thanks,

Leslie Meyer
Regulatory & Policy Manager
British Columbia Ferry Services Inc.
T: 604-204-2212 [redacted] ss. 15, 19
leslie.meyer@bcferries.com
bcferries.com

From: Adams, James W <James.Adams@bcferries.com>
Sent: March 28, 2022 5:36 PM
To: Weigold, Andrew <Andrew.Weigold@bcferries.com>; Meyer, Leslie A. <Leslie.Meyer@bcferries.com>; Cennon, Quentin <Quentin.Cennon@bcferries.com>; Paterson, Bruce <Bruce.Paterson@bcferries.com>
Cc: Stahuliak, Marian <Marian.Stahuliak@bcferries.com>; Bliss, Rick <Rick.Bliss@bcferries.com>; Seitz, Robert <Robert.Seitz@bcferries.com>
Subject: RE: BSC Emergency spare cable

Hi Leslie, Bruce, and Quentin,

Please note the following summary and action items from today's meeting regarding the emergency spare cable for the BSC:

- It is anticipated that the emergency spare cable may require installation as soon as late-April 2022, pending future condition assessments on the in-service cables. If the cable were installed, the weather matrix would require an adjustment restricting sailings above 40knot sustained winds. The cable would likely remain in service for 12 or more months and would be subject to standard inspections as per the cable maintenance plan.
- Leslie to prepare draft letter to Lloyds referencing the 3GA "engineering" memo and cable maintenance plan to be prepared to LRTM. Draft letter to be prepared by mid-April
- Quentin to prepare draft cable maintenance plan document by mid-April. (Keep in mind the OSL action is due April 4)
- James to brief Andy that the VSM will may require a revision to the Heavy Weather Matrix if the emergency spare cable is installed. James/Quentin to keep Andy posted with potential installation timeline.

Please let me know if you have any questions or concerns with the above.

Thanks everyone for your input and support.

James

James Adams, P.Eng.
Project Manager, Terminal Construction
British Columbia Ferry Services Inc.
T: 250-978-1317 [redacted]**:** 250-361-4922
james.adams@bcferries.com ss. 15, 19
bcferries.com

From: Adams, James W
Sent: March 23, 2022 5:37 PM
To: Weigold, Andrew <Andrew.Weigold@bcferries.com>; Meyer, Leslie A. <Leslie.Meyer@bcferries.com>; Cennon, Quentin <Quentin.Cennon@bcferries.com>; Seitz, Robert <Robert.Seitz@bcferries.com>; Paterson, Bruce <Bruce.Paterson@bcferries.com>

Cc: Stahuliak, Marian <Marian.Stahuliak@bcferries.com>
Subject: RE: Emergency cable report for LR (Draft)

Thanks Andy, this will be reviewed further early next week.

James Adams, P.Eng.
Project Manager, Terminal Construction
British Columbia Ferry Services Inc.
T: 250-978-1317 [redacted] **F:** 250-361-4922
james.adams@bcferries.com
bcferries.com

ss. 15, 19

From: Weigold, Andrew <Andrew.Weigold@bcferries.com>
Sent: March 23, 2022 2:37 PM
To: Adams, James W <James.Adams@bcferries.com>; Meyer, Leslie A. <Leslie.Meyer@bcferries.com>; Cennon, Quentin <Quentin.Cennon@bcferries.com>; Seitz, Robert <Robert.Seitz@bcferries.com>; Paterson, Bruce <Bruce.Paterson@bcferries.com>
Cc: Stahuliak, Marian <Marian.Stahuliak@bcferries.com>
Subject: RE: Emergency cable report for LR (Draft)

Written policy is required its the duty of operational supervisor to report limitations to duty superintendents as they are responsible for the entire coast so they can't keep the details for every vessel. If it's temporary I can create a directive and vessel staff would inform duty super of the temporary limitation directive if conditions were met.

Andy

Sent with BlackBerry Work
(www.blackberry.com)

From: Adams, James W <James.Adams@bcferries.com>
Date: Wednesday, Mar 23, 2022, 1:25 PM
To: Meyer, Leslie A. <Leslie.Meyer@bcferries.com>, Cennon, Quentin <Quentin.Cennon@bcferries.com>, Seitz, Robert <Robert.Seitz@bcferries.com>, Paterson, Bruce <Bruce.Paterson@bcferries.com>
Cc: Stahuliak, Marian <Marian.Stahuliak@bcferries.com>, Weigold, Andrew <Andrew.Weigold@bcferries.com>
Subject: RE: Emergency cable report for LR (Draft)

Hi Leslie,

Sorry for the late reply. I'll arrange a conf call with the group to discuss next steps.

I'm not sure if anyone else has any comments regarding the 3GA report?

The Heavy Weather Matrix currently requires a consult with the duty Superintendent above 40 knots. The report indicates no sailings can take place above this limit if the emergency spare cable is installed. I'm not sure if it is sufficient for the Superintendent to simply be aware of this limitation or if written procedures are required.

I'll provide you with additional information on the timeline for the replacement cables.

Regards,

James Adams, P.Eng.

Project Manager, Terminal Construction
British Columbia Ferry Services Inc.
T: 250-978-1317 [redacted] **F:** 250-361-4922
james.adams@bcferries.com ss. 15, 19
bcferries.com

From: Meyer, Leslie A. <Leslie.Meyer@bcferries.com>
Sent: March 21, 2022 2:01 PM
To: Adams, James W <James.Adams@bcferries.com>; Cennon, Quentin <Quentin.Cennon@bcferries.com>; Seitz, Robert <Robert.Seitz@bcferries.com>; Paterson, Bruce <Bruce.Paterson@bcferries.com>
Cc: Stahuliak, Marian <Marian.Stahuliak@bcferries.com>
Subject: RE: Emergency cable report for LR (Draft)

Hi James,

My question would be whether the vessel's Heavy Weather Matrix and cable maintenance plan will be updated to reflect the stipulations imposed by this report?

In terms of submission, I can assist with sending the finalized report on to LR. I've attached the LR conversation from the Dec 2019 cable change. In that case, we requested LR to issue a letter of no objection for our records. That would be helpful this time around too, especially as we prepare to submit the revised collision bulkhead/double bottom MTRB. In that case, I'd ask you to provide some additional context around the timeline for procurement and replacement of the cable.

Thanks,

Leslie Meyer ss. 15, 19
Regulatory & Policy Manager
British Columbia Ferry Services Inc.
T: 604-204-2212 [redacted]
leslie.meyer@bcferries.com
bcferries.com

From: Adams, James W <James.Adams@bcferries.com>
Sent: March 15, 2022 6:16 PM
To: Cennon, Quentin <Quentin.Cennon@bcferries.com>; Seitz, Robert <Robert.Seitz@bcferries.com>; Paterson, Bruce <Bruce.Paterson@bcferries.com>; Meyer, Leslie A. <Leslie.Meyer@bcferries.com>
Cc: Stahuliak, Marian <Marian.Stahuliak@bcferries.com>
Subject: FW: Emergency cable report for LR (Draft)

All,

Attached is the draft memo for LR submission regarding temporary use of the emergency spare cable. Can you please review and let me know if you have any questions?

I'll be back in the office next week and will review the memo then.

Bruce or Leslie – How did you want to proceed with the submission to LR once we have finalized the report?

Thanks,

James

James Adams, P.Eng.

Project Manager, Terminal Construction
British Columbia Ferry Services Inc.
T: 250-978-1317 [redacted] **F:** 250-361-4922
james.adams@bcferries.com
bcferries.com

ss. 15, 19

From: David Mietla <dmietla@3gamarine.com>
Sent: March 15, 2022 12:13 PM
To: Adams, James W <James.Adams@bcferries.com>
Cc: Shaun Wallis <swallis@3gamarine.com>
Subject: [EXTERNAL] Emergency cable report for LR

CAUTION: This email originated from outside of BC Ferries. Do not click links or open attachments unless you recognize the sender and know the content is safe.

Hi James,
Here is the report for LR as discussed. Please let me know if you have any questions or comments.

Thank you and kind regards,

David Mietla, P.Eng.
President
3GA Marine Ltd.
Cell: (250) 589 7404

Optimizing Solutions

Rasmussen, Shauna

From: Weigold, Andrew
Sent: April 19, 2022 10:12 AM
To: Adams, James; Meyer, Leslie A.; Seitz, Robert
Cc: Stahuliak, Marian; Bliss, Rick; Cennon, Quentin; Paterson, Bruce; Raduta, Captain Claudiu
Subject: RE: BSC Emergency spare cable
Attachments: SMD 01-2022 - South Guide Cable.docx

Hi,

I just spoke with Leslie and added a hard stop at 39kts. Pre consultations are not necessary.

Regards,

Andy Weigold
Sr. Master, Route 17, Salish Class
Sr. Master, Route 21, Baynes Sound Connector
British Columbia Ferry Services Inc.
1300 Ellenor Rd., Comox, BC, V9M 4B3
[redacted] ss. 15, 19
Andrew.Weigold@bcferries.com
bcferries.com

From: Adams, James W
Sent: April 14, 2022 4:13 PM
To: Meyer, Leslie A. ; Weigold, Andrew ; Seitz, Robert
Cc: Stahuliak, Marian ; Bliss, Rick ; Cennon, Quentin ; Paterson, Bruce ; Raduta, Captain Claudiu
Subject: RE: BSC Emergency spare cable

Thanks Leslie, see attached for one suggested edit in yellow.

The 39 knot sustained wind is a hard stop; no sailings should take place above this limit according to the 3GA report, which is based the 100 year storm condition.

Andy, what are thoughts on Leslie's comments in blue? Did you want to modify the weather matrix by creating a consultation window below 40knots? I don't believe this is required from an engineering perspective. Wave and current requirements remain the same for the new cable.

Thanks,

James Adams, P.Eng.
Project Manager, Terminal Construction
British Columbia Ferry Services Inc.
T: 250-978-1317 [redacted] **F:** 250-361-4922
james.adams@bcferries.com
bcferries.com ss. 15, 19

From: Meyer, Leslie A. <Leslie.Meyer@bcferries.com>
Sent: April 14, 2022 3:20 PM
To: Adams, James W <James.Adams@bcferries.com>; Weigold, Andrew <Andrew.Weigold@bcferries.com>; Seitz, Robert <Robert.Seitz@bcferries.com>
Cc: Stahuliak, Marian <Marian.Stahuliak@bcferries.com>; Bliss, Rick <Rick.Bliss@bcferries.com>; Cennon, Quentin <Quentin.Cennon@bcferries.com>; Paterson, Bruce <Bruce.Paterson@bcferries.com>; Raduta, Captain Claudiu <Claudiu.Raduta@bcferries.com>
Subject: RE: BSC Emergency spare cable

Thanks Andy and James.

James: I've revised the letter accordingly. Please review and confirm acceptability.

Also, can you confirm that the 39 knots sustained wind speed is a hard stop (i.e. cancel sailings) limit vs. a "consult with Supt/OSC" limit? For consistency (and efficiency for obtaining LR approval), suggest we incorporate similar language as the MTRB into the Sr Master Directive:

> **MTRB 14754**
> g. The cable ferry operates in compliance with the BC Ferries 'Heavy Weather Precautions Procedures for a Cable Ferry" and will initiate heavy weather precaution above 35 knots of sustained wind speed. Crossing will not be undertaken in sustained wind speed of more than 55 knots, significant wave height of more than 1.03 metres, or current of more than 1.9 knots;

While also incorporating the format of the existing heavy weather matrix.

So for example:

> The engineering analysis undertaken by 3GA Marine Consultants confirms the 1-1/2" diameter cable exceeds all safety requirements when the weather matrix is adjusted to 39knots. Due to the south guide cable strength we must reduce the weather matrix to a sustained wind strength of 39kts at Sisters Island land station.
>
> While the new cable type is in place, the following procedures apply:
>
> - Heavy weather precautions are to be initiated above 30 knots of sustained wind speed;
> - Consultation with OSC prior to sailing shall occur for sustained wind speed between xx – xx. [do these limits change for new cable type?];
> - Crossing will not be undertaken in sustained wind speed of more than 39 knots, or significant wave height of more than 1.0 metre [does wave height need to be amended for new cable type?];

Thanks,

Leslie Meyer
Regulatory & Policy Manager
British Columbia Ferry Services Inc.
T: 604-204-2212 [redacted]
leslie.meyer@bcferries.com
bcferries.com

ss. 15, 19

From: Adams, James W <James.Adams@bcferries.com>
Sent: April 14, 2022 2:02 PM
To: Weigold, Andrew <Andrew.Weigold@bcferries.com>; Meyer, Leslie A. <Leslie.Meyer@bcferries.com>; Seitz, Robert <Robert.Seitz@bcferries.com>
Cc: Stahuliak, Marian <Marian.Stahuliak@bcferries.com>; Bliss, Rick <Rick.Bliss@bcferries.com>; Cennon, Quentin <Quentin.Cennon@bcferries.com>; Paterson, Bruce <Bruce.Paterson@bcferries.com>; Raduta, Captain Claudiu

<Claudiu.Raduta@bcferries.com>
Subject: RE: BSC Emergency spare cable

Hi Leslie,

Further to my comments below, 3GA has confirmed their analysis covers both guide cables. This cable should not be used in the drive position though since the bull wheel liners are sized for a 1-5/8" dia cable.

As mentioned earlier, it may be difficult to find an equivalent "off the shelf cable" since the Northern Strands cable is constructed with the highest grade material available. Most off the shelf cables use a medium grade steel with a lower breaking strength.

Regards,

James Adams, P.Eng.
Project Manager, Terminal Construction
British Columbia Ferry Services Inc.
T: 250-978-1317 [redacted] **F:** 250-361-4922
james.adams@bcferries.com ss. 15, 19
bcferries.com

From: Weigold, Andrew <Andrew.Weigold@bcferries.com>
Sent: April 14, 2022 12:57 PM
To: Adams, James W <James.Adams@bcferries.com>; Meyer, Leslie A. <Leslie.Meyer@bcferries.com>; Seitz, Robert <Robert.Seitz@bcferries.com>
Cc: Stahuliak, Marian <Marian.Stahuliak@bcferries.com>; Bliss, Rick <Rick.Bliss@bcferries.com>; Cennon, Quentin <Quentin.Cennon@bcferries.com>; Paterson, Bruce <Bruce.Paterson@bcferries.com>; Raduta, Captain Claudiu <Claudiu.Raduta@bcferries.com>
Subject: RE: BSC Emergency spare cable

See directive for new cable attached

Andy Weigold
Sr. Master, Route 17, Salish Class
Sr. Master, Route 21, Baynes Sound Connector
British Columbia Ferry Services Inc.
1300 Ellenor Rd., Comox, BC, V9M 4B3
[redacted] ss. 15, 19
Andrew.Weigold@bcferries.com
bcferries.com

From: Adams, James W <James.Adams@bcferries.com>
Sent: April 14, 2022 10:25 AM
To: Weigold, Andrew <Andrew.Weigold@bcferries.com>; Meyer, Leslie A. <Leslie.Meyer@bcferries.com>; Seitz, Robert <Robert.Seitz@bcferries.com>
Cc: Stahuliak, Marian <Marian.Stahuliak@bcferries.com>; Bliss, Rick <Rick.Bliss@bcferries.com>; Cennon, Quentin <Quentin.Cennon@bcferries.com>; Paterson, Bruce <Bruce.Paterson@bcferries.com>
Subject: RE: BSC Emergency spare cable

Hi Andy,

See below for the directive:

What was the agreed wind speed: maximum sustained wind shall not exceed 20m/s [39 knots]
Current in-service cables: 1-5/8"diameter flattened strand steel cable with breaking strength of 285,000 lbs
Emergency spare cable: 1-1/2" diameter steel cable with breaking strength of 249,000 lbs
Note: The engineering analysis undertaken by 3GA Marine Consultants confirms the 1-1/2" diameter cable exceeds all safety requirements when the weather matrix is adjusted to 39knots.
Which cable is it going to replace: South guide cable
Is there anything special for crew to watch for? No, continue with standard visual inspections. LRTM will continue with the standard monitoring program.

Thanks,

James

James Adams, P.Eng.
Project Manager, Terminal Construction
British Columbia Ferry Services Inc.
T: 250-978-1317 [redacted] **F:** 250-361-4922
james.adams@bcferries.com
bcferries.com ss. 15, 19

From: Weigold, Andrew <Andrew.Weigold@bcferries.com>
Sent: April 14, 2022 9:35 AM
To: Adams, James W <James.Adams@bcferries.com>; Meyer, Leslie A. <Leslie.Meyer@bcferries.com>; Seitz, Robert <Robert.Seitz@bcferries.com>
Cc: Stahuliak, Marian <Marian.Stahuliak@bcferries.com>; Bliss, Rick <Rick.Bliss@bcferries.com>; Cennon, Quentin <Quentin.Cennon@bcferries.com>; Paterson, Bruce <Bruce.Paterson@bcferries.com>
Subject: RE: BSC Emergency spare cable

What was the agreed wind speed, what is new cable size vs. old, what is the difference in breaking strain, which cable is it going to replace, is there anything special for crew to watch for?

I'll use this info in the directive.

Regards,

Andy Weigold
Sr. Master, Route 17, Salish Class
Sr. Master, Route 21, Baynes Sound Connector
British Columbia Ferry Services Inc.
1300 Ellenor Rd., Comox, BC, V9M 4B3
[redacted] ss. 15, 19
Andrew.Weigold@bcferries.com
bcferries.com

From: Adams, James W <James.Adams@bcferries.com>
Sent: April 14, 2022 9:14 AM
To: Meyer, Leslie A. <Leslie.Meyer@bcferries.com>; Weigold, Andrew <Andrew.Weigold@bcferries.com>; Seitz, Robert <Robert.Seitz@bcferries.com>
Cc: Stahuliak, Marian <Marian.Stahuliak@bcferries.com>; Bliss, Rick <Rick.Bliss@bcferries.com>; Cennon, Quentin <Quentin.Cennon@bcferries.com>; Paterson, Bruce <Bruce.Paterson@bcferries.com>
Subject: RE: BSC Emergency spare cable

Hi Leslie,

Thanks again for preparing the letter to LR. See below in red for response to your comments.

It is mentioned in the letter that LR can contact you or myself for further questions. Can you please change the contact to Robert Seitz since this work is maintenance related.

Thanks,

James

James Adams, P.Eng.
Project Manager, Terminal Construction
British Columbia Ferry Services Inc.
T: 250-978-1317 [redacted] **F:** 250-361-4922
james.adams@bcferries.com ss. 15, 19
bcferries.com

From: Meyer, Leslie A. <Leslie.Meyer@bcferries.com>
Sent: April 13, 2022 4:24 PM
To: Adams, James W <James.Adams@bcferries.com>; Weigold, Andrew <Andrew.Weigold@bcferries.com>; Seitz, Robert <Robert.Seitz@bcferries.com>
Cc: Stahuliak, Marian <Marian.Stahuliak@bcferries.com>; Bliss, Rick <Rick.Bliss@bcferries.com>; Cennon, Quentin <Quentin.Cennon@bcferries.com>; Paterson, Bruce <Bruce.Paterson@bcferries.com>
Subject: RE: BSC Emergency spare cable

Hi James,

Thanks for organizing the meeting today.

I've amended the LR letter based on the discussion today and have attached for your review and comment. Will await your confirmation on the following before finalizing/submitting to LR:

1. Scope of the 3GA memo – does it cover one guide cable or both? (I see the Conclusion refers only to the "proposed Northern Strand", so perhaps it only covers a single cable?). The current revision of the LR letter does not specify the scope of the replacement, but we should modify it to align with the 3GA memo. JA: 3GA believes the analysis should cover both guide cables, though they are double checking their numbers and will provide a response today. This cable should not be used in the drive position since the bull wheel liners are sized for a 1-5/8" dia cable. It should also be noted that it may be difficult to find an equivalent "off the shelf cable" since the Northern Strands cable is constructed with the highest grade material available. Most off the shelf cables use a medium grade steel with a lower breaking strength.

2. Timing of Sr. Master's directive for heavy weather limitations – will this be ready in time to include in LR package (tomorrow or Tuesday), or should we proceed with the LR submission while the Directive is a work in progress? JA: Andy will provide a copy of the directive today.

Thanks,

Leslie Meyer
Regulatory & Policy Manager
British Columbia Ferry Services Inc.
T: 604-204-2212 [redacted]
ss. 15, 19

leslie.meyer@bcferries.com
bcferries.com

From: Adams, James W <James.Adams@bcferries.com>
Sent: April 12, 2022 11:37 AM
To: Weigold, Andrew <Andrew.Weigold@bcferries.com>; Seitz, Robert <Robert.Seitz@bcferries.com>
Cc: Stahuliak, Marian <Marian.Stahuliak@bcferries.com>; Bliss, Rick <Rick.Bliss@bcferries.com>; Meyer, Leslie A. <Leslie.Meyer@bcferries.com>; Cennon, Quentin <Quentin.Cennon@bcferries.com>; Paterson, Bruce <Bruce.Paterson@bcferries.com>
Subject: RE: BSC Emergency spare cable

Hi Rob,

Leslie has prepared the attached draft letter (MS Word) to Lloyds regarding the emergency spare cable. The letter is indented to reference the cable maintenance plan, which I understand is now scheduled for completion at the end of June. Unfortunately this creates a conflict since LRTM is currently scheduled to install the spare cable April 28th.

I'll arrange a group conf call to discuss how to finalize and submit the memo in advance of the cable install.

Andy – In terms of the heavy weather matrix, I understand your preference is to issue a directive indicating the heavy weather matrix has been modified for the emergency spare cable. We can discuss this further during the conf call.

Regards,

James Adams, P.Eng.
Project Manager, Terminal Construction
British Columbia Ferry Services Inc.
T: 250-978-1317 [redacted] **F:** 250-361-4922
james.adams@bcferries.com
bcferries.com
ss. 15, 19

From: Meyer, Leslie A. <Leslie.Meyer@bcferries.com>
Sent: April 04, 2022 10:19 AM
To: Adams, James W <James.Adams@bcferries.com>; Weigold, Andrew <Andrew.Weigold@bcferries.com>; Cennon, Quentin <Quentin.Cennon@bcferries.com>; Paterson, Bruce <Bruce.Paterson@bcferries.com>
Cc: Stahuliak, Marian <Marian.Stahuliak@bcferries.com>; Bliss, Rick <Rick.Bliss@bcferries.com>; Seitz, Robert <Robert.Seitz@bcferries.com>
Subject: RE: BSC Emergency spare cable

Morning James and all,

Attached is the draft LR letter for review and comment by the group. Since the proposal is to leave the new cable type installed for its lifespan (rather than a short term fix), I've proposed within the letter that the heavy weather matrix be amended and a copy included with the submission to LR:

https://sms.bcferries.corp/eFleetReader/eFleetPublishedDocuments/07.10.30.120G_HeavyWeatherFleetSummaryTable_FOM.pdf

Perhaps the "cancel sailing" threshold could be amended to the new limit with a footnote referencing the new cable type.

Thanks,

Leslie Meyer

Regulatory & Policy Manager
British Columbia Ferry Services Inc.
T: 604-204-2212 [redacted]
leslie.meyer@bcferries.com
bcferries.com ss. 15, 19

From: Adams, James W <James.Adams@bcferries.com>
Sent: March 28, 2022 5:36 PM
To: Weigold, Andrew <Andrew.Weigold@bcferries.com>; Meyer, Leslie A. <Leslie.Meyer@bcferries.com>; Cennon, Quentin <Quentin.Cennon@bcferries.com>; Paterson, Bruce <Bruce.Paterson@bcferries.com>
Cc: Stahuliak, Marian <Marian.Stahuliak@bcferries.com>; Bliss, Rick <Rick.Bliss@bcferries.com>; Seitz, Robert <Robert.Seitz@bcferries.com>
Subject: RE: BSC Emergency spare cable

Hi Leslie, Bruce, and Quentin,

Please note the following summary and action items from today's meeting regarding the emergency spare cable for the BSC:

- It is anticipated that the emergency spare cable may require installation as soon as late-April 2022, pending future condition assessments on the in-service cables. If the cable were installed, the weather matrix would require an adjustment restricting sailings above 40knot sustained winds. The cable would likely remain in service for 12 or more months and would be subject to standard inspections as per the cable maintenance plan.
- Leslie to prepare draft letter to Lloyds referencing the 3GA "engineering" memo and cable maintenance plan to be prepared to LRTM. Draft letter to be prepared by mid-April
- Quentin to prepare draft cable maintenance plan document by mid-April. (Keep in mind the OSL action is due April 4)
- James to brief Andy that the VSM will may require a revision to the Heavy Weather Matrix if the emergency spare cable is installed. James/Quentin to keep Andy posted with potential installation timeline.

Please let me know if you have any questions or concerns with the above.

Thanks everyone for your input and support.

James

James Adams, P.Eng.
Project Manager, Terminal Construction
British Columbia Ferry Services Inc.
T: 250-978-1317 [redacted] **F:** 250-361-4922
james.adams@bcferries.com
bcferries.com ss. 15, 19

From: Adams, James W
Sent: March 23, 2022 5:37 PM
To: Weigold, Andrew <Andrew.Weigold@bcferries.com>; Meyer, Leslie A. <Leslie.Meyer@bcferries.com>; Cennon, Quentin <Quentin.Cennon@bcferries.com>; Seitz, Robert <Robert.Seitz@bcferries.com>; Paterson, Bruce <Bruce.Paterson@bcferries.com>
Cc: Stahuliak, Marian <Marian.Stahuliak@bcferries.com>
Subject: RE: Emergency cable report for LR (Draft)

Thanks Andy, this will be reviewed further early next week.

James Adams, P.Eng.
Project Manager, Terminal Construction
British Columbia Ferry Services Inc.
T: 250-978-1317 [redacted] **F:** 250-361-4922
james.adams@bcferries.com
bcferries.com ss. 15, 19

From: Weigold, Andrew <Andrew.Weigold@bcferries.com>
Sent: March 23, 2022 2:37 PM
To: Adams, James W <James.Adams@bcferries.com>; Meyer, Leslie A. <Leslie.Meyer@bcferries.com>; Cennon, Quentin <Quentin.Cennon@bcferries.com>; Seitz, Robert <Robert.Seitz@bcferries.com>; Paterson, Bruce <Bruce.Paterson@bcferries.com>
Cc: Stahuliak, Marian <Marian.Stahuliak@bcferries.com>
Subject: RE: Emergency cable report for LR (Draft)

Written policy is required its the duty of operational supervisor to report limitations to duty superintendents as they are responsible for the entire coast so they can't keep the details for every vessel. If it's temporary I can create a directive and vessel staff would inform duty super of the temporary limitation directive if conditions were met.

Andy

Sent with BlackBerry Work
(www.blackberry.com)

From: Adams, James W <James.Adams@bcferries.com>
Date: Wednesday, Mar 23, 2022, 1:25 PM
To: Meyer, Leslie A. <Leslie.Meyer@bcferries.com>, Cennon, Quentin <Quentin.Cennon@bcferries.com>, Seitz, Robert <Robert.Seitz@bcferries.com>, Paterson, Bruce <Bruce.Paterson@bcferries.com>
Cc: Stahuliak, Marian <Marian.Stahuliak@bcferries.com>, Weigold, Andrew <Andrew.Weigold@bcferries.com>
Subject: RE: Emergency cable report for LR (Draft)

Hi Leslie,

Sorry for the late reply. I'll arrange a conf call with the group to discuss next steps.

I'm not sure if anyone else has any comments regarding the 3GA report?

The Heavy Weather Matrix currently requires a consult with the duty Superintendent above 40 knots. The report indicates no sailings can take place above this limit if the emergency spare cable is installed. I'm not sure if it is sufficient for the Superintendent to simply be aware of this limitation or if written procedures are required.

I'll provide you with additional information on the timeline for the replacement cables.

Regards,

James Adams, P.Eng.
Project Manager, Terminal Construction
British Columbia Ferry Services Inc.
T: 250-978-1317 [redacted] **F:** 250-361-4922
james.adams@bcferries.com
bcferries.com ss. 15, 19

From: Meyer, Leslie A. <Leslie.Meyer@bcferries.com>
Sent: March 21, 2022 2:01 PM
To: Adams, James W <James.Adams@bcferries.com>; Cennon, Quentin <Quentin.Cennon@bcferries.com>; Seitz, Robert <Robert.Seitz@bcferries.com>; Paterson, Bruce <Bruce.Paterson@bcferries.com>
Cc: Stahuliak, Marian <Marian.Stahuliak@bcferries.com>
Subject: RE: Emergency cable report for LR (Draft)

Hi James,

My question would be whether the vessel's Heavy Weather Matrix and cable maintenance plan will be updated to reflect the stipulations imposed by this report?

In terms of submission, I can assist with sending the finalized report on to LR. I've attached the LR conversation from the Dec 2019 cable change. In that case, we requested LR to issue a letter of no objection for our records. That would be helpful this time around too, especially as we prepare to submit the revised collision bulkhead/double bottom MTRB. In that case, I'd ask you to provide some additional context around the timeline for procurement and replacement of the cable.

Thanks,

Leslie Meyer
Regulatory & Policy Manager
British Columbia Ferry Services Inc.
T: 604-204-2212 ss. 15, 19 [redacted]
leslie.meyer@bcferries.com
bcferries.com

From: Adams, James W <James.Adams@bcferries.com>
Sent: March 15, 2022 6:16 PM
To: Cennon, Quentin <Quentin.Cennon@bcferries.com>; Seitz, Robert <Robert.Seitz@bcferries.com>; Paterson, Bruce <Bruce.Paterson@bcferries.com>; Meyer, Leslie A. <Leslie.Meyer@bcferries.com>
Cc: Stahuliak, Marian <Marian.Stahuliak@bcferries.com>
Subject: FW: Emergency cable report for LR (Draft)

All,

Attached is the draft memo for LR submission regarding temporary use of the emergency spare cable. Can you please review and let me know if you have any questions?

I'll be back in the office next week and will review the memo then.

Bruce or Leslie – How did you want to proceed with the submission to LR once we have finalized the report?

Thanks,

James

James Adams, P.Eng.
Project Manager, Terminal Construction
British Columbia Ferry Services Inc.
T: 250-978-1317 [redacted] **F:** 250-361-4922
james.adams@bcferries.com
bcferries.com

ss. 15, 19

From: David Mietla <dmietla@3gamarine.com>
Sent: March 15, 2022 12:13 PM
To: Adams, James W <James.Adams@bcferries.com>
Cc: Shaun Wallis <swallis@3gamarine.com>
Subject: [EXTERNAL] Emergency cable report for LR

Hi James,
Here is the report for LR as discussed. Please let me know if you have any questions or comments.

Thank you and kind regards,

David Mietla, P.Eng.
President
3GA Marine Ltd.
Cell: (250) 589 7404

3GA MARINE

Optimizing Solutions

BCFerries

British Columbia Ferry Services Inc.
Suite 500, 1321 Blanshard St.
Victoria, BC V8W 0B7

Tel (250) 381-1401

bcferries.com

April 19, 2022

Reza Zargham
Area Operations Manager
Lloyd's Register Canada Limited
221 West Esplanade, Suite 502
North Vancouver, British Columbia V7M 3J3
Reza.zargham@lr.org

File: BSC-0340

Dear Sir:

Re: BAYNES SOUND CONNECTOR – Request for Lloyd's Register "Letter of No Objection" for Proposed New Replacement Cable Type in Accordance with MTRB M14754

BC Ferries requests Lloyd's Register's review and support of a proposed new cable type to be used as a replacement cable for the BAYNES SOUND CONNECTOR (BSC).

The current steel cables, replaced in 2019, are wearing faster than those from original construction due to the lack of protective plastic coating.[1] Given the ongoing global supply chain issues, BCF anticipates that the current cables will need to be replaced before identical replacements can be procured, and has therefore had to source an alternative cable type that is available within the required timeframe.

The attached memorandum from 3GA Marine Ltd. outlines the specifications of the new cable type and provides an analysis to conclude that the cable is suitable for use on the vessel in the guide position only, provided that stated mitigations are in place. To address these limitations, BCF will employ the following:

1) Amendment to the vessel's Heavy Weather procedures by way of a Senior Master's Directive outlining the sailing restrictions in accordance with the 3GA Memo while the new cable type is in use; and

2) Continuation of the inspection and maintenance routine, including:
   a. Weekly visual inspection;
   b. Quarterly electromagnetic testing; and
   c. Periodic tension monitoring

Although wire rope cables are not normally a Class Survey item, they are covered in the vessel's subdivision MTRB, and so are subject to Class/Statutory oversight:

> ***MTRB 14754***
> *e. The cable ferry working mechanism, cable rope sizes/specifications, design loads, safety factors, maintenance plans and replacement schedule of cables* ***are approved by the RO****. BC Ferries' cable maintenance plan is to involve placing a new cable into the drive position annually until such time as a duty cycle can be established for the vessel's route. Subject to cable condition, used drive cables may be utilized in the guide cable positions for two (2) years*

When the cables were first replaced in 2019, LR reviewed the specifications for the new cable type and issued a 'Letter of No Objection' referencing the MTRB (see attached).

[1] The original plastic valley-filled cables from construction were replaced with all-steel cables in 2019 due to environmental issues with plastic shedding.

Most urgently, it is anticipated that the South guide cable will need to be replaced in late April 2022 pending results of the quarterly NDT cable report, and so replacement has proactively been planned for April 27-28, 2022. Once the new cable type is installed, the intent is for it to remain in place for its lifespan in order for BCF to collect data and determine suitability of the cable type for long term use.

It may also become necessary to replace the North guide cable in the near future, and 3GA has confirmed that the analysis covers both guide cables, provided that an equivalent second cable can be sourced. However, it is currently anticipated that the original Flattened Strand cable will be delivered before the North guide cable requires replacement.

The new cable type will not be used in the drive position.

We request that LR review the information for the new cable type as presented in this package and issue a 'Letter of No Objection' to support continuity of the existing MTRB decision.

Please address the Letter of No Objection to the following:

Mr. Stephen Jones, Executive Director, Engineering
British Columbia Ferry Services Inc.
Suite 500 – 1321 Blanshard Street, Victoria BC V8W 0B7

Should you have any questions or require further clarification, please contact me or Mr. Rob Seitz, Director Terminal Maintenance, at [redacted]

ss. 15, 19

For British Columbia Ferry Services Inc.,

s. 22

[redacted]

Regulatory & Policy Manager, BC Ferries

Cc: Richard Chern, Senior Surveyor, Lloyd's Register
Bruce Paterson, Director, Naval Architecture
Rob Seitz, Director Terminal Maintenance, BCF
Greg Peterson, Director Engineering Services, BCF
Marian Stahuliak, Engineering Superintendent, BCF
Claudiu Raduta, Marine Superintendent, BCF
James Adams, Project Manager, Terminal Construction, BCF

Attachments:
3GA Memo: Baynes Sound Connector Temporary Cable Replacement Analysis
Senior Master's Directive re: Heavy Weather limitations
MTRB 14754
LR 2019 Letter of No Objection

208-1497 Admirals Rd
Victoria, BC V9A 2P8
Canada
+1 250 920 9992
+1 250 483 6301

MEMORANDUM

To: James Adams, P.Eng. Project Manager, British Columbia Ferry Services Inc.
From: David Mietla, P.Eng. President, 3GA Marine Ltd.
Prepared By: Shaun Wallis, EIT Marine Systems Engineer, 3GA Marine Ltd.
Date: 2022-03-09
RE: Baynes Sound Connector Temporary Cable Replacement Analysis for LR Review

EGBC PERMIT TO PRACTICE No.
1001132

The Baynes Sound Connector was originally designed to run on three 1-5/8" plastic valley filled ropes with a breaking strength of 263,925 lbs. Due to environmental issues with the plastic valley filled ropes, in 2019 BC ferries started transitioning their ropes to all steel cables. The current ropes have a diameter of 1-5/8", a 285,000lbs breaking strength and a 6x25B flattened strand construction. They are finished with a proprietary Bezinal 3000 (95% zinc, 5% aluminum) coating similar to galvanization.

As the new ropes do not have the plastic protection, they are wearing faster then before. s. 13 [redacted]
s. 13 There are also several factors contributing to procurement issues including, the requirement for an extremely long continuous strand, an uncommon rope diameter, and global supply chain issues. Therefor, BC Ferries was required to look for alternative ropes that can be procured within the required timeframe and will not sacrifice vessel performance or safety.

3GA's analysis is to determine whether the proposed rope meets the operational requirements of the vessel.

Rope Strength Requirements

EYE, during the design of this vessel, performed a computational study to determine the required cable strengths. The results of this study have been included in Table 1.

Table 1: EYE report Table 8-2 shows the maximum loads predicted during the Time Domain Analysis

	Maximum Load kN	Factor of Safety	Minimum Breaking Strength Required kN
Pretension	196	5.0	980
100 Year Storm	429.4	2.0	859
Worst Operation 55 knots	571.7	2.0	1143
Damaged	691	1.33	919

For further details on how these values were determined, refer to the EYE report "Dynamic analysis of cable ferry system Buckley Bay to Denman Island, February 2013".

Analysis: Northern Strands Wire Rope

Diameter: 1-1/2", breaking strength: 249,000lbs, 6XF125, supplied length: 10,000'
Lubricant: Dry, Finish: galvanized, Lay: Right Lang

The proposed rope has a 1-1/2" diameter opposed to the current 1-5/8". 3GA does not expect any issues using a 1.5" cable. However, the sheave grooves are designed for 1-5/8" cable. The smaller cable may be subject to additional vibrations, potentially leading to excess noise and accelerated wear. BC ferries must continue executing quarterly inspections specifically looking for signs of accelerated wear, and any other unforeseen issues, caused by the reduced diameter. This information will be critical for future decision making. BC ferries will subject this rope to the same rejection criteria, already in place, for the existing ropes.

The EYE analysis during the "worst operation 55knots" condition determined a maximum load on the rope as 128,523 lbs (571.7 kN). The original plastic valley rope used for this vessel had a breaking strength of 263,925 lbs (1174 kN). This resulted as a 2.05 safety factor. This 1.5" rope has a minimum breaking strength of 249,000 lbs (1107.6 kN), which leads to a safety factor of 1.94. The EYE report required a safety factor of 2; this rope does not meet the EYE requirements for the "worst operation 55 knots" condition.

The EYE analysis also analysed a "100-year storm condition" which determined the maximum load when the vessel is subjected to 39 Knot winds, opposed to 55 Knots. For this condition, the maximum load on the rope is 96,533 lbs (429.4 kN). The proposed 1.5" rope has a minimum breaking strength of 249,000 lbs (1107.6 kN) which leads to a safety factor of 2.58. If BC ferries Limits their operational profile, to environmental conditions below the 100-year storm conditions, described in the EYE report, this rope is acceptable for use.

EYE has also specified a damage case with a max load of 155,342lbs (691kN) and a SF of 1.33. The proposed rope achieves a SF of 1.6 in this condition.

The EYE requirements were calculated using computational fluid dynamics software. As a result, there is no way for 3GA to validate the results. We do not have access to the software or the run files. Furthermore, we do not know the assumptions made, scenarios analysed, Or relative tensions on the ropes. 3GA only has access to the published results for max breaking load provided in the report. There is no way to explore alternative scenarios and conditions within their framework.

During the 2021 propulsion system upgrade, 3GA developed our own model to determine tensions in the cable. This model does not calculate the maximum load on the rope, like the EYE model, but is used to create a matrix of allowable pre-tensions, given a known cable strength. This model can be used to determine the operational parameters required to allow for one or all the cable(s) to be changed to this proposed 1.5" rope. Furthermore, the model uses a safety factor of 3 compared to 2, used for the EYE Analysis.

For additional confidence in this analysis, 3GA performed spot checks, using our model, to assure the cable will still have a reasonable range of allowable tensions. The spot checks were performed for the scenario where the north cable is replaced with this 1.5" cable. When setting both guide cables to 14 tonnes, there was no change in the allowable drive cable tensions. When setting the north cable to 14 tonnes and the south to 12 the range of allowable drive cable tensions went from 7.75-15.25 Tonnes to 11.25 -15.25 Tonnes. When setting the north cable to 12 tonnes and the south to 14 tonnes the allowable drive cable tensions remained unchanged. These results are shown in Table 2.

Table 2: Tension Matrix Spot Checks

Proposed Rope			
	South 14 Tonnes		
	T_d Min	Drift	Min SF
	T_d Max	Drift	Min SF
North 14 Tonnes*	7.5	92.32	3.4
	15.75	81.7	3.07
	South 12 Tonnes		
	T_d Min	Drift	Min SF
	T_d Max	Drift	Min SF
North 14 Tonnes*	11.25	94.26	3.04
	15.25	85.3	3.01
	South 14 Tonnes		
	T_d Min	Drift	Min SF
	T_d Max	Drift	Min SF
North 12 Tonnes*	7.75	96.16	3
	15.25	85.28	3.02
*North Wire strength 249,000lbs			

Current Rope			
	South 14 Tonnes		
	T_d Min	Drift	Min SF
	T_d Max	Drift	Min SF
North 14 Tonnes	7.50	92.3	3.88
	15.75	81.6	3.07
	South 12 Tonnes		
	T_d Min	Drift	Min SF
	T_d Max	Drift	Min SF
North 14 Tonnes	7.75	96.1	3.01
	15.25	85.4	3.01
	South 14 Tonnes		
	T_d Min	Drift	Min SF
	T_d Max	Drift	Min SF
North 12 Tonnes	7.75	96.1	3.01
	15.25	85.4	3.01

This further confirms the ferry will be able to safely operate with the proposed cable installed, under the 100-year storm condition. It also shows it is best when the pretensions in all three cables are similar.

The lay of this rope is regular opposed to Lang. Lang lay ropes are known to have a large fatigue resistance rating and robust resistance against abrasion. However, for this application the difference in lay is likely negligible.

This rope is galvanized, so it will be more resistant to corrosion caused by the environment, compared to bare wire. The current rope is coated with a proprietary Bezinal 3000 (95% zinc, 5% aluminum) coating. The manufacturer, Briden, claims this product is far superior to standard hot dipped galvanization, but this is only a claim from the manufacturer. 3GA is not aware of any 3rd party reviews of these claims.

s. 17, s. 21, s. 13

[redacted]

Conclusion

From the information provided in EYE's report and our own independent calculations, 3GA Marine ltd. has determined the proposed Northern Strands 1-1/2" rope, with a breaking strength of 249,000lbs, is acceptable for use on the Baynes Sound Connector. However, the BC Ferries must change its operational profile to limit sailing to the "100-year storm" conditions outlined in the EYE report.

3GA does not expect any issues using a 1.5" cable. However, the sheave grooves are designed for 1-5/8" cable. The smaller cable may be subject to additional vibrations, potentially leading to excess noise and accelerated wear. BC ferries must continue executing quarterly inspections.

BCFerries

SMD 01-2022

Date April 28, 2022

To OSC, Duty Duperintendents Lead Operators & Operators

Subject South Guide Cable (39kt Sustained at Sisters Island Land Station Limitation)

A non-destructive cable test has determined that the south guide cable is no longer sufficient for use. The cable was 1-5/8″ diameter with a 285,000 lb breaking strength. The Cable has been replaced with a 1-1/2″ diameter cable with a 249,000 lb breaking strength.

The engineering analysis undertaken by 3GA Marine Consultants confirms the 1-1/2″ diameter cable exceeds all safety requirements when the weather matrix is adjusted to 39knots. Due to the south guide cable strength we must reduce the weather matrix to a sustained wind strength of 39kts at Sisters Island land station.

Do not sail in sustained winds exceeding 39kts at Sisters Island land station

In the event a cable parts, here are some notes to be aware of;

1. Crew and passengers are not in danger, the cable will drop away to the sea floor. It may be loud as it runs out the sheaves however there is no risk of the cable coming up to the deck level.
2. The vessel is safe to operate on two cables. Both guide cables are redundant, meaning they add a safety factor. When running on two cables inform OSC who will have Dock 2000 or a suitable vessel on standby to assist if additional situation arrises.
3. When a cable parts, complete the voyage, discharge passengers and stop service. Carry out a hull inspection with the rescue boat and commence an OSC conference. The conference will determine what actions are required to continue operating on 2 cables.

Regards,

Andy Weigold
Snr. Master, Baynes Sound Connector
ss. 15, 19 British Columbia Ferry Services Inc.
1300 Ellenor Rd., Comox, BC, V9M 4B3
[redacted]
Andrew.Weigold@bcferries.com
bcferries.com

	A Watch	B Watch	C Watch	Relief	Relief	Relief
Lead Op.						
Operator						

Transport Canada
Safety and Security

Transports Canada
Sécurité et sûreté

Marine Safety Directorate
330 Sparks Street
Ottawa, Ontario K1A 0N8

Direction générale de la sécurité maritime
330, rue Sparks
Ottawa (Ontario) K1A 0N8

Marine Technical Review Board Decision / Décision du Bureau d'examen technique en matière maritime

Applicant: **Demandeur :**	BRITISH COLUMBIA FERRY SERVICES INC.
Board Decision No.: **N° de la décision du Bureau :**	M14754
Vessel Name: **Nom du bâtiment :**	BAYNES SOUND CONNECTOR
Official Number: **N° matricule :**	839270
Effective Date: **Date d'effet** :	
Expiry Date:	Valid for life of vessel
Date d'expiration :	Durée de vie du bâtiment

This Marine Technical Review Board Decision authorizes BRITISH COLUMBIA FERRY SERVICES INC. as the authorized representative of the BAYNES SOUND CONNECTOR, to fulfill its obligations under paragraph 106(1)(a) of the *Canada Shipping Act, 2001*, in a manner that does not comply with sections (C.R.C., c. 1431) of Hull Construction Regulations, if:

Cette décision du Bureau d'examen technique en matière maritime autorise BRITISH COLUMBIA FERRY SERVICES INC. en sa capacité de représentant autorisé du BAYNES SOUND CONNECTOR à exécuter ses obligations en vertu de l'alinéa 106(1)a) de la *Loi de 2001 sur la marine marchande du Canada* d'une façon non conforme aux articles (C.R.C., c. 1431) du Règlement sur la construction de coques, si :

CONDITIONS

Please see RDIMS document #12257638 MTRB-BETMM - FINAL CONDITIONS-CONDITIONS FINALE - M14754- BAYNES SOUND CONNECTOR - HULL CONSTRUCTION REGULATIONS- RÈGLEMENT SUR LA CONSTRUCTION DE COQUES

Veuillez voir le document RDIMS #12257638 MTRB-BETMM - FINAL CONDITIONS-CONDITIONS FINALE - M14754- BAYNES SOUND CONNECTOR - HULL CONSTRUCTION REGULATIONS- RÈGLEMENT SUR LA CONSTRUCTION DE COQUES

Note: This Marine Technical Review Board Decision in no way reduces the vessel's, the applicant's or any other person's responsibility to comply with any other requirements of the *Canada Shipping Act, 2001* and regulations made under it that are not specifically addressed in this decision.

Note : La présente décision du Bureau d'examen technique en matière maritime n'exempte en aucune façon le bâtiment, le demandeur ou toute autre personne de l'observation des autres exigences de la *Loi de 2001 sur la marine marchande du Canada* et de ses règlements qui ne sont pas citées explicitement dans cette décision.

s. 22 [redacted]

s. 22 [redacted] Naim Nazha
Chair of the MTRB
Président du BETMM

FINAL CONDITIONS FOR BAYNES SOUND CONNECTOR #M14754	CONDITIONS FINALES POUR BAYNES SOUND CONNECTOR N^{O} M14754
a. The operational profile of the cable ferry remains the same and runs in the sheltered waters between Buckley Bay and Denman Island service;	a. Le profil de fonctionnement du traversier à câble demeure le même et consiste en les eaux abritées séparant la baie Buckley et l'île Denman.
b. The ferry complies with two (2) compartment subdivision stability criteria of the standards TP 10943, and of the bottom damage requirements of SOLAS regulations II-1/9.8 for area not fitted with a double-bottom, based on the Centre of Gravity and Lightship displacement values determined in accordance with the MTRB Decision #M139290 for all loading conditions;	b. Le traversier est conforme aux deux (2) critères de stabilité de la norme TP 10943, pour ce qui est du compartimentage, ainsi qu'aux exigences d'endommagement du fond de la section II-1/9.8 de la SOLAS, en ce qui concerne les parties ne comportant aucun double-fond, si l'on se base sur les valeurs relatives au déplacement de bateau-feu et au centre de gravité qui ont été déterminées conformément à la décision du BETMM n^{o} M139290 pour toutes les conditions de charge.
c. A Letter of Maximum Subdivision Draft is issued by the Recognized Organization specifying the maximum drafts that will comply with the subdivision standards stated in condition b).	c. L'organisme reconnu doit présenter une lettre de tirant d'eau de compartimentage maximal, dans laquelle il indique les tirants d'eau maximaux conformes aux normes de la condition b).
d. The Design methodology and numerical analysis, the Baynes Sound Environmental Characterization Study (Roddan Engineering LTD., Nov 2012) and all other relevant documents are reviewed and accepted by the RO;	d. L'organisme reconnu a étudié et accepté la méthode de conception, l'analyse numérique, l'étude de caractérisation environnementale du détroit de Baynes (Roddan Engineering LTD., nov. 2012), ainsi que tous les autres documents pertinents.
e. The cable ferry working mechanism, cable rope sizes/specifications, design loads, safety factors, maintenance plans and replacement schedule of cables are approved by the RO. BC Ferries' cable maintenance plan is to involve placing a new cable into the drive position annually until such time as a duty cycle can be established for the vessel's route. Subject to cable condition, used drive cables may be utilized in the guide cable positions for two (2) years;	e. L'organisme reconnu approuve le mécanisme de fonctionnement, la taille et les spécifications du câble, les charges nominales, les facteurs de sécurité, les plans d'entretien et le calendrier de remplacement de câble du traversier. Le plan d'entretien de câble de BC Ferries doit prévoir l'installation annuelle d'un nouveau câble à la position d'entraînement, et ce, jusqu'à ce qu'un nouveau cycle d'utilisation puisse être établi pour le circuit du traversier. Les câbles d'entraînement usagés pourront être installés aux positions de câble de guidage pendant deux (2) ans, selon leur état.
f. The vessel is instrumented to monitor and record dynamic motions and cable tensions. Six months	f. Le traversier comporte des instruments conçus pour surveiller et enregistrer les mouvements dynamiques

after the entry in service of the vessel, the authorized representative will submit to the Recognized Organization and Transport Canada an analysis of the motions, loads and related wind and weather conditions with an updated heavy weather matrix.	et les tensions que le câble subit. Un représentant autorisé devra présenter à l'organisme reconnu et à Transports Canada une analyse des mouvements, des charges et des conditions éoliennes et météorologiques, ainsi qu'une matrice des mauvaises conditions météorologiques, après six mois d'exploitation du traversier.
g. The cable ferry operates in compliance with the BC Ferries 'Heavy Weather Precautions Procedures for a Cable Ferry" and will initiate heavy weather precaution above 35 knots of sustained wind speed. Crossing will not be undertaken in sustained wind speed of more than 55 knots, significant wave height of more than 1.03 metres, or current of more than 1.9 knots;	g. Le traversier à câble est exploité conformément aux précautions de BC Ferries relatives à l'exploitation d'un traversier à câble lorsque les conditions météorologiques sont mauvaises (Heavy Weather Precautions Procedures for a Cable Ferry), lesquelles doivent être prises par un vent soutenu supérieur à 35 noeuds. Il ne devra pas être exploité si un vent soutenu souffle à plus de 55 noeuds, si les vagues atteignent plus de 1,03 m et si le courant se chiffre à plus de 1,9 nœud.
h. Crossing is not undertaken when the cable tension exceeds the approved design loads limits. A record of measured cable tension is maintained and provided to TCMSS on request;	h. Le traversier à câble n'est pas exploité si la tension exercée sur le câble dépasse les limites de charges nominales approuvées. Un dossier de mesure de la tension exercée sur le câble est tenu à jour et présenté sur demande à SSMTC;
i. The anchor is sized according to the Equipment Numeral as required by the Classification Rules of the Recognized Organization;	i. La taille de l'ancre est conforme au numéral de l'équipement et aux règles de classification de l'organisme reconnu;
j. Operational / emergency procedures are developed in case of cable system malfunction and incorporated in the Safety Management System (SMS). Crew training and simulation are carried on a periodical basis as per the procedures;	j. Des procédures d'exploitation et d'urgence relatives à une défaillance du système de câble sont élaborées et intégrées au système de gestion de la sécurité. L'équipage suit une formation et participe à des simulations périodiquement et conformément aux procédures pertinentes;
k. Operational readiness with regards to deployment of the anchor is demonstrated. Procedures are incorporated in the Safety Management System (SMS) with regards to periodical crew training and deployment;	k. Une préparation au jet de l'ancre est démontrée. Des procédures de formation de l'équipage et de participation de ce dernier à des exercices sont intégrées au système de gestion de la sécurité;
l. Trials are performed to measure the stopping capability of the ferry. The information is	l. Des essais sont exécutés pour évaluer la capacité d'immobilisation du traversier. Les données d'essai

incorporated in the vessel documentation and made available to the Master;	font partie du ou des documents relatifs au bâtiment et sont présentées au capitaine;
m. The vessel operates / loads vehicle and passengers in accordance with the conditions contained in the approved Loading Manual;	m. L'exploitation du traversier et l'embarquement de véhicules et de passagers à son bord sont conformes aux conditions figurant dans le manuel d'embarquement approuvé;
n. The vessel is fitted with permanent tug mooring arrangement;	n. Le traversier comporte des amarres de remorquage permanents;
o. The vessel meets the fire protection requirements as set out in Part III of the Transport Canada Equivalent Standards for Fire Protection of Passenger Ships (TP 2237E);	o. Le traversier est conforme aux exigences de protection contre les incendies figurant dans la partie III des *Normes équivalentes de protection contre l'incendie des navires à passagers* de Transports Canada (Equivalent Standards for Fire Protection of Passenger Ships - TP 2237E);
p. In addition to the applicable requirements of the Fire Detection and Extinguishing Equipment Regulations for Class E vessels, the vessel is: i. fitted with a water mist fixed fire suppression system, approved as equivalent to a pressure water-spraying system meeting the requirements of Schedule III of the Fire Detection and Extinguishing Equipment Regulations, in the machinery spaces; ii. fitted with a water mist fixed fire suppression system, approved as equivalent to an automatic sprinkler system meeting the requirements if Schedule VI of the Fire Detection and Extinguishing Equipment Regulations, in the crew space and passenger lounge; and iii. fitted with an automated fire monitor system to cover the vehicle deck;	p. Le traversier est conforme aux exigences pertinentes figurant dans le *Règlement sur le matériel de détection et d'extinction d'incendie* en ce qui concerne les bâtiments de classe E, mais il comporte également : i. dans la tranche des machines, un système fixe d'extinction d'incendie par brouillard d'eau qui a été approuvé comme l'équivalent d'un système de projection d'eau sous pression conforme aux exigences de l'annexe III du *Règlement sur le matériel de détection et d'extinction d'incendie*; ii. dans le ou les locaux de l'équipage et le salon des passagers, un système fixe d'extinction d'incendie par brouillard d'eau qui a été approuvé comme l'équivalent d'un extincteur automatique conforme aux exigences de l'annexe VI du *Règlement sur le matériel de détection et d'extinction d'incendie*; iii. un système automatisé de surveillance des incendies sur le pont des véhicules.
q. In addition to the requirements of the Life Saving Equipment Regulations for Class VII vessels, the vessel is:	q. Le traversier est conforme aux exigences du *Règlement sur l'équipement de sauvetage* visant les bâtiments de classe VII, mais il comporte également :

i. fitted with two Marine Evacuation System (MES) stations each with a capacity sufficient for 100% of the persons on board; and	i. deux postes d'évacuation maritime d'une capacité équivalant à 100 % des personnes à bord;
ii. fitted with an approved emergency boat meeting the requirement of Schedule VII of the Life Saving Equipment Regulations. The emergency boat is installed under a launching device meeting the requirements of Schedule IX of the Life Saving Equipment Regulations..	ii. un bateau d'urgence approuvé qui est conforme à l'exigence figurant à l'annexe VII du *Règlement sur l'équipement de sauvetage* et qui a été installé sous un dispositif de mise à l'eau conforme aux exigences de l'annexe IX dudit règlement.

Lloyd's Register
Marine

Lloyd's Register Canada Limited

502-221 West Esplanade
North Vancouver
BC
Canada, V7M 3J3

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E ben.thompson@lr.org
http:\\www.lr.org

Frank Camaraire
Executive Director, Engineering
Operations Division
British Columbia Ferry Services Inc.
Suite 500 – 1321 Blanshard Street, Victoria,
British Columbia, V8W 0B7

04 December 2019

Dear Frank,

MEMORANDUM Ref. No.19057 is referred.
Considering condition “e” of the MTRB 14754, this is to confirm that Lloyds Register will have no objection to the proposed wire rope replacement detailed in aforementioned Memorandum, to be used on BAYNES SOUND CONNECTOR (BSC) -, provided all other conditions in MTRB 14754 are followed.

s. 22

Yours sincerely[redacted]

Reza Zargham [redacted]

Operation Man[redacted]ca

LRCL Vancouver Office.

Working together for a safer world

Rasmussen, Shauna

From:	Meyer, Leslie A.
Sent:	April 19, 2022 4:47 PM
To:	Reza Zargham (reza.zargham@lr.org)
Cc:	Richard Chern (richard.chern@lr.org); Paterson, Bruce; Seitz, Robert; Peterson, Greg; Stahuliak, Marian; Raduta, Captain Claudiu; Adams, James W
Subject:	BAYNES SOUND CONNECTOR Proposal for new cable type - LR approval requested
Attachments:	20220328_LRLtr-BSC_ReplacementCable-Apr2022-FINAL-pkg.pdf

Hello Reza,

Please find attached a letter and information package outlining a proposed new cable type for BAYNES SOUND CONNECTOR. In order to enable continuity of condition "e" of the vessel's existing subdivision MTRB, BCF requests LR to review the information provided and indicate approval of the new cable by way of issuing a "letter of no objection".

Urgency: cable change out is tentatively planned for April 27-28, 2022.

Thank you,

Leslie Meyer
Regulatory & Policy Manager
Engineering Services
British Columbia Ferry Services Inc.
12800 Rice Mill Road, Richmond, BC, V6W 1A1
T: 604-204-2212 [redacted]
leslie.meyer@bcferries.com ss. 15, 19
bcferries.com | **Facebook** | **Twitter**

Rasmussen, Shauna

From: Adams, James W
Sent: April 27, 2022 1:07 PM
To: Meyer, Leslie A.; Seitz, Robert; Weigold, Andrew
Cc: Stahuliak, Marian; Raduta, Captain Claudiu; Cennon, Quentin; Parsons, Alex; Paterson, Bruce
Subject: RE: BAYNES SOUND CONNECTOR Proposal for new cable type - LR approval requested
Attachments: BSCLetter of No Objection RZ .pdf

Importance: High

Hi Rob,

Lloyds called me today asking for an update on the three conditions listed in the attached no-objections letter regarding the emergency spare cable. They are aware the cable is being installed tonight and have requested confirmation that the three conditions are being met.

Leslie is submitting a response to LR with documentation on items #1 and #3. Please advise the status of item #2 - Implementation of the new maintenance regime.

Thanks,

James

James Adams, P.Eng.
Project Manager, Terminal Construction
British Columbia Ferry Services Inc.
T: 250-978-1317 [redacted] **F:** 250-361-4922
james.adams@bcferries.com
bcferries.com

ss. 15, 19

From: Adams, James W
Sent: April 22, 2022 5:08 PM
To: Meyer, Leslie A. ; Seitz, Robert ; Weigold, Andrew
Cc: Stahuliak, Marian ; Raduta, Captain Claudiu ; Cennon, Quentin (Quentin.Cennon@bcferries.com) ; Parsons, Alex ; Paterson, Bruce
Subject: RE: BAYNES SOUND CONNECTOR Proposal for new cable type - LR approval requested

Hi Leslie,

Thanks again for your efforts getting the letter of no objection from LR. See attached for the cable test certificates as per LR requirement item #1. It is interested to note that the engineering review is based on minimum rated strength, which is why the operational matrix was reduced to 39knots; however, the break test exceeded the minimum load requirement for the 55knot storm scenario. While we still need to enforce the 39knot operational sailing matrix, this provides confidence that the cable remains safe despite having a smaller outer diameter.

Rob will need to confirm item #2 - Implementation of the maintenance regime. It should be noted that LRTM is currently reviewing an option that may allow for continued use of the load cell on the south cable. This may allow LRTM to maintain the existing maintenance regime.

Andy will need to confirm item #3 – new operational matrix is implemented.

Regards,

James

James Adams, P.Eng.
Project Manager, Terminal Construction
British Columbia Ferry Services Inc.
T: 250-978-1317 [redacted] **F:** 250-361-4922
james.adams@bcferries.com
bcferries.com

ss. 15, 19

From: Paterson, Bruce <Bruce.Paterson@bcferries.com>
Sent: April 22, 2022 4:11 PM
To: Meyer, Leslie A. <Leslie.Meyer@bcferries.com>; Adams, James W <James.Adams@bcferries.com>
Cc: Seitz, Robert <Robert.Seitz@bcferries.com>; Stahuliak, Marian <Marian.Stahuliak@bcferries.com>; Raduta, Captain Claudiu <Claudiu.Raduta@bcferries.com>; Weigold, Andrew <Andrew.Weigold@bcferries.com>
Subject: RE: BAYNES SOUND CONNECTOR Proposal for new cable type - LR approval requested

It might be better for Andy to confirm the operational conditions.

Bruce Paterson, P.Eng, M.Eng
Director, Naval Architecture, Engineering British Columbia Ferry Services Inc.
Tel: (250) 978-1385
[redacted]
Fax: (250) 978-1166
bruce.paterson@bcferries.com
www.bcferries.com
Safety and Operational Readiness

ss. 15, 19

From: Meyer, Leslie A. <Leslie.Meyer@bcferries.com>
Sent: April 22,2022 3:25 PM
To: Adams, James W <James.Adams@bcferries.com>
Cc: Paterson, Bruce <Bruce.Paterson@bcferries.com>; Seitz, Robert <Robert.Seitz@bcferries.com>; Stahuliak, Marian <Marian.Stahuliak@bcferries.com>; Raduta, Captain Claudiu <Claudiu.Raduta@bcferries.com>; Weigold, Andrew <Andrew.Weigold@bcferries.com>
Subject: FW: BAYNES SOUND CONNECTOR Proposal for new cable type - LR approval requested

Hi James,

Are you able to provide the info to confirm that the three conditions within the attached letter have been met once the new cable is installed? Do you have the certificates for the new cable that we can pass along to LR for their review?

Thank you,

Leslie Meyer
Regulatory & Policy Manager
British Columbia Ferry Services Inc.
T: 604-204-2212 [redacted]
leslie.meyer@bcferries.com
bcferries.com

ss. 15, 19

From: Zargham, Reza <Reza.Zargham@lr.org>
Sent: April 21, 2022 12:47 PM
To: Meyer, Leslie A. <Leslie.Meyer@bcferries.com>
Cc: Chern, Richard <richard.chern@lr.org>; Paterson, Bruce <Bruce.Paterson@bcferries.com>; Seitz, Robert <Robert.Seitz@bcferries.com>; Peterson, Greg <Greg.Peterson@bcferries.com>; Stahuliak, Marian <Marian.Stahuliak@bcferries.com>; Raduta, Captain Claudiu <Claudiu.Raduta@bcferries.com>; Adams, James W <James.Adams@bcferries.com>
Subject: [EXTERNAL] RE: BAYNES SOUND CONNECTOR Proposal for new cable type - LR approval requested

Hi Leslie,
A confirmation email covering the 3 points should be sufficient.

Kind regards,
Reza

Reza Zargham, Lloyds Register
Area Operations Manager - West of Canada and USA (NAW) , Marine & Offshore
T +1 604 985 0477 D +1 604 982 2124 M +1 604 857 3206 E reza.zargham@lr.org
Lloyds Register Canada Limited, 502-221 West Esplanade, North Vancouver, BC V7M 3J3, Canada
Visit www.lr.org or follow us on: LinkedIn Facebook Twitter

From: Meyer, Leslie A. <Leslie.Meyer@bcferries.com>
Sent: Thursday, 21 April, 2022 12:28 PM
To: Zargham, Reza <Reza.Zargham@lr.org>
Cc: Chern, Richard <richard.chern@lr.org>; Paterson, Bruce <Bruce.Paterson@bcferries.com>; Seitz, Robert <Robert.Seitz@bcferries.com>; Peterson, Greg <Greg.Peterson@bcferries.com>; Stahuliak, Marian <Marian.Stahuliak@bcferries.com>; Raduta, Captain Claudiu <Claudiu.Raduta@bcferries.com>; Adams, James W <James.Adams@bcferries.com>
Subject: RE: BAYNES SOUND CONNECTOR Proposal for new cable type - LR approval requested

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Many thanks, Reza; appreciate the quick turnaround on this.

Can you confirm whether LR requires any further information from BCF in order to fulfill the three conditions mentioned in the letter?

Thank you,

Leslie Meyer
Regulatory & Policy Manager
British Columbia Ferry Services Inc.
T: 604-204-2212 [redacted]
leslie.meyer@bcferries.com
bcferries.com

ss. 15, 19

From: Zargham, Reza <Reza.Zargham@lr.org>
Sent: April 21, 2022 11:56 AM
To: Meyer, Leslie A. <Leslie.Meyer@bcferries.com>
Cc: Chern, Richard <richard.chern@lr.org>; Paterson, Bruce <Bruce.Paterson@bcferries.com>; Seitz, Robert <Robert.Seitz@bcferries.com>; Peterson, Greg <Greg.Peterson@bcferries.com>; Stahuliak, Marian <Marian.Stahuliak@bcferries.com>; Raduta, Captain Claudiu <Claudiu.Raduta@bcferries.com>; Adams, James W <James.Adams@bcferries.com>
Subject: [EXTERNAL] RE: BAYNES SOUND CONNECTOR Proposal for new cable type - LR approval requested

CAUTION: This email originated from outside of BC Ferries. Do not click links or open attachments unless you recognize the sender and know the content is safe.

Hi Lesley,
Please see attached Letter of No Objection issued for BAYNES SOUND CONNECTOR.

Kind regards,
Reza

Reza Zargham, Lloyds Register
Area Operations Manager - West of Canada and USA (NAW) , Marine & Offshore
T +1 604 985 0477 D +1 604 982 2124 M +1 604 857 3206 E reza.zargham@lr.org
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Visit www.lr.org or follow us on: LinkedIn Facebook Twitter

From: Meyer, Leslie A. <Leslie.Meyer@bcferries.com>
Sent: Tuesday, 19 April, 2022 4:47 PM
To: Zargham, Reza <Reza.Zargham@lr.org>
Cc: Chern, Richard <richard.chern@lr.org>; Paterson, Bruce <Bruce.Paterson@bcferries.com>; Seitz, Robert <Robert.Seitz@bcferries.com>; Peterson, Greg <Greg.Peterson@bcferries.com>; Stahuliak, Marian <Marian.Stahuliak@bcferries.com>; Raduta, Captain Claudiu <Claudiu.Raduta@bcferries.com>; Adams, James W <James.Adams@bcferries.com>
Subject: BAYNES SOUND CONNECTOR Proposal for new cable type - LR approval requested

***** THIS IS AN EXTERNAL EMAIL:** do not click any links or open any attachments unless you trust the sender and know the content is safe. ***

Hello Reza,

Please find attached a letter and information package outlining a proposed new cable type for BAYNES SOUND CONNECTOR. In order to enable continuity of condition "e" of the vessel's existing subdivision MTRB, BCF requests LR to review the information provided and indicate approval of the new cable by way of issuing a "letter of no objection".

Urgency: cable change out is tentatively planned for April 27-28, 2022.

Thank you,

Leslie Meyer
Regulatory & Policy Manager
Engineering Services
British Columbia Ferry Services Inc.
12800 Rice Mill Road, Richmond, BC, V6W 1A1
T: 604-204-2212 [redacted] ss. 15, 19
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bcferries.com | Facebook | Twitter

Rasmussen, Shauna

From:	Meyer, Leslie A.
Sent:	April 29, 2022 11:20 AM
To:	Seitz, Robert
Cc:	Paterson, Bruce; Peterson, Greg; Stahuliak, Marian; Raduta, Captain Claudiu; Adams, James; Weigold, Andrew
Subject:	RE: BAYNES SOUND CONNECTOR Proposal for new cable type - LR approval requested
Attachments:	BSCLetter of No Objection RZ .pdf

Thanks, Rob; I'll confirm back to LR that the new cable will follow the same maintenance plan as existing cables (as stated in our application).

Do you have an ETA on when the written maintenance plan might be finalized? That's the key missing piece for our application to revise the conditions in MTRB 14745. Since the LR letter specifically requires that the MTRB conditions are followed, there is some urgency to revise the MTRB to ensure that the conditions are in line with our current practice.

Thank you,

Leslie Meyer
Regulatory & Policy Manager
British Columbia Ferry Services Inc.
T: 604-204-2212 [redacted]
leslie.meyer@bcferries.com
bcferries.com

ss. 15, 19

From: Seitz, Robert
Sent: April 28, 2022 9:33 PM
To: Meyer, Leslie A.
Cc: Paterson, Bruce ; Peterson, Greg ; Stahuliak, Marian ; Raduta, Captain Claudiu ; Adams, James W ; Weigold, Andrew
Subject: RE: BAYNES SOUND CONNECTOR Proposal for new cable type - LR approval requested

Hi Leslie,

There is no "new maintenance regime" as Reza's letter states. We will continue to maintain the new cable as we maintain all cables as your letter stated.

Unless I am missing something that we agreed to do differently?

Regards,
Rob

Rob Seitz, P.Eng
Director, Terminal Maintenance
British Columbia Ferry Services Inc.
T: 250-978-1268 [redacted] **F:** 250-361-4922

ss. 15, 19

From: Meyer, Leslie A. <Leslie.Meyer@bcferries.com>
Sent: April 27, 2022 1:07 PM
To: Zargham, Reza <Reza.Zargham@lr.org>

Cc: Chern, Richard <richard.chern@lr.org>; Paterson, Bruce <Bruce.Paterson@bcferries.com>; Seitz, Robert <Robert.Seitz@bcferries.com>; Peterson, Greg <Greg.Peterson@bcferries.com>; Stahuliak, Marian <Marian.Stahuliak@bcferries.com>; Raduta, Captain Claudiu <Claudiu.Raduta@bcferries.com>; Adams, James W <James.Adams@bcferries.com>; Weigold, Andrew <Andrew.Weigold@bcferries.com>
Subject: RE: BAYNES SOUND CONNECTOR Proposal for new cable type - LR approval requested

Hello Reza, Richard;

In reference to the three conditions in the Letter of No Objection, please find attached the certificates for the new cable type. Additionally, the Senior Master has confirmed that the new operational matrix has been implemented. We are just waiting for confirmation from our maintenance team that the new cable has been incorporated into the maintenance regime, at which point I will follow up with you again to confirm.

Regards,

Leslie Meyer
Regulatory & Policy Manager
British Columbia Ferry Services Inc.
T: 604-204-2212 [redacted]
leslie.meyer@bcferries.com
bcferries.com

ss. 15, 19

From: Zargham, Reza <Reza.Zargham@lr.org>
Sent: April 21, 2022 12:47 PM
To: Meyer, Leslie A. <Leslie.Meyer@bcferries.com>
Cc: Chern, Richard <richard.chern@lr.org>; Paterson, Bruce <Bruce.Paterson@bcferries.com>; Seitz, Robert <Robert.Seitz@bcferries.com>; Peterson, Greg <Greg.Peterson@bcferries.com>; Stahuliak, Marian <Marian.Stahuliak@bcferries.com>; Raduta, Captain Claudiu <Claudiu.Raduta@bcferries.com>; Adams, James W <James.Adams@bcferries.com>
Subject: [EXTERNAL] RE: BAYNES SOUND CONNECTOR Proposal for new cable type - LR approval requested

Hi Leslie,
A confirmation email covering the 3 points should be sufficient.

Kind regards,
Reza

Reza Zargham, Lloyds Register
Area Operations Manager - West of Canada and USA (NAW) , Marine & Offshore
T +1 604 985 0477 D +1 604 982 2124 M +1 604 857 3206 E reza.zargham@lr.org
Lloyds Register Canada Limited, 502-221 West Esplanade, North Vancouver, BC V7M 3J3, Canada
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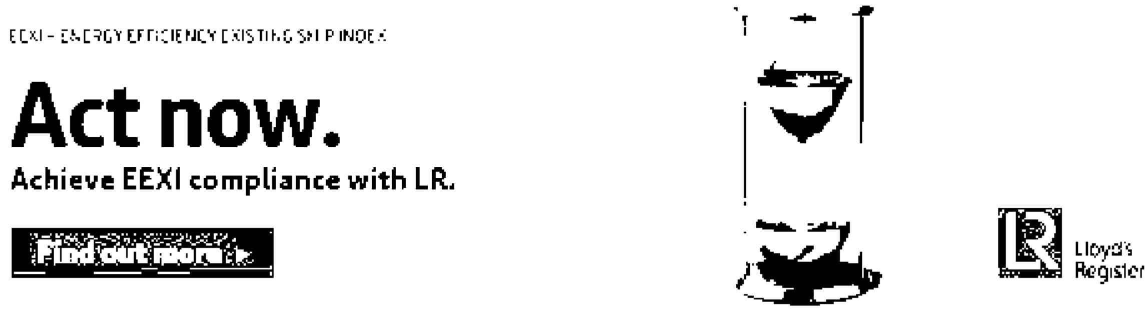

From: Meyer, Leslie A. <Leslie.Meyer@bcferries.com>
Sent: Thursday, 21 April, 2022 12:28 PM
To: Zargham, Reza <Reza.Zargham@lr.org>
Cc: Chern, Richard <richard.chern@lr.org>; Paterson, Bruce <Bruce.Paterson@bcferries.com>; Seitz, Robert <Robert.Seitz@bcferries.com>; Peterson, Greg <Greg.Peterson@bcferries.com>; Stahuliak, Marian <Marian.Stahuliak@bcferries.com>; Raduta, Captain Claudiu <Claudiu.Raduta@bcferries.com>; Adams, James W <James.Adams@bcferries.com>
Subject: RE: BAYNES SOUND CONNECTOR Proposal for new cable type - LR approval requested

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Many thanks, Reza; appreciate the quick turnaround on this.

Can you confirm whether LR requires any further information from BCF in order to fulfill the three conditions mentioned in the letter?

Thank you,

Leslie Meyer
Regulatory & Policy Manager
British Columbia Ferry Services Inc.
T: 604-204-2212 [redacted]
leslie.meyer@bcferries.com
bcferries.com

ss. 15, 19

From: Zargham, Reza <Reza.Zargham@lr.org>
Sent: April 21, 2022 11:56 AM
To: Meyer, Leslie A. <Leslie.Meyer@bcferries.com>
Cc: Chern, Richard <richard.chern@lr.org>; Paterson, Bruce <Bruce.Paterson@bcferries.com>; Seitz, Robert <Robert.Seitz@bcferries.com>; Peterson, Greg <Greg.Peterson@bcferries.com>; Stahuliak, Marian <Marian.Stahuliak@bcferries.com>; Raduta, Captain Claudiu <Claudiu.Raduta@bcferries.com>; Adams, James W <James.Adams@bcferries.com>
Subject: [EXTERNAL] RE: BAYNES SOUND CONNECTOR Proposal for new cable type - LR approval requested

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Hi Lesley,
Please see attached Letter of No Objection issued for BAYNES SOUND CONNECTOR.

Kind regards,
Reza

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From: Meyer, Leslie A. <Leslie.Meyer@bcferries.com>
Sent: Tuesday, 19 April, 2022 4:47 PM
To: Zargham, Reza <Reza.Zargham@lr.org>
Cc: Chern, Richard <richard.chern@lr.org>; Paterson, Bruce <Bruce.Paterson@bcferries.com>; Seitz, Robert <Robert.Seitz@bcferries.com>; Peterson, Greg <Greg.Peterson@bcferries.com>; Stahuliak, Marian <Marian.Stahuliak@bcferries.com>; Raduta, Captain Claudiu <Claudiu.Raduta@bcferries.com>; Adams, James W <James.Adams@bcferries.com>
Subject: BAYNES SOUND CONNECTOR Proposal for new cable type - LR approval requested

Hello Reza,

Please find attached a letter and information package outlining a proposed new cable type for BAYNES SOUND CONNECTOR. In order to enable continuity of condition "e" of the vessel's existing subdivision MTRB, BCF requests LR to review the information provided and indicate approval of the new cable by way of issuing a "letter of no objection".

Urgency: cable change out is tentatively planned for April 27-28, 2022.

Thank you,

Leslie Meyer
Regulatory & Policy Manager
Engineering Services
British Columbia Ferry Services Inc.
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T: 604-204-2212 [redacted] ss. 15, 19
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bcferries.com | **Facebook** | **Twitter**

From:	Zargham, Reza <Reza.Zargham@lr.org>
Sent:	May 02, 2022 1:54 PM
To:	Meyer, Leslie A.
Cc:	Chern, Richard; Paterson, Bruce; Seitz, Robert; Stahuliak, Marian; Raduta, Captain Claudiu; Adams, James W; Weigold, Andrew
Subject:	[EXTERNAL] RE: BAYNES SOUND CONNECTOR Proposal for new cable type - LR approval requested

Thanks Leslie,

Kind regards,
Reza

From: Meyer, Leslie A. <Leslie.Meyer@bcferries.com>
Sent: Friday, 29 April, 2022 11:22 AM
To: Zargham, Reza <Reza.Zargham@lr.org>
Cc: Chern, Richard <richard.chern@lr.org>; Paterson, Bruce <Bruce.Paterson@bcferries.com>; Seitz, Robert <Robert.Seitz@bcferries.com>; Stahuliak, Marian <Marian.Stahuliak@bcferries.com>; Raduta, Captain Claudiu <Claudiu.Raduta@bcferries.com>; Adams, James W <James.Adams@bcferries.com>; Weigold, Andrew <Andrew.Weigold@bcferries.com>
Subject: RE: BAYNES SOUND CONNECTOR Proposal for new cable type - LR approval requested

Hello Reza,

Please be advised that "condition 2" is now confirmed – the new cable type is incorporated into the same maintenance regime as the existing cables.

Kind regards,

Leslie Meyer
Regulatory & Policy Manager
British Columbia Ferry Services Inc.
T: 604-204-2212 [redacted]
leslie.meyer@bcferries.com
bcferries.com

ss. 15, 19

From: Zargham, Reza <Reza.Zargham@lr.org>
Sent: April 27, 2022 2:16 PM
To: Meyer, Leslie A. <Leslie.Meyer@bcferries.com>
Cc: Chern, Richard <richard.chern@lr.org>; Paterson, Bruce <Bruce.Paterson@bcferries.com>; Seitz, Robert

<Robert.Seitz@bcferries.com>; Peterson, Greg <Greg.Peterson@bcferries.com>; Stahuliak, Marian <Marian.Stahuliak@bcferries.com>; Raduta, Captain Claudiu <Claudiu.Raduta@bcferries.com>; Adams, James W <James.Adams@bcferries.com>; Weigold, Andrew <Andrew.Weigold@bcferries.com>
Subject: [EXTERNAL] RE: BAYNES SOUND CONNECTOR Proposal for new cable type - LR approval requested

Thanks Leslie,

Kind regards,
Reza

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From: Meyer, Leslie A. <Leslie.Meyer@bcferries.com>
Sent: Wednesday, 27 April, 2022 1:07 PM
To: Zargham, Reza <Reza.Zargham@lr.org>
Cc: Chern, Richard <richard.chern@lr.org>; Paterson, Bruce <Bruce.Paterson@bcferries.com>; Seitz, Robert <Robert.Seitz@bcferries.com>; Peterson, Greg <Greg.Peterson@bcferries.com>; Stahuliak, Marian <Marian.Stahuliak@bcferries.com>; Raduta, Captain Claudiu <Claudiu.Raduta@bcferries.com>; Adams, James W <James.Adams@bcferries.com>; Weigold, Andrew <Andrew.Weigold@bcferries.com>
Subject: RE: BAYNES SOUND CONNECTOR Proposal for new cable type - LR approval requested

Hello Reza, Richard;

In reference to the three conditions in the Letter of No Objection, please find attached the certificates for the new cable type. Additionally, the Senior Master has confirmed that the new operational matrix has been implemented. We are just waiting for confirmation from our maintenance team that the new cable has been incorporated into the maintenance regime, at which point I will follow up with you again to confirm.

Regards,

Leslie Meyer
Regulatory & Policy Manager
British Columbia Ferry Services Inc.
T: 604-204-2212 [redacted]
leslie.meyer@bcferries.com
bcferries.com

ss. 15, 19

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Thank you,

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Subject: [EXTERNAL] RE: BAYNES SOUND CONNECTOR Proposal for new cable type - LR approval requested

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Urgency: cable change out is tentatively planned for April 27-28, 2022.

Thank you,

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Engineering Services
British Columbia Ferry Services Inc.
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T: 604-204-2212 [redacted]
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Transport Canada
Safety and Security

Transports Canada
Sécurité et sûreté

Marine Safety Directorate
330 Sparks Street
Ottawa, Ontario K1A 0N8

Direction générale de la sécurité maritime
330, rue Sparks
Ottawa (Ontario) K1A 0N8

Marine Technical Review Board Decision / Décision du Bureau d'examen technique en matière maritime

Applicant: **Demandeur :**	BRITISH COLUMBIA FERRY SERVICES INC.
Board Decision No.: **N° de la décision du Bureau :**	M14754
Vessel Name: **Nom du bâtiment :**	BAYNES SOUND CONNECTOR
Official Number: **N° matricule :**	839270
Effective Date: **Date d'effet :**	
Expiry Date:	Valid for life of vessel
Date d'expiration :	Durée de vie du bâtiment

This Marine Technical Review Board Decision authorizes BRITISH COLUMBIA FERRY SERVICES INC. as the authorized representative of the BAYNES SOUND CONNECTOR, to fulfill its obligations under paragraph 106(1)(a) of the *Canada Shipping Act, 2001*, in a manner that does not comply with sections (C.R.C., c. 1431) of Hull Construction Regulations, if:

Cette décision du Bureau d'examen technique en matière maritime autorise BRITISH COLUMBIA FERRY SERVICES INC. en sa capacité de représentant autorisé du BAYNES SOUND CONNECTOR à exécuter ses obligations en vertu de l'alinéa 106(1)a) de la *Loi de 2001 sur la marine marchande du Canada* d'une façon non conforme aux articles (C.R.C., c. 1431) du Règlement sur la construction de coques, si :

CONDITIONS

Please see RDIMS document #12257638 MTRB-BETMM - FINAL CONDITIONS-CONDITIONS FINALE - M14754- BAYNES SOUND CONNECTOR - HULL CONSTRUCTION REGULATIONS-RÈGLEMENT SUR LA CONSTRUCTION DE COQUES

Veuillez voir le document RDIMS #12257638 MTRB-BETMM - FINAL CONDITIONS-CONDITIONS FINALE - M14754- BAYNES SOUND CONNECTOR - HULL CONSTRUCTION REGULATIONS-RÈGLEMENT SUR LA CONSTRUCTION DE COQUES

Note: This Marine Technical Review Board Decision in no way reduces the vessel's, the applicant's or any other person's responsibility to comply with any other requirements of the *Canada Shipping Act, 2001* and regulations made under it that are not specifically addressed in this decision.

Note : La présente décision du Bureau d'examen technique en matière maritime n'exempte en aucune façon le bâtiment, le demandeur ou toute autre personne de l'observation des autres exigences de la *Loi de 2001 sur la marine marchande du Canada* et de ses règlements qui ne sont pas citées explicitement dans cette décision.

s. 22 [redacted]

s. 22 [redacted] Naim Nazha
Chair of the MTRB
Président du BETMM

FINAL CONDITIONS FOR BAYNES SOUND CONNECTOR #M14754	CONDITIONS FINALES POUR BAYNES SOUND CONNECTOR N^{O} M14754
a. The operational profile of the cable ferry remains the same and runs in the sheltered waters between Buckley Bay and Denman Island service;	a. Le profil de fonctionnement du traversier à câble demeure le même et consiste en les eaux abritées séparant la baie Buckley et l'île Denman.
b. The ferry complies with two (2) compartment subdivision stability criteria of the standards TP 10943, and of the bottom damage requirements of SOLAS regulations II-1/9.8 for area not fitted with a double-bottom, based on the Centre of Gravity and Lightship displacement values determined in accordance with the MTRB Decision #M139290 for all loading conditions;	b. Le traversier est conforme aux deux (2) critères de stabilité de la norme TP 10943, pour ce qui est du compartimentage, ainsi qu'aux exigences d'endommagement du fond de la section II-1/9.8 de la SOLAS, en ce qui concerne les parties ne comportant aucun double-fond, si l'on se base sur les valeurs relatives au déplacement de bateau-feu et au centre de gravité qui ont été déterminées conformément à la décision du BETMM n^{o} M139290 pour toutes les conditions de charge.
c. A Letter of Maximum Subdivision Draft is issued by the Recognized Organization specifying the maximum drafts that will comply with the subdivision standards stated in condition b).	c. L'organisme reconnu doit présenter une lettre de tirant d'eau de compartimentage maximal, dans laquelle il indique les tirants d'eau maximaux conformes aux normes de la condition b).
d. The Design methodology and numerical analysis, the Baynes Sound Environmental Characterization Study (Roddan Engineering LTD., Nov 2012) and all other relevant documents are reviewed and accepted by the RO;	d. L'organisme reconnu a étudié et accepté la méthode de conception, l'analyse numérique, l'étude de caractérisation environnementale du détroit de Baynes (Roddan Engineering LTD., nov. 2012), ainsi que tous les autres documents pertinents.
e. The cable ferry working mechanism, cable rope sizes/specifications, design loads, safety factors, maintenance plans and replacement schedule of cables are approved by the RO. BC Ferries' cable maintenance plan is to involve placing a new cable into the drive position annually until such time as a duty cycle can be established for the vessel's route. Subject to cable condition, used drive cables may be utilized in the guide cable positions for two (2) years;	e. L'organisme reconnu approuve le mécanisme de fonctionnement, la taille et les spécifications du câble, les charges nominales, les facteurs de sécurité, les plans d'entretien et le calendrier de remplacement de câble du traversier. Le plan d'entretien de câble de BC Ferries doit prévoir l'installation annuelle d'un nouveau câble à la position d'entraînement, et ce, jusqu'à ce qu'un nouveau cycle d'utilisation puisse être établi pour le circuit du traversier. Les câbles d'entraînement usagés pourront être installés aux positions de câble de guidage pendant deux (2) ans, selon leur état.
f. The vessel is instrumented to monitor and record dynamic motions and cable tensions. Six months	f. Le traversier comporte des instruments conçus pour surveiller et enregistrer les mouvements dynamiques

after the entry in service of the vessel, the authorized representative will submit to the Recognized Organization and Transport Canada an analysis of the motions, loads and related wind and weather conditions with an updated heavy weather matrix.	et les tensions que le câble subit. Un représentant autorisé devra présenter à l'organisme reconnu et à Transports Canada une analyse des mouvements, des charges et des conditions éoliennes et météorologiques, ainsi qu'une matrice des mauvaises conditions météorologiques, après six mois d'exploitation du traversier.
g. The cable ferry operates in compliance with the BC Ferries 'Heavy Weather Precautions Procedures for a Cable Ferry" and will initiate heavy weather precaution above 35 knots of sustained wind speed. Crossing will not be undertaken in sustained wind speed of more than 55 knots, significant wave height of more than 1.03 metres, or current of more than 1.9 knots;	g. Le traversier à câble est exploité conformément aux précautions de BC Ferries relatives à l'exploitation d'un traversier à câble lorsque les conditions météorologiques sont mauvaises (Heavy Weather Precautions Procedures for a Cable Ferry), lesquelles doivent être prises par un vent soutenu supérieur à 35 noeuds. Il ne devra pas être exploité si un vent soutenu souffle à plus de 55 noeuds, si les vagues atteignent plus de 1,03 m et si le courant se chiffre à plus de 1,9 nœud.
h. Crossing is not undertaken when the cable tension exceeds the approved design loads limits. A record of measured cable tension is maintained and provided to TCMSS on request;	h. Le traversier à câble n'est pas exploité si la tension exercée sur le câble dépasse les limites de charges nominales approuvées. Un dossier de mesure de la tension exercée sur le câble est tenu à jour et présenté sur demande à SSMTC;
i. The anchor is sized according to the Equipment Numeral as required by the Classification Rules of the Recognized Organization;	i. La taille de l'ancre est conforme au numéral de l'équipement et aux règles de classification de l'organisme reconnu;
j. Operational / emergency procedures are developed in case of cable system malfunction and incorporated in the Safety Management System (SMS). Crew training and simulation are carried on a periodical basis as per the procedures;	j. Des procédures d'exploitation et d'urgence relatives à une défaillance du système de câble sont élaborées et intégrées au système de gestion de la sécurité. L'équipage suit une formation et participe à des simulations périodiquement et conformément aux procédures pertinentes;
k. Operational readiness with regards to deployment of the anchor is demonstrated. Procedures are incorporated in the Safety Management System (SMS) with regards to periodical crew training and deployment;	k. Une préparation au jet de l'ancre est démontrée. Des procédures de formation de l'équipage et de participation de ce dernier à des exercices sont intégrées au système de gestion de la sécurité;
l. Trials are performed to measure the stopping capability of the ferry. The information is	l. Des essais sont exécutés pour évaluer la capacité d'immobilisation du traversier. Les données d'essai

incorporated in the vessel documentation and made available to the Master;	font partie du ou des documents relatifs au bâtiment et sont présentées au capitaine;
m. The vessel operates / loads vehicle and passengers in accordance with the conditions contained in the approved Loading Manual;	m. L'exploitation du traversier et l'embarquement de véhicules et de passagers à son bord sont conformes aux conditions figurant dans le manuel d'embarquement approuvé;
n. The vessel is fitted with permanent tug mooring arrangement;	n. Le traversier comporte des amarres de remorquage permanents;
o. The vessel meets the fire protection requirements as set out in Part III of the Transport Canada Equivalent Standards for Fire Protection of Passenger Ships (TP 2237E);	o. Le traversier est conforme aux exigences de protection contre les incendies figurant dans la partie III des *Normes équivalentes de protection contre l'incendie des navires à passagers* de Transports Canada (Equivalent Standards for Fire Protection of Passenger Ships - TP 2237E);
p. In addition to the applicable requirements of the Fire Detection and Extinguishing Equipment Regulations for Class E vessels, the vessel is: i. fitted with a water mist fixed fire suppression system, approved as equivalent to a pressure water-spraying system meeting the requirements of Schedule III of the Fire Detection and Extinguishing Equipment Regulations, in the machinery spaces; ii. fitted with a water mist fixed fire suppression system, approved as equivalent to an automatic sprinkler system meeting the requirements if Schedule VI of the Fire Detection and Extinguishing Equipment Regulations, in the crew space and passenger lounge; and iii. fitted with an automated fire monitor system to cover the vehicle deck;	p. Le traversier est conforme aux exigences pertinentes figurant dans le *Règlement sur le matériel de détection et d'extinction d'incendie* en ce qui concerne les bâtiments de classe E, mais il comporte également : i. dans la tranche des machines, un système fixe d'extinction d'incendie par brouillard d'eau qui a été approuvé comme l'équivalent d'un système de projection d'eau sous pression conforme aux exigences de l'annexe III du *Règlement sur le matériel de détection et d'extinction d'incendie*; ii. dans le ou les locaux de l'équipage et le salon des passagers, un système fixe d'extinction d'incendie par brouillard d'eau qui a été approuvé comme l'équivalent d'un extincteur automatique conforme aux exigences de l'annexe VI du *Règlement sur le matériel de détection et d'extinction d'incendie*; iii. un système automatisé de surveillance des incendies sur le pont des véhicules.
q. In addition to the requirements of the Life Saving Equipment Regulations for Class VII vessels, the vessel is:	q. Le traversier est conforme aux exigences du *Règlement sur l'équipement de sauvetage* visant les bâtiments de classe VII, mais il comporte également :

i. fitted with two Marine Evacuation System (MES) stations each with a capacity sufficient for 100% of the persons on board; and	i. deux postes d'évacuation maritime d'une capacité équivalant à 100 % des personnes à bord;
ii. fitted with an approved emergency boat meeting the requirement of Schedule VII of the Life Saving Equipment Regulations. The emergency boat is installed under a launching device meeting the requirements of Schedule IX of the Life Saving Equipment Regulations..	ii. un bateau d'urgence approuvé qui est conforme à l'exigence figurant à l'annexe VII du *Règlement sur l'équipement de sauvetage* et qui a été installé sous un dispositif de mise à l'eau conforme aux exigences de l'annexe IX dudit règlement.

Transport Canada | Transports Canada
Safety and Security | **Sécurité et sûreté**

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330, rue Sparks

Ottawa (Ontario) K1A 0N8

Your file
Votre référence

Our file
Notre référence

Classification 8562-19633

BRITISH COLUMBIA FERRY SERVICES INC.
SUITE 500 - 1321 BLANSHARD ST.
VICTORIA, BRITISH COLUMBIA
V8W 0B7

SUBJECT:
BAYNES SOUND CONNECTOR
MARINE TECHNICAL REVIEW BOARD DECISION NO. M14754

Further to your request to the Marine Technical Review Board (MTRB) regarding the application of the (C.R.C., c. 1431) of Hull Construction Regulations for BAYNES SOUND CONNECTOR, please be advised that the MTRB has granted your request subject to the conditions outlined in the enclosed Record of Decision.

Please keep a copy of this Record of Decision on board of the vessel and for future reference. This Record of Decision will also be made available to the public in a manner that the Chair of the MTRB considers appropriate.

OBJET :
BAYNES SOUND CONNECTOR
DÉCISION N^O M14754 DU BUREAU D'EXAMEN TECHNIQUE EN MATIÈRE MARITIME

Comme suite à votre demande adressée au Bureau d'examen technique en matière maritime (BETMM) concernant l'application du (C.R.C., c. 1431) du Règlement sur la construction de coques pour BAYNES SOUND CONNECTOR, nous vous avisons que le BETMM a accepté votre demande sous réserve des conditions énoncées dans le rapport de décision ci-joint.

Veuillez conserver une copie du rapport de décision à bord du navire pour consultation ultérieure. Le rapport sera aussi rendu public de la manière que le président du BETMM jugera appropriée.

Sincerely / Cordialement,

s. 22 [redacted]

Marine Technical Review Board Secretariat |
Secrétariat du Bureau d'examen technique en matière maritime

Enclosure(s): Marine Technical Review Board Decision
Pièce jointe : Décision du Bureau d'examen technique en matière maritime
c.c. *manual entry/saisie manuelle*

Rasmussen, Shauna

From:	Adams, James
Sent:	January 09, 2023 11:00 AM
To:	Meyer, Leslie A.
Subject:	FW: BSC Emergency spare cable
Attachments:	SMD 01-2022 - South Guide Cable.docx; 20220328_LRLtr-BSC_EmergencyCable-Mar2022 DRAFT-v0.3.docx

Hi Leslie,

I'm looking for the final version of the attached letter to LR. See attached draft V0.3.

Thanks!

James Adams, P.Eng.
Project Manager, Terminal Construction
British Columbia Ferry Services Inc.
T: 250-978-1317 [redacted] **F:** 250-361-4922
james.adams@bcferries.com
bcferries.com

ss. 15, 19

From: Meyer, Leslie A.
Sent: April 14, 2022 3:20 PM
To: Adams, James W ; Weigold, Andrew ; Seitz, Robert
Cc: Stahuliak, Marian ; Bliss, Rick ; Cennon, Quentin ; Paterson, Bruce ; Raduta, Captain Claudiu
Subject: RE: BSC Emergency spare cable

Thanks Andy and James.

James: I've revised the letter accordingly. Please review and confirm acceptability.

Also, can you confirm that the 39 knots sustained wind speed is a hard stop (i.e. cancel sailings) limit vs. a "consult with Supt/OSC" limit? For consistency (and efficiency for obtaining LR approval), suggest we incorporate similar language as the MTRB into the Sr Master Directive:

> **MTRB 14754**
> g. The cable ferry operates in compliance with the BC Ferries 'Heavy Weather Precautions Procedures for a Cable Ferry" and will initiate heavy weather precaution above 35 knots of sustained wind speed. Crossing will not be undertaken in sustained wind speed of more than 55 knots, significant wave height of more than 1.03 metres, or current of more than 1.9 knots;

While also incorporating the format of the existing heavy weather matrix.

So for example:

> The engineering analysis undertaken by 3GA Marine Consultants confirms the 1-1/2" diameter cable exceeds all safety requirements when the weather matrix is adjusted to 39knots. Due to the south guide cable strength we must reduce the weather matrix to a sustained wind strength of 39kts at Sisters Island land station.
>
> While the new cable type is in place, the following procedures apply:

- Heavy weather precautions are to be initiated above 30 knots of sustained wind speed;
- Consultation with OSC prior to sailing shall occur for sustained wind speed between xx – xx. [do these limits change for new cable type?];
- Crossing will not be undertaken in sustained wind speed of more than 39 knots, or significant wave height of more than 1.0 metre [does wave height need to be amended for new cable type?];

Thanks,

Leslie Meyer
Regulatory & Policy Manager
British Columbia Ferry Services Inc.
T: 604-204-2212 [redacted] ss. 15, 19
leslie.meyer@bcferries.com
bcferries.com

From: Adams, James W
Sent: April 14, 2022 2:02 PM
To: Weigold, Andrew ; Meyer, Leslie A. ; Seitz, Robert
Cc: Stahuliak, Marian ; Bliss, Rick ; Cennon, Quentin ; Paterson, Bruce ; Raduta, Captain Claudiu
Subject: RE: BSC Emergency spare cable

Hi Leslie,

Further to my comments below, 3GA has confirmed their analysis covers both guide cables. This cable should not be used in the drive position though since the bull wheel liners are sized for a 1-5/8" dia cable.

As mentioned earlier, it may be difficult to find an equivalent "off the shelf cable" since the Northern Strands cable is constructed with the highest grade material available. Most off the shelf cables use a medium grade steel with a lower breaking strength.

Regards,

James Adams, P.Eng.
Project Manager, Terminal Construction
British Columbia Ferry Services Inc.
T: 250-978-1317 [redacted] **F:** 250-361-4922
james.adams@bcferries.com ss. 15, 19
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From: Weigold, Andrew <Andrew.Weigold@bcferries.com>
Sent: April 14, 2022 12:57 PM
To: Adams, James W <James.Adams@bcferries.com>; Meyer, Leslie A. <Leslie.Meyer@bcferries.com>; Seitz, Robert <Robert.Seitz@bcferries.com>
Cc: Stahuliak, Marian <Marian.Stahuliak@bcferries.com>; Bliss, Rick <Rick.Bliss@bcferries.com>; Cennon, Quentin <Quentin.Cennon@bcferries.com>; Paterson, Bruce <Bruce.Paterson@bcferries.com>; Raduta, Captain Claudiu <Claudiu.Raduta@bcferries.com>
Subject: RE: BSC Emergency spare cable

See directive for new cable attached

Andy Weigold
Sr. Master, Route 17, Salish Class
Sr. Master, Route 21, Baynes Sound Connector

British Columbia Ferry Services Inc.
1300 Ellenor Rd., Comox, BC, V9M 4B3
[redacted] ss. 15, 19
Andrew.Weigold@bcferries.com
bcferries.com

From: Adams, James W <James.Adams@bcferries.com>
Sent: April 14, 2022 10:25 AM
To: Weigold, Andrew <Andrew.Weigold@bcferries.com>; Meyer, Leslie A. <Leslie.Meyer@bcferries.com>; Seitz, Robert <Robert.Seitz@bcferries.com>
Cc: Stahuliak, Marian <Marian.Stahuliak@bcferries.com>; Bliss, Rick <Rick.Bliss@bcferries.com>; Cennon, Quentin <Quentin.Cennon@bcferries.com>; Paterson, Bruce <Bruce.Paterson@bcferries.com>
Subject: RE: BSC Emergency spare cable

Hi Andy,

See below for the directive:

What was the agreed wind speed: maximum sustained wind shall not exceed 20m/s [39 knots]
Current in-service cables: 1-5/8"diameter flattened strand steel cable with breaking strength of 285,000 lbs
Emergency spare cable: 1-1/2" diameter steel cable with breaking strength of 249,000 lbs
Note: The engineering analysis undertaken by 3GA Marine Consultants confirms the 1-1/2" diameter cable exceeds all safety requirements when the weather matrix is adjusted to 39knots.
Which cable is it going to replace: South guide cable
Is there anything special for crew to watch for? No, continue with standard visual inspections. LRTM will continue with the standard monitoring program.

Thanks,

James

James Adams, P.Eng.
Project Manager, Terminal Construction
British Columbia Ferry Services Inc.
T: 250-978-1317 [redacted] **F:** 250-361-4922
james.adams@bcferries.com
bcferries.com ss. 15, 19

From: Weigold, Andrew <Andrew.Weigold@bcferries.com>
Sent: April 14, 2022 9:35 AM
To: Adams, James W <James.Adams@bcferries.com>; Meyer, Leslie A. <Leslie.Meyer@bcferries.com>; Seitz, Robert <Robert.Seitz@bcferries.com>
Cc: Stahuliak, Marian <Marian.Stahuliak@bcferries.com>; Bliss, Rick <Rick.Bliss@bcferries.com>; Cennon, Quentin <Quentin.Cennon@bcferries.com>; Paterson, Bruce <Bruce.Paterson@bcferries.com>
Subject: RE: BSC Emergency spare cable

What was the agreed wind speed, what is new cable size vs. old, what is the difference in breaking strain, which cable is it going to replace, is there anything special for crew to watch for?

I'll use this info in the directive.

Regards,

Andy Weigold
Sr. Master, Route 17, Salish Class
Sr. Master, Route 21, Baynes Sound Connector
British Columbia Ferry Services Inc.
1300 Ellenor Rd., Comox, BC, V9M 4B3
[redacted] ss. 15, 19
Andrew.Weigold@bcferries.com
bcferries.com

From: Adams, James W <James.Adams@bcferries.com>
Sent: April 14, 2022 9:14 AM
To: Meyer, Leslie A. <Leslie.Meyer@bcferries.com>; Weigold, Andrew <Andrew.Weigold@bcferries.com>; Seitz, Robert <Robert.Seitz@bcferries.com>
Cc: Stahuliak, Marian <Marian.Stahuliak@bcferries.com>; Bliss, Rick <Rick.Bliss@bcferries.com>; Cennon, Quentin <Quentin.Cennon@bcferries.com>; Paterson, Bruce <Bruce.Paterson@bcferries.com>
Subject: RE: BSC Emergency spare cable

Hi Leslie,

Thanks again for preparing the letter to LR. See below in red for response to your comments.

It is mentioned in the letter that LR can contact you or myself for further questions. Can you please change the contact to Robert Seitz since this work is maintenance related.

Thanks,

James

James Adams, P.Eng.
Project Manager, Terminal Construction
British Columbia Ferry Services Inc.
T: 250-978-1317 [redacted] **F:** 250-361-4922
james.adams@bcferries.com
bcferries.com
ss. 15, 19

From: Meyer, Leslie A. <Leslie.Meyer@bcferries.com>
Sent: April 13, 2022 4:24 PM
To: Adams, James W <James.Adams@bcferries.com>; Weigold, Andrew <Andrew.Weigold@bcferries.com>; Seitz, Robert <Robert.Seitz@bcferries.com>
Cc: Stahuliak, Marian <Marian.Stahuliak@bcferries.com>; Bliss, Rick <Rick.Bliss@bcferries.com>; Cennon, Quentin <Quentin.Cennon@bcferries.com>; Paterson, Bruce <Bruce.Paterson@bcferries.com>
Subject: RE: BSC Emergency spare cable

Hi James,

Thanks for organizing the meeting today.

I've amended the LR letter based on the discussion today and have attached for your review and comment. Will await your confirmation on the following before finalizing/submitting to LR:

1. Scope of the 3GA memo – does it cover one guide cable or both? (I see the Conclusion refers only to the "proposed Northern Strand", so perhaps it only covers a single cable?). The current revision

of the LR letter does not specify the scope of the replacement, but we should modify it to align with the 3GA memo. JA: 3GA believes the analysis should cover both guide cables, though they are double checking their numbers and will provide a response today. This cable should not be used in the drive position since the bull wheel liners are sized for a 1-5/8" dia cable. It should also be noted that it may be difficult to find an equivalent "off the shelf cable" since the Northern Strands cable is constructed with the highest grade material available. Most off the shelf cables use a medium grade steel with a lower breaking strength.

2. Timing of Sr. Master's directive for heavy weather limitations – will this be ready in time to include in LR package (tomorrow or Tuesday), or should we proceed with the LR submission while the Directive is a work in progress? JA: Andy will provide a copy of the directive today.

Thanks,

Leslie Meyer
Regulatory & Policy Manager
British Columbia Ferry Services Inc.
T: 604-204-2212 [redacted]
leslie.meyer@bcferries.com ss. 15, 19
bcferries.com

From: Adams, James W <James.Adams@bcferries.com>
Sent: April 12, 2022 11:37 AM
To: Weigold, Andrew <Andrew.Weigold@bcferries.com>; Seitz, Robert <Robert.Seitz@bcferries.com>
Cc: Stahuliak, Marian <Marian.Stahuliak@bcferries.com>; Bliss, Rick <Rick.Bliss@bcferries.com>; Meyer, Leslie A. <Leslie.Meyer@bcferries.com>; Cennon, Quentin <Quentin.Cennon@bcferries.com>; Paterson, Bruce <Bruce.Paterson@bcferries.com>
Subject: RE: BSC Emergency spare cable

Hi Rob,

Leslie has prepared the attached draft letter (MS Word) to Lloyds regarding the emergency spare cable. The letter is indented to reference the cable maintenance plan, which I understand is now scheduled for completion at the end of June. Unfortunately this creates a conflict since LRTM is currently scheduled to install the spare cable April 28th.

I'll arrange a group conf call to discuss how to finalize and submit the memo in advance of the cable install.

Andy – In terms of the heavy weather matrix, I understand your preference is to issue a directive indicating the heavy weather matrix has been modified for the emergency spare cable. We can discuss this further during the conf call.

Regards,

James Adams, P.Eng.
Project Manager, Terminal Construction
British Columbia Ferry Services Inc.
T: 250-978-1317 [redacted] **F:** 250-361-4922
james.adams@bcferries.com ss. 15, 19
bcferries.com

From: Meyer, Leslie A. <Leslie.Meyer@bcferries.com>
Sent: April 04, 2022 10:19 AM
To: Adams, James W <James.Adams@bcferries.com>; Weigold, Andrew <Andrew.Weigold@bcferries.com>; Cennon, Quentin <Quentin.Cennon@bcferries.com>; Paterson, Bruce <Bruce.Paterson@bcferries.com>

Cc: Stahuliak, Marian <Marian.Stahuliak@bcferries.com>; Bliss, Rick <Rick.Bliss@bcferries.com>; Seitz, Robert <Robert.Seitz@bcferries.com>
Subject: RE: BSC Emergency spare cable

Morning James and all,

Attached is the draft LR letter for review and comment by the group. Since the proposal is to leave the new cable type installed for its lifespan (rather than a short term fix), I've proposed within the letter that the heavy weather matrix be amended and a copy included with the submission to LR:

https://sms.bcferries.corp/eFleetReader/eFleetPublishedDocuments/07.10.30.120G_HeavyWeatherFleetSummaryTable_FOM.pdf

Perhaps the "cancel sailing" threshold could be amended to the new limit with a footnote referencing the new cable type.

Thanks,

Leslie Meyer
Regulatory & Policy Manager
British Columbia Ferry Services Inc.
T: 604-204-2212 ss. 15, 19
leslie.meyer@bcferries.com
bcferries.com

From: Adams, James W <James.Adams@bcferries.com>
Sent: March 28, 2022 5:36 PM
To: Weigold, Andrew <Andrew.Weigold@bcferries.com>; Meyer, Leslie A. <Leslie.Meyer@bcferries.com>; Cennon, Quentin <Quentin.Cennon@bcferries.com>; Paterson, Bruce <Bruce.Paterson@bcferries.com>
Cc: Stahuliak, Marian <Marian.Stahuliak@bcferries.com>; Bliss, Rick <Rick.Bliss@bcferries.com>; Seitz, Robert <Robert.Seitz@bcferries.com>
Subject: RE: BSC Emergency spare cable

Hi Leslie, Bruce, and Quentin,

Please note the following summary and action items from today's meeting regarding the emergency spare cable for the BSC:

- It is anticipated that the emergency spare cable may require installation as soon as late-April 2022, pending future condition assessments on the in-service cables. If the cable were installed, the weather matrix would require an adjustment restricting sailings above 40knot sustained winds. The cable would likely remain in service for 12 or more months and would be subject to standard inspections as per the cable maintenance plan.
- Leslie to prepare draft letter to Lloyds referencing the 3GA "engineering" memo and cable maintenance plan to be prepared to LRTM. Draft letter to be prepared by mid-April
- Quentin to prepare draft cable maintenance plan document by mid-April. (Keep in mind the OSL action is due April 4)
- James to brief Andy that the VSM will may require a revision to the Heavy Weather Matrix if the emergency spare cable is installed. James/Quentin to keep Andy posted with potential installation timeline.

Please let me know if you have any questions or concerns with the above.

Thanks everyone for your input and support.

James

James Adams, P.Eng.
Project Manager, Terminal Construction
British Columbia Ferry Services Inc.
T: 250-978-1317 [redacted] **F:** 250-361-4922
james.adams@bcferries.com ss. 15, 19
bcferries.com

From: Adams, James W
Sent: March 23, 2022 5:37 PM
To: Weigold, Andrew <Andrew.Weigold@bcferries.com>; Meyer, Leslie A. <Leslie.Meyer@bcferries.com>; Cennon, Quentin <Quentin.Cennon@bcferries.com>; Seitz, Robert <Robert.Seitz@bcferries.com>; Paterson, Bruce <Bruce.Paterson@bcferries.com>
Cc: Stahuliak, Marian <Marian.Stahuliak@bcferries.com>
Subject: RE: Emergency cable report for LR (Draft)

Thanks Andy, this will be reviewed further early next week.

James Adams, P.Eng.
Project Manager, Terminal Construction
British Columbia Ferry Services Inc.
T: 250-978-1317 [redacted] **F:** 250-361-4922
james.adams@bcferries.com ss. 15, 19
bcferries.com

From: Weigold, Andrew <Andrew.Weigold@bcferries.com>
Sent: March 23, 2022 2:37 PM
To: Adams, James W <James.Adams@bcferries.com>; Meyer, Leslie A. <Leslie.Meyer@bcferries.com>; Cennon, Quentin <Quentin.Cennon@bcferries.com>; Seitz, Robert <Robert.Seitz@bcferries.com>; Paterson, Bruce <Bruce.Paterson@bcferries.com>
Cc: Stahuliak, Marian <Marian.Stahuliak@bcferries.com>
Subject: RE: Emergency cable report for LR (Draft)

Written policy is required its the duty of operational supervisor to report limitations to duty superintendents as they are responsible for the entire coast so they can't keep the details for every vessel. If it's temporary I can create a directive and vessel staff would inform duty super of the temporary limitation directive if conditions were met.

Andy

Sent with BlackBerry Work
(www.blackberry.com)

From: Adams, James W <James.Adams@bcferries.com>
Date: Wednesday, Mar 23, 2022, 1:25 PM
To: Meyer, Leslie A. <Leslie.Meyer@bcferries.com>, Cennon, Quentin <Quentin.Cennon@bcferries.com>, Seitz, Robert <Robert.Seitz@bcferries.com>, Paterson, Bruce <Bruce.Paterson@bcferries.com>
Cc: Stahuliak, Marian <Marian.Stahuliak@bcferries.com>, Weigold, Andrew <Andrew.Weigold@bcferries.com>
Subject: RE: Emergency cable report for LR (Draft)

Hi Leslie,

Sorry for the late reply. I'll arrange a conf call with the group to discuss next steps.

I'm not sure if anyone else has any comments regarding the 3GA report?

The Heavy Weather Matrix currently requires a consult with the duty Superintendent above 40 knots. The report indicates no sailings can take place above this limit if the emergency spare cable is installed. I'm not sure if it is sufficient for the Superintendent to simply be aware of this limitation or if written procedures are required.

I'll provide you with additional information on the timeline for the replacement cables.

Regards,

James Adams, P.Eng.
Project Manager, Terminal Construction
British Columbi[redacted]nc.
T: 250-978-1317 [redacted] **F:** 250-361-4922
james.adams@bcferries.com
bcferries.com
ss. 15, 19

From: Meyer, Leslie A. <Leslie.Meyer@bcferries.com>
Sent: March 21, 2022 2:01 PM
To: Adams, James W <James.Adams@bcferries.com>; Cennon, Quentin <Quentin.Cennon@bcferries.com>; Seitz, Robert <Robert.Seitz@bcferries.com>; Paterson, Bruce <Bruce.Paterson@bcferries.com>
Cc: Stahuliak, Marian <Marian.Stahuliak@bcferries.com>
Subject: RE: Emergency cable report for LR (Draft)

Hi James,

My question would be whether the vessel's Heavy Weather Matrix and cable maintenance plan will be updated to reflect the stipulations imposed by this report?

In terms of submission, I can assist with sending the finalized report on to LR. I've attached the LR conversation from the Dec 2019 cable change. In that case, we requested LR to issue a letter of no objection for our records. That would be helpful this time around too, especially as we prepare to submit the revised collision bulkhead/double bottom MTRB. In that case, I'd ask you to provide some additional context around the timeline for procurement and replacement of the cable.

Thanks,

Leslie Meyer
Regulatory & Policy Manager
British Columbia Ferry Services Inc.
T: 604-204-2212 [redacted]
leslie.meyer@bcferries.com
bcferries.com
ss. 15, 19

From: Adams, James W <James.Adams@bcferries.com>
Sent: March 15, 2022 6:16 PM
To: Cennon, Quentin <Quentin.Cennon@bcferries.com>; Seitz, Robert <Robert.Seitz@bcferries.com>; Paterson, Bruce <Bruce.Paterson@bcferries.com>; Meyer, Leslie A. <Leslie.Meyer@bcferries.com>
Cc: Stahuliak, Marian <Marian.Stahuliak@bcferries.com>
Subject: FW: Emergency cable report for LR (Draft)

All,

Attached is the draft memo for LR submission regarding temporary use of the emergency spare cable. Can you please review and let me know if you have any questions?

I'll be back in the office next week and will review the memo then.

Bruce or Leslie – How did you want to proceed with the submission to LR once we have finalized the report?

Thanks,

James

James Adams, P.Eng. ss. 15, 19
Project Manager, Terminal Construction
British Columbia Ferry Services Inc.
T: 250-978-1317 [redacted] **F:** 250-361-4922
james.adams@bcferries.com
bcferries.com

From: David Mietla <dmietla@3gamarine.com>
Sent: March 15, 2022 12:13 PM
To: Adams, James W <James.Adams@bcferries.com>
Cc: Shaun Wallis <swallis@3gamarine.com>
Subject: [EXTERNAL] Emergency cable report for LR

Hi James,
Here is the report for LR as discussed. Please let me know if you have any questions or comments.

Thank you and kind regards,

David Mietla, P.Eng.
President
3GA Marine Ltd.
Cell: (250) 589 7404

3GA MARINE

Optimizing Solutions

Rasmussen, Shauna

From: Bajwa, Karan
Sent: January 10, 2023 4:07 PM
To: Paterson, Bruce
Subject: Fwd: Commissioner question - BSC cable thickness

Hi Bruce, for discussion tomorrow morning.

Regards
Karan

Karan S Bajwa
Director, Fleet Engineering

British Columbia Ferry Services Inc.
#1 Ferry Causeway, Delta, BC V4M 4G6
O: 604-948-3575 [redacted]
karan.bajwa@bcferries.com ss. 15, 19
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Begin forwarded message:

> **From:** "Johnston, Darren" <Darren.Johnston@bcferries.com>
> **Date:** January 10, 2023 at 3:40:27 PM PST
> **To:** "Bajwa, Karan" <Karan.Bajwa@bcferries.com>, "Adams, James" <James.Adams@bcferries.com>, "Raduta, Captain Claudiu" <Claudiu.Raduta@bcferries.com>
> **Subject: RE: Commissioner question - BSC cable thickness**
>
> Thanks Karan – these documents do not specify exactly what the operational limit (reduced) needs to be so I am unclear how we arrived at 39 knots. I suspect that this was chosen as it may have seemed reasonable by the operational team at the time.
>
> I suggest that Fleet Technical provide Ops with a recommended upper wind limit for operations.
>
> Your thoughts?
>
> Darren Johnston
> Executive Director, Fleet Operations
> **British Columbia Ferry Services Inc.**
> Suite 500, 1321 Blanshard St., Victoria, BC V8W 0B7
> **T:** 250-978-1222 ss. 15, 19 [redacted]
> darren.johnston@bcferries.com
> **bcferries.com**

From: Bajwa, Karan <Karan.Bajwa@bcferries.com>
Sent: January 10, 2023 12:45 PM
To: Johnston, Darren <Darren.Johnston@bcferries.com>
Subject: FW: Commissioner question - BSC cable thickness

Hi Darren, As discussed attached are letters to Lloyds and their response. Both have mentions of changes to limitation matrix changes.

Regards
Karan

Karan S Bajwa
Director, Fleet Engineering

British Columbia Ferry Services Inc.
#1 Ferry Causeway. Delta, BC V4M 4G6
O: 604-948-3575 [redacted] ss. 15, 19
karan.bajwa@bcfe[redacted]ies.com
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Transport Canada Transports Canada
Safety and Security Sécurité et sûreté

Tower C, Place de Ville
11th Floor
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Tour C, Place de Ville
11e étage
330, rue Sparks

Ottawa (Ontario) K1A 0N8

Your file
Votre référence

Our file
Notre référence

Classification 8562-19633

BRITISH COLUMBIA FERRY SERVICES INC.
SUITE 500 - 1321 BLANSHARD ST.
VICTORIA, BRITISH COLUMBIA
V8W 0B7

SUBJECT:
BAYNES SOUND CONNECTOR
MARINE TECHNICAL REVIEW BOARD DECISION NO. M14754

Further to your request to the Marine Technical Review Board (MTRB) regarding the application of the (C.R.C., c. 1431) of Hull Construction Regulations for BAYNES SOUND CONNECTOR, please be advised that the MTRB has granted your request subject to the conditions outlined in the enclosed Record of Decision.

Please keep a copy of this Record of Decision on board of the vessel and for future reference. This Record of Decision will also be made available to the public in a manner that the Chair of the MTRB considers appropriate.

OBJET :
BAYNES SOUND CONNECTOR
DÉCISION N^O M14754 DU BUREAU D'EXAMEN TECHNIQUE EN MATIÈRE MARITIME

Comme suite à votre demande adressée au Bureau d'examen technique en matière maritime (BETMM) concernant l'application du (C.R.C., c. 1431) du Règlement sur la construction de coques pour BAYNES SOUND CONNECTOR, nous vous avisons que le BETMM a accepté votre demande sous réserve des conditions énoncées dans le rapport de décision ci-joint.

Veuillez conserver une copie du rapport de décision à bord du navire pour consultation ultérieure. Le rapport sera aussi rendu public de la manière que le président du BETMM jugera appropriée.

Sincerely,/ Cordialement,

s. 22 [redacted]

Marine Technical Review Board Secretariat |
Secrétariat du Bureau d'examen technique en matière maritime

Enclosure(s): Marine Technical Review Board Decision
Pièce jointe : Décision du Bureau d'examen technique en matière maritime
c.c. *manual entry/saisie manuelle*

Transport Canada
Safety and Security

Transports Canada
Sécurité et sûreté

Marine Safety Directorate
330 Sparks Street
Ottawa, Ontario K1A 0N8

Direction générale de la sécurité maritime
330, rue Sparks
Ottawa (Ontario) K1A 0N8

Marine Technical Review Board Decision / Décision du Bureau d'examen technique en matière maritime

Applicant:
Demandeur : BRITISH COLUMBIA FERRY SERVICES INC.

Board Decision No.:
N° de la décision du Bureau : M14754

Vessel Name:
Nom du bâtiment : BAYNES SOUND CONNECTOR

Official Number:
N° matricule : 839270

Effective Date:
Date d'effet :

Expiry Date: Valid for life of vessel
Date d'expiration : Durée de vie du bâtiment

This Marine Technical Review Board Decision authorizes BRITISH COLUMBIA FERRY SERVICES INC. as the authorized representative of the BAYNES SOUND CONNECTOR, to fulfill its obligations under paragraph 106(1)(a) of the *Canada Shipping Act, 2001*, in a manner that does not comply with sections (C.R.C., c. 1431) of Hull Construction Regulations, if:

Cette décision du Bureau d'examen technique en matière maritime autorise BRITISH COLUMBIA FERRY SERVICES INC. en sa capacité de représentant autorisé du BAYNES SOUND CONNECTOR à exécuter ses obligations en vertu de l'alinéa 106(1)a) de la *Loi de 2001 sur la marine marchande du Canada* d'une façon non conforme aux articles (C.R.C., c. 1431) du Règlement sur la construction de coques, si :

CONDITIONS

Please see RDIMS document #12257638 MTRB-BETMM - FINAL CONDITIONS-CONDITIONS FINALE - M14754- BAYNES SOUND CONNECTOR - HULL CONSTRUCTION REGULATIONS-RÈGLEMENT SUR LA CONSTRUCTION DE COQUES

Veuillez voir le document RDIMS #12257638 MTRB-BETMM - FINAL CONDITIONS-CONDITIONS FINALE - M14754- BAYNES SOUND CONNECTOR - HULL CONSTRUCTION REGULATIONS-RÈGLEMENT SUR LA CONSTRUCTION DE COQUES

Note: This Marine Technical Review Board Decision in no way reduces the vessel's, the applicant's or any other person's responsibility to comply with any other requirements of the *Canada Shipping Act, 2001* and regulations made under it that are not specifically addressed in this decision.

Note : La présente décision du Bureau d'examen technique en matière maritime n'exempte en aucune façon le bâtiment, le demandeur ou toute autre personne de l'observation des autres exigences de la *Loi de 2001 sur la marine marchande du Canada* et de ses règlements qui ne sont pas citées explicitement dans cette décision.

s. 22 [redacted]

s. 22 [redacted] Naim Nazha
Chair of the MTRB
Président du BETMM

FINAL CONDITIONS FOR BAYNES SOUND CONNECTOR #M14754	CONDITIONS FINALES POUR BAYNES SOUND CONNECTOR N^{O} M14754
a. The operational profile of the cable ferry remains the same and runs in the sheltered waters between Buckley Bay and Denman Island service;	a. Le profil de fonctionnement du traversier à câble demeure le même et consiste en les eaux abritées séparant la baie Buckley et l'île Denman.
b. The ferry complies with two (2) compartment subdivision stability criteria of the standards TP 10943, and of the bottom damage requirements of SOLAS regulations II-1/9.8 for area not fitted with a double-bottom, based on the Centre of Gravity and Lightship displacement values determined in accordance with the MTRB Decision #M139290 for all loading conditions;	b. Le traversier est conforme aux deux (2) critères de stabilité de la norme TP 10943, pour ce qui est du compartimentage, ainsi qu'aux exigences d'endommagement du fond de la section II-1/9.8 de la SOLAS, en ce qui concerne les parties ne comportant aucun double-fond, si l'on se base sur les valeurs relatives au déplacement de bateau-feu et au centre de gravité qui ont été déterminées conformément à la décision du BETMM n° M139290 pour toutes les conditions de charge.
c. A Letter of Maximum Subdivision Draft is issued by the Recognized Organization specifying the maximum drafts that will comply with the subdivision standards stated in condition b).	c. L'organisme reconnu doit présenter une lettre de tirant d'eau de compartimentage maximal, dans laquelle il indique les tirants d'eau maximaux conformes aux normes de la condition b).
d. The Design methodology and numerical analysis, the Baynes Sound Environmental Characterization Study (Roddan Engineering LTD., Nov 2012) and all other relevant documents are reviewed and accepted by the RO;	d. L'organisme reconnu a étudié et accepté la méthode de conception, l'analyse numérique, l'étude de caractérisation environnementale du détroit de Baynes (Roddan Engineering LTD., nov. 2012), ainsi que tous les autres documents pertinents.
e. The cable ferry working mechanism, cable rope sizes/specifications, design loads, safety factors, maintenance plans and replacement schedule of cables are approved by the RO. BC Ferries' cable maintenance plan is to involve placing a new cable into the drive position annually until such time as a duty cycle can be established for the vessel's route. Subject to cable condition, used drive cables may be utilized in the guide cable positions for two (2) years;	e. L'organisme reconnu approuve le mécanisme de fonctionnement, la taille et les spécifications du câble, les charges nominales, les facteurs de sécurité, les plans d'entretien et le calendrier de remplacement de câble du traversier. Le plan d'entretien de câble de BC Ferries doit prévoir l'installation annuelle d'un nouveau câble à la position d'entraînement, et ce, jusqu'à ce qu'un nouveau cycle d'utilisation puisse être établi pour le circuit du traversier. Les câbles d'entraînement usagés pourront être installés aux positions de câble de guidage pendant deux (2) ans, selon leur état.
f. The vessel is instrumented to monitor and record dynamic motions and cable tensions. Six months	f. Le traversier comporte des instruments conçus pour surveiller et enregistrer les mouvements dynamiques

after the entry in service of the vessel, the authorized representative will submit to the Recognized Organization and Transport Canada an analysis of the motions, loads and related wind and weather conditions with an updated heavy weather matrix.	et les tensions que le câble subit. Un représentant autorisé devra présenter à l'organisme reconnu et à Transports Canada une analyse des mouvements, des charges et des conditions éoliennes et météorologiques, ainsi qu'une matrice des mauvaises conditions météorologiques, après six mois d'exploitation du traversier.
g. The cable ferry operates in compliance with the BC Ferries 'Heavy Weather Precautions Procedures for a Cable Ferry" and will initiate heavy weather precaution above 35 knots of sustained wind speed. Crossing will not be undertaken in sustained wind speed of more than 55 knots, significant wave height of more than 1.03 metres, or current of more than 1.9 knots;	g. Le traversier à câble est exploité conformément aux précautions de BC Ferries relatives à l'exploitation d'un traversier à câble lorsque les conditions météorologiques sont mauvaises (Heavy Weather Precautions Procedures for a Cable Ferry), lesquelles doivent être prises par un vent soutenu supérieur à 35 noeuds. Il ne devra pas être exploité si un vent soutenu souffle à plus de 55 noeuds, si les vagues atteignent plus de 1,03 m et si le courant se chiffre à plus de 1,9 nœud.
h. Crossing is not undertaken when the cable tension exceeds the approved design loads limits. A record of measured cable tension is maintained and provided to TCMSS on request;	h. Le traversier à câble n'est pas exploité si la tension exercée sur le câble dépasse les limites de charges nominales approuvées. Un dossier de mesure de la tension exercée sur le câble est tenu à jour et présenté sur demande à SSMTC;
i. The anchor is sized according to the Equipment Numeral as required by the Classification Rules of the Recognized Organization;	i. La taille de l'ancre est conforme au numéral de l'équipement et aux règles de classification de l'organisme reconnu;
j. Operational / emergency procedures are developed in case of cable system malfunction and incorporated in the Safety Management System (SMS). Crew training and simulation are carried on a periodical basis as per the procedures;	j. Des procédures d'exploitation et d'urgence relatives à une défaillance du système de câble sont élaborées et intégrées au système de gestion de la sécurité. L'équipage suit une formation et participe à des simulations périodiquement et conformément aux procédures pertinentes;
k. Operational readiness with regards to deployment of the anchor is demonstrated. Procedures are incorporated in the Safety Management System (SMS) with regards to periodical crew training and deployment;	k. Une préparation au jet de l'ancre est démontrée. Des procédures de formation de l'équipage et de participation de ce dernier à des exercices sont intégrées au système de gestion de la sécurité;
l. Trials are performed to measure the stopping capability of the ferry. The information is	l. Des essais sont exécutés pour évaluer la capacité d'immobilisation du traversier. Les données d'essai

incorporated in the vessel documentation and made available to the Master;	font partie du ou des documents relatifs au bâtiment et sont présentées au capitaine;
m. The vessel operates / loads vehicle and passengers in accordance with the conditions contained in the approved Loading Manual;	m. L'exploitation du traversier et l'embarquement de véhicules et de passagers à son bord sont conformes aux conditions figurant dans le manuel d'embarquement approuvé;
n. The vessel is fitted with permanent tug mooring arrangement;	n. Le traversier comporte des amarres de remorquage permanents;
o. The vessel meets the fire protection requirements as set out in Part III of the Transport Canada Equivalent Standards for Fire Protection of Passenger Ships (TP 2237E);	o. Le traversier est conforme aux exigences de protection contre les incendies figurant dans la partie III des *Normes équivalentes de protection contre l'incendie des navires à passagers* de Transports Canada (Equivalent Standards for Fire Protection of Passenger Ships - TP 2237E);
p. In addition to the applicable requirements of the Fire Detection and Extinguishing Equipment Regulations for Class E vessels, the vessel is: i. fitted with a water mist fixed fire suppression system, approved as equivalent to a pressure water-spraying system meeting the requirements of Schedule III of the Fire Detection and Extinguishing Equipment Regulations, in the machinery spaces; ii. fitted with a water mist fixed fire suppression system, approved as equivalent to an automatic sprinkler system meeting the requirements if Schedule VI of the Fire Detection and Extinguishing Equipment Regulations, in the crew space and passenger lounge; and iii. fitted with an automated fire monitor system to cover the vehicle deck;	p. Le traversier est conforme aux exigences pertinentes figurant dans le *Règlement sur le matériel de détection et d'extinction d'incendie* en ce qui concerne les bâtiments de classe E, mais il comporte également : i. dans la tranche des machines, un système fixe d'extinction d'incendie par brouillard d'eau qui a été approuvé comme l'équivalent d'un système de projection d'eau sous pression conforme aux exigences de l'annexe III du *Règlement sur le matériel de détection et d'extinction d'incendie*; ii. dans le ou les locaux de l'équipage et le salon des passagers, un système fixe d'extinction d'incendie par brouillard d'eau qui a été approuvé comme l'équivalent d'un extincteur automatique conforme aux exigences de l'annexe VI du *Règlement sur le matériel de détection et d'extinction d'incendie*; iii. un système automatisé de surveillance des incendies sur le pont des véhicules.
q. In addition to the requirements of the Life Saving Equipment Regulations for Class VII vessels, the vessel is:	q. Le traversier est conforme aux exigences du *Règlement sur l'équipement de sauvetage* visant les bâtiments de classe VII, mais il comporte également :

i. fitted with two Marine Evacuation System (MES) stations each with a capacity sufficient for 100% of the persons on board; and	i. deux postes d'évacuation maritime d'une capacité équivalant à 100 % des personnes à bord;
ii. fitted with an approved emergency boat meeting the requirement of Schedule VII of the Life Saving Equipment Regulations. The emergency boat is installed under a launching device meeting the requirements of Schedule IX of the Life Saving Equipment Regulations..	ii. un bateau d'urgence approuvé qui est conforme à l'exigence figurant à l'annexe VII du *Règlement sur l'équipement de sauvetage* et qui a été installé sous un dispositif de mise à l'eau conforme aux exigences de l'annexe IX dudit règlement.

APPLICATION SUMMARY

DECISION NUMBER (M14754)

PROPOSED EXPIRY DATE: 2500-12-31

OFFICE: Vancouver (502) **DATE:** 2016-06-29

VESSEL NAME:	IMO NUMBER:	OFFICIAL NUMBER:	FILE NO.:
BAYNES SOUND CONNECTOR	839270	839270	19633

VESSEL TYPE: FERRY

RECOGNIZED ORGANIZATION:

GROSS TONNAGE:	LENGTH:	PASSENGERS:	CREW:
753	75.33 m	146	4

CON. MATERIAL:	BUILT:	LAST MAJOR MODIFICATION:
STEEL	2015	

PROP. TYPE:	PROP. POWER:	PROP. METHOD:
SELF-PROPELLED	744 KILOWATTS	CABLE

VOYAGE LIMITATION:
Sheltered Waters (Buckley Bay to Denman Island) ** Note: the vessel will operate year-round, therefore the old voyage limitation reference is Minor Waters Voyage Class II.

SUBJECT:
Flip LOA to MTRB. Request for exemption from the requirement for the position of the collision bulkheads. Request for exemption from the requirement for a double bottom.

RDIMS NOs - APPLICATION REQUEST/BACKGROUND:
#12075163: Application Request
#12075139: BAYNES SOUND CONNECTOR - LOAIP - SUBDIVISION DB - CONFIRMATION LETTER PKG
#12075163: BAYNES SOUND CONNECTOR - MTRB-RESUBMIT - SUBDIVISION DOUBLE BOTTOM - EDITABLE - ON 839270
#12075188: BAYNES SOUND CONNECTOR - MTRB-RESUBMIT - SUBDIVISION DOUBLE BOTTOM - SIGNED - ON 839270
#12075228: APPROVED LETTER OF AGREEMENT - VSY HULL 189
#12075243: STABILITY DAD MTES - SLT - WP16235756
#12257638: MTRB - FINAL CONDITIONS -M14754- BAYNES SOUND CONNECTOR - HULL CONSTRUCTION REGULATIONS

REGULATION REFERENCE[1]:
Canada Shipping Act, 2001: Hull Construction Regulations ((C.R.C., c. 1431))

PRECEDENTS:
12046 (Francois Forester, ON 820154).

APPLICATION SUMMARY (M14754)

1. **REVIEW:**
The Baynes Sound Connector is a 78m cable ferry built by Seaspan Vancouver Shipyards Company Ltd. and delivered on 19 November 2015 for British Columbia Ferry Services Inc. The vessel was built to Lloyd's Register Rules and Regulations for the Classification of Inland Waterways Ships, complying with the class notation: +AT IWW Passenger and Vehicle Ferry, Zone 2, Buckley Bay to Denman Island Service, *IWS MCH Descriptive Note: Cable Operated The vessel operates in Baynes Sound, which is classified as Sheltered Waters. The vessel is a Class VIII passenger ship, as per Hull Construction Regulations, Application, Section 6.(1)(h). The vessel is a Group B ship, as per Hull Construction Regulations, Part II, Section 23.(b). A Letter of Agreement in Principle(LOAIP) with subject title VSY Hull 189 - Agreement in Principle "Request for exemption from the requirement for the position of the collision bulkheads. Request for exemption from the requirement for a double bottom," was issued by Transport Canada on 12 May 2015 based on the original MTRB application submitted on 9 April 2015 stipulated various conditions for compliance. All conditions in the LOAIP has been addressed. BC Ferries letter is attached confirming the status of each of the condition from the LOAIP. (Refer Attachment: 1. BSC-LOAIP-SubdivisionDB-ConfirmationLetter-pkg).

2. **DETAILS OF REGULATORY REQUIREMENTS:**
Canada Shipping Act, 2001: Hull Construction Regulations ((C.R.C., c. 1431))

    Position of Collision Bulkhead: Hull Construction Regulations Part II, Section 31. The requirements for peak and machinery space bulkheads as specified in Section 10 of Part I apply to ships to which this Part applies, except that the requirements for afterpeak bulkheads specified in subsection 10(2) apply only to ships over 150 tons, gross tonnage. Hull Construction Regulations Part I, Section 10: (1) Subject to subsection (1.1), every ship shall be equipped with a collision bulkhead (a) that is watertight up to the bulkhead deck, and (b) that is fitted at a distance abaft the ship's forward perpendicular of not less than 5%, and not more than 3.05 m + 5%, of the length of the ship. ++++++++++++++++++++++++++++++ Double Bottom: Hull Construction Regulations Part II, Section 30: The requirements for double bottoms as specified in Section 11 of Part I apply to the ships of this Part. Hull Construction Regulations Part I, Section 11: (1) Every ship of 50 m in length or more shall be fitted with a watertight double bottom that: (c) in ships of 76 m or more in length, extends at least from the collision bulkhead to the afterpeak bulkhead, or as near to those bulkheads as is practicable.

3. **ALTERNATIVE PROPOSALS:**
Collision Bulkhead Position: Locate the collision bulkheads (Peak bulkheads fore and aft) aft of the aft-most allowable position by approx. 52 mm at Frame Nos. 3 and 29 vice Frame Nos. 2 and 30. Section 4 refers. ++++++++++++++++++++++ Double Bottom: Accept the vessel design as a shallow pontoon (2.1m depth) under Hull Construction Regulations Part I, Section 11: (6) The Board may exempt any ship, other than a ship of Class I, from the requirements of a double bottom in any portion of the ship that is subdivided by application of a factor of subdivision not exceeding 0.5 if it is satisfied that the fitting of a double bottom in that

portion of the ship would not be compatible with the design and proper working of the ship. Section 4 refers.

4. **REASON WHY REGULATORY REQUIREMENT CANNOT BE MET OR WHY ALTERNATIVE PROPOSAL IS PREFERABLE:**
Canada Shipping Act, 2001: Hull Construction Regulations ((C.R.C., c. 1431))

Collision Bulkhead Position - reason why the alternative proposal is preferable: The critical compartments for damage stability with two compartments flooded are: Void Nos. 2 (Frame Nos. 3 to 6) and 3 (Frame Nos. 6 to 10) Void Nos. 6 (Frame Nos. 22 to 26) and 7 (Frame Nos. 26 to 29). If the collision bulkheads were located at Frame Nos. 2 and 30 (within the required range), damage stability requirements for two compartment flooding would not be met, as required by Hull Construction Regulations, Part II, Section 24.(3)(c). Two additional bulkheads could have been fitted in the fore / aft ends. However, the additional vessel weight / inertia in yaw and sway motions would have had a negative effect on cable loading with no significant compensating improvement to the capability of the vessel to sustain damage. The end result would have been a marginal reduction in the overall safety of the vessel. ++++++++++++++++++++++++ Double Bottom - reason why the alternative proposal is preferable: The design is typical for many inter-island, inland and cable ferries. Fitting a double bottom in a shallow pontoon would require increasing the depth of the hull which, together with the double bottom structure itself, would substantially increase the weight of the vessel and increase the windage of the vessel. This would in turn require increased winch powering /sizing and cable sizing.

5. **REASON WHY SAFETY AND THE ENVIRONMENT WILL NOT BE COMPROMISED:**
See Section 6. below - Potential Risks to Safety and the Environment. The points following address these risks. Collision Bulkhead Position a. The vessel operates on a fixed, charted route with little commercial traffic. b. The vessel complies with navigational aids that warn of traffic on the route and navigational lighting. c. The vessel has the capability to stop within one vessel length from full operational speed in the event of an obstruction on the route. (For reference, it is noted that MSC.137(76) - Standards for Ship Manoeuvrability, Section 5, Paragraph 5.3.4 (Stopping ability) requires the following: the track reach in the full astern stopping test should not exceed 15 ship lengths. However, this value may be modified by the Administration where ships of large displacement make this criterion impracticable, but should in no case exceed 20 ship lengths.) ++++++++++++++++++++++++ Double Bottom d. The vessel operates on a fixed, charted route where there are no known underwater obstructions. e. The vessel does not need to beach to load / unload, but docks into floating berths with substantial water under the keel. f. The vessel has a three (3) cable system to provide a high level of redundancy in the event of a cable breakage. In addition, a deployable anchor is fitted onboard the vessel. g. Extensive simulation of the performance of the cable system has been undertaken to ensure an acceptable safety factor on the cables. The cables are sized in accordance with the design practice developed by the American Petroleum Institute (API 2SK) for moored offshore structures. See Section 7 f. for cable inspection / monitoring and maintenance. h. The ferry complies with two (2) compartment subdivision stability criteria of the standards TP 10943, and of the bottom damage requirements of SOLAS regulations II-1/9.8 for area not fitted with a double-bottom.(DAD MTES/SLT/WP16235756 para 3.0 refers) The vessel

complies with damage stability criteria for two compartment flooding based on estimated centre of gravity and lightship displacement values. The vessel complies with damage stability criteria for three midships compartment flooding based on estimated centre of gravity and lightship displacement values. i. A Letter of Maximum Subdivision Draft issued by LR specifying the maximum drafts(1.078 m) that will comply with a two compartment subdivision standard. j. All compartments below the main deck are voids except the compartment amidships, which contains some independent tanks. All machinery and fuel tanks are located above the main (vehicle) deck. In the event of grounding, no machinery operation is affected which might result in jeopardizing the safety of the vessel or its crew, passengers and cargo.

6. **POTENTIAL RISKS TO SAFETY AND THE ENVIRONMENT:**
a. Collision with another vessel that crosses the path of the cable ferry. (See Section 5a. to c.) b. Cable breakage, causing the cable ferry to drift and either collide with another vessel or run aground. (See Section 5f. to h.) c. Vessel grounding on route. (Addressed by Section 5d. and e.) d. Pollution incident from machinery spaces as a result of no double bottom. (See Section 5j.)

7. **PROPOSED CONDITIONS[2]:**
a. The vessel operates in accordance with the requirements of the company's Safety Management System.

b. The Voyage Limitation of the vessel does not change (i.e. Sheltered Waters, Buckley Bay to Denman Island Service).

c. The vessel operates in accordance with BC Ferries' Heavy Weather Precautions Procedures in accordance with the Vessel Specific Manual.

d. The vessel operates / loads vehicles in accordance with the conditions contained in the approved Loading Manual.

e. In-situ cable inspection / monitoring is carried out and maintenance is completed in accordance with appropriate standards / industry practice. BC Ferries' cable maintenance plan will involve placing a new cable into the drive position annually until such time as a duty cycle can be established for the vessel's route. Subject to cable condition, used drive cables will be utilized in the guide cable positions for two (2) years.

8. **FINAL CONDITIONS[2]:**
Please see RDIMS document #12257638 MTRB-BETMM - FINAL CONDITIONS-CONDITIONS FINALE -M14754- BAYNES SOUND CONNECTOR - HULL CONSTRUCTION REGULATIONS-RÈGLEMENT SUR LA CONSTRUCTION DE COQUES

REQUIRED NOTIFICATIONS:

☐ IMO Notification required

☑ Delegated Classification Society Notification required

SOMMAIRE DE L'APPLICATION

NUMÉRO DE LA DÉCISION (M14754)

DATE D'EXPIRATION PROPOSÉE: 2500-12-31

BUREAU: Vancouver (502) **DATE:** 2016-06-29

NOM DU BÂTIMENT :	N° OMI :	N° MATRICULE :	N° DE DOSSIER :
BAYNES SOUND CONNECTOR	839270	839270	19633

TYPE DE BÂTIMENT : TRAVERSIER

ORGANISATION RECONNUE:

JAUGE BRUTE :	LONGUEUR :	PASSAGERS	ÉQUIPAGE :
753	75.33 m	146	4

MATERIAUX DE CONSTRUCTION :	ANNÉE DE CONSTRUCTION :	DERNIÈRE MODIFICATION MAJEURE :
ACIER	2015	

TYPE DE PROPULSION :	PROPULSION :	MÉTHODE DE PROPULSION :
AUTOPROPULSE	744 KILOWATTS	CABLE

LIMITE DES VOYAGES :

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OBJET :

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N°s SDGGI - APPLICATION ET DEMANDE / INFORMATION CONNEXE :

#12075163: Application Request
#12075139: BAYNES SOUND CONNECTOR - LOAIP - SUBDIVISION DB - CONFIRMATION LETTER PKG
#12075163: BAYNES SOUND CONNECTOR - MTRB-RESUBMIT - SUBDIVISION DOUBLE BOTTOM - EDITABLE - ON 839270
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#12075228: APPROVED LETTER OF AGREEMENT - VSY HULL 189
#12075243: STABILITY DAD MTES - SLT - WP16235756
#12257638: MTRB - FINAL CONDITIONS -M14754- BAYNES SOUND CONNECTOR - HULL CONSTRUCTION REGULATIONS

RÉFÉRENCE RÈGLEMENTAIRE[1] :

Loi de 2001 sur la marine marchande du Canada: Règlement sur la construction de coques ((C.R.C., c. 1431))

PRÉCÉDENTS :

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SOMMAIRE DE L'APPLICATION (M14754)

1. **REVUE :**

2. **DÉTAILS DES EXIGENCES RÉGLEMENTAIRES :**
   Loi de 2001 sur la marine marchande du Canada: Règlement sur la construction de coques ((C.R.C., c. 1431))

3. **SOLUTION PROPOSÉE EN REMPLACEMENT DE L'EXIGENCE RÈGLEMENTAIRE :**

4. **RAISON POUR LAQUELLE L'EXIGENCE RÈGLEMENTAIRE NE PEUT PAS ÊTRE RESPECTÉE OU POUR LAQUELLE LA SOLUTION DE RECHANGE EST JUGÉE PRÉFÉRABLE :**
   Loi de 2001 sur la marine marchande du Canada: Règlement sur la construction de coques ((C.R.C., c. 1431))

5. **RAISON POUR LAQUELLE IL N'Y A PAS DE RISQUE POUR LA SÉCURITÉ ET L'ENVIRONNEMENT**

6. **RISQUES POSSIBLES POUR LA SÉCURITÉ ET L'ENVIRONNEMENT :**

7. **CONDITIONS PROPOSÉES :**

8. **CONDITIONS DÉFINITIVES :**
   Veuillez voir le document RDIMS #12257638 MTRB-BETMM - FINAL CONDITIONS-CONDITIONS FINALE -M14754- BAYNES SOUND CONNECTOR - HULL CONSTRUCTION REGULATIONS-RÈGLEMENT SUR LA CONSTRUCTION DE COQUES

AVIS REQUIS :

☐ Avis requis à l'OMI

☑ Avis requis à la société de classification déléguée

BCFerries

13 January 2017

PREPARED FOR: **RO – CF Baynes Sound Connector**

SUBJECT: **Closure of Condition (e) of MTRB 14754**

ACTION REQUIRED: **As per document**

OVERVIEW

The BAYNES SOUND CONNECTOR (BSC) cable ferry, operated by BC Ferry Services (BCF), was built to service the Buckley Bay to Denman Island ferry route (Route 21). The cable ferry operates with a number of MTRB decisions, including MTRB 14754 regarding the location of collision bulkheads and the fitting of a double bottom under the Hull Construction Regulations. The MTRB includes a number of conditions, including:

e) *The cable ferry working mechanism, cable rope sizes/specifications, design loads, safety factors, maintenance plans and replacement schedule of cables are approved by the RO. BC Ferries' cable maintenance plan is to involve placing a new cable into the drive position annually until such time as a duty cycle can be established for the vessel's route. Subject to cable condition, used drive cables may be utilized in the guide cable positions for two (2) years.*

The attached report (**Reference 1**) and the summary herein are provided to close off this condition.

REFERENCE

1) Cable Re-Tensioning Criteria and Discard Criteria for the Baynes Sound Connector. Prepared by E.Y.E. Marine Consultants, Report Ref: EYE Cable Report, Rev Final, Dated 07 December 2016. 36p.

SUMMARY

The report completed by E.Y.E. Marine Consultants (EYE) outlines the criteria developed for the cable maintenance program regarding cable load monitoring, cable re-tensioning, cable condition inspections and the ultimate discard of a cable. The combination of the above criteria forms a comprehensive cable monitoring and inspection system, ensuring that the designed Factor of Safety will maintained the throughout the operational lifespan of each cable.

The cable loads are monitored via load cell pins to detect any potential abnormalities and peak loads. The cable load data is recorded throughout each week and the weekly average tension is used to determine if it is necessary to re-tension a cable that has lost tension over time. Cable re-tensioning criteria was developed to ensure the Factor of Safety on any individual cable will remain above 3.0 during storm conditions. When all of the cables have deteriorated to the point that they have lost 15 percent of their initial area, the Factor of Safety on any cable will be greater than 2.0 during storm conditions, with cables tensions at the extreme ranges.

The criteria for visual inspections was developed by selecting relevant criteria from the following two cable standards: ISO 4309 Cranes-Wire Ropes-Care and Maintenance, Inspection and Discard and API In-Service Inspection of Mooring Hardware for Floating Structures. Any abnormalities noticed during the cable inspection process are compared to the criteria for visual standards to determine severity. The cable diameter is measured in suspect areas to ensure the minimum specified cable diameter is maintained. Due to the cable being plastic valley filled, it is difficult to visually inspect the cables without removal of the coating. As a result, the cable inspection process includes using an electromagnetic testing device whereby the cable will be inspected on a quarterly basis to detect any potential abnormalities. The electromagnet inspection results are evaluated to ensure maximum loss of cable area does not exceed 15 percent.

Cable stretch criteria was developed with the cable manufacturer and EYE to determine the maximum allowable stretch on the cable. Cable stretch is measured any time a cable is re-tensioned to its nominal pretension value. The cumulative cable stretch is evaluated to ensure the cables have not exceeded the maximum allowable cable stretch of 0.3 percent.

The cable maintenance plan includes conducting a detailed post-operational assessment of the first two (2) cables which have been removed from service. The analysis will be conducted on suspect sections of each cable and will include a forensic evaluation and destructive testing to refine the criteria for maximum allowable loss of area and cable stretch.

CONCLUSION

A cable maintenance program has been developed to ensure a safe and reliable cable system, which includes installation and change-out procedures, cable load monitoring, cable condition inspections and programmed cable replacements commensurate with cable wear and loading experience. The report developed by E.Y.E. Marine Consultants provides a comprehensive set of criteria to assess the condition of a cable, to ensure that the designed Factor of Safety will maintained the throughout the operational lifespan of each cable.

Each cable will have a notional operational service life of three years. Initially, the cables will be rotated annually from the center drive cable position to either of the guide cable locations, where the replaced cable would remain for two years. This procedure is considered to be both prudent and safe and may be modified with operational data, experience and engineering review.

DECISION REQUEST

On the basis of the attached report outlining the cable inspection, cable re-tensioning and cable discard criteria developed for the cable maintenance program for the Cable Ferry BAYNES SOUND CONNECTOR, the Recognized Organization (LR) is requested to recommend to the Marine Technical Review Board of Transport Canada Marine Safety that condition (e) is satisfied and can be closed.

Lloyd's Register Canada Limited

502-221 West Esplanade
North Vancouver, BC

Canada V7M 3J3

21 April 2022

Mr. Stephen Jones, Executive Director, Engineering
British Columbia Ferry Services Inc.
Suite 500 – 1321 Blanshard Street, Victoria BC V8W 0B7

Dear Steve,
MEMORANDUM ref. No. 1001132 is referred.
Considering condition "e" of the MTRB 14754, this is to confirm that Lloyd's Register will have no objection to the proposed wire rope replacement detailed in aforementioned Memorandum to be used on BAYNE SOUND CONNECTOR (BSC) provided all other conditions in MTRB 14754 as well as following conditions are followed:

1. Review of the new cable documentation / certificates.
2. confirmation that the new maintenance regime is implemented.
3. Confirmation that the new operation matrix is implemented.

Yours sincerely,
s. 22
[redacted]

Reza Z[redacted]

Operation Manager for Western North America

LRCL Vancouver office.

Cable Re-Tensioning Criteria and Discard Criteria

For the

Baynes Sound Connector

BY:	E.Y.E. MARINE CONSULTANTS
FOR:	BC FERRIES
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Contents

Appendices

Summary

This report describes the reasoning and limits for re-tensioning the cables for the *Baynes Sound Connector* and describes the methods for inspection and ultimate discard of a cable.

Cable Retensioning

Safety Factor and Drift Criteria

To determine when it will be necessary to re-tension a cable that has lost tension over time, a series of calculations have been completed. The first set of calculations evaluated the ferries drift off course and the load on each cable during 100 year storm conditions in four scenarios. The 100 year storm conditions were taken as a 20 m/s wind speed, 1 m/s current speed, and 1 m high waves all on the beam of the vessel. The scenarios were evaluated in an extreme weather condition because it is only in these conditions that we will see critical loads occurring in a cable, when one or more cables have lost tension and is no longer sharing an equal part of the loads. During calm conditions, the side loads on the ferry are small, and there is no large increase in cable tension as the ferry crosses the channel. Therefore critical loads on the cable to not occur in calm conditions, even when one cable has lost tension and the other two cables have to carry the load.

The four evaluated scenarios were as follows:

- one guide cable loses tension
- both guide cables lose tension
- the drive cable loses tension
- all three cables lose tension

For each scenario the tension in the subject cable was started at 20 tonnes and then dropped at 5% intervals until minimum criteria was met. The minimum criteria were when the safety factor in any of the three cables dropped to 3.0 or below and if the drift of the ferry exceeded 100 m.

Slippage Criteria Drive Cable

The next calculation looked at the drive cable only. This calculation was done to determine the minimum tension necessary to eliminate slippage. In this case slippage is defined as the point when the cable loses traction in the bullwheel grove and begins to slip. Slippage will occur when the ratio of the tension fore and aft of the ferry exceeds the number defined by the equations below. The ferry can exert a maximum pulling force of 5.45 tonnes. Therefore the cable tension forward of the ferry can be 5.45 tonnes tighter then the tension aft of the ferry. This means the minimum drive cable tension to eliminate slippage is 10.03 tonnes (1.84 x 5.45). This calculation is a simplification of the actual system but due to the length of the crossing and the quantity of cable on the ground it would be virtually impossible to model cable slippage any other way using static calculation methods.

$$\frac{T_1}{T_2} = e^{f(\mu)\emptyset} = 1.84$$

Where:

T_1 = tension forward of the ferry

T_2 = tension aft of the ferry

$f(\mu)$ = 0.194 friction factor between the cable and bullwheel, related to the shape of the bullwheel groove and the coefficient of friction between the bullwheel and cable.

Θ = the angle contact between the bullwheel and the cable. 360° for the Denman Ferry but will be taken as 180° to give margin of safety.

Results of Minimum Tension Calculations

The results for these calculations were:

- When one guide cable lost tension the minimum criteria was met when then tension dropped to 12 tonnes (a 40% drop).
- When both guide cables lost tension the minimum criteria was met when the tension dropped to 16 tonnes (a 20% drop).
- When the drive cable lost tension the minimum criteria was met when the tension dropped to 11 tonnes (a 45 % drop).
- When all three cables lost tension the minimum criteria for loading and drift was met when cable tensions dropped to 5 tonnes, but slippage will occur at 10 tonnes so cable tension should not be allowed to go this low.

Detailed results for these calculations can be seen in tables 1 - 4.

Table 1 One Guide Cable Loses Tension

	Drive Cable	North Guide	South Guide	Drift (m)
Tension (MT) Safety Factor	20 3.13	20 3.14	20 3.14	82.01
Tension (MT) Safety Factor	20 3.11	20 3.13	19 3.22	82.33
Tension (MT) Safety Factor	20 3.1	20 3.11	18 3.28	82.6
Tension (MT) Safety Factor	20 3.07	20 3.09	17 3.38	83.04
Tension (MT) Safety Factor	20 3.06	20 3.08	16 3.44	83.25
Tension (MT) Safety Factor	20 3.05	20 3.06	15 3.53	83.58
Tension (MT) Safety Factor	20 3.03	20 3.05	14 3.61	83.88
Tension (MT) Safety Factor	20 3.02	20 3.03	13 3.7	84.18
Tension (MT) Safety Factor	20 3	20 3.01	12 3.79	84.47

Minimum criteria met when tension in one guide cable falls to 12 tonnes

Table 2 Two Guide Cables Lose Tension

	Drive Cable	North Guide	South Guide	Drift (m)
Tension (MT)	20	20	20	82.01
Safety Factor	3.13	3.14	3.14	
Tension (MT)	20	19	19	82.65
Safety Factor	3.11	3.2	3.2	
Tension (MT)	20	18	18	83.2
Safety Factor	3.07	3.25	3.25	
Tension (MT)	20	17	17	84.09
Safety Factor	3.02	3.32	3.32	
Tension (MT)	20	16	16	84.53
Safety Factor	3	3.37	3.37	

Minimum criteria met when tension in both guide cables fall to 16 tonnes

Table 3 Drive Cable Loses Tension

	Drive Cable	North Guide	South Guide	Drift (m)
Tension (MT)	20	20	20	82.01
Safety Factor	3.13	3.14	3.14	
Tension (MT)	19	20	20	82.33
Safety Factor	3.2	3.13	3.13	
Tension (MT)	18	20	20	82.59
Safety Factor	3.26	3.11	3.11	
Tension (MT)	17	20	20	83.63
Safety Factor	3.36	3.06	3.09	
Tension (MT)	16	20	20	83.63
Safety Factor	3.42	3.08	3.08	
Tension (MT)	15	20	20	83.57
Safety Factor	3.5	3.06	3.06	
Tension (MT)	14	20		83.87
Safety Factor	3.59	3.05	3.05	
Tension (MT)	13	20	20	84.17
Safety Factor	3.67	3.03	3.03	
Tension (MT)	12	20	20	84.46
Safety Factor	3.76	3.02	3.02	
Tension (MT)	11	20	20	84.72
Safety Factor	3.84	3.01	3.01	
Tension (MT)	10	20	20	85.00
Safety Factor	3.94	2.99	2.99	

Minimum criteria met when drive cable tension falls below 11 tonnes, coincidently this also the close to the tension where the risk of slippage occurs.

Table 4 All Cables Lose Tension

	Drive Cable	North Guide	South Guide	Drift (m)
Tension (MT) Safety Factor	20 3.13	20 3.14	20 3.14	82.01
Tension (MT) Safety Factor	19 3.16	19 3.18	19 3.18	82.98
Tension (MT) Safety Factor	18 3.19	18 3.21	18 3.21	83.8
Tension (MT) Safety Factor	17 3.24	17 3.26	17 3.26	85.16
Tension (MT) Safety Factor	16 3.27	16 3.29	16 3.29	85.84
Tension (MT) Safety Factor	15 3.31	15 3.33	15 3.33	86.9
Tension (MT) Safety Factor	14 3.35	14 3.37	14 3.37	87.89
Tension (MT) Safety Factor	13 3.38	13 3.41	13 3.41	88.87
Tension (MT) Safety Factor	12 3.42	12 3.44	12 3.44	89.86
Tension (MT) Safety Factor	11 3.45	11 3.48	11 3.48	90.77
[redacted]				
Tension (MT) Safety Factor	9 3.56	9 3.59	9 3.59	93.66
Tension (MT) Safety Factor	8 3.62	8 3.65	8 3.65	95.28
Tension (MT) Safety Factor	7 3.69	7 3.72	7 3.72	97.11
Tension (MT) Safety Factor	6 3.77	6 3.8	6 3.8	99.20
Tension (MT) Safety Factor	5 3.84	5 3.88	5 3.88	101.36

Minimum criteria for loading and drift met when cable tensions drops to 5 tonnes, but slippage will occur at 10 tonnes so cable tension should not be allowed to go this low.

Procedure for Determining if Re-tensioning is required

The tensions in the cable are recorded throughout each week and the weekly average is determined. The tensions are recorded from the pin readings on Denman Island, and modified by the individual correction factors for each pin to correlate with the actual tension at Buckley Bay.

1. The minimum allowable tension in any of the three cables shall be 26000 lbs.
2. The sum of the tensions between all three cables must meet the criteria listed in Table 5:

Table 5 Cable Tension Criteria

Max Tension in any one Cable (lbs to nearest thousandths)	Sum of Tensions of all three Cables to be greater than lbs to the nearest thousandths)
44000	115000
42000	104000
40000	99000
37000	90000
35000	88000
33000	86000
31000	84000
29000	82000
26000	79000

The spreadsheet titled "LoadCell Data SumR4" can be utilised to evaluate the requirements for re-tensioning.

Cable Tension Correction Factors

The cable tensions measured by load cell at Denman West do not match the cable tensions recorded at Buckley Bay during cable installation. The criteria described in Table 5 are based on a preliminary cable tension of 20 tonnes (44,000 lbs), which is what was recorded at Buckley Bay at the time of installation. In order to use Table 5, the cable tension recorded by the load cell at Denman west must be multiplied by the following correction factors:

- North Guide Cable Factor = 1.35
- Drive Cable Factor = 1.46
- South Guide Cable Factor = 1.59

In the event that the correction factors are recalculated or reset, these values need to be recorded in the spreadsheet to ensure that the actual loads are being recorded and compared to the re-tensioning criteria. The instructions for revising the correction factors are detailed in the spreadsheet.

Warning limits

The system of measuring cable tensions at Denman Island has the capability to send alerts to BC Ferries as an early warning system that cables may need adjustment. There are two suggested limits, a lower limit to indicate when drive slippage might occur, and an upper limit to indicate when cables are being stressed to design limits.

The following limits are suggested:

Table 6 Warning Limits

	Reason	Load in lbs	Time
Lower Limit	Possible Cable Slippage and approaching suggested lower limit before re-tensioning	20,000 lbs, direct load reported without application of the correction factors	30 minutes
Upper Limit	To indicate when cables are being loaded above normal design limits such as storm conditions.	70,000 lbs, direct load reported without application of the correction factors	10 seconds

The time is the length of time that the condition exists before sending a message to BC Ferries. This is to avoid loads of short term duration from overwhelming the reporting system and masking issues that need attention.

Data Recording

BC Ferries records the data continuously and the weekly averages are input to an excel spreadsheet. This spreadsheet has been edited to incorporate the action required regarding re-tensioning of the cable. A sample copy of the spreadsheet is included in *Appendix A*.

Worst Operating Condition With 15% Loss in Cable Strength

Athwartship loads from 55 Knots of wind, a 1.87 Knot current, and 1.5 m waves are applied to the ferry. The ferry is travelling at 7.0 knots.

Table 7 Minimum Safety Factors in Extreme Conditions

	Pre-Tension	Tension at Mid channel		Safety Factor
	(MT)	(kN)	(MT)	
Drive Cable	20	471	48.02	2.01
North Guide Cable	12	363	36.97	2.61
South Guide Cable	12	363	36.97	2.61

Summary of Re-tensioning Criteria

When the criteria above is applied, it will ensure that the safety factor on each individual cable will remain above 3.0 during normal operations with the full strength of the cables

When all of the cables have deteriorated to a point that they have lost 15% of their initial area, the Factor of Safety on any cable will be greater than 2.0 during storm conditions with cable tensions at the extreme ranges. While it is unlikely that all of these conditions would exist at the same time (3 cables at the discard limit and at the outside range for re-tensioning), the discard criteria has been set at 15 % loss of area to prevent a condition existing where there could be a sequential loss of cables with a single cable break.

Cable Discard Criteria

Very little information is available for cable discard criteria for plastic valley filled cables that are used in non-lifting or non-hoisting operations. There are however, standards that can be used as guidance to determine the discard criteria.

Two relevant cable standards were investigated to determine a suitable criteria for cable ferries. They are *ISO 4309 Cranes-Wire Ropes-Care and Maintenance, Inspection and Discard* and *API In-Service Inspection of Mooring Hardware for Floating Structures.*

Visual Inspection of the Cables

Table 8 lists the two relevant criteria that were utilised to formulate the BC Ferries criteria (shown in the right hand column). Any defects noticed in the cable during daily operations or formal inspections which are performed every 3 months shall be compared to the ISO standards (Appendix B) to determine severity. The type and locations of any cable discrepancies shall be recorded in a format similar to the example in Appendix D.

Table 8 Discard Criteria Comparison

Discard Criteria		*ISO 4309 Cranes-Wire Ropes-Care and maintenance, inspection and discard*	*API In-Service Inspection of Mooring Hardware for Floating Structures*	BC Ferries Criteria
Wire Strand Break	Visible	Complete Discard Immediately (6.4)	3 or more wires in one strand	Wire breaks cannot be detected reliably with plastic valley filled cable. Monitoring by ultrasonic methods to determine loss of area and direct measurement of cable stretch over time will be utilised to determine condition.
Wire Breaks occurring randomly	Visible	3 in 6d or 6 in 30d (6.2)	8 in one lay length ie 6.5d	Wire breaks cannot be detected reliably with plastic valley filled cable. Monitoring by ultrasonic methods to determine loss of area and direct measurement of cable stretch over time will be utilised to determine condition.
Localised grouping of wire breaks	Visible	one or two neighboring strands (6.2)	not covered directly	Wire breaks cannot be detected reliably with plastic valley filled cable. Monitoring by ultrasonic methods to determine loss of area and direct measurement of cable stretch over time will be utilised to determine condition.
Valley wire breaks	Visible	2 or more breaks in a rope lay 6d (6.2)	more than two adjacent wires	Valley wire breaks cannot be detected reliably with plastic valley filled. Monitoring by ultrasonic methods to determine loss of area and direct measurement of cable stretch over time will be utilised to determine condition.
Wire breaks at a terminal	Visible	2 or more (6.2)	3 or more within 12 inches of termination.	3 Wire breaks within 12” of the terminal requires relocation outside of the tensioned area or discard

Decrease in diameter	Measured	7.5% reduction in diameter (6.3)	8% reduction in area	A decrease in diameter of 7.5% (less than 1.50" in one location would require relocation outside the tensioned area or discard
External Corrosion	Visible	Wire surface pitted and slack wires (6.5)	not covered directly	Unlikely to be observed with Plastic Valley filled cables. BC Ferries will rely on ultrasonic area loss criteria and direct measurement of the cable stretch to determine condition of the cable.
Internal Corrosion	Visible	Obvious visible signs of internal corrosion(6.5)	Observed internal corrosion	An increase in diameter coinciding with decreased area measurement would indicate internal cable deterioration that would require cable replacement.
Fretting Corrosion	Visible	(Not likely to be seen in ferry application)	not covered directly	Fretting Corrosion cannot be detected with plastic valley filled cables. BC Ferries will rely on ultrasonic area loss criteria and direct measurement of the cable stretch to determine condition of the cable.
Visibly damaged, kinking, bending or flattening	Visible	a kink or core protrusion is grounds for removal 6.6.6, 6.6.7, 6.6.8, 6.6.4, 6.6.5	Severe deformation means discard	Severe deformation means discard unless the deformed part of the cable can be relocated outside of the tensioned areas (beyond anchors)
Wear and Stretch	Measured	Not covered directly	Average of 3 measured diameter is less than 94% of nominal	Average of 3 measured diameter is less than 1.53". See also measurement of stretch during re-tensioning

References to Sections in the ISO standard refer to Annex B which is included as *Appendix B*.

Note that the measurement of diameters definition of lay length are included in *Appendix C*.

The ISO criteria was developed for overhead cranes where the failure of a crane wire rope would have catastrophic consequences, and as a result the criteria for discard are higher than is warranted for a Cable Ferry.

The API criteria was developed for marine cables used as moorings for offshore rigs where access for inspection is more difficult than a cable ferry where the cables are brought to the surface during every crossing resulting in good access for visual inspection.

Due to the cable being plastic valley filled it is difficult to visually inspect the cables without removal of the coating. As a result, the inspection of the cables must incorporate other non-destructive methods to determine the condition.

Ultrasonic methods should be utilised to determine the loss of area and subsequent loss of strength. It is recommended that the cables are inspected quarterly to determine the loss of area. The location and percent loss of area should be recorded for each cable so that the inspection results can be compared to previous reports. Note that previous non-destructive reports have approximated individual wire breakage as a result of loss of area. Since the cable construction is quite complex, it is recommended to report the inspection results as a percent loss of metallic area in order to accurately evaluate against criteria for loss of area.

Figure 1 Cable Cross Section provided by Wire Rope Industries for the original cable construction

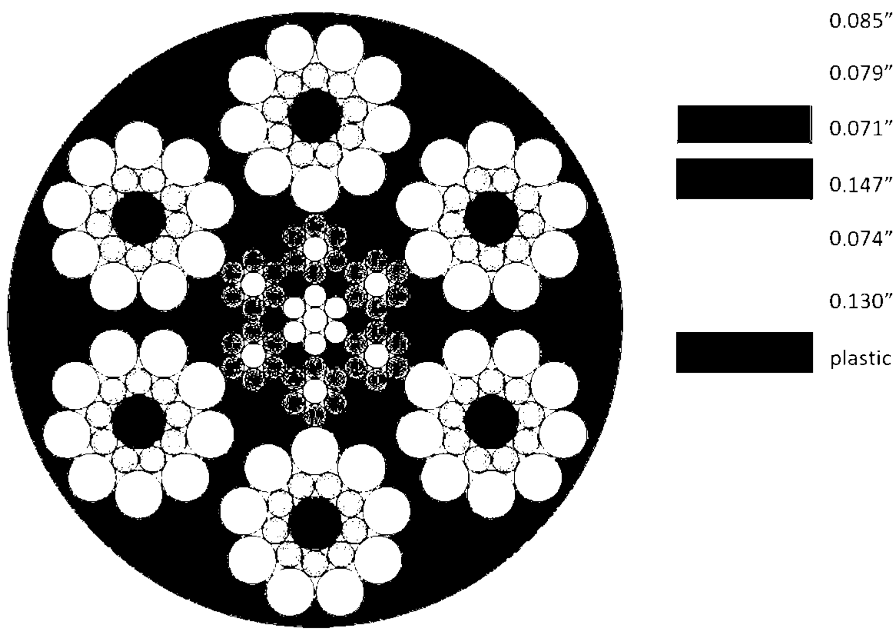


Table 9 Cable Construction Provided by Wire Rope Industries

Wire Colour in Figure 1	Quantity of Wires	Diameter inches	Area/Wire Inches ^2	Area of all similar Wires
Pink	1	0.085	0.0057	0.0057
Yellow	12	0.079	0.0049	0.0588
Grey	36	0.071	0.0040	0.1425
Black	6	0.147	0.0170	0.1018
Salmon	54	0.074	0.0043	0.2323
Light grey	54	0.13	0.0133	0.7168
Total				1.2580

The specification for the cable purchased for the ferry is included in *Appendix E.* Should the cables change from this specification the values in table 9 may change.

Visible Wire Breaks would likely only be seen in the light grey layer (the crown wires) since these are on the surface. 8 wire breaks in one lay length would represent a reduction in area of 0.1062in^2 or 8.44%. The important thing to consider is that if there are 8 visible breaks there may be more hidden breaks which further reduce the area and strength of the remaining wire. 8 visible breaks should therefore be used in conjunction with the loss of area measurements to confirm the discard of the cable.

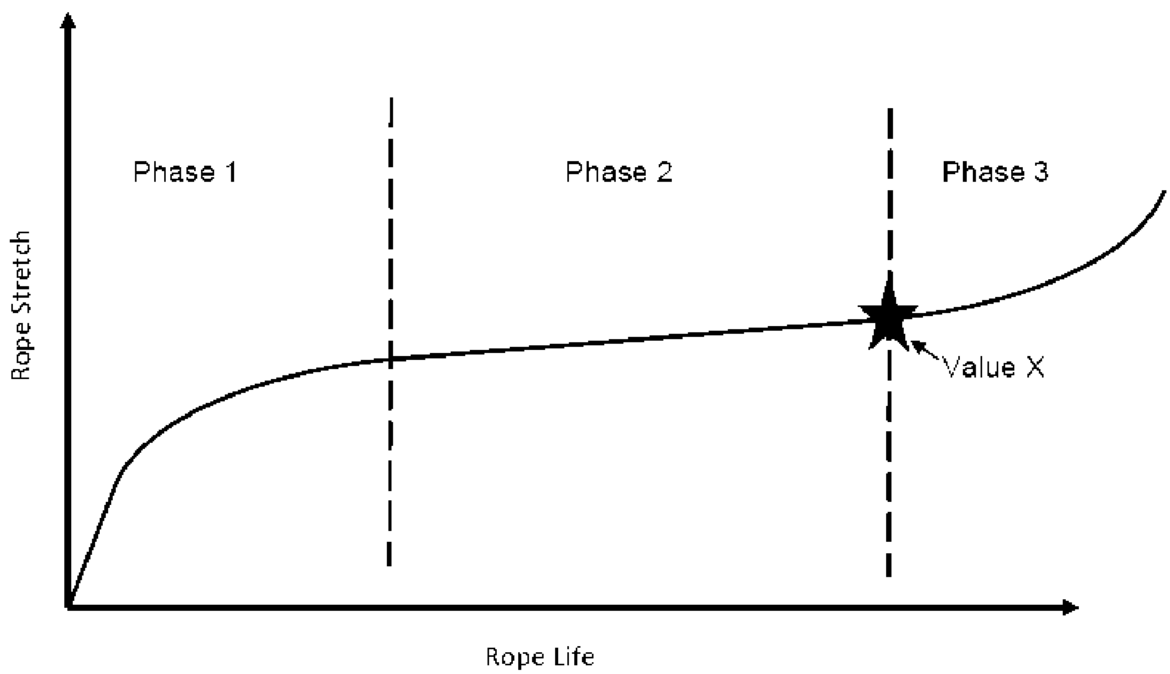
Cable Stretch Criteria

The manufacturer of the cable provided information on Stretch vs Rope Life which can be plotted against a time basis to determine discard criteria as a result of re-tensioning the cable. It is recommended that a section of discarded cable is destructively tested by Wire Rope Industries to validate the stretch vs remaining strength as a percentage of total length.

The figure below shows the three phases throughout the life of a cable as they relate to stretch.

Figure 2 Information provided by Wire Rope Industries

The wire rope user manual* states that all wire ropes undergo 3 cycles of stretch in their life span. This stretch can be represented by a 3 phase graph as shown below.



Phase 1 represents initial stretch caused by the rope adjusting to operating conditions. This is also known as constructional stretch. As the cable for BC Ferries was prestretched, we expect this phase to be short lived.

Phase 2 shows a slight increase of stretch over a long period of time which results from normal wear and fatigue. This phase represents normal operating conditions for wire rope.

Phase 3 marks the beginning of accelerated stretch. The rope in this phase is showing signs that it is near the end of its life.

The cable manufacturer recommends discarding the cable when it has exceeded 0.3% stretch (18.70 ft). The change in cable length must be measured any time a cable is re-tensioned to its nominal pretension value. The results must be plotted to determine if the cables have exceed 0.3% stretch. See example in *Appendix D*

The loss of cable area that would result in a minimum factor of safety of 2.0 in the worst anticipated condition was determined to be 15 % loss of area. The ISO criteria refers to a discard criteria of 7.5% loss of diameter and this is approximately a 15% reduction in cross sectional area and an equivalent loss of strength. All of the cables being used to guide and drive the ferry can be reduced by 15 % area and this would result in factor of safety of greater than 2 in the storm conditions. Ferries fitted with single cables in the Maritimes use a Factor of Safety of 2 during operations with wind and waves. While a single-cable ferry is more at peril in the event of a cable breakage, as this would result in the ferry having to anchor to hold position, the ferries on shorter routes are not subjected to the higher winds and fetch that exists on a longer route.

Summary of Cable Discard Criteria

Visual Inspection - compare condition of cable to visual standards in the ISO standard which are copied in Appendix C and determine severity. The defects found and location on each cable shall be recorded.

Diameter Measurement- measure diameter in suspect areas and record location and diameter. A 7.5% loss of diameter (diameter less than 1.50 inches) is approximately equal to 15 % loss of area. (Area reduced by 0.189 inches^2)

Ultrasonic Measurement NDT inspection is done every 3 months, and the areas with loss of area to be recorded for each cable. 15% loss of area represents the maximum loss of cable before a cable is discarded or a damaged section is moved outside of the tensioned area.

Stretch on Cable should be measured at any time a cable is re-tensioned to its nominal pretension value. The results to be plotted to determine if the cables have exceeded 0.3% stretch.

Monitor the cable tensions system to identify peak loads and the frequency of the pulsating load to determine if peak loads or fatigue are affecting the cable lifespan.

A spreadsheet is provided to record both visual and NDT measurements as well as to plot the stretch measurements. Required actions on exceeding the criteria are identified. A sample of the spreadsheet is included in *Appendix D* of this report.

Appendix A

Sample Cable Criteria Spreadsheet

Draft Copy - Load Cell Retensioning Criteria Table

Instructions :

1. Data Input:
Log-in to the remote monitoring system and record the following parameters in the table below:
- Date (format must be: yy-mm-dd)
- Weekly Average Tension (Pin 1 = North Guide Cable, Pin 2 = Drive Cable, Pin 3 = South Guide Cable)
- Weekly Maximum Tension (Pin 1 = North Guide Cable, Pin 2 = Drive Cable, Pin 3 = South Guide Cable)
- Weekly Minimum Tension (Pin 1 = North Guide Cable, Pin 2 = Drive Cable, Pin 3 = South Guide Cable)

2. Correction Factors:
Correction Factors are used to correlate the load cells with actual loads recorded at Buckley Bay. Correction Factors are unique to each load cell and are based on a preliminary cable tension of 20 tonnes (44,000 lbs), which is what was recorded at Buckley Bay at the time of each cable installation. Correction Factors must be revised if cables are replaced, retensioned or if a load cell is replaced.

3. Retensioning Criteria:
Review the four cable retensioning criteria columns and determine if cable tensions are "OK" or if "Retensioning" is required.

4. General Notes:
Record specific notes regarding revised correction factors, cable replacement or retensioning dates, load cell replacement, etc

5. Graph
Refer to the "Tension Graph" tab to review the cable tensions

	Pin 1 (North Guide Cable)					Pin 2 (Drive Cable)					Pin 3 (South Guide Cable)					Retensioning Criteria Action: [Ok or Retension]			
Date, End of 7 Day Average (yy-mm-dd)	7 Day Average (lbs)	7 Day Max (lbs)	7 Day Min (lbs)	Correction Factor	7 Day Average with Correction Factor (tonnes)	7 Day Average (lbs)	7 Day Max (lbs)	7 Day Min (lbs)	Correction Factor	7 Day Average with Correction Factor (tonnes)	7 Day Average (lbs)	7 Day Max (lbs)	7 Day Min (lbs)	Correction Factor	7 Day Average with Correction Factor (tonnes)	Pin 1 North Guide Cable	Pin 2 Drive Cable	Pin 3 South Guide Cable	Combined Cables
31/01/2016	32,726	48,371	24,299	1.35	20.0	30,178	45,095	18,282	1.46	20.0	27,690	40,703	19,573	1.59	20.0	OK	OK	OK	OK
05/02/2016	33,047	46,370	24,104	1.35	20.2	32,259	49,013	19,566	1.46	21.4	28,097	40,169	19,267	1.59	20.3	OK	OK	OK	Recheck Data
12/02/2016	32,554	45,308	23,558	1.35	19.9	33,480	49,122	19,210	1.46	22.2	27,577	39,086	18,783	1.59	19.9	OK	OK	OK	Recheck Data
19/02/2016	32,283	47,709	23,726	1.35	19.8	37,711	53,449	23,115	1.46	25.0	27,189	40,459	18,829	1.59	19.6	OK	OK	OK	Recheck Data
25/02/2016	32,281	45,905	23,420	1.35	19.8	32,477	47,790	10,801	1.46	21.5	27,082	40,058	18,719	1.59	19.5	OK	OK	OK	Recheck Data
04/03/2016	32,402	46,892	-	1.35	19.8	31,367	50,775	-	1.46	20.8	27,010	40,191	-	1.59	19.5	OK	OK	OK	OK
11/03/2016	31,986	47,629	23,227	1.35	19.6	36,572	57,021	20,455	1.46	24.2	26,661	42,254	18,336	1.59	19.2	OK	OK	OK	Recheck Data
18/03/2016	31,718	45,743	-	1.35	19.4	No Data	-	-	1.46		26,464	40,517	-	1.59	19.1	OK	No Data	OK	No Data
25/03/2016	31,427	43,107	-	1.35	19.2	No Data	-	-	1.46		26,381	37,554	18,442	1.59	19.0	OK	No Data	OK	No Data
01/04/2016	31,435	44,288	22,978	1.35	19.2	34,341	56,848	21,339	1.46	22.7	26,140	38,460	17,989	1.59	18.9	OK	OK	OK	Recheck Data
08/04/2016	31,604	44,920	22,605	1.35	19.4	34,672	55,802	21,712	1.46	23.0	26,318	40,086	18,171	1.59	19.0	OK	OK	OK	Recheck Data
15/04/2016	31,127	42,768	23,016	1.35	19.1	31,958	49,814	20,979	1.46	21.2	25,870	37,293	18,269	1.59	18.7	OK	OK	OK	Recheck Data
22/04/2016	31,294	43,053	-	1.35	19.2	32,852	48,695	-	1.46	21.8	25,918	37,754	-	1.59	18.7	OK	OK	OK	Recheck Data
29/04/2016	31,044	43,214	-	1.35	19.0	31,356	49,483	-	1.46	20.8	25,678	36,962	-	1.59	18.5	OK	OK	OK	OK
06/05/2016	31,100	44,356	-	1.35	19.0	32,530	78,093	-	1.46	21.5	25,633	38,551	-	1.59	18.5	OK	OK	OK	Recheck Data
13/05/2016	30,912	43,146	22,683	1.35	18.9	29,792	46,043	18,423	1.46	19.7	25,393	37,354	17,698	1.59	18.3	OK	OK	OK	OK
20/05/2016	31,145	43,230	22,442	1.35	19.1	29,464	47,037	17,251	1.46	19.5	25,188	36,785	17,247	1.59	18.2	OK	OK	OK	OK
27/05/2016	31,029	43,800	22,458	1.35	19.0	28,458	45,312	16,279	1.46	18.8	24,882	36,770	16,729	1.59	17.9	OK	OK	OK	OK
03/06/2016	31,176	43,965	21,870	1.35	19.1	29,569	46,042	16,326	1.46	19.6	24,445	37,041	16,400	1.59	17.6	OK	OK	OK	OK
10/06/2016	29,512	42,324	-	1.35	18.1	No Data	41,223	-	1.46		19,101	37,316		1.59	13.8	OK	No Data	OK	No Data
17/06/2016	30,516	-	-	1.35	18.7	No Data	-	-	1.46		20,920	-	-	1.59	15.1	OK	No Data	OK	No Data
24/06/2016	30,831	44,429	21,758	1.35	18.9	23,807	-	-	1.46	15.8	25,638	38,016	17,542	1.59	18.5	OK	OK	OK	OK
01/07/2016	30,937	44,256	22,159	1.35	18.9	23,781	38,543	10,931	1.46	15.7	25,804	38,416	17,566	1.59	18.6	OK	OK	OK	OK
08/07/2016	30,753	44,247	-	1.35	18.8	24,920	38,679	-	1.46	16.5	25,603	38,985	-	1.59	18.5	OK	OK	OK	OK
15/07/2016	30,527	42,416	-	1.35	18.7	30,411	44,394	-	**1.47**	20.3	25,456	36,797	-	1.59	18.4	OK	OK	OK	OK
22/07/2016	30,393	42,738	-	1.35	18.6	30,917	44,272	-	1.47	20.6	25,711	37,575	-	1.59	18.5	OK	OK	OK	OK
29/07/2016	30,439	43,438	-	1.35	18.6	29,880	43,801	-	1.47	19.9	25,918	38,033	-	1.59	18.7	OK	OK	OK	OK
05/08/2016	30,515	43,050	21,498	1.35	18.7	30,439	43,102	15,650	1.47	20.3	25,947	37,727	17,163	1.59	18.7	OK	OK	OK	OK
12/08/2016	30,319	42,117	21,356	1.35	18.6	28,791	42,795	16,801	1.47	19.2	25,734	37,936	17,301	1.59	18.6	OK	OK	OK	OK
19/08/2016	30,426	43,258	21,622	1.35	18.6	29,553	42,612	16,503	1.47	19.7	25,677	37,707	16,992	1.59	18.5	OK	OK	OK	OK
29/08/2016	30,421	42,940	21,762	1.35	18.6	29,466	42,535	16,694	1.47	19.6	25,760	37,377	17,365	1.59	18.6	OK	OK	OK	OK
05/09/2016	30,468	43,703	21,958	1.35	18.7	29,060	42,847	16,712	1.47	19.4	26,454	38,778	17,856	1.59	19.1	OK	OK	OK	OK

Appendix B

ISO 4309: Annex B

Annex B
(informative)

Typical modes of deterioration

Table B.1 shows the defects which can occur and the corresponding discard criteria. Figures B.1 to B.19 show a typical example of each defect.

Table B.1 — Defects occurring in wire rope

Figure	Defect	Clause /subclause reference
B.1	Wire protrusion	6.6.5
B.2	Core protrusion – Single-layer rope	6.6.4
B.3	Local reduction in rope diameter (sunken strand)	6.3
B.4	Strand protrusion/distortion	6.6.4
B.5	Flattened portion	6.6.7
B.6	Kink (positive)	6.6.8
B.7	Kink (negative)	6.6.8
B.8	Waviness	6.6.2
B.9	Basket deformation	6.6.3
B.10	External wear	5.3.1, Table 1 and E.2
B.11	External corrosion	6.5
B.12	Enlargement of Figure B.11	6.5
B.13	Crown wire breaks	6.2
B.14	Valley wire breaks	6.2
B.15	Protrusion of inner rope of rotation-resistant rope	E.4 c)
B.16	Local increase in rope diameter due to core distortion	6.6.6
B.17	Kink	6.6.8
B.18	Flattened portion	6.6.7
B.19	Internal corrosion	6.5

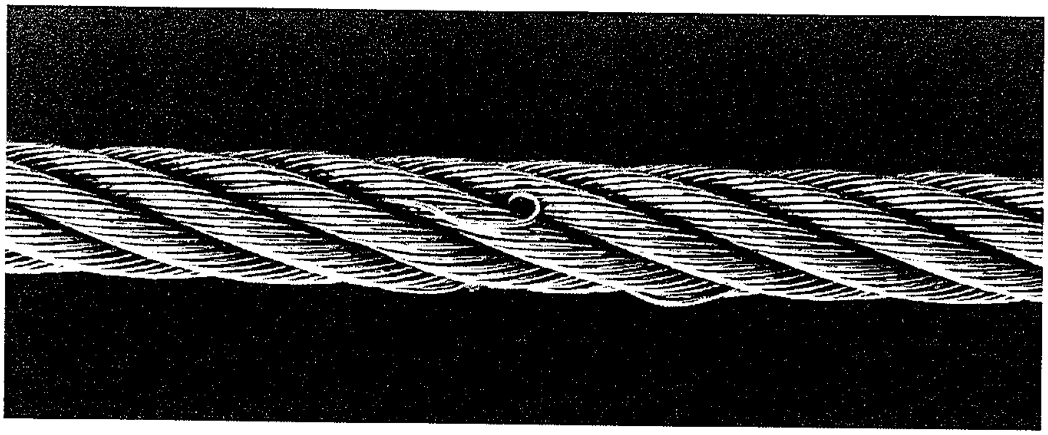


Figure B.1 — Wire protrusion

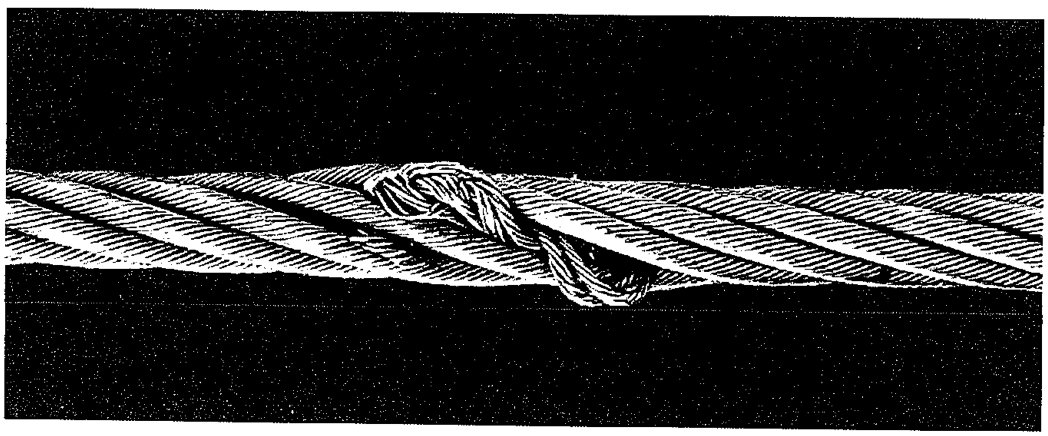


Figure B.2 — Core protrusion – Single-layer rope

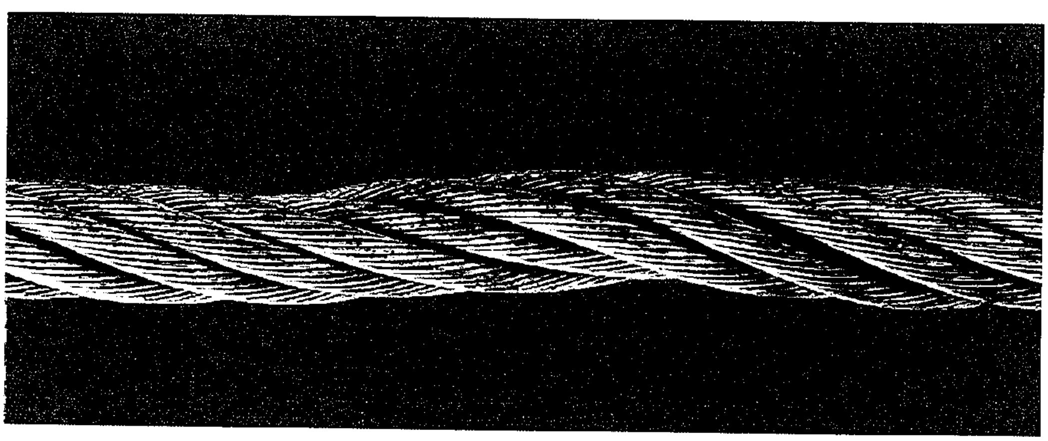


Figure B.3 — Local reduction in rope diameter (sunken strand)

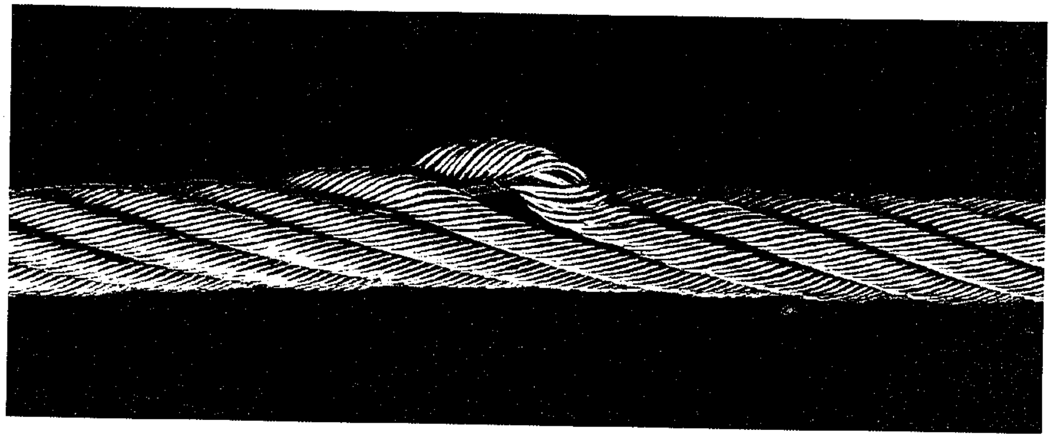


Figure B.4 — Strand protrusion or distortion

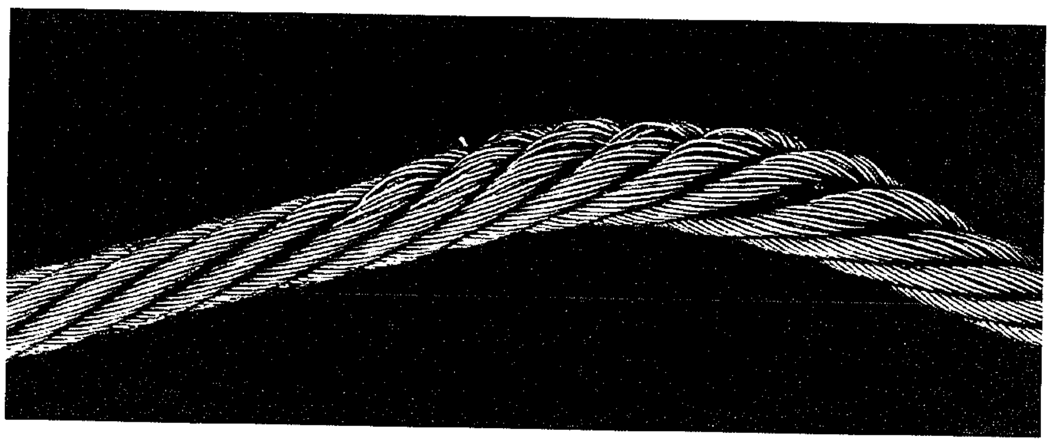


Figure B.5 — Flattened portion

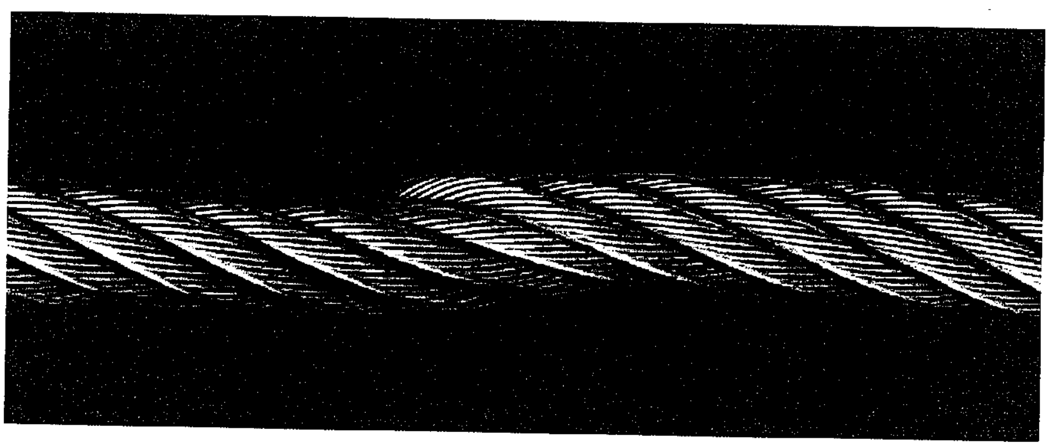


Figure B.6 — Kink (positive)

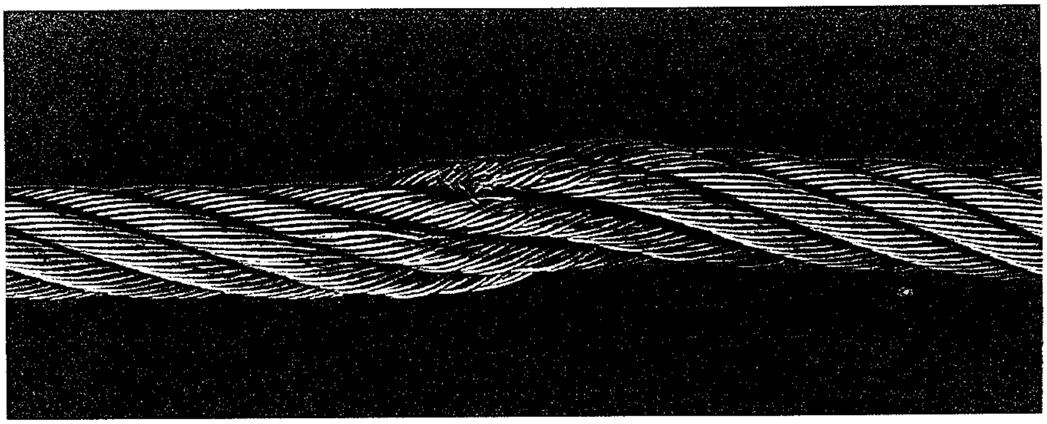


Figure B.7 — Kink (negative)

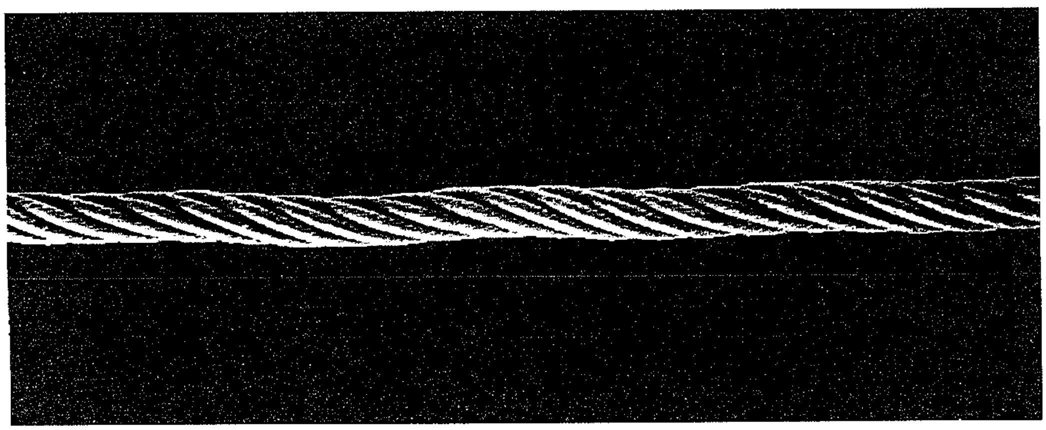


Figure B.8 — Waviness

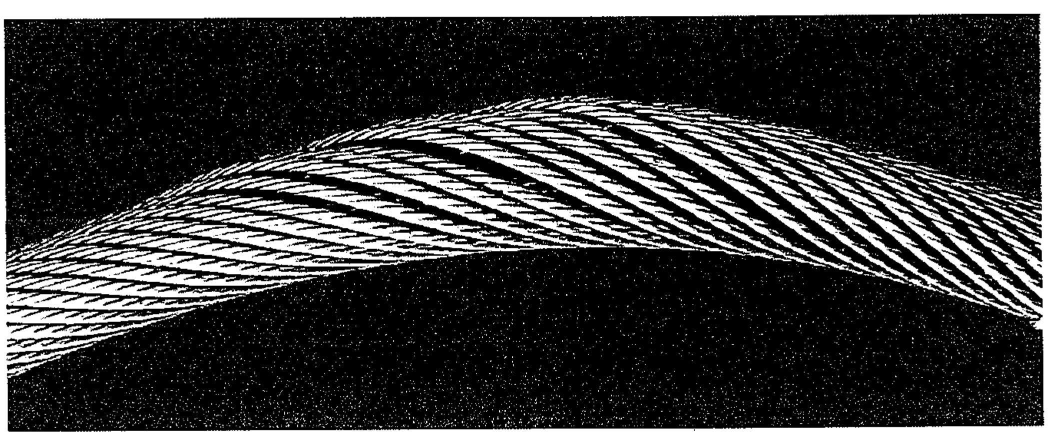


Figure B.9 — Basket deformation

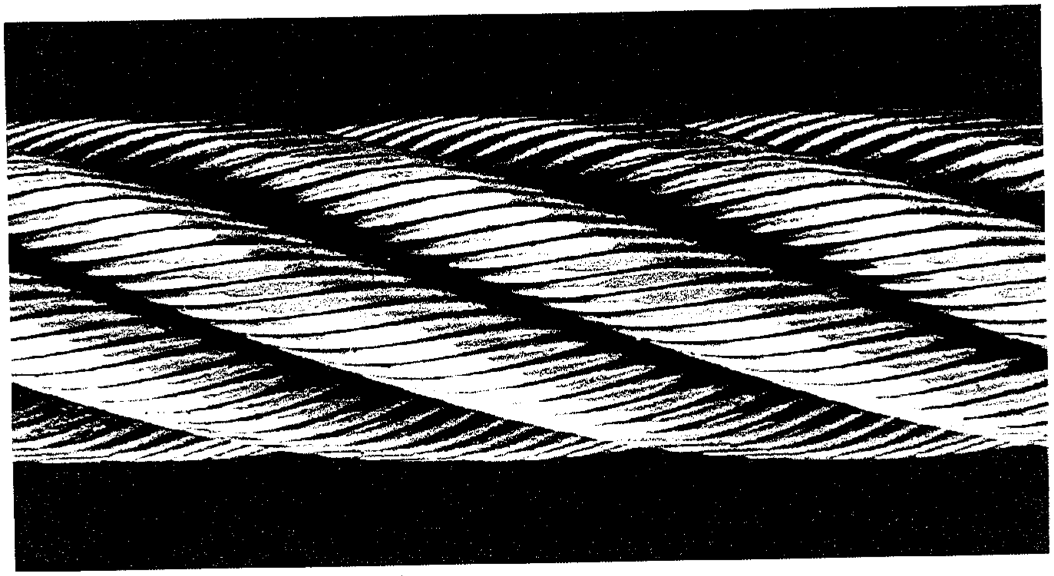


Figure B.10 — External wear

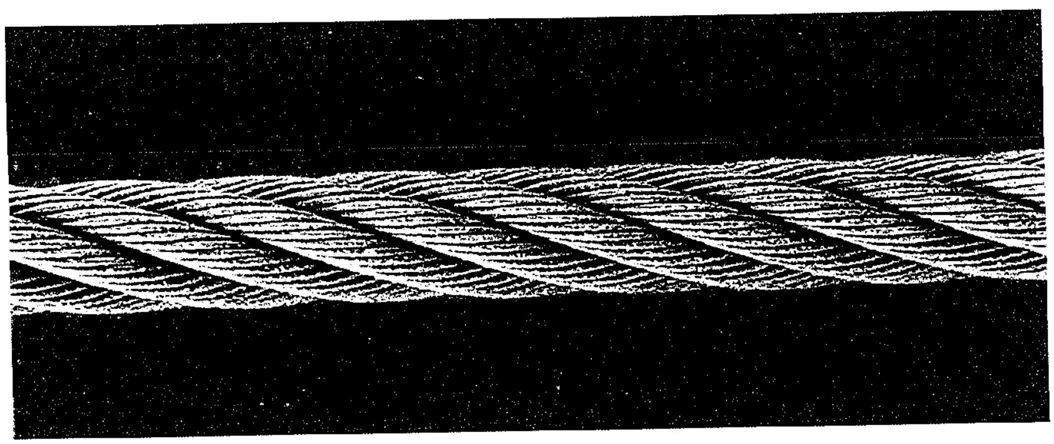


Figure B.11 — External corrosion

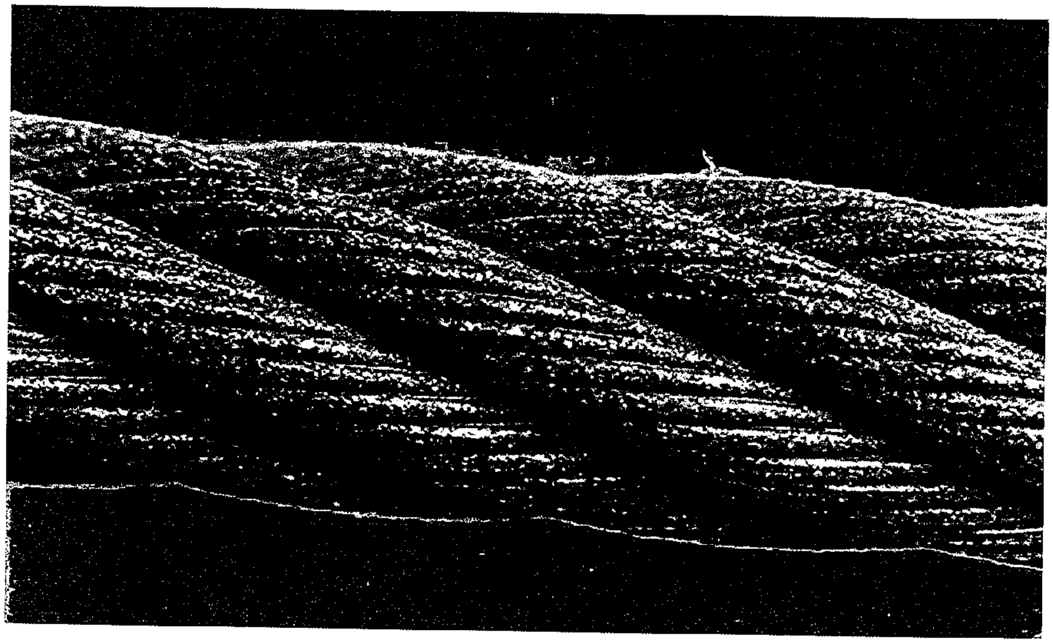


Figure B.12 — Enlargement of Figure B.11

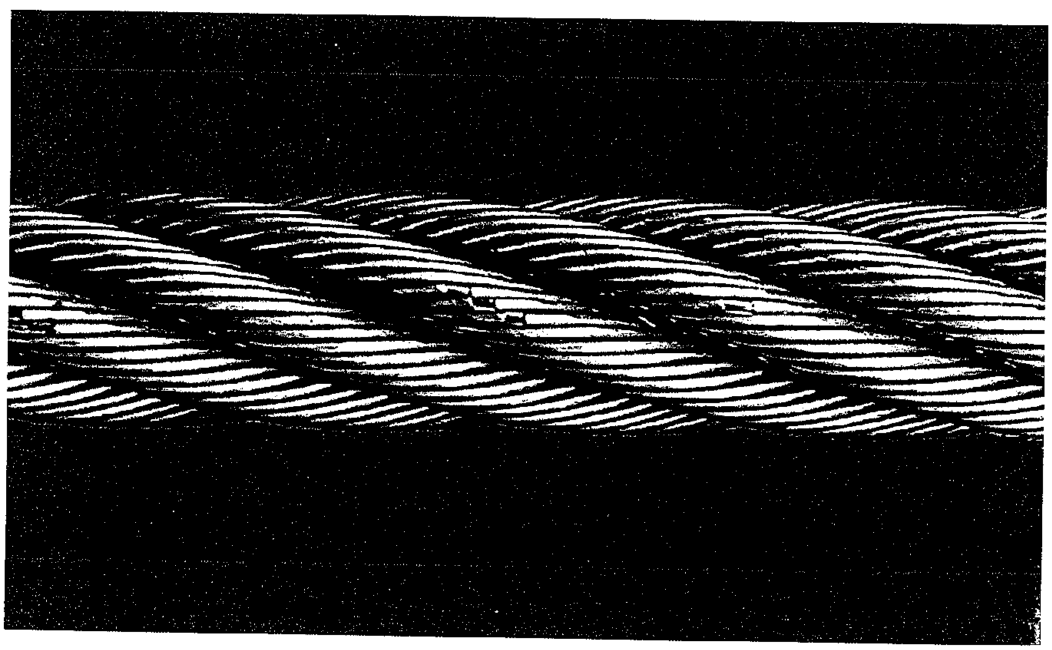


Figure B.13 — Crown wire breaks

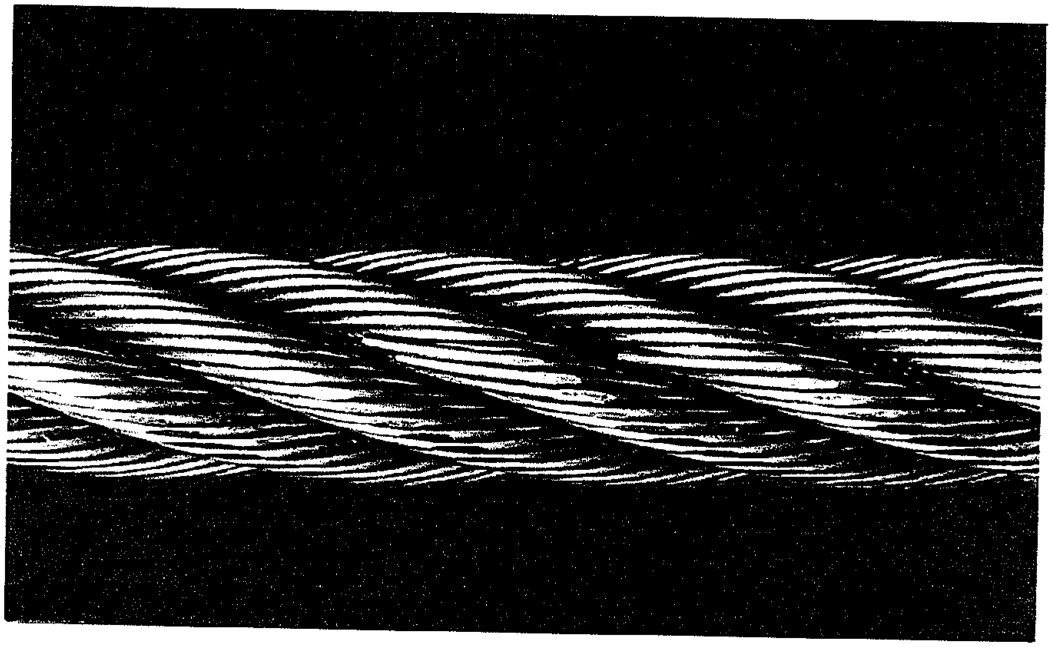


Figure B.14 — Valley wire breaks

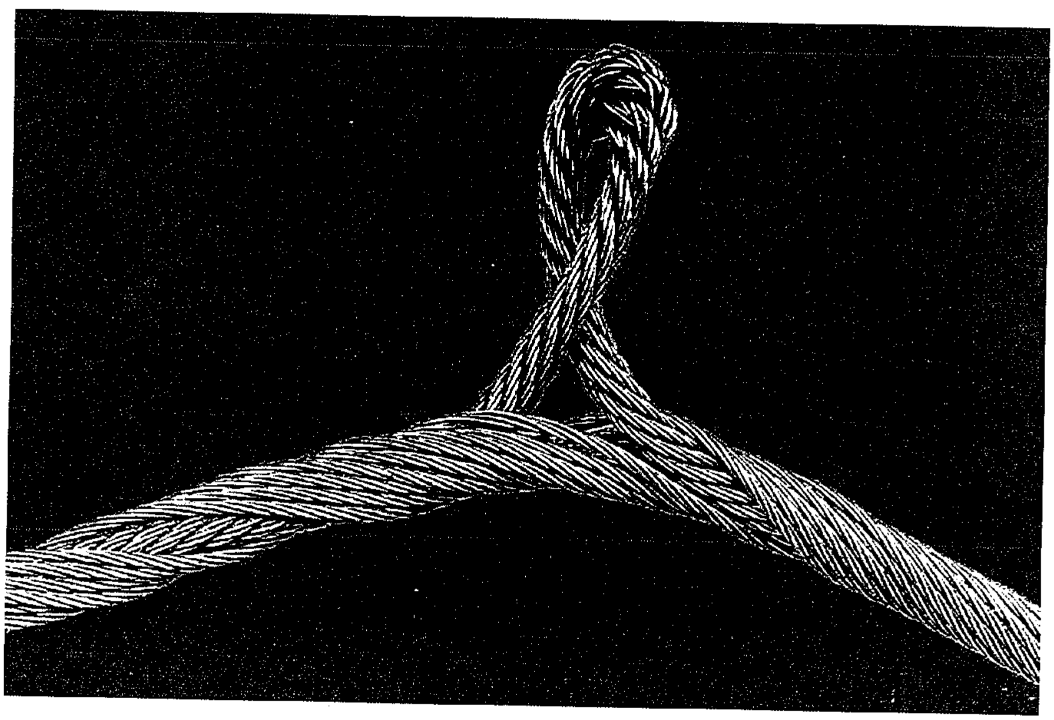


Figure B.15 — Protrusion of inner rope of rotation-resistant rope

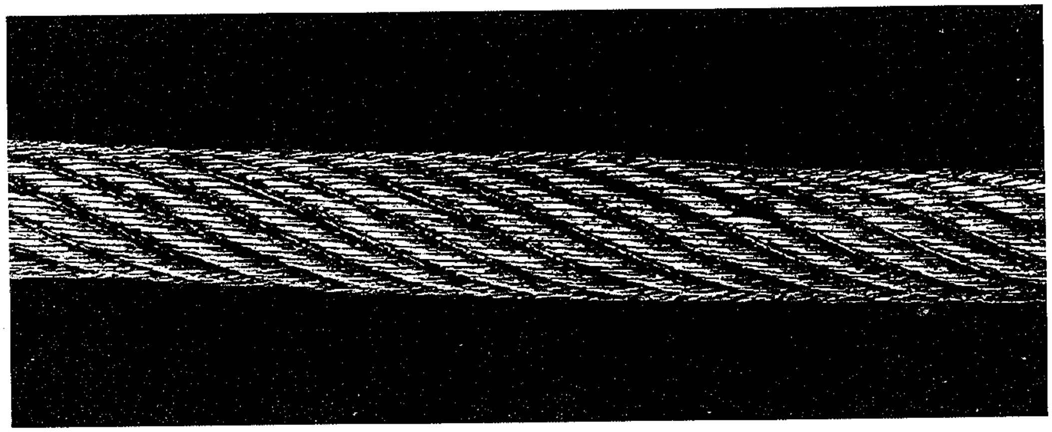


Figure B.16 — Local increase in rope diameter due to core distortion

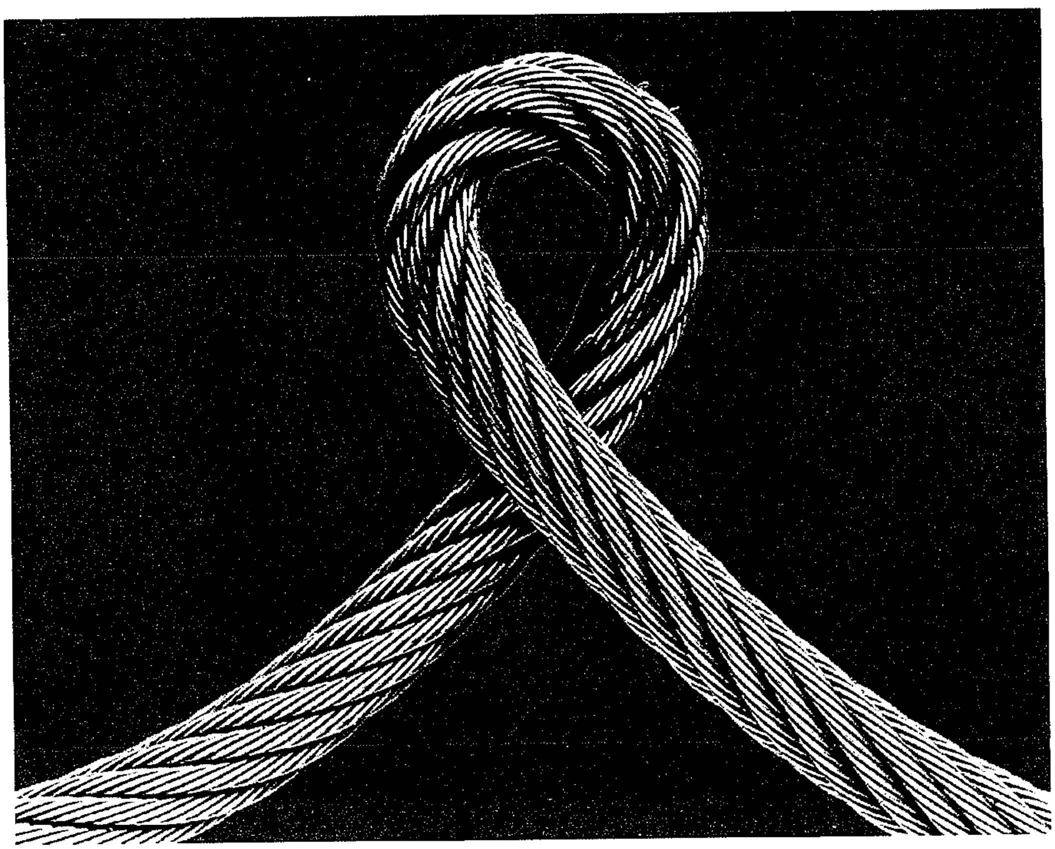


Figure B.17 — Kink

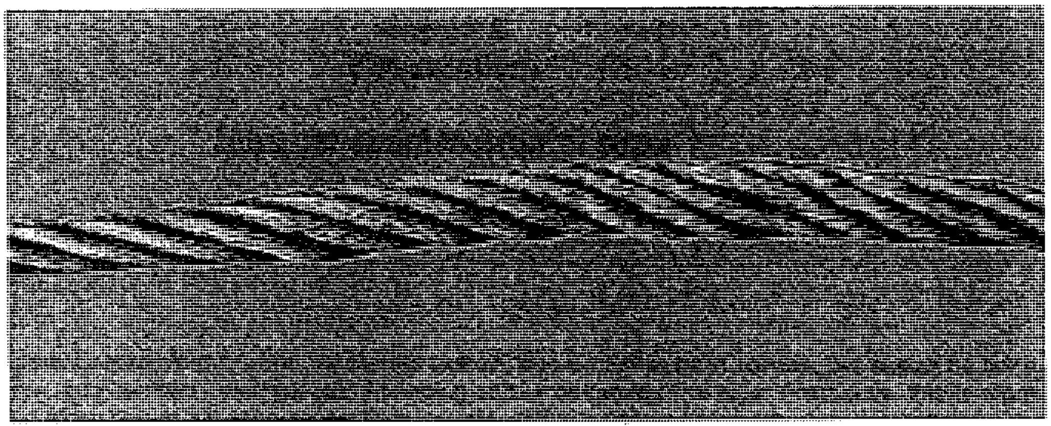


Figure B.18 — Flattened portion

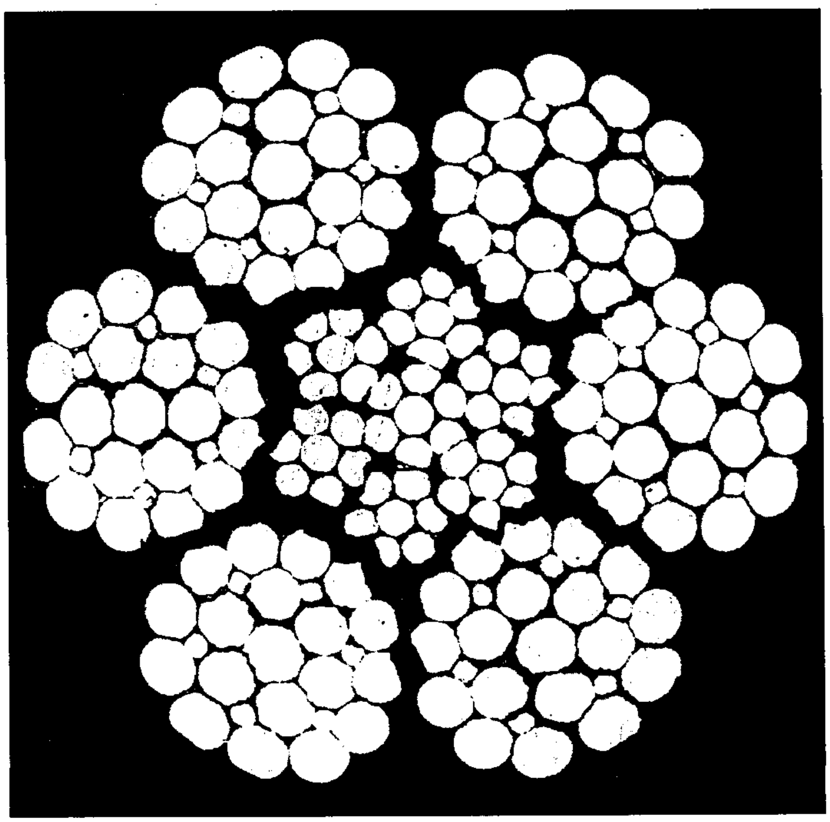
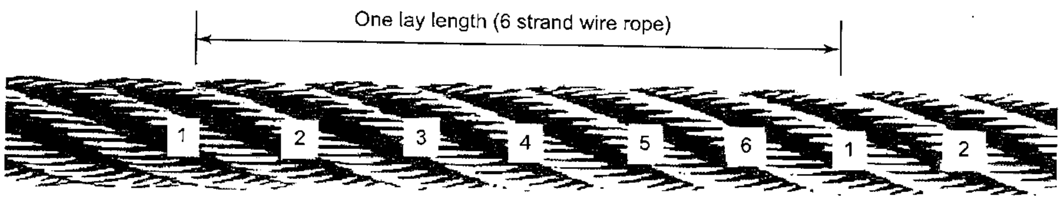


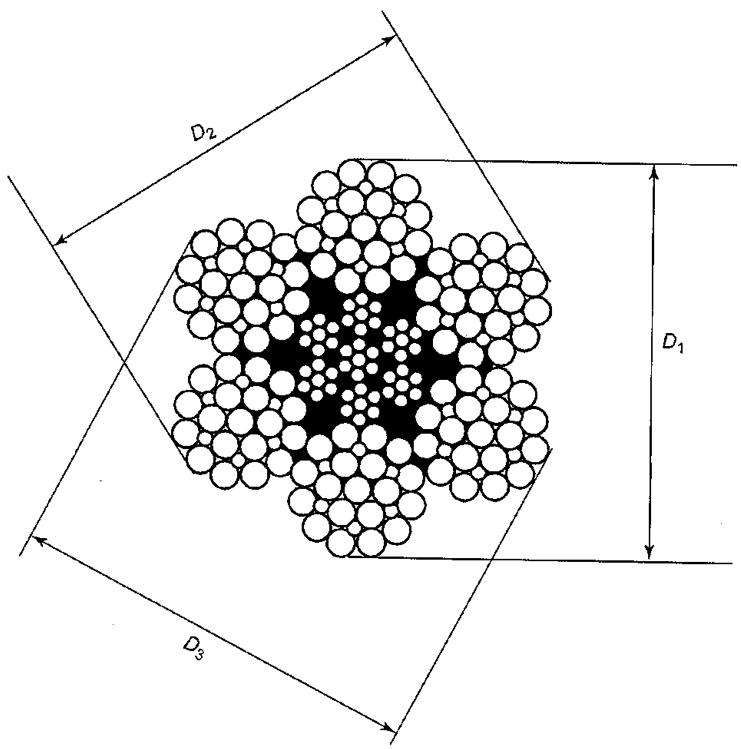
Figure B.19 — Internal corrosion

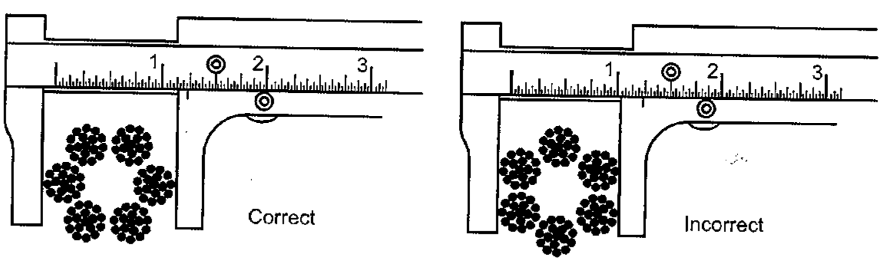
Appendix C

API Standard Lay Length and Diameter Measurement



a) Definition of lay length





b) Diameter measurement

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Figure 21—Lay Length and Diameter Measurement

Appendix D

Sample Discard Criteria Spreadsheet

Discard Criteria

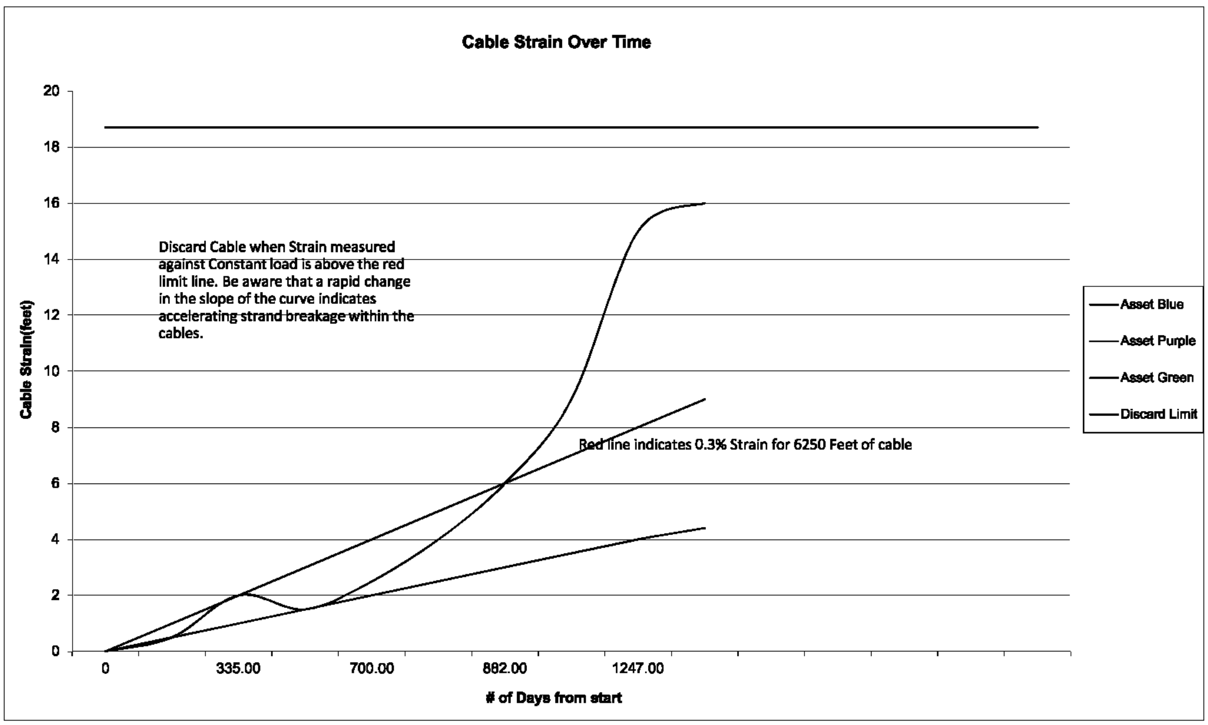
Example Table Provided Below

Measurement of Cables Strains at Retensioning

The asset number refers to the Cable, cable location is South(S), North (N) or Drive(Dr) and identifies where the asset is being utilise(

			Strain in Feet from Datum						
Date YEAR-MO-D	Days		Cable Asset No	Location	Cable Asset No	Location	Cable Asset No	Location	Limit
			[redacted]	S, N or Dr	[redacted]	S, N or Dr		S, N or Dr	Feet
2016/01/01	0		0		0		0		18.7
2016/06/01	152.00		0.5		1		0.5		18.7
2016/12/01	335.00		1		2		2		18.7
2017/06/01	517.00		1.5		3		1.5		18.7
2017/12/01	700.00		2		4		2.5		18.7
2018/01/01	731.00		2.5		5		4		18.7
2018/06/01	882.00		3		6		6		18.7
2019/01/01	1096.00		3.5		7		9		18.7
2019/06/01	1247.00		4		8		15		18.7
2019/07/01	1277.00		4.4		9		16		18.7
									18.7
									18.7
									18.7
									18.7
									18.7

Length of Wire Rope 6250 Feet



The following Tables are used to record the data from the Visual and NDT Inspections

The ISO 4309 Annex B shall be used to evaluate the severity of localised damages on the cable

API Standard Figure 21 shall be used to determine lay length and the Diameter Appendix D

Example Table Provided Below

NDT Measurements			Visual Inspection									
Date YEAR-MO-DAY	Cable location North.Drive or South	% Loss of Area	Type of Damage	Severity	Location on Cable	Maximum wire breaks in one lay length	Notes	Action				
		10			200	8		Check Loss of Area, cable exceeds wire break criteria				
		16			300	7		Replace Cable, Loss of Cross Section is greater than 15%				
		16			350	9		Replace Cable, Loss of Cross Section is greater than 15%				
			kink		457			OK				
			corrosion		600			OK				
			reduced diameter					OK				
								OK				
								OK				
								OK				
								OK				
								OK				
								OK				
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								OK				
								OK				

Appendix E

BC Ferries Cable Specification

Detailed Cable Specification:	
General Description:	1.625 in. Dia, 2140 m Long, 6X19 SEALE, IWRC, EIPS, PVF, Colour: Yellow, Right Lang Lay, Open Spelter Socket at Bottom End
General Notes:	1. No manufacturer substitutions allowed; cable specification and tolerances must be maintained for cable anchorages 2. No spelter socket substitutions allowed; dimensions critical for load cell system 3. Cable anchorage is customized for a cable lay length of 10.468 inches. Cable must be manufactured with a cable lay length of 10.468 +/- 0.300 inches. 4. Manufacturer must provide assembly certification documents with rope lay length measurements to verify compatibility with existing carpenter stoppers
Length:	2,140 m
Diameter:	1.625 inch
Rope Construction:	6x19 Seale IWRC
Wire Finish:	Bright (Non-galvanized)
Rope Grade:	EIPS
Min Breaking Strength:	1,175 kN (264,000 lbs)
Core Type:	PVF (Plastic valley filled) 1. Solid Polymer Colour: Yellow 2. ASTM A1023, Section 3.17.2.4 Plastic-filled Rope: Rope in which the free spaces up to the diameter of the rope are filled with a solid polymer.
Pre-stretched:	ASTM A1023, Section 7.5 Pre-stretching: Three cycles of tensile loading to 105,600 lbs
Actual Lay:	Right Lang Lay, with cable lay length: 10.468" +/- 0.300 inches
Lubrication:	Fuchs Lubricants; ANTICORIT WRC 10 RZB-400LB DR
Applicable Specification:	Manufactured in accordance with ASTM A1023;
Type of Certificate:	Certificate of Conformance, as per ASTM A1023, Section 4.2.
Termination of Rope Ends:	**Bottom End of Cable:** Spelter socket shall be installed in accordance with the manufacturer's published instructions; 1 5/8", ESCO L-7007G, Open Spelter Socket; Galvanized Alloy Steel; Min Ultimate Capacity 1200 kN; Spelter sockets require certificates showing results for magnetic particle, ultrasonic inspections and proof load testing to 105,000 lbs; Serial numbers shall be stamped on each socket and recorded on all sales and transport bills. **Top End of Cable:** Cable to be secured to reel for shipping
Special Packaging and Identification:	1. Cable shall be spooled on customer supplied reel with two part flange with pre-spooled 3/4" leader line. 2. Spelter socket on bottom end of cable shall be shackled to end of 3/4" leader line in secondary compartment of reel. 3. Spelter socket and first ~ 3 m of cable to be spooled in secondary compartment; remaining cable shall be spooled in primary section of drum. 4. Shrink wrap to be applied over entire spool for shipping.

Revision History:	
Date (YY-MM-DD)	**Description**
16-07-21	General description revised to include "Colour: Yellow"

NORTHERN STRANDS
Co. Ltd.

TEST CERTIFICATE OF COMPLIANCE

NO: G – 22 – 0020

CUSTOMER: BC FERRIES SUITE 500 1321 BLANSHARD STREET VICTORIA, BC, V8W 0B7	**CUSTOMER P.O. NUMBER:** 356623 **ORDER DATE:** March 10, 2022 **DATE OF SAMPLE TEST:** April 19, 2018
SHIPPED TO: LITTLE RIVER TERMINAL MAINTENANCE 1300 ELLENOR ROAD COMOX, BC, V9M 4B3	**MILL REFERENCE NUMBER:** 2018A-092-01 **ORDER CONFIRMATION NUMBER:** JOB009175 **N.S. ORDER NUMBER:** 032787

QTY	DIA	CONSTRUCTION	FINISH	LAY	MASTER REEL NO.	MINIMUM BREAKING STRENGTH	ACTUAL BREAKING STRENGTH
1 X 7021 FT	1 -1/2”	WIRE ROPE, 6xFI25 CONSTRUCTION, IWRC, EEIPS	GALVANIZED	RIGHT REGULAR LAY	2018A-092-01	249,000 LBS	259,000 LBS

REMARKS: **R1-32787-2018A09201**

s. 22 [redacted]

DATE: **April 7, 2022**

SIGNED: **Les Nimmo**
FOR: **NORTHERN STRANDS CO. LTD.**
AT: **Saskatoon, SK**

HEAD OFFICE:
P.O. BOX 7799, 3235 MILLAR AVENUE
SASKATOON SK CANADA S7K 4R5
PH: 306.242.7073 FAX: 306.934.2920

BRANCH LOCATION:
125 HENDERSON DRIVE
REGINA SK CANADA S4N 5W4
PH: 306.352.7073 FAX: 306.352.9112

www.northernstrands.com

NORTHERN STRANDS
3235 Millar Avenue
Saskatoon, SK, Canada
(306) 242-7073

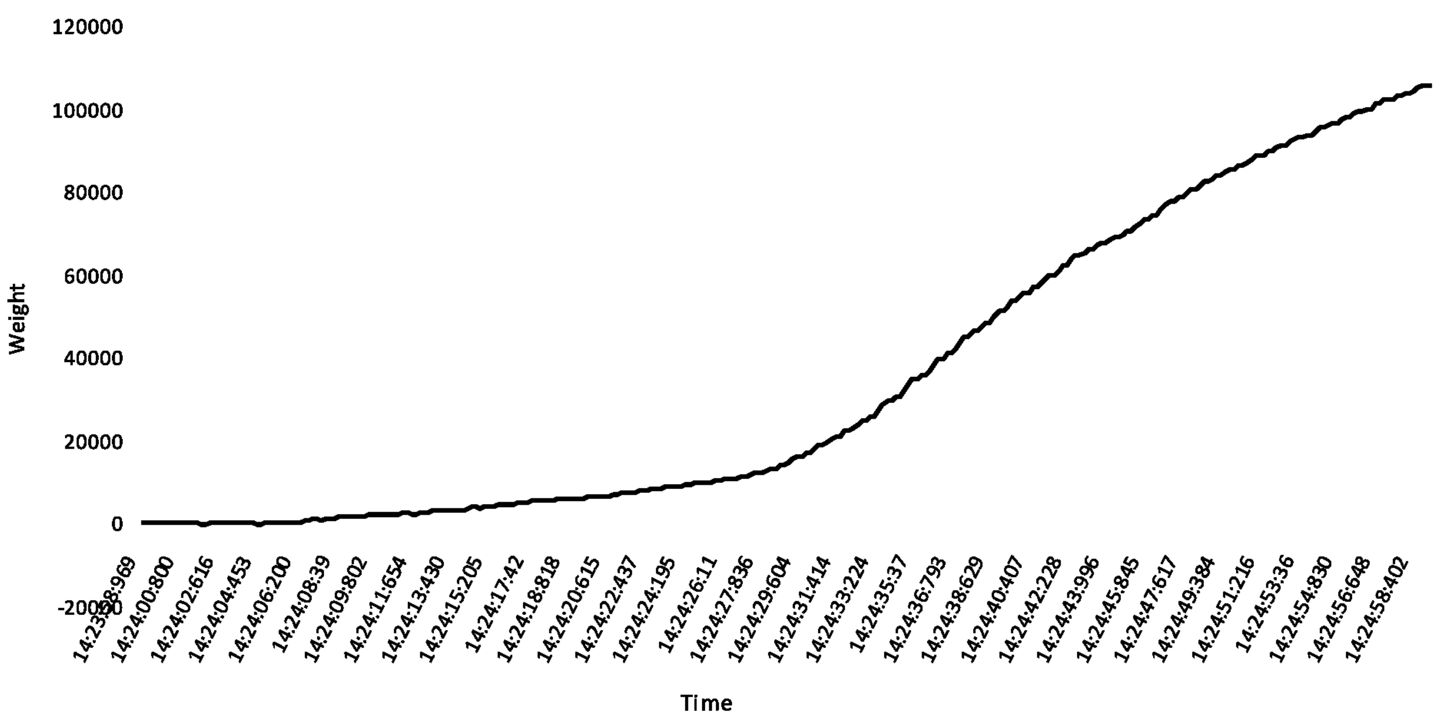
CERTIFICATE OF TESTING

Test Certificate Number: 04-01-20676

Customer Name:	BC Ferries	**Type Of Test:**	P1.00 = Proof Loaded 100%
Address:		**Working LL:**	105,000 lbs
		Proof Load:	105,000 lbs
Customer PO #:	356623	**Factor Of Safety:**	5:1
Company Job #:	9175	**Time:**	61
Test Operator:	Brody Vogel	**Date Of Test:**	2022-03-29
Test Supervisor:	Clint Holmes		
File Name:	04-01-20676 BC Ferries .pdf		

Description of item(s) tested:

1 - Serial #: R1-32787-2018A-092-01, Item: Wire Rope Assembly, Manufacturer: Northern Strands, Length/Size: 1 1/2" x 702
2 - No Item Entered
3 - No Item Entered
4 - No Item Entered
5 - No Item Entered
6 - No Item Entered



Remarks:
1 1/2" x 7021 ft Wire Rope Assembly

WE CERTIFY THAT THE ABOVE HARDWARE HAS BEEN TESTED AND EXAMINED BY A COMPETENT PERSON AND FOUND TO BE FREE FROM HARMFUL FLAWS AND DEFECTS.

Date: 2022-03-29 Test Operator: Brody Vogel Signature: s. 22

For: Northern Strands Co Ltd.