Wire rope Inspection

Ship Personnel

Doc No: TEC-028

Rev No.: 0

Issued by: QHSE Manager & DPA

Approved by: Head of Fleet

Date Issued: 08/10/2025

Number of Pages: 21

Contents

1 Introduction

This procedure outlines the systematic approach for the inspection and monitoring of wire ropes installed on cranes. Wire ropes are critical components that directly impact the safety and operational reliability of lifting equipment. Regular checks and continuous monitoring are essential to ensure compliance with safety standards, prevent mechanical failures, and extend the service life of the crane. The following guidelines define the responsibilities, inspection intervals, criteria for wear and damage assessment, and documentation requirements to maintain optimal performance and safety

2 Scope

Due to the limited service life of wire ropes, ropes must be checked at regular intervals during use to correctly identify when the rope has reached the end of its service life and to remove it from service before it fails completely.

3 Responsibilities

- **Chief Officer :** Responsible for maintaining the record of the proper form and supervising the check and monitoring activities.
- **Master:** Oversees the inspection process and ensures that all relevant documentation is available. Coordinates with the Chief Officer to resolve any non-compliance issues.
- **Ship's Crew:** Carry out the inspection process and providing feedback based on the inspected done to the C/O.

4 Safety Precautions

Work Planning & Authorization

- Ensure inspection activity is included in the daily work plan and approved by the supervisor.
- Conduct Toolbox Meeting (TBM) with all personnel involved to explain scope of work, hazards, and safety measures.

Lock-Out / Tag-Out (LOTO)

- Isolate and secure crane power source before inspection.
- Place "Do Not Operate" tag on the crane control panel.

Area Safety Preparation

- Barricade and mark the crane working area to restrict unauthorized entry.
- Ensure adequate lighting and safe access to the inspection area.

Personnel Protective Equipment (PPE)

- Wear appropriate PPE: safety helmet, safety shoes, gloves, eye protection, and fall arrest equipment (if working at height).

Crane Condition

- Ensure crane is in safe resting position and luffing boom is properly secured.
- Release all operational loads; wire should be free of tension before inspection.

Environmental Condition

- Stop inspection if weather is unsafe (e.g., strong wind, heavy rain, lightning).
- Ensure deck and work platform are dry and non-slippery.

Inspection Tools & Equipment

- Check all inspection tools are in good condition.
- Use proper lifting/working platforms (man basket, scaffolding) if needed.

Emergency Preparedness

- Confirm first aid kit and emergency communication (radio/phone) are available.
- Assign standby personnel for watchkeeping during inspection.

5 Inspection Frequency

Table 1 - WIRE INSPECTION FREQUENCY

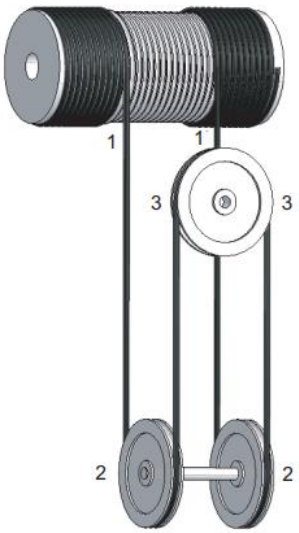
Wire	Type of inspection	Frequency	PIC
Luffing	Frequent	Daily – Every shift	CR Ops / Bosun
	Periodic	Every 40 RH / 100 RH / Every change vessel	Bosun trained
		Every 500 RH	Bosun trained/ 3rd parties
	Post - even	After shock loading, overload or suspected damage	Bosun trained, manufacture can follow if needed
Hoisting	Frequent	Daily – Every shift	CR Ops / Bosun
	Periodic	Every 40 RH	Bosun trained

		Every 500 RH	Bosun trained/ 3rd parties
	Post - even	After shock loading, overload or suspected damage	Bosun trained, manufacture can follow if needed

5.1 Frequent/Daily Inspection

1. To do visual assessment of the condition of as much us the rope length as possible, including the points of attachment to the equipment, to observed the objective of detecting any general deterioration or mechanical damage.
2. The rope should also be checked to ensure that it is sitting correctly on the drum and over the sheave(s) and has not been displaced from its normal operation position.

Key areas requiring particular close inspection



Key

1 sections spooling on drum at point of load being lifted and other sections suffering greatest interference (usually coinciding with maximum fleet angle)

2 section(s) entering block sheave(s) at point of load being lifted

3 sections in direct contact with compensating sheave, particularly at points of entry

5.2 Periodic Inspection

The information gained from a periodic inspection is used to assist in deciding whether a crane rope : can safely remain in service and by which latest time is shall undergo its next periodic inspection, or needs to be withdrawn immediately or within a specified timeframe.

1. Assessment method used : Counting/ visual/ measurement
2. The severity of deterioration shall be assessed and expressed either as a percentage (20%, 40%, 60%, 80%, 100%) or
3. Expressed in words (e.g slight, medium, high, very high, or discard).
4. Any damage shall be assessed by competent person/ trained crew prior to back in service.
5. Observation shall be recorded.

5.3 Post - Even

1. If an incident may have damaged the rope / termination – carry out a periodic inspection.
2. Do not use the rope until inspection is completed
3. Follow competent person's instruction before resuming work.

Table 2 - Modes of deterioration and assessment methods

MODE OF DETERIORATION		ASSESSMENT METHOD
1	Number of visible broken wires (including those which are randomly distributed, localised, groupings, valley wire breaks and those that are at, or in the vicinity of, the termination	By counting
2	Decrease in rope diameter (resulting from external wear/abrasion, internal wear and core deterioration)	By measurement
3	Fracture of strand(s)	Visual
4	Corrosion (external, internal, fretting)	Visual
5	Deformation (Pockets, Loop formation, Necking, Knots, Corkscrews and Protrusion)	Visual and by measurement (wave only)

6	Mechanical Damage	Visual
7	Heat damage (including electric arcing)	Visual

6 Area to be Inspected

1. Each rope shall be inspected along its entire length.
2. In the case of long length, and at the discretion of the competent person, the working length plus at least five warps on the drum may be inspected.
3. In such a case, where a greater working length is subsequently foreseen after the previous inspection and prior to the next one, that additional length should also be inspected before the additional length of rope is used.

Particular care, however, shall be taken at the following critical areas and locations:

a) drum

b) any section at, and in the vicinity of, a rope termination;

- Inspect rope near termination, especially at entry point (check for wire breaks, corrosion, etc)

- Probe with spike if needed – check for looseness indicating hidden broken wires.

- Inspect termination for distortion or excessive wear

- Check ferrules (eyes/loops) for cracks or slippage between ferrule and rope

- Inspect detachable terminations (e.g., wedge sockets) for broken wires and correct assembly

- Eyes splices must be checked – visual inspected for broken wire.

c) any section that travels through one or more sheaves;

d) any section that travels through a safe load indicator which incorporates sheaves;

e) any section that travels through the hook block;

f) in the case of cranes performing a repetitive operation, any part of the rope that lies over a sheave while

the crane is in a loaded condition;

g) that part of the rope which lies over a compensating sheave;

h) any section that travels through a spooling device;

i) those sections that spool on the drum, particularly cross-over zones that are associated with multi-layer spooling;

j) any section that is subjected to abrasion by external features (e.g. hatch combings);

k) any part of rope that is exposed to heat.

7 Inspection Tool

Wire rope gauge, test template, ruler/tape, Flashlight, Minifying glass (optional), Cleaning cloth and equipment.

8 Documentation

The wire must be certified with a 3.2 Certificate Class. The certificate shall be properly recorded, including clear identification of the location where the wire is installed

9 Rope Discard Criteria

a. Luffing wire must be discard every 2000RH ; Hoisting wire must be discard every 3000RH
b. Wire can be discard before achieve the RH mentioned, with refer to : Manufacturer's specifications (ISO 4309 : 2004) ; ISO 4309:2010 Edition 4 criteria , as below :

9.1 Visible broken wires

Table 3 – Discard criteria for visible broken wires

NATURE OF VISIBLE BROKEN WIRE		DISCARD CRITERIA
1	Wire breaks occurring randomly in sections of rope which run through one or more steel sheaves and spool on and off drum when single layer spooling or occurring at sections of rope which are coincident with cross-over zone when multi-layer spooling[a]	See Table 4 for single – layer and parallel – closed ropes
2	Localised grouping of wire breaks in sections of rope which do not spool on and off drum, (broken wires in sections of rope that do not spool on and off drum are normally associated with mechanical damage and an incident that may have occurred)	If grouping is concentrated in one or two neighbouring strands it might be necessary to discard the rope, even if the number is lower tan the values over a length of 6d, which are given in Table 4. (three or

		more visible adjacent wire breaks in one outer strand or adjacent strands may justify discard
3	Valley wire breaks[b]	Two or more wire breaks in a rope lay length (approximately equivalent to a length of 6d.
4	Wire breaks at termination (Wire breaks often occur at or within the rope termination as a result of the rope flexing at the entrance to the termination. These breaks can be difficult to see and may be associated with loose wires at the entrance to the termination)	Two or more wire breaks

For the rope with a single-layer or parallel-closed rope, apply the corresponding Rope Category Number (RCN) and read off the discard values in Table below for broken wires over a length of 6d and 30d.

Table 4 - Number of wire breaks, reached or exceeded, of visible broken wires occurring in single -layer and parallel – closed ropes, signalling discard rope

Rope category number RCN (see Annex G)	Total number of load-bearing wires in the outer layer of strands[a] n	Number of visible broken outer wires[b]					
		Sections of rope working in steel sheaves and/or spooling on a single-layer drum (wire breaks randomly distributed)				Sections of rope spooling on a multi-layer drum[c]	
		Classes M1 to M4 or class unknown[d]				All classes	
		Ordinary lay		Lang lay		Ordinary and Lang lay	
		Over a length of $6d$[e]	Over a length of $30d$[e]	Over a length of $6d$[e]	Over a length of $30d$[e]	Over a length of $6d$[e]	Over a length of $30d$[e]
01	$n \leqslant 50$	2	4	1	2	4	8
02	$51 \leqslant n \leqslant 75$	3	6	2	3	6	12
03	$76 \leqslant n \leqslant 100$	4	8	2	4	8	16
04	$101 \leqslant n \leqslant 120$	5	10	2	5	10	20
05	$121 \leqslant n \leqslant 140$	6	11	3	6	12	22
06	$141 \leqslant n \leqslant 160$	6	13	3	6	12	26
07	$161 \leqslant n \leqslant 180$	7	14	4	7	14	28
08	$181 \leqslant n \leqslant 200$	8	16	4	8	16	32
09	$201 \leqslant n \leqslant 220$	9	18	4	9	18	36
10	$221 \leqslant n \leqslant 240$	10	19	5	10	20	38
11	$24 \leqslant n \leqslant 260$	10	21	5	10	20	42
12	$261 \leqslant n \leqslant 280$	11	22	6	11	22	44
13	$281 \leqslant n \leqslant 300$	12	24	6	12	24	48
	$n > 300$	$0{,}04 \times n$	$0{,}08 \times n$	$0{,}02 \times n$	$0{,}04 \times n$	$0{,}08 \times n$	$0{,}16 \times n$

NOTE Ropes having outer strands of Seale construction where the number of wires in each strand is 19 or less (e.g. 6 × 19 Seale) are placed in this table two rows above that row in which the construction would normally be placed based on the number of load bearing wires in the outer layer of strands.

[a] For the purposes of this International Standard, filler wires are not regarded as load-bearing wires and are not included in the values of n.

[b] A broken wire has two ends (counted as one wire).

[c] The values apply to deterioration that occurs at the cross-over zones and interference between wraps due to fleet angle effects (and not to those sections of rope which only work in sheaves and do not spool on the drum).

[d] Twice the number of broken wires listed may be applied to ropes on mechanisms whose classification is known to be M5 to M8.

[e] d = nominal diameter of rope.

a. The maximum number of broken wires allowed within a length of **6 × Rope Diameter (d)** is **9 broken wires**.
   Example:

   For a wire rope with a diameter of 32 mm, the maximum number of broken wires permitted within a length of 6 × d, or 192 mm, is 9 broken wires. This requirement also applies proportionally to other rope diameters.

b. The maximum number of broken wires allowed within a length of **30 × Rope Diameter (d) is 18 broken wires**. The calculation method is the same as the above example. For

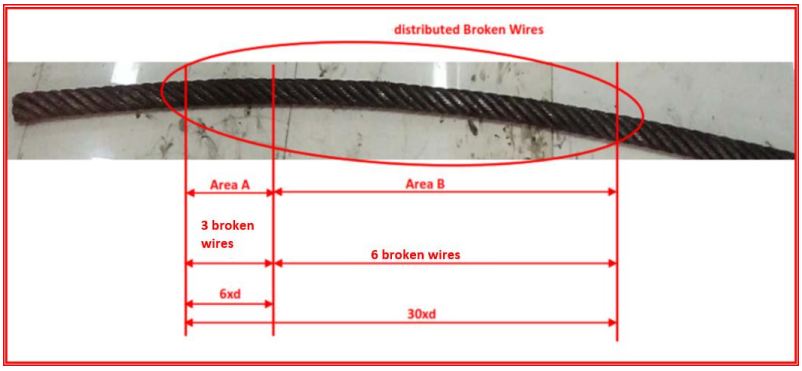
a wire rope diameter of 32 mm, the maximum number of broken wires permitted within a length of 30 × d, or 960 mm, is 18 broken wires

c. These two criteria shall be applied during wire rope inspections to determine the higher level of damage.

Example:

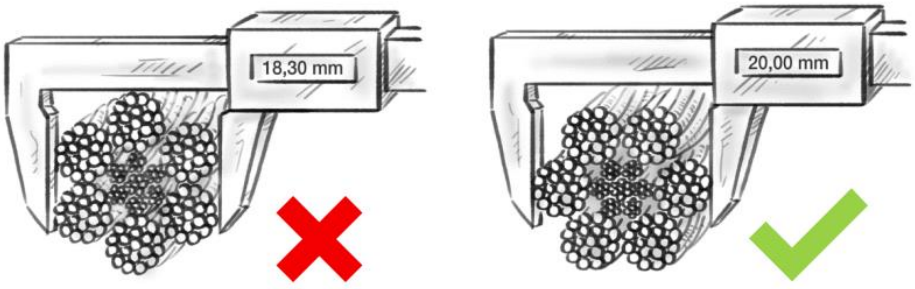
For a 32 mm diameter wire rope, type 6×36WS IWRC, the distribution of broken wires is as follows:

- Within a length of 6 × d (192 mm), there are 3 broken wires. The damage level is calculated as **3/9 × 100% = 30%**.
- Within a length of 30 × d (960 mm), there are 9 broken wires in total (the 3 broken wires within 6 × d are also included). The damage level is calculated as **9/18 × 100% = 50%**.
- The higher damage level shall be taken into account, i.e., 50% at 30 × d (960 mm).
- In subsequent inspections, the number of broken wires may vary between 6 × d and 30 × d. In such cases, the higher percentage of damage shall be applied.



9.2 Decrease in rope diameter

When using a conventional caliper, wire ropes with an even number of outer strands (four-,six-,eight-,and multi strand) ropes must be measured from crown to crown.



2.1.1 Uniform decrease along the rope

1. Refer to Table 5 for discard values (bold numbers)
2. Apply only to rope sections on single-layer drum and/or running through steel sheave

The discard criteria values for uniform decrease in rope diameter for sections of rope which spool on a singlelayer drum and/or run through a steel sheave are shown, in bold, in Table 5 below. They do not apply to those sections of rope which are coincident with cross-over zones or other sections of rope which are similarly deformed as a result of spooling on a multi-layer drum.

The table also shows the equivalent uniform decreases in diameter, expressed as a percentage of nominal diameter of rope, for severity ratings expressed in increments, for convenience, of 20 % (i.e. 20 %, 40 %, 60 %, 80 % and 100%). Other severity ratings, e.g. expressed in increments of 25 % (i.e. 25 %, 50 %, 75 % and 100 %), may also be selected.

Table 5 - Uniform decrease in diameter signalling discard of rope — Rope spooling on a single-layer drum and/or running through a steel sheave

Rope type	Uniform decrease in diameter (expressed as % of nominal diameter)	Severity rating	
		Description	%
Single-layer rope with fibre core	Less than 6 %	—	0
	6 % and over but less than 7 %	Slight	20
	7 % and over but less than 8 %	Medium	40
	8 % and over but less than 9 %	High	60
	9 % and over but less than 10 %	Very high	80
	10 % and over	**Discard**	**100**
Single-layer rope with steel core or parallel-closed rope	Less than 3,5 %	—	0
	3,5 % and over but less than 4,5 %	Slight	20
	4,5 % and over but less than 5,5 %	Medium	40
	5,5 % and over but less than 6,5 %	High	60
	6,5 % and over but less than 7,5 %	Very high	80
	7,5 % and over	**Discard**	**100**
Rotation-resistant rope	Less than 1 %	—	0
	1 % and over but less than 2 %	Slight	20
	2 % and over but less than 3 %	Medium	40
	3 % and over but less than 4 %	High	60
	4 % and over but less than 5 %	Very high	80
	5 % and over	**Discard**	**100**

The calculation to determine the amount of decrease in diameter and expression as a percentage of nominal diameter of rope is given below :

Actual uniform decrease in diameter expressed as a per cent of nominal diameter is calculated using Equation (1):

$[(^{d}ref - {}^{d}m)/^{d}] \times 100$ (%)

(1)

Where :

^{d}ref is the reference diameter;

^{d}m is the measured diameter;

^{d} is the nominal diameter.

EXAMPLE 1 :

For a 40 mm diameter 6 × 36-IWRC rope having a reference diameter of 41,2 mm and measuring 39,5 mm at inspection, the per cent decrease is equal to

[(41,2 − 39,5)/40] × 100 = 4,25 %

NOTE 1 : From Table 4, the severity rating for uniform decrease in diameter is 20 % towards discard (i.e. slight).

NOTE 2 : Discard is reached when the rope decreases from reference diameter by an amount equivalent to 7,5 % of nominal diameter, i.e. 3 mm. In this case, diameter at discard would be 38,2 mm.

EXAMPLE 2 :

For the same rope, but measuring 38,5 mm at inspection, the per cent decrease is equal to

[(41,2 − 38,5)/40] × 100 = 6,75 %

NOTE 3 From Table 5, the severity rating is 80 % (i.e. very high).

2.1.2 Local decrease

1. Check for obvious local decrease in rope diameter
2. If caused by core/centre failure or sunken strand – discard rope

2.1.3 Fracture of strands

If a complete strand fracture occurs, the rope shall be immediately discarded.

9.3 Corrosion

1. Refer to Table 6 for corrosion discard/ severity ratings
2. Distinguish between wire corrosion and surface corrosion from foreign particles.
3. Clean rope section by wiping or brushing before inspection.
4. Do not use solvents for cleaning

Table 6 – Discard criteria for corrosion and intermediate severity ratings

Type of corrosion	Condition	Severity rating
External corrosion[a]	Signs of surface oxidation but can be wiped clean	Superficial – 0 %
	Wire surface rough to touch	High – 60 %[c]
	Wire surface heavily pitted and slack wires[b]	**Discard – 100 %**
Internal corrosion[d]	**Obvious visible signs of internal corrosion – i.e. corrosion debris exuding from the valleys between the outer strands**[e]	**Discard – 100 %** or if deemed practicable by the competent person, internal examination in accordance with the procedure described in Annex C
Fretting corrosion	The process of fretting involves the removal of fine particles of steel from the wires due to dry wires and strands constantly rubbing together and then oxidizing and creating internal corrosion debris, which manifests itself as a dry powder, similar to a red rouge.	Evidence of such a characteristic should be further investigated and if there is any doubt about its severity, the rope should be discarded (100 %).

[a] For examples, see Figures B.11 and B.12. For an example of the progression of external corrosion in a rope, see Annex H.

[b] For any other intermediate condition, an assessment should be made as to its severity rating (i.e. contribution towards the combined effect).

[c] The oxidation of zinc-coated wires can result in a wire surface which is also rough to the touch, but the overall condition might not be as serious as wires which are not coated. In such cases, the inspector may consider applying a lower contribution towards the combined effect to that given above in this table.

[d] For an example, see Figure B.19.

[e] Assessment of internal corrosion is subjective; however, if there is any doubt about the seriousness of any internal corrosion, the rope should be discarded.

Note : An increase in diameter can result from internal or fretting corrosion

Table 7 – Guidance on assessment and rating of external corrosion

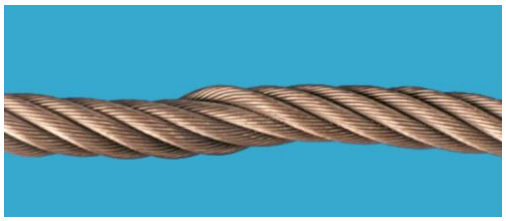
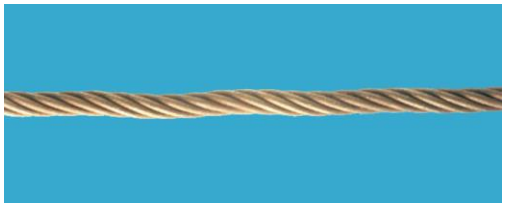
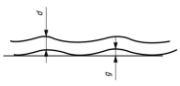
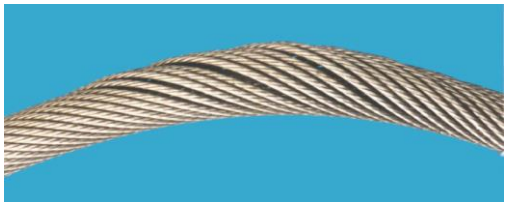
Beginning of surface oxidation, can be wiped clean, superficial — Rating: 0 % towards discard	
Wires rough to touch, general surface oxidation — Rating: 20 % towards discard	
Surface of wire now greatly affected by oxidation — Rating: 60 % towards discard	
Surface heavily pitted and wires quite slack, gaps between wires — Discard immediately	

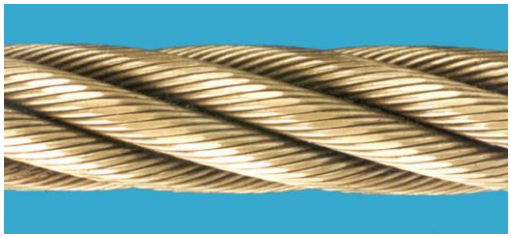
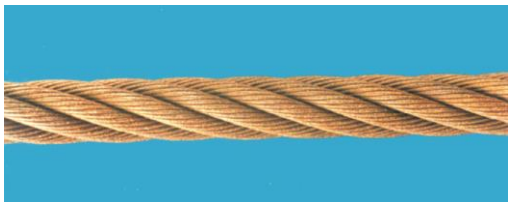
2.2 Deformation and damage

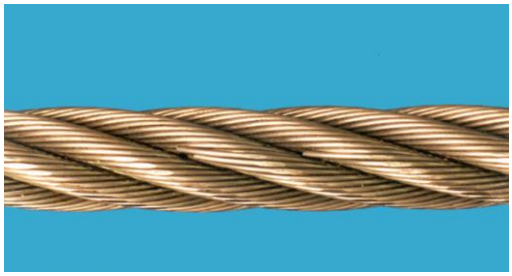
1. Check for visible distortion from normal rope shape – classify as deformation.
2. Refer to the discard criteria in Table 8 for common types
3. Any rope is in dangerous condition – discard immediately

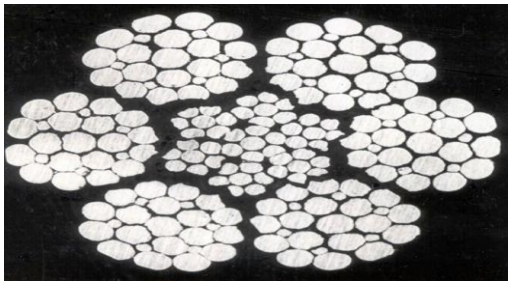
Table 8 – Discard criteria from the more common types

NO	TYPE	PICTURE	INFORMATION
1	Wire Protrusion		Shall immediately discard
2	Core Protrusion – Single layer rope		Shall immediately discard
3	Local reduction in rope diameter (sunken strand)		Table 4 - Uniform decrease in diameter signalling discard of rope — Rope spooling on a single-layer drum and/or running through a steel sheave
4	Strand protrusion or distortion		Shall immediately discard
5	Flattened portion		- Check flattened rope sections in sheaves → may deteriorate faster / broken wires. - If flattening is severe → consider discarding rope. - In rigging, flattened rope → higher corrosion risk (esp. if strands open & moisture enters).

			- If rope kept in service → inspect more frequently. - Otherwise → discard rope.
6	Kink (positive)		Shall immediately discard
7	Kink (negative)		Shall immediately discard
8	Waviness		- Straight rope section (not through sheave/drum): gap ≥ **1/3 × d** → **discard rope**. - Rope section through sheave/drum: gap ≥ **1/10 × d** → **discard rope**. Note : The gap between straightedge and rope helix  Key d nominal rope diameter g gap
9	Basket deformation		Shall immediately discard

10	External wear		- Check rope diameter decrease → may be due to external wear - Identify if wear is general, localized, uniform, or one-sided - If wear is uneven → find cause and take corrective action - Inspect rope sections in contact with sheaves/drums, especially during load changes - Check lubrication → lack, wrong type, or contamination with dust/grit increases wear.
11	External corrosion		Refer to 6.3
12	Enlargement of Figure B.11		Refer to 6.3
13	Crown wire breaks		Refer to 6.1

14	Valley wire breaks		Refer to 6.1
15	Protrusion of inner rope of rotation-resistant rope		Shall immediately discard
16	Local increase in rope diameter due to core distortion		- Measure rope diameter during service. - If **steel core** → increase ≥ **5%** → investigate cause. - If **fibre core** → increase ≥ **10%** → investigate cause. - After investigation → **consider discarding rope**.
17	Kink		Shall immediately discard
18	Flattened portion		Refer to No 5 - Flattened portion

19	Internal corrosion		Refer to 6.3
20	Bend in Rope		- Check rope for bends (angular deformation) - If severe bend (esp. with fold on underside) → discard immediately. - If bend not severe and rope kept in service → inspect more frequently - Otherwise → consider discarding rope.
21	Damage due to heat or electric arcing		- Check rope for heat damage → discoloration on wires or grease loss. - If heat damage found → discard immediately - Check for electric arcing damage (from welding, poor grounding). - If 2 or more wires affected → discard rope. - Pay attention to points where current may enter/exit rope.

9.4 Combined effect assessment of rope condition and severity rating – one method

Broken wires are a common discard reason, but ropes often deteriorate from combined factors (e.g., broken wires + wear from sheaves + corrosion in marine use). In such cases, the competent person must:

a) Consider all types of deterioration, especially if at the same location.

b) Assess the combined effect of the deterioration.
c) Decide if the rope can stay in service and if inspection/discard rules need to be adjusted.

Combined Effect Assessment :

d) Inspect rope → record type & amount of each deterioration (broken wires, diameter decrease, corrosion).
e) Rate each deterioration:
- As % of discard criteria (e.g. 40%), **or**
- In words (slight / medium / high / very high / discard).

f) If deterioration occurs at same location:
- Add % ratings for a combined value, **or**
- Judge combined severity in words.

Note :

1. The method assumes deterioration occurs progressively.
   - If two or three types contribute equally (e.g., 40% broken wires + 40% diameter decrease) → less serious than one type dominating (e.g., 80% broken wires).
2. Uniform diameter decrease ratings do not apply to rope on multi-layer drums withcrushing/deformation (cross-over zones).
3. Competent person may use other assessment methods based on experience with similar ropes/cranes

Table 8 – Example of severity rating

Example	Severity rating of individual modes of deterioration %			Combined severity rating %	Comment
	Wire breaks	Decrease in diameter[a]	External corrosion		
1	0	20	20	40	Safe to continue
2	20	20	0	40	Safe to continue
3	20	20	20	60	Safe to continue
4	40	20	20	80	Inspect more frequently
5	40	40	0	80	Inspect more frequently
6	0	80	0	80	Consider discard if reduction in diameter is mainly attributed to external wear
7	60	0	0	60	Inspect (particularly for broken wires) more frequently
8	60	20	0	80	Inspect more frequently (particularly for broken wires) and prepare for replacement

[a] Only taken into account when rope travels through steel sheave and/or spools on to single-layer drum.

9.5 Post Inspection

Documentation and Reporting

- Prepare an inspection report using Form TCF-024 or TCF-025
- Relevant inspection records or checklists c/w picture, shall be attached in the Ship Manager (SM) system to the corresponding items as specified, including documentation of any corrective actions taken.

Corrective Action

- Mark or tag the damaged section of the wire.
- If discard criteria are exceeded → the wire rope must be replaced immediately.
- If still within allowable limits → carry out cleaning, lubrication, or preventive maintenance, with close monitoring

Follow-Up Monitoring

- Schedule re-inspection of areas where early signs of damage were found.
- Ensure corrective and preventive actions are implemented and closed out.

10 Records and References

Other Examples:

- TCF – 024 CHECKLIST - DAILY CRANE WIRE INSPECTION
- TCF - 025 CRANE INSPECTION RECORD