

Wire rope inspection sheet: ISO 4309:2017

One rope per sheet. How to fill it in: page 4. Mark ✓ nothing found, X found (write where and what), N/A does not apply. **Free analysis:** send us a photo of the completed sheet for a same-day response (page 2).

Date	Inspection type (codes: page 4)	Hours (machine or rope)	Inspector (print)	Trolley distance (m) or boom angle (°)	Hook height (m) and hook load
Customer / owner	Site / location	Crane make	Crane model	Serial number	Unit number
Winch number	Winch duty (main hoist, aux, boom hoist, trolley)	Rope length (m / ft)	Nominal diameter d (mm)	Construction (e.g. 6x36 WS)	Core (IWRC, WSC)
Lay (ordinary / regular or Lang, direction)	Grade / finish	OEM specified breaking force (crane manual, not the mill cert)	Minimum breaking force (mill cert)	Date installed	Certificate number
Rope manufacturer / supplier	Drum: single or multi-layer	Sheaves: steel or synthetic	Mechanism class (M1 to M8, or unknown)		

Your limits for this rope (how to work them out: page 6; tables: page 9)

Broken wires: sections of rope working in steel sheaves and/or spooling on a single-layer drum	Broken-wire limit (reached or exceeded: discard): over 6d _____ over 30d _____	Table 3 / 4
Broken wires: sections of rope spooling on a multi-layer drum (crossover zones and wrap interference)	Broken-wire limit (reached or exceeded: discard): over 6d _____ over 30d _____ (N/A if single-layer)	Table 3 / 4 note c
Diameter limit (Table 5): tick your rope	☐ Single-layer rope with steel core, or parallel-closed rope: 7.5% of nominal d ☐ Rotation-resistant rope: 5% of nominal d	6.4.1
Discard diameter = dref - (% x nominal d) (discard at or below)	_____ mm	6.4.2
Waviness gap limit	d/10 = _____ mm (rope that runs over sheaves or onto the drum) d/3 = _____ mm (straight rope that never runs through or around a sheave or onto the drum)	6.7.2
Diameter increase check (investigate, consider discard)	Steel core: dref x 1.05 = _____ mm (dref as the base: CRS practice)	6.7.6
Sheave grooves	Rope nominal Ø (d): _____ mm Groove should be d x 1.05 = _____ to d x 1.10 = _____ mm New rope actual Ø _____ x 1.01 = _____ mm (4.4)	

Reference diameter dref (measured directly after running in the new rope, on a section not subject to bending; copy it from that record, do not re-measure): _____ mm, measured at _____ m from the _____ end on (date) _____. D1 _____ mm, D2 _____ mm, averaged (ISO 4309 3.2).

1. Diameter: D1 and D2 at right angles, average (D1 + D2) / 2 (averaging: ISO 4309 3.2)

#	Measured at	D1 (mm)	D2 (mm)	Average (mm)
1.1	_____ m from the _____ end			
1.2	_____ m from the _____ end			
1.3	_____ m from the _____ end			
1.4	_____ m from the _____ end			
1.5	_____ m from the _____ end			
1.6	_____ m from the _____ end			

3. Other measurements

	Check	Reading	Where (m from which end)
3.1	Largest waviness gap g (mm), loaded or unloaded		
3.2	Largest diameter (mm)		
3.3	Breaks not from service (shipping, storage, installation, manufacture)		
3.4	Protruding wire broken off as maintenance		

Notes



2. Broken wires: one line for every broken wire or group you find

	Where (m from which end)	Zone SH or ML	Ø at this spot D1 / D2 (mm)	Broken wires in 6d	Broken wires in 30d	Valley breaks in one lay	Breaks at a termination	Notes
2.1	___ m from the ___ end		/					
2.2	___ m from the ___ end		/					
2.3	___ m from the ___ end		/					
2.4	___ m from the ___ end		/					
2.5	___ m from the ___ end		/					
2.6	___ m from the ___ end		/					
2.7	___ m from the ___ end		/					
2.8	___ m from the ___ end		/					
2.9	___ m from the ___ end		/					
2.10	___ m from the ___ end		/					
2.11	___ m from the ___ end		/					

Zone SH: rope working in steel sheaves and/or spooling on a single-layer drum (wire breaks randomly distributed). Zone ML: multi-layer drum, for deterioration at the crossover zones and interference between wraps due to fleet angle effects, not sections of rope which only work in sheaves and do not spool on the drum (Table 3 / 4 note c). Ø at this spot: D1 and D2 measured where the breaks are, because the competent person assesses the combined effect of deterioration at the same position in the rope (6.1, Annex G). On a crossover zone (ML) the Table 5 diameter limit does not apply (6.4.1): write the reading anyway (CRS practice). Broken-wire limits: page 1.

Check	✓ / X / N/A	If X: where and what	Check	✓ / X / N/A	If X: where and what
4. Rope condition			5. Rope ends and drum		
4.1			4.16		
4.2			5.1		
4.3			5.2		
4.4			5.3		
4.5			5.4		
4.6			5.5		
4.7			5.6		
4.8			5.7		
4.9			5.8		
4.10			5.9		
4.11					
4.12					
4.13					
4.14					
4.15					

6. Sheaves: one line per sheave (groove gauges: page 10; groove limits: page 1)

Sheave (which one)	Groove Ø (mm) or gauge OK / not OK (4.4)	Groove wear: corrugation (negative impressions) or other irregularities, wall too thin (4.4); uneven wear (4.8 Note): ✓ / X	Flange: cracks, chips, breaks, deformation (CRS practice): ✓ / X	Bearing: turns freely (4.8): ✓ / X	If X: where and what
6.1					
6.2					
6.3					
6.4					
6.5					

Severity: slight / medium / high / very high / discard (5.3.1)

Max. interval to next periodic (5.3.5)

Competent person: print name and sign

Date



Wire rope inspection: ISO 4309:2017

A free inspection sheet and guide from Crane Rope Solutions. It shows what ISO 4309:2017 asks you to check and record, and how to record it. One rope per inspection sheet.

How to use this guide

1. Work out your limits for this rope once (page 6) and write them at the top of page 1.
2. Inspect the rope and fill in the inspection sheet, pages 1 and 2. How to fill it in: page 4. A filled-in example is on pages 11 and 12.
3. Send us a photo of the completed sheet for a free analysis (below).

WHO

A competent person (5.3.1). The crane driver/operator may be appointed to do the daily checks, to the extent that they are sufficiently trained and considered competent (5.2).

WHEN

Daily: the rope in use that day, its attachment points, and that it sits right on the drum and sheaves; again after re-rigging (5.2). Periodic: at the interval the competent person sets, taking account of at least the law where the crane works, crane type and environment, mechanism class, previous results, time in service, experience from inspecting ropes on comparable cranes, frequency of use, and the crane maker's recommendations (5.3.2). Also after any incident (5.4), after more than 3 months out of use (5.5), and shorter intervals where lack of maintenance or no dressing is likely to shorten rope life, particularly in a corrosive environment (4.7, shall).

HOW MUCH ROPE

The entire length of every rope. For a long rope, at the competent person's discretion, the working length plus at least five wraps on the drum (5.3.3).

Have on hand

- Rope details from the certificate: nominal diameter, construction, core, wire finish, lay direction and type; the RCN from ISO 4309 Annex H (Annex E, 6.2.2).
- The reference diameter (dref) and the date the rope was installed (Annex E).
- Your broken-wire numbers from Table 3 or Table 4 on page 9 (6.2.2), and the previous record so changes can be compared (5.3.2 d), E.2).

Look closely at these areas (5.3.3, Annex A)

- Drum anchorage
- At and near each rope termination
- Sections that travel through sheaves
- Sections through a load indicator with sheaves
- Sections through the hook block
- Rope lying over a sheave while the crane is loaded (repetitive work)
- Rope over a compensating sheave
- Sections through a spooling device
- Rope that spools on the drum, especially crossover zones (multi-layer)
- Sections abraded by external features
- Any part of the rope exposed to heat
- Where the rope sits on the drum, head sheave and block sheaves as a load is picked up (Annex A)
- Sections with the greatest interference, usually at the greatest fleet angle (Annex A)



Send it to us: free analysis, same-day response

When you finish the sheet, take a clear photo of both pages and text it to **604-813-WIRE (9473)** (scan the code), or email it to **dean@craneropesolutions.com**. Add photos of anything you marked X, with a tape or ruler in the frame. We send back our analysis the same day.

A photo review is advice only. It does not replace the inspection the standard requires; the decision stays with the competent person.

ISO 4309:2017, Cranes - Wire ropes - Care and maintenance, inspection and discard. Clause numbers in brackets point to the standard. Text marked Crane Rope Solutions (CRS) practice is our method, not the standard.



How to fill in the inspection sheet

1 Top of page 1: the inspection, crane and rope

- Date, inspection type (codes below), hours, your name, and the crane set-up at the time: Trolley distance: only for cranes with a trolley; otherwise write the boom angle. Hook height and hook load (none, block only, or tonnes). Set the crane up the same way each time if you can, so the same part of the rope sits at your points (CRS practice).
- Rope details from the mill certificate (size, construction, core, lay, grade, minimum breaking force) and the crane manual (OEM specified breaking force).

2 Your limits (page 1)

- Work them out once for this rope with page 6 and copy them onto each new sheet.

3 Section 1: diameter

- ISO 4309 3.2: the measured diameter is the average of two measurements taken at right angles to one another. Use calipers with jaws wide enough to span at least two strands (CRS practice).
- Take D1 and D2 at right angles across the tops of the strands, not into the gaps (CRS practice), and write the average $(D1 + D2) / 2$ (3.2).
- Choose points you can find again (areas to look at: page 3), including the place with the smallest diameter you can find.
- For each point, write how far along the rope it is from the drum end or from the dead end (picture on page 5). Measure the distance with a tape measure, or read it from a rope counter, and mark the spot on the rope with a paint pen so the next inspection measures the same place (CRS practice).
- The reference diameter dref is measured on a section of rope that is not subject to bending, directly after running in the new rope (3.3). For running in, the crane should be operated at reduced speed and loading, down to 10% of WLL, for a number of operational cycles (4.6).

4 Section 2: broken wires

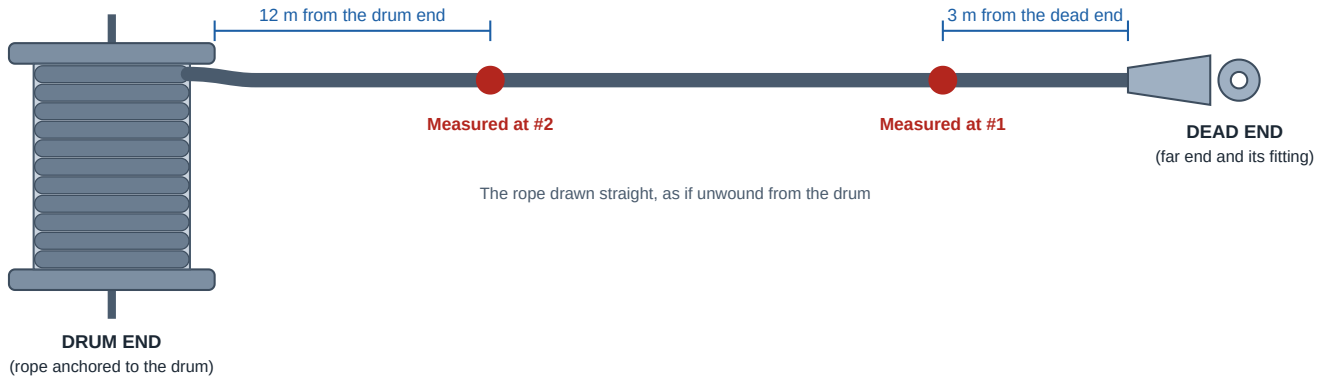
- Look along the rope this inspection covers (page 3). Write one line for every broken wire, or group of broken wires, that you find, and mark each spot on the rope with a paint pen (CRS practice).
- For each line, write how far along the rope it is from the drum end or the dead end. In each count column, write the most broken wires in any 6d length, and in any 30d length, that includes this spot. 6d and 30d mean 6 or 30 times the nominal diameter d: for a 28 mm rope, 168 mm and 840 mm.
- Zone SH: rope working in steel sheaves and/or spooling on a single-layer drum (wire breaks randomly distributed). Zone ML: multi-layer drum, for deterioration at the crossover zones and interference between wraps due to fleet angle effects, not sections of rope which only work in sheaves and do not spool on the drum (Table 3 / 4 note c).
- On every line, also measure D1 and D2 at that spot, the same way as section 1, and write them in the Ø column: the competent person assesses the combined effect of deterioration at the same position in the rope (6.1, Annex G). On a crossover zone (ML) the Table 5 diameter limit does not apply (6.4.1): write the reading anyway (CRS practice).
- Write ML only for breaks at a crossover zone or where wraps interfere; otherwise write SH. Breaks grouped in one or two neighbouring strands: also mark row 4.1.
- Breaks from shipping, storage, installation or manufacture are not normally counted: note them in row 3.3 only (6.2.3). A protruding wire broken off during maintenance is counted as a broken wire: log it here and in row 3.4 (4.7).

Inspection type codes

D daily (5.2) P periodic (5.3) I after an incident (5.4) S after more than 3 months out of use (5.5) R after re-rigging (5.2)



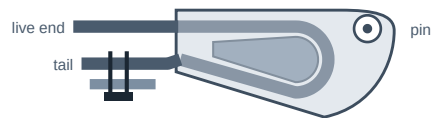
Finding your points again



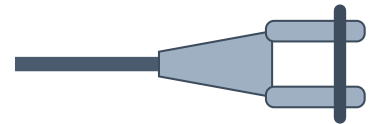
Common dead-end fittings (Crane Rope Solutions illustration)



Button (swaged or poured)



Wedge socket



Open spelter socket (pin through the jaws)

5 Sections 3 to 6: everything else

- Measurements: write the reading and where. Checks: mark ✓ nothing found, X found, N/A does not apply. For every X, write where it is (m from which end, or which part) and what you found in the same row.
- Corrosion (rows 4.4, 4.5 and 4.6): clean the rope first, then write where it is and which Table 6 condition you see: surface oxidation that can be wiped clean; wire surface rough to touch; wire surface heavily pitted and slack wires; corrosion debris coming out of the valleys between the outer strands; or a dry powder like red rouge (fretting) (6.6, Table 6).
- Sheaves (section 6): one line per sheave, named so you can find it again (for example "Boom tip 2"). Groove: write the groove diameter in mm, or OK / not OK from a go / no-go gauge (page 10). Then mark ✓ or X for groove wear, flange and bearing as the column headings say, and for every X write what and where in the last column. Negative impressions: the pattern of the rope's strands pressed or worn into the groove.

6 Sign and send

- Sign or initial, write the next inspection due, and send us a photo of both pages for a free analysis and a same-day response.



Your limits from ISO 4309:2017

Work these out once for each rope and write them on page 1. Then the rules below tell you what each finding means. **FAIL** the standard says (shall) the rope or that part comes out of service, or the item must be put right. **SHOULD** the standard recommends (should) it; the competent person decides (3.8). **EVALUATE** no fixed limit; the competent person judges it (3.8). Rows not listed are for the record only.

A. Broken-wire limits

- Find your rope construction in ISO 4309 Annex H and use the RCN shown there. Not listed? Count n: all the wires in the outer layer of strands, leaving out filler wires (for a rotation-resistant rope also count the outer strands).
- Single-layer and parallel-closed ropes use Table 3; rotation-resistant ropes use Table 4 (page 9). Table 3 only: pick ordinary or Lang lay.
- Write the broken-wire limits over 6d and over 30d for rope working in steel sheaves and/or spooling on a single-layer drum. Multi-layer drum: also write the broken-wire limits from the multi-layer drum columns. Those apply only at the crossover zones and where wraps interfere due to fleet angle effects (Table 3 / 4 note c).
- Mechanism known to be class M5 to M8: Table 3 says twice the single-layer number may be applied.
- Example: RCN 09, ordinary lay, single-layer drum: 9 broken wires over 6d and 18 over 30d.

B. Minimum diameter

- Tick your rope type on page 1: single-layer rope with steel core or parallel-closed rope 7.5%, rotation-resistant rope 5%. The % is of the nominal diameter d.
- Minimum diameter = dref - (% x nominal d) (6.4.2).
- Example: 20 mm single-layer steel-core rope, dref 20.8 mm. 7.5% of the nominal 20 mm = 1.5 mm. Minimum = 20.8 - 1.5 = 19.3 mm. A reading of 19.3 mm or less fails.
- Crossover zones on a multi-layer drum: where one wrap crosses another or the rope climbs a layer at the flange. Spooling deforms the rope there, so the Table 5 diameter limit does not apply at crossovers or other sections deformed the same way (6.4.1), and Annex G leaves diameter out there (G.1 Note 2). Do not put a "measured at" point on a crossover (CRS practice). At the crossovers, broken wires and deformation are the main expected problems (F.1 b): use the multi-layer numbers on page 1 and the deformation rows; the other rows (local decrease, strand fracture, corrosion, heat) still apply.

C. Other limits

- Waviness: lay a straightedge along the rope and measure the gap between it and the underside of the wave, loaded or unloaded. Discard if the gap is d/10 or greater where the rope runs through a sheave or spools onto the drum (20 mm rope: 2 mm), or d/3 or greater on a straight portion that never does (6.7.2).
- Diameter increase of 5% or more (steel core) during service: find the reason and consider discard (6.7.6).
- The crane or rope manufacturer's instructions come first; these ISO criteria apply where they give none (5.1, 6.1).
- Single-layer spooling with exclusively synthetic sheaves, or metal sheaves with synthetic linings: ISO 4309 does not recommend this combination and gives no discard criteria for it (clause 1, NOTE). Ask the rope or crane manufacturer (Crane Rope Solutions practice).

D. Rules for the sheet rows

Row	Check	Rule	Clause
1.1 to 1.6	Each average diameter	FAIL At or below your minimum diameter (page 1). Not on drum crossover zones (6.4.1): see page 6, part B.	6.4.1, Table 5
1	Combined severity at the worst position	EVALUATE The competent person shall assess the combined effect (6.1). One method (Annex G, informative): add the ratings found at the same position, or judge it in words; 100% or more = discard	6.1, Annex G
1	Noticeable change in the rate of deterioration	EVALUATE The reason shall be investigated and, wherever possible, corrective action taken. In extreme cases the competent person may discard the rope, shorten the time to the next periodic inspection, or lower the discard criteria	6.1
2	Most broken wires in any 6d. Sections of rope working in steel sheaves and/or spooling on a single-layer drum (wire breaks randomly distributed)	FAIL Reaches or exceeds the broken-wire limit over 6d (page 1)	Table 3 / 4
2	Most broken wires in any 30d. Sections of rope working in steel sheaves and/or spooling on a single-layer drum (wire breaks randomly distributed)	FAIL Reaches or exceeds the broken-wire limit over 30d (page 1)	Table 3 / 4
2	Most broken wires in any 6d. Sections of rope spooling on a multi-layer drum (at the crossover zones and where wraps interfere due to fleet angle effects)	FAIL Reaches or exceeds the multi-layer drum broken-wire limit over 6d (page 1)	Table 3 / 4 note c
2	Most broken wires in any 30d. Sections of rope spooling on a multi-layer drum (at the crossover zones and where wraps interfere due to fleet angle effects)	FAIL Reaches or exceeds the multi-layer drum broken-wire limit over 30d (page 1)	Table 3 / 4 note c
2	Valley breaks in one lay length (about 6d)	FAIL 2 or more	Table 2
2	Broken wires at a termination	FAIL 2 or more	Table 2



Row	Check	Rule	Clause
3.1	Largest waviness gap g (mm), loaded or unloaded	FAIL d/10 or greater where the rope runs through or around a sheave or spools onto the drum; d/3 or greater on a straight portion that never does (page 1)	6.7.2
3.2	Largest diameter (mm)	EVALUATE At or above your increase figure (page 1): find the reason, consider discard	6.7.6
4.1	Grouped breaks in one or two neighbouring strands (sections that do not spool on and off the drum)	EVALUATE Might need discard even below the 6d broken-wire limit	Table 2
4.2	Local decrease in diameter (core failure, sunken strand)	FAIL Any obvious local decrease	6.4.3
4.3	Fracture of a strand	FAIL Any complete strand fracture	6.5
4.4	External corrosion (wipe or brush clean first; avoid solvents)	FAIL Wires heavily pitted and slack. Rough to touch = high (60%); galvanized may rate lower	6.6, Table 6
4.5	Internal corrosion	FAIL Corrosion debris exuding from the valleys: discard, or, if the competent person deems it practicable, internal examination per 6.3 or Annex C. Any doubt about its seriousness: discard (should)	Table 6
4.6	Fretting corrosion (dry red powder)	SHOULD Investigate further; if in any doubt about its severity, discard	Table 6
4.7	Basket deformation (birdcage)	FAIL Any: discard immediately, or remove the affected section if the remaining length is in a serviceable condition	6.7.3
4.8	Core or strand protrusion or distortion	FAIL Any: discard immediately, or remove the affected section if the remaining length is in a serviceable condition	6.7.4
4.9	Protruding wires in loops	FAIL Any. A single core king wire may not need discard if it can be removed or does not interfere	6.7.5
4.10	Flattened portion	EVALUATE Through a sheave: depending on extent, discard may be considered. Standing rigging: if retained, inspect more often (shall); otherwise consider discard (should). From multi-layer spooling: may not need discard, provided the broken wires associated with it do not exceed Tables 3 / 4	6.7.7
4.11	Kink or tightened loop	FAIL Any	6.7.8
4.12	Bend in rope	FAIL Severe bend in a portion that runs through a sheave: discard immediately. A fold in the rope on the underside of the bend should be considered severe, whether or not the rope runs over a sheave. Lesser bend, if retained: inspect more often (shall); otherwise consider discard (should)	6.7.9
4.13	Heat damage or electric arcing	FAIL Rope not normally operated at temperature showing exceptionally high thermal effects (heat colours and/or a distinct loss of grease); or two or more wires affected locally by electric arcing	6.7.10
4.14	Rope in a dangerous condition	FAIL Any	6.7.1
4.15	MRT (magnetic rope test) result, if used	FAIL Loss beyond the Annex C maximum permissible (6.3): LF 6% over 6d or 10% over 30d; LMA 10% over 30d. An MRT should be used where defects might not be found visually, and shall be performed together with a visual inspection (5.6)	5.6, 6.3, Annex C
4.16	Rope dressing (lubrication)	EVALUATE Shall be dressed from time to time, before signs of dryness or corrosion, as the competent person determines; dressing shall be compatible with the original lubricant and penetrating. If no dressing can be applied, the inspection interval shall be reduced	4.7
5.1	Rope entering the termination: loose wires (a spike may be used to probe)	EVALUATE Broken wires here: use the termination row on section 2 of the sheet (rules: page 6)	5.3.4
5.2	Termination itself: excessive distortion or wear	EVALUATE Competent person decides	5.3.4
5.3	Ferrules: cracks, or slippage between ferrule and rope	EVALUATE Competent person decides	5.3.4
5.4	Detachable terminations (e.g. wedge sockets): correctly assembled	EVALUATE Shall be checked that it is correctly assembled; if not, put right before use (Crane Rope Solutions practice)	5.3.4
5.5	Eye splices: serving only over the taper; rest of splice checked for broken wires	EVALUATE Competent person decides	5.3.4
5.6	Rope sitting correctly on the drum and over every sheave	EVALUATE Any appreciable change: report it; competent person examines (5.3)	5.2
5.7	Drum anchorage / point of attachment to the crane	EVALUATE Competent person decides	5.3.3 a)
5.8	Drums rotate freely in their bearings	EVALUATE Drums and sheaves shall be checked periodically to ensure they rotate freely (4.8). If not, follow the crane manual	4.8
5.9	Before cutting and re-terminating: drum wraps left at the most extreme operating limit	FAIL Shall be checked: the required minimum wraps must remain (number: see the crane manual)	4.7

E. Sheaves (section 6)

EVALUATE Before a new rope goes on, the groove should be 5% to 10% over nominal d and at least 1% over the new rope's actual diameter, free of corrugations, with enough wall left to support the rope (4.4). Drums and sheaves shall be checked periodically to ensure they rotate freely in their bearings (4.8). Act per the crane manual.

When: Check the grooves of every sheave and drum before each new rope (4.4); check drums and sheaves turn freely periodically (4.8); doing it at each periodic inspection is Crane Rope Solutions practice.



F. After the inspection

Limit reached: Rope to be withdrawn from service immediately, or within a specified timeframe (5.3.1 b)). Where the criterion says "immediately" (6.5, 6.7.1, 6.7.3 to 6.7.5, 6.7.8, 6.7.9 severe bend through a sheave, 6.7.10 heat damage), withdraw it immediately.

Corrective actions: Noticeable change in the rate of deterioration: find the reason (shall) and correct it where possible (6.1). Protruding wire broken off: record where (should) and count it as a broken wire (shall) (4.7). Before shortening and re-terminating, check the drum wraps (4.7, shall).

Records: After each periodic inspection the competent person shall provide a rope inspection record (5.3.5; examples in Annex E), with a severity for each mode found (5.3.1). State the longest interval allowed before the next periodic inspection (5.3.5). Preferably keep a running record from one inspection to the next (5.3.5, E.2). Assess the combined effect at each position (6.1, shall; one method: Annex G). A record of each rope change shall be placed on file (4.2).



How many broken wires reach the limit?

1) Find your rope construction in ISO 4309 Annex H and use its RCN. If it is not listed, count n: all the wires in the outer layer of strands, leaving out filler wires (rotation-resistant rope: also count the outer strands). 2) Read the broken-wire limit for your lay and the length counted over (6d or 30d). Multi-layer columns are only for crossover zones and where wraps interfere due to fleet angle effects (Table 3 / 4 note c). Reaching or exceeding that limit signals discard. d = nominal rope diameter. A broken wire has two ends and counts once.

Table 3: single-layer and parallel-closed ropes

RCN	Load-bearing outer wires (n)	Working in steel sheaves and/or a single-layer drum: classes M1 to M4 or unknown				Spooling on a multi-layer drum: all classes	
		Ordinary lay		Lang lay		Ordinary and Lang lay	
		6d	30d	6d	30d	6d	30d
01	n ≤ 50	2	4	1	2	4	8
02	51 to 75	3	6	2	3	6	12
03	76 to 100	4	8	2	4	8	16
04	101 to 120	5	10	2	5	10	20
05	121 to 140	6	11	3	6	12	22
06	141 to 160	6	13	3	6	12	26
07	161 to 180	7	14	4	7	14	28
08	181 to 200	8	16	4	8	16	32
09	201 to 220	9	18	4	9	18	36
10	221 to 240	10	19	5	10	20	38
11	241 to 260	10	21	5	10	20	42
12	261 to 280	11	22	6	11	22	44
13	281 to 300	12	24	6	12	24	48
	n > 300	0.04n	0.08n	0.02n	0.04n	0.08n	0.16n

Table 4: rotation-resistant ropes

RCN	Outer strands and load-bearing outer wires (n)	Steel sheaves and/or single-layer drum		Multi-layer drum	
		6d	30d	6d	30d
21	4 strands, n ≤ 100	2	4	2	4
22	3 or 4 strands, n ≥ 100	2	4	4	8
23-1	11+ outer strands, 71 to 100	2	4	4	8
23-2	101 to 120	3	5	5	10
23-3	121 to 140	3	5	6	11
24	141 to 160	3	6	6	13
25	161 to 180	4	7	7	14
26	181 to 200	4	8	8	16
27	201 to 220	4	9	9	18
28	221 to 240	5	10	10	19
29	241 to 260	5	10	10	21
30	261 to 280	6	11	11	22
31	281 to 300	6	12	12	24
	n > 300	6	12	12	24

Seale outer strands with 19 wires or fewer per strand (e.g. 6x19 Seale): use the row two rows above where n would place it. Table 3 single-layer columns: twice the number may be applied on mechanisms known to be class M5 to M8. Multi-layer columns apply to deterioration at crossover zones and interference between wraps due to fleet angle effects only. Also discard (Table 2): two or more valley breaks in one lay length (about 6d); two or more breaks at a termination; a localized grouping in one or two neighbouring strands, in sections that do not spool on and off the drum, might need discard even below the 6d numbers. Summarized from ISO 4309:2017 Tables 2, 3 and 4 for field reference.

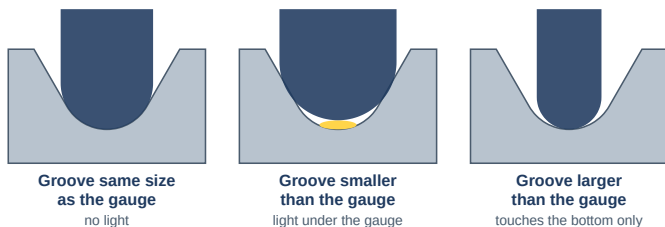


Checking sheave grooves with groove gauges

There are two types of groove gauge: **go / no-go gauges** and **actual size gauges**. How to use them, and what to do about a groove outside the limits, is Crane Rope Solutions practice unless a clause is given. The groove sizes come from ISO 4309:2017 (box at the bottom).

1. Go / no-go gauges

1. Clean the groove so the gauge sits on bare metal, not grease or dirt.
2. A go / no-go gauge is made to a groove size, not to the rope size: check the size marked on it. For a 28 mm rope use a **minimum gauge of 29.40 mm** (smallest groove ISO 4309 4.4 recommends, $d \times 1.05$) and a **maximum gauge of 30.80 mm** (largest groove ISO 4309 4.4 recommends, $d \times 1.10$). ISO 4309 4.4 gives this range for checking the grooves before a new rope goes on.
3. Place it into the groove, square to the sheave. **Plastic gauges: do not push down hard.** They flex, and pressing down can easily give a wrong reading, so plastic gauges are not the best choice. Crane-specific steel groove gauges are available at craneropesolutions.com.
4. Shine a flashlight behind the gauge.
5. **Minimum gauge, any light under it** (middle picture): replace the sheave (Crane Rope Solutions practice).
6. **Maximum gauge touches only the bottom, with gaps at both sides** (right picture): the groove is more than 10% larger than the nominal rope diameter: oversized. Replace the sheave (Crane Rope Solutions practice).
7. Check several places around each sheave and write the result in section 6 of the sheet.



2. Actual size gauges

Crane Rope Solutions offers actual size gauges in 0.25 mm steps. Try gauges until you find the one that best fills the groove without letting light underneath it. That gauge is your true groove size. Write the size in section 6 of the sheet.

Check it against the minimum. ISO 4309 4.4 figure for before a new rope goes on: the groove should be at least 5% larger than the nominal rope diameter. For a 28 mm rope: $28 \times 1.05 = 29.40$ mm, so the closest 0.25 mm step at or above it is the **29.50 mm** gauge.

Check it is not oversized. ISO 4309 4.4, before a new rope goes on: no more than 10% larger. For a 28 mm rope: $28 \times 1.10 = 30.80$ mm; a groove reading more than this is oversized.

Why we prefer actual size gauges

A go / no-go gauge only tells you pass or fail. An actual size gauge shows how much wear is left, so your maintenance plan can move from pass, pass, pass, fail to 100% life remaining, 75%, 50%, 25%, replace.

100% 30.50 mm	75% 30.25 mm	50% 30.00 mm	25% 29.75 mm	Plan to replace 29.50 mm
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Example, 28 mm rope: new groove 30.50 mm, minimum gauge 29.50 mm. Life remaining = $(\text{gauge now} - \text{minimum}) / (\text{new} - \text{minimum})$. Crane Rope Solutions planning practice: "Plan to replace" is the last 0.25 mm step at or above the minimum, so plan the work before the groove goes below it. Example figures; use your manufacturer's limit where it has one.

What ISO 4309:2017 says. ISO 4309 4.4 (before installing the rope): check that all sheave and drum grooves can accept the size of the new rope; the sheave groove diameter should be between 5% and 10% larger than the nominal rope diameter, and for optimal performance at least 1% greater than the actual diameter of the new rope. For sheave replacement, follow the crane manual.



Don't have gauges? Scan to see our groove gauges.

Want a free gauge? Give us a shot at quoting your wire ropes and we will send you a free groove gauge, just to say thank you.

604-813-WIRE (9473) | dean@craneropesolutions.com



EXAMPLE, made-up readings. A 28 mm rope filled in to show how the sheet works. Your blank sheet is pages 1 and 2.

Wire rope inspection sheet: ISO 4309:2017

One rope per sheet. How to fill it in: page 4. Mark ✓ nothing found, X found (write where and what), N/A does not apply. **Free analysis:** send us a photo of the completed sheet for a same-day response (page 2).

Date 2026-04-03	Inspection type (codes: page 4) P	Hours (machine or rope) 4,318	Inspector (print) J. Smith	Trolley distance (m) or boom angle (°) 60 deg	Hook height (m) and hook load 15 m, block
Customer / owner Example Crane Co.	Site / location Vancouver yard	Crane make ABC Cranes	Crane model Example 100T	Serial number EX-12345	Unit number 12
Winch number W1	Winch duty (main hoist, aux, boom hoist, trolley) Main hoist	Rope length (m / ft) 210 m	Nominal diameter d (mm) 28	Construction (e.g. 6x36 WS) 8xK26WS-IWRC, RCN 09	Core (IWRC, WSC) IWRC
Lay (ordinary / regular or Lang, direction) Right regular (ordinary), SZ	Grade / finish 1960 / bright	OEM specified breaking force (crane manual, not the mill cert) Per crane manual	Minimum breaking force (mill cert) Per mill cert	Date installed 2025-12-15	Certificate number EX-0001
Rope manufacturer / supplier Crane Rope Solutions	Drum: single or multi-layer Multi-layer	Sheaves: steel or synthetic Steel	Mechanism class (M1 to M8, or unknown) M4		

Your limits for this rope (how to work them out: page 6; tables: page 9)

Broken wires: sections of rope working in steel sheaves and/or spooling on a single-layer drum	Broken-wire limit (reached or exceeded: discard): over 6d 9 over 30d 18	Table 3 / 4
Broken wires: sections of rope spooling on a multi-layer drum (crossover zones and wrap interference)	Broken-wire limit (reached or exceeded: discard): over 6d 18 over 30d 36 (N/A if single-layer)	Table 3 / 4 note c
Diameter limit (Table 5): tick your rope	☒ Single-layer rope with steel core, or parallel-closed rope: 7.5% of nominal d ☐ Rotation-resistant rope: 5% of nominal d	6.4.1
Discard diameter = dref - (% x nominal d) (discard at or below)	26.74 mm	6.4.2
Waviness gap limit	d/10 = 2.80 mm (rope that runs over sheaves or onto the drum) d/3 = 9.34 mm (straight rope that never runs through or around a sheave or onto the drum)	6.7.2
Diameter increase check (investigate, consider discard)	Steel core: dref x 1.05 = 30.28 mm (dref as the base: CRS practice)	6.7.6
Sheave grooves	Rope nominal Ø (d): 28 mm Groove should be d x 1.05 = 29.40 to d x 1.10 = 30.80 mm New rope actual Ø 28.90 x 1.01 = 29.19 mm (4.4)	

Reference diameter dref (measured directly after running in the new rope, on a section not subject to bending; copy it from that record, do not re-measure): **28.84** mm, measured at **1** m from the **dead** end on (date) **2025-12-16**. D1 **28.88** mm, D2 **28.80** mm, averaged (ISO 4309 3.2).

1. Diameter: D1 and D2 at right angles, average (D1 + D2) / 2 (averaging: ISO 4309 3.2)

#	Measured at	D1 (mm)	D2 (mm)	Average (mm)
1.1	3 m from the dead end	28.62	28.54	28.58
1.2	120 m from the drum end	28.50	28.42	28.46
1.3	150 m from the drum end	28.76	28.72	28.74
1.4	180 m from the drum end	28.80	28.74	28.77
1.5	___ m from the ___ end			
1.6	___ m from the ___ end			

3. Other measurements

	Check	Reading	Where (m from which end)
3.1	Largest waviness gap g (mm), loaded or unloaded	none	
3.2	Largest diameter (mm)	28.79	180 m from the drum end
3.3	Breaks not from service (shipping, storage, installation, manufacture)	none	
3.4	Protruding wire broken off as maintenance	none	

Reading this example: The rope is RCN 09 (ISO 4309 Annex H), mechanism class M4, regular (ordinary) lay, so Table 3 gives 9 over 6d and 18 over 30d, and 18 / 36 at crossover zones and where wraps interfere due to fleet angle effects (Table 3 note c). Single-layer steel core, Table 5: 7.5% x 28 = 2.10 mm, so the minimum is 28.84 - 2.10 = 26.74 mm. Waviness: 28 / 10 = 2.80 mm and 28 / 3 = 9.333 mm, written 9.34 (a gap of 9.34 mm or more meets the d/3 rule). Increase: 28.84 x 1.05 = 30.28 mm.

Reading this example: The lowest average at this inspection is 28.46 mm at point 1.2 (120 m from the drum end). The minimum diameter at the top of this sheet is 26.74 mm, so every reading passes.



EXAMPLE, made-up readings. Page 2 of the example sheet.

2. Broken wires: one line for every broken wire or group you find

	Where (m from which end)	Zone SH or ML	Ø at this spot D1 / D2 (mm)	Broken wires in 6d	Broken wires in 30d	Valley breaks in one lay	Breaks at a termination	Notes
2.1	120 m from the drum end	SH	28.50 / 28.42	3	6	0	0	6 within 840 mm
2.2	35 m from the drum end	ML	28.80 / 28.74	1	2	0	0	Crossover zone
2.3	___ m from the ___ end		/					
2.4	___ m from the ___ end		/					

Zone SH: rope working in steel sheaves and/or spooling on a single-layer drum (wire breaks randomly distributed). Zone ML: multi-layer drum, for deterioration at the crossover zones and interference between wraps due to fleet angle effects, not sections of rope which only work in sheaves and do not spool on the drum (Table 3 / 4 note c). Ø at this spot: D1 and D2 measured where the breaks are, because the competent person assesses the combined effect of deterioration at the same position in the rope (6.1, Annex G). On a crossover zone (ML) the Table 5 diameter limit does not apply (6.4.1): write the reading anyway (CRS practice). Broken-wire limits: page 1.

	Check	✓ / X / N/A	If X: where and what		Check	✓ / X / N/A	If X: where and what
4. Rope condition				5. Rope ends and drum			
4.1	Grouped breaks in one or two neighbouring strands (sections that do not spool on and off the drum)	✓		4.16	Rope dressing (lubrication)	X	30-40 m from drum end: dry; lubricated
4.2	Local decrease in diameter (core failure, sunken strand)	✓		5.1	Rope entering the termination: loose wires (a spike may be used to probe)	✓	
4.3	Fracture of a strand	✓		5.2	Termination itself: excessive distortion or wear	✓	
4.4	External corrosion (wipe or brush clean first; avoid solvents)	✓		5.3	Ferrules: cracks, or slippage between ferrule and rope	N/A	
4.5	Internal corrosion	✓		5.4	Detachable terminations (e.g. wedge sockets): correctly assembled	✓	
4.6	Fretting corrosion (dry red powder)	✓		5.5	Eye splices: serving only over the taper; rest of splice checked for broken wires	N/A	
4.7	Basket deformation (birdcage)	✓		5.6	Rope sitting correctly on the drum and over every sheave	✓	
4.8	Core or strand protrusion or distortion	✓		5.7	Drum anchorage / point of attachment to the crane	✓	
4.9	Protruding wires in loops	✓		5.8	Drums rotate freely in their bearings	✓	
4.10	Flattened portion	✓		5.9	Before cutting and re-terminating: drum wraps left at the most extreme operating limit	N/A	
4.11	Kink or tightened loop	✓					
4.12	Bend in rope	✓					
4.13	Heat damage or electric arcing	✓					
4.14	Rope in a dangerous condition	✓					
4.15	MRT (magnetic rope test) result, if used	N/A					

6. Sheaves: one line per sheave (groove gauges: page 10; groove limits: page 1)

	Sheave (which one)	Groove Ø (mm) or gauge OK / not OK (4.4)	Groove wear: corrugation (negative impressions) or other irregularities, wall too thin (4.4); uneven wear (4.8 Note): ✓ / X	Flange: cracks, chips, breaks, deformation (CRS practice): ✓ / X	Bearing: turns freely (4.8): ✓ / X	If X: where and what
6.1	Boom tip 1	30.25	✓	✓	✓	
6.2	Boom tip 2	29.50	✓	✓	✓	Last step: plan replacement (CRS)
6.3	Block 1	30.50	✓	✓	✓	
6.4	Block 2	30.00	✓	✓	✓	
6.5	Block 3	30.25	✓	✓	✓	

Severity: slight / medium / high / very high / discard (5.3.1) Broken wires 33%, diameter 0%; combined 33% at 120 m	Max. interval to next periodic (5.3.5) 1 month (by 2026-05-03)	Competent person: print name and sign J. Smith	Date 2026-04-03
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Reading this example: Worst spot 120 m from the drum end: 3 breaks in 6d (limit 9) and 6 in 30d (limit 18), so the rope passes the broken-wire limits. Severity: 3 of 9 = 33%; the diameter loss of 0.38 mm is 1.4% of d, under the first Table 5 band, so 0%. Combined at that spot: 33%.

Reading this example: Boom tip 2 reads 29.50 mm. The 4.4 new-rope minimum is $28 \times 1.05 = 29.40$ mm, so 29.50 is the last 0.25 mm gauge step above it: no life left, plan to replace it (Crane Rope Solutions planning practice).



Words used on these forms

Defined in ISO 4309:2017 clause 3

Term	Clause	What it means
Nominal diameter, d	3.1	The diameter by which the rope is designated (named).
Measured diameter, dm	3.2	The average of two measurements, taken at right angles to one another, of the diameter that goes around the rope cross-section.
Reference diameter, dref	3.3	The measured diameter of a section of rope that does not bend, taken right after running in the new rope. It is the baseline for uniform change in diameter.
Crossover zone	3.4	The part of the rope where one wrap crosses over another as the rope moves across the drum, or rises from one layer to the next at the drum flange.
Wrap	3.5	One turn of rope around a drum.
Competent person	3.8	A person with enough knowledge and experience of wire ropes on cranes and hoists to assess the rope, judge whether it may stay in service and set the longest time between inspections.
Valley wire break	3.9	A wire break at the contact point, or valley, between two outer strands.
Severity rating	3.10	How much deterioration there is, as a percentage towards discard, for one kind of damage or several combined.
Magnetic rope test, MRT	3.11	Non-destructive testing based on measuring the magnetic flux leakage of a magnetized rope.
Local fault, LF	3.14	A short discontinuity in the wire rope, such as a wire break, welded wire, corrosion pit or inter-strand nicking.
Loss of metallic area, LMA	3.15	Change in metallic cross-sectional area, as a percentage of the nominal metallic cross-sectional area of the new rope.

Described elsewhere in ISO 4309:2017 (not clause 3 definitions)

Term	Clause	What it means
Load-bearing wires, n	Table 3 note a, 6.2.2	All the wires in the outer layer of strands, not counting filler wires.
Broken wire	Table 3 note b	A broken wire has two ends; count it as one wire.
RCN	6.2.2, Annex H	Rope category number; Annex H gives examples by construction.
Waviness	F.4 a)	A deformation where the centreline of the rope takes the shape of a helix, loaded or unloaded.
Basket deformation (birdcage)	F.4 b)	Caused by a difference in length between the rope core and the outer layer of strands.
Kink or tightened loop	6.7.8 Note	A deformation created by a loop in the rope that has been tightened without allowing rotation about its axis.

Words this form uses (Crane Rope Solutions)

D1 and D2	Two diameter readings at the same point, at right angles to each other. The form uses their average.
Negative impressions	The pattern of the rope's strands pressed or worn into the groove surface of a sheave or drum.
Measured at	A point you can find again, written as the distance from the drum end or the dead end.
Winch number	The number or name of the winch this rope is on.
Winch duty	What the winch does: main hoist, auxiliary hoist, boom hoist, trolley.
OEM specified breaking force	The breaking force the crane manual asks for. Not the figure on the mill certificate.
Minimum breaking force (mill cert)	The figure on the rope's mill certificate.
Drum end / dead end	The drum end is where the rope is fixed to the drum. On this form the dead end means the other end of the rope and its end fitting (button, wedge socket, spelter socket).

