



Anskaffelse av Løfteinnretninger, NORSOK R-002 Edition 2 Lifting equipment

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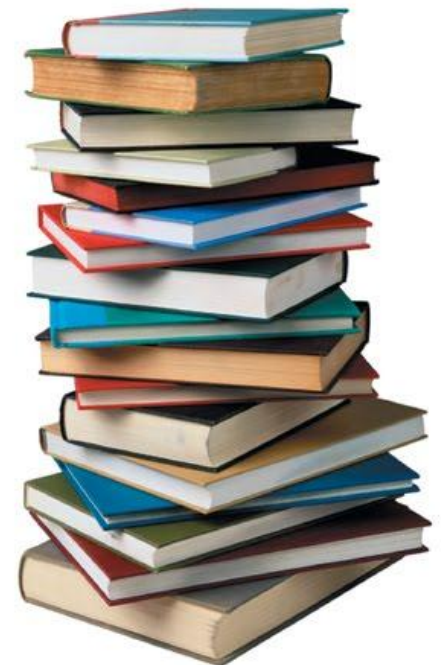
NORSOK STANDARD

R-002

Preliminary Edition 2, April 2010

Standardize,
Simplify
Safer and more effective

Lifting equipment



NORSOK C-002

Architectural components and equipment

Edition 3, June 2006

- **20.10.1 General**
- Gantry cranes, monorails and lifting systems shall be provided and arranged in close cooperation with the operator/company.



Gyldighetsområde



NORSOK R-002 Lifting Equipment:



Ny NORSOK R-002 Lifting Equipment?

- Behov for nytt regelverk innen:
 - Utsettingsarrangement
 - Løfteutstyr i boreområdet
 - NORSOK R-CR-002 var fra 1995 og foreldet



Lære av hverandres feil for å unngå å gjøre dem selv

Produsentene kan standardisere
sikkert utstyr for petroleumsindustrien

En lettere hverdag for oss alle



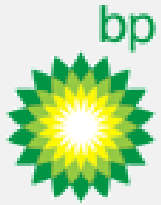
Standardisering av: Mengder med ulike krav og tilleggskrav hos de forskjellige oljeselskap

- Eksempel: En forespørsel for ny offshorekran refererte til 70 forskjellige dokumenter og 3 uker frist til å levere tilbudet



- Vanskelig å forholde seg til for leverandører og produsenter (Take it or Leave it)?
- Fordyrende og gir ingen forbedret sikkerhetseffekt.

Standardisering forenkler for alle parter

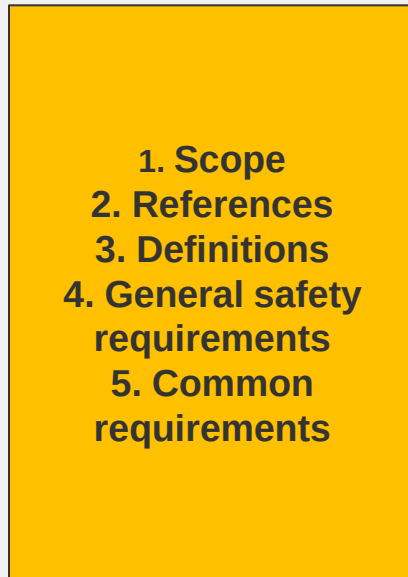


- En felles standard for alt løfteutstyr med relativt like krav for petroleumsindustri onshore og offshore.
- *Referanser til ISO, EN-, DNV standardere så langt som mulig*
- Samme sikkerhetskrav til flytende og faste installasjoner
- Unngår for mange selskapspesifikke tilleggskrav ved innkjøp
- Gir krav til løfteutstyr for løfting av personell i petroleumsindustrien

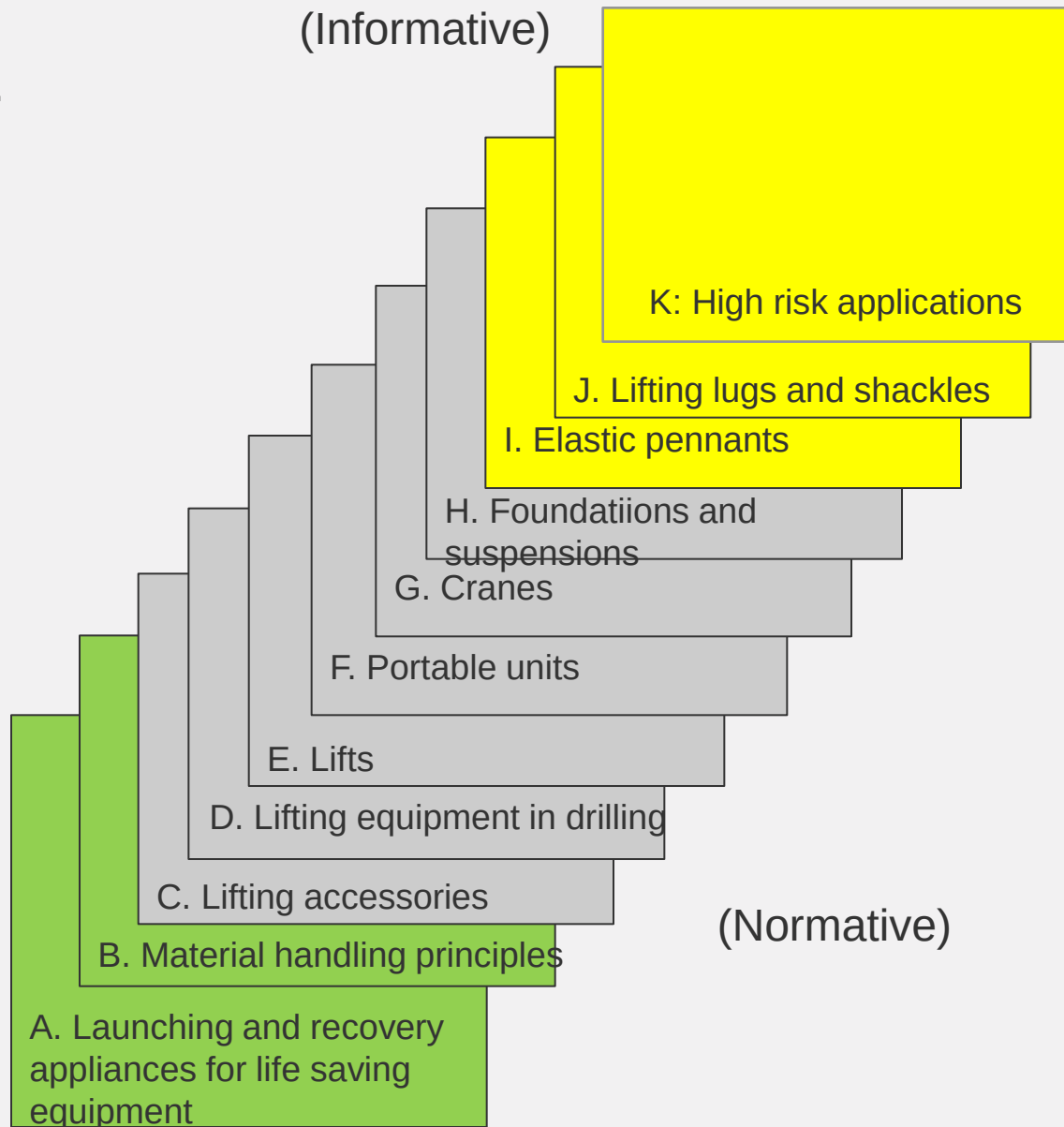


R-002 Content

Main part



Annexes



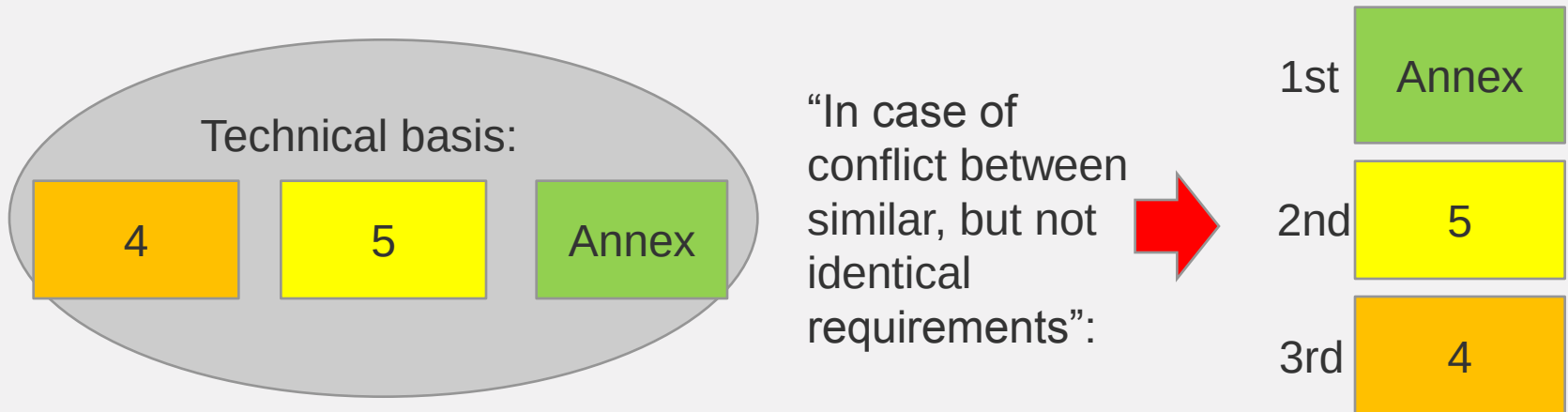
(Informative)

(Normative)



Extract from introduction:

The requirements of this NORSOK standard are given in clause 4, clause 5 and in the annexes. The combination of **all these requirements** forms the technical basis the lifting equipment has to comply with. In case of conflict between similar, but not identical requirements, the requirements of the annexes prevail over the common requirements of clause 5, which in turn prevails over the safety requirements of clause 4. However, this general rule may only be waived if the manufacturer makes use of a recognised solution and documents by means of a risk assessment that said solution gives an equal or better safety level than the conflicting requirement.



Condition: Recognised solution

Generell del – Kap. 4

4 General safety requirements (Design philosophy)



- 4.1 Sikkerhet
- 4.2 Egnethet for bruken (Fitness for Use)
- 4.3 Pålitelighet og tilgjengelighet
- 4.4 Prinsipper for integrering av sikkerhet
- 4.5 Design med innebygget sikkerhet
- 4.6 Vern, skjerming
- 4.7 Information til bruker (Brukermanual)
- 4.8 Styrke forhold (Sammenbruddsrekkefølge)
- 4.9 Vedlikehold
- 4.10 Kvalitetssikringssystem
- 4.11 Risikoanalyse
- 4.12 Risikoreduksjon
- 4.14 Dokumentasjon av risikoanalyser
- 4.15 Verifikasjon



NORSOK R-002, 4.1 Safety (1)

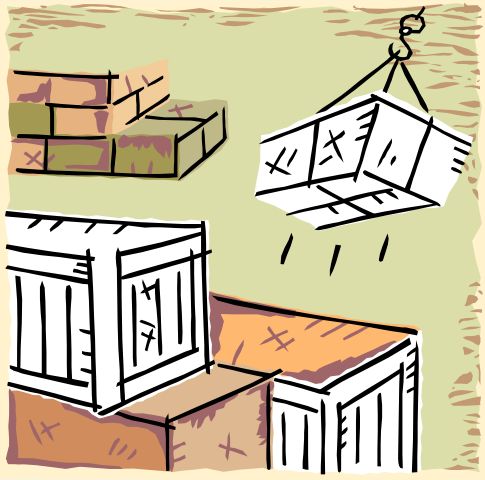
- Lifting equipment shall be designed, fabricated, tested, installed and maintained in such a way to reduce and minimise risks to humans, the environment and material assets.



Risk	= combination of probability of harm and severity of harm
Harm	= physical injury or damage to health
Extended harm	= damage to material assets or the environment

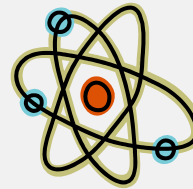
NORSOK R-002, 4.1 Safety (2)

- All forms of energy including lifting and moving objects, represented or produced by lifting equipment, shall be controlled at any time in a safe manner.



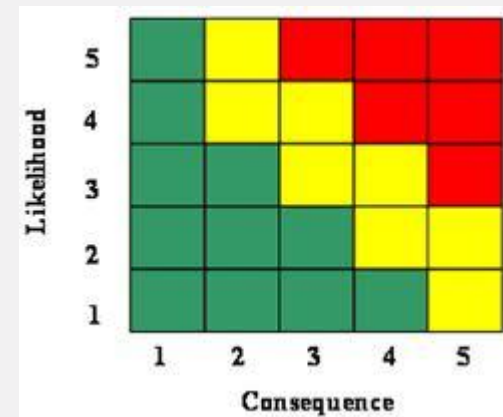
$$E_p = mgh$$

$$E_k = \frac{1}{2} mv^2$$



NORSOK R-002, 4.1 Safety (3)

- The lifting equipment shall be designed such that no single technical failure results in an unacceptable risk.



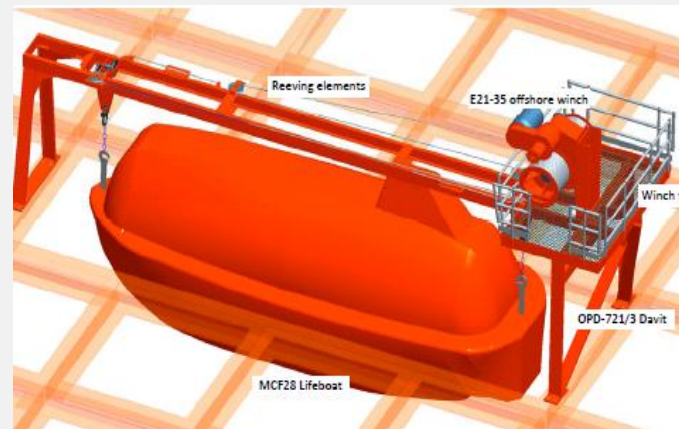
Hva er nytt?



Maskinforskriftens sikkerhetsnivå
legges til grunn også for:

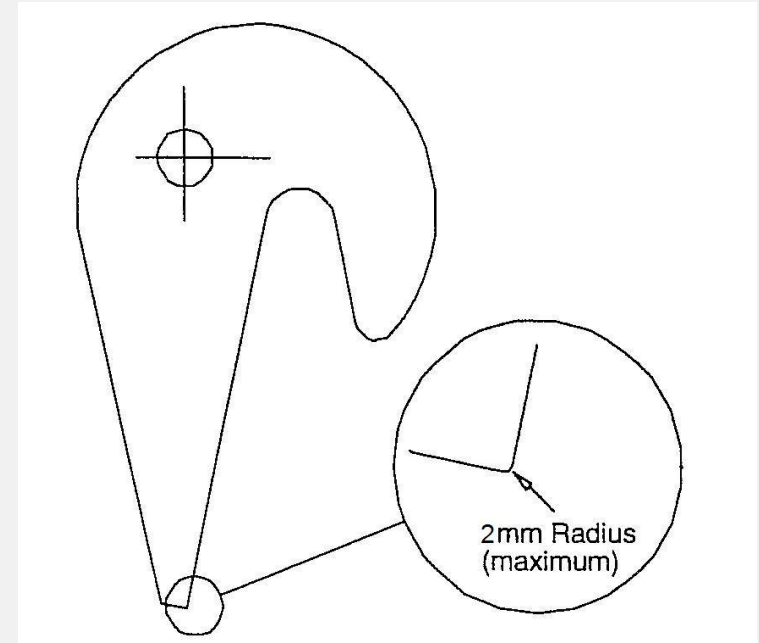
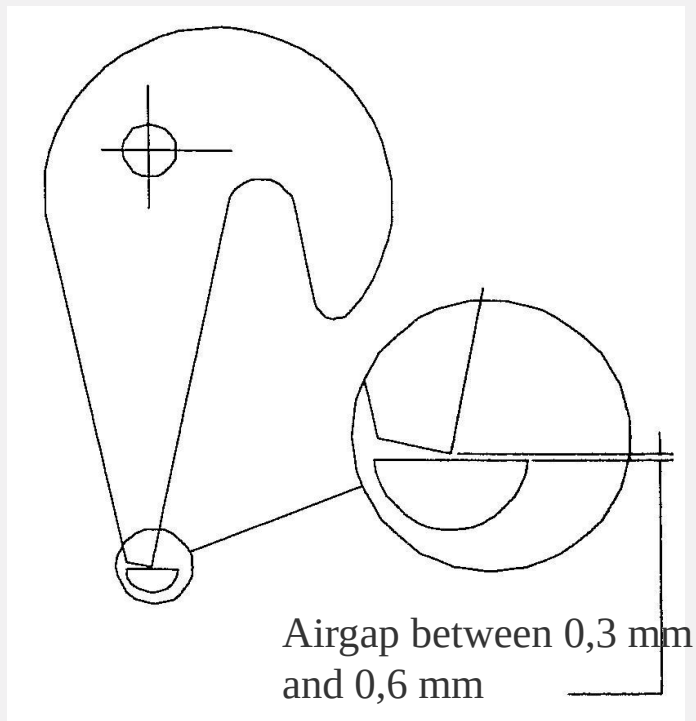
- Utsettingsarrangementer
- Løfteutstyr i boreområdet

Risikoanalyser, FMECA
"Inherently safe design",



Livbåt krok

- Hvis krok er utenfor toleransene vil den åpne seg selv ved belastning og medføre fritt fall (50-70 personer).

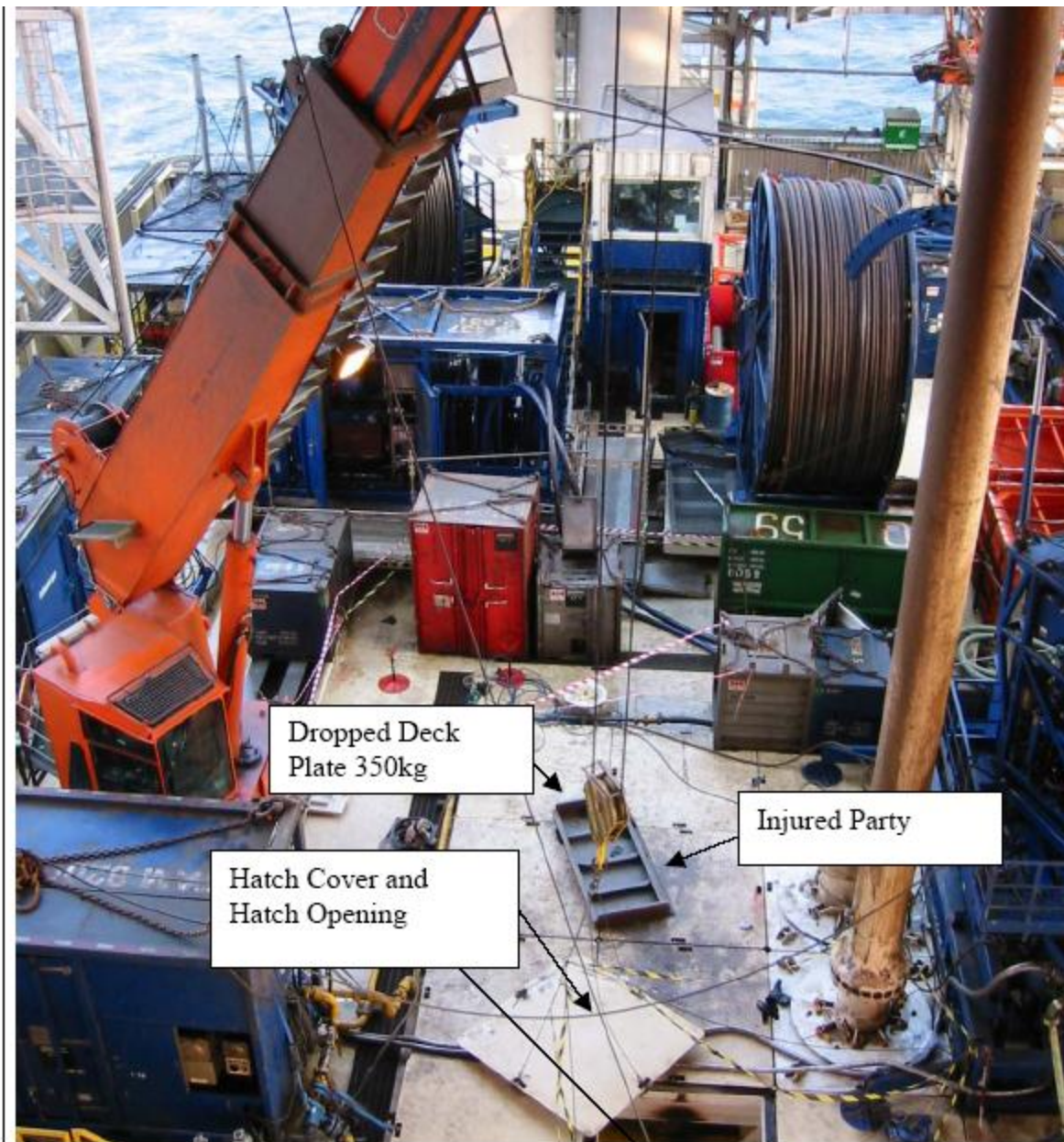


Inherently safe design measures

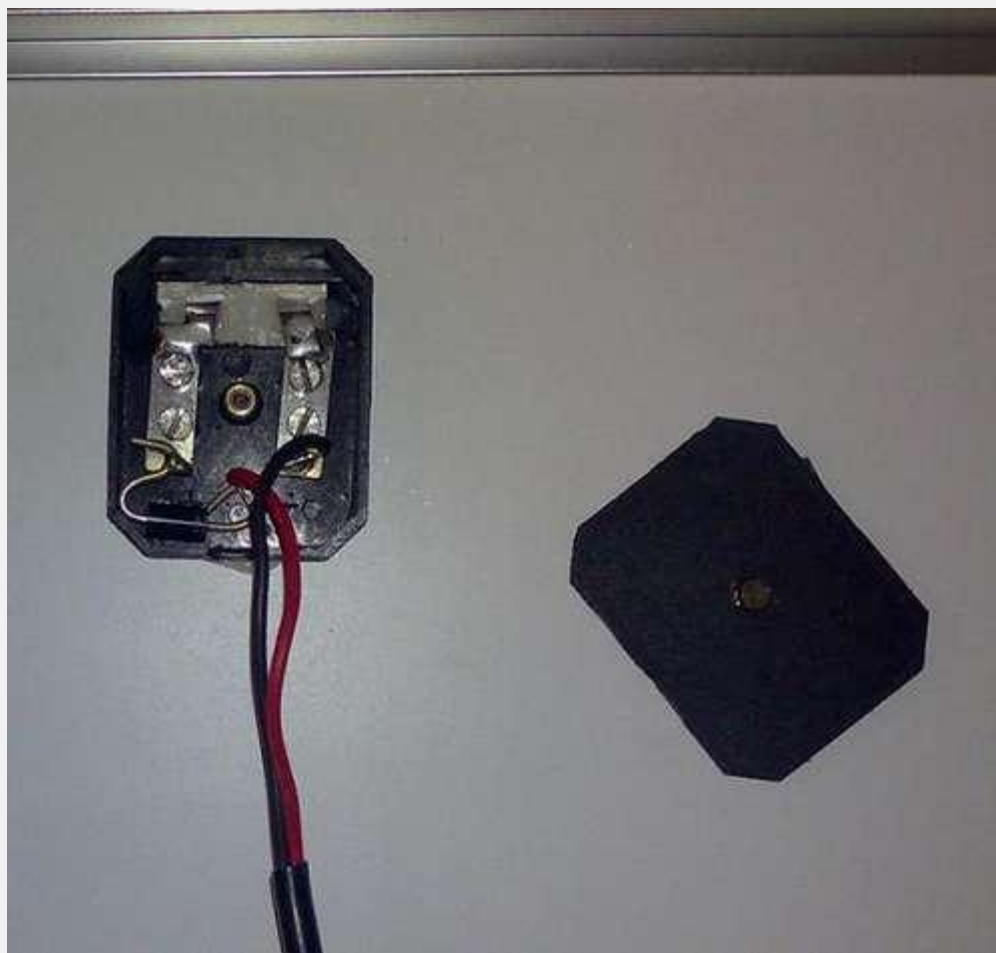
- Design med innebygget sikkerhet
- Pålitelige komponenter skal benyttes i designet, se ISO 12100-2.
- Avhengig av risikoanalysen så skal:
 - “fail-safe” komponenter
 - Pålitelige komponenter (MTTF).
 - redundante komponenter brukes.



April 2004 Valhall Flanke Nord ulykken



Ledninger ble byttet om av elektrikeren:

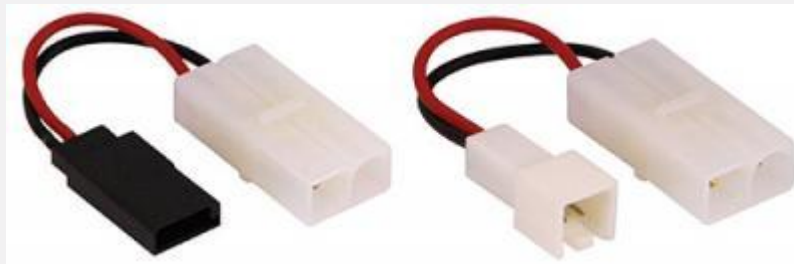
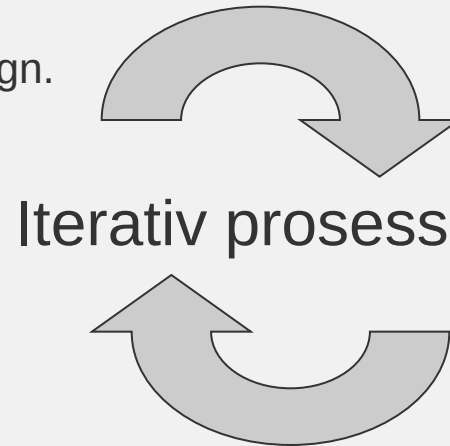


4.12 Risk reduction

Produsenten skal benytte alle muligheter for å redusere risikoen for skader på mennesker:

Inkludert redesign,

- Design modifikasjoner; Inherently safe by design.
- Vern, skjerming og beskyttelse
- Informasjon til bruker; Brukermanualen.



4.2 Fitness for use (1)

Design:

- Simplicity
- Comprehensibility
- Maintainability
- Recognisability





NYHETER
Innenriks
Oslo
Utenriks
Økonomi
Sport
Vær
Netthinnen
Siste 100

TIPS EN VENN
Fra:

Forside / nyheter / innenriks

Scandinavia Online
Oppdatert 08.11.00 kl. 15:2

Tøff kritikk i "Sleipner"-rapport

Flere av de omkomne etter "Sleipner"-forliset kunne reddet livet dersom evakueringsystemet og redningsvestene hadde fungert bedre. Utløsende årsak var feilnavigering, slår Undersøkelseskommissjonen fast.





4.2 Fitness for use (2)

Selection:

- Specific conditions at the workplace
- The work itself
- Any risk that may arise during the work



4.3 Reliability and availability

Lifting equipment shall be designed and constructed using well-proven components and safety principles to ensure reliability by withstanding

- The operating stresses and loadings
- The environmental influences
- Other relevant influences

Reliability = ability to perform and maintain the required function

Availability = ability to function

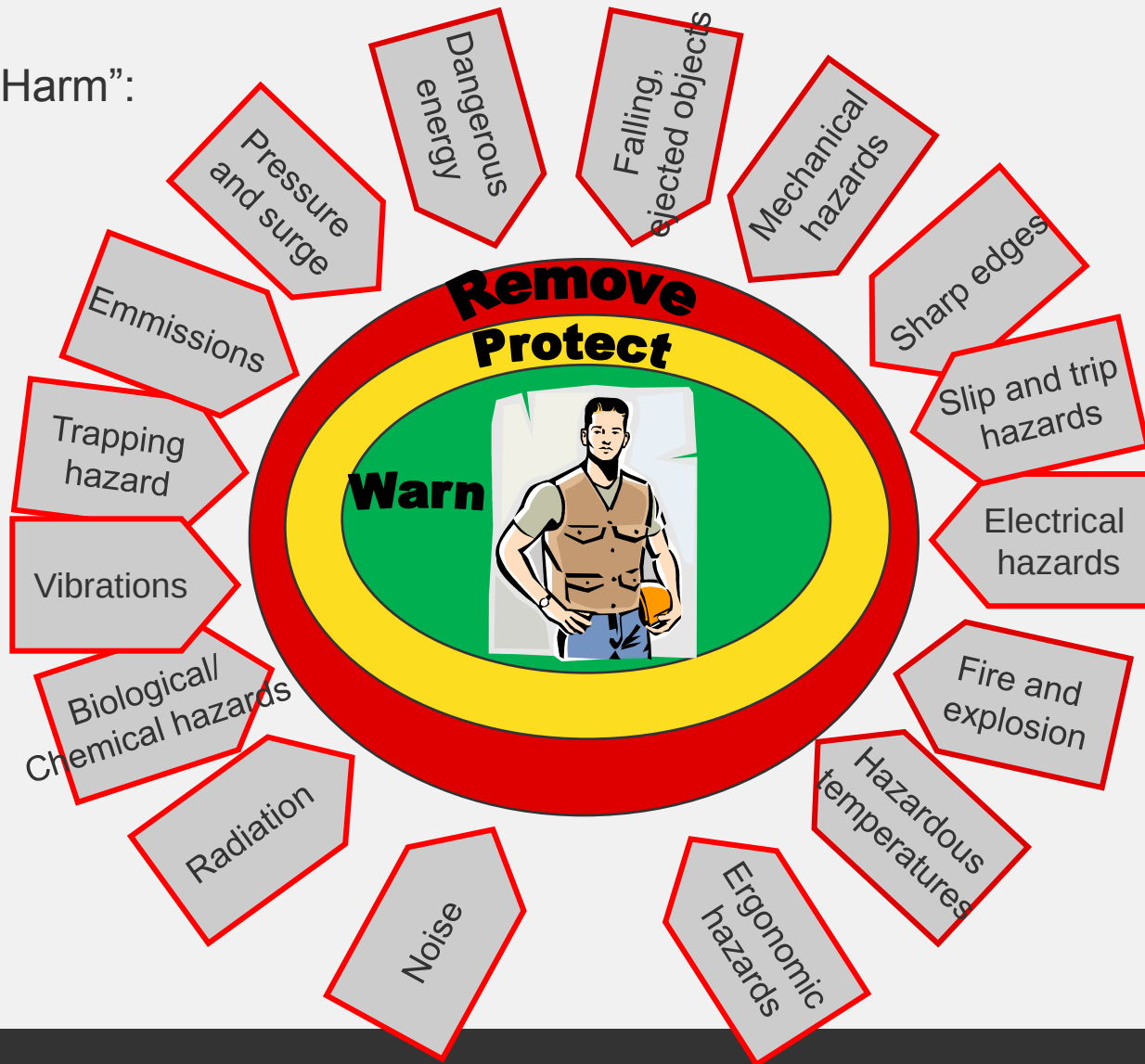
In case of conflict:

1. Safety
2. Reliability
3. Availability

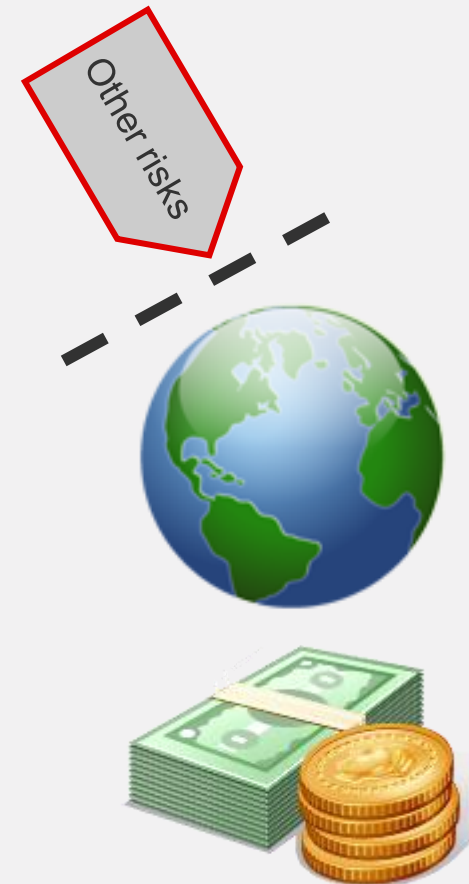


4.4 Principle of safety integration

“Harm”:



“Extended harm:”



4.5 Inherently safe design measures

- Fit for use
- Reliable, well proven
- Strength
- Stability
- Fail-safe
- Redundant
- Interlock
- Ergonomic design
- Etc.



4.6 Safeguarding and complementary protective measures

- Guards
- Locking devices
- Motion limiters, buffers
- Rated capacity indictator
- Rated capacity limiters
- Overload protection devices
- Alarms
- Anti collision
- Safe access and escape
- Etc.



4.7 Information for use

- Text
- Words
- Signs
- Pictograms
- Signals
- Symbols
- Colors
- Sounds, etc.



4.8 Strength proportion

The strength elements (structural and mechanical) of lifting equipment shall be designed such that the consequences of accidental overloading or unexpected load conditions which causes break down are known and minimised.

This requirement does not apply for lifting accessories and portable units.

For cranes this requirement may be achieved by ensuring that the first element to fail is not the foundation or any other element which is essential for the structural integrity of the entire crane.



4.9 Maintenance

- Design for easy and efficient maintenance
- Access for maintenance
- Maintenance priority:
 1. Safety
 2. Reliability
 3. Availability



All lifting equipment



Risk assessment &
Maintenance program

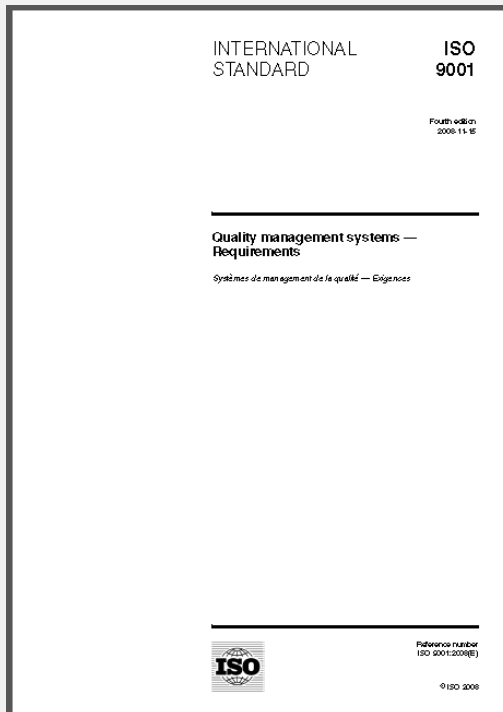
Complex lifting appliances



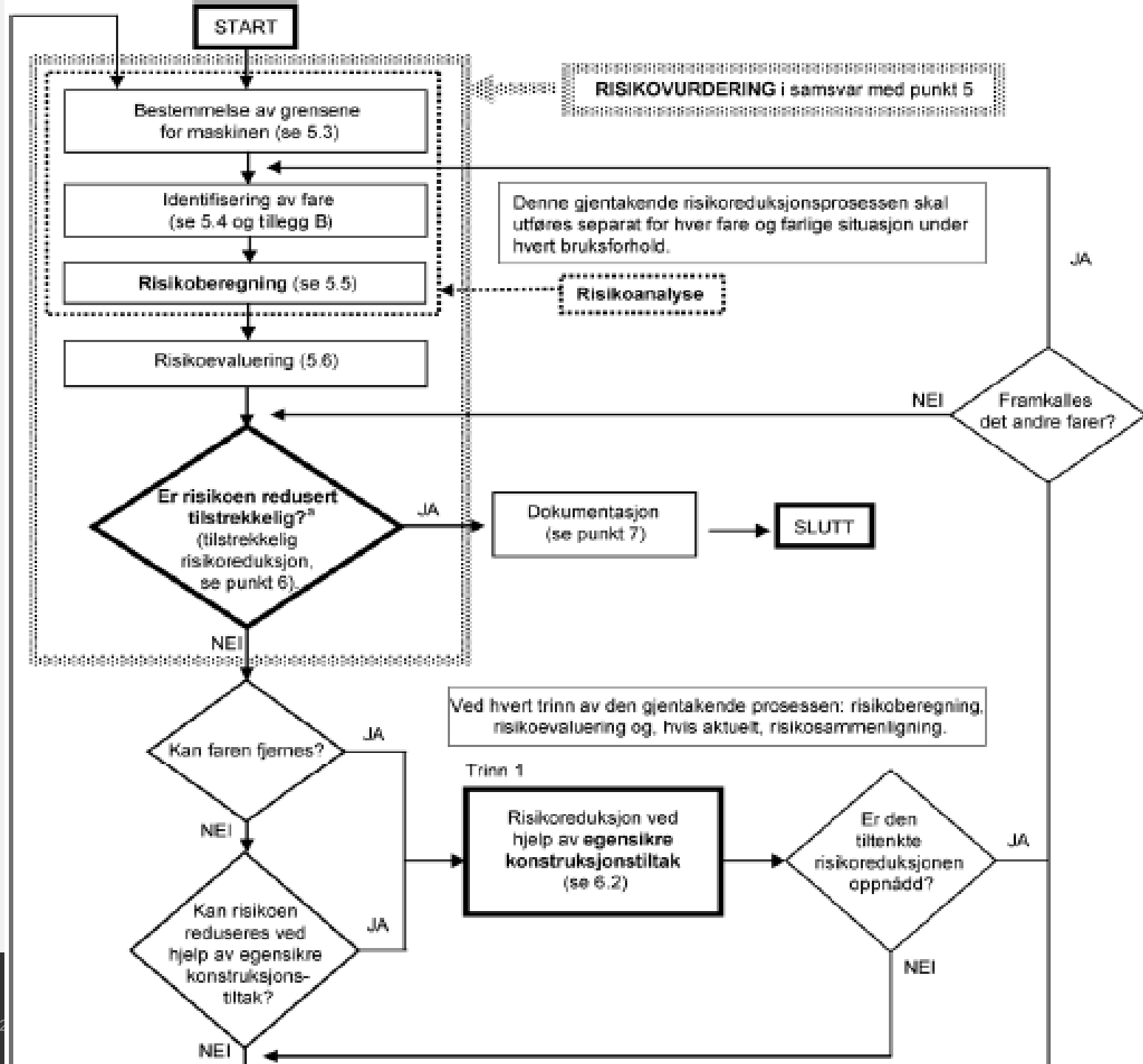
Reliability Centered Maintenance

4.10 Quality management system

- ISO 9001 or equivalent
- Continuous improvement



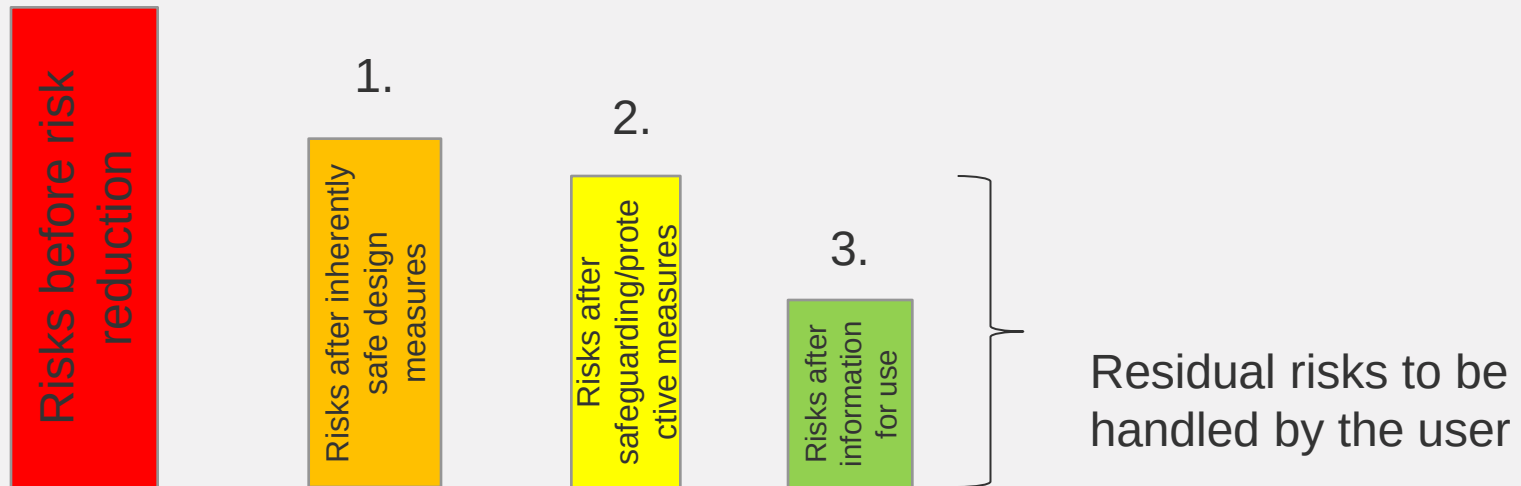
4.11 Risk assessment



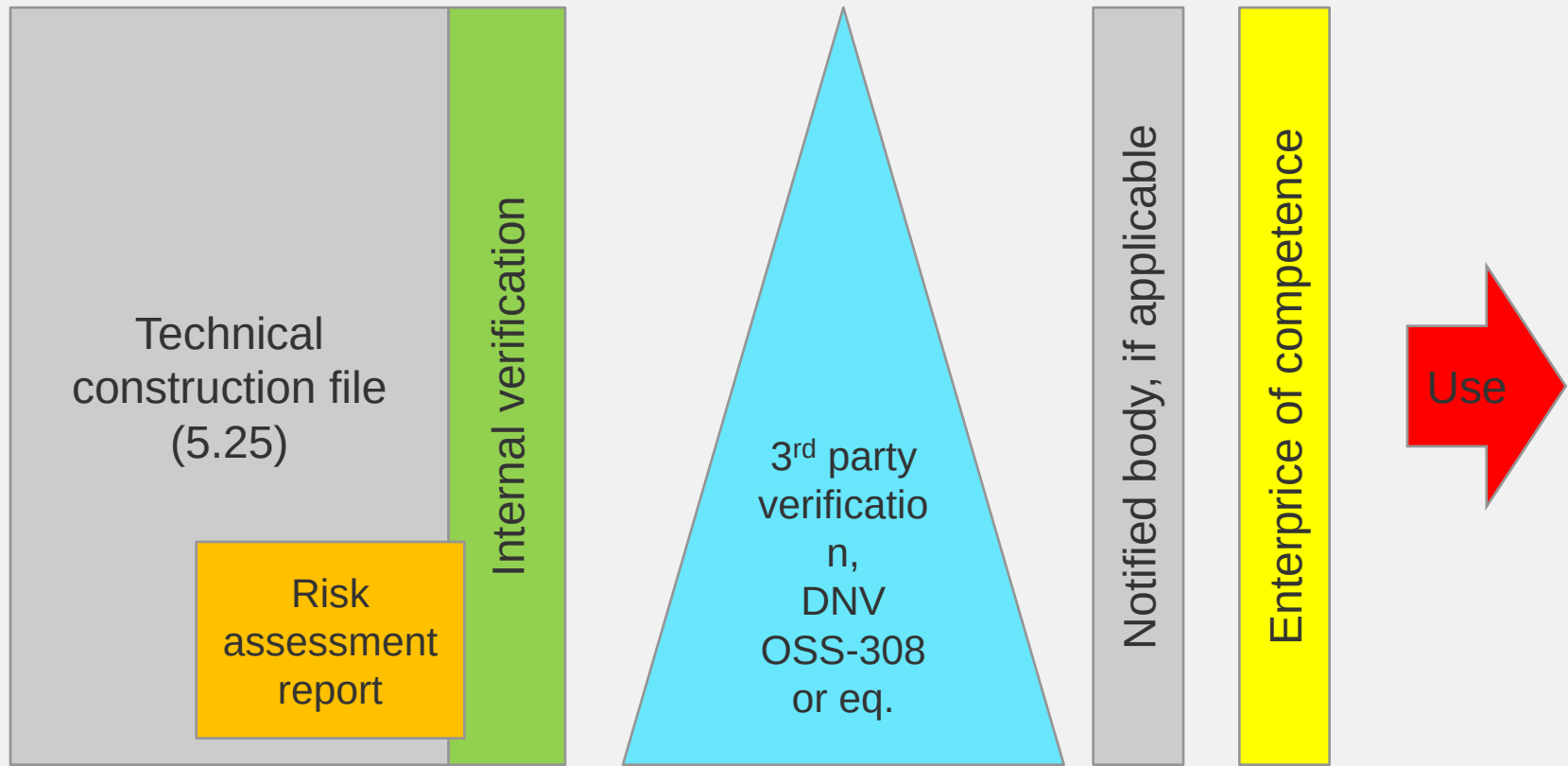
4.12 Risk reduction

Shall comprise all possibilities to reduce the risk by using the 3 step method:

1. Inherently safe design measures
2. Safeguarding and possible complementary protective measures
3. Information for use



4.13 Documentation of risk assessment / 4.14 Verification



4.15 Qualification of new technology ?

5 Common requirements

5.1 Suitability

5.2 Materials and products



5.3 Fire and explosion

Some standards referred to:

- EN 13463
- NORSOK S-001
- EN 13478
- ISO 7010
- IEC 60079 series
- EN 1127-1
- IEC 61892
- NORSOK S-002
- ISO 13702



“All types of lifting appliances, fixed, mobile or temporary, electrical or non-electrical, installed or used in hazardous areas, shall comply with ATEX requirements, i.e. Zone 0, Zone 1 or Zone 2”.

“Electrotechnical equipment mounted externally (exposed to potential explosive atmosphere) on lifting appliances located in non-hazardous areas, shall as a minimum be classified for use in hazardous area Zone 2, see NORSOK S-002. Crane boom movements may require Zone 1 equipment”.

“Lifting appliances which represent a hazard if operated in an explosive atmosphere, shall be equipped with an automatic shut-down system which is activated upon confirmed gas detection in the crane ventilation system or in the combustion air inlet, without delay, see NORSOK S-001”.

5.4 Ergonomics

Topics covered:

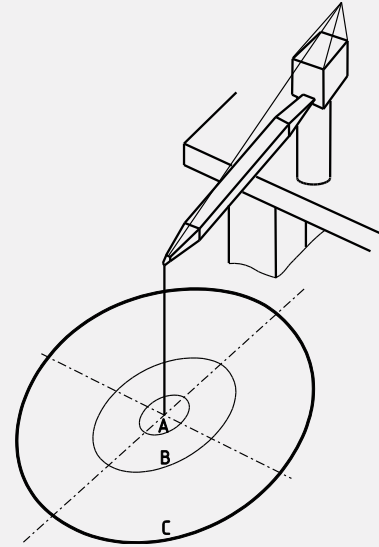
- Operator position
- Escape and access
- Marking
- Illumination
- Unexpected start-up
- Guards
- Crushing hazard
- Falling objects
- Mechanical vibration and shock
- Handling and transport facilities
- Hot surfaces



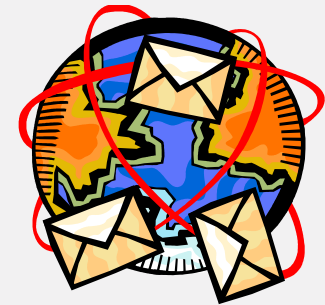
5.5 Environmental conditions and 5.6 Operational loads

Operational parameters such as:

- Temperatures
- Atmosphere
- Radiation
- Wind
- Waves
- Sea induced motions and inclinations
- Operational loads



that need to be communicated in time between the manufacturer, the supplier and the end user



5.7 Strength and stability – structure

The strength and stability design of lifting equipment shall be made in accordance with recognised international standards and design codes.

The following standards should be used:

- NS-EN 13001-1
- NS-EN 13001-2

The following technical specifications should be used:

- CEN/TS 13001-3-1
- CEN/TS 13001-3-2
- prCEN/TS 13001-3-3
- prCEN/TS 13001-3-4

For fatigue design of steel structures reference is made to DNV RP-C203.



5.15 Emergency systems

Emergency lowering system required for power operated lifting appliances for suspended loads

- Positioned to give a clear view to the load
- “hold to run” function
- Controlled lowering
- Simple to operate
- Available without undue delay (15min to land the load)
- Clear and unambiguous operation procedure

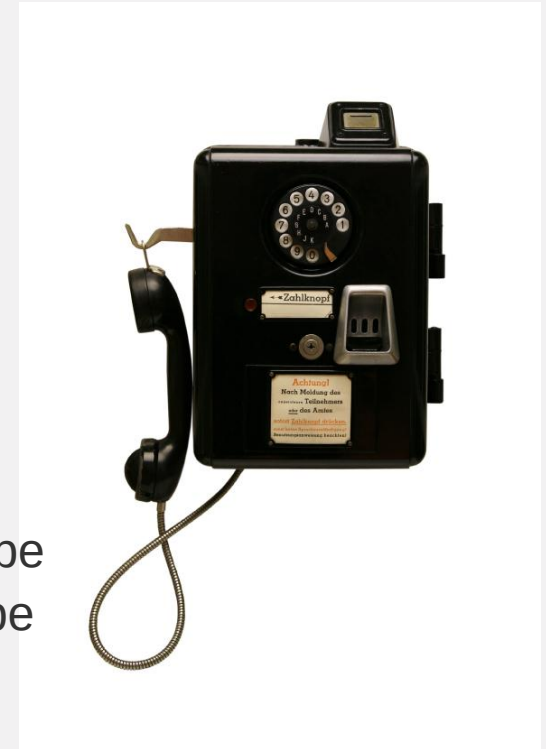
Emergency operation system (EOS) required for lifting appliances for the lifting of persons

- Move the load in any direction
- Secondary independent power supply system
- Secondary independent control system
- Simple to operate, one motion at the time
- 10% speed
- Separate emergency stop



5.16 Communication

- Cranes and enclosed control stations: Permanently installed telephone system
- Lifting appliance with enclosed control stations: Permanently installed UHF/VHF radio facilities with “handsfree” send/receive function
- Lifting appliances with an enclosed control station shall be fitted with an external loadspeaker/alarm horn that can be operated “handsfree”.



5.17 Pneumatics & 5.18 Hydraulics

Pneumatics:

EN ISO 4414

Hydraulics:

EN ISO 4413



- The hydraulic system should be fitted with metallic tube connections for fluid power with elastomeric sealing rings in accordance with ISO 8434 or DIN 2353 combined with hydraulic pipes with cold formed tube ends.
- Flexible hoses shall not be used between any load holding valves and hydraulic motors or cylinders.
- NORSOK standard specifications for piping and pipe fittings for process plants and instrument tubing shall not be used for lifting appliances.

5.21 Utility systems

Sight

Lifting appliances which have an enclosed control station shall have permanent means for window cleaning operated from inside the control station. In addition access means shall be provided for replacement of windshield wipers and manual cleaning of the windows from the outside.

Ventilation

Indoor climate of lifting appliances shall be in accordance with NORSOK S-002, 5.7.

Utility supplies

Lifting appliances shall have permanent arrangements for utility supplies (e.g. water, fuel, service air and electrical connections), as applicable. Details to be agreed upon.

Lifting appliances containing fuel, oil, grease etc. which represent a hazard to the environment, shall have permanent arrangements for enclosed drainage to tank.



5.22 Fabrication 5.23 Installation and assembly

Lifting appliances shall be fabricated, installed and assembled in accordance with DNV Standard for certification of lifting appliances No. 2.22, Ch.2, Section 2 Materials and fabrication. This include e.g.

- material selection,
- material certificates,
- material quality,
- welding,
- forming (hot or cold),
- inspection and testing.

For installation and assembly relevant parts of Norsok Z-007 also applies.



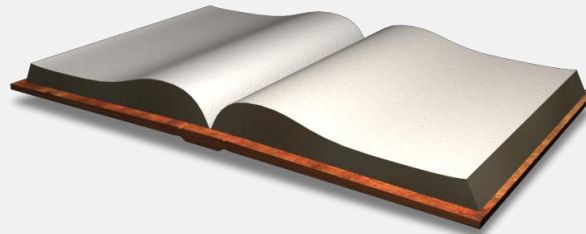
5.24 Corrosion protection, Surface preparation, Protective coating and Bolting

- Due consideration to risk of corrosion when selecting materials and material combinations
- Surface preparation and protective coating shall be in accordance with NORSOK M-501 and/or ISO 12944-1.
- Corrosion resistant steel shall be used for external bolting of 10 mm diameter and smaller. (NB: For temperaturer >50 grader bør en ikke bruke vanlig 316 eller 316L pga. Chloride cracking)
- Larger bolts shall normally be hot-dip galvanised low alloy steel. If other qualities are used, special corrosion protection measures shall be applied, e.g. protected cups grease filled.
- Bolt assemblies that are essential to mechanical safety, shall be in accordance with ISO 898-1 and DNV Standard for certification of lifting appliances, No.2.22, Ch.2, Sec. 2, C200 and D400.



5.25 Technical construction file

- A technical construction file shall be compiled by the manufacturer of lifting equipment.
- The technical construction file shall address all requirements of this NORSOK standard, as applicable.
- The technical construction file shall be prepared and presented in such detail that a third party is able to perform a verification of the product according to the requirements of this NORSOK standard, without supplementary information.



5.25 Technical construction file, continued

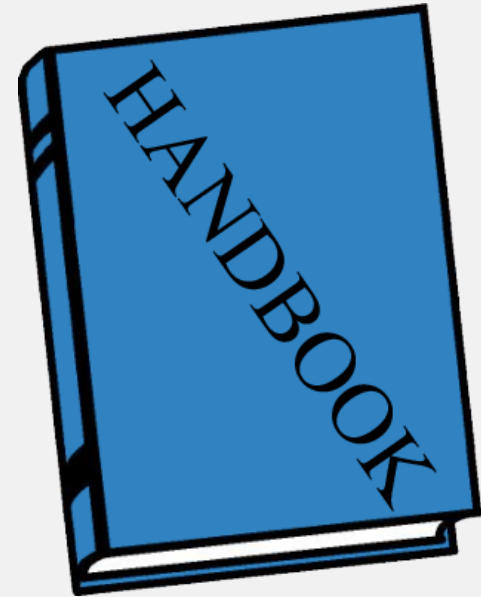
The technical file shall contain, as a minimum,

- unique identification details of the lifting equipment,
- design specification including design parameters,
- risk assessments including resulting risk reduction measures and residual risk level,
- applicable requirements for the lifting appliance,
- standards and codes used,
- technical information, such as drawings, diagrams, calculations, test reports etc.,
- fabrication documentation, e.g. material certificates, fabrication procedures, welding documentation etc.,
- verification reports,
- formal statements, declarations and certificates,
- instructions for use, including inspection and maintenance instructions, including wear and tear tolerances, non destructive examination (NDE) programmes, if applicable.



5.25. Instruction for use

- The instruction for use shall be made available to the end user.
- The instruction for use of lifting appliances shall be in accordance with EN 12644-1.
- The instruction for use of lifting accessories shall be in accordance with EN 13155, 7.1.
- The maintenance instructions shall include a maintenance programme in accordance with 4.9.
- The maintenance instructions shall include information on training of operators and maintenance personnel.
- In the case of complex lifting appliances, the information on training of operators and maintenance personnel shall take into account the local conditions on/at the installation and its location.





Lifting appliances with
inherently safe design.



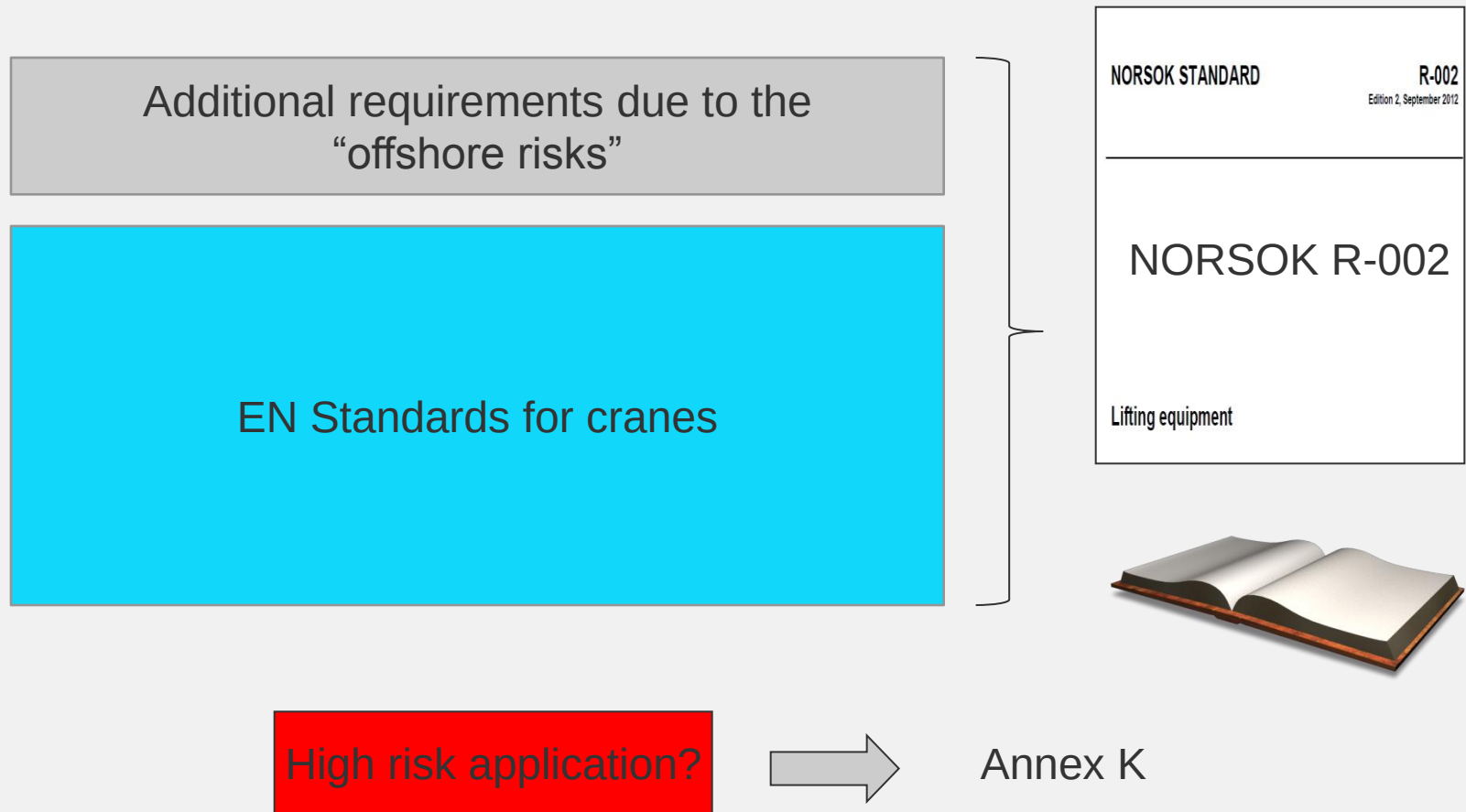
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Annex G (Normative) Cranes

Group no.	Group
G1	Mobile cranes
G2	Tower cranes
G3	Slewing jib cranes
G4	Bridge and gantry cranes
G5	Offshore cranes
G6	Floating cranes
G7	Winches and hoists - Power driven winches - Power driven hoists - Manrider winches
G8	Loader cranes
G9	Cable cranes
G10	Hand powered hoists and trolleys
G20	Other cranes

Annex G – Cranes - Requirement philosophy



CEN/TC147 Crane safety

TC147

WG1 Terminology and harmonisation
WG2 Crane Safety – Design - General
WG3 Crane Safety – Design – Requirements for equipment
WG4 Crane Safety – Requirements for health and safety
WG5 Crane Safety – Requirements for inspection and safe use

WG11

Mobile cranes

WG12

Tower cranes

WG13

Slewing jib cranes

WG14

Bridge and gantry

WG15

Offshore cranes

WG16

Floating cranes

WG17

Winches and hoists

WG18

Loader cranes

WG19

Cable cranes

WG20

Hand operated cranes

WG21

Non fixed attachments

WG22

Manipulating devices

Annex G Cranes – types



NORSOK R-CR-002 Lifting Equipment 1995

Data sheet specification

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
1								Made by									
2	NORSOK			HYDRAULIC OFFSHORE CRANE				Checked by									
3	R-CR-002			DATA SHEET				Date									
4	Rev. 1, Jan. 1995							Data sheet		RDS.050							
5																	
6	Package no.			Doc. no.				Rev.		Page 2 of 8							
7																	
8																	
9	4 CRANE PARAMETERS																
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44																	
45																	
46																	
47																	
48																	
49	A Overall height maximum:							m									
50	B Main boom length:							m									
51	C Total boom length with whip line:							m									
52	D Tail swing:							m									
53	E Height crane base - lat:							m									
54	F Max height of hook above crane base:							m rad									
55	G Actual hook travel main hoist							m rad									
56	H Actual hook travel whip hoist							m rad									
57	K							m									
58	L Min. distance between hooks:							m									
59	M Height over "A" frame:							m									
60	P C.L. pedestal to C.L. boom bearing							m									
61	R Crane base to C.L. boom bearing:							m									

G.3 Design criteria

Strength proportion, ref. 4.8

Design loads, ref. 5.7

Principle for proof of competence:

Load combinations:

Loads, load actions, load combinations and load effects:

EN13001-1

DNV SC 2.22

EN13001-2

Fatigue:

DNV RP-C203

Mechanisms:

FEM 1.001

EN13135-2

Operating temperatures

$T_{0min} = -20^{\circ}\text{C}$ unless otherwise agreed

G.3 Wind loads

Cranes located outdoor in exposed areas shall be designed for loads due to wind in accordance with EN 13001-2. The wind velocities shall unless otherwise agreed between the buyer and the manufacturer, be taken as follows:

- a) 25 m/s for in service;
- b) 63 m/s for out of service.

NOTE These wind velocities are to be understood as a 3 s gust wind. Wind velocities are often given as 10 min mean wind velocity. A 3 s gust wind velocity of 25 m/s will correspond to about 17 m/s 10 min mean wind velocity, but may depend on surrounding structures on the platform.



G.3.7 Lifting of persons

For the lifting of persons, the methods of decreasing the probability of failure in accordance with EN 13135-2, 5.12.3.2, shall be applied.

The risk coefficient γ_n for cranes designed for the lifting of persons, shall be minimum 1,5.

The required performance level for cranes lifting personnel shall be **d** in accordance with ISO 13849-1.

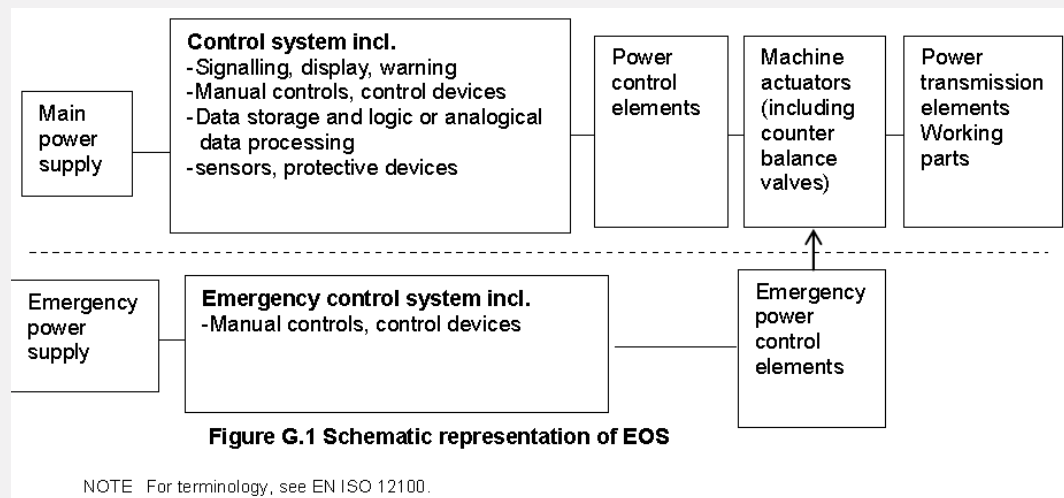
See also item 5.9 and annex K High risk applications

G.3.8 Cranes for temporary use offshore

Powered cranes intended for temporary use on an offshore installation shall also comply with NORSOK Z-015.

G.4 Cranes with emergency operation system (EOS)

- Initiated and controlled from the control station
- Secondary independent power supply
- Secondary independent controls
- Main functions for moving the load – one at the time
- Simple to operate without undue delay (1 min)
- Min.10% of required speeds
- Emergency stop



Mobile cranes (Group G1)



Use:

EN13000:2010 + G.1 + General part of
NORSOK R-002

(Additional requirements if used for the lifting of
persons and high risk applications)

Tower cranes (Group G2) (Tårn kran)



Use:

EN14439:2006+A2:2009 + G.1 + General
part of NORSOK R-002

(Additional requirements if used for the lifting of
persons and high risk applications)

Slewing Jib cranes (Portalkran) (Group G3) (Slewing hydraulic deck crane.)

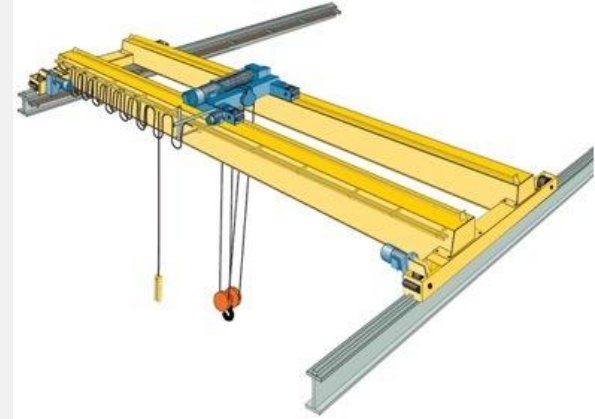
Use:

EN14985:2012 + G.1 + General part of
NORSOK R-002

(Additional requirements if used for the lifting of
persons and high risk applications)



Bridge and gantry cranes (Group G4)



Use:

EN15011:2012 + G.1 + General part of
NORSOK R-002

(Additional requirements if used for the lifting of
persons and high risk applications)

Offshore cranes (Group G5)

Use:

EN13852-1 + G.1-G.6 + General
part of NORSOK
R-002



Size, capacity, no. off, location etc:

- Compatible with **Annex B** (Material handling and offshore crane study)
- Capable of offboard lifting in $H_s=6\text{m}$ at 25m outreach
- Capable of offboard lifting of 15 tonnes at $H_s=0$ at 32m from the side of the installation.
- Reflect the need of redundancy and ensure optimal working conditions
- Unobstructed sight and avoid blind zones

G.11.3 Access

Offshore cranes shall be equipped with a main access route and a separate alternative escape route from the cabin/machinery house and to the deck of the installation. The main access route shall have stairway ladders between different levels and be designed for the transport of supplies and spares, and in an emergency to facilitate transport of a stretcher, smoke diving and fire fighting equipment.

Fixed means of access shall be provided to areas of the crane requiring maintenance and inspection. For access between different levels externally on the crane, stairs should be used instead of ladders. Walkways of type 1 in accordance with EN 13586 shall be provided for access to crane boom.

A service platform shall be provided for safe access when changing the configuration of the crane, replacement of wire ropes and sheaves etc.

G.11.4 View from the control station

The control station shall be arranged with the aim to give unobstructed view for the crane operator of the working area with the boom and the hook in any position. Any equipment, such as rated capacity indicators, camera monitors, window wipers, window protection bars, etc. shall be so located and arranged to reduce this view as little as possible.

NOTE This implies that metal grids in front of windows, is not accepted.

The window wiper system shall be robust and suitable for a marine environment. Wipers on front window shall be oriented vertically and move horizontally and be able to keep at least 80 % of the window area clean from water and spray.

G.11.5 Control station outfitting

The control station shall be equipped with an ergonomic chair for the operator with easy adjustments for optimal view and individual comfort. The main controls shall follow the movements of the chair.

Other controls and switches shall be located within the recommended reach for hands and feet. A second seat shall be provided for an instructor or a trainee.

G.11.6 Video camera (CCTV)

In order to allow overview of the suspended load and its surroundings from the crane operator's cabin, one or more cameras shall be mounted in the boom head in order to display a live picture in the crane operator's cabin. The live picture in the cabin shall be displayed on a different screen than the rated capacity indicator, without obstructing the view significantly. It shall be possible to zoom in and out on the load at all lifting heights.

G.11.7 Data recorder

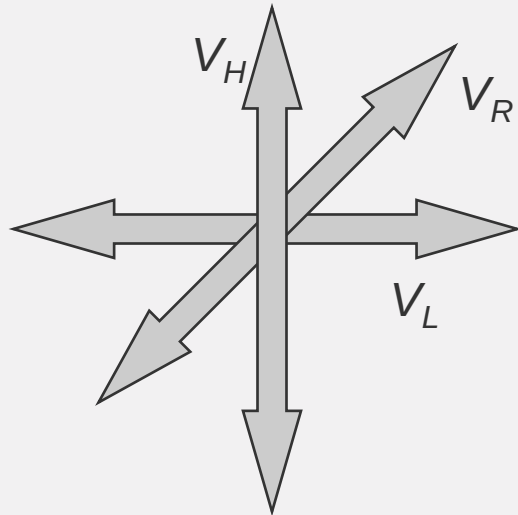
A data recorder shall be installed for continuous logging of main operational data for the purpose of

- a) tracking of events, e.g.:
 - 1) overload,
 - 2) changes in operational parameters,
 - 3) alarm and acknowledge history.
- b) condition monitoring,
- c) fatigue assessment.

For tracking of events essential parameters (e.g. load, motion, speeds, position, limits, brake status, pressures, operator commands and alarm status) shall be continuously recorded. The recording system shall contain data for at least 30 calendar days.

Offshore cranes (Group G5), continued

Hook velocities:



With and without loads

$$V_i = K_i * \sqrt{(V_D^2 + V_C^2)}$$

Table G.1 — Velocity factor K_H

	Single fall reeving	Multiple fall reeving
No hook load	0,78	0,40
At rated capacity	0,50	0,28

Table G.2 — Velocity factor K_R and K_L

	K_R	K_L
Any hook load	0,20	1,0

Single fall, No hook load, factor 0,78

FACTOR 0,78

SWH m	Required speed			Net power		
	Fixed	Semi	FPSO	Fixed	Semi	FPSO
1,00	0,64	0,67	0,75	102	106	119
1,50	0,89	0,93	1,06	142	149	170
2,00	1,10	1,17	1,35	176	187	216
2,50	1,29	1,38	1,62	207	221	259
3,00	1,46	1,57	1,87	233	252	299
3,50	1,61	1,75	2,11	257	279	337
4,00	1,74	1,91	2,34	279	305	374
4,50	1,86	2,06	2,56	298	329	409
5,00	1,97	2,20	2,77	315	351	443
5,50	2,07	2,33	2,98	331	373	477
6,00	2,16	2,45	3,18	345	393	509

Multiple fall, hook load

FACTOR 0,28

SWH m	Required speed			Net power		
	Fixed	Semi	FPSO	Fixed	Semi	FPSO
1,00	0,23	0,24	0,27	99	104	117
1,50	0,32	0,33	0,38	138	146	166
2,00	0,40	0,42	0,48	172	183	211
2,50	0,46	0,50	0,58	202	216	253
3,00	0,52	0,56	0,67	228	246	292
3,50	0,58	0,63	0,76	251	273	329
4,00	0,62	0,68	0,84	272	298	365
4,50	0,67	0,74	0,92	291	321	400
5,00	0,71	0,79	0,99	308	343	433
5,50	0,74	0,84	1,07	323	364	465
6,00	0,77	0,88	1,14	337	383	497

Single fall, no load

Single fall, hook load

FACTOR

0,50

Hook load

16 000

SWH	Required speed			Net power		
	Fixed	Semi	FPSO	Fixed	Semi	FPSO
m						
1,00	0,41	0,43	0,48	65	68	77
1,50	0,57	0,60	0,68	91	96	109
2,00	0,71	0,75	0,87	113	120	139
2,50	0,83	0,89	1,04	133	142	166
3,00	0,94	1,01	1,20	150	161	192
3,50	1,03	1,12	1,35	165	179	216
4,00	1,12	1,22	1,50	179	196	240
4,50	1,19	1,32	1,64	191	211	262
5,00	1,26	1,41	1,78	202	225	284
5,50	1,33	1,49	1,91	212	239	306
6,00	1,38	1,57	2,04	221	252	326

EN 13852-1:2013 Horizontal luffing speed for Heavy duty operation:

Luffing with load

FACTOR

0,25

Hook load

SWH	Required speed		
	Fixed	Semi	FPSO
m			
1,00	0,17	0,18	0,21
1,50	0,24	0,25	0,30
2,00	0,30	0,33	0,39
2,50	0,36	0,39	0,47
3,00	0,41	0,45	0,55
3,50	0,46	0,51	0,63
4,00	0,50	0,56	0,71
4,50	0,54	0,61	0,78
5,00	0,58	0,66	0,85
5,50	0,61	0,70	0,92
6,00	0,64	0,74	0,99

Luffing with load

FACTOR

0,20

Hook load

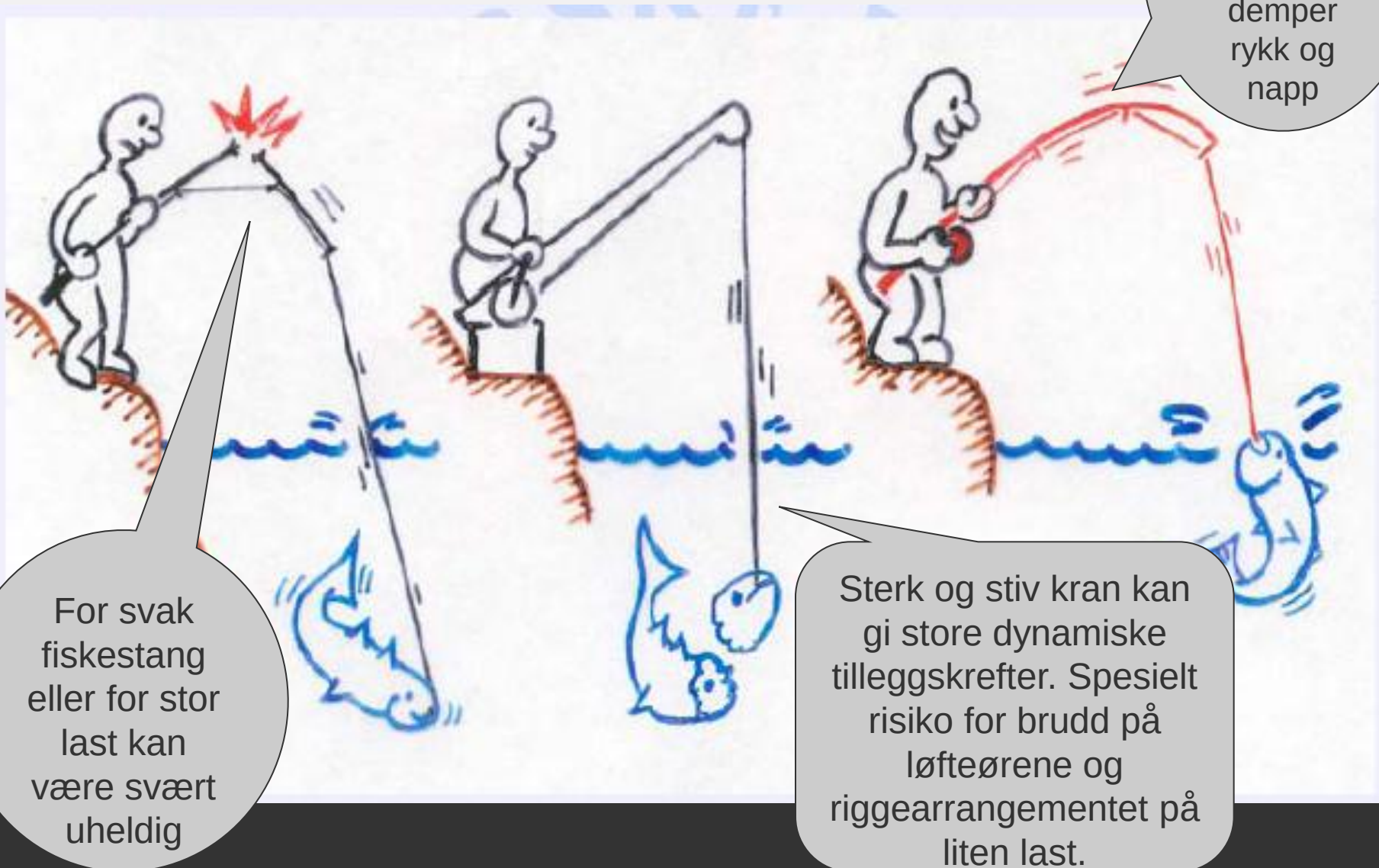
SWH	Required speed		
	Fixed	Semi	FPSO
m			
1,00	0,13	0,14	0,17
1,50	0,19	0,20	0,24
2,00	0,24	0,26	0,31
2,50	0,29	0,31	0,38
3,00	0,33	0,36	0,44
3,50	0,37	0,40	0,51
4,00	0,40	0,45	0,57
4,50	0,43	0,49	0,62
5,00	0,46	0,52	0,68
5,50	0,49	0,56	0,74
6,00	0,51	0,60	0,79

NORSOK har krav om 0.2 faktor for bomforflytting i horisontal planet [m/s]

5.2	Load: at radius:	m	T	m	T	m
5.3	Max. radius:	m				
5.4	Min. radius	m				
5.5	Lifting height above slewing ring	m		At radius:		
5.6	Lifting height below slewing ring	m		At radius:		
5.7	Hoist speed: with load as in 5.1	m/s		m/s		
5.8	Hoist speed: with load as in 5.2	m/s		m/s		
5.9	Hoist speed without load:	m/s		m/s		
5.10	Hoist speed cont. variable between zero and max:					
5.11	Hoist speed variable with load:					
<u>Hoist 2 (WHIP) if required</u>						
5.12	Max. load:	T				
5.13	Max. radius:	m				
5.14	Min. radius:	m				
5.15	Lifting height above slewing ring	m		At radius:		
5.16	Lifting height below slewing ring	m		At radius:		
5.17	Hoist speed: with:	T		m/s		
5.18	Hoist speed: with:	T		m/s		
5.19	Hoist speed without load:	m/s				
5.20	Hoist speed cont. variable between zero and max:					
5.21	Hoist speed variable with load (const. torque motor):					
6 DATA FOR SLEWING AND LUFFING						
6.1	Slewing speed with max. load in hook:					
6.2	Slewing operation with full load at max.:					
6.3	Luffing time with max. load:	from:	° boom angle	to:	° boom angle	time:

Store hastigheter og store kraner = Dynamiske tilleggskrefter=

Rykk og napp pga. lite dempning ved belastning med stor hastighet



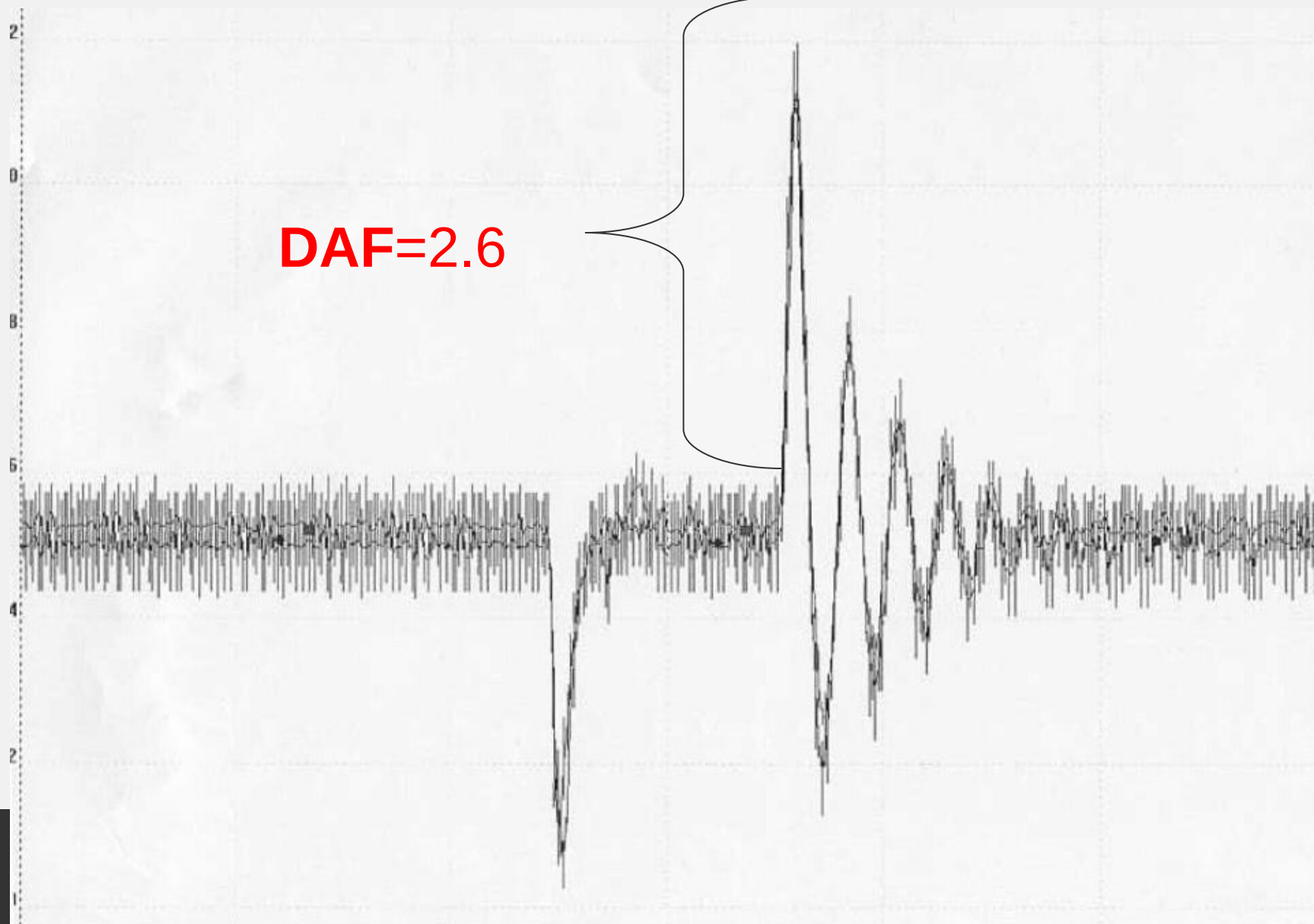
Fiskestang
som er
tilpasset
fisken,
demper
rykk og
napp

For svak
fiskestang
eller for stor
last kan
være svært
uheldig

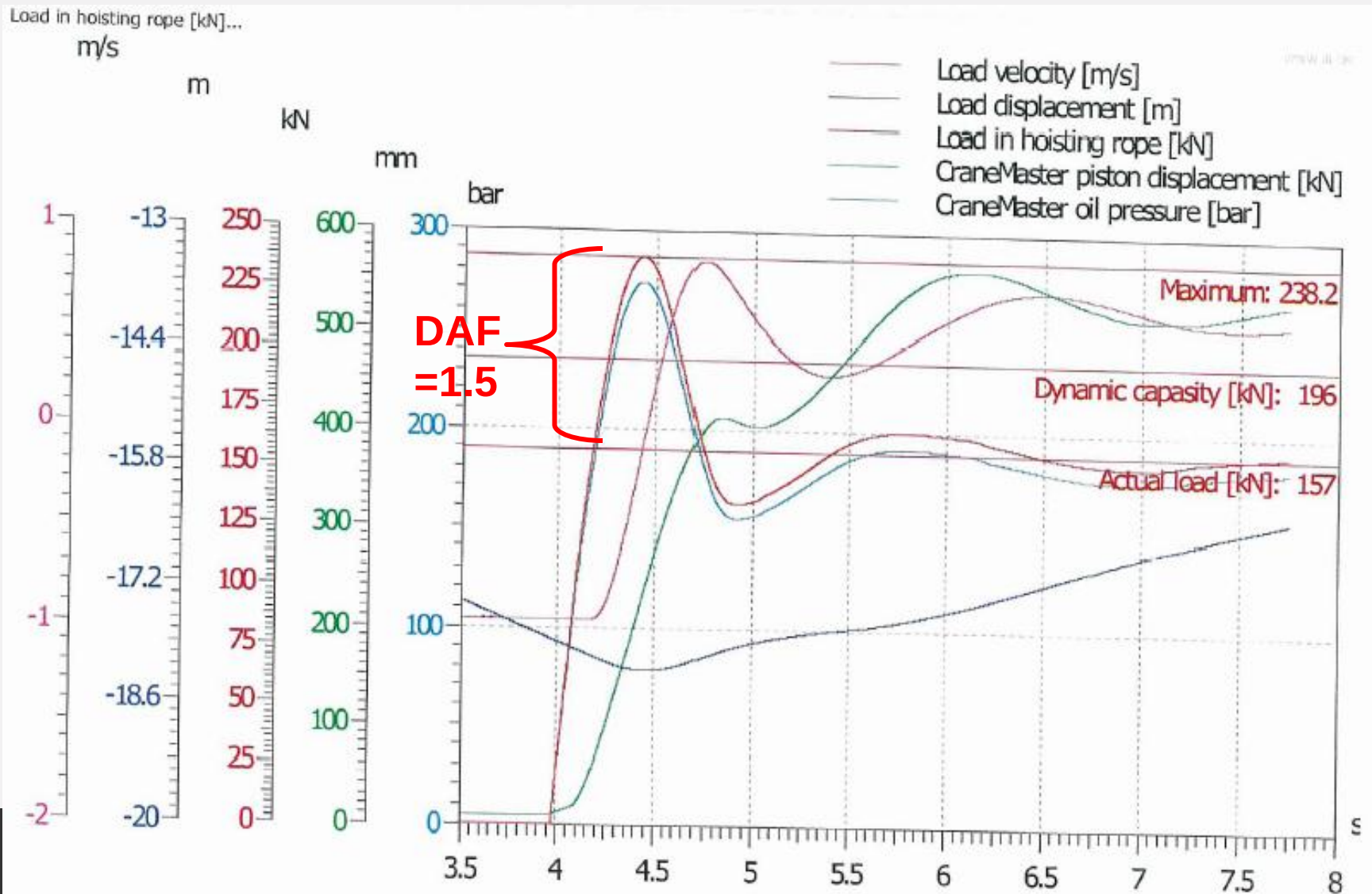
Sterk og stiv kran kan
gi store dynamiske
tilleggskrefter. Spesielt
risiko for brudd på
løfteørene og
riggearrangementet på
liten last.

Høyere DAF ved 50% utnyttelse av SWLwire

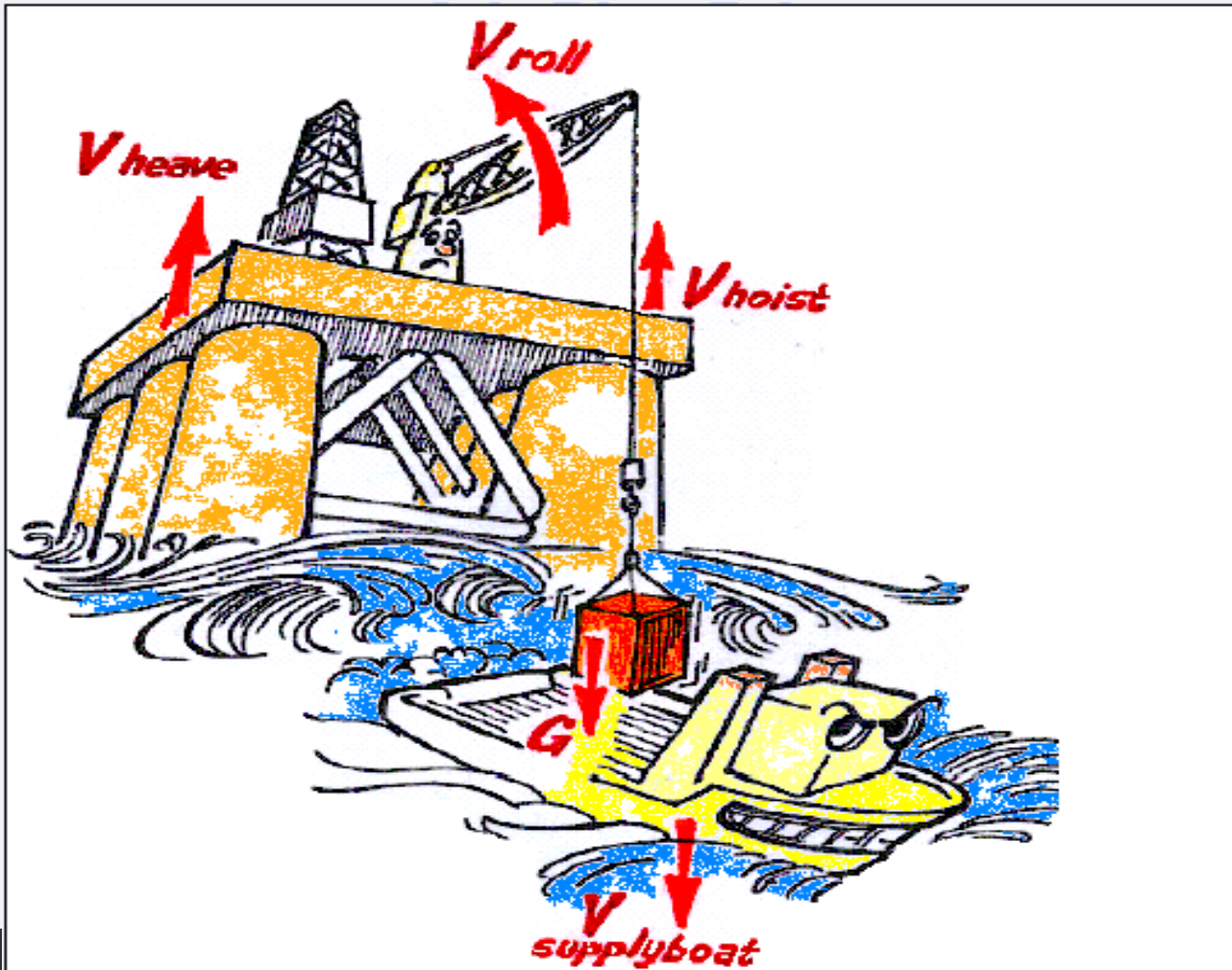
DAF=2.6



Dynamisk last i wire med SWL 16t whip line og 100% utnyttet (16 t last)



Høyere hastighet ved plutselig belastning, gir større rykk (Dynamiske tilleggskrefter)



Figuren viser mange kilder til at den relative løftehastigheten kan bli stor.

Stor hastighet kan medføre stort rykk.

Spesielt ved slakk wire, som plutselig blir belastet med last i stor hastighet, gir høy DAF.

Dynamisk faktor

Legg merke til
at liten last
under
brøkstreken gir
stort bidrag til
DAF.

Hoved ligninger

$$\Psi = 1 + \Delta V * \sqrt{\frac{C}{W * g}}$$

$$\Delta V = V_L + \sqrt{V_{in}^2 + V_t^2}$$

ΔV = relativ hastighet mellom last og krok ved tidspunkt "pick up" (m/sec.)

C = kran stivhet (geometrical) KN/m

W = aktuell arbeidslast (KN)

V_L = heisehastighet

V_{in} = supplybåt dekkhastighet, nedover

V_t = Krantuppens hastighet (på flyter) , oppover

V_H = minimum nødvendig heisehastighet for å gå klar 2nd bølge = $0.1 (H_{1/3} + 1)$



DAF forenklet formel:

- Forenklet regne eksempel:
 - Benytter 50t kran for løft på henholdsvis 50t og 1t:
 - Antar lik løftehastighet for begge løft (1 m/s):
 - $DAF_{50t} = 1 + 1\sqrt{50t/50t} = (1 + 1 * 1) = 2$
 - $DAF_{1t} = 1 + 1\sqrt{50t/1t} = (1 + 1 * 7) = 8$

DAF forenklet formel:

- Forenklet regne eksempel:

- Benytter 50t kran for løft på henholdsvis 50t og 1t:

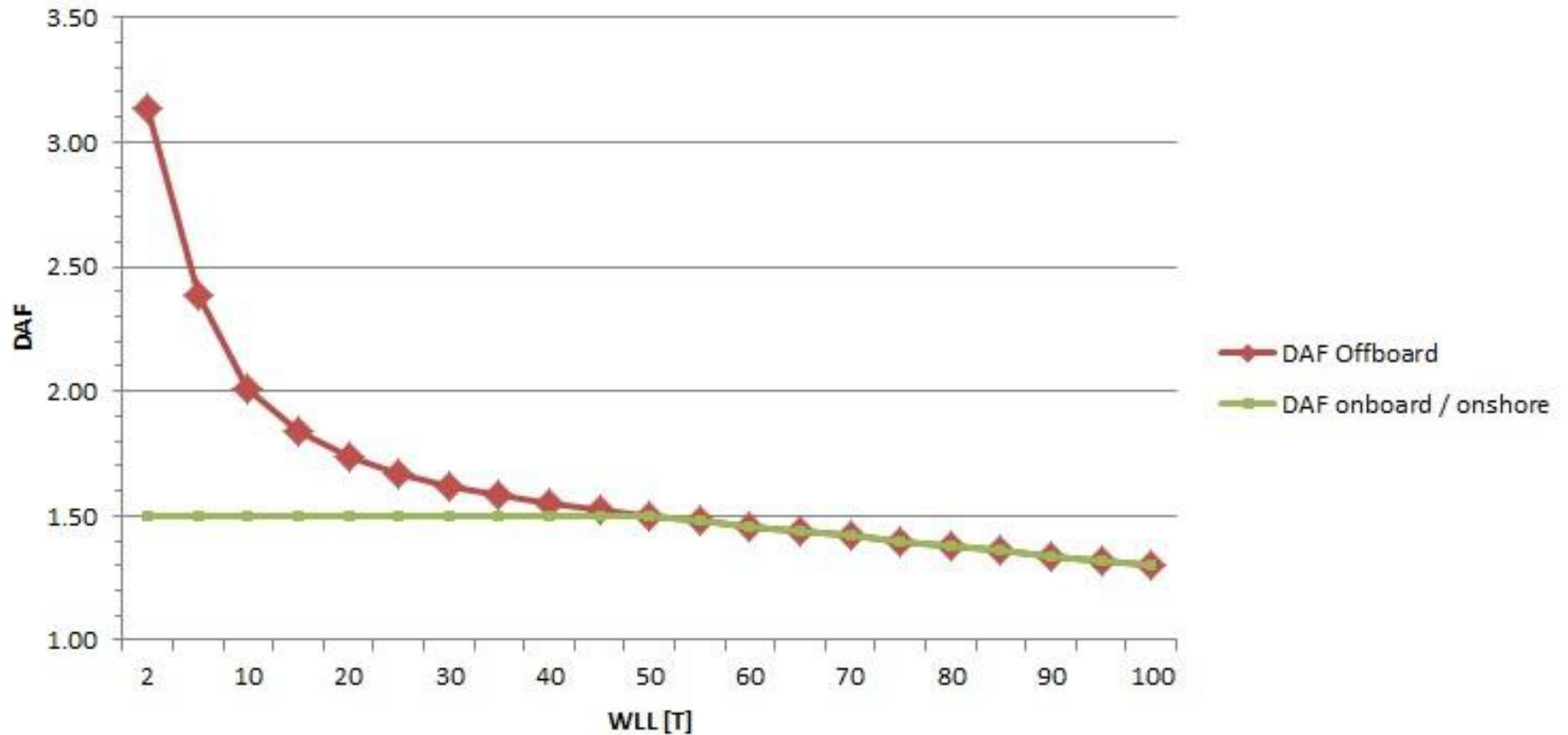
- Antar ulik løftehastighet (0,5 m/s) og (2 m/s)

- $DAF_{50t} = 1 + 0.5 \sqrt{50t / 50t} = (1 + 0,5) = 1,5$

- $DAF_{1t} = 1 + 2 \sqrt{50t / 1t} = (1 + 2 * 7) = 15$

NORSOK R-002 Annex F

DAF =Dynamisk faktor for løft off board/in board



MOB-båt løfting

G.11.19 Rescue boat lifting operations

Offshore cranes intended for rescue boat lifting operations shall have hoisting speed not less than required in G.11.16 for rated capacity when lifting goods with single fall reeving. The hoisting speed shall be available for the actual weight of the rescue boat intended to be lifted.

For offshore cranes intended for rescue boat lifting operations, the requirements of 5.8.6 in EN 13852-1 are to be replaced by the requirements of 5.15 and G.4

The dynamic load chart shall include rescue boat operations from $H_s = 0$ m to $H_s = 6$ m.

The dynamic load chart for training and maintenance operations shall be calculated for sea states from $H_s = 0$ m to $H_s = 3$ m using load effects in accordance with EN 13001-2. Such operations are considered as load combinations A and B, ref. Table 10 of EN 13001-2, taking into account partial safety factors $\gamma_p = 1,34$ and $1,22$, respectively, a dynamic coefficient $\phi_2 = 2,5$ and a risk coefficient $\gamma_n = 1,5$.

The dynamic load chart for emergency (real rescue) operations shall be calculated for sea states from $H_s = 3$ m to $H_s = 6$ m using load effects in accordance with EN 13001-2. Such operations are considered as load combination C, see Table 10 of EN 13001-2, taking into account partial safety factor $\gamma_p = 1,1$, a dynamic coefficient $\phi_2 = 3,0$ and a risk coefficient $\gamma_n = 1,5$.

NOTE The dynamic coefficients of 2,5 and 3,0 are related to lifting in $H_s=3$ m and $H_s = 6$ m, respectively, and take into account the use of an elastic pendant in accordance with Annex A. The dynamic factors given for such elastic pendants do not take into account any favourable effect of the cranes own elasticity or damping. The favourable effects resulting from the combination of crane and pendant properties may be taken into account provided the total elasticity of crane and pendant is documented by calculations. Alternatively an elastic pendant with better elastic properties may be specified as a condition for the resulting load chart.

Dynamic factor Φ and dynamic safety factor SF_{dyn}

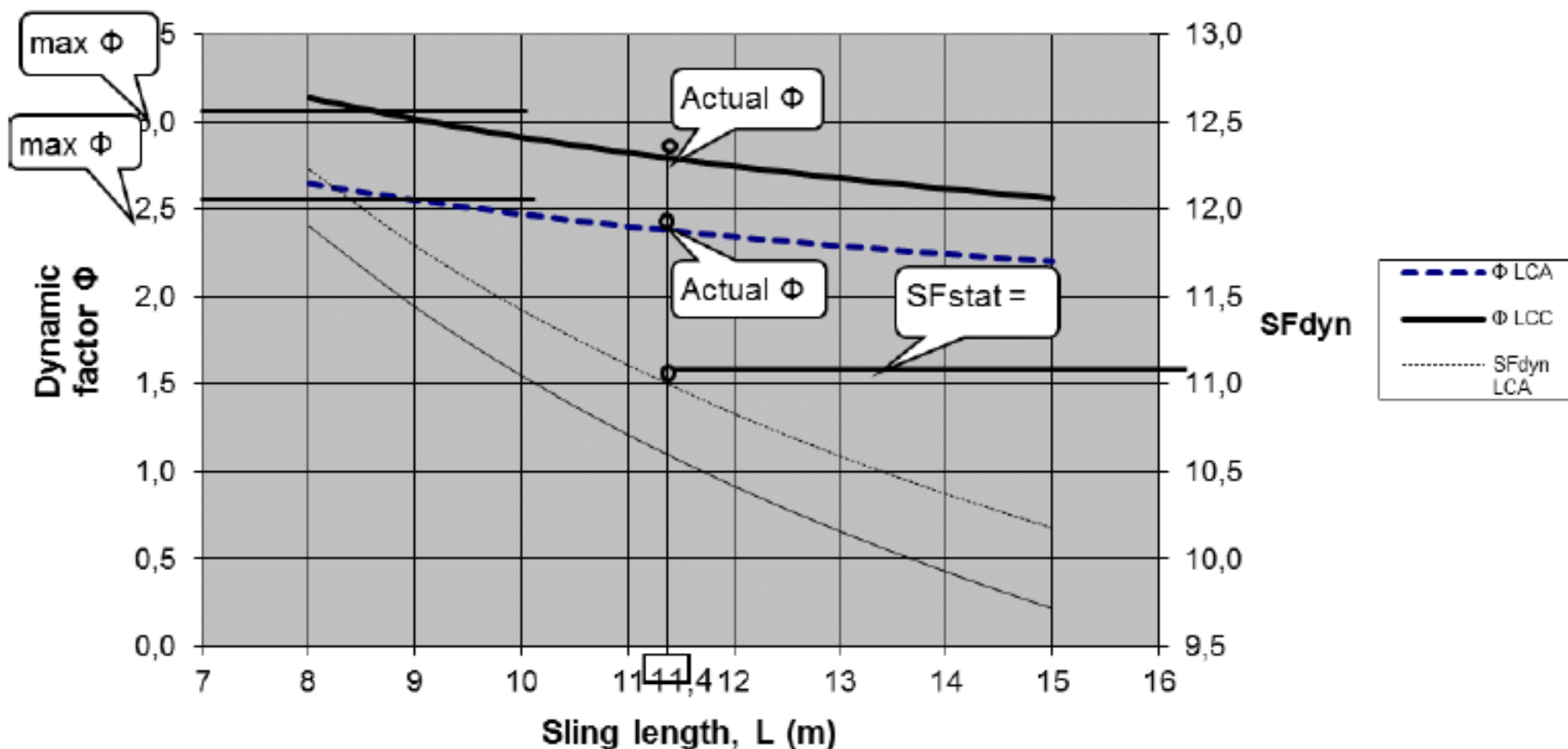


Figure I.2 – Dynamic factor, Φ , and dynamic safety factor, SF_{dyn} , plotted against sling length

Cranes for subsea operation (Group G5, G6, G7 etc.)

Additional requirements to address:

- Sea water penetration and corrosion
 - Load hoist drum
 - Rated capacity indicator
 - Rope tensioning system
 - Heave compensation system
 - Performance level
 - Subsea operation mode
 - AOPS
-
- Instruction for use

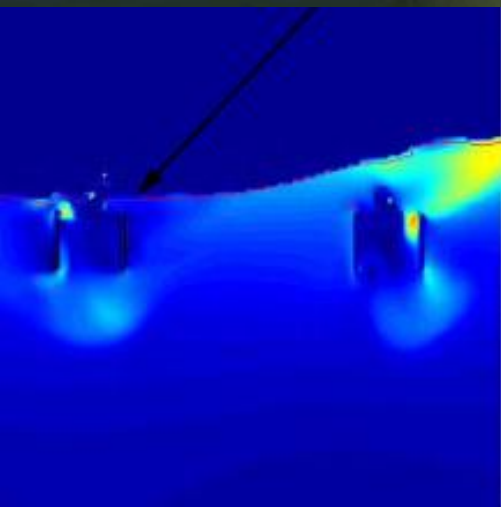


Aktiv hiv kompensering reduserer dynamiske tilleggskrefter

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ACTIVE HEAVE COMPENSATION

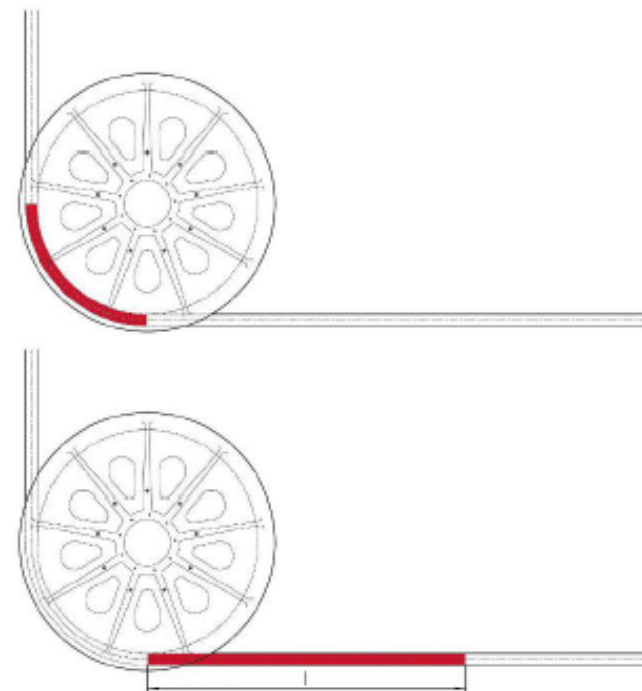
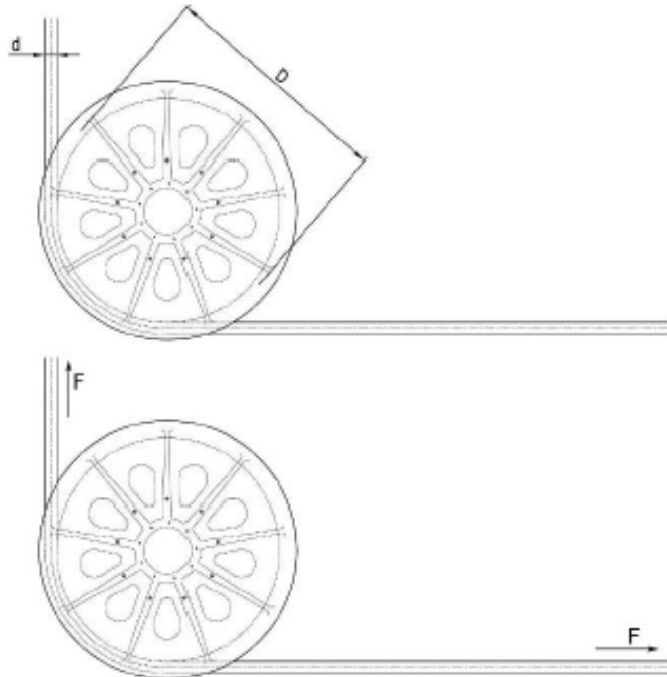
D=0800

A=0.0

Bending Fatigue Tests

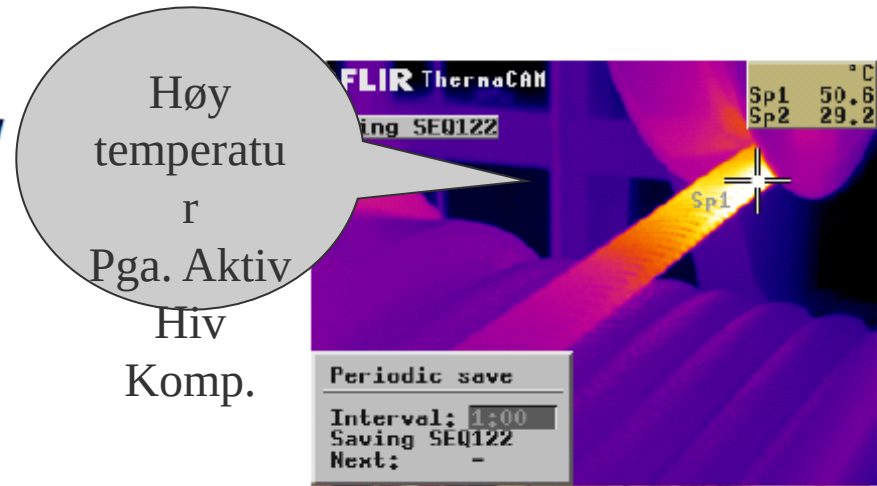
Relevant parameters for Bending Fatigue tests are:

- D/d ratio
- Tensile Load
- Wrap angle over sheave
- Bending length

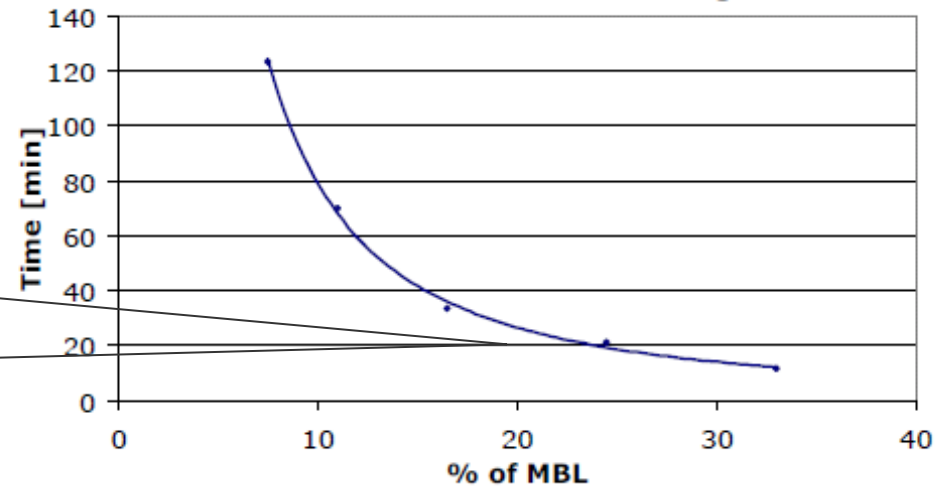


Conditions onboard construction vessels

- Space limitations only allow use of 20 D/d sheaves
- Heave Compensator used for critical phases of installation
- Rapid heat increase in rope during HC operations
- Limit curve to reach 50°C



Used time to reach 50°C over Percentage of MBL



Levetid blir
redusert i løpet av
få minutter ved
høy belastning

What can increase the lifetime of the wire during the work period



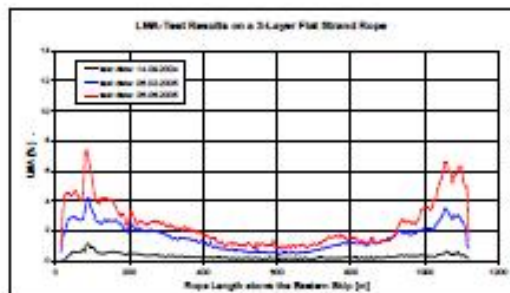
Re-Lubricate whole wire
minimum once per year



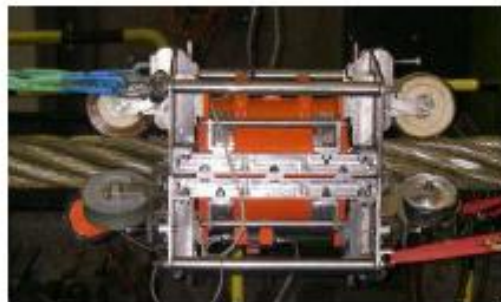
Cut back outer end and
re-socket



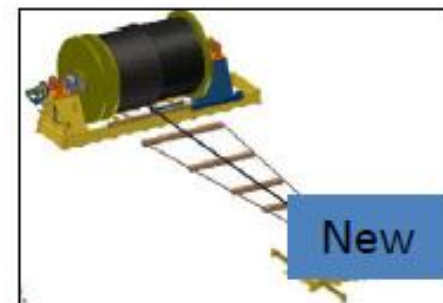
Change the position of the stress
in cross over section by cutting in
end



Analyse the history of the
crane with software program.



Magneto Inductive Wire
Rope Testing once per year



Always spooling the wire
onto the drum with back
tension

Power driven winches and hoists (Group G7)



Winches:

EN14492-1 + G.1-G.6 + General part of Norsok R-002

Hoists:

EN14492-2 + G.1-G.6 + General part of Norsok R-002

(Additional requirements if used for the lifting of persons, subsea lifting and high risk applications)

Loader cranes (Group G8)



Use:

EN12999 + G.3 + General part of NORSOK R-002

(Additional requirements if used for the lifting of persons and high risk applications)

Hand powered hoists and trolleys (Group G10)

Use:

EN13157 + G.3 + General part of NORSOK R-002



Double set of braking pals and overload protection system

(Additional requirements if used for high risk applications)

Other cranes (G20)

The design criteria stated in G.3 apply.

- Mobile elevating work platforms shall be in accordance with EN 280.
- Mast climbing platforms shall be in accordance with EN 1495.
- Suspended access equipment shall be in accordance with EN 1808.
- Lifting tables shall be in accordance with EN 1570.



For cranes used in drilling operations, reference is also made to the requirements in Annex D.

NOTE Powered slewing cranes mounted in a fixed installation (often referred to as “G20 cranes” in the industry) are covered by Group G3.

Annex K High risk appliances (Informative)



Why high risk applications?

Kran veltet ved Xstrata



En kran knakk og ødela flere gassholdige rør ved Xstrata Nikkelverk.

Why high risk applications?

Lifeboat launching arrangement incident



During testing, a 85mm Ø solid piston rod of a hydraulic cylinder failed, lifeboat with crew of 5 saved to fall to sea by second cylinder.

Luffing winch gear Statoil GFA Offshore crane



Boom failure during lifting of persons



NORSOK STANDARD

N-003

Edition 2, September 2007

Actions and action effects

8.3.3 Dropped objects

Actions due to dropped objects should for instance include following types of incidents:

- a) dropped cargo from lifting gear;
- b) falling lifting gear;
- c) unintentionally swinging objects;
- d) loss of valves designed to prevent blow-out or loss of other drilling equipment.

The impact energy from the lifting gear can be determined based on lifting capacity and lifting height, and on the expected weight distribution in the objects being lifted.

Unless more accurate calculations are carried out, the action from falling objects on to the deck may be based on the safe working action for the lifting equipment. This action should be assumed to be falling from the lifting gear from the highest specified lifting height and at the most unfavourable place. Sideways movements of the dropped object due to possible motion of the structure and the crane hook should be considered.

The trajectories and velocity of objects dropped in water should be determined on the basis of the initial velocity, impact angle with the water, effect of water impact, possible current velocity and the hydrodynamic resistance. It is non-conservative for impacts in shallow water depths to neglect the effect of water impact. A typical trajectory for slender objects (pipes) is straight motion until it has reached the maximum horizontal excursion. Then it starts to fall, exhibiting horizontal oscillations. The possibility of a straight trajectory for pipes with a rotation about the longitudinal axis should be considered.

The impact effect of long objects such as pipes should be subject to special consideration.

Relevant impact situations can be determined by the operating area of the lifting equipment and the relevant lifting arrangement.

Whether the equipment on deck may fall down should be considered. Damage caused by subsequent actions should also be considered.

Similarly it should be considered what damage possible fender systems would cause if they should fall down.

What are high risk applications?

Hamonised standards adress technical solutions for the vast majority of cranes. Cranes are sometimes used in applications which represent exeptional risks.

The exeptional risks can be assosiated with major accidents, where the crane or the lifting operation might cause seroius harm beyond the damage of the crane or the load itself.

Such unacceptable consequences need to be avoided regardless of the probability.

Table K.1 - Classes of high risk

Risk class	Description	Exposure
High risk class I	Consequences of failure are limited to the vicinity of the lifting equipment with considerable economic, social and environmental consequences or potential for loss of human lives within the work space of the lifting appliance.	- Personnel - Dangerous materials, e.g. explosives, flammables and dangerous chemicals - Work space
High risk class II	Consequences of failure extending beyond the vicinity of the lifting equipment with very serious economic, social and environmental consequences or potential for loss of human lives at the work space and at the whole site/installation/vessel.	- Personnel - Dangerous materials, e.g. explosives, flammables and dangerous chemicals - Live plant/ wellheads/risers/pipelines - Site/installation/vessel

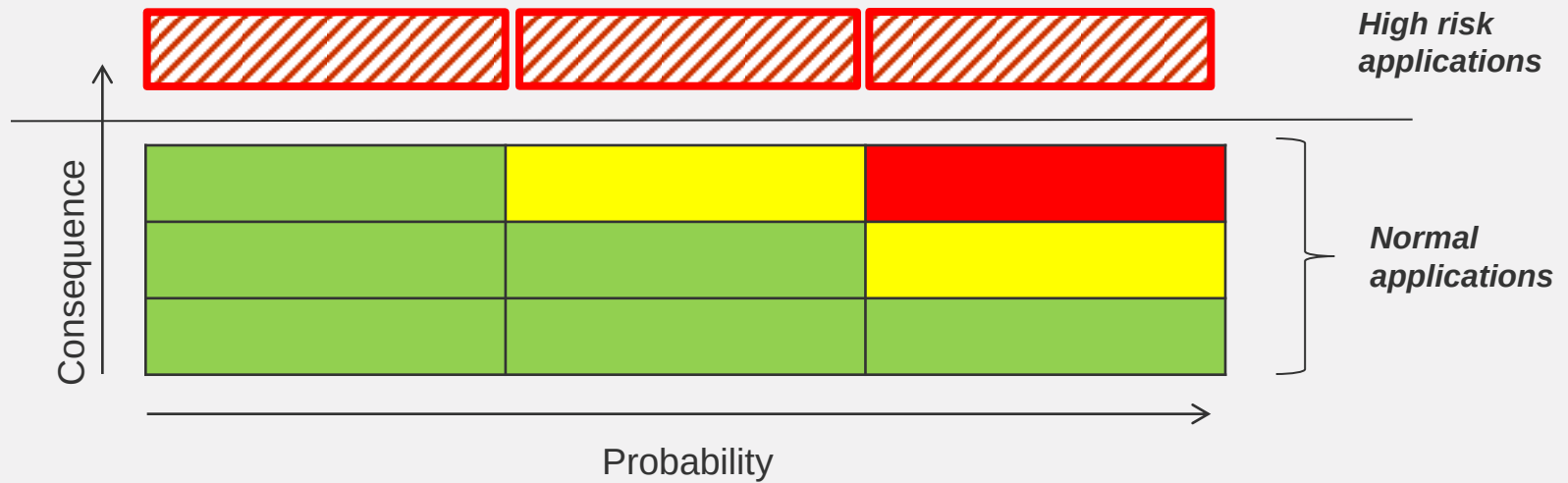
High risk applications - typical

Some cranes have higher risk than others:

- Lifting of or over persons
- Lifting in nuclear plants
- Lifting of explosives and radioactive materials
- Lifting of hot molten metal
- Operations in explosive atmospheres
- Lifting over explosives, flammable and dangerous chemicals
- Lifting of giant constructions

SPØRSMÅL?

Risk matrix



The potential consequences of high risk applications need to be avoided/reduced regardless of the probability

Strategy for mitigation of high risks

	Probability reduction	Consequence reduction
Operational measures (M)	Competence, training and procedures, etc.	Emergency preparedness plans, etc.
Technological measures (T)	Fail-safe, redundant and improved technical solutions combined with monitoring, etc.	Strength proportion, emergency systems, instructions for use, etc.
Organisational measures (O)	Resources and capabilities, etc.	Strategies for major accidents

K.2 Principle of high risk reduction

The prioritized sequence of reducing high risks:

1. Inherent safe design, see K.3
2. Protective measures, see K.4
3. Information for use, see K.5

K.3 Inherent safe design

- Inherent safe design shall ensure that a component or element which are needed to suspend or move the load or main parts e.g. the boom, of the lifting appliance, does not cause the load or the part of the lifting appliance to fall or move unexpectedly in case of a single failure.
- All load bearing structure, mechanisms and suspensions for high risk applications shall either be redundant (duplicated) or be designed with an increased risk coefficient, γ_n .
- Redundancy by duplicating components shall be the preferred measure, except for structure such as foundations, pedestals, superstructure, booms and mechanisms where duplication is normally not feasible or will create other significant hazards of high risks.

Table K.2 Examples of duplication related to high risk class

Example of duplication	High risk class I	High risk class II
Backup brake with independent load path on single winch	X	
Single hydraulic cylinders with mechanical lock	X	
Single winch with dual load suspension system (wireropes or chains)	X	
Dual winch with dual suspension (Single failure proof)	X	X
Dual hydraulic cylinders with independent load holding valves (Single failure proof)	X	X

Table K.3 Risk coefficient for high risk classes

	γ_n
High risk class I	Min. 1,5
High risk class II	2

γ_n is the risk coefficient as defined in EN13001-2.

Table K.4 Required performance level (EN ISO 13849-1)

	Performance level PLr
High risk class I	d or e
High risk class II	e

PLr = d, Average probability of dangerous failure per hour $\geq 10^{-7}$ to $< 10^{-6}$

PLr = e, Average probability of dangerous failure per hour $\geq 10^{-8}$ to $< 10^{-7}$

Other protective measures and information for use

- Back-up motion limiters of diverted technology
 - Crane level limiter for mobile cranes, loader cranes etc.
 - Automatic rigging detection system
 - Emergency operation system (EOS)
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- Competence
 - Operation, inspection and maintenance
 - Specific operational risk analysis
 - Planning of lifting routes
 - Operational limitations
 - Protection of equipment
 - Lifting accessories

High Risk Application summary

