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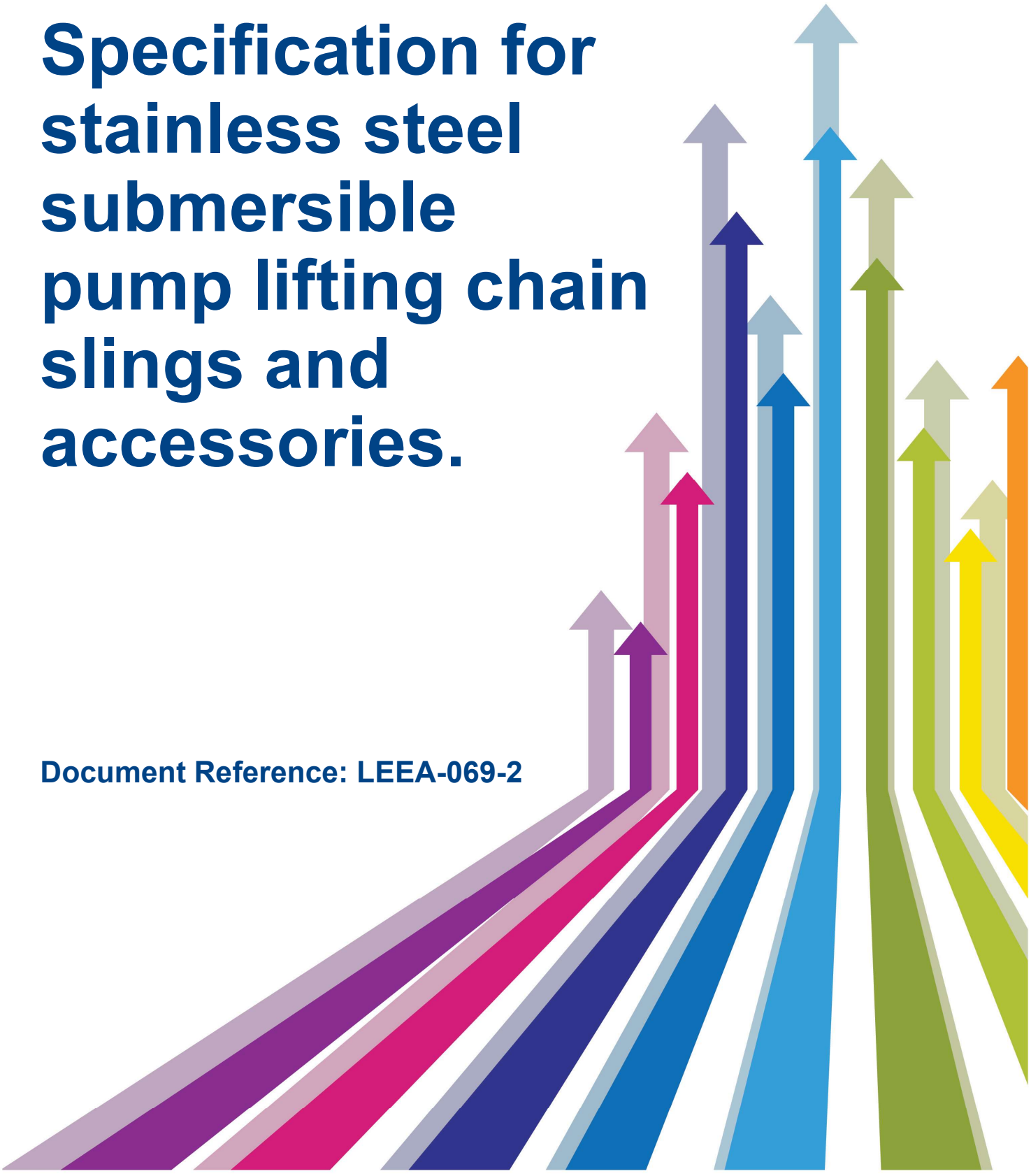
Specification for stainless steel submersible pump lifting chain slings and accessories.



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1.1 Scope:
Stainless steel lifting chain assemblies are typically used for lifting submersible pumps and mixers from wet wells or tanks.

This document specifies the design, construction, mechanical properties, and documentation and marking requirements for stainless steel lifting chain assemblies. It also specifies the limitations of use of these assemblies with certain corrosive chemicals.

For the purpose of this document, stainless steel Lifting chain assemblies will be referred to as 'assembly' or 'assemblies'.

1.2 Construction of a typical type Grade 5 and Grade 6 assembly.
The assembly shall be manufactured with an oval master link at each end and at approximately every metre interval, allowing for the variations in chain pitch and the number of links needed to achieve a given segment length (SL) (see Figure 1 below). The assembly shall be supplied with a polished surface finish to all components used within the assembly.

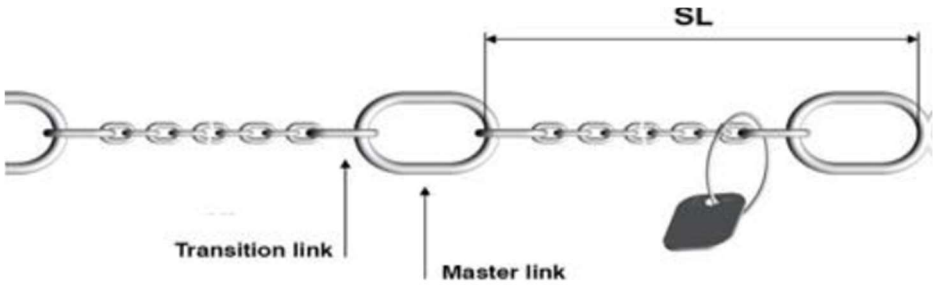

Figure 1: Showing the master link/chain assembly and segment length

The nominal bearing to bearing length (reach) shall be calculated as the number of segment lengths (SL) required + 1 master link (inside length), excluding the shackle length.

The assembly shall be of a suitable length to enable the removal of the submerged plant using lifting equipment.

The assembly shall be made to suit the Working Load Limit (WLL) capacities of the nominal chain diameters as per the following tables *(table 2 for grade 5)* and *(table 3 for grade 6). (Variance in capacities due to different manufacturers works standard),* and be used in the uniform load method of rating as a single leg, with a minimum factor of safety of 4:1

The assembly shall comply with the applicable supply legislation and essential health and safety requirements for the country of use' (in Europe either the Supply of Machinery (Safety) Regulations 2008 or the EU Machinery Directive 2006/42/EC will apply for the UK or the EU respectively).

The legislation may state that only welded short link chain must be used for lifting. Short link chain being defined as the internal length (pitch) of the chain is 3 x the nominal chain diameter, subject to the standard manufacturing tolerances when new. This is certainly true for Europe however you should check the national requirement for your location (the USA allows long link chain to be used in lifting applications.)

1.3 Material specification and standards of manufacture:
The assembly shall be made of 1.4404 (AISI 316L) for chain, and 1.4571 (AISI 316Ti) + 1.4462 (AISI 318 LN in which the proportion of carbon is limited) for forged components. (*Table 1 shows the mechanical properties for both grade 5 and 6 for which the chain and components shall meet or exceed)*

There are no specific EN or BS standards for stainless steel lifting chains, but the following shall apply;

1. Chain: Grade 5 and Grade 6 are based on DIN 5687-1 and EN 818-1 non-calibrated medium tolerance chain short link for lifting purposes or equivalent recognised standards for your location
2. General conditions of acceptance and the manufacturer's works standard and technical files for each product;
3. The welding of the chain shall be produced using the resistance butt or flash butt process;
4. Components based on EN 1677 forged steel components for lifting slings or equivalent recognised standards for your location, and/or the manufacturer's works standard and technical files for each product;
5. It is recommended to follow (BS) ENISO12100 2010 *Safety of machinery. General principles for design. Risk assessment and risk reduction,* however this is not mandatory but will ensure the process is assessed correctly and the manufacturers works standard complies with the requirements.

Table 1 Mechanical properties of the completed assembly

Mechanical properties	Grade 5	Grade 6
Breaking Stress	500N/mm² minimum	630N/mm² minimum
Breaking elongation	20% minimum	20% minimum
Stress at MTF (manufacturers test force)	250 N/mm²	315 N/mm²
Stress at WLL (working load limit)	125 N/mm²	160 N/mm²

Table 2: Working load limits Grade 5 (uniform load method of rating as single leg assembly)

Chain Grade	Chain (nominal) Diameter (Ø mm)	WLL (kg)
5	5	500
5	7	1000
5	10	2000
5	13	3200
5	16	5000
5	18	7000
5	20*	8000
Grade 4+	26*	12000

*Supplied as a standard base length of 2 x SL

Table 3: Working load limits Grade 6 (uniform load method of rating as single leg chain assembly)

Chain Grade	Chain (nominal) Diameter (Ø mm)	WLL (kg)
6	3	With smaller master link 200
6	4	With smaller master link 200
6	4	400
6	5	With smaller master link 560
6	5	630
6	6	850
6	7	1250
6	8	1600
6	9	2000
6	10	2450 / 2500
6	13	3500
6	13	With larger master link 3850
6	13	With larger master link 4250
6	16	6300

1.4 Safe Working load:
The Safe Working Load (SWL) requirements are to be determined by the specifiers/designer after consideration of all aspects of the application. The SWL can be the same as the WLL but cannot exceed the WLL of the assembly.

In determining the required SWL of the assembly, consideration should include an allowance for the dry weight of the equipment to be lifted and also an added provision to allow for other factors, e.g. fretting, breaking out from suction, friction, blockages within the equipment casing and possible additional shock loads exerted by electrically operated winches or hoists. The designer shall also take the weight of the chain sling into consideration when specifying the SWL required. In many cases this may mean a factor of 50% added to the dry weight of the pump. Other considerations in determining the SWL are detailed in *(table 4).*

Table 4: Working load limits reductions.

Chain Temp	-40°C +350°C	Over 350°C
Load factor	1	Not permissible

Edge loading	R = radius of corner more than 2 x d chain diameter	R = radius of corner more than 1 x d chain diameter	R = radius of corner smaller than 1 x d chain diameter
Load factor	1	0.7	0.5

Shock load	Slight	Medium	Strong Impact
Load factor	1	0.7	Not permissible

1.5 Marking of the assembly components:
All components used in the construction of the assembly shall be marked with:

1. Manufacturers name, address or symbol
2. Grade or type of material,
3. Product code, and batch or traceability code,

1.6 Shackles:
A safety pin chain link Dee shackle ("Type A or X" screw pin with longer length **complete with split pin** see figure 2) shall be supplied and attached to one end of the assembly.

Figure 2: Dee Shackle and 'A type' screw pin

Alternative shackle types are allowable i.e. with type E or W pin (nut and bolt c/w split pin). The normal screw A or X pin shackle shall be avoided as it is possible for the pin to unscrew when in situ.

Figure 3: Alternative shackle types

The shackle shall be manufactured from ISO 1.4404 (marine grade stainless steel 316L). If the shackle is to be made captive to the assembly, this shall be done using a non-welded rivet pin.

The designer shall ensure that the size of the shackle is sufficient to enable its attachment to the pump lifting point allowing free movement on the pump, and that it has a working load limit (WLL) at least equal to that of the assembly that is to be attached.

Each shackle shall have the following information stamped or etched onto the shackle body
1) Identification of material or grade i.e.316 Stainless.
2) Nominal size
3) Working load limit (WLL) in tonnes.
4) Manufacturers traceability batch code
5) Individual serial number
6) Conformity marking if required (UKCA/CE)

1.7 Marking of the assembly:
The completed assembly shall show the following particulars:

The tag will have the following information
1) Identification of the manufacturer (Name or Symbol or recognized mark).
2) Identification of material or grade i.e. grade 6, Stainless steel.
3) Nominal chain size and number of legs
4) Working load limit (WLL) in kilograms or tonnes
5) Serial number of the sling.
6) Year of manufacture
7) If required the owner's asset number
8) Conformity marking if required (UKCA/CE)

This shall be marked on to a tag of an acceptable format normally in the shape of a five-pointed star (grade 5) or in the case of six-pointed star tag (grade 6), the tag shall be manufactured from stainless steel fixed permanently to the assembly.

Where required, following final proof load testing and thorough inspection by a competent person, the CE or UKCA mark shall be affixed to the sling by stamping of the tag.

**Important note: Cold stamping of any product information, serial numbers, and batch codes directly to the master links must be avoided to eliminate potential stress cracking of the component. This is particularly important when the master links are of the formed and welded type. It should also be stressed that round master links of a welded and circular format cannot be used in the construction of the pump chain assembly due to high risk of excessive stresses to the weld.*

1.8 Certification and Documentation:
The assembly and shackle shall each be issued with an manufacturers certificate, and be accompanied with user instructions, it is these original manufacturer's documents that must accompany the equipment before entering service for the first time, without which the assembly and shackle shall not be used. They are to be retained by the duty holder.

Where necessary, Declarations of Conformity are to be supplied for the shackles chain assembly or both if shackle is captive. The recognised national supply legislation for the EU and UK, the Machinery directive 2006/42/EC or the Supply of Machinery (Safety) Regulations 2008 (SOM(S)R) will apply.

1.8.1 User instructions
These documents will be specific to individual manufacturers of the equipment, but all must follow the guidance as detailed both in the machinery regulations and the LEEA-062-general guidance to the manufacturer of lifting equipment to the development of instructions for use. It is essential that the user instructions be read and understood by both the specifiers and user.

1.8.2 Additional corrosion risks associated with the assembly's limitations of use within the water industry:
Typically, sewage pH values are in the range 5 to 7, and therefore there will be limited corrosion of the assembly.

Typically, clean water during treatment will have pH values between 4.9 and 10.1. For assemblies operating in water outside this pH range, it does not mean that stainless steel assemblies cannot be used, only that the frequency of examination should be determined to suit these particular conditions.

To further aid in the selection of a stainless-steel assembly table 5 shows the values of corrosion resistance of 316 stainless in various media.

Table 5: Values for resistance in different media

Material No	DIN-short name	Cr %	Ni %	Mo %	Ti
1.4571 (AISI 316 Ti)	X6CrNiMoTi 17 12 2	16.5 – 18.5	10.5 - 13.5	2.0 – 2.5	Addition
1.4404 (AISI 316 L)	X2 CrNiMo 18 10	16.0 -18.0	10.0 – 13.0	2.0 – 2.5	-
1.4462 (AISI 318LN)	X2CrNiMoN22-5-3	21.0 – 23.0	4.5 – 6.5	2.5 - 3.5	-

0	1	2	3	P	S
Completely resistant	Practically resistant	Little resistance	Theoretically non-resistant	pitting	Stress corrosion

Corroding Media	Concentration %	Temperature C	Resistance		Corroding Media	Concentration %	Temperature C	Resistance
*Atmospheric corrosion			0		Lime milk Ca (OH)2 Calcium hydroxide		20 / Boiling	0
Benzene		20 / boiling	0		Sea water		20 Boiling	0 P 1
Formic acid HCOOH	10 – 50 80	20 boiling 20 boiling	0 1 0 3		Phosphor-acid H3PO4	1 50 80 concentrated	20 Boiling Boiling Boiling	0 1 2 3
Ammonia NH4OH		20 / boiling	0		Nitric acid HNO3	1-90 50	20 Boiling	0 1
Ammonium nitrateNH4N03	hydrous, cold saturated solvent	20 / boiling	0		Hydrochloric acid HCI	0.2 – 0.5 1 2	20 50 20 50 20 - 50	0 P 1 P 0 P 1 P 1 P
Corroding Media	Concentration %	Temperature C	Resistance		Corroding Media	Concentration %	Temperature C	Resistance
Chloride	Hydrous solvent	20	1 -3 P		Sulphuric acid H2SO4	0.1 1 5 10	Boiling 20 80 Boiling 20 80 Boiling 20 50 80 Boiling	0 0 1 1 0 1 2 0 1 2 2
Acetic-acid CH3COOH	10 10-50 80	20 Boiling boiling	0 0(1for 318LN) 1P		Trichloroethylene CHCI: CCI2		20 / Boiling	0 P
Fatty-acid (oil)		150	0		Potassium hydroxide KOH	Hot saturated	120	1 S
Hydrofluoric acid	10 40	20 20	2 P 3		Tannic-acid	50	20 / Boiling	0

*Atmospheric corrosion, the complete resistance depends on kind, composition and the water content of the atmosphere and in the area the equipment is being used, for example more resistant in the highland and dry regions to those in industrial or coastal regions