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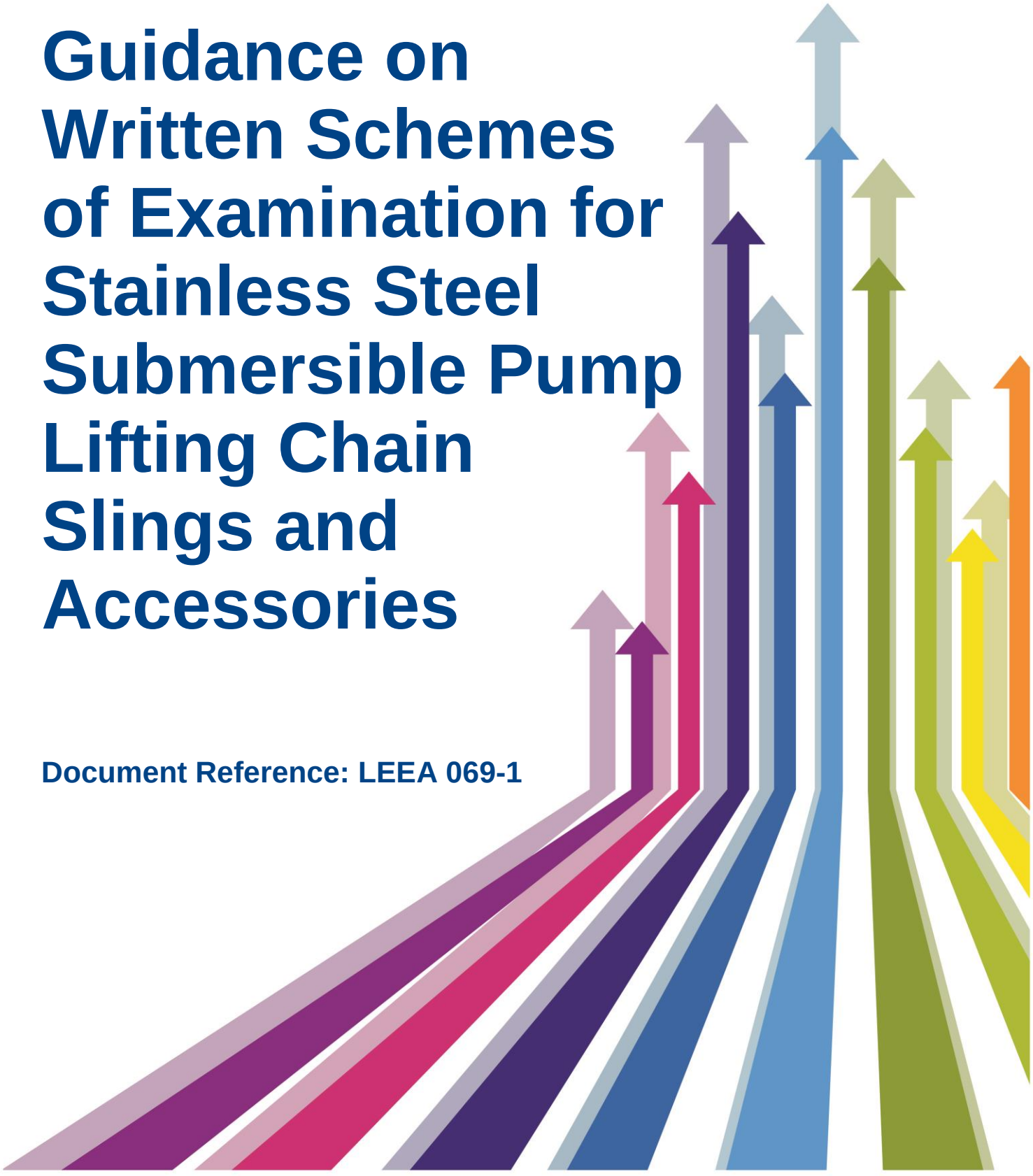
Guidance on Written Schemes of Examination for Stainless Steel Submersible Pump Lifting Chain Slings and Accessories



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Guidance to Written Schemes of Examination for Stainless Steel Submersible Pump Lifting Chain and Accessories.
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1.0 Introduction

The Lifting Operations and Lifting Equipment Regulations 1998 (LOLER) permit a scheme of examination, drawn up by a competent person, as an alternative to the fixed maximum periods. Prior to LOLER, there was no history of examination schemes for lifting equipment. However for several years there have been schemes for pressure equipment which provide useful guidance.

The benefit of an examination scheme is that, by focusing on the most safety critical areas, the examinations can be carried out in the most cost effective way. This may provide a means of reducing examination costs; however, it may also provide a means of enhancing safety without increased cost.

Written schemes of examination are often used in the water industry for the examination of pump lifting chains and their accessories for the above reasons. However, a review of many of these schemes has highlighted some inadequacies that have an effect on the validity of the scheme. This guidance document is aimed at the Duty Holder, and the Competent Person drawing up the scheme for pump lifting chains used in the water industry on his behalf, to ensure that all the associated risks are properly assessed and, with a robust written scheme, reduced to an acceptable minimum.

2.0 Roles and Responsibilities.

In respect of this document the key legislation is the Lifting Operations and Lifting Equipment Regulations (LOLER) and the Provision and Use of Work Equipment Regulations (PUWER).

PUWER require that pump lifting chain assemblies that are provided for use at work are:

- Suitable for the intended use and meet the essential health and safety requirements of directive 2006/42/EC;
- Safe for use, maintained in a safe condition and inspected to ensure it is correctly installed and does not subsequently deteriorate;
- Is used by people who have received adequate information, instruction and training

LOLER, require that pump lifting chain assemblies are thoroughly examined;

- Before putting into service unless supplied with an EC Declaration of Conformity made not more than 12 months before the equipment is put into service, or;
- Every 6 months, or;
- After exceptional circumstances, or;
- In accordance with and examinations scheme.

With regards to the above it is important to note that it is the duty holder who is ultimately responsible for ensuring that the above is completed, and that that all personnel involved are competent for their individual tasks. The duty holder may subcontract out some or all of the above to competent organisation, but he would still be responsible for ensuring that those organisations are suitably competent for the task.

To ensure that the pump chain is maintained in a serviceable condition and does not deteriorate such that it becomes a danger to persons, the legislation requires the duty holder to do the following:

1. Pre-use checking - This is normally completed by the operator of the equipment before each use and is a basic check for obvious signs of damage. This is not reasonably practical for pump lifting chain, but as a means of compensating for this it is recommended that the equipment is inspected before being returned to the wet well. As this is not ideal it is expected that this inspection is more thorough than a standard pre-use check. This means that the operator / or inspector must have sufficient knowledge and experience in order to identify defects that may affect the safety of the equipment if returned to the well. If during this inspection any such defect is identified, then the equipment shall be quarantined and referred to a Competent Person. It is recommended that the inspector has a check list of critical components identified in the risk assessment.
2. Routine inspection and maintenance - These are often completed at the same time. The periods between planned inspection and maintenance would depend upon a risk assessment taking into account such things that are likely to result in deterioration of the equipment, such as environmental conditions for example. The inspections in this case are often limited to critical components that have been identified in the risk assessment. Any defects found can be rectified as appropriate.

3. Thorough Examination - This is performed by a Competent Person who has sufficient theoretical and practical knowledge of the equipment that they are examining in order to identify defects and assess their importance in terms of the continued safety of the equipment. If points 1 and 2 are affective then this thorough examination should not find any defects, if it does then it suggests that there is an issue with the inspection maintenance regime, the competency of the inspectors or maintainers, the product fitness for purpose, etc. It would therefore be the responsibility of the duty holder to investigate the root cause of any defect found and put measures in place to prevent reoccurrence. In terms of a written scheme, this would require the scheme to be reassessed and improved.

The duty holder is also responsible under regulation 10 of PUWER to ensure that any pump lifting chain coming into his undertaking meets the Essential Health and Safety Requirements (EHSRs) of the Machinery Directive 2006/42/EC.

3.0 When an examination scheme is appropriate for pump chain assemblies
An examination scheme is only appropriate when the advantages gained from the scheme outweigh the disadvantages. This is most likely under the following circumstances:

(1) When the condition of the equipment depends primarily on the amount and/or nature of the usage and such usage can be monitored.
(2) When equipment is only used occasionally and the chain assembly is of adequate specification to be left in in that given environment.
(3) When the risks associated with the requirement to do a statutory examination are greater than the consequence of failure.

Conversely a statutory periodic examination is more likely to be appropriate when:

(1) The amount of use cannot easily or cost effectively be monitored.

(2) When the equipment may deteriorate due to time and/or storage conditions whether used or not. When the condition of the various parts of the equipment deteriorates at markedly different rates. For example, induced wear due to vibrations caused by the pump or the flow within the well.

(3) When the equipment is vulnerable to damage each time it is used and the thorough examination is in effect a ‘long stop’ to detect any deterioration not noticed during the in-service inspection. For example, induced due to vibrations caused by the pump or the flow within the well.

(4) The use pattern is considered general purpose and all parts subject to similar rate of deterioration, due to the working environment.

4.0 Objectives of the examination scheme pump chain assemblies
The objective of the thorough examination is to check whether the equipment is fit for the coming period of service. Implicit in this is the objective that, given normal wear and tear and the forecast usage of the equipment, it should still be safe to use at the end of the period of service.

Clearly unforeseen events may occur which may render the equipment unsafe and LOLER makes provision for such eventualities by requiring inspection at suitable intervals between thorough examinations. LEEA has long recommended the inspection of lifting equipment before each use, particularly lifting accessories which can easily be damaged if misused. However, in the case of submersed pump chain slings LEEA will accept that this is not reasonably practicable and would recommend that the inspection is done each time the chain is removed from the well.

The examination scheme should therefore ensure that all parts of the equipment upon which safety depends are thoroughly examined by appropriate means and at such frequency as will allow defects to be detected and remedial action taken before the equipment becomes dangerous.

5.0 The information which should be in the examination scheme for pump lifting chains
The written scheme of examination must be documented and recorded, and should contain at least the following information:

(1) The name and address of the owner (duty holder) of the lifting equipment.

(2) The name and contact details of the person responsible for the equipment.

If the responsibility is divided, then there may be more than one name. However, it should be clear who should be notified in the event of a dangerous defect and to whom reports should be sent.

(3) The name, and address of the competent person(s) drawing up the scheme.

If the competent person is not working on their own account, the name of their employing organisation and their position in that organisation should be given.

(5) The identity and location of the equipment.

The examination scheme will vary depending upon equipment variation and application. Therefore, a description including specification and unique identity is required to trace the scheme to a specific item of equipment and location. For multiple items a range of unique identification numbers could be used rather than listing each number. For products where they only differ slightly, i.e. the working load limit, then a range of working load limits could be covered by the scheme.

(6) Details of any information or references used in drawing up the scheme.

The manufacturer's instructions and limitations for use would be the best source of information. Product safety standards, best practice guides, test data or data accumulated from similar schemes for example, would also be beneficial in support of the scheme.

There shall be a system in place to ensure that the above sources of information are kept up to date and are maintained.

(7) The basis for the scheme.

This should be a brief justification for the examination scheme. In the case of pump chain used in wet wells LEEA recommends that the chain meets the minimum specification as detailed in LEEA-069-2 to ensure minimum degradation during periods of submersion in the wet well.

During periods of submersion it is also recommended that its condition is monitored. This can be achieved by keeping records of each lift and inspecting the chain against the manufacturers discard criteria before returning it to the well. The extent of the inspection would depend on the risk assessment (refer to point 11) taking into account the factors that may cause deterioration of the equipment, such as the environmental conditions for example.

The written scheme shall be audited at specific intervals by an independent competent person. This person must be competent in terms of the thorough examination of pump chain, as they will be required check random samples of chain covered by the written scheme to prove the system is effective.

Note: an independent competent person from another branch within the organisation, the company's internal or external auditor, another examination company, or a competent person from an ISO 17020 accredited organisation are examples of the independent organisation doing the checks on the scheme.

(8) Details of any data logging system fitted, including a list of the parameters monitored and the means of data retrieval, monitoring and storage.

It is not possible to fit data logging systems to lifting accessories, however, it is therefore recommended that the status of the chain is monitored and recorded. We recommend that this includes:

- A log of each lift including the time and date of the lift so that the periods submersion can be determined;
- Details of the inspection done on the chain before it is returned to the well;
- Details of any findings from the inspection and any maintenance done (this could be in the form of a signed check list);

LEEA also advises that such a scheme is subjected to an auditing system by an independent competent person to check the effectiveness of the scheme. This person must be competent in terms of thorough examination as they would be required to examine random samples of equipment covered by the scheme as a part of the audit process. The information gathered from such audits must be used to re-evaluate the scheme at suitable intervals.

(9) What determines when the thorough examination shall take place and who is responsible for monitoring that and instigating the examination?

The equipment will be thoroughly examined when:
- The period specified by the scheme has elapsed, or;
- The monitoring systems identify something affecting the scheme; or
- The conditions of use covered by the scheme change or are exceeded.

(10) Identification of the safety critical parts requiring thorough examination.

Each item of lifting equipment must have a defined scope of examination, which details the examination procedure and the rejection and acceptance criteria.

The scope of examination must include details of the Competent Person and the techniques to be deployed in support of the examination, i.e. visual, measurement, NDT, operational test, load test, etc.

(11) A risk assessment.

The basic requirements for the risk assessment are contained in the Approved Code of Practice to Regulation 9 of LOLER.

This must be done to identify which components have potential to deteriorate during periods of submersion and use. The risk assessment must also consider other factors, such as the environment to which the equipment is to be stored or may potentially be used. It should include details of any assumptions about usage and expected component life

Where the scheme is based on the hours of service we recommend that a maximum period between thorough examinations is always specified as equipment can deteriorate whether used or not.

The following are suggestions to expand upon the basic requirements:

<u>(a) The condition of the equipment</u>
Consider:
- Overall condition - older equipment may need more frequent monitoring particularly if fatigue or corrosion are beginning to set in. Additional tests, measurements or NDT techniques may be required at certain stages of its life.
- Component condition – items such as accessories and galvanised chain may require frequent monitoring.
- Short term condition – It may be possible that equipment with a defect can continue to be used until a repair can be made subject to more frequent or stringent monitoring.

<u>(b) The environment in which it is to be used</u>
Consider:
- Weather conditions if used outdoors including exposure low or high temperatures;
- Corrosive environments such as salt water, exposure to fumes, chemicals;
- The effect of such environments on key components particularly whilst not in use e.g. wear caused by vibrations;
- The risk to the environment by the equipment e.g. explosive atmospheres;
- Mechanical damage during lifting and lowering operations;

<u>(c) The number and nature of lifting operations and the loads lifted</u>
Consider:
- Is it a frequent usage?
- Are the loads in the upper part of the load range?

- Consideration of pull out forces, as a result of break out forces or ragging contamination

Note: LEEA recommends the use of a load cell in this instance

- Ensure that the lift is a true vertical lift to avoid additional loading due to the angle of lift.
- Is it a well-controlled lift or are shock conditions and overload possible?
- Does the load affect the lifting machine e.g. pull out forces?
- The type of accessory, refer to LEEA 069-2

(d) the period of submersion

Consider:

- Period of monitoring
- Changes in the pH levels within the well
- The flow within the well
- The specification of the chain, refer to LEEA 069-2.

(13) The method of examination of those safety critical parts, which may include:

- The degree of dismantling required and the techniques employed e.g. visual examination, measurement, NDT, operational test, load test.
- The rejection criteria or a reference to where this information may be found.

(15) An indication of the resources required to prepare the equipment and carry out the thorough examination.

This may include qualified personnel, workshop facilities, specialist NDT, load test, cleaning equipment, etc.

(16) Any changes to equipment condition, operational or environmental parameters that will require a review of the scheme by the competent person.

These may include damage to the equipment or change of use from general duty to heavy duty or moving from an inland location to a coastal environment for example.

(17) A requirement for the person responsible for the equipment to monitor its circumstances of use and inform the competent person who drafted the scheme of any changes.

If the process of control deviates in any way from the basis of the scheme, refer to point 7, then all those involved in the process who encounter such issues must notify the competent person who devised the scheme immediately so that it can be re-evaluated.

(18) The date of drawing up the scheme and the date at which any routine review is required.

Annex A

A1.1 Introduction.

Written schemes of examination for pump lifting chain are only valid if the increased period between examinations is adequately justified. This means that the risk assessment must take into account all of the variables that can cause deterioration of the equipment and demonstrate that under the scheme the continued safe operation of the equipment can be maintained.

This annex identifies some of the common variables that can affect the safe operation of the equipment.

A1.2 Cavitation

Cavitation is an undesirable occurrence associated with the efficiency of the pump in the wet well. It can usually result in vibrations that, in some cases, are sufficient enough to damage components attached to the pump. Below are some examples of the damage caused by this variable.

Figure A1 Excessive wear to an eyebolt and shackle due to vibrations caused by cavitation.

It is clear from figures A1 and A2 that the damage caused by vibration is sufficient to result in catastrophic failure of the lifting equipment if it is not identified and rectified in a timely manner. Therefore, it is vital that adequate measures are included in the written scheme to ensure that this risk is reduced to an acceptable minimum.

A1.3 Substandard Equipment.

It is a requirement of PUWER Regulation 10 that the duty holder is responsible for ensuring that all work equipment coming into his undertaking meets any essential health and safety requirements. In the case of pump lifting chain the duty holder should ensure that they receive an EC Declaration of Conformity in accordance with the Machinery Directive 2006/42/EC. It is also recommended that the duty holder requests in the tender that the equipment meets the minimum specification defined in LEEA 069-2 Specification for stainless steel submersible pump lifting chain slings and accessories.

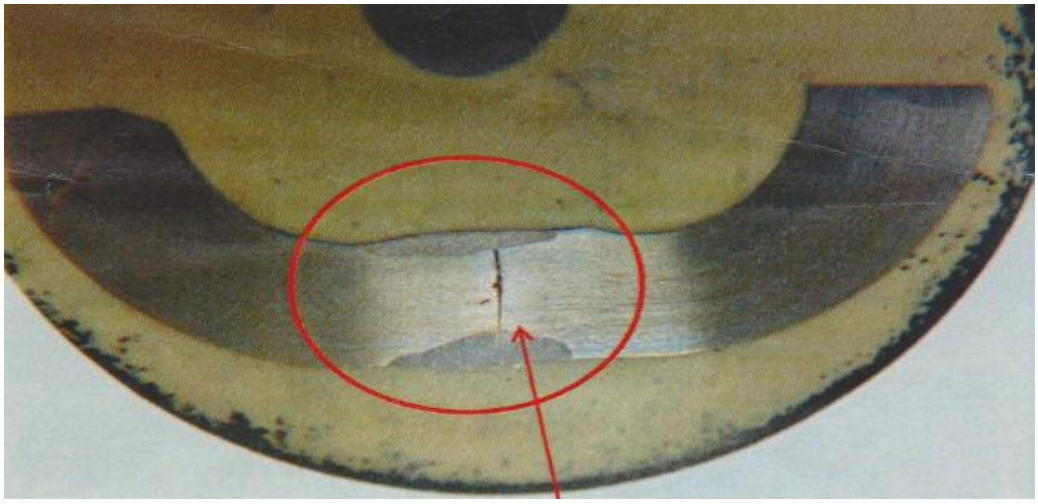

Figure A3 Showing a welding penetration defect of a chain link due to inadequate manufacturing processes.

A1.4 Additional corrosion risks associated with chain slings / limitations of use within the water industry:

Typically, sewage pH values are in the range 5 to 7, and therefore there will be no chemical damage to the chains.

Clean water treatment pH values are in a range below 4.9 and 10.1. For chains operating in water outside this pH range,
It does not mean that stainless steel chain assemblies cannot be used, only that the frequency of examination should be determined to suit these particular conditions.

To aid further the in the assessment if the written scheme, the table below -*)* shows the values of corrosion resistance of 316 stainless in various media.

Table A1: Values for resistance in different media

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 HCl	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

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