Stainless Steel Specification

AM2760

Contents

Document History

Version No.	Date	Author	Version Description
0	*Feb 2018*	*R. Jagger*	*First Draft for Review*
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1. INTRODUCTION

1.1. Scope of Specification

Stainless steel shall be selected when it is the most appropriate material as outlined in South East Water's Corrosion Mitigation standard AM2739.

This specification applies to the following stainless steel components procured for South East Water (SEW) assets:

- Pipework ≥DN50 (not tubing for chemical systems)
- Fabrications made from wire, bar, angle, beam, sheet or plate
- Lifting chain and wire rope
- Fasteners

When used, stainless steel components are subject to the following limitations:

- Operate at < 60°C temperature and:
- not exposed to chloride levels higher than that of sea water (35 g/L, or 35 ppm), and:
- not utilised for the containment of chemicals (although stainless steel may be suitable for containing some chemicals).

Compliance is required to the latest versions of all referenced standards.

While this specification applies to all SEW stainless steel assets, emergency works requiring the use of stainless steel may not be able comply. This will typically be the case when short timeframes do not allow for an investigation the operating environment (eg: soil conditions for buried stainless steel) or the sourcing of the optimum items. In such situations, this specification should be applied as much as practical given the circumstances.

1.2. Key References

The following key references provide further information relevant to this specification:

- *Australian Stainless Steel Development Association (ASSDA), "Australian Stainless Steel Reference Manual".*
  Provides wide ranging information on the selection and fabrication of stainless steel.
- *The European Stainless Steel Development Association,* "Performance of Stainless Steels in Waste Water Installations".
- *Australian Stainless Steel Development Association (ASSDA), "FAQ 7 – Guidelines for Use of Stainless Steel Underground"*
- *WSAA Materials Facts Sheet No.2, "Selection of Stainless Steels for use in the Water Industry".*
  Provides a brief summary of Grade Selection and corrosion resistance.
- *The Steel Construction Institute, "Design Manual for Structural Stainless Steel".*
  http://www.worldstainless.org/Files/issf/non-image-files/PDF/Euro_Inox/Recommend_EN.pdf
  Provides information about using Stainless Steel for structures.
- *Atlas Steels Technical Handbook of Stainless Steels*
  http://www.atlassteels.com.au/documents/Atlas%20Technical%20Handbook%20rev%20Aug%202013.pdf
  This is very similar to the ASSDA publication mentioned above.

- *Atlas Steels product catalogue*
  http://www.atlassteels.com.au/documents/Atlas%20Product%20Reference%20Manual%202010.pdf
  Provides information on the items commonly stocked in Australia.
- AM2739- SEW Corrosion Mitigation Specification

This specification has been produced on the basis of the version of these documents that was current in January 2018.

1.3. When to Use Stainless Steel

Stainless steel materials have the following benefits:

- A number of grades have good weldability, enabling complex shapes and structures to be fabricated to fit within existing site and asset constraints.
- They are generally resistant (depending on grade and surface finish) to corrosion in most naturally occurring environments.
- They have a range of physical properties (strength, modulus, toughness and fatigue resistance) approximately equivalent to or superior to normal carbon steels.

1.4. When Not to Use Stainless Steel

Stainless steel is unlikely to be appropriate in the following situations:

- When none of the benefits set out in Section 1.3 are required and less costly materials would be adequate.
- In aggressively corrosive environments (ie: low pH / high hydrogen sulphide / high chloride (especially at elevated temperatures) / high level of microbial activity).
- Where poor quality fabrication environments elevate the risk of stainless steel contamination.
- Where there is an absence of oxygen. Stainless steel requires oxygen to form a protective outer coating.
- Geometries which contain narrow crevices (where small levels of corrosive agents can corrode the material).
- Adhesion, stagnation or settlement of liquids or solids on a stainless steel surface which can elevate the effects of contaminants.
- When thermal expansion cannot be tolerated and the items will be subjected to elevated temperatures. This is especially the case for austenitic stainless steels (eg: 316 SS).
- Below the water line in protective coated mild steel tanks

2. MATERIAL PROPERTIES & SELECTION

Select the material grade based on the following factors:

- The corrosion resistance and required mechanical properties.
- Operating temperature and proposed fabrication method.

Generally, the stainless steel grade is selected on the required corrosion resistance and the structural design is then completed according to the mechanical properties of the selected material.

Stainless steel materials shall comply with the following standards:

- ASTM A666 for Austenitic sheet, strip, plate and flat bar
- ASTM A484 for Austenitic bar and forgings
- ASTM A240 (UNS 32205) for Duplex

2.1 Grades for Typical Situations

Table 1 outlines the minimum grades that shall typically be utilised. These grades have properties that suit most situations, are readily available and generally represent reasonable value. These material grades are not suitable in all situations, as noted in the section 2.2.

Table 1: Typical South East Water Preferred Stainless Steel Grades:

Grade	SS Type, Composition	Acceptable Situations of Use
304	Austenitic. 8% Ni 18% Cr	• Only exposed to substances with chlorides < 200 ppm, & • Only above ground assets, & • Only away from the coast (ie: > 2km away) & • Only exposed to water / non drinking water (not sewage or sludge).
316	Austenitic. 12% Ni 17% Cr	• Only exposed to H2S environments generally < 100ppm (consider using ventilation / air treatment to reduce H2S levels), & • Not exposed to Acid Sulphate soils or soils with pH < 4.5, & • Only exposed to substances with chlorides < 1000 ppm
2205	Duplex. > 5% Ni, & > 22% Cr Austenitic	Virtually any soils, marine water or sewage environments. Note that 2205 is also substantially stronger & harder than grade 316.

2.2 Grades for Less Common Situations

Table 2: South East Water Preferred Stainless Steel Grades in Non-Standard Situations

Situation	Appropriate Materials or Fabrication
Below Ground Applications	Refer to section 2.3
Machined (lathed, milled) stainless steel	Use "Ugima" grade (machine grade, eg: Ugima 316) stainless steel
> 3mm **thick welded** substrates	To prevent weld embrittlement & intergranular corrosion: • Use "L" grade (low carbon, eg: 304L or 316L) stainless steel, or • Post weld heat treat all welds- refer to below section 3.1 on welding
Component geometry contains **crevices** < 0.5mm wide	Crevice corrosion risks would be elevated and a higher grade of stainless steel should be utilised (ie: 316 instead of 304 or 2205 instead of 316).
Exposed to **stagnant** liquid, ie: flow velocity is low (< 0.6 m/s)	Pitting corrosion risks would be elevated and a higher grade of stainless steel should be utilised (ie: 316 instead of 304 or 2205 instead of 316).
Situations where there is a low tolerance for **expansion / contraction**	304 and 316 grades have a high expansion co-efficient. If the asset cannot be designed to accommodate the high expansion / contraction, a non-austenitic grade should be selected.
Sewage or below ground applications at **elevated temperatures > 50 °C**	Duplex 2205 only should be used in these situations due to the elevated risk of stress corrosion cracking in 304 or 316 grades.
High temperature **applications > 300°C**	Duplex 2205 only should be used in these situations

2.3 Below Ground Stainless Steel

Buried Stainless Steel material has substantial additional risks over above ground Stainless Steel as it is in contact with potentially more aggressively corrosive environments and low oxygen. Table 3 and Table 4 provides basic guidelines to select the grade of Stainless Steel material based on ground conditions.

Stainless steel should not be buried in soils which contain significant stray currents and 316 stainless steel should not be exposed to pH < 4.5.

Where a structure is situated both below and above ground, undertake one of the following:

- Select a common grade of SS for the entire structure. Select a material that will provide the required asset life in both environments.
- Select different materials for the below ground and above ground environment. Transition from one to the other at approximately 500mm above the finished surface level. Where different metals are to be joined, ensure that dissimilar metal corrosion risks are adequately controlled by insulating one metal from the other.

Table 3: Required Minimum Requirements for Stainless Steel in Buried Applications

Asset Type	Min SS Grade Required
Low risk SS component *(1)*	316
High risk SS component (with soil monitoring) *(3)*	As per Table 4
High risk SS component (no soil monitoring – further than 2km from a coastline or maintenance item)	2205 or petrolatum tape system wrapped or coated 316 *(4)*
High risk SS component (no soil monitoring – within 2km of a coastline)- maintenance items excluded	Super duplex or petrolatum tape system wrapped or coated 2205 *(4)*

Table 3 Notes:

(1) Low risk Stainless Steel components are those that have full automatic redundancy or a contingency that can be rapidly implemented. Typically this includes water reticulation items.

(2) High risk are all other assets. Typically this includes all pressurised sewage items and distribution water main items.

(3) Soil analysis shall be undertaken to determine the chloride ion concentration, pH and soil resistivity so that Table 4 can be applied to select grade. Soil measurements shall be taken at each location where SS containing assets are to be located, or every 100m where continuous SS containing assets are to be buried. Where a number of measurements yield the same result and the ground conditions are clearly consistent, testing levels may be reduced.

(4) Refer to Clause 15.20 of the MRWA edition of the WSAA Water Supply Code WSA 03—2011-3.1 and MRWA-W-306A for petrolatum tape system application details.

Table 4: Preferred Minimum Grades for Buried Stainless Steel Applications:

Resistivity Ω.cm	Chloride ion concentration (ppm)			
	200	1000	2000	15,000
>5000	304/304L			
2000-5000	316/316L/2304		2205	Super duplex
1000-2000	2205		Super duplex	
<1000	Super duplex			

Source: ArcelorMittal.

- Table 4 assumes a soil pH > 4.5 (ie: not acid sulphate soils)
- Refer to ASSDA FAQ 7 for additional information on the Use of Stainless Steel Underground.
- Granular embedment and backfill (eg: sand / crushed rock) shall be used with all high risk buried stainless steel to enable oxygen transfer to the stainless steel surface.

2. FABRICATIONS

3.1 Welding

Welding of stainless steel shall meet the following requirements:

- Weld stainless steel in accordance with clause 15.20 of the MRWA edition of the WSAA Water Supply Code WSA 03—2011-3.1 with the following exceptions:
  - External corrosion protection which may or may not be required depending on the soil conditions (refer Table 4 if welded pipe is to be buried).
  - The cement mortar lining is not required for stainless steel pipelines.
  - Cathodic protection of stainless steel which is not required.
  - Pipe fittings shall be fabricated from the pipe specified below rather than from AS1579 pipe.
- In accordance with Table 2 above, ensure that substrate stainless steel is of a grade suitable for welding or that the fabricated item is post weld heat treated (as per section 3.2).
- Weld electrodes must match the material being welded (except for Grade 2205 SS where grade 2209 consumable weld electrodes shall be used).
- Welds shall be tested in accordance with section 15.20.1.2 of the MRWA edition of the WSAA Water Supply Code WSA 03—2011-3.1, except that these requirements shall apply to all stainless steel welds, not only those undertaken on pipelines.

3.2 Cutting, Grinding and Machining

Cutting, grinding and machining of stainless steel shall meet the following requirements:

- Avoid carbon steel contamination (which can significantly lower the corrosion resistance of the stainless steel) by:
  - not using tools (especially cutting wheels and grinders) which have been used on carbon steel,
  - not allowing stainless steel to come into contact with carbon steel objects (ie: ensure they are stored separately),
  - not undertaking carbon steel shot, grit or wire blasting of stainless steel, and
  - ensuring that abrasive or polishing compounds are iron and carbon free.
- Stainless steel has a low thermal conductivity and therefore heats up substantial more than carbon steel when welded or mechanically worked. Austenitic grades of stainless steel in particular are subject to significant work hardening and the heat can result in a heat scale or heat tinting which can create a point of corrosion.
- Use “Ugima” grades when machining (ie: fabricating with mill, lathe) more complex shapes.
- Avoid high speed cutting, grinding or drilling which creates excessive surface heat.
- Avoid grinding of stainless steel surfaces which roughens the surface and thereby lowers the corrosion resistance.

3.3 Surface Treatment & Finish

Stainless steel surfaces shall be treated when:

- Excessive surface heat has occurred through welding or mechanical work and there is evidence of heat scale or heat tinting. Heat tinting often appears as hues of yellow, red, purple or blue.
- Where iron or carbon contamination of the stainless steel surface may have occurred.
- Where stainless steel surfaces are rough (ie: > 5 micron surface roughness, not class 2B finish or better).

Treat surfaces by:

- Mechanical cleaning (eg: iron free Garnet sand blasting) to a minimum class 2B finish.
- In conjunction with or instead of mechanical cleaning, reduce roughness through polishing to a No.4 finish (using a "Scotch-brite" buffing wheel or iron free fine cutting compound).
- Alternatively, reduce less substantial contamination, heat scale or heat tinting through Passivation of Pickling as per ASTM A380.

Stainless steel is typically highly reflective and when used in the construction or large above ground surfaces such as tanks, this reflection may have a significant impact on nearby customers and traffic. Where this risk is present, stainless steel surfaces shall be coated as per WSA201, Manual for the Selection and Application of Protective Coatings. Colour shall be Eucalyptus Green to AS2700, colour G52, unless otherwise stipulated in the project brief.

3.4 Chain, Wire Rope and Casting Fabrications

- Stainless steel lifting chains, master links, dee shackles, clevis shackles, clevis hooks, lifting eye hooks and lifting points shall:
  - comply with AS4797- Stainless Steel Chain for Lifting Purposes
  - be constructed from minimum Grade 50 grade 316L (low carbon) stainless steel or any higher grade of low carbon stainless steel as required to suit the conditions.
  - contain welded or forged joints where practical.
  - come with test certificates indicating that the item(s) have been tested to AS4797.
  - have a certified Safe Working Load (SWL) equal to or greater than the forces to which the item will be subjected.
  - come with SWL permanent markings as per AS4797.
  - be used within the manufacturer's documented limitations

- Stainless steel wire rope shall:
  - not be used for lifting people or heavy (ie: > 50 kg) objects such as pumps as their condition is more difficult to accurately assess.
  - comply with AS3569
  - use swages / crimps which are constructed from SS316 or any higher grade of stainless steel required to suit the conditions.

- Stainless steel castings shall:
  - comply with AS2074 with respect to materials.
  - H5 class alloys can considered to be equivalent to grade 304.
  - H8 class alloys can be considered to be equivalent to grade 316.
  - H10 class alloys can be considered to be equivalent to grade 2205.
  - Comply with AS4738 with respect to all other casting requirements.

4 PIPEWORK

The following section relates to stainless steel pipework used for any fluid subject to pressure up to 1700 kPa, whether it be water, sewage, sludge, biogass, fuel or air. It is applicable to sleeving (typically used for road / rail / waterway crossing) provided the sleeving is not placed under excessive tension or compression (such as may occur during trenchless construction). This pipe is not suitable for jacking applications.

4.1 Pipe Standards

Stainless steel pipe shall comply with the following standards:

- ASTM A312M for Austenitic pipe up to DN600
- ASTM A359M for Austenitic large diameter pipe >DN600
- ASTM A790M for Duplex pipe.

This pipe shall either be:

- longitudinally welded and annealed, or
- seamless formed.

Spiral welded pipe stainless steel tube manufactured to ASTM A554, ASTM A269 or ASTM A778 shall not be used without SEW approval due to its substantially lower wall thickness when compared with longitudinally welded or seamless formed stainless steel pipe. It may be appropriate in situations where the risk of impact is low, i.e. where the pipe is elevated and protected from accidental impacts from plant.

4.2 Pipe Schedule / Pressure Class

For pipelines of all preferred Stainless Steel grades up to DN600 (ASTM A312), pipe schedule shall comply with Table 5. This is based on the wall thickness required to provide adequate durability in addition to providing an adequate pressure rating of the pipe. Pipe wall thicknesses have been selected according to what schedule most closely matches traditional steel pipe.

Table 5: Required Minimum Pipe Schedules.

Asset Type	≤ DN200	≥ DN250
Low risk pipework (2)	Schedule 10S	Schedule 5S
High risk pipework	Schedule 40S	Schedule 10S

Table 4 Notes:

(1) Minimum pipe schedules assume a Test Pressure (Maximum Operating Pressure x 1.25) of 1700 kPa. Where test pressures exceed 1700 kPa, Schedule 40S pipe shall be selected.

(2) Low risk pipelines shall be those that have full automatic redundancy or a contingency that can be rapidly implemented. High risk pipelines are all other pipelines. Refer table 3 notes for details.

4.3 Jointing (including Flanges)

Joints shall comply with the following:

- Lengths of pipe, flanges and fittings shall be butt weld joined where practical as per section 3.1 of this Specification. Flanged joints shall be minimised.
- Flanges shall be a slip-on type as per AS4087, factory welded to the pipe where practical.
- Flanged joints shall be installed as per Water Standards MRWA-W-306A and 306B.

4.4 Pipe Fittings

Pipe fittings shall comply with the following:

- All pipe transitions and deflections (bends, tees and tapers) shall be seamless where possible,
- The grade of stainless steel used in pipe transitions and deflections shall match the grade of stainless steel used for the pipe.
- Smooth inner surface and gradual change fittings shall be used (ie: not “lobster back” segmented fittings) where they are available.

- Austenitic stainless steel transitions and deflections shall comply with ASTM A403 and ASME B16.9.
- Duplex stainless steel transitions and deflections shall comply with ASTM A815 and ASME B16.9.
- All valves and any non stainless steel metal pipe shall be electrically isolated (insulated) from stainless steel pipework as per Water Standards MRWA-W-306A and MRWA-W-400.

5 FASTENERS

Fasteners shall comply with the following:

- The grade of stainless steel used in fasteners shall match the grade of stainless steel used for the pipe (noting that grade 2205 fasteners may not be generally available).
- Where stainless steel fasteners are used in conjunction with grade 2205 pipe flanges, they may be grade 316 as long as the flange joint is wrapped with a petrolatum tape system as specified in Clause 15.20 of the MRWA edition of the WSAA Water Supply Code WSA 03—2011-3.1.
- Stainless steel 316 bolts, nuts and washers shall comply with the SS fastener listings in the MRWA products web portal.
- Stainless steel bolts, nuts and washers shall comply with ISO 3506 (Mechanical Properties of corrosion-resistant stainless steel fasteners).
- Fasteners shall be used in conjunction with washers which comply with AS 1237.1 & 2.
- Stainless steel threads (either the female or male thread) shall be FTFE (Teflon) or Molybond coated to prevent seizing or galling.
- Threads should be kept grit free through the application of sleeving and tape as per Water Standard MRWA-W-306A.