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# API Technical Report 938-C

## Use of Duplex Stainless Steels in the Oil Refining Industry

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This report covers many of the “lean”, “standard”, “super”, and “hyper” grades of duplex stainless steels (DSSs) most commonly used within refineries. The definitions of these terms have not been firmly established by the industry, and vary between literature references and materials suppliers. Table 1 shows how the various grades are being classified into “families” for the purposes of this report. The UNS numbers of the standard grades being used for corrosive refining services include:

- Lean DSSs: S32101, S32202, S32304, S32003, S82011, and S82441;
- Standard DSSs: S31803 and S32205;
- Super DSSs: S32520, S32550, S32750, S32760, and S32906;
- Hyper DSS: S32707.

The grades which are labeled as “lean” (including grades sometimes called “semi-lean”) have either lower Cr, Ni, or Mo than the standard grades, and are used in some process services that are less aggressive (primarily in corrosive environments to replace 304L SS). These alloys have also been used for storage tanks and structural applications, primarily for their higher strength as compared to carbon steel (CS). It is observed that new DSS alloys are being introduced and are likely to continue to be introduced. These new grades can be reasonably placed in the context of this discussion based on their composition.

The product forms within the scope are tubing, plate, sheet, forgings, pipe, and fittings for piping, vessel, exchanger, and tank applications. The use of DSSs for tanks is also addressed by API 650, Annex X. The Third Edition of this report (API 938-C) has added sections covering castings and hot isostatically-pressed (HIP) components for pumps, valves, and other applications. The limited use of DSSs as a cladding is also briefly covered within this document.

The majority of refinery services where DSSs are currently being used or being considered in the refining industry contain:

- a) a wet, sour (H<sub>2</sub>S) environment, which may also contain hydrogen, ammonia, carbon dioxide, chlorides, and/or hydrocarbons, which typically has a pH greater than 7;
- b) water containing chlorides, with or without hydrocarbons—this includes many fresh water cooling water systems, and some salt water systems with higher alloy grades;
- c) hydrocarbons with naphthenic acids at greater than 200 °C (400 °F), but below the maximum allowable temperatures in the ASME Code for DSSs (260 °C to 343 °C [500 °F to 650 °F], depending on the grade);
- d) amines, such as MEA, MDEA, DEA, etc.; or
- e) other environments, such as those containing caustic conditions.

The specific plant locations containing these services are described in a later section and the report scope will be limited to the first four environments. Although DSSs have good resistance to caustic environments, this service is not unique to or widespread in refining, and hence is not covered in detail in this report.

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