

**A. Shielding Gas Dewpoint Study for Titanium Welding:
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Historically, U.S. Navy surface ships have used copper-nickel (Cu-Ni) alloy as the standard material for construction of seawater cooling and piping systems. However, numerous seawater system failures due to Cu-Ni's susceptibility to corrosion has prompted the U.S. Navy to select titanium, commercially pure (Ti-CP) grade 2 for two main seawater systems, firemain and auxiliary, on the LPD-17 Amphibious Transport Dock ship class. The implementation of Ti-CP, grade 2 for the seawater systems offers life cycle cost savings and weight savings.

Titanium is an extremely reactive material therefore, titanium welding fabrication requires complete inert gas shielding in the forms of trailing, torch, and back shielding gas. NAVSEA Technical Publication S9074-AR-GIB-010/278 requires all inert shielding gases used in titanium welding to have a purity of at least 99.995-percent and a dewpoint of -60°F or less at the workpiece or purge exit. In order to achieve this requirement, piping must be purged with inert shielding gas prior to welding. Shipyard personnel consider this requirement difficult to achieve as it leads to purge times that may be several hours. These delays impact fabrication schedules and overall production costs. However, the purge time can be reduced by raising the inert gas shielding dewpoint to -40°F or higher which potentially offers significant cost savings.

The objective of this study was to examine the feasibility of relaxing the inert gas shielding dewpoint requirement for titanium pipe welding fabrication. A weldment was fabricated at -40°F with Ti-CP, grade 2 base plate and filler material. The completed weldment was evaluated for chemical and mechanical properties. Chemical analysis of the weld metal for interstitials meet ASTM B265 requirements for all elements. Tensile properties were in conformance with ASTM B265. Impact toughness properties were comparable to historical data indicating exceptional impact toughness properties. Fracture toughness properties were also comparable to historical data. The results demonstrate high strength, good ductility, good impact, and good fracture toughness. This study demonstrated that relaxing the inert gas shielding dewpoint to -40°F has no detrimental effects on the chemical and mechanical properties of Ti-CP, grade 2 weldment.