

Subject

Weld Parameter Invalidation as a Result of Early Life Cycle Qualification

Abstract

A failure occurred during the first attempt at welding of the Europa Clipper Venturi Flow Meter (VFM) flight units. During the first pass, excessive heat input to the welding area caused the weld root reinforcement material to melt. This left a divot on the top surface and an obstruction in the internal flow passage of the VFM. Upon further investigation, it was determined that the weld test samples used to qualify the weld procedure did not adequately represent the geometry of the flight units. Ultimately, it was found that the decision of performing weld qualification prior to baselining the final design led to inadequate insight into a key geometrical feature surrounding the weld joint. Following this event, a spare flight unit was scrapped and new weld parameters were developed to complete assembly of the remaining units.

Excessive heat input to the welding area caused the weld root reinforcement material to melt

Excessive heat input to the welding area left a divot on the top surface and an obstruction in the internal flow passage of the venturi flow meter VFM

Driving Event

In order to complete assembly of the Europa Clipper VFM component, the VFM team developed and qualified a weld procedure specification (WPS). This was done early in the product's life cycle and prior to completion of the VFM flight design. This required the team to attempt to represent the internal geometry of the VFM on a "best effort" basis. Although AMS2680C only requires that the weld joint be represented, the team strived to include the features of the converging section of the VFM to account for the small amount of heat sink expected at the area below the weld root.

After the weld failure occurred, it was determined that the test sample did not adequately represent the flight hardware weld. In fact, the amount of material below the weld root was half of what was expected. Therefore new weld parameters had to be developed to reduce the heat input of the weld and avoid melting the material at the weld root reinforcement. Though a design review was conducted for the approval of the final VFM design, the agenda did not include a comparison of the flight design to the weld test samples.

Lesson(s) Learned

Early life cycle qualification of weld parameters should be justified. If this decision is made, the risks associated with this decision should be understood and communicated.

Recommendation(s)

If a Weld Procedure Specification (WPS) is developed and qualified early in the product's life cycle, a design review (such as a Manufacturing Readiness Review), should include an assessment of any departures between the weld qualification test samples and the flight design.

Evidence of Recurrence Control Effectiveness

N/A

Program Relation

Europa Clipper

Program/Project Phase

Implementation » Phase C

Mission Directorate(s)

No directorate(s) listed

Topic(s)

- Manufacturing and Assembly
- Flight Equipment
- Hardware
- Parts
- Materials
- & Processes
- Spacecraft
- Test & Verification
- Propulsion
- Spacecraft and Spacecraft Instruments
- Review boards
- Engineering design and project processes and standards