Best Practice # 215

Facility: Multiple

Best Practice Title: Welding in Support of Research and Development

Point of Contact: Gary Cannell, Welding Director, FLUOR (509-392-5897); gary.cannell@fluor.com) representing the EFCOG Engineering Practices Welding Task Team

Brief Description of Best Practice: This practice addresses welding in support of research and development activities. Research and development welding in the context of this practice is defined as follows:

> **Welding in support of Research and Development:** Includes welding and related activities utilized in support of general research and development, e.g., welding of components used to support the development of new glass melter or reactor technology, etc.
>
> **Research and Development Welding:** Includes the development and study of new / existing welding processes, such as hybrid laser arc welding or friction stir welding.

The distinction between the two types of welding is significant. Research and Development welding (R&D welding) is typically limited to the development and understanding of welding processes, not the welding of components and structures. Welding in support of R&D activities frequently involves the fabrication of such items and therefore standard welding controls must always be considered to ensure personnel safety. Welds must be sound and of good quality, compatible with the items being welded and be able to carry the design loads / pressures. Appropriate qualification of procedures and personnel is critical to ensuring welds will perform their intended function. Standard welding controls also call for practices that prevent risk to safety during fabrication, such as exposure to harmful fumes, electrical hazards, and to hazards associated with welding and purge gases.

In addition, many of the welds performed in support of R&D activities must comply with national codes and standards that require documentation of certifications, qualifications, performance of weld inspection, examination, and etc. Lack of compliance can jeopardize the use of the welded components and create risk to cost and schedule, regardless of whether or not the weld is of acceptable quality.

Welding in support of R&D activities, as defined above, must comply with standard welding practices to ensure the safe function and operation of weldments and compliance to national codes and standards.

The challenge experienced over the years has been the mindset that “welding in support of R&D activities is different” and therefore standard welding controls are not applicable – see the Problems / Issues section below. This “thinking” has put DOE personnel and resources at risk

and must not continue. The following provides a "general" approach to how welding in support of R&D activities should be conducted.

Recommended Practice: The best practice provides a summary of the steps to be followed; these are typical of a DOE Site Welding Program (SWP). It is noted that once determination is made the application falls within the scope of welding in support of R&D activities, all welding and related activities are conducted in accordance with SWP requirements.

1) R&D Welding Determination – Is it Welding in Support of R&D Activities or R&D Welding
    a) This determination is made by the Welding Program Authority (WPA) or person(s) designated by the WPA.
        - The responsible supervision requesting approval shall review the welding activities and application with the WPA.
2) Welding Supervision and Oversight
    a) Welding supervision / oversight should be performed by individuals with appropriate experience and knowledge as defined and designated in applicable work control procedures and practices, Site Welding Program manual, or other.
3) Welders and Procedures for Welding in Support of R&D Activities
    a) Welders shall be qualified and certified in accordance with applicable codes and standards.
    b) Welding shall be performed in accordance procedures qualified in accordance with applicable codes and standards.
4) Process, Equipment and Filler Material for Welding in Support of R&D Activities
    a) Supervision shall ensure:
        - The welding process is suitable for the application.
        - The welding and related equipment has been properly maintained and is capable of producing sound weld metal.
        - Filler material is issued, controlled and returned in accordance with the Site Welding Program requirements.
5) Weld Inspection / Examination and Documentation for Welding in Support of R&D Activities
    a) Welding supervision shall ensure all welds are subjected to and meet applicable inspection and examination requirements.
    b) Welding supervision shall ensure welding documentation, as required in applicable work control packages, travelers, etc., is accurate and complete and represents the work performed.

Why the Best Practice was used: To ensure the safety and well-being of personnel and compliance to codes and standards, it is imperative that welding in support of R&D activities be executed in accordance with standard welding practices. The welding task team has identified

multiple instances where such requirements / practices were not followed, putting personnel safety and code compliance at risk.

What are the benefits of the Best Practice: Implementation of proper practices for the performance of welding in support of R&D activities will help ensure personnel safety, and codes and standards compliance.

What problems/issues associated with not using the Best Practice: The problem with not using or applying this practice can impact personnel safety, and project cost and schedule.

The following describes welding in support of R&D activities in which appropriate welding controls were not implemented – the reason: "it's just R&D welding":

- A research and development (R&D) engineer elected to receive off-site training on an automatic GTAW, autogenous tube welding process. Having completed the training, the R&D engineer developed and fabricated (on site) an instrument panel containing more than 300 welds. When the facility took receipt of the panel, it was discovered that applicable code requirements were not met, including qualification of the welder (the R&D engineer) and welding procedure. The R&D engineer was subsequently qualified to the appropriate requirements and the welds examined in accordance with applicable Code requirements. All three hundred plus welds failed examination due to lack of penetration. If the R&D engineer had trained and qualified to the SWP, it is likely that the weld quality would have met required acceptance criteria and the project would have avoided significant impact to cost and schedule.

- An NDE Level III inspector was passing through a site facility when he noticed, in one of the offices, a small, flat-head pressure vessel bulging at the top. The inspector alerted the appropriate personnel who immediately turned off the pump and relieved the pressure from the vessel. It was discovered that the vessel was part of an R&D experiment and was not designed or fabricated in accordance with the governing code (e.g., ASME Section VIII of the Boiler & Pressure Vessel code). Because this was an "R&D experiment," the R&D engineers did not recognize or see the need to involve appropriate work control practices, including review against SWP requirements and criteria.

- A major project at one of the sites utilized unqualified procedures and welders in the development and fabrication of process equipment. The welding scope included high pressure / temperature components and was legally required to comply with the ASME Boiler & Pressure Vessel code. Lack of compliance with applicable codes and standards rendered the equipment unusable and its ability to function in a safe manner indeterminate.

These examples, among many, had a substantial impact on project cost and schedule and had the potential for significant safety risk, had the equipment / components been put into service. Site management must establish and communicate a culture that all welding is to comply with applicable requirements and practices; and "all" includes welding in support of R&D activities.

In addition, negative consequences associated with the above examples could have been avoided had appropriate site Welding Program personnel been invited to participate in the planning and preparation of the work.

How the success of the Best Practice was measured: Welding in support of R&D activities is common throughout the Complex and for the most part, is performed in accordance with SWP requirements and practices. The metric or measure by which success is determined, is the avoidance of personnel safety issues and adverse impact to project cost and schedule.

Description of process experience using the Best Practice: There are many examples of where welding in support of R&D activities have been performed in accordance with the SWP, governing codes and standards, standard site work practices, etc. Even when an R&D component, being developed and fabricated, is not intended for a production application, the safety and well-being of personnel can be at risk when proper welding controls are not followed. And, it is not uncommon that when such a component is completed, tested and found to perform a needed function, an attempt to re-classify for a production purpose is made. Unfortunately, without proper pedigree and documentation, established through compliance with a SWP, the component is not likely to ever be used in production.