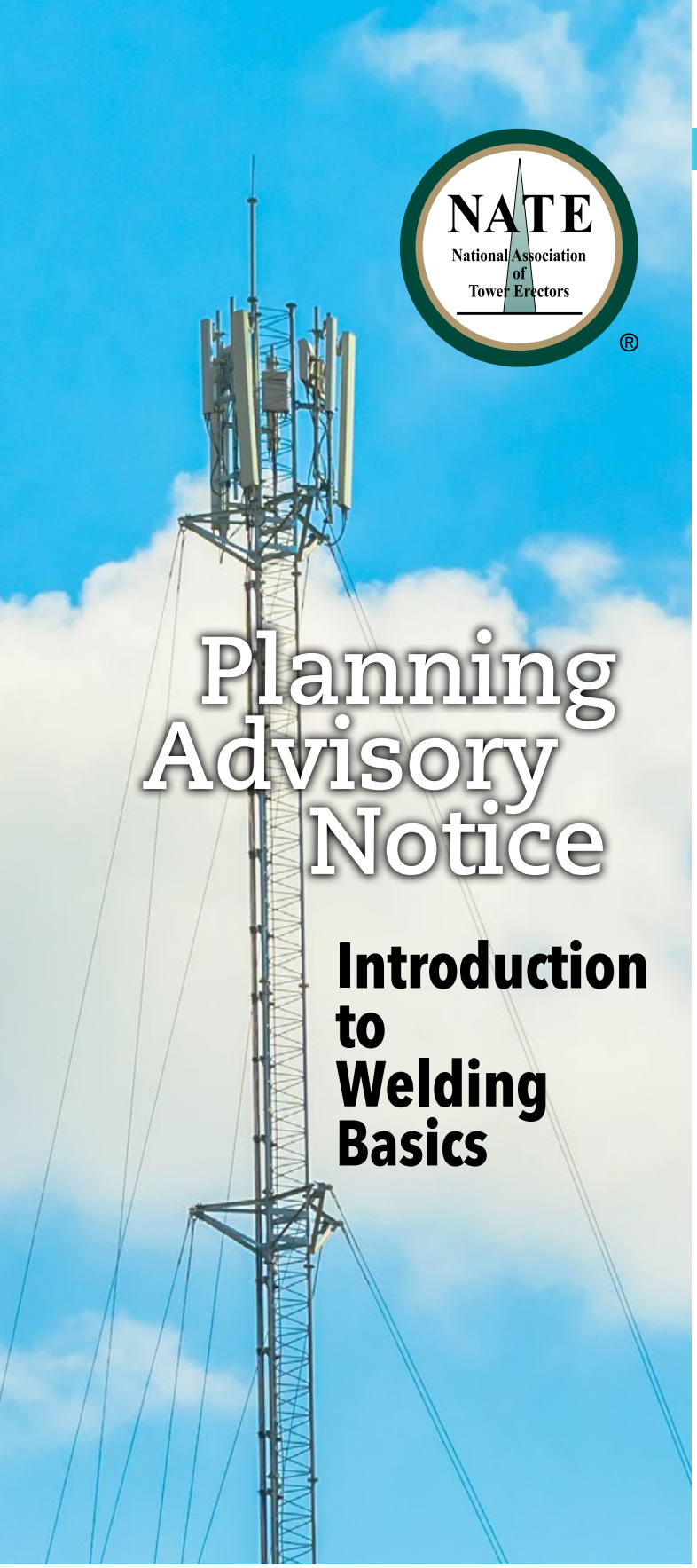

Planning Advisory Notice

Introduction to Welding Basics

This month we have a Planning Advisory Notice (PAN) that is a little different than some of the others. This article will be part of a series. It is intended to address several American Welding Society (AWS) welding basics. As we all know, new and most modified structures in this industry require welds. Special note: If possible avoid welding on existing structures, and whenever welding is to occur ensure that the structure, safety and system are attended to in accord with the standards. Safety and quality are so closely linked and it is critical to be aware that not following the standards can lead to issues as shown in some of the pictures.

Each SOW (Scope of Work) requires different approaches and careful consideration of which standards apply. In order to communicate effectively between contractor(s) and engineer(s) we need to understand common terms. Remember, when in doubt or in the middle of a changing condition apply the SAUCE (Stop, Assess, Understand, Communicate and then Execute).

It is important that we understand the distinction between codes, specifications, and standards. The following is a high level overview of their interaction.

Standards and How They are Related to Codes

- A standard is defined as, "Something established for the use as a rule or basis of comparison in measuring or judging capacity, quantity, content, extent, value, quality, etc."
- Standards can be considered mandatory. A mandatory standard is precise, clearly defined and suitable for adoption as part of a law or regulation.
- Codes are examples of mandatory standards because they have legal status.

An example of a non-mandatory standard would be a recommended practice that contains text such as "should" and "could" instead of "shall" and "will". The American Society for Nondestructive Testing (ASNT) Recommended Practice No. SNT-TC-1A was established to provide guidelines for the qualification and certification of NDT personnel. This non-mandatory standard provides the basis for mandatory document development.

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The members of the **PAN Advisory Group** who are involved in writing and researching each PAN topic include **Scott Kisting** (Vice President, MUTI-Sabre Industries Telecom Services), **John Erichsen** (Principal EET PE, Chairman TIA Committee TR 14), **Craig Snyder** (President, Sioux Falls Tower & Communications), **Stephanie Brewer** (Compliance Coordinator, MUTI-Sabre Industries Telecom Services), and **Richard Cullum** (Program Manager, Crown Castle).

Specifications Developed by AWS

- Specifications are defined as "a detailed description of the parts of a whole; statement or enumeration of particulars, as to actual or required size, quality, performance, terms, etc.".
- AWS has developed a number of specifications that describe requirements for welding filler metals and specialized types of fabrication. The A5.XX series of specifications, AWS A5.1 through A5.33, cover the requirements for various types of welding consumables and electrodes.
- For example, AWS Specification A5.01 Filler Metal Procurement Guidelines outlines procedures for ordering filler materials.

Welding Procedure Responsibilities and Codes

As with all work it is critical to understand who is involved in the process and what the areas of responsibility are. In this PAN, we will discuss some of the standards and common roles of the Contractors, Engineers and Certified Weld Inspectors (CWI's).

- Part of every major welding project, whether completed in the shop or in the field, is the qualification of welding procedures and welders, or welding operations.
- Most codes place the burden of responsibility on the fabricator or contractor. Therefore, welding qualifications are statements by the company verifying that the welding procedures and personnel have been tested in accordance with the proper codes and specifications and found to be acceptable.
- Codes are a "body of law" having legal status and therefore considered mandatory. Codes often contain text such as "shall" and "will".

Applicable AWS Codes

- AWS D1.1 – Structural Welding Code – Steel
- AWS D1.2 – Structural Welding Code – Aluminum
- AWS D1.3 – Structural Welding Code – Sheet Steel
- AWS D1.4 – Structural Welding Code – Reinforcing Steel
- AWS D1.5 – Bridge Welding Code
- AWS D9.1 – Sheet Metal Welding Code

Depending on the type of welding being performed, one or more of the above codes would be selected to detail the weld quality requirements.

Common Fabrication Requirements D14.1 – D14.6

- D14.1 – Specification for Welding Industrial and Mill Cranes
- D14.2 – Specification for Metal Cutting Machine Tool Weldments
- D14.3 – Specification for Welding Earthmoving and Construction Equipment
- D14.4 – Specification for Welded Joints in Machinery and Equipment
- D14.5 – Specification for Welding Presses and Press Components
- D14.6 – Specification for Rotating Elements of Equipment

Engineer Responsibilities per AWS D1.1

- Per AWS D1.1 – 1.4 Responsibilities – 1.4.1 Engineer's Responsibility. "The Engineer shall be responsible for the development of the contract documents that govern products or structural assemblies produced under this code. The Engineer may add to, delete from, or otherwise modify, the requirements of this code to meet the particular requirements of a specific structure. All requirements

that modify this code shall be incorporated into contract documents. The Engineer shall determine the suitability of all joint details to be used in a welded assembly. The Engineer shall specify in the contract documents, as necessary, and as applicable, the following:

1. Code requirements that are applicable only when specified by the Engineer
2. All additional NDT that is not specifically addressed in the code
3. Verification inspection, when required by the Engineer
4. Weld acceptance criteria other than that specified in Section 6
5. CVN toughness criteria for weld metal, base metal, and/or heat affected zone (HAZ) when required
6. For non-tubular applications, whether the structure is statically or cyclically loaded
7. All additional requirements that are not specifically addressed in the code
8. For OEM applications, the responsibilities of the parties involved

CWI (Certified Weld Inspector) Responsibilities per AWS – Knowledge, Attitude, Skills and Habits (KASH)

- Welding Inspection embodies activities taking place before, during and after welding. It is therefore essential that a CWI be both proactive and reactive!
- CWI's must be knowledgeable about:
  1. Contract drawing and specifications
  2. Welding terms
  3. Welding processes
  4. Testing methods
- CWI's must maintain a professional attitude.
- CWI skills should include:
  1. Training in engineering and metallurgy
  2. Inspection experience
  3. Welding experience

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- CWI habits should include:
  1. Safe practices
  2. Ability to maintain records. CWI's are required to maintain a log that cannot be erased!
  3. Good physical condition
  4. Good vision
  5. Common sense, integrity and honesty

Contractors/Fabricators have the Responsibility for the Qualification of Welders and Procedures

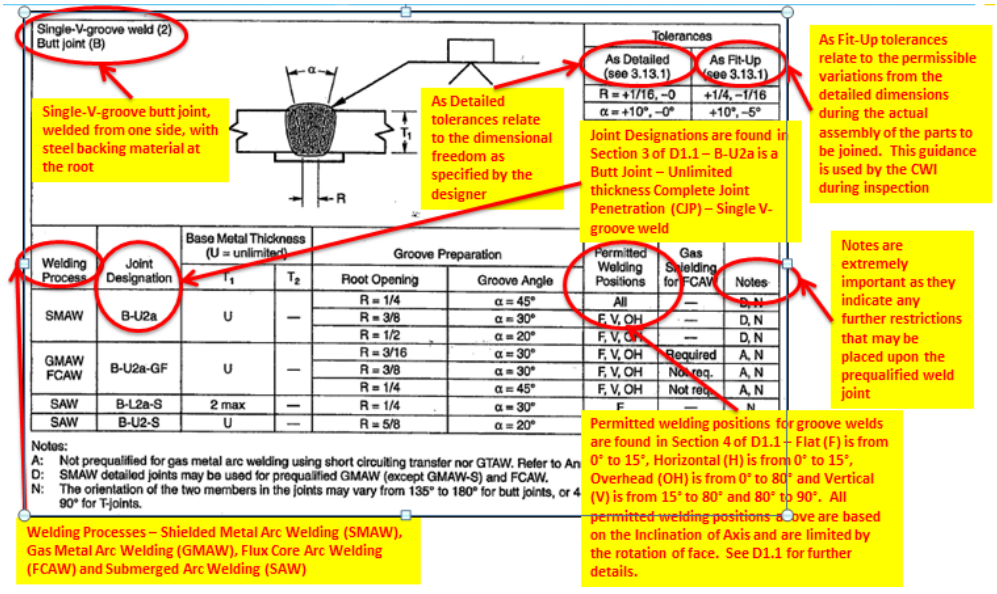
Some of the major considerations that apply are as follows:

- Procedure qualification (PQR)
  1. The very first step in the qualification process is the development of the welding procedure and its performance within the procedure qualification. This precedes both the welder qualification and the production welding because it determines if the actual technique and materials are compatible. Determines the compatibility of:
  2. Base metals
  3. Weld filler materials
  4. Process or processes
  5. Techniques
- There are three (3) general approaches to procedure qualification:
  1. Prequalified procedures
  2. Actual procedure qualification testing
  3. Mock up tests for special applications
- AWS D1.1 recognizes four welding processes as being prequalified:
  1. Shielded Metal Arc Welding (SMAW)
  2. Submerged Arc Welding (SAW)
  3. Flux Core Arc Welding (FCAW)
  4. Gas Metal Arc Welding (GMAW)
- AWS D1.1 is limited to the welding of steel 1/8 in. thick and greater.
- See the example of a single-v-groove butt joint prequalified weld joint below.

Welding Procedure Qualification Specification (WPS) Process

1. Select welding variables
2. Check equipment and materials for suitability
3. Monitor weld joint fit up as well as actual welding, recording all important variables and observations
4. Select, identify and remove required test specimens
5. Test and evaluate specimens
6. Review test results for compliance with applicable code requirements
7. Release approved procedure for production

Single-V-Groove Butt Joint Prequalified Weld Joint



8. Qualify individual welders in accordance with this specification
9. Monitor the use of that procedure during production to assure that it continues to produce satisfactory results

Control of Materials is also an Area of Responsibility for the Contractors/Fabricators – Typical Considerations:

- An important aspect of fabrication is the identification and traceability of materials.
- Material (Mill) Test Reports (MTR's) or Material Test Certificates (MTC's) are typically notarized statements from the manufacturer tabulating the chemical and physical properties for the material.
- Alloy identification through the use American Iron and Steel Institute (AISI) or the Unified Number System (UNS).
- Steel specification
- Typical filler metal specification

WPS (Welding Procedure Specification) and Welder Considerations

- Welding problems such as high levels of restraint and joint inaccessibility can only be addressed through actual trial welds on joint mockups.
- Special service conditions may require additional tests to evaluate weld properties. Some of these tests are impact, hardness, chemistry and special service conditions such as corrosion and abrasion resistance.
- Welding procedures are welding instructions and should be readily available to the welder during production.
- Once the WPS is qualified, it is of no use until welders have been qualified to perform welding in accordance with that procedure. Basically the welder qualification confirms that the welder has sufficient skill to perform the WPS.
- Welder Qualifications are similar to WPS's in that they share essential variables. These include welding position, joint configuration, electrode type and size, process, base metal type, base metal thickness and specific welding technique.
- AWS D1.1 gives specific guidance on the welding test positions, thicknesses the welder is qualified to weld, number of specimens required, NDT/destructive testing requirements, electrode classification (Group F1-F4), coupon labeling, etc.

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- Once a welder is "qualified", they have demonstrated sufficient skill to perform a certain weld. Certification, however, applies to the documents which support the qualification. Once qualified, the welder will be permitted to weld in production as long as that welding doesn't involve positions, thicknesses, electrodes, etc., which are outside the limits of the qualifications.

Summary and Conclusion

- In summary, most codes place the burden of responsibility on the fabricator or contractor to assure adherence with the engineer's plan and design. Therefore, welding qualifications are statements by the company verifying that the welding procedures and personnel have been tested in accordance with the proper codes and specifications and found to be acceptable.
- Successful projects consist of clearly defined plans and specifications, and clear lines of communications between the Engineer of Record, Certified Weld Inspector and the General Contractor or Fabricator.
- Almost all welding defects can be attributed to a welding process or welder that was out of control or not qualified. If the welding processes laid out in the codes, standards and specifications are adhered to, the chances of a quality weld and successful project are greatly increased. Companies that adhere to the strict set of welding guidelines typically finish jobs on time and within budget because the amount of rejected welds or welding defects is limited. Conversely, the opposite can be said of companies that routinely ignore the basic principles of welding fundamentals.

Good Welds

Bad Welds

In conclusion, there is no article that can substitute knowing the Engineers, CWI's and contractors responsibilities as detailed in AWS D1.1.

This base level overview is intended to set the stage for us to review in future PAN's some of the common problems observed in the industry and what can be done to resolve them. It is important to recognize that in order for any SOW to be completed properly, efficiently, and safely, it is critical that the proper standards are applied and the planning is communicated and executed. In closing, we would like to thank so many that make these PAN's worthwhile. ■