

DR. G L GOSWAMI MEMORIAL AWARD

# Role of Quality Assurance in Welding to Meet Consistency

**R. Srinivasan**AMIE, DMM, IWE, Fellow IIW-India  
Contech Services, Navi Mumbai  
Email: srini50@gmail.com

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## Abstract

The successful welding of a product or services not only depends on the manufacturing design or the fabrication technique. How the product is manufactured and how the quality control at each and every stage of operation will only enhance the standards of the Product. An attempt is made to inform the welding personal by adopting the systematic quality control system at every step of the manufacturing process consistently will increase product quality and reduce the cost of manufacturing. The controls to be adopted at various stages are being dealt in this Article.

**Keywords:** Welding; quality; quality assurance; WPQ; WPS; standards; ISO 3834.

## 1.0 Introduction

Welding is the heart of the fabrication process. Welding is a critical process which if not controlled can produce various defects which will hamper the job quality and performance and can invite big accidents.

In the ISO 9001 documents many aspects of the manufacturing aspects are detailed. But the absence of the welding control at the time of manufacturing has enabled to develop the total welding quality standards ISO 3834 to meet the requirements of the welded components.

The system of implementing the quality needs as per the needs of ISO 3834 at various stages irrespective of codes that are used to manufacture the welded components or Equipment has given a new direction in the process of manufacturing.

This Quality Management System enables the manufacturer to work in more systematic methods.

**Objective:** The term quality plays a vital role in establishing the Product or services credibility. In order to have uniform welding quality for various equipment or components manufactured anywhere in the world, it has become almost mandatory to have rules to be followed uniformly all over the

world. It also demands that certain audit and certification should be carried out to improve the quality standards that are to be implemented as per these rules and guidelines. All this necessitated formation of various Apex bodies that can thoroughly study and set the standard for good welding. The objective of the rules are to reasonably assure protection of life, safe working conditions and safety to the personal, property and to provide a margin for deterioration for the estimated life of the equipment. ASME, EN codes and various other standards has devised such certifications for various tasks including manufacturing the Pressure equipment, Equipment for Nuclear industries conforming to various codes.

## 2.0 Terminologies in use

Now let us understand the various terminologies that we often come across

- Quality- The totality of features and characteristics of a product or service that bear on its ability to satisfy stated and implied needs.
- Quality Management- That aspect of overall management functions that determines and implement Quality System & Policy.

- Quality System - The organizational structure, responsibilities, procedures, processes and resources for implementing Quality Management.
- Quality Assurance - All those systematic actions necessary to provide adequate confidence that a product or service will satisfy given requirement for quality.
- **Quality Control** - The operational techniques and activities that are used to fulfill requirements for quality.
- **Quality Document** - All necessary papers required to produce Quality Product/Service duly approved by respective authorities.
- **Quality Records** - All necessary papers to demonstrate the achievement of required quality and the effective operation of the quality system.
- **Quality Plan** - A document setting out specific quality practices, resources and sequence of activities relevant to a particular product, service contract or project.

### 3.0 The Plan and the Methods

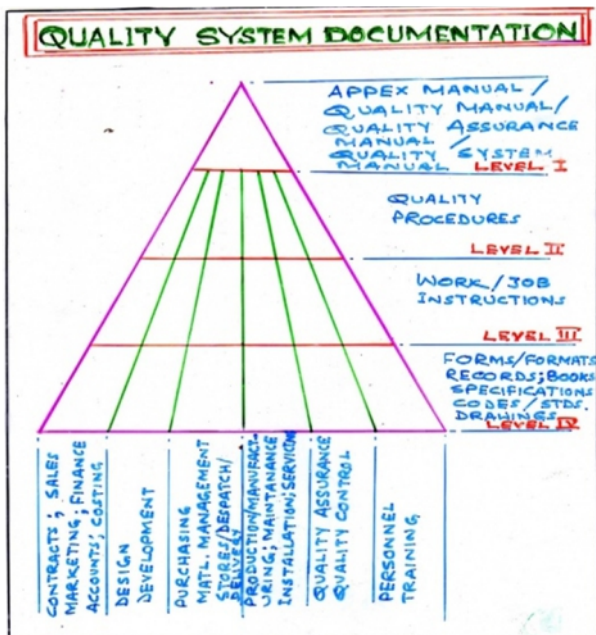
In this article we will understand the Role of the Quality Management System that is to be adopted by the manufacturers who are into the welding activities on step by step methods so that the continuous Improvement is achieved.

The ISO 3834 standards are exclusively developed by the ISO committee to implement uniform welding standards. This clearly guides the manufacturer step by step method to ensure implementation of the quality system. In the ISO system Welding is treated as a Special Process. Hence this needs to be addressed differently and separately.

A 'special process' is a process where the conformity to the requirement of the resulting product cannot be "verified by subsequent monitoring or measurements and as a consequence the deficiencies become apparent only after the product is in use". Welding has been identified as a Special Process by ISO 9001:2015.

The organization which follows the ISO guidelines and use ISO 3834 as a controlling system for their welding activities is the organization which generally meets the requirements of the codes and standards. This system if properly implemented will have an excellent Traceability record at each level of manufacturing or construction that enables to identify the imperfections if any noticed later. Various welding processes are the 'Key' feature of production In many organizations. It is essential, therefore, to ensure that these processes are carried out in the most effective, systematic way and appropriate control is exercised at every level. As All aspects of the operation and quality of welding cannot be readily verified, hence, it is mandatory to introduce the step by step process checks and record, since welding is considered to be a 'Special Process'.

Invariably over 75% of the fabricators do the quality checks when the activities are mostly completed or in the verge of competition. This makes the system very complicated and lot of discrepancies are being observed at this stage. Rectifying at this stage involves substantial cost, time, reworks and re inspection resulting in delay in completion. This is more so in the on site projects. Due to the pressure of completion some of the welded joints with discrepancies gets passed at this stage due to paucity of time and the welds which do not meet the required standards gets cleared.



### 4.0 Procedures and Methods to Follow

In order to have a total control of the welding activities it is always advisable to prepare an exclusive Welding Control document or a Manual for the welding activities and for the Inspection of the welds. This document will also deal on the various control documents that are needed to maintain and implement the quality standards that are needed. A Typical Quality System Documentation is provided in the Figure. This shows the total involvement of all the departments and the persons in preparing the Quality system document. This document should be the guideline for the organization and should be adhered totally at all times.

The control of quality is to be introduced first at the stage of Enquiry level. At this stage the feasibility study of the manufacturing techniques and the methods should be clearly identified with respect to the design criteria, The capability of the organization to meet the technical conditions, testing methods, manufacturing techniques and methods are to be predetermined. Marketing/ sales, Design team, the welding

Engineers and the Quality control persons should jointly study the Enquiry and understand and prepare the commercial offer. By doing this, the manufacturers will be able to foresee the difficulties which might arise during the fabrication and testing stages. Any difficulty may be discussed with the Customer to arrive at a mutually acceptable level.

The second stage is to totally review the design requirements with respect to the feasibility, code demands and the client requirements are to be understood. While doing the design various aspects such as the material selection, Pre heat, Post weld treatment, Mechanical properties are to be taken into the considerations. And on acceptance, the Bill of materials is to be properly prepared including the various sub-assembly's needs.

When once the design is frozen, the welding engineers has to prepare the welding process documents such as WPS, WPQR, WPQ, etc based on the code in which the fabrication is to be done.

Irrespective of any code of construction the system of quality control methods and the techniques should be same and is to be implemented at all levels during the work in progress.

Hence the personal involved in the various stages of manufacturing are very important. The welding engineers who control the welding activity, The welders, the operators, the welding inspectors etc are the core functional team. It is to be asserted that competence and knowledge level of these persons to deliver are vital for any organizations and is to be asserted. Hence, it is Mandatory to have the qualified and certified persons, like the welders, welding operators, The welding coordinating personnel and the welding inspection personnel should comply to the requirements of IS14731/14732.9712 standards or as per the applicable codes (be it ASME, EN, DIN, IS and other standards). These persons' capability to produce the required quality products consistently and continuously are to be regularly monitored so that in case any training needs are felt at various stages the same should be planned and imparted.

Weld quality is achieved by sound welding, not by inspection. Inspection only identifies defects deficiencies in the product, but cannot improve poor quality. Sound welding requires continuous control and following of the validated and documented procedures.

For achieving this, the total manufacturing process has to be supported by an effective Quality Management System such as:

- **ISO:3834 – Quality Requirements for Fusion Welding** : Further, an established manufacturing standard e.g. EN: 15085: Fabrication of Railway Vehicles and Components or EN 1090: Fabrication of Steel and Aluminium structures is to be followed for quality assurance of the product, which requires compliance to

ISO: 3834.

The ISO 3834 system requires the systematic approach toward the completion of the following aspects such as

- **Review of requirements & Technical review:** To understand parent material specification and welded joint properties, quality and acceptance requirements, reviewing the availability of the existing facilities and documents etc. from the initial Enquiry stage onwards till competition.&
- **Subcontracting:** Supplier to be treated as extension of manufacturers facility.
- **Welding personnel:** Welders and welding operators, Welding coordination personnel. (Qualification as per ISO 14731/14732)
- **Inspection & testing personnel:** Welding Inspection personnel; Non-destructive testing personnel (Qualification as per ISO 14731 & ISO 9712)
- **Equipment:** Production and testing equipment; Suitability of equipment; Equipment maintenance
- **Welding and related activities:** Production planning; Welding Procedure Specifications (WPS); Welding Process Qualification (WPQ); Work instructions;
- **Welding Consumables:** Batch testing; Storage and handling.
- **Storage of parent materials:** Avoidance of damage and mix up.
- **Inspection and testing:** Inspection & testing before, during & after welding; Inspection & test status
- **Post-weld heat treatment (As per ISO/TR 17663)**
- **Non-conformance and corrective actions:** Learning from experience
- Calibration of measuring, inspection and testing equipment
- For correct monitoring & measurement at all stages
- **Identification & traceability:** Enabling any failure to be traced back to process for learning
- Quality records Arising out of additional requirements as above.

It is better to have the total welding control in three stages of operation before the final inspection.

First stage should be done before the start of the welding activities, second during the welding and the third after the welding is completed. These stages of exercising the quality checks will ensure the proper fit ups, the necessary shrinkage allowance and the distortion control methods can be verified before the start of the weld. The Welding Engineers has to

ensure the approved and qualified welders as per the Weld map are deployed and all in process parameters are maintained as per the approved welding control documents.

Wherever Non-Destructive checks and the Production coupons requirements are to be included be clearly identified in the Weld Map/ Weld Plan.

All these points should be referred in the QAP/ Route card as hold points so that the welding activities are not started without the proper clearance by the concerned authorities.

We need to exercise the following controls for the welding activities.

### **The Inspection that needs to be carried out**

#### **Before Welding.**

- 1) Application Standard
- 2) WPS, PQR, WPQ
- 3) Drawings
- 4) Material Composition
- 5) Condition of Material
- 6) Type of edge preparation, method & finish
- 7) Consumables
- 8) Welding process
- 9) Clearance dimensions, Type of backing (if any)
- 10) Alignment, Tack welds, Presets etc.
- 11) Pre-heat (if any)
- 12) Distortion control methods.
- 13) Temporary fit-up.
- 14) Production Test coupons if any.

#### **During Welding**

- 1) Welding Process Parameter
- 2) Inter pass Temperature
- 3) Filler metal , Electrode condition
- 4) Inter pass cleaning
- 5) Distortion
- 6) Flux /Shielding gas flow
- 7) Verification of all essential variables

#### **After welding**

- Dimensional accuracy
- Appearance/ Profile of the weld
- Visual Inspection of the Weld
- Post Weld Heat Treatment (if any).
- Weld meeting the acceptance standards as per the code used.

### **Evaluation of internal and surface defects with or without the aid of Destructive/ Non-destructive testing**

A detailed Non Destructive Procedures should be developed by

the Approved personal and the same is to be established and to be used.

All weld visual Inspections should be inspected as per the recommendations mentioned in the ISO 5817 /10042 with the respective class of Quality as agreed between the manufacturer and the client.

The detailed Manufacturing and Inspection Plan are to be made as follows.

### **Validation of the Procedures**

The Inspection procedure and plans and the stages are to be identified and implemented and records to be maintained.

In the ISO 9001, section 7.5.2 (2008)/ 8.5.1 (2015), there is a requirement of "Process Validation" for such special processes.

Welding, being defined as a special process and must be validated as per ISO 9001. Some of the most important among are

- ✦ A proper welding control procedure (WPS, WPAR) are to be developed and validated before the implementation.
- ✦ A proper Tack welding Procedure is to be prepared and qualified.
- ✦ A detailed Repair welding Procedure is to be prepared and qualified.
- ✦ In case of any PWHT requirements a detailed procedure is to be established and to be validated
- ✦ The non destructive procedures like the Liquid Penetrant testing, Radiography, Ultrasonic testing, PMI, etc be prepared by the authorized persons and establish the same.
- ✦ A detailed periodical maintenance plan is to be in place for the welding Machines and the Tools and tackles.

### **Takeaways**

- ✦ Rework/rejection would be considerably less, as controls are exercised at the maximum stages.
- ✦ Cost due to rejection/ rework will go down.
- ✦ Use of certified personal will increase the quality of work.
- ✦ If welded joints are sound and controlled properly, overdesign if any has been included can be avoided.
- ✦ An opportunity to relook to design and if needed can reduce sections used, resulting in lower weight, savings of materials, savings on time leading to reduction in cost.
- ✦ Opportunity to reduce cost of manufacturing at every level.
- ✦ As the documentation system is maintained gives an opportunity for Traceability at all levels.

- ✦ Failures will be less and safety/reliability will go up.
- ✦ Will be able to meet the delivery commitments.

All the above ultimately ensure a Competitive edge in terms of highly satisfied quality product at a comfortable price and performance and total customer satisfaction.

## 5.0 Conclusion

A proper study and implementation of the aspects described above will help the organizations to produce products with the highest quality controls and standards which will meet the requirements of the product as per the Manufacturing Codes. Such products will enhance the reliability of the product and

also increase the customer confidence on the manufacturing capabilities of the organizations.

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