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Comparison of PQR and WPQ for Jacket Long Seam Joint of Pressure Vessel as per ASME Section IX

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Abstract

Small and medium size stocked components intended for boiler and pressure vessel are often manufactured and welded with reference to ASME section III and IX. This paper mainly focuses on rules for welding qualification, monitoring welding activities during manufacturing and the extent of supervision by independent inspection body required by the quality system. In this work comparison required for welder procedure qualification as well as welder qualification accordance with procedure qualification record is carried out. Finally, range of qualified will decide the welder qualification based on WPQ and PQR.

Keywords: *PQR, WPQ, long seam joint, ASME section IX and SA-516 M grade 380 (carbon steel)*

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INTRODUCTION

Welding process is now a special process because it is highly dependent on the control of the process or skill of operators, or both. Quality of the product or process confirmed with the standards or construction of the code cannot be verified after the welding is done. Nondestructive testing as well as destructive testing should be undertaken for quality of weld. An attempt is made to overcome this problem by first qualifying the process and also operator(s). All codes and standards are provided for a qualification of welding process and the operators. As per the requirement, take a test piece, then undergo for welding as well as nondestructive or destructive test examination; and examination is a part of qualification of the reliability and quality of process and/or the welder [1].

LITERATURE REVIEW

Basics of Welding Qualification Standards (ASME Section III and IX)

These qualification standards are for welding and brazing procedures, welders, brazers and welding, and welding and brazing operators [2].

NB/NC/ND 4311 of Section III and IX

According to NB/NC/ND 4311 of Section III and IX, only those welding processes, which are capable of producing welds in accordance with the welding procedure qualification requirements of section IX.

NB/NC/ND 4321

Each certificate holder is responsible for the welding done by his organization, and each certificate holder shall establish the procedure and conduct the test required by section IX for qualifying of both welding procedure and performance of welder and operators.

Observations under section IX of ASME B and PV code is governed by following:

QW-300.2: Contained QW-103 and QW-301.2. Each manufacturer shall be responsible for qualifying of welding procedure and performance of welder.

QW-301.2: Each manufacturer shall qualify each welder for each welding process.

QW-103.1: Each manufacturer is responsible for welding done by his organization and also qualify welding procedure and performance of welder.

QW-300.2 b: It is not permissible for manufacturer or organization to have welding performed by other organization.

QW-200.2 b: The PQR (Procedure Qualification Record) is certified and accurate by manufacturer.

Respective Scopes of ASME B and PV Code
ASME boiler and pressure vessel code, section VIII, division 1 is referred as rules for construction of pressure vessel, 2010 edition [3].

ASME boiler and pressure vessel code, section I, subsection NCA is referred as general requirements of division 1 and 2, 2010 edition [4].

Approach towards WPQ (Welding Procedure Qualification)
ASME section IX welding qualification standards share the objective of guaranteeing the quality of welded joints with purpose to fabricate a welded construction that will operate safely and reliably.

To achieve that objective a welding procedure qualification shall demonstrate that the welded permanent joints have properties same or better than the joined materials. The welder also proves that he has ability to perform welding procedure with the desired quality.

To achieve these objectives, welding qualification standards have summarized following four points:

- Write how you want to weld.
- Weld test piece.
- Execute examination and testing as per WPQ.
- Reporting with determination of the range of approval based on PQR.

As described to above points, the ASME section IX [2], SS-EN 287-1 [5] and SS-EN ISO 15614-1 [6] are almost similar, but application is different.

Forms and Structure
Section IX of the ASME B and PV code [2] is operating since 1940 addenda to the 1937 edition of the ASME B and PV. The structure part QW divided into welding compilation of sub-article.

Article 1: Welding general requirement.
Article 2: Concerning welding procedure qualification.
Article 3: Concerning welding performance qualification.
Article 4: Providing welding data including Tables and Figures.

Application of ASME IX
ASME section IX is a boiler and pressure vessel code, so it is specifically applicable to pressure components.

Responsibilities of Manufacturer (ASME IX)
Following are the responsibilities of manufacturer:

- Welding is done by his own organization.
- Welding supervision of other organization and welding in another organization is not permissible.
- WPS and PQR documents only valid in own organization under full supervision.
- Effective operational control of welder procedure qualification.
- If new owner wants to use WPS and PQR of one of the acquired manufacturer, then new owner has to take permission from acquired manufacturer.

Terms and Definitions
WPS: (Welding Procedure Specification)
WPS is written qualified welding procedure prepared to provide direction for making production welds to meet code requirements.
The WPS shall be used to provide direction to the welder or welding operator to assure compliance with the code requirements.

PQR: (Procedure Qualification Record)
PQR is a record of the welding data used to welded test coupon. The PQR is a record of variables recording during the welding of test coupon.

Recorded variables normally fall with a small range of the actual variables that will be used in production welding.

WPQ: (Welder Procedure Qualification)
The purpose of this document is to ensure that manufacturer or contractor has determined that his welder or welding operators are using his procedures.

These procedures are capable of developing the minimum requirements specified for an acceptable weldment.

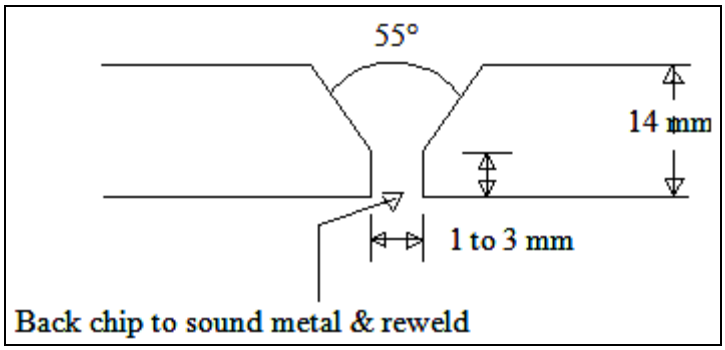

Fig. 1: *Groove Design of Joint.*

PROCEDURE QUALIFICATION RECORD (PQR) ASME, SECTION IX

Here PQR is prepared for a joint of pressure vessel [2]:

JOINT: Jacket Long Seam

Welding Process (QW-401)

Welding Processes: SMAW + SAW
Types: Manual + Semiautomatic

Joints (QW-402)

Figure 1 shows specimen joint details of groove design which is as under:

- Single V groove joint,
- Plate Thickness: 14 mm,
- Root Gap for back chip: 1 to 3 mm,
- Root face: 1 to 3 mm,
- Groove angle: 55°.

Base Metal (QW-403) [7]

- Material specifications: SA 516 M (C.S.)
- Type of grade : GR 380
- P no. : 1 to 1
- Thickness of joint : 14 mm
- Length of Joint : 2500 mm
- Diameter of Joint : ø 7860 mm

Filler Metal (QW-404)

Table 1 shows the filler metal details for SMAW and SAW.

Table 1: *Filler Metal Detail.*

Description	SMAW	SAW
SFA specification	5.1	5.17
AWS classification	E 7018	EL 8
Filler metal F no.	4	6
Weld metal analysis A no	1	1
Size of filler metal	ø3.15 mm	ø3.20 mm

Position (QW-405)

- Position of groove: 1G (Flat)
- Weld progression: Down Hill

Pre-Heat (QW-406)

- Pre-heat Temp.: 16°C (min)
- Inter Pass Temp.: -----.

Gas (QW-408)

Table 2 shows percent compositions of gas which gives details of shielding gas type, gas mixture and flow rate of gas.

Table 2: *Gas Compositions.*

Percent Compositions			
	Gas	**Mixture**	**Flow Rate**
Shielding	N.A.	N.A.	N.A.

Electrical Characteristics (QW-409)

Current: DC and Polarity: DCEP

	Amperes	***Volts***
For SMAW	: 110–125 A	20–30 V
For SAW	: 350–475 A	28–36 V

Tungsten Electrode Size: N.A.

Technique (QW-410)

- Bead Type: String and Weave.
- Passes: Multipass.
- Other: Individual Pass <13 mm.

Operation Sequences

1. Set-up (Checking the Length and Diameter of the joint, Angle of the Joint and root gap).
2. Tack weld.
3. Grinding (To remove contaminations).
4. NDT (PT after grinding to check surface defects).
5. SMAW (Root pass on 1st side).

6. Grinding (to remove contaminations).
7. SAW (on 1st side three pass of SAW).
8. Back Chip (on 2nd side).
9. NDT (PT on joint to check surface defects).
10. SAW (Two passes on 2nd side).

Table 3: *Process Equipment Detail.*

Equipment	SMAW	SAW
Current Range	0–400 A	0–1200 A
Machine No.	WL-4	SAW-1
Company Name	Advani Ocrlikon	Mogora Cosmic

Process Equipment Details

Table 3 shows the detail of process equipment used in this welding process.

Nondestructive Test

Liquid penetrant test (LPT) is carried out on tack weld of joint set-up and back chip of sound metal from first side weld [8].

Defects

No defects found

COMPARISON OF PQR AND WPQ

Table 4 shows comparison of PQR and WPQ as per ASME section IX with respect to range of qualified on the basis of PQR [2]:

Table 4: *Comparison of PQR and WPQ for a Joint.*

Welder Performance Qualifications (WPQ) (Section IX, ASME Boiler and Pressure Vessel Code)		
Base metal Specification: SA-516 M GR380 Thickness: 14, 18, 22 mm		
Testing Condition and Qualification Limits		
Welding Variable	**Range Qualified**	**Actual Values of Joint**
Welding Processes	SAW	SAW
Type	Semiautomatic	Semiautomatic
Backing	With Backing (weld metal)	With Backing (weld metal)
Base Metal P No.	P-1 to P-11	P-1
Filler metal or electrode specification(s)	SAW (5.17)	SAW (5.17)
Filler metal or electrode classification(s)	F7A0-EL 8	F7A0-EL 8
Filler metal F-number	6	6
Process: SAW 3 layers minimum	Unlimited	10, 14, 18 mm
Position qualified	Groove-F, V, Plate and Pipe Over 610 mm OD, F	Flat
Weld progression	Uphill-Flat	Flat
Inert gas backing	With and Without Backing	Without Backing
Current type/polarity	SAW (DCEP)	SAW (DCEP)
Visual examination result	Acceptable	Acceptable
Radiographic testing result	Acceptable	Acceptable

CONCLUSION

By verifying and comparing PQR with WPQ, the welder must have to prove that, by his former training and experience, has a sufficient welding knowledge and can ensure that procedures are followed and common practice are compiled with. After comparison, it has been proved that values of welding variables of actual joints are acceptable with range qualified with no defect.

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