



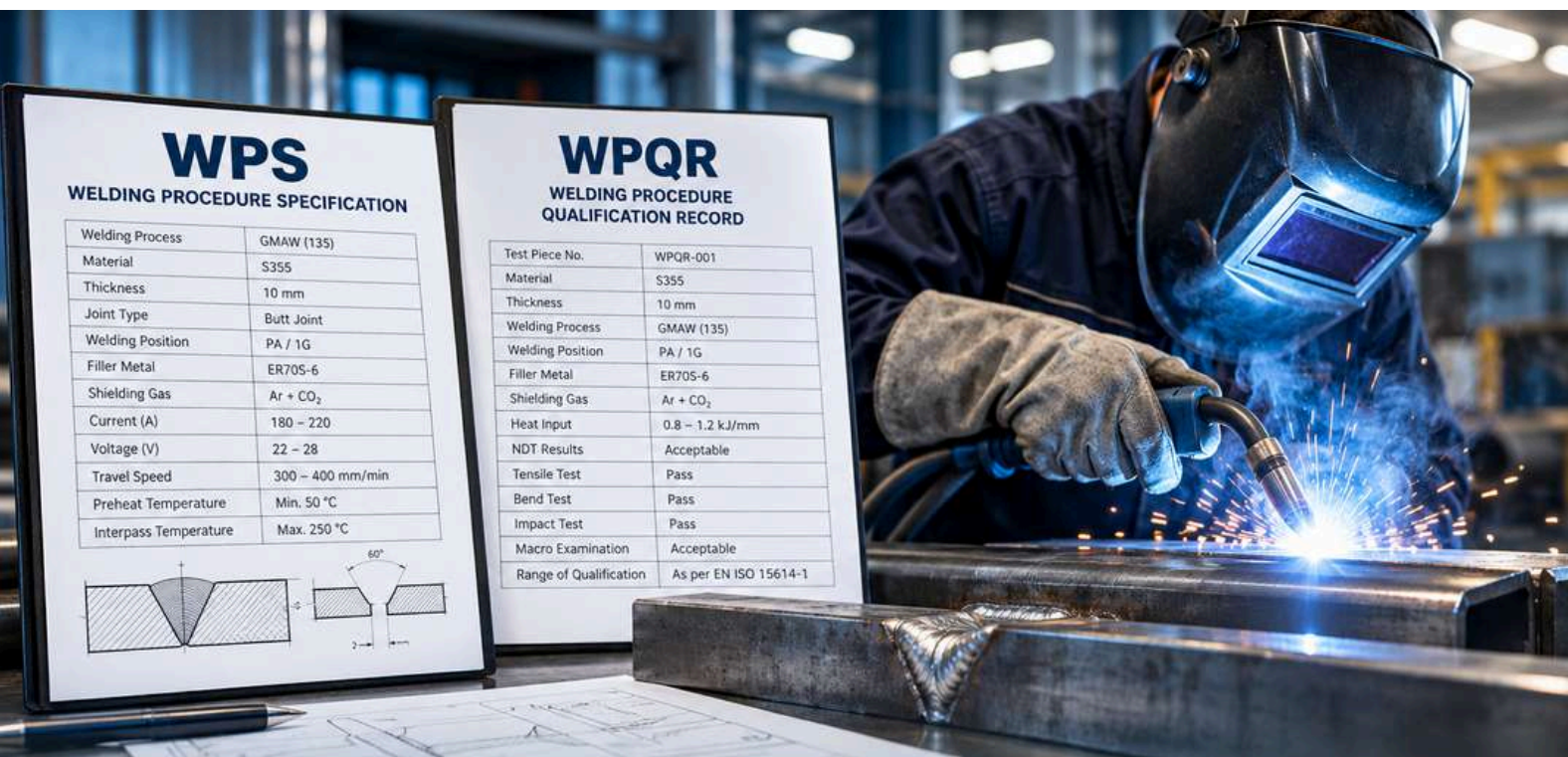
PRVÁ ZVÁRAČSKÁ, a. s.
FIRST WELDING Inc.

WPS & WPQR

Welding Procedure Specification & Welding Procedure Qualification Record

Technical Handbook for Welding Procedure Qualification

EN ISO 15609-1 • EN ISO 15614-1 • WPS Preparation • WPQR Qualification • Welding Variables • Essential Variables • Test Assemblies • Testing & Examination • Acceptance Criteria • Qualification Range • Welding Procedure Control



For Welding Engineers, Manufacturers, Fabricators, Welding Supervisors & Quality Professionals
First Welding Certification Pvt Ltd (PRVÁ ZVÁRAČSKÁ, a. s.)

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INTRODUCTION TO WELDING PROCEDURE QUALIFICATION

1. Introduction

Welding procedure qualification is a controlled technical process used to demonstrate that a proposed welding procedure is capable of producing a welded joint that meets specified mechanical, metallurgical and quality requirements.

A [Welding Procedure Qualification Record \(WPQR\)](#) is the documented record of the actual welding conditions used to produce and test a qualification test piece. The WPQR records the essential welding variables, examination and test results, and the resulting range of qualification.

The qualification process normally follows the sequence:

pWPS → Test Coupon → Welding → Examination & Testing → WPQR → Qualified WPS → Production Welding

For a detailed explanation of the WPQR qualification sequence, test coupon selection, welding parameters, testing and qualification range, see our [WPQR preparation guide](#).

The qualification test is performed under controlled conditions using specified materials, joint preparation, welding process, consumables, welding parameters, positions and other relevant variables.

2. Objectives of WPQR

The principal objectives are to:

- Demonstrate the capability of a proposed welding procedure.
- Establish acceptable welding variables for production.
- Verify required mechanical and metallurgical properties.
- Establish the applicable range of qualification.
- Provide objective evidence for preparation of a qualified WPS.
- Maintain traceability of materials, consumables, welding parameters and test results. Establish a controlled basis for production welding.

3. Fundamental Principle

A WPQR is based on actual welding conditions used during the qualification test.

The values recorded in the WPQR shall correspond to the actual conditions used for the test coupon. Welding variables shall not be entered based only on intended or theoretical values.

The qualification of a welding procedure is not, by itself, a general approval of every welding application. The qualified range and applicable requirements shall be considered for each production application.

Product standards, contractual requirements, regulatory requirements and project specifications may impose additional requirements.

4. Preliminary Welding Procedure Specification – pWPS

A pWPS is the preliminary welding procedure specification prepared before performing the qualification test.

It defines the proposed welding conditions to be used for producing the test coupon.

Typical information includes:

- Parent material and material group
- Material thickness
- Joint type and preparation
- Welding process
- Welding position
- Welding consumable
- Consumable diameter
- Current and voltage
- Travel speed
- Heat input or arc energy, where applicable
- Preheat temperature
- Interpass temperature
- Shielding gas
- Welding technique

- Number and sequence of runs
- Backing or back gouging
- PWHT, where applicable

The pWPS shall be sufficiently detailed to allow the test coupon to be welded under controlled conditions.

5. Welding Procedure Specification – WPS

A WPS is the controlled welding instruction used for production welding within the applicable qualification range.

The WPS is normally prepared using the qualified information established by the WPQR.

A WPS defines the welding variables and instructions necessary to produce the required weld consistently. Check the [WPR & WPQR](#)

[Requirements](#)

6. Welding Procedure Qualification Record – WPQR

The WPQR records the actual variables used during the welding of the qualification test piece and the results of the examinations and tests.

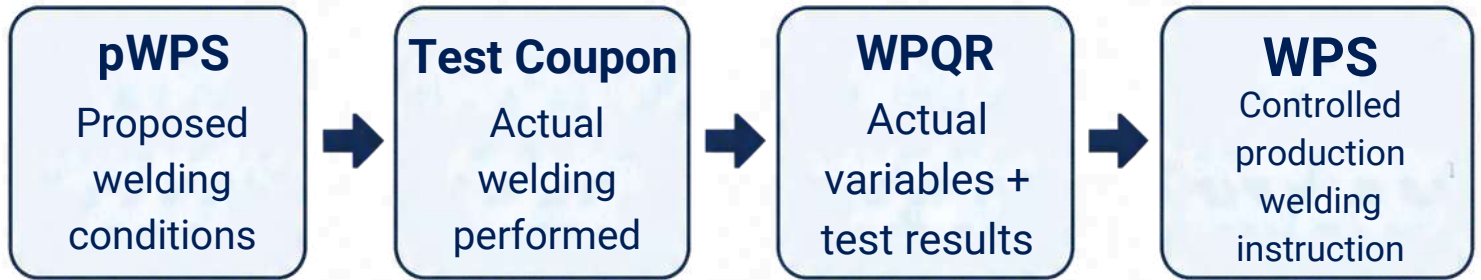
A typical WPQR contains:

- Test piece identification
- Parent material identification
- Material group
- Thickness
- Joint configuration
- Welding process
- Welding position
- Consumable details
- Welding parameters
- Preheat and interpass temperature
- Heat input or arc energy
- PWHT, if applicable
- NDT results
- Mechanical test results
- Acceptance results & Range of Qualification

7. Relationship

The relationship can be summarized as:

The WPQR provides technical evidence for the qualification of the welding procedure; it is not itself a production welding instruction



APPLICABLE STANDARDS AND QUALIFICATION PROCESS

8. Applicable Standards

EN ISO 15614-1

EN ISO 15614-1 specifies requirements for the qualification of welding procedures by welding procedure tests for arc and gas welding of steels and arc welding of nickel and nickel alloys within its scope.

The applicable edition and any amendments shall be confirmed for the specific project.

EN ISO 15609-1

EN ISO 15609-1 specifies requirements for the content of welding procedure specifications for arc welding.

It provides the framework for identifying and controlling the welding variables required in a WPS.

EN ISO 4063

EN ISO 4063 provides the identification system for welding and allied processes.

Examples include:

- 111 – Manual metal arc welding
- 121 – Submerged arc welding with solid wire electrode
- 131 – MIG welding
- 135 – MAG welding
- 136 – MAG welding with flux-cored wire
- 141 – TIG welding

The exact process designation shall be confirmed against the applicable standard and welding process used.

ISO/TR 15608

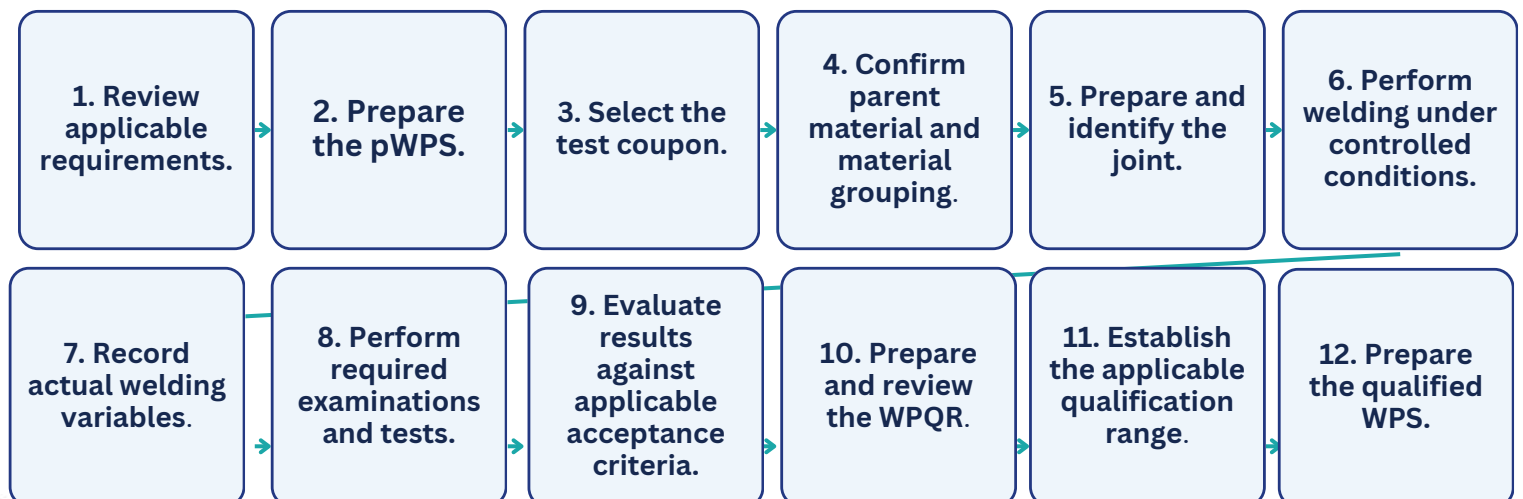
ISO/TR 15608 provides a system for grouping metallic materials for welding purposes.

Material grouping is important when establishing the applicable qualification range.

EN ISO 6947

EN ISO 6947 provides welding position designations such as PA, PB, PC, PD, PE and PF.

9. Qualification Process



TEST COUPON, PARENT MATERIAL AND MATERIAL GROUPING

10. Test Coupon Selection

The test coupon shall be representative of the intended production application.

Selection shall consider:

- Material type
- Material group
- Thickness
- Diameter, where applicable
- Joint type
- Welding process
- Welding position
- Single or multiple process
- Production application

The test piece dimensions and configuration shall comply with the applicable qualification standard.

11. Test Coupon Preparation

Before welding, the test coupon shall be identified and inspected.

Important controls include:

- Correct material identification
- Material certificate verification
- Thickness verification
- Joint preparation
- Dimensions
- Root gap
- Root face
- Groove angle
- Surface condition
- Alignment
- Tack welding
- Traceability identification

12. Parent Material

The parent material shall be positively identified.

Relevant information may include:

- Manufacturer
- Material designation
- Material grade
- Heat or cast number
- Material group
- Thickness
- Material certificate reference

Material certificates shall be retained as part of the qualification documentation where required.

13. Material Grouping

Materials are grouped for welding qualification purposes according to the applicable material grouping system.

Where dissimilar materials are welded, both materials shall be identified and the applicable qualification requirements shall be evaluated.

Material substitution shall not be assumed to be acceptable solely because the materials appear similar.

The qualification range shall be determined according to the applicable standard.

14. Traceability

Traceability shall be maintained between:

Material Certificate → Test Coupon → Welding Record → WPQR → WPS

The identification marking on the test coupon should remain traceable throughout welding, testing and documentation.

15. Joint Design

The joint configuration shall be clearly defined.

Important parameters include:

- Joint type
- Groove type
- Groove angle
- Root gap
- Root face
- Root radius, where applicable
- Backing
- Back gouging
- Weld type
- Weld size
- Fillet weld throat dimension
- Joint accessibility

The test joint should represent the intended production joint within the qualification range.

16. Backing and Back Gouging

The use of permanent or temporary backing shall be recorded where applicable.

The following may require control:

- Backing material
- Backing thickness
- Backing removal
- Back gouging
- Grinding
- Cleaning before subsequent welding

Changes to the joint configuration may affect the qualification range.

17. Welding Process

The welding process shall be clearly identified using the applicable ISO 4063 designation.

Example:

Root: GTAW – 141

Fill/Cap: GMAW – 135

The process sequence shall be recorded.

Where multiple processes are used, the deposited thickness associated with each process may be relevant to the applicable qualification range.

18. Welding Consumables

Consumables shall be controlled and traceable.

Relevant information includes:

- Consumable classification
- Manufacturer
- Product designation
- Diameter
- Batch or lot number
- Applicable standard
- Storage condition
- Drying or baking requirements
- Reconditioning requirements

Consumables shall be suitable for the parent material, welding process and application.

Electrodes and fluxes requiring controlled storage shall be maintained according to the applicable manufacturer's and standard requirements.

19. Consumable Traceability

The consumable used for the test coupon shall be traceable through the qualification documentation.

A typical traceability chain is:

Consumable Batch → Welding Record → Test Coupon → WPQR

Substitution of consumables shall only be accepted where permitted by the applicable qualification requirements.

20. Welding Parameters

The actual welding parameters shall be recorded during qualification.

Typical variables include:

- Welding current
- Voltage
- Travel speed
- Wire feed speed
- Polarity
- Welding process
- Electrode or wire diameter
- Shielding gas
- Gas flow rate
- Welding position
- Number of runs
- Deposited thickness

The recorded values shall represent the actual welding conditions.

21. Heat Input

Heat input or arc energy is an important welding variable because it can influence:

- Cooling rate
- Microstructure
- Mechanical properties
- Hardness
- Toughness
- Distortion
- Heat-affected zone characteristics

A commonly used calculation format is:

$\text{Heat Input} = (\text{Voltage} \times \text{Current} \times 60 \times \text{Efficiency}) / (\text{Travel Speed} \times 1000)$

where the applicable units and efficiency factor shall be consistent with the governing standard or procedure.

Example

For:

- Current = 180 A
- Voltage = 24 V
- Travel speed = 150 mm/min
- Efficiency = 0.8

Heat input:

$$(24 \times 180 \times 60 \times 0.8) / (150 \times 1000) \\ = 1.382 \text{ kJ/mm}$$

The applicable calculation method shall always be confirmed against the governing standard.

22. Preheating

Preheating may be required to control cooling rate and reduce the risk of hydrogen-assisted cracking.

The pWPS/WPS may specify:

- Minimum preheat temperature
- Preheat measurement location
- Heating method
- Minimum temperature before welding
- Temperature maintenance requirements

Preheat shall be verified before welding begins.

23. Interpass Temperature

The maximum interpass temperature shall be controlled where specified. The temperature should be measured at the appropriate location and recorded during welding.

Excessive interpass temperature can affect metallurgical properties and mechanical performance.

24. Post-Weld Heat Treatment – PWHT

Where applicable, PWHT shall be controlled and documented.

Relevant parameters include:

- Heating rate & Soaking temperature
- Holding time & Cooling rate

- Furnace or local heating arrangement
- Temperature recording

PWHT requirements may arise from the material, thickness, product standard, design requirements or applicable regulation.

WELDING TECHNIQUE AND NON-DESTRUCTIVE TESTING

25. Welding Technique

The welding technique shall be recorded sufficiently to reproduce the qualified procedure.

Important factors include:

- Manual, mechanized or automatic welding
- Stringer or weaving technique
- Electrode manipulation
- Single-run or multi-run welding
- Run sequence
- Cleaning between runs
- Inter-run inspection
- Tack welding
- Welding direction
- Start and stop locations
- Back gouging
- Grinding between runs

26. Tack Welding

Tack welds shall be made using suitable materials and controlled welding conditions.

Important considerations include:

- Tack weld size
- Tack weld location
- Welding process
- Consumable
- Preheat
- Removal or incorporation of tack welds
- Quality of tack welds

27. Welding Sequence

The welding sequence should be controlled to minimize:

- Distortion
- Residual stress
- Excessive heat accumulation
- Lack of fusion
- Unacceptable weld geometry

Where sequence is significant to the procedure, it shall be documented.

28. Non-Destructive Testing – NDT

The qualification test piece shall undergo the examinations specified by the applicable qualification standard.

Common NDT methods include:

Visual Testing – VT

VT is used to examine:

- Weld profile
- Surface defects
- Cracks
- Undercut
- Overlap
- Surface porosity
- Weld dimensions
- General workmanship

Radiographic Testing – RT

RT may be used to detect internal discontinuities such as:

- Porosity
- Slag inclusions
- Lack of fusion
- Other volumetric imperfections

Ultrasonic Testing – UT

UT is used for the detection and evaluation of internal discontinuities using ultrasonic techniques.

Magnetic Particle Testing – MT

MT is applicable to suitable ferromagnetic materials and can detect surface and near-surface discontinuities.

Penetrant Testing – PT

PT is used to detect surface-breaking discontinuities on suitable non-porous materials.

NDT results shall be documented in controlled reports and evaluated against the applicable acceptance criteria.

MECHANICAL TESTING, ACCEPTANCE AND RETESTING

29. Mechanical Testing

The qualification test may require mechanical testing depending on the applicable standard and application.

Common tests include:

Tensile Test

Used to determine:

- Tensile strength
- Failure location
- General strength performance

Bend Test

Bend testing evaluates the ductility and soundness of the welded joint.

Depending on the applicable requirements, face, root or side bends may be performed.

Impact Test

Impact testing evaluates toughness at a specified test temperature where required.

Relevant information includes:

- Test temperature
- Specimen dimensions
- Notch location
- Absorbed energy
- Individual and average results

Hardness Test

Hardness testing may be required to assess hardness distribution across:

- Weld metal
- Heat-affected zone & Parent Material

Macro Examination

Macro examination can provide information on:

- Weld penetration
- Fusion
- Weld profile
- Layer arrangement
- Defects
- Heat-affected zone

30. Acceptance Criteria

The test results shall be evaluated against the acceptance criteria specified by the applicable qualification standard and any applicable product or contractual requirements.

Acceptance shall consider all required examinations and tests.

A qualification should not be declared acceptable based only on selected satisfactory results if another mandatory test has failed.

31. Failed Tests and Retesting

Where a required test does not meet the applicable acceptance criteria, the reason for failure shall be reviewed.

Retesting shall only be performed where permitted by the applicable standard.

The retest requirements, number of specimens and conditions shall follow the governing qualification standard.

The original test results shall remain traceable and shall not be removed merely because additional tests are performed.

32. Controlled Modification

Changes to essential welding variables shall not be made uncontrolled after qualification.

If a proposed production condition falls outside the qualified range, a technical evaluation shall determine whether:

- The existing qualification remains applicable,
- A new qualification is required, or
- Another permitted qualification route applies.

33. Range of Qualification

The WPQR establishes a defined range within which the welding procedure is qualified.

The applicable range may depend on variables including:

- Welding process
- Parent material
- Material group
- Material thickness
- Pipe diameter
- Joint type
- Welding position
- Consumable
- Deposited thickness
- Heat input or arc energy
- Preheat
- Interpass temperature
- PWHT
- Shielding gas
- Backing
- Welding technique

The exact qualification range shall be determined from the applicable edition of the governing qualification standard.

34. Thickness Qualification

Thickness is an important qualification variable.

The qualified thickness range is determined according to the applicable requirements and depends on factors such as:

- Test coupon thickness
- Weld type
- Welding process
- Material
- Qualification level

- Applicable standard

A general thickness formula should not be applied without checking the relevant qualification clause.

35. Pipe Diameter

For pipe welding, outside diameter may influence the qualification range.

The applicable diameter range shall be established according to the governing standard.

36. Welding Position

Welding position is an important qualification variable.

Common designations include:

- PA – Flat
- PB – Horizontal fillet
- PC – Horizontal
- PD – Horizontal overhead fillet
- PE – Overhead
- PF – Vertical upwards
- PG – Vertical downwards

The qualified positions shall be determined according to the test position and applicable standard.

37. WPQR and Welder Qualification

A WPQR is not the same as a welder qualification certificate.

A WPQR demonstrates that a welding procedure can produce an acceptable welded joint under specified conditions.

A welder qualification demonstrates the ability of an individual welder to produce an acceptable weld using a specified welding process and applicable conditions.

Therefore:

WPQR → Qualification of Welding Procedure

Welder Qualification → Qualification of Individual Welder

A WPQR shall not automatically be treated as a substitute for a welder qualification

38. WPQR Documentation

A complete WPQR file should contain the applicable technical evidence, such as:

- Approved or reviewed pWPS
- Test coupon identification
- Material certificates
- Consumable certificates or identification
- Welding parameters
- Welding record
- Preheat and interpass records
- PWHT records, where applicable
- NDT reports
- Mechanical test reports
- Test laboratory information, where applicable
- Acceptance evaluation
- Qualification range
- WPQR document
- Applicable approvals or witnessing records

39. Document Control

The WPQR shall have controlled identification.

Typical information includes:

- WPQR number
- Revision
- Date
- Company identification
- Applicable standard
- Test piece identification
- Prepared by, Reviewed by, Approved by

Certification or witnessing information, where applicable

Corrections shall be controlled so that the original information remains traceable.

Uncontrolled alteration of qualification records shall not be permitted. Refer [WPS qualification range and key variables](#)

40. Traceability

Complete traceability should be maintained between:

Parent Material → Test Coupon → Welding Consumable → Welding Parameters → Examination → Testing → WPQR → WPS

Traceability provides confidence that the reported test results correspond to the actual qualification test.

41. Preparation of WPS

Once the WPQR has been reviewed and accepted, a WPS may be prepared based on the qualified variables and applicable qualification range.

The WPS shall:

- Reflect the qualified welding process
- Identify applicable materials
- Specify joint preparation
- Identify consumables
- Define welding parameters
- Specify preheat/interpass requirements
- Define applicable welding technique
- Include PWHT requirements where applicable
- Remain within the qualification range

42. Production Welding Control

During production, welding shall be performed in accordance with the applicable qualified WPS.

Production controls may include:

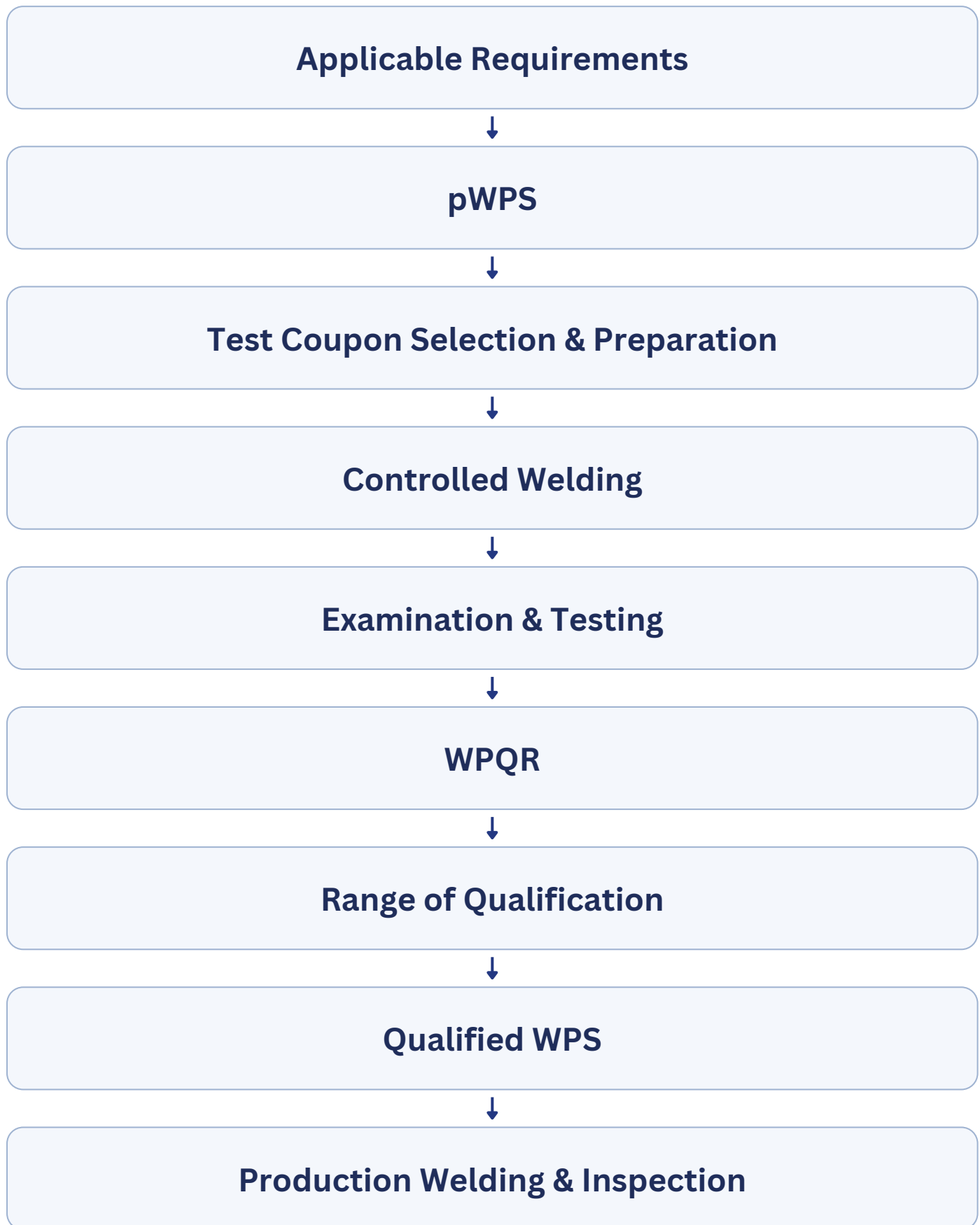
- Material identification
- Consumable control
- Joint preparation
- Preheat verification
- Welding parameter monitoring

43. Final WPQR Review Checklist

Before finalizing a WPQR, verify:

- ☐ Applicable qualification standard identified
- ☐ Correct pWPS available
- ☐ Test coupon correctly identified
- ☐ Parent material verified
- ☐ Material group confirmed
- ☐ Material certificate available
- ☐ Thickness verified
- ☐ Joint preparation recorded
- ☐ Root gap and groove details recorded
- ☐ Backing/back gouging recorded
- ☐ Welding process identified
- ☐ Process sequence recorded
- ☐ Welding position recorded
- ☐ Consumable classification recorded
- ☐ Consumable diameter recorded
- ☐ Consumable traceability established
- ☐ Current, Voltage & Travel speed recorded
- ☐ Wire feed speed recorded & Polarity recorded where applicable
- ☐ Heat input/arc energy evaluated where applicable
- ☐ Preheat recorded & Interpass temperature recorded
- ☐ PWHT recorded & Welding technique recorded
- ☐ Tack welding controlled
- ☐ Welding sequence recorded where relevant
- ☐ Required NDT completed
- ☐ NDT results accepted
- ☐ Required mechanical tests completed
- ☐ Mechanical test results accepted
- ☐ Acceptance criteria confirmed
- ☐ Retesting addressed where applicable
- ☐ Range of qualification established
- ☐ WPQR technically reviewed & WPS prepared within range
- ☐ Documentation and traceability complete

44. Final Technical Principle



A properly qualified welding procedure is based on controlled actual welding conditions, objective examination and testing, documented results, and a clearly established range of qualification.

The WPQR provides the technical evidence from which a qualified WPS can be established. Production welding shall remain within the applicable qualified range and shall be controlled according to the approved WPS and applicable requirements.

Technical References

EN ISO 15614-1:2017 + A1:2019 – Specification and qualification of welding procedures for metallic materials – Welding procedure test – Part 1.

EN ISO 15609-1:2019 – Specification and qualification of welding procedures for metallic materials – Welding procedure specification – Part 1: Arc welding.

EN ISO 4063 – Welding and allied processes – Nomenclature of processes and reference numbers.

ISO/TR 15608 – Welding – Guidelines for a metallic materials grouping system.

EN ISO 6947 – Welding – Working positions.

Applicable material, product, execution, inspection and regulatory requirements.

Disclaimer: This technical guide is intended as a general technical reference. The applicable edition of the relevant standard, product standard, regulatory requirement, project specification and contractual requirement shall be confirmed before qualification or production welding. Qualification ranges and acceptance requirements shall be determined from the applicable governing documents and shall not be assumed from general examples alone.