VOLUME 4 — WELDING

(Expanded – BS EN 1090-2:2018 + BS EN ISO 3834 + Eurocode 3)

(All organization names replaced with XXXXXX)

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1. GENERAL WELDING REQUIREMENTS

1.1 Compliance with Standards

All welding activities shall comply with the latest editions of:

- **BS EN 1090-2:2018** – Execution of steel structures
- **BS EN ISO 3834 (Parts 2, 3, 4)** – Welding quality requirements
- **BS EN ISO 14731** – Welding coordination
- **BS EN ISO 15614** – Welding procedure qualification
- **BS EN ISO 9606-1** – Welder qualification
- **BS EN ISO 9692-1** – Joint preparation
- **BS EN 1011-2** – Welding of steel
- **BS EN ISO 17637** – Visual inspection of welds
- **BS EN ISO 17640** – Ultrasonic testing
- **BS EN ISO 23278** – Magnetic particle testing
- **BS EN ISO 3452** – Penetrant testing
- **BS EN ISO 5817** – Weld quality levels

1.2 Execution Classes and Welding Requirements

Execution Class	Welding Quality System	Weld Quality Level (ISO 5817)
EXC1	ISO 3834-4	Level D
EXC2	ISO 3834-3	Level C
EXC3	ISO 3834-2	Level B
EXC4	ISO 3834-2	Level B+ (project-specific)

1.3 Welding Coordination

The Contractor shall appoint a **Responsible Welding Coordinator (RWC)** in accordance with **BS EN ISO 14731**.

The RWC shall:

- Approve WPS and WPQR
- Supervise welding activities
- Verify welder qualifications
- Approve consumable storage procedures
- Review NDT results
- Approve repair procedures

The RWC must have:

- Documented competence
- Relevant experience
- Authority to stop welding operations

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2. WELDING DOCUMENTATION

2.1 Welding Procedure Specifications (WPS)

A WPS shall be prepared for each weld type, including:

- Joint type and preparation
- Welding process
- Welding position
- Preheat and interpass temperature
- Filler material
- Heat input
- Travel speed
- Shielding gas
- Backing materials
- Post-weld heat treatment

No welding shall begin without an approved WPS.

2.2 Procedure Qualification Records (WPQR)

WPQRs shall comply with:

- **BS EN ISO 15614-1** (steel)
- **BS EN ISO 14555** (stud welding)

WPQRs shall include:

- Test results
- Mechanical properties
- Macro/micro examination
- NDT results
- Heat input range
- Qualified thickness range
- Qualified positions

2.3 Welder Qualifications

All welders shall be qualified to:

- **BS EN ISO 9606-1** (steel)
- **BS EN ISO 14732** (welding operators)

Welder qualifications shall:

- Be valid and current
- Cover the required welding positions
- Cover the required thickness ranges
- Be traceable to each weld

2.4 Welding Plan

The Contractor shall prepare a **Welding Plan** including:

- Weld map
- Weld numbering system
- WPS/WPQR references
- Welder assignments
- NDT requirements
- Inspection hold points

- Preheat requirements
- Consumable control procedures

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3. JOINT PREPARATION

3.1 General Requirements

Joint preparation shall comply with:

- **BS EN ISO 9692-1**
- **BS EN 1090-2 Clause 7.5**

3.2 Joint Types

- Butt joints
- Fillet joints
- T-joints
- Corner joints
- Lap joints
- Stud welds

3.3 Edge Preparation

Edges shall be:

- Free from burrs
- Smooth and uniform
- Free from laminations
- Ground where required

3.4 Fit-Up Requirements

Fit-up shall:

- Maintain root gap per WPS
- Ensure proper alignment
- Avoid excessive force
- Use clamps or temporary bolts

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4. PREHEAT & INTERPASS TEMPERATURE

4.1 General

Preheat shall be applied in accordance with:

- **BS EN 1011-2**
- WPS requirements

4.2 Minimum Preheat Temperatures

Typical values:

Steel Grade	Thickness	Minimum Preheat
S235	≤ 25 mm	20–50°C
S355	≤ 25 mm	75–100°C
S355	> 25 mm	100–150°C
S460	All	150–200°C

4.3 Interpass Temperature

Interpass temperature shall:

- Not exceed WPS limits
- Be monitored continuously
- Be recorded for EXC3–EXC4

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5. WELDING PROCESSES

5.1 Shielded Metal Arc Welding (SMAW)

- Low-hydrogen electrodes required for S355+
- Electrodes stored in heated ovens
- Re-baking per manufacturer instructions

5.2 Gas Metal Arc Welding (GMAW/MIG/MAG)

- Shielding gas per WPS
- No porosity allowed
- Suitable for fillet and butt welds

5.3 Flux-Cored Arc Welding (FCAW)

- Gas-shielded or self-shielded
- Suitable for high-productivity applications

5.4 Submerged Arc Welding (SAW)

- Used for long butt welds
- High deposition rate
- Requires flux control

5.5 Stud Welding

Shall comply with:

- **BS EN ISO 14555**

Stud welding shall:

- Use ceramic ferrules
- Be performed in dry conditions
- Be tested by bend tests

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6. WELD EXECUTION

6.1 General Requirements

Welding shall:

- Follow the approved WPS
- Be performed by qualified welders
- Be supervised by the RWC
- Not be performed in rain or high humidity
- Not be performed below 0°C without protection

6.2 Welding Positions

Welding positions shall comply with:

- **BS EN ISO 6947**

Positions include:

- PA (flat)
- PB (horizontal)
- PC (vertical)
- PF (vertical up)
- PG (vertical down)
- PE (overhead)

6.3 Backing Materials

Backing may be:

- Permanent steel backing
- Removable ceramic backing
- Copper backing bars

Backing shall:

- Be continuous
- Be free from defects
- Be removed where required

6.4 Temporary Welds

Temporary welds shall:

- Be minimized
- Be removed after use
- Not cause distortion
- Be ground flush

6.5 Distortion Control

Distortion shall be controlled by:

- Balanced welding
- Back-step welding
- Intermittent welding
- Clamping and jigs
- Pre-setting

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7. WELD QUALITY & ACCEPTANCE CRITERIA

7.1 Visual Inspection

Performed per **BS EN ISO 17637**.

Checks include:

- Weld size
- Weld profile
- Undercut
- Overlap
- Cracks
- Porosity
- Arc strikes

7.2 NDT Requirements

NDT shall comply with:

- **BS EN ISO 17640** (UT)
- **BS EN ISO 23278** (MT)
- **BS EN ISO 3452** (PT)

Typical NDT Levels

Execution Class	NDT Level
EXC1	Visual only
EXC2	VT + MT/PT (selected)
EXC3	VT + MT/PT + UT (critical)
EXC4	Full NDT per project requirements

7.3 Acceptance Criteria

Acceptance criteria shall comply with:

- **BS EN ISO 5817**

Quality Levels

- EXC1 → Level D
- EXC2 → Level C
- EXC3 → Level B
- EXC4 → Level B+

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8. WELD REPAIR PROCEDURES

8.1 General

Repairs shall:

- Be approved by the RWC
- Follow a Repair WPS
- Be documented

8.2 Repair Methods

- Grinding
- Gouging
- Re-welding
- Local heat treatment

8.3 Re-Inspection

All repaired welds shall be re-inspected using the same NDT method.

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9. WELDING RECORDS

9.1 Required Records

- Welder ID
- Weld number
- WPS reference
- Preheat temperature
- Interpass temperature
- Consumables used
- NDT results
- Repair records

9.2 Record Retention

Records shall be retained for **minimum 10 years**.