5-Day Nuclear Orbital Welding Training Agenda

Critical Quality / Code-Controlled / Traceable Welding Applications

A detailed, application-based training program built around nuclear-quality preparation, contamination control, purge control, weld schedule development, orbital GTAW process variables, inspection, documentation, troubleshooting, and qualification-style weld performance for critical service and code-controlled work.

PROCESS TRAINING	NUCLEAR QUALITY	REAL WELD DEVELOPMENT

Prepared by OWETEC Services

Welding education, training, consulting, documentation, inspection, and qualification support.

Program Overview

This agenda rebuilds the nuclear orbital welding outline into a true OWETEC-level training plan. It removes the hour-by-hour structure and replaces it with a detailed day-by-day progression focused on real nuclear and critical-quality welding capability for tube systems, pipe systems, skids, assemblies, qualification work, and documentation-controlled fabrication.

The course is designed for welders, welding operators, maintenance teams, fabrication personnel, QA/QC, inspectors, engineers, supervisors, and project teams working around code-controlled joints, critical systems, traceable materials, procedure-controlled welding, and high-consequence quality requirements.

Training philosophy

This is not an equipment demonstration. The purpose is to train people to understand the welding process - not just load a program and press cycle start. Students learn how fit-up, facing, beveling, material traceability, cleanliness, foreign material control, tungsten geometry, purge pressure, gas quality, amperage, pulse timing, travel speed, heat input, weld head setup, filler-wire control, documentation, and inspection criteria all affect the final nuclear-quality weld.

Nuclear	Code-Controlled Quality	Traceability

Training area	What the class is built to accomplish
Process scope	Closed-head orbital fusion GTAW for tube work and open-head orbital / wire-feed orbital GTAW for pipe, heavier-wall components, code-controlled joints, and customer-specific critical welds.
Nuclear quality focus	Procedure compliance, traceability, cleanliness, FME awareness, heat input control, root/profile control, NDE readiness, repair prevention, and documentation discipline.
Equipment focus	Power source setup, weld head selection, collets/fixtures, open-head setup, wire feeder, tungsten installation, arc gap, purge setup, program entry, machine records, and weld head maintenance.
Hands-on focus	Cutting, facing, beveling, cleaning, fit-up, purge setup, coupon welding, schedule development, mock assembly work, inspection, and troubleshooting.
Documentation focus	Weld travelers, weld logs, weld maps, heat numbers, machine data, calibration awareness, inspection records, NDE coordination, repair tracking, WPS/PQR/WPQ/WOPQ concepts, and turnover packages.

Course outcomes

- Understand why nuclear and critical-quality orbital welding demands stronger process discipline than general industrial welding.
- Prepare tube, pipe, and fittings correctly through cutting, facing, beveling, cleaning, handling, fit-up verification, and FME awareness.
- Set up orbital welding equipment, weld heads, tungsten, wire feed, purge, shielding gas, and documentation controls correctly.
- Build and adjust weld schedules using process logic while respecting procedure control and quality-system limits.
- Evaluate OD and ID/root weld conditions, recognize common defects, and identify root causes.
- Apply nuclear-quality welding practices to tube welds, pipe welds, fittings, valves, sockets, mock spools, and realistic assemblies.
- Understand documentation, traceability, qualification concepts, NDE expectations, continuity, and quality expectations for code-controlled work.

5-Day Program Map

Day	Primary focus	Practical output
Day 1	Nuclear welding foundations, quality-system expectations, materials, traceability, cleanliness, and tube/pipe fundamentals.	Students understand what makes a nuclear-quality weld acceptable and what can make it fail before the weld is even made.
Day 2	Equipment setup, weld head selection, joint preparation, purge control, tungsten/wire setup, documentation checks, and first weld programs.	Students can set up equipment, prepare coupons, establish purge, and make controlled orbital welds while maintaining documentation discipline.
Day 3	Process variable control, weld schedule development, parameter adjustment, defect prevention, procedure control, and inspection.	Students can troubleshoot weld results and make intelligent changes while respecting controlled procedure requirements.
Day 4	Code-controlled assemblies, weld travelers, sequence planning, documentation, traceability, NDE readiness, and qualification concepts.	Students fabricate and inspect realistic assemblies while maintaining traceability and weld documentation.
Day 5	Final application project, qualification-style welds, inspection review, troubleshooting, SOP review, and closeout.	Students demonstrate the complete workflow from preparation through inspection, documentation, and corrective action.

No hourly schedule

This agenda intentionally avoids times. The instructor can control pace based on the customer's equipment platform, pipe/tube sizes, material groups, student skill level, quality expectations, code requirements, and production pain points.

Day 1 Detailed Agenda

DAY 1

Nuclear Welding Foundations, Quality Requirements, Materials, Traceability, and Tube/Pipe Fundamentals

Build the foundation before touching the machine.

Training purpose

Day 1 establishes why nuclear and critical-quality orbital welding requires tighter process discipline, traceability, cleanliness, and procedure control than normal industrial welding. The class focuses on nuclear-quality expectations, root/profile control, material behavior, tube/pipe components, and the fundamentals that determine weld success before the arc starts.

Application and industry review

- How orbital welding is used in nuclear fabrication, critical service piping, tubing systems, skids, repair work, and controlled shop environments.
- Typical applications: instrument tubing, process tubing, small-bore pipe, socket welds, valves, fittings, and traceable assemblies.
- Difference between general industrial welding and nuclear-quality welding under strict quality-plan control.
- Why root quality, cleanliness, documentation, NDE readiness, and repair prevention are central to the work.
- How poor welds create repair cycles, documentation failures, NDE issues, contamination risk, and quality escapes.

Quality system and code awareness

- ASME Section IX awareness for procedure qualification, welder qualification, welding operator qualification, and continuity.
- Weld travelers, hold points, witness points, controlled procedures, and revision control.
- Material traceability, heat numbers, filler control, machine identification, calibration awareness, and welder/operator accountability.
- Foreign material exclusion awareness, cleanliness, tool control, and contamination prevention.

GTAW and orbital process fundamentals

- Closed-head orbital fusion GTAW versus open-head orbital GTAW and open-head wire-feed orbital GTAW.
- Arc length, arc gap, arc cone shape, heat transfer, puddle control, and gravity effects around pipe.
- Primary/high pulse amperage, background/low pulse amperage, pulse timing, travel speed, wire feed, AVC, oscillation, and heat input.
- Shielding gas versus internal purge gas, including purge quality, flow, pressure, oxygen control, and venting.

Materials and metallurgy for oil and gas service

- Carbon steel, stainless steel, chrome-moly, duplex/super duplex, nickel alloy, and customer-specific material awareness.
- P-number/material-group concepts at a practical training level.
- Heat input, interpass temperature, hardenability, corrosion resistance, and service environment awareness.
- Why the same program may not respond the same across different heats, wall thicknesses, or material groups.

Hands-on lab: pipe and tube preparation fundamentals

- Cutting, facing, beveling, land/root opening review, deburring, cleaning, and handling.
- Checking joint squareness, bevel quality, wall mismatch, hi-low, root gap, alignment, and fit-up.

- Identifying damaged ends, poor bevels, contamination, clamp marks, ovality, and poor tack strategy.
- Preparing initial coupons for Day 2 setup and welding.

Day outcome

Students understand the oil and gas welding environment, what defects matter, why material and fit-up control weld results, and how to evaluate whether a joint is ready to weld.

Day 2 Detailed Agenda

DAY 2

Equipment Setup, Joint Preparation, Purge Control, Documentation Checks, and First Welds

Turn fundamentals into controlled setup and repeatable first welds.

Training purpose

Day 2 focuses on equipment, tooling, purge, tungsten, wire feed, fit-up, beveling, and the first controlled weld schedule. Students learn how orbital equipment is configured and how setup details directly affect weld quality.

Orbital welding system components

- Power supply, closed-head weld head, open-head weld head, track, rotor, motor drive, collets/fixtures, gas lines, grounds, pendant, cooling, wire feeder, AVC, oscillation, printer, and data output.
- Closed-head orbital fusion equipment for tube work and open-head wire-feed equipment for pipe/heavier-wall applications.
- How equipment platform differences affect setup, programming, documentation, and troubleshooting.

Weld head and track setup

- Selecting the correct weld head or track system for diameter, wall, joint configuration, and access.
- Collet/fixture selection, track alignment, tube/pipe support, rotor clearance, torch alignment, and cable management.
- Arc gap gauge use and why consistent arc gap matters around the entire joint.
- Common setup mistakes that create inconsistent penetration, OD profile, lack of fusion, or tie-in problems.

Tungsten and wire-feed setup

- Tungsten type, diameter, taper, tip flat, stickout, and contamination control.
- Wire size, feed angle, wire position, wire speed, start/stop behavior, and puddle entry.
- How tungsten geometry and wire-feed consistency affect bead placement, penetration, sidewall fusion, and cap shape.

Purge and gas control

- Shielding gas flow and internal purge gas flow for stainless and alloy systems.
- Flow versus pressure and how poor purge routing or excessive pressure affects root quality.
- Purge dams, plugs, tape, venting, pre-purge time, post-purge time, and oxygen displacement.
- Diagnosing oxidation, sugaring, root concavity, lack of purge, or trapped volume.

Hands-on lab: setup and first welds

- Prepare coupons from start to finish.
- Install tungsten, set arc gap, verify collets/track setup, set wire position, and set up purge.
- Enter or load a starting program and perform pre-weld checks.
- Make first controlled closed-head and/or open-head orbital welds and inspect results.

Day outcome

Students can prepare joints, set up orbital equipment, establish purge, install tungsten/wire feed, verify arc gap, and make basic controlled orbital welds.

Day 3 Detailed Agenda

DAY 3

Weld Schedule Development, Procedure Control, Process Variables, Defect Prevention, and Inspection

Teach students how to think through the weld, not just run the machine.

Training purpose

Day 3 is the core process-development day. Students learn how to adjust weld variables based on actual weld results, identify root causes, and evaluate welds using practical inspection logic.

Amperage and heat input control

- Primary/high pulse amperage and how it drives penetration, bead shape, and root/ID response.
- Background/low pulse amperage and how it supports puddle control, cooling, and consistency.
- Recognizing lack of penetration, excessive penetration, excessive bead width, overheating, and color changes.
- How heat builds through the weld cycle and why later levels may require adjustment.

Pulse timing and pulse frequency

- Pulse frequency, high pulse time, low pulse time, and puddle freeze behavior.
- Ripple pattern, bead consistency, internal bead shape, and thin-wall or heavy-wall response.
- How pulse balance can stabilize penetration and reduce overheating without losing fusion.

Travel speed and level strategy

- Travel speed effect on heat input, bead width, penetration, reinforcement, and tie-in.
- Fast travel versus slow travel symptoms and how to read the weld result.
- Level 1 start behavior, Level 2 stabilization, Level 3 side/gravity behavior, and Level 4 closure behavior.
- Why programs are divided by segments/quadrants and why parameters may change around the tube or pipe.

Arc gap, tungsten position, and weld head mechanics

- Arc gap influence on arc voltage, bead width, penetration, and OD/ID consistency.
- Tube ovality, collet fit, track alignment, rotor drag, poor grounding, and cable strain problems.
- Recognizing when a weld issue is equipment setup or fixturing, not just program settings.

Downslope, tie-in, and closure control

- Crater fill, tie-in appearance, final penetration, oxidation at closure, and end-of-weld concavity.
- Correcting poor closure, overlap, undercut, crater issues, and excessive heat at the stop point.
- How downslope settings must match tube size, wall thickness, heat input, and final weld behavior.

Filler-wire, AVC, and oscillation control

- Wire feed speed, delay, start/stop timing, wire position, and how filler metal changes bead profile and heat balance.
- AVC response, voltage control, arc gap, torch height, and oscillation width/dwell for open-head applications.
- Root/fill/cap strategy and how travel, wire, current, and oscillation must work together.

Oil and gas defect recognition and root cause analysis

- Lack of fusion, lack of penetration, excessive penetration, concavity, convexity, undercut, overlap, porosity, oxidation, tungsten inclusion, crater defects, and poor tie-in.
- Distinguishing prep defects, purge defects, material behavior, machine setup, and programming issues.
- Using weld results and inspection feedback to decide the next controlled parameter change.

Hands-on lab: controlled weld development

- Make welds with controlled changes to amperage, travel speed, pulse timing, arc gap, purge pressure, downslope, wire feed, AVC, and oscillation.
- Compare weld results side by side and document what changed.
- Build a refined weld program from initial welds.
- Inspect, critique, and troubleshoot student welds.

Day outcome

Students can diagnose weld results, understand cause and effect, make controlled process changes, and evaluate welds against critical-service quality expectations.

Day 4 Detailed Agenda

DAY 4

Code-Controlled Assemblies, Weld Travelers, Documentation, Traceability, and Qualification Concepts

Apply the process to real-world critical-service assemblies.

Training purpose

Day 4 moves students from coupons into realistic fabrication. The focus is fitting-specific weld behavior, weld sequence planning, mock spools, documentation, traceability, and how qualification concepts support production welding.

Advanced oil and gas weld applications

- Tube-to-tube, pipe-to-pipe, socket weld, tube-to-fitting, pipe-to-elbow, pipe-to-reducer, pipe-to-valve, and branch-style training examples.
- Short access joints, limited-clearance welds, heavier-wall components, dissimilar thicknesses, and heat-sink conditions.
- Why a coupon program may not be right for valves, reducers, sockets, elbows, or heavy-wall fittings.

Assembly planning and weld sequencing

- Reading a layout, identifying weld numbers, planning weld order, and preventing trapped welds.
- Purge routing, venting strategy, fit-up sequence, tack strategy, support, and distortion control.
- Maintaining accessibility for the weld head/track, inspection, and NDE.
- Protecting finished welds, open pipe ends, and clean surfaces during fabrication.

Mock spool assembly

- Build a realistic assembly using pipe/tube, elbows, reducers, sockets, and valve-simulated components.
- Identify weld numbers and plan the sequence before welding.
- Prepare, fit, purge, weld, inspect, and record each weld.
- Discuss what would be accepted, repaired, reworked, or escalated in production.

WPS/PQR/WPQ/WOPQ and qualification concepts

- Practical explanation of WPS, PQR, WPQ, and WOPQ.
- Difference between procedure qualification, welder qualification, and welding operator qualification.
- How ASME Section IX concepts support code-controlled fabrication.
- How company-specific and customer-specific qualification testing may differ from code minimums.

Weld documentation and traceability

- Weld maps, weld logs, heat numbers, welder/operator ID, machine ID, procedure/program ID, NDE coordination, and repair tracking.
- Machine printouts, parameter records, inspection reports, and turnover package structure.
- What information welders should capture before, during, and after welding.

Day outcome

Students can apply orbital welding to realistic assemblies, plan weld sequence and purge, document work, and understand how qualification and quality systems control production welding.

Day 5 Detailed Agenda

DAY 5

Final Application Project, Qualification-Style Welds, Inspection Review, Troubleshooting, and Closeout

Demonstrate the complete workflow from prep to documentation.

Training purpose

Day 5 brings the training together through final welds, inspection review, troubleshooting, customer-specific discussion, SOP recommendations, and closeout. Students demonstrate the full workflow from preparation through weld evaluation.

Final practical welding evaluation

- Complete tube-to-tube, pipe-to-pipe, socket, fitting, or customer-specific qualification-style welds.
- Demonstrate cutting, facing, beveling, cleaning, fit-up, equipment setup, tungsten/wire setup, purge, program selection, and weld execution.
- Make controlled adjustments when weld results require correction.
- Record relevant information for weld traceability and quality review.

Final weld inspection and critique

- Review OD appearance, ID/root profile where accessible, bead width, tie-in, color, penetration, and consistency.
- Evaluate concavity, convexity, mismatch, undercut, oxidation, porosity, surface contamination, and cap quality.
- Discuss whether welds are acceptable, questionable, repairable, or rejectable.
- Focus on why the weld result happened and how to prevent recurrence.

Advanced troubleshooting scenarios

- Good OD with bad root oxidation.
- Proper flow but poor purge because of bad venting or trapped volume.
- Root suck-back caused by excessive heat or purge pressure issues.
- Lack of fusion on fittings or heavy-wall components.
- Program works on one heat/wall but not another.
- Tie-in fails even though the rest of the weld is acceptable.

Customer-specific application review

- Review actual pipe/tube sizes, fittings, equipment platform, materials, quality expectations, NDE requirements, and production challenges.
- Discuss current pain points, inspection failures, documentation gaps, or operator skill needs.
- Recommend next steps for SOPs, qualification testing, weld maps, inspection process, and production control.

Day outcome

Students complete a full oil and gas orbital welding progression and leave with a clear understanding of how to prepare, weld, inspect, troubleshoot, document, and support critical-service fabrication work.

Optional Customer-Specific Add-On Modules

These modules can be emphasized or added depending on the customer's systems, materials, equipment platform, codes, internal quality plan, and production needs.

Nuclear Quality System Emphasis

- Procedure compliance, controlled documents, travelers, hold points, witness points, and accountability.
- Material traceability, heat/lot control, filler control, calibration awareness, and documentation discipline.
- Foreign material exclusion awareness, cleanliness, tool control, and work-area discipline.

Code / Qualification Emphasis

- ASME Section IX concepts for WPS, PQR, WPQ, WOPQ, essential variables, ranges, and continuity.
- How customer-specific nuclear quality requirements can exceed minimum code requirements.
- How to build training and qualification ranges that support production while maintaining process control.

NDE / Repair Prevention Emphasis

- VT, PT, RT, UT, borescope, and customer-specific inspection awareness.
- Weld profile, root condition, oxidation control, repair prevention, and escalation practices.
- Repair documentation, reinspection expectations, and corrective-action thinking.

Critical Materials Emphasis

- Stainless, carbon steel, nickel alloys, chrome-moly, and project-specific materials.
- Heat input, interpass temperature, purge quality, root profile, and material behavior.
- Customer-specific coupon development and schedule validation for critical joints.

OWETEC differentiator

The goal is not to create machine operators. The goal is to develop welders and technical personnel who understand nuclear-quality orbital welding well enough to make repeatable welds, recognize problems, correct defects, support documentation, and improve the customer's internal welding capability.

Training Deliverables and Closeout

At the conclusion of the training, OWETEC can support the customer with additional deliverables depending on the scope of work, governing code, nuclear quality requirements, project specification, NDE expectations, and quality-plan requirements.

Potential deliverables

- Completed training agenda and attendance record.
- Course completion certificates.
- Student performance review or skill observations.
- Recommended weld procedure or schedule notes.
- Customer-specific weld schedule development support.
- WPS/PQR/WPQ/WOPQ support where required.
- SOP recommendations for orbital welding workflow, inspection, documentation, repair, and equipment maintenance.
- Inspection and documentation recommendations.
- Follow-up consulting support for production weld problems, qualification planning, or internal process development.

Important note

Final qualification requirements, acceptance criteria, documentation requirements, and inspection methods must be controlled by the customer's governing code, project specification, contract documents, quality plan, and internal procedures. This agenda is a training plan and can be tailored to the customer's specific applications.

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