WILLBROS GOVERNMENT SERVICES (U.S.), LLC

A WILLBROS COMPANY

# APPENDIX B

# PROJECT CHECKLIST
## Tank Inspection Checklist
## Section B-2

| Rev | Date | Description | Reviewed | Approved |
|---|---|---|---|---|
| A | 6/02/2011 | Preliminary - For Approval | DB | TDA |
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| | Tank Out-of-service Inspection Checklist | | |
|---|---|---|---|
| | Item | Completed X | Comments |
| C.2.1 | **Overview** | | |
| a) | Check that tank has been cleaned, is gas free, and safe for entry. | X | |
| b) | Check that the tank is completely isolated from product lines, all electrical power, and steam lines. | X | |
| c) | Check that roof is adequately supported, including fixed roof structure and floating roof legs. | X | |
| d) | Check for presence of falling object hazards, such as corroded-through roof rafters, asphalt stalactites, and trapped hydrocarbons in unopened or plugged equipment or appurtenances, ledges, etc. | X | |
| e) | Inspect for slipping hazards on the bottom and roof decks. | X | |
| f) | Inspect structural welds on accessways and clips. | X | |
| g) | Check surfaces needing inspection for a heavy-scale buildup and check weld seams and oily surfaces where welding is to be done. Note areas needing more cleaning, including blasting. | X | |
| h) | Review cathodic protection potential readings. | NA | NA=Not applicable/accessible |
| C.2.2. | **Tank Exterior** | NA | NA=Not applicable/accessible |
| a) | Inspect appurtenances opened during cleaning such as lower floating swing sheave assemblies, nozzle interiors (after removal of valves). | NA | |
| b) | Hammer test or ultrasonically test he roof. | NA | |
| c) | Enter and inspect he floating roof pontoon compartments. | NA | |
| C.2.3. | **Bottom Interior Surface** | | |
| a) | Using a flashlight held close to and parallel to the bottom plates, and using the bottom plate layout as a guide, visually inspect and hammer test the entire bottom. | X | See inspection report |
| b) | Measure the depth of pitting and describe the pitting appearance (sharp edged, lake type, dense, scattered, etc ) | X | See inspection report |
| c) | Mark areas requiring patching or further inspection. | X | See inspection report |
| d) | Mark locations for turning coupons for inspection. | NA | |
| e) | Inspect all welds for corrosion and leaks, particularly he shell-to-bottom weld. | X | See inspection report |
| f) | Inspect sketch plates for corrosion. | X | See inspection report |
| g) | Check condition of internal sump, if applicable. Standing liquid should be removed from he sump to allow for complete inspection and vacuum testing of weld seams as appropriate. Sump bottom and sidewall plate and seams need to be evaluated for both product-side and soil-side corrosion. | NA | |
| h) | Locate and mark voids under the bottom. | X | See inspection report |
| i) | Record bottom data on a layout sketch using the existing bottom plates as a grid. List he number and sizes of patches required. | X | See inspection report |
| j) | Vacuum test the bottom lap welds. | NA | |
| k) | Hammer test or ultrasonically examine any slightly discolored spots or damp areas. | X | |
| l) | Check for reinforcing pads under all bottom attached clips, brackets, and supports. | X | |
| m) | Inspect floating roof leg pads for pitting or cutting, and excessive dimpling (indicating excessive loading). | NA | |
| n) | Check the column bases of fixed roof supports for adequate pads and restraining clips. | X | |
| o) | In earthquake Zones 3 and 4, check that roof supports are not welded down to the tank bottom, but are only restrained from horizontal movement. | X | |
| p) | Check area beneath swing line cable for indications of cable cutting or dragging. | NA | |
| q) | Mark old oil and air test connection for removal and patching. | NA | |
| r) | Identify and report low areas on the bottom that do not drain adequately. | X | |
| s) | Inspect coating for holes, disbonding, deterioration, and discoloration. | X | |
| C.2.4. | **Shell Seams and Plate** | | |
| a) | On cone up bottoms, closely inspect and gauge the depth of metal loss on the lower 2 in. to 4 in. of the shell (area of standing water). | NA | |
| b) | Measure the depth of pitting on each course. | X | See inspection report |

| | Tank Out-of-service Inspection Checklist | | |
|---|---|---|---|
| | Item | Completed X | Comments |
| c) | Inspect and es imate the amount of metal loss on the heads of rivets and bolts. | NA | NA=Not applicable/accessible |
| d) | Inspect shell-to-bottom riveted lap joints. | NA | NA=Not applicable/accessible |
| e) | Inspect for vertical grooving damage from seal assembly protrusions. | NA | NA=Not applicable/accessible |
| f) | Inspect existing protective coa ings for damage, deterioration, and disbonding. | X | See inspection report |
| g) | Check for areas of rubbing (indicating too much pressure by the seal assembly shoes or inadequate annular space). | NA | |
| h) | Visually inspect the shell plates and seams for indications of leakage. | X | See inspection report |
| i) | If the shell has riveted or bolted seams, record the leak locations by film or chart in case he locations are lost during surface preparation for painting. | NA | |
| j) | Measure annular space at 40-ft intervals. | NA | |
| k) | Survey the shell to check for roundness and plumb. | X | |
| C.2.5 | **Shell-mounted Overflows** | NA | NA=Not applicable/accessible |
| a) | Inspect overflow for corrosion and adequate screening. | NA | |
| b) | Check location of overflow that it is not above any tank valves or equipment. | NA | |
| C.2.6 | **Roof Interior Surface** | | |
| C.2.6.1 | **General** | NA | NA=Not applicable/accessible |
| a) | Visually inspect the underside surface of the roof plates for holes, scale buildup, and pitting. | NA | |
| b) | Hammer test or ultrasonically examine to check for thin areas, particularly in the vapor space of floating roofs and at edge of roof on cone roof tank. | NA | |
| c) | Check all clips, brackets, braces, etc., welded to he roof deck plate for welded reinforcing pads and see that they have not broken free. | NA | |
| d) | If no pad is present, penetrant test for cracking of he weld or deck plate. | NA | |
| e) | Inspect for protective coating for breaks, disbondment, and deterioration. | NA | |
| f) | Spark test the interior surface coating if recoating is not planned. | NA | |
| C.2.6.2 | **C.2.6.2 Fixed Roof Support Structure** | NA | |
| a) | Inspect the support columns for thinning in the upper 2 ft. | NA | |
| b) | On API columns (two channels welded together) check for corrosion scale breaking the tack welds, unless the joint between he channels is completely seal welded. | NA | |
| c) | Check that the reinforcing pad on the bottom is seal-welded to the tank bottom wi h horizontal movement restraining clips welded to the pad. | NA | |
| d) | Determine if pipe column supports are concrete filled or open pipe. If open pipe, check for a drain opening in the bottom of the pipe. | NA | |
| e) | Inspect and gauge rafters for thinning, particularly near the center of the roof. Report metal loss. | NA | |
| f) | Check for loose or twisted rafters. | NA | |
| g) | Inspect girders for thinning and check that they are attached securely to the top of the columns. | NA | |
| h) | Report if the columns have cross bracing in the area between the low pump out of the top of the shell (for future internal floating roof installation). | NA | |
| i) | Inspect and report presence of any roof-mounted swing line bumpers. | NA | |
| j) | Photograph the roof structure if no rafter layout drawing exists. | NA | |
| C.2.7 | **Fixed Roof Appurtenances** | NA | NA=Not applicable/accessible |
| C.2.7.1 | **Inspection and Light Hatches** | NA | |
| a) | Inspect the hatches for corrosion, paint and coating failures, holes, and cover sealing. | NA | |
| b) | On loose covers, check for a safety chain in good condition. | NA | |
| c) | On light hatches over 30 in. across, check for safety rods. | NA | |
| d) | Inspect the condition of the gaskets on bold or latched down hatch covers. | NA | |
| C.2.7.2 | **Staging Support Connection** | NA | |
| | Inspect the condition of the staging support for corrosion. | NA | |
| C.2.7.3 | **Breathers and Vents** | NA | |
| a) | Inspect and service the breather. | NA | |
| b) | Inspect screens on vents and breathers. | NA | |
| C.2.7.4 | **Emergency P/V Hatches** | NA | |

| | Tank Out-of-service Inspection Checklist | | |
|---|---|---|---|
| | Item | Completed X | Comments |
| a) | Inspect and service pressure/vacuum hatches. (Setting should be high enough to prevent chattering of breather during normal operation. See breather manufacturer's guide.) | NA | |
| b) | Inspect liquid seal hatches for corrosion and proper liquid level in the seal. | NA | |
| C.2.7.5 | **Sample Hatch** | NA | |
| a) | Inspect sample hatch for corrosion. | NA | |
| b) | Check that the cover operates properly. | NA | |
| c) | If the tank has no gauge well, check for a hold-off distance marker and check measurement. | NA | |
| C.2.8 | **Floating Roof** | NA | NA=Not applicable/accessible |
| C.2.8.1 | **Roof Deck** | NA | |
| a) | Hammer test the area between roof rim and shell. (If access for hammer testing is inadequate, measure the distance from he bottom edge of he roof to the corroded area and then hammer test from inside the pontoon.) | NA | |
| b) | In sour water service, clean and test all deck plate weld seams for cracking unless the lower laps have been seal-welded. | NA | |
| c) | Check that either the roof drain is open or the drain plug in the roof is open in case of unexpected rain. | NA | |
| d) | On flat bottomed and cone bottom roof decks, check for a vapor dam around the periphery of the roof. The dam should be continuous without break to prevent escape of vapors to the seal area from under the center of he roof. | NA | |
| C.2.8.2 | **Floating Roof Pontoons** | NA | |
| a) | Visually inspect each pontoon for liquid leakage. | NA | |
| b) | Run a light wire through the gooseneck vents on locked down inspection hatch covers to make sure they are open. | NA | |
| c) | Inspect lockdown latches on each cover. | NA | |
| d) | Check and report if each pontoon is: | NA | |
| 1) | vapor tight (bulkhead seal welded on one side on bottom, sides, and top), | NA | |
| 2) | liquid tight (seal-welded on bottom and sides only), or | NA | |
| 3) | unacceptable (minimum acceptable condition is liquid tight). | NA | |
| C.2.8.3 | **Floating Roof Cutouts** | NA | |
| a) | Inspect underside of cutouts for mechanical damage. | NA | |
| b) | Inspect welds for cracks. | NA | |
| c) | Inspect plate for thinning, pitting, and erosion. | NA | |
| d) | Measure mixer cutouts and record plate thickness for future mixer installation or replacement.<br>Plate thickness _____ . | NA | |
| C.2.8.4 | **Floating Roof Supports** | NA | |
| a) | Inspect fixed low and removable high floating roof legs for thinning. | NA | |
| b) | Inspect for notching at bottom of legs for drainage. | NA | |
| c) | Inspect for leg buckling or felling at bottom. | NA | |
| d) | Inspect pin hole in roof guide for tears. | NA | |
| e) | Check plumb of all legs. | NA | |
| f) | Inspect for adequate reinforcing gussets on all legs through a single portion of the roof. | NA | |
| g) | Inspect the area around the roof legs for cracking if there is no internal reinforcing pad or if the topside pad is not welded to the deck plate on the underside. | NA | |
| h) | Inspect the sealing system on the two-position legs and the vapor plugs in the fixed low leg for deterioration of he gaskets. | NA | |
| i) | On shell-mounted roof supports, check for adequate clearance based on he maximum floating roof movement as determined by the posi ion of the roof relative to he gauge well and/or counter-rotational device. | NA | |
| C.2.9 | **Floating Roof Seal Assemblies** | NA | |
| C.2.9.1 | **Primary Shoe Assembly** | NA | |
| a) | Remove four sections of foam log (foam-filled seals) for inspection on 90° locations. | NA | |

| | Tank Out-of-service Inspection Checklist | | |
|---|---|---|---|
| | Item | Completed X | Comments |
| b) | Inspect hanger attachment to roof rim for thinning, bending, broken welds, and wear of pin holes. | NA | |
| c) | Inspect clips welded to roof rim for thinning. | NA | |
| d) | Shoes—inspect for hinning and holes in shoes. | NA | |
| e) | Inspect for bit-metal bolts, clips, and attachments. | NA | |
| f) | Seal fabric—inspect for deterioration, stiffening, holes, and tears in fabric. | NA | |
| g) | Measure length of fabric from top of shoe to roof rim, and check against maximum anticipated annular space as roof operates. | NA | |
| h) | Inspect any modification of shoes over shell nozzles, mixers, etc., for clearance. | NA | |
| i) | Inspect shoes for damage caused by striking shell nozzles, mixers, etc. | NA | |
| C.2.9.2 | **Primary Toroidal Assembly** | NA | |
| a) | Inspect seal fabric for wear, deterioration, holes, and tears. | NA | |
| b) | Inspect hold-down system for buckling or bending. | NA | |
| c) | Inspect foam for liquid absorption and deterioration. | NA | |
| C.2.9.3 | **Rim-mounted Secondaries** | NA | |
| a) | Inspect the rim-mounted bolting bar for corrosion and broken welds. | NA | |
| b) | Measure and chart seal-to-shell gaps. | NA | |
| c) | Visually inspect seam from below, looking for holes as evidenced by light. | NA | |
| d) | Inspect fabric for deterioration and stiffness. | NA | |
| e) | Inspect for mechanical damage, corrosion, and wear on tip in contact with shell. | NA | |
| f) | Inspect for contact with obstructions above top of shell. | NA | |
| C.2.10 | **Floating Roof Appurtenances** | NA | |
| C.2.10.1 | **Roof Manways** | NA | |
| a) | Inspect walls of manways for pit ing and thinning. | NA | |
| b) | On tanks with interface autogauges, check seal around gauge tape cable and guide wires through manway cover. | NA | |
| c) | Inspect cover gasket and bolts. | NA | |
| C.2.10.2 | **Rim Vent** | NA | |
| a) | Check rim vent for pitting and holes. | NA | |
| b) | Check vent for condi ion of screen. | NA | |
| c) | On floating roof tanks where the environmental rules require closing off the vent, check he vent pipe for corrosion at the pipe-to-rim joint and check that the blinding is adequate. | NA | |
| C.2.10.3 | **Vacuum Breaker, Breather Type** | NA | |
| a) | Service and check operation of breather valve. | NA | |
| b) | Check that nozzle pipe projects no more than 1/2 in. below roof deck. | NA | |
| C.2.10.4 | **Vacuum Breaker, Mechanical Type** | NA | |
| | Inspect the stem for thinning. Measure how far the vacuum breaker cover is raised off he pipe when he roof is resting on high or low legs. | NA | |
| a) | On high legs: _____ . | NA | |
| b) | On low legs: _____ . | NA | |
| C.2.10.5 | **Roof Drains: Open Systems, Including Emergency Drains** | NA | NA=Not applicable/accessible |
| a) | Check liquid level inside open roof drains for adequate freeboard. Report if there is insufficient distance between liquid level and top of drain. | NA | |
| b) | If tank comes under Air Quality Monitoring District rules, inspect the roof drain vapor plug. | NA | |
| c) | If emergency drain is not at the center of the roof, check that there are at least hree emergency drains. | NA | |
| C.2.10.6 | **Closed Drain Systems: Drain Basins** | NA | NA=Not applicable/accessible |
| a) | Inspect for hinning and pitting. | NA | |
| b) | Inspect protective coating (topside). | NA | |
| c) | Inspect basin cover or screen for corrosion. | NA | |
| d) | Test operation of check valve. | NA | |

| | Tank Out-of-service Inspection Checklist | | |
|---|---|---|---|
| | Item | Completed X | Comments |
| e) | Check for presence of check valve where bottom of basin is below product level. | NA | |
| f) | Inspect drain basin(s) to roof deck welds for cracking. | NA | |
| g) | Check drain basin(s) outlet pipe for adequate reinforcement to roof deck (including reinforcing pad). | NA | |
| C.2.10.7 | **Closed Drain Systems: Fixed Drain Line on Tank Bottom** | | |
| a) | Hammer test fixed drain line on tank bottom for thinning and scale/debris plugging. | X | |
| b) | Inspect supports and reinforcing pads for weld failures and corrosion. | X | |
| c) | Check that pipe is guided, not rigidly locked to support, to avoid tearing of tank bottom plate. | X | |
| C.2.10.8 | **Closed Drain Systems: Flexible Pipe Drain** | NA | NA=Not applicable/accessible |
| a) | Inspect for damage to exterior of pipe. | NA | |
| b) | Check for obstructions that pipe could catch on. | NA | |
| c) | Inspect shields to protect pipe from snagging. | NA | |
| d) | Inspect results of hydrostatic test on flexible roof drain system. | NA | |
| C.2.10.9 | **Closed Drain Systems: Articulated Joint Drain** | NA | NA=Not applicable/accessible |
| a) | Hammer test rigid pipe in flexible joint systems for thinning and scale/debris plugging. | NA | |
| b) | Inspect system for signs of bending or strain. | NA | |
| c) | Inspect results of system hydrostatic test. | NA | |
| d) | Inspect landing leg and pad. | NA | |
| C.2.10.10 | **Autogauge System and Alarms** | NA | NA=Not applicable/accessible |
| a) | Check freedom of movement of tape through autogauge tape guide. | NA | |
| b) | Inspect sheaves for freedom of movement. | NA | |
| c) | Test operation checker. | NA | |
| d) | Inspect tape and tape cable for twisting and fraying. | NA | |
| e) | Test the tape's freedom of movement through guide sheaves and tape guide pipe. | NA | |
| f) | On open-top tanks, check that gate tapes with cables have no more than one foot of tape exposed with float at lowest point. | NA | |
| g) | Check float for leakage. | NA | |
| h) | Test float guide wire anchors for spring action by pulling on wire and releasing. | NA | |
| i) | Inspect floatwells in floating roofs for thinning and pitting of walls just above the liquid level. | NA | |
| j) | Check that the autogauge tape is firmly attached to the float. | NA | |
| k) | Inspect the tape cable and float guide wire fabric seals through the float well cover. | NA | |
| l) | Inspect the bottom guide wire attachment clip: inspect for a temporary weighted bar instead of a permanent welded down clip. | NA | |
| m) | Inspect board-type autogauge indicators for legibility and freedom of movement of indicator. | NA | |
| n) | Measure and record these distances to determine if seal damage will occur if tank is run over from: | NA | |
| 1) | Shell top angle to underside of tape guide system. | NA | |
| 2) | Liquid level on floating top to top of secondary seal. | NA | |
| o) | Identify floating roofs where the tape is connected directly to the roof. | NA | |
| p) | Overfill alarm: Inspect tank overfill prevention alarm switches for proper operation. | NA | |
| C.2.11 | **Common Tank Appurtenances** | | |
| C.2.11.1 | **Gauge Well** | NA | NA=Not applicable/accessible |
| a) | Inspect gate well pipe for thinning at about two-thirds distance above the bottom: look for thinning at the edge of the slots. | NA | |
| b) | Check for corrosion on the pipe joint. Check that sample cords, weights, thermometers, etc., have been removed from the pipe. | NA | |
| c) | Check for cone at bottom end of pipe about one foot above he bottom. | NA | |

| | Tank Out-of-service Inspection Checklist | | |
|---|---|---|---|
| | Item | Completed X | Comments |
| d) | Check condition of well washer pipe and that its flared end is directed at the near side of the hold off pad. | NA | |
| e) | Check that supports for gauge well are welded to pad or to shell and not directly to bottom plate. | NA | |
| f) | Check operation of gauge well cover. | NA | |
| g) | Check presence of a hold-off distance marker in well pipe and record hold-off distance. Hold-off distance _____ . | NA | |
| h) | Identify and report size and pipe schedule, and whether pipe is solid or slotted. Report slot size. | NA | |
| i) | Check that the hold-off distance plate is seal-welded to he bottom and hat any gauge well supports are welded to the plate and not directly to the bottom. | NA | |
| j) | Inspect vapor control float and cable. | NA | |
| k) | Check for presence and condition of gauge well washer. | NA | |
| l) | Check for bull plug or plate blind on gauge well washer valve. | NA | |
| m) | Inspect gauge well guide in floating roof for pitting and thinning. | NA | |
| n) | Inspect the guide rollers and sliding plates for freedom of movement. | NA | |
| o) | Inspect condition of gauge well pipe seal system. | NA | |
| p) | On black oil and diesel services: if gauge well is also used for sampling, check for presence of a thief- and gauge-type hatch to avoid spillage. | NA | |
| q) | Visually inspect inside of pipe for pipe weld protrusions which could catch or damage vapor control float. | NA | |
| C.2.11.2 | **Sampling Systems: Roof Sample Hatches** | NA | NA=Not applicable/accessible |
| a) | Inspect roof-mounted sample hatches for reinforcing pads and cracking. | NA | |
| b) | Inspect cover for operation. | NA | |
| c) | For tanks complying with Air Quality Monitoring District rules, inspect sample hatch covers for adequate sealing. | NA | |
| d) | Check horizontal alignment of internal floating roof sample hatches under fixed roof hatches. | NA | |
| e) | Inspect the sealing system on the internal floating roof sample hatch cover. | NA | |
| f) | Inspect floating roof sample hatch cover recoil reel and rope. | NA | |
| C.2.11.3 | **Shell Nozzles** | | |
| a) | Inspect shell nozzles for thinning and pitting. | X | See inspection report |
| b) | Inspect hot tap nozzles for trimming of holes. | X | See inspection report |
| c) | Identify type of shell nozzles. | X | See inspection report |
| d) | Identify and describe internal piping, including elbow-up and elbow-down types. | X | See inspection report |
| C.2.11.4 | **For Nozzles Extended Into the Tank** | | |
| a) | Inspect pipe support pads welded to tank bottom. | X | See inspection report |
| b) | Inspect to see that pipe is free to move along support without strain or tearing action on bottom plate. | X | See inspection report |
| c) | Inspect nozzle valves for packing leaks and damaged flange faces. | X | See inspection report |
| d) | Inspect heater stream nozzle flanges and valves for wire cutting. | X | See inspection report |
| e) | Report which nozzles have thermal pressure relief bosses and valves. | X | See inspection report |
| f) | In internal elbow-down fill line nozzles, inspect the wear plate on the tank bottom. | X | See inspection report |
| g) | On elbow-up fill lines in floating roof tanks, check that opening is directed against underside of roof, not against vapor space. Inspect impact are for erosion. | X | See inspection report |
| C.2.11.5 | **Diffusers and Air Rolling Systems** | NA | NA=Not applicable/accessible |
| a) | Inspect diffuser pipe for erosion and thinning. | NA | |
| b) | Check holes in diffuser for excessive wear and enlargement. | NA | |
| c) | Inspect diffuser supports for damage and corrosion. | NA | |
| d) | Check that diffuser supports restrain, not anchor, longitudinal line movement. | NA | |
| e) | Inspect air spiders on bottom of lube oil tanks for plugging and damaged or broken hreaded joints. | NA | |
| C.2.11.6 | **Swing Lines** | NA | NA=Not applicable/accessible |

| | Tank Out-of-service Inspection Checklist | | |
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| | Item | Completed X | Comments |
| a) | Inspect flexible joint for cracks and leaks. | NA | |
| b) | Scribe the flexible joint across the two moving faces and raise end of swing line to check the joint's freedom of movement, indicated by separa ion of scribe marks. | NA | |
| c) | Check that flexible joints over 6 in. are supported. | NA | |
| d) | Inspect the swing pipe for deep pitting and weld corrosion. | NA | |
| e) | Loosen the vent plugs in the pontoons and listen for a vacuum. Lack of a vacuum indicates a leaking pontoon. | NA | |
| f) | Check the results of air test on pontoons during repairs. | NA | |
| g) | Inspect the pontoons for pitting. | NA | |
| h) | Inspect the pull-down cable connections to the swing. | NA | |
| i) | Inspect the condition of the bottom-mounted support, fixed roof limiting bumper, or shell-mounted limiting bumper for wood condition, weld and bolt corrosion, and seal welding to bottom or shell. | NA | |
| j) | Inspect safety hold-down chain for corrosion and weak links. | NA | |
| k) | Check that there is a welded reinforcing pad where the chain connects to the bottom. | NA | |
| l) | If the floa ing swing in a floating or internal floating roof tank does not have a limiting device preventing the swing from exceeding 60 degrees, measure and calculate the maximum angle possible with the roof on overflow.<br>Max. angle on overflow _____ .<br>(If the calculated angle exceeds 65 degrees, recommended installation of a limiting bracket.) | NA | |
| m) | Inspect pull-down cable for fraying. | NA | |
| n) | Inspect for hree cable clamps where cable attaches to end of swing line (single-reeved) or to roof assembly (double-reeved). Inspect sheaves for freedom of move-ment. | NA | |
| o) | Inspect winch opera ion and check the height indicator for legibility and accuracy. | NA | |
| p) | Inspect bottom-mounted sheave assembly at end of pontoon for freedom of rotation of sheave. | NA | |
| q) | Inspect shell-mounted lower sheave assembly for freedom of rotation of sheave, corrosion thinning, and pitting of sheave housing. | NA | |
| r) | Inspect upper sheave assembly for freedom of movement of sheave. | NA | |
| s) | Inspect the cable counterbalance assembly for corrosion and freedom of operation. | NA | |
| C.2.11.7 | **Manway Heater Racks** | NA | NA=Not applicable/accessible |
| a) | Inspect the manway heater racks for broken welds and bending of the sliding rails. | NA | |
| b) | Measure and record the length of the heater and length of the track. | NA | |
| C.2.11.8 | **Mixer Wear Plates and Deflector Stands** | NA | NA=Not applicable/accessible |
| a) | Inspect bottom and shell plates and deflector stands. | NA | |
| b) | Inspect for erosion and corrosion on the wear plates. Inspect for rigidity, structural soundness, corrosion, and erosion of deck plates and reinforcing pads that are seal-welded to the bottom under the deflector stand legs. | NA | |
| c) | Measure for propeller clearance between the bottom of deflector stand and roof when he roof is on low legs. | NA | |
| C.2.12 | **Access Structures** | | |
| C.2.12.1 | **Handrails** | X | See inspection report |
| a) | Identify and report type (steel pipe, galvanized pipe, square tube, angle) and size of handrails. | X | |
| b) | Inspect for pitting and holes, paint failure. | X | |
| c) | Inspect attachment welds. | X | |
| d) | Identify cold joints and sharp edges. Inspect the handrails and midrails. | X | |
| e) | Inspect safety drop bar (or safety chain) for corrosion, func ioning, and leng h. | X | |
| f) | Inspect the handrail between the rolling ladder and the gaging platform for a hazard-ous opening when the floating roof is at its lowest level. | X | |
| C.2.12.2 | **Platform Frame** | X | See inspection report |
| a) | Inspect frame for corrosion and paint failure. | X | |

| | Tank Out-of-service Inspection Checklist | | |
|---|---|---|---|
| | Item | Completed X | Comments |
| b) | Inspect the attachment of frame to supports and supports to tank for corrosion and weld failure. | X | |
| c) | Check reinforcing pads where supports are attached to shell or roof. | X | |
| d) | Inspect the surface that deck plate or grating rests on, for thinning and holes. | X | |
| e) | Check that flat-surface-to-flat-surface junctures are seal-welded. | X | |
| C.2.12.3 | **Deck Plate and Grating** | X | See inspection report |
| a) | Inspect deck plate for corrosion-caused hinning or holes (not drain holes) and paint failure. | X | |
| b) | Inspect plate-to-frame weld for rust scale buildup. | X | |
| c) | Inspect gra ing for corrosion-caused thinning of bars and failure of welds. | X | |
| d) | Check grating tie down clips. Where grating has been retrofitted to replace plate, | X | |
| | measure the rise of the step below and above the grating surface and compare with other risers on the stairway. | X | |
| C.2.12.4 | **Stairway Stringers** | NA | NA=Not applicable/accessible |
| a) | Inspect spiral stairway stringers for corrosion, paint failure, and weld failure. Inspect attachment of stairway treads to stringer. | NA | |
| b) | Inspect stairway supports to shell welds and reinforcing pads. | NA | |
| c) | Inspect steel support attachment to concrete base for corrosion. | NA | |
| C.2.12.5 | **Rolling Ladder** | NA | NA=Not applicable/accessible |
| a) | Inspect rolling ladder stringers for corrosion. | NA | |
| b) | Identify and inspect ladder fixed rungs (square bar, round bar, angles) for weld attachment to stringers and corrosion, particularly where angle rungs are welded to stringers. | NA | |
| c) | Check for wear and corrosion where rolling ladder attaches to gaging platform. | NA | |
| d) | Inspect pivot bar for wear and secureness. | NA | |
| e) | Inspect operation of self-leveling stairway treads. | NA | |
| f) | Inspect for corrosion and wear on moving parts. | NA | |
| g) | Inspect rolling ladder wheels for freedom of movement, flat spots, and wear on axle. | NA | |
| h) | Inspect alignment of rolling ladder with roof rack. | NA | |
| i) | Inspect top surface of rolling ladder track for wear by wheels to assure at least 18 in. of unworn track (track long enough). | NA | |
| j) | Inspect rolling ladder track welds for corrosion. | NA | |
| k) | Inspect track supports on roof for reinforcing pads seal-welded to deck plate. | NA | |
| l) | Check by dimensioning, the maximum angle of the rolling ladder when the roof is on low legs. | NA | |
| m) | If rolling ladder track extends to within 5 ft of the edge of the roof on the far side, check for a handrail on the top of the shell on that side. | NA | |
| NOTES - | | | |
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*FY-78 MILCON P-060, Repair Red Hill Fuel Storage Facility – Scope of Work*

1. Basic repairs by contractor:
   a. Mobilize electrical power, compressed air, water, and tank ventilation/dehumidification equipment. Note: electric power supplied from Hawaiian Electric Co. (HECO) directly to contractor substation at Red Hill.
   b. Isolate tank(s) to be repaired from in-service tanks connected to the Red Hill tank vent system.
   c. Drain residual fuel from nozzle pipes, remove skin valves, and install blinds on skin valve nozzle flanges except for the low-point drain line (slop line) to isolate tank(s) to be repaired from the fuel piping system.
   d. Drain tank bottom residual fuel and waste oil via the slop line to the waste oil/oily waste Stilling Basin outside Adit 3. Transport waste oil/oily waste by tank truck from the Adit 3 Stilling Basin to the Waste Oil Reclamation Facility at the Naval Supply Center on the Pearl Harbor Naval Base.
   e. Ventilate tank to condition of gas-free safe for entry. Continue ventilation throughout work in tank.
   f. Remove the 8-foot diameter flanged dished head for access to tank from Upper Tunnel. Use extreme care in handling to avoid damage to the 72-bolt flange face. Store the dished head in a protected area.
   g. Install lighting adequate for initial tank cleaning.
   h. Working from the catwalk, wash down the catwalk, center tower, and tank walls.
   i. Drain tank wash water, and oily waste from tank bottom via the slop line. Water and oily waste to the Adit 3 Stilling Basin.
   j. Squeegee, shovel, and pump sludge from the tank bottom to the Lower Access Tunnel (LAT) and load it into 55-gallon drums. Load drums onto GFE rail flat cars and coordinate with Fuel Department Operations to use the government owned locomotive to tow the flat cars to Adit 3. Contractor unload the drums and dispose of sludge off-site In accordance with environmental regulations.
   k. Flush and drain all liquid and solid material from the slop line nozzle pipe, remove skin valve, and install blinds on nozzle flanges to isolate tank from slop piping system.
   l. Hydrostatically test all manually operated skin (gate-type) valves and repair gate, valve seat, and packing as necessary to meet leakage criteria. Rehab valve motor operator on first valve downstream of each skin valve.
   m. Install additional lighting in tank.
   n. Check center tower for missing/loose bolting and missing structural members, and replace/tighten as necessary.
   o. Rehab/replace the elevator cab locked in place in the center tower at the catwalk level, and install new cables, safety stops, counterweights, power climbers, etc. to make it operational in accordance with appropriate safety codes. Remove and dispose of wooden stopping rails in center tower.

p. Permanently install structural members to stiffen and strengthen the upper end of the center tower to accommodate rotating dome truss scaffold.
q. Install rotating dome truss scaffold to provide access to tank shell in Upper Dome of tank.
r. Install trolley rail just above spring line level to support hanging scaffold platforms for access to tank shell in Barrel and Lower Dome of tank.
s. Remove and dispose of tell-tale pipes and pipe supports from tank walls in the Upper Dome, Barrel, and Lower Dome, and weld patch plates over thru-shell holes. Remove and dispose of tell-tale jumper pipes and the collector ring in the Lower Dome and weld patch plates over thru-shell holes.
t. Remove and dispose of steam lines and supports from tank bottom, and seal openings at the tank bottom for the steam supply line and steam condensate return line.
u. Brush blast the entire tank shell to expose welds and remove most rust from plate surfaces. During sand blasting and tank shell coating operations, tank ventilation is exhausted to the LAT via the 32-inch dia. pipe nozzle and through an air filter bank.
v. Inspect all existing welds; and test, grind, re-weld, and/or patch leaks (and suspected leaks) as required. Test welds with MT and/or PT. All existing welds, repaired welds, and new patch plate welds tested with soap film and vacuum box.
w. Inspect all areas of tank shell plates; and test, grind, weld, and/or patch holes (and suspected holes) as required. Test welds with MT and/or PT. All welds tested with soap film and vacuum box.
x. Seal weld channels over all vertical and horizontal joints connecting shell plates in the Upper Dome. Test all new welds.
y. Install fuel sample lines from various levels on tank shell to the Lower Access Tunnel.
z. Hydrostatically test fuel nozzle pipes and slop line nozzle pipe from tank bottom to first flange in Lower Access Tunnel, and repair or in the case of the slop line, slip-line, as required.
aa. Sandblast tank shell to white metal, clean all surfaces of sandblast residue, treat with acid wash primer, and coat with NRL polyurethane coating system. Note: After sandblast to white metal, apply flame sprayed aluminum to circular 20-foot diameter bottom plate at center of Lower Dome and lower half of first course of sloping plates adjacent to circular bottom plate prior to application of polyurethane coating system.
bb. De-mobilize and close tank
    (1) Remove rotating boom truss.
    (2) Remove trolley rail and handing scaffold platforms.
    (3) Lock elevator cab in place in the center tower at the catwalk level and remove cables, counterweights, power climbers, etc.
    (4) Remove lights, electrical power, compressed air, water, and tank ventilation equipment.
    (5) Reinstall 8-foot diameter bolted dished head at entryway to tank with new gasket.
    (6) Remove blinds from tank skin valve nozzle flanges and install repaired skin valves.
    (7) Reconnect tank to Red Hill tank vent system.

2. Fill test /leak check by Naval Supply Center Fuel Department:
    a. Reinstall and calibrate Asteroid float/tape/telemeter/counterweight level gauging system. Gauging system measures fuel level to nearest 0.001-foot (approx. 0.005-foot = 1/16-inch).
    b. Refill tank with fuel.
        (1) Use "old" thermally stable fuel from another Red Hill tank as much as possible. Avoid using fuel from tanks that are exposed to the sun in the Upper and Middle Tanks Farms.
        (2) Transfer fuel slowly by gravity as much as possible to:
            (a) avoid pumping which adds energy (heat) to fuel, and
            (b) avoid cavitation which can entrain air in the fuel
        (3) Fill tank to maximum fill level, 235-feet for Tanks 1-4 and 242-feet for Tanks 5-16. At that level a 0.001-foot change in tank level equals a volume change of approx. 2.35 gallons. Use strapping table for Upper Dome to compute precise volume per 0.001-foot level change.
    c. Close and tighten skin valves.
    d. Monitor skin valves for leakage.
    e. Gauge tank for water, if any, accumulated at bottom of tank. Measure quantity of water/fuel drawn off tank bottom via low-point drain (slop) line.
    f. Monitor and record telemeter reading on each 8-hour shift 24/7.
    g. Plot telemeter reading (y-axis) versus time (x-axis).
        (1) A straight line plot, i.e. a constant level drop with time most likely indicates a leak from either a hole(s) in the tank shell or a leak through a skin valve.
        (2) A curved line plot asymptotic to x-axis indicates most likely indicates fuel shrinkage over time due to fuel cooling.
    h. If indicated by leak test monitoring data, remove fuel from tank in stages to bring fuel level below the level of the hole through the shell.
    i. If monitoring data indicates probable leakage, transfer all fuel out of tank via main fuel pipelines except for fuel/water/residue in tank bottom.
    j. Slack main fuel pipelines in Lower Access Tunnel and drain residual fuel in nozzle pipelines from tank bottom to skin valves into main fuel pipelines.
    k. Drain fuel/water/residue from tank bottom via slop line to another fuel tank or to Adit 3 slop tank depending on fuel quality.
    l. Pull up and secure gauge float as high as possible in the tank to get it out of the way and preclude damage during leak rework.

3. Leak search and rework by contractor:
    a. Mobilize electrical power, compressed air, water, and tank ventilation systems.
    b. Isolate tank from in-service tanks in Red Hill tank vent system.
    c. Insert blinds at skin valve nozzle flanges except for the low-point drain line (slop line) to isolate tank from fuel piping system.

d. Ventilate tank to gas-free safe for entry condition. Continue ventilation throughout work in tank.
e. Remove 8-foot diameter dished head for access to tank from Upper Tunnel.
f. Install lighting adequate for tank cleaning.
g. Working from the catwalk wash down center tower and tank walls.
h. Drain tank wash water and residual sludge from tank bottom via the slop line.
i. Drain all liquid and solid material from slop line nozzle pipe, and insert a blind on nozzle flange at skin valve to isolate tank from slop piping system.
j. Install additional lighting.
k. Install two pad mounts on opposite legs of center tower to attach and support two telescoping box booms.
l. Fabricate and install two telescoping box booms each with a hanging man basket to provide access to all areas of the tank shell except the tank shell located below the catwalk.
m. Install a hanging scaffold platform beneath the catwalk to access the portion of tank shell inaccessible from the telescoping box booms.
n. Inspect all welds for leaks (backseepage of fuel); and test, grind, re-weld, and/or patch leaks (and suspected leaks) as required. Test repaired and suspect welds with MT and PT. All welds re-tested with vacuum box.
o. Inspect all areas of tank shell plates for leaks (backseepage of fuel); and test, grind, weld, and/or patch holes (and suspected holes) as required. Test repaired and suspect welds with MT and PT. All welds re-tested with vacuum box.
p. Prepare surface and recoat all repaired areas.
q. If no leaks found in tank shell, hydrostatically re-test fuel nozzle pipes and slop line nozzle pipe from tank bottom to first flange in Lower Access Tunnel, and repair or in the case of the slop line, slip-line, as required.
r. De-mobilize and close tank
    (1) Remove two spider booms and man baskets.
    (2) Remove lights, electrical power, compressed air, water, and tank ventilation equipment.
    (3) Reinstall 8-foot diameter bolted dished head at entryway to tank with new gasket.
    (4) Remove insert blinds from nozzle flanges at skin valves.
    (5) Reconnect tank to Red Hill tank vent system.

4. Fill test /leak check by Naval Supply Center Fuel Department:

# WILLBROS GOVERNMENT SERVICES

JOB NO.: 54118 PREPARED BY: TDA DATE: 1/27/2010 Rev 1

CLIENT NAME: NAVFAC CHECKED BY: GH SHEET: 1 OF 1

SUBJECT: Welding Procedure Specifications (WPS) & Procedure Qualification Record (PQR)

| Material | P No. | Process | Consumable/ Rod | Required Position | Progression | WGS / InServ Weld Procedure | Remarks |
|---|---|---|---|---|---|---|---|
| (see P No. ) | 1 | SMAW | 7018 | 6G | ↑ UP (ALL) | 1-S-1 | |
| (see P No. ) | 1 | SMAW | E7024 | 1F | F | 1-S-10 | |
| (see P No. ) | 1 | SMAW | 5P (6010) | 6G | ↓DOWN(ALL) | 1-S-6 | |
| (see P No. ) | 1 | SMAW | 5P / 7018 | 6G | ↑ UP (ALL) | 1-S-4 | |
| (see P No. ) | 1 | GTAW/SMAW | ER70S / 7018 | 6G | ALL | 1-TS-1 | |
| (see P No. ) | 1 | FCAW | | 1G/2G | ALL | 1-F-1 | |
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1. Per ASME IX Code Requirements.
2. System - Tanks, Piping & Pipe Attachments or Supports.

INTEGRATED SERVICE COMPANY, L.L.C.
1900 N. 161st. E. AVENUE
TULSA, OKLAHOMA 74116

**Welding Procedure Specification (WPS)**

WPS No.: 1-S-1 Date: 6/28/1994 Rev. No.: 0 

Supporting PQR(s): P1-E-1

Weld Type: **Groove and fillet welds**

**BASE METALS** (QW-403)
P-No. 1 Thickness Range: 0.1875 in. to 1.5000 in.
to P-No. 1

**PREHEAT** (QW-406)
Minimum Preheat Temperature: 50 °F
Maximum Interpass Temperature: 500 °F
Preheat Maintenance: None after weldment

**POSTWELD HEAT TREATMENT** (QW-407)
PWHT Type: No PWHT will be performed
PWHT Temperature : None °F
PWHT Holding Time: None

| | 1st Process | | |
|---|---|---|---|
| Weld Process / Method | **SMAW / Manual** | | |
| Weld Deposit Limit | 0.0000 in. to 1.5000 in. | | |
| **POSITION** (QW-405) | | | |
| Position of Joint | All Positions | | |
| Weld Progression | Vertical up | | |
| **FILLER METAL** (QW-404) | | | |
| AWS Classification | E7018 | | |
| SFA Spec. / F-No. | 5.1 / 4 | | |
| A-No. or Chemical Composition | 1 | | |
| Filler Metal Trade Name | n/r | | |
| Pass Greater Than ½": | No | | |
| Filler Metal Size (in.) | 1/8 | 5/32 | 3/16 |
| **ELECTRICAL** (QW-409) | | | |
| Welding Amperage Range | 90-160 | 110-200 | 200-300 |
| Welding Voltage Range | n/r | n/r | n/r |
| Travel Speed (in/min) | Var. | Var. | Var. |
| Max. Heat Input (J/in) | None | | |
| Current Type and Polarity | DCEP (reverse) | | |
| **TECHNIQUE** (QW-410) | | | |
| Peening | None | | |
| Stringer or Weave Bead | Stringer and weave bead | | |

(1) No peening done with this procedure.
No pass greater than 1/2" allowed.
Preheat to 175F if "T" > 1" and C > 0.30%;To 200F if 1.25 < "T" <= 1.5"

C - WPS IX - W - WPW 2010.1.0
Form 1999 Rev. 0

INTEGRATED SERVICE COMPANY, L.L.C.

Welding Procedure Specification (WPS)

WPS No.: I-S-I Rev. No.: 0 

JOINT DESIGN (QW-402)

Weld Type: Groove and fillet welds

| Joint Type | Backing | Root Opening | Groove Angle | Root Face | Groove Radius |
|---|---|---|---|---|---|
| Single-V groove | no backing | 3/16" max. | 50 degree min. | 1/8" max. | |
| Single-bevel groove | no backing | 3/16" max. | 45 degree min. | 1/8" max. | |
| Single-V groove | gouged & back welded | 1/4" max. | 50 degree min. | 3/16" max. | |
| Double-bevel groove | gouged & back welded | 1/4" max. | 45 degree min. | 3/16" max. | |
| Double-V groove | gouged & back welded | 1/4" max. | 45 degree min. | 3/16" max. | |
| Square groove | T-joint | 1/32" max. | | | |
| Square groove | no backing | 3/32" max. | | | |

Fillet Welds: All (QW-451.4)

Retainers: None

See fabrication drawing.

WELD JOINT DESCRIPTIONS SHOWN ARE NOT INCLUSIVE OF ALL THOSE FOUND ON A JOB. WELD JOINT DESIGN REFERENCE IN AN ENGINEERING SPECIFICATION OR A DESIGN DRAWING SHALL TAKE PRECEDENCE OVER WELD JOINTS SHOWN IN THIS WPS.

Initial and Interpass Cleaning: With wire brush clean 1" both sides of weld joint.

Method of Back Gouging: Grind until all defects are removed.

Minimum preheat must be maintained during thermal cutting, tacking, and welding operations.

Welds shall be cleaned between each pass. When completed, remove all slag and projections.

We certify that the statements in this specification are correct and in accordance with the requirements of Section IX of the ASME Code.

By: David S. Graves 6/28/1994 QC Manager

David S. Graves — Date

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**INTEGRATED SERVICE COMPANY, L.L.C.**
1900 N. 161st. E. AVENUE
TULSA, OKLAHOMA 74116

**Procedure Qualification Record (PQR)**

PQR No.: P1-E-1 Date: 3/17/1975 WPS No.: 1-S-1 

**JOINT DESIGN** (QW-402)
Weld Type: Groove weld
Groove Type: Single-V groove
Backing: Open butt, no back weld
Root Opening: 1/8 in. Root Face: 1/16 in.
Groove Angle: 60 °

**BASE METALS** (QW-403)
Specification Type and Grade:
SA-515, Grade 70 to SA-515, Grade 70
P-No. 1 Group No. 2 to P-No. 1 Group No. 2
Thickness (in.): 0.7500

**PREHEAT** (QW-406)
Minimum Preheat Temperature: 50 °F
Maximum Interpass Temperature: 500 °F
Preheat Maintenance: None after weldment

**POSTWELD HEAT TREATMENT** (QW-407)
Type: No PWHT performed
PWHT Temperature: None °F
PWHT Holding Time: None hr.

| | 1st Process | | |
|---|---|---|---|
| Weld Process / Method | **SMAW / Manual** | | |
| **POSITION** (QW-405) | | | |
| Position of Joint | 3G - Vertical | | |
| Weld Progression | Vertical up | | |
| **FILLER METAL** (QW-404) | | | |
| AWS Classification | E7018 | | |
| SFA Spec. / F-No. | 5.1 / 4 | | |
| A-No. or Chemical Composition | 1 | | |
| Filler Metal Trade Name | n/r | | |
| Weld Deposit 't' (in.) | 0.7500 | | |
| Pass Greater Than ½": | No | | |
| Filler Metal Size (in.) | 1/8 | 5/32 | - |
| **ELECTRICAL** (QW-409) | | | |
| Amperage Used | 90-110 | 110-150 | - |
| Voltage Used | 20 | 22-23 | - |
| Travel Speed (in/min) | 4-9 | 4-9 | - |
| Max. Heat Input (J/in) | None | | |
| Current Type and Polarity | DCEP (reverse) | | |
| **TECHNIQUE** (QW-410) | | | |
| Stringer or Weave Bead | Stringer and weave bead | | |

(1) Peening was not used with this weld test.
No Pass > 1/2" t.

INTEGRATED SERVICE COMPANY, L.L.C.

Procedure Qualification Record (PQR)

PQR No.: P1-E-1



**Tensile Test (QW-150)**

| Specimen No. | Diameter (in.) | Area ($in^2$) | Ultimate Total Load (lb) | Ultimate Unit Stress (PSI) | Failure Type and Location |
|---|---|---|---|---|---|
| 1 | 0.521 | 0.213 | 17100 | 80300 | Weld metal |
| 2 | 0.521 | 0.213 | 17400 | 81700 | Weld metal |

**Guided Bend Tests (QW-160)**

| Type and Figure No. | Result | Type and Figure No. | Result |
|---|---|---|---|
| QW-462.2 Side bend | Satisfactory | QW-462.2 Side bend | Satisfactory |
| QW-462.2 Side bend | Satisfactory | QW-462.2 Side bend | Satisfactory |

**Hardness Test - Brinell hardness**

| Location | Readings | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| SA-515 HAZ | 187 | 185 | 180 | | | | | |
| Weld Metal | 180 | 170 | 185 | | | | | |

Welder's Name: Herman Kohlmeyer I.D.: Stamp No.: K

PQR was done and welding of coupon was witnessed by: Cust-O-Fab Inc

Test conducted by: Metlab Testing Services Lab Test No.: P1-E-1

We certify that the statements in this record are correct and that the test welds were prepared, welded, and tested in accordance with the requirements of Section IX of the ASME Code.

By: David Gloves 3/17/1975 QC Manager

David S. Gloves Date

INTEGRATED SERVICE COMPANY, L.L.C.
1900 N. 161st. E. AVENUE
TULSA, OKLAHOMA 74116

**Welding Procedure Specification (WPS)**

WPS No.: 1-S-10 Date: 7/30/2008 Rev. No.: 0 

Supporting PQR(s): 7024-A

Weld Type: Groove and fillet welds

**BASE METALS** (QW-403)
P-No. 1 Thickness Range: 0.0625 in. to 0.7500 in.
to P-No. 1

**PREHEAT** (QW-406)
Minimum Preheat Temperature: 60 °F
Maximum Interpass Temperature: 400 °F
Preheat Maintenance: None

**POSTWELD HEAT TREATMENT** (QW-407)
PWHT Type: No PWHT will be performed
PWHT Temperature : None °F
PWHT Holding Time: None

| | 1st Process | | |
|---|---|---|---|
| Weld Process / Method | **SMAW / Manual** | | |
| Weld Deposit Limit | 0.7500 in. maximum | | |
| **POSITION** (QW-405) | | | |
| Position of Joint | Flat only | | |
| Weld Progression | N/A | | |
| **FILLER METAL** (QW-404) | | | |
| AWS Classification | E7024 | | |
| SFA Spec. / F-No. | 5.1 / 1 | | |
| A-No. or Chemical Composition | 1 | | |
| Pass Greater Than ½": | No | | |
| Filler Metal Size (in.) | 5/32 | 3/16 | 1/4 |
| **ELECTRICAL** (QW-409) | | | |
| Welding Amperage Range | 170-240 | 220-300 | 260-350 |
| Welding Voltage Range | n/r | n/r | n/r |
| Travel Speed (in/min) | Var. | Var. | Var. |
| Max. Heat Input (J/in) | None | | |
| Current Type and Polarity | DCEP (reverse) | | |
| **TECHNIQUE** (QW-410) | | | |
| Peening | None | | |
| Stringer or Weave Bead | Stringer and weave bead | | |
| Multiple / Single Pass (per side) | Multipass | | |

INTEGRATED SERVICE COMPANY, L.L.C.

Welding Procedure Specification (WPS)

WPS No.: 1-S-10 Rev. No.: 0 

JOINT DESIGN (QW-402)

Weld Type: Groove and fillet welds

| Joint Type | Backing | Root Opening | Groove Angle | Root Face | Groove Radius |
|---|---|---|---|---|---|
| Single-V groove | No backing | 3/16" max | 50 deg min | 1/8" max | |
| Single bevel | No backing | 3/16" max | 45 deg min | 1/8" max | |
| Single-V groove | Gouged & back welded | 1/4" max | 50 deg min | 3/16" max | |
| Double bevel | Gouged & back welded | 1/4" max | 45 deg min | 3/16" max | |
| Double-V groove | Gouged & back welded | 1/4" max | 45 deg min | 3/16" max | |
| Square groove | T-joint | 1/32" max | | | |
| Square groove | No backing | 3/32" max | | | |

Fillet Welds: All fillet sizes on all base metal thicknesses and all diameters.

Retainers: None

WELD JOINT DESCRIPTIONS SHOWN ARE NOT INCLUSIVE OF ALL THOSE FOUND ON A JOB. WELD JOINT DESIGN REFERENCE IN AN ENGINEERING SPECIFICATION OR A DESIGN DRAWING SHALL TAKE PRECEDENCE OVER WELD JOINTS SHOWN IN THIS WPS.

Initial and Interpass Cleaning: With wire brush clean 1 inch (25 mm) on both sides of weld joint

Method of Back Gouging: When required, grind until all defects are removed.

Minimum preheat must be maintained during thermal cutting, tacking, and welding operations.
Welds shall be cleaned between each pass. When completed, remove all slag and projections.

We certify that the statements in this specification are correct and in accordance with the requirements of Section IX of the ASME Code.

By: David Haas 7/30/2008 QC Process Manager
Date

INTEGRATED SERVICE COMPANY, L.L.C.
1900 N. 161st. E. AVENUE
TULSA, OKLAHOMA 74116

**Procedure Qualification Record (PQR)**

PQR No.: 7024-A Date: 10/21/1987 WPS No.: 1-S-10 

**JOINT DESIGN** (QW-402)
Weld Type: Groove weld
Groove Type: Single-V groove
Backing: Open butt, no back weld
Root Opening: 3/32 in. Root Face: 1/8 in.
Groove Angle: 60 °

**BASE METALS** (QW-403)
Specification Type and Grade:
SA-36 to SA-36
P-No. 1 Group No. 1 to P-No. 1 Group No. 1
Thickness (in.): 0.3750

**PREHEAT** (QW-406)
Minimum Preheat Temperature: 100 °F
Maximum Interpass Temperature: 400 °F
Preheat Maintenance: None after welding

**POSTWELD HEAT TREATMENT** (QW-407)
Type: No PWHT performed
PWHT Temperature: None °F
PWHT Holding Time: None hr.

| | 1st Process<br>**SMAW / Manual** | | |
|---|---|---|---|
| Weld Process / Method | | | |
| **POSITION** (QW-405) | | | |
| Position of Joint | 1G - Flat | | |
| Weld Progression | N/A | | |
| **FILLER METAL** (QW-404) | | | |
| AWS Classification | E7024 | | |
| SFA Spec. / F-No. | 5.1 / 1 | | |
| A-No. or Chemical Composition | 1 | | |
| Filler Metal Trade Name | n/r | | |
| Weld Deposit 't' (in.) | 0.3750 | | |
| Pass Greater Than ½": | No | | |
| Filler Metal Size (in.) | 1/8 | 5/32 | 3/16 |
| **ELECTRICAL** (QW-409) | | | |
| Amperage Used | 195 | 225 | 255 |
| Voltage Used | 24 | 27 | 28 |
| Travel Speed (in/min) | 3-5 | 5-7 | 6-8 |
| Max. Heat Input (J/in) | None | | |
| Current Type and Polarity | DCEP (reverse) | | |
| **TECHNIQUE** (QW-410) | | | |
| Stringer or Weave Bead | Stringer and weave bead | | |

(1) Peening was not used with this weld test.

INTEGRATED SERVICE COMPANY, L.L.C.

**Procedure Qualification Record (PQR)**

PQR No.: 7024-A



**Tensile Test (QW-150)**

| Specimen No. | Width (in.) | Thickness (in.) | Area ($in^2$) | Ultimate Total Load (lb) | Ultimate Unit Stress (PSI) | Failure Type and Location |
|---|---|---|---|---|---|---|
| 1 | 1.000 | 0.375 | 0.375 | 28000 | 74700 | Base metal |
| 2 | 1.000 | 0.375 | 0.375 | 28000 | 74700 | Base metal |

**Guided Bend Tests (QW-160)**

| Type and Figure No. | Result | Type and Figure No. | Result |
|---|---|---|---|
| QW-462.3(a) Face bend | Acceptable | QW-462.3(a) Root bend | Acceptable |
| QW-462.3(a) Face bend | Acceptable | QW-462.3(a) Root bend | Acceptable |

**Hardness Test - Brinell hardness**

| Location | Readings | | |
|---|---|---|---|
| SA-36 BM | 198 | 181 | 196 |
| SA-36 HAZ | 188 | 182 | 190 |
| Weld metal | 160 | 163 | 188 |

Visual Examination: Satisfactory

Liquid Penetrant Test: Satisfactory

Added hardness, visual and penetrant results January 12, 2009.

Welder's Name: Charlie Wood I.D.: Stamp No.: A

PQR was done and welding of coupon was witnessed by: Cust-O-Fab

Test conducted by: Tulsa Testing and Insp. Lab Test No.: 2024-A

We certify that the statements in this record are correct and that the test welds were prepared, welded, and tested in accordance with the requirements of Section IX of the ASME Code.

By: David S. Glaves 10/21/1987 QC Manager
David S. Glaves Date

INTEGRATED SERVICE COMPANY, L.L.C.
1900 N. 161st. E. AVENUE
TULSA, OKLAHOMA 74116

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## Welding Procedure Specification (WPS)

WPS No.: 1-S-6 Date: 2/24/1999 Rev. No.: 2 Date: 7/16/1999 

Supporting PQR(s): 99-010016-2

Weld Type: **Groove and fillet welds**

**BASE METALS** (QW-403)
P-No. 1 Thickness Range: 0.1875 in. to 0.8640 in.
to P-No. 1

**PREHEAT** (QW-406)
Minimum Preheat Temperature: 60 °F
Maximum Interpass Temperature: 550 °F
Preheat Maintenance: None after weldment

**POSTWELD HEAT TREATMENT** (QW-407)
PWHT Type: No PWHT will be performed
PWHT Temperature : None °F
PWHT Holding Time: None

| | 1st Process | | |
|---|---|---|---|
| Weld Process / Method | **SMAW / Manual** | | |
| Weld Deposit Limit | 0.0000 in. to 0.2500 in. | | |
| **POSITION** (QW-405) | | | |
| Position of Joint | All Positions | | |
| Weld Progression | Any | | |
| **FILLER METAL** (QW-404) | | | |
| AWS Classification | E6010 | | |
| SFA Spec. / F-No. | 5.1 / 3 | | |
| A-No. or Chemical Composition | 1 | | |
| Filler Metal Trade Name | n/r | | |
| Pass Greater Than ½": | No | | |
| Filler Metal Size (in.) | 3/32 | 1/8 | 5/32 |
| **ELECTRICAL** (QW-409) | | | |
| Welding Amperage Range | 60-90 | 80-120 | 110-165 |
| Welding Voltage Range | n/r | n/r | n/r |
| Travel Speed (in/min) | Var. | Var. | Var. |
| Max. Heat Input (J/in) | None | | |
| Current Type and Polarity | DCEP (reverse) | | |
| **TECHNIQUE** (QW-410) | | | |
| Peening | None | | |
| Stringer or Weave Bead | Stringer and weave bead | | |

(1) No peening done with this procedure.
Revision 2: Progression.
Preheat to 175F if "T" > 1" and C > 0.30%; To 200F if 1.25" < "T" <= 1.5"

C - WPS IX - W - WPW 2010.1.0
Form 1999 Rev. 0

INTEGRATED SERVICE COMPANY, L.L.C.

Welding Procedure Specification (WPS)

WPS No.: 1-S-6 Rev. No.: 2 

JOINT DESIGN (QW-402)

Weld Type: Groove and fillet welds

| Joint Type | Backing | Root Opening | Groove Angle | Root Face | Groove Radius |
|---|---|---|---|---|---|
| Single-V groove | no backing | 3/16" max. | 50 degree min. | 1/8" max. | |
| Single-bevel groove | no backing | 3/16" max. | 45 degree min. | 1/8" max. | |
| Single-V groove | gouged & back welded | 1/4" max. | 50 degree min. | 3/16" max. | |
| Double-bevel groove | gouged & back welded | 1/4" max. | 45 degree min. | 3/16" max. | |
| Double-V groove | gouged & back welded | 1/4" max. | 45 degree min. | 3/16" max. | |
| Square groove | T-joint | 1/32" max. | | | |
| Square groove | no backing | 3/32" max. | | | |

Fillet Welds: All (QW-451.4)

Retainers: None

See fabrication drawing.

WELD JOINT DESCRIPTIONS SHOWN ARE NOT INCLUSIVE OF ALL THOSE FOUND ON A JOB. WELD JOINT DESIGN REFERENCE IN AN ENGINEERING SPECIFICATION OR A DESIGN DRAWING SHALL TAKE PRECEDENCE OVER WELD JOINTS SHOWN IN THIS WPS.

Initial and Interpass Cleaning: With wire brush clean 1" both sides of weld joint.

Method of Back Gouging: When required, grind until all defects are removed.

Minimum preheat must be maintained during thermal cutting, tacking, and welding operations.

Welds shall be cleaned between each pass. When completed, remove all slag and projections.

We certify that the statements in this specification are correct and in accordance with the requirements of Section IX of the ASME Code.

By: David S. Glaves 2/24/1999 QC Manager

David S. Glaves Date

INTEGRATED SERVICE COMPANY, L.L.C.
1900 N. 161st. E. AVENUE
TULSA, OKLAHOMA 74116

**Procedure Qualification Record (PQR)**

PQR No.: 99-010016-2 Date: 1/8/1999 WPS No.: 1-S-6 

| **JOINT DESIGN** (QW-402) | | **BASE METALS** (QW-403) | |
|---|---|---|---|
| Weld Type: | Groove weld | Specification Type and Grade: | SA-106, Grade B to SA-106, Grade B |
| Groove Type: | Single-V groove | P-No. 1 Group No. 1 | to P-No. 1 Group No. 1 |
| Backing: | Open butt, no back weld | Thickness (in.): | 0.4320 |
| Root Opening: 1/8 in. | Root Face: 1/16 in. | Diameter (in.): | 6.6250 |
| Groove Angle: 75 ° | | | |
| **PREHEAT** (QW-406) | | **POSTWELD HEAT TREATMENT** (QW-407) | |
| Minimum Preheat Temperature: | 60 °F | Type: | No PWHT performed |
| Maximum Interpass Temperature: | 350 °F | PWHT Temperature: | None °F |
| Preheat Maintenance: | None | PWHT Holding Time: | None hr. |

| | 1st Process | 2nd Process |
|---|---|---|
| Weld Process / Method | **SMAW / Manual** | **SMAW / Manual** |
| **POSITION** (QW-405) | | |
| Position of Joint | 6G - 45 degree pipe | 6G - 45 degree pipe |
| Weld Progression | Vertical up and down | Vertical up and down |
| **FILLER METAL** (QW-404) | | |
| AWS Classification | E6010 | E7018 |
| SFA Spec. / F-No. | 5.1 / 3 | 5.1 / 4 |
| A-No. or Chemical Composition | 1 | 1 |
| Filler Metal Trade Name | n/r | n/r |
| Weld Deposit 't' (in.) | 0.1250 | 0.3070 |
| Pass Greater Than ½": | No | No |
| Filler Metal Size (in.) | 3/32 \| - \| - | 1/8 \| - \| - |
| **ELECTRICAL** (QW-409) | | |
| Amperage Used | 90 \| - \| - | 100 \| - \| - |
| Voltage Used | 23 \| - \| - | 24 \| - \| - |
| Travel Speed (in/min) | Var. \| - \| - | Var. \| - \| - |
| Max. Heat Input (J/in) | None | None |
| Current Type and Polarity | DCEP (reverse) | DCEP (reverse) |
| **TECHNIQUE** (QW-410) | | |
| Stringer or Weave Bead | Stringer bead | Stringer bead |

(1) Peening was not used with this weld test.
Revised to define root pass progression up, fill passes down.

INTEGRATED SERVICE COMPANY, L.L.C.

Procedure Qualification Record (PQR)

PQR No.: 99-010016-2



**Tensile Test (QW-150)**

| Specimen No. | Width (in.) | Thickness (in.) | Area (in²) | Ultimate Total Load (lb) | Ultimate Unit Stress (PSI) | Failure Type and Location |
|---|---|---|---|---|---|---|
| 1 | 0.743 | 0.399 | 0.296 | 24110 | 81500 | Ductile - BM |
| 2 | 0.745 | 0.384 | 0.286 | 23890 | 83500 | Ductile - BM |

**Guided Bend Tests (QW-160)**

| Type and Figure No. | Result | Type and Figure No. | Result |
|---|---|---|---|
| QW-462.2 Side bend | Satisfactory | QW-462.2 Side bend | Satisfactory |
| QW-462.2 Side bend | Satisfactory | QW-462.2 Side bend | Satisfactory |

**Hardness Test - Brinell hardness**

| Location | Readings | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| SA-106 BM | 150 | 150 | 160 | | | | | | | |
| SA-106 HAZ | 185 | 185 | 190 | | | | | | | |
| Weld Metal | 190 | 190 | 185 | | | | | | | |

Welder's Name: Jesse Hobbs I.D.: Stamp No.: JH

PQR was done and welding of coupon was witnessed by: Cust-O-Fab Service Co.

Test conducted by: Sherry Laboratories Lab Test No.: 99-010016-2

We certify that the statements in this record are correct and that the test welds were prepared, welded, and tested in accordance with the requirements of Section IX of the ASME Code.

By: David S. Glaves 1/8/1999 Date QC Manager

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**INTEGRATED SERVICE COMPANY, L.L.C.**
1900 N. 161st. E. AVENUE
TULSA, OKLAHOMA 74116

**Welding Procedure Specification (WPS)**

WPS No.: 1-S-4 Date: 1/8/1999 Rev. No.: 0 

Supporting PQR(s): 99-010016-2

Weld Type: **Groove and fillet welds**

**BASE METALS** (QW-403)
P-No. 1 Thickness Range: 0.1875 in. to 0.8640 in.
to P-No. 1

| **PREHEAT** (QW-406) | | **POSTWELD HEAT TREATMENT** (QW-407) | |
|---|---|---|---|
| Minimum Preheat Temperature: | 60 °F | PWHT Type: | No PWHT will be performed |
| Maximum Interpass Temperature: | 350 °F | PWHT Temperature : | None °F |
| Preheat Maintenance: | None | PWHT Holding Time: | None |

| | 1st Process | | | 2nd Process | | |
|---|---|---|---|---|---|---|
| Weld Process / Method | **SMAW / Manual** | | | **SMAW / Manual** | | |
| Weld Deposit Limit | 0.2500 in. maximum | | | 0.6140 in. maximum | | |
| **POSITION** (QW-405) | | | | | | |
| Position of Joint | All Positions | | | All Positions | | |
| Weld Progression | Any | | | Vertical up | | |
| **FILLER METAL** (QW-404) | | | | | | |
| AWS Classification | E6010 | | | E7018 | | |
| SFA Spec. / F-No. | 5.1 / 3 | | | 5.1 / 4 | | |
| A-No. or Chemical Composition | 1 | | | 1 | | |
| Pass Greater Than ½": | No | | | No | | |
| Filler Metal Size (in.) | 3/32 | 1/8 | 5/32 | 3/32 | 1/8 | 5/32 |
| **ELECTRICAL** (QW-409) | | | | | | |
| Welding Amperage Range | 60-90 | 80-120 | 110-165 | 70-110 | 90-160 | 130-220 |
| Welding Voltage Range | n/r | n/r | n/r | n/r | n/r | n/r |
| Travel Speed (in/min) | Var. | Var. | Var. | Var. | Var. | Var. |
| Max. Heat Input (J/in) | None | | | None | | |
| Current Type and Polarity | DCEP (reverse) | | | DCEP (reverse) | | |
| **TECHNIQUE** (QW-410) | | | | | | |
| Peening | None | | | None | | |
| Stringer or Weave Bead | Stringer bead | | | Stringer bead | | |
| Multiple / Single Pass (per side) | Multipass | | | Multipass | | |

INTEGRATED SERVICE COMPANY, L.L.C.

Welding Procedure Specification (WPS)

WPS No.: I-S-4 Rev. No.: 0 

JOINT DESIGN (QW-402)

Weld Type: Groove and fillet welds

| Joint Type | Backing | Root Opening | Groove Angle | Root Face | Groove Radius |
|---|---|---|---|---|---|
| Single-V groove | No backing | 3/16" max | 50 deg min | 1/8" max | |
| Single bevel | No backing | 3/16" max | 45 deg min | 1/8" max | |
| Single-V groove | Gouged & back welded | 1/4" max | 50 deg min | 3/16" max | |
| Double bevel | Gouged & back welded | 1/4" max | 45 deg min | 3/16" max | |
| Double-V groove | Gouged & back welded | 1/4" max | 45 deg min | 3/16" max | |
| Square groove | T-joint | 1/32" max | | | |
| Square groove | No backing | 3/32" max | | | |

Fillet Welds: All fillet sizes on all base metal thicknesses and all diameters.

Retainers: None

WELD JOINT DESCRIPTIONS SHOWN ARE NOT INCLUSIVE OF ALL THOSE FOUND ON A JOB. WELD JOINT DESIGN REFERENCE IN AN ENGINEERING SPECIFICATION OR A DESIGN DRAWING SHALL TAKE PRECEDENCE OVER WELD JOINTS SHOWN IN THIS WPS.

Initial and Interpass Cleaning: With wire brush clean 1 inch (25 mm) on both sides of weld joint

Method of Back Gouging: When required, grind until all defects are removed.

Minimum preheat must be maintained during thermal cutting, tacking, and welding operations.
Welds shall be cleaned between each pass. When completed, remove all slag and projections.

We certify that the statements in this specification are correct and in accordance with the requirements of Section IX of the ASME Code.

By: _____ 1/8/1999 QC Manager

David S. Graves — Date

C - WPS IX - W - WPS 2010.1.0
Form 2860 Rev. 0

INTEGRATED SERVICE COMPANY, L.L.C.
1900 N. 161st. E. AVENUE
TULSA, OKLAHOMA 74116

**Procedure Qualification Record (PQR)**

PQR No.: 99-010016-2 Date: 1/8/1999 WPS No.: 1-S-4 

| | |
|---|---|
| **JOINT DESIGN** (QW-402) | **BASE METALS** (QW-403) |
| Weld Type: Groove weld | Specification Type and Grade: |
| Groove Type: Single-V groove | SA-106, Grade B to SA-106, Grade B |
| Backing: Open butt, no back weld | P-No. 1 Group No. 1 to P-No. 1 Group No. 1 |
| Root Opening: 1/8 in. Root Face: 1/16 in. | Thickness (in.): 0.4320 |
| Groove Angle: 75 ° | Diameter (in.): 6.6250 |
| **PREHEAT** (QW-406) | **POSTWELD HEAT TREATMENT** (QW-407) |
| Minimum Preheat Temperature: 60 °F | Type: No PWHT performed |
| Maximum Interpass Temperature: 350 °F | PWHT Temperature: None °F |
| Preheat Maintenance: None | PWHT Holding Time: None hr. |

| | 1st Process | 2nd Process |
|---|---|---|
| Weld Process / Method | **SMAW / Manual** | **SMAW / Manual** |
| **POSITION** (QW-405) | | |
| Position of Joint | 6G - 45 degree pipe | 6G - 45 degree pipe |
| Weld Progression | Vertical up and down | Vertical up and down |
| **FILLER METAL** (QW-404) | | |
| AWS Classification | E6010 | E7018 |
| SFA Spec. / F-No. | 5.1 / 3 | 5.1 / 4 |
| A-No. or Chemical Composition | 1 | 1 |
| Filler Metal Trade Name | n/r | n/r |
| Weld Deposit 't' (in.) | 0.1250 | 0.3070 |
| Pass Greater Than ½": | No | No |
| Filler Metal Size (in.) | 3/32 \| - \| - | 1/8 \| - \| - |
| **ELECTRICAL** (QW-409) | | |
| Amperage Used | 90 \| - \| - | 100 \| - \| - |
| Voltage Used | 23 \| - \| - | 24 \| - \| - |
| Travel Speed (in/min) | Var. \| - \| - | Var. \| - \| - |
| Max. Heat Input (J/in) | None | None |
| Current Type and Polarity | DCEP (reverse) | DCEP (reverse) |
| **TECHNIQUE** (QW-410) | | |
| Stringer or Weave Bead | Stringer bead | Stringer bead |

(1) Peening was not used with this weld test.
Revised to define root pass progression up, fill passes down.

INTEGRATED SERVICE COMPANY, L.L.C.

**Procedure Qualification Record (PQR)**

PQR No.: 99-010016-2 

**Tensile Test (QW-150)**

| Specimen No. | Width (in.) | Thickness (in.) | Area (in²) | Ultimate Total Load (lb) | Ultimate Unit Stress (PSI) | Failure Type and Location |
|---|---|---|---|---|---|---|
| 1 | 0.743 | 0.399 | 0.296 | 24110 | 81500 | Ductile - BM |
| 2 | 0.745 | 0.384 | 0.286 | 23890 | 83500 | Ductile - BM |

**Guided Bend Tests (QW-160)**

| Type and Figure No. | Result | Type and Figure No. | Result |
|---|---|---|---|
| QW-462.2 Side bend | Satisfactory | QW-462.2 Side bend | Satisfactory |
| QW-462.2 Side bend | Satisfactory | QW-462.2 Side bend | Satisfactory |

**Hardness Test - Brinell hardness**

| Location | Readings | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| SA-106 BM | 150 | 150 | 160 | | | | | |
| SA-106 HAZ | 185 | 185 | 190 | | | | | |
| Weld Metal | 190 | 190 | 185 | | | | | |

Welder's Name: Jesse Hobbs I.D.: Stamp No.: JH

PQR was done and welding of coupon was witnessed by: Cust-O-Fab Service Co.

Test conducted by: Sherry Laboratories Lab Test No.: 99-010016-2

We certify that the statements in this record are correct and that the test welds were prepared, welded, and tested in accordance with the requirements of Section IX of the ASME Code.

By: David S. Glaves 1/8/1999 QC Manager
Date

C - PQR IX - W - WPW 2010 1.0
Form 1999 Rev. 0

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**INTEGRATED SERVICE COMPANY, L.L.C.**
1900 N. 161st. E. AVENUE
TULSA, OKLAHOMA 74116

**Welding Procedure Specification (WPS)**

WPS No.: 1-TS-1 Date: 7/20/1994 Rev. No.: 0 

Supporting PQR(s): 92-159-1

Weld Type: **Groove and fillet welds**

**BASE METALS** (QW-403)
P-No. 1 Thickness Range: 0.1875 in. to 1.5000 in.
to P-No. 1

**PREHEAT** (QW-406)
Minimum Preheat Temperature: 200 °F
Maximum Interpass Temperature: 550 °F
Preheat Maintenance: None after weldment

**POSTWELD HEAT TREATMENT** (QW-407)
PWHT Type: No PWHT will be performed
PWHT Temperature : None °F
PWHT Holding Time: None

| | 1st Process | 2nd Process |
|---|---|---|
| Weld Process / Method | **GTAW / Manual** | **SMAW / Manual** |
| Weld Deposit Limit | 0.0000 in. to 0.3750 in. | 0.0000 in. to 1.1250 in. |
| **POSITION** (QW-405) | | |
| Position of Joint | All Positions | All Positions |
| Weld Progression | Any | Vertical up |
| **GAS** (QW-408) | | |
| Shielding Gas / CFH | 100% Argon / 27-36 | |
| Trailing Gas / CFH | None / - | |
| Backing Gas / CFH | None / - | |
| **FILLER METAL** (QW-404) | | |
| AWS Classification | ER70S-2 | E7018 |
| SFA Spec. / F-No. | 5.18 / 6 | 5.1 / 4 |
| A-No. or Chemical Composition | 1 | 1 |
| Filler Metal Trade Name | n/r | n/r |
| Filler Metal Product Form | Bare (Solid) | |
| Consumable Insert | None | |
| Pass Greater Than ½": | | No |
| Filler Metal Size (in.) | 1/16 \| 3/32 \| 1/8 | 5/32 \| 3/16 \| 7/32 |
| **ELECTRICAL** (QW-409) | | |
| Welding Amperage Range | 70-150 \| 80-180 \| 130-275 | 130-220 \| 200-300 \| 250-350 |
| Welding Voltage Range | n/r \| n/r \| n/r | n/r \| n/r \| n/r |
| Travel Speed (in/min) | Var. \| Var. \| Var. | Var. \| Var. \| Var. |
| Max. Heat Input (J/in) | None | None |
| Current Type and Polarity | DCEN (straight) | DCEP (reverse) |
| Tungsten Type / Size | EWTh-2 / 1/16" - 3/16" | |
| Pulsed Current | None | |
| **TECHNIQUE** (QW-410) | | |
| Peening | None | None |
| Stringer or Weave Bead | Stringer and weave bead | Stringer and weave bead |
| Multiple / Single Pass (per side) | Multipass | |
| Nozzle / Gas Cup Size | # 5 to # 10 | |

(1) No peening done with this procedure.
No pass greater than 1/2" allowed.
Preheat to 200 Deg.F.for repairs.
Preheat to 175F if "T" > 1" and C > 0.30%;To 200F if 1.25 < "T" <= 1.5"

INTEGRATED SERVICE COMPANY, L.L.C.

Welding Procedure Specification (WPS)

WPS No.: I-TS-1 Rev. No.: 0 

JOINT DESIGN (QW-402)

Weld Type: Groove and fillet welds

| Joint Type | Backing | Root Opening | Groove Angle | Root Face | Groove Radius |
|---|---|---|---|---|---|
| Single-V groove | no backing | 3/16" max. | 50 degree min. | 1/8" max. | |
| Single-bevel groove | no backing | 3/16" max. | 45 degree min. | 1/8" max. | |
| Single-V groove | gouged & back welded | 1/4" max. | 50 degree min. | 3/16" max. | |
| Double-bevel groove | gouged & back welded | 1/4" max. | 45 degree min. | 3/16" max. | |
| Double-V groove | gouged & back welded | 1/4" max. | 45 degree min. | 3/16" max. | |
| Square groove | T-joint | 1/32" max. | | | |
| Square groove | no backing | 3/32" max. | | | |

Fillet Welds: All (QW-451.4)

Retainers: None

See fabrication drawing.

WELD JOINT DESCRIPTIONS SHOWN ARE NOT INCLUSIVE OF ALL THOSE FOUND ON A JOB. WELD JOINT DESIGN REFERENCE IN AN ENGINEERING SPECIFICATION OR A DESIGN DRAWING SHALL TAKE PRECEDENCE OVER WELD JOINTS SHOWN IN THIS WPS.

Initial and Interpass Cleaning: With wire brush clean 1" both sides of weld joint.

Method of Back Gouging: Grind until all defects are removed.

Minimum preheat must be maintained during thermal cutting, tacking, and welding operations.

Welds shall be cleaned between each pass. When completed, remove all slag and projections.

We certify that the statements in this specification are correct and in accordance with the requirements of Section IX of the ASME Code.

By: David S. Glaves 7/20/1994 QC Manager

David S. Glaves Date

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**INTEGRATED SERVICE COMPANY, L.L.C.**
1900 N. 161st. E. AVENUE
TULSA, OKLAHOMA 74116

**Procedure Qualification Record (PQR)**

PQR No.: 92-159-1 Date: 1/10/1992 WPS No.: 1-TS-1 

**JOINT DESIGN** (QW-402)
Weld Type: Groove weld
Groove Type: Single-V groove
Backing: Open butt, no back weld
Root Opening: 1/8 in. Root Face: 1/32 in.
Groove Angle: 60-70 °
None

**BASE METALS** (QW-403)
Specification Type and Grade:
SA-516, Grade 70 to SA-516, Grade 70
P-No. 1 Group No. 2 to P-No. 1 Group No. 2
Thickness (in.): 0.7500
None

**PREHEAT** (QW-406)
Minimum Preheat Temperature: 175 °F
Maximum Interpass Temperature: 450 °F
Preheat Maintenance: None after weldment
None

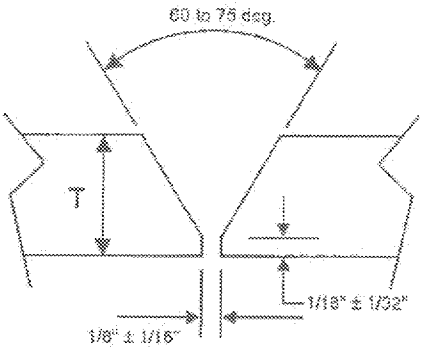
**POSTWELD HEAT TREATMENT** (QW-407)
Type: No PWHT performed
PWHT Temperature: None °F
PWHT Holding Time: None hr.
N/A

| | 1st Process **GTAW / Manual** | | | 2nd Process **SMAW / Manual** | | |
|---|---|---|---|---|---|---|
| Weld Process / Method | | | | | | |
| **POSITION** (QW-405) | | | | | | |
| Position of Joint | 1G - Flat | | | 1G - Flat | | |
| Weld Progression | N/A | | | N/A | | |
| Notes | None | | | None | | |
| **GAS** (QW-408) | | | | | | |
| Shielding Gas / CFH | 100% Argon / 30 | | | | | |
| Trailing Gas / CFH | None / - | | | | | |
| Backing Gas / CFH | None / - | | | | | |
| **FILLER METAL** (QW-404) | | | | | | |
| AWS Classification | ER70S-2 | | | E7018 | | |
| SFA Spec. / F-No. | 5.18 / 6 | | | 5.1 / 4 | | |
| A-No. or Chemical Composition | 1 | | | 1 | | |
| Filler Metal Trade Name | n/r | | | n/r | | |
| Filler Metal Product Form | Bare (Solid) | | | | | |
| Consumable Insert | None | | | | | |
| GTAW Flux | N/A | | | | | |
| Weld Deposit 't' (in.) | 0.1875 | | | 0.5625 | | |
| Pass Greater Than ½": | | | | No | | |
| Filler Metal Size (in.) | 3/32 | - | - | 5/32 | 3/16 | - |
| **ELECTRICAL** (QW-409) | | | | | | |
| Amperage Used | 120 | - | - | 175 | 225 | - |
| Voltage Used | 18 | - | - | 24 | 28 | - |
| Travel Speed (in/min) | Var. | - | - | Var. | Var. | - |
| Max. Heat Input (J/in) | NR | | | NR | | |
| Current Type and Polarity | DCEN (straight) | | | DCEP (reverse) | | |
| Tungsten Type / Size | EWTh-2 / 1/8 | | | | | |
| Pulsed Current | None | | | | | |
| **TECHNIQUE** (QW-410) | | | | | | |
| Thermal Processes: | No | | | No | | |
| Stringer or Weave Bead | Stringer bead | | | Stringer bead | | |
| Multiple / Single Pass (per side) | Multipass | | | Multipass | | |
| Nozzle / Gas Cup Size | # 8 | | | | | |

(1) (1) Peening was not used with this weld test.
(2) No Pass > 1/2" t.
10-20-08; corrected typo "No Thermal Processes".

(2) None

Joint Detail Image




SINGLE VEE GROOVE

INTEGRATED SERVICE COMPANY, L.L.C.

Procedure Qualification Record (PQR)

PQR No.: 92-159-1 

**Tensile Test (QW-150)**

| Specimen No. | Width (in.) | Thickness (in.) | Area (in²) | Ultimate Total Load (lb) | Ultimate Unit Stress (PSI) | Failure Type and Location |
|---|---|---|---|---|---|---|
| 1 | 0.754 | 0.760 | 0.573 | 43400 | 75700 | Base metal |
| 2 | 0.750 | 0.755 | 0.566 | 43000 | 76000 | Base metal |

**Guided Bend Tests (QW-160)**

| Type and Figure No. | Result | Type and Figure No. | Result |
|---|---|---|---|
| QW-462.2 Side bend | Satisfactory | QW-462.2 Side bend | Satisfactory |
| QW-462.2 Side bend | Satisfactory | QW-462.2 Side bend | Satisfactory |

**Hardness Test - Brinell hardness**

| Location | Readings | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| SA-516 BM | 140 | 156 | 146 | | | | | | | |
| SA-516 HAZ | 167 | 174 | 174 | | | | | | | |
| Weld Metal | 149 | 140 | 156 | | | | | | | |

Visual Examination: Satisfactory

None

Welder's Name: Paul Stokes I.D.: - Stamp No.: R

PQR was done and welding of coupon was witnessed by: Integrated Service Company LLC

Test conducted by: Metlab Testing Services Lab Test No.: 92-159-1

We certify that the statements in this record are correct and that the test welds were prepared, welded, and tested in accordance with the requirements of Section IX of the ASME Code.

By: R.S.L 1/10/1993 MFG QC Manager

Roy Laird (Date)

C - PQR IX - W - WPW 2016.1.0
Form 3006 Rev. 0

INSERV
INTEGRATED SERVICE COMPANY LLC
A WILLBROS COMPANY

**INTEGRATED SERVICE COMPANY, L.L.C.**
1900 N. 161st. E. AVENUE
TULSA, OKLAHOMA 74116

**Welding Procedure Specification (WPS)**

WPS No.: 1-F-1 Date: 7/13/1994 Rev. No.: 0 

Supporting PQR(s): 90-1884-6 ; 92-2474

Weld Type: **Groove and fillet welds**

**BASE METALS** (QW-403)
P-No. 1 Thickness Range: 0.0625 in. to 1.5000 in.
to P-No. 1

**PREHEAT** (QW-406)
Minimum Preheat Temperature: 50 °F
Maximum Interpass Temperature: 600 °F
Preheat Maintenance: None after weldment

**POSTWELD HEAT TREATMENT** (QW-407)
PWHT Type: No PWHT will be performed
PWHT Temperature : None °F
PWHT Holding Time: None

| | 1st Process | | |
|---|---|---|---|
| Weld Process / Method | **FCAW / Semiautomatic** | | |
| Weld Deposit Limit | 0.0000 in. to 1.5000 in. | | |
| **POSITION** (QW-405) | | | |
| Position of Joint | All Positions | | |
| Weld Progression | Vertical up | | |
| **GAS** (QW-408) | | | |
| Shielding Gas / CFH | 75% Argon, 25% CO2 / 23-30 | | |
| Trailing Gas / CFH | None / - | | |
| Backing Gas / CFH | None / - | | |
| **FILLER METAL** (QW-404) | | | |
| AWS Classification | E71T-1 | | |
| SFA Spec. / F-No. | 5.20 / 6 | | |
| A-No. or Chemical Composition | 1 | | |
| Filler Metal Trade Name | n/r | | |
| Filler Metal Product Form | Flux cored | | |
| Supplemental Filler Metal | None | | |
| Pass Greater Than ½": | No | | |
| Filler Metal Size (in.) | 0.035 | 0.045 | 1/16 |
| **ELECTRICAL** (QW-409) | | | |
| Welding Amperage Range | 120-200 | 170-270 | 225-300 |
| Welding Voltage Range | 19-24 | 22-26 | 25-28 |
| Travel Speed (in/min) | Var. | Var. | Var. |
| Max. Heat Input (J/in) | None | | |
| Current Type and Polarity | DCEP (reverse) | | |
| Transfer Mode | Globular arc | | |
| **TECHNIQUE** (QW-410) | | | |
| Peening | None | | |
| Stringer or Weave Bead | Stringer and weave bead | | |
| Multiple / Single Pass (per side) | Multipass | | |
| Nozzle / Gas Cup Size | 1/2"-3/4" | | |
| Contact Tube to Work Distance | 1/2"-1" | | |

(1) No peening done with this procedure.
No pass greater than 1/2" allowed.
Preheat to 175F if "T" > 1" and C > 0.30%;To 200F if 1.25 < "T" <= 1.5"

INTEGRATED SERVICE COMPANY, L.L.C.

Welding Procedure Specification (WPS)

WPS No.: 1-F-1 Rev. No.: 0 

JOINT DESIGN (QW-402)

Weld Type: Groove and fillet welds

| Joint Type | Backing | Root Opening | Groove Angle | Root Face | Groove Radius |
|---|---|---|---|---|---|
| Single-V groove | no backing | 3/16" max. | 50 degree min. | 1/8" max. | |
| Single-bevel groove | no backing | 3/16" max. | 45 degree min. | 1/8" max. | |
| Single-V groove | gouged & back welded | 1/4" max. | 50 degree min. | 3/16" max. | |
| Double-bevel groove | gouged & back welded | 1/4" max. | 45 degree min. | 3/16" max. | |
| Double-V groove | gouged & back welded | 1/4" max. | 45 degree min. | 3/16" max. | |
| Square groove | T-joint | 1/32" max. | | | |
| Square groove | no backing | 3/32" max. | | | |

Fillet Welds: All (QW-451.4)

Retainers: None

See fabrication drawing.

WELD JOINT DESCRIPTIONS SHOWN ARE NOT INCLUSIVE OF ALL THOSE FOUND ON A JOB. WELD JOINT DESIGN REFERENCE IN AN ENGINEERING SPECIFICATION OR A DESIGN DRAWING SHALL TAKE PRECEDENCE OVER WELD JOINTS SHOWN IN THIS WPS.

Initial and Interpass Cleaning: With wire brush clean 1" both sides of weld joint.

Method of Back Gouging: Grind until all defects are removed.

Minimum preheat must be maintained during thermal cutting, tacking, and welding operations.

Welds shall be cleaned between each pass. When completed, remove all slag and projections.

We certify that the statements in this specification are correct and in accordance with the requirements of Section IX of the ASME Code.

By: David S. Glaves 7/13/1994 QC Manager

David S. Glaves Date

T - WPS IX - W - WPW 3010.1.0
Form 1999 Rev. 0

INTEGRATED SERVICE COMPANY, L.L.C.
1900 N. 161st. E. AVENUE
TULSA, OKLAHOMA 74116

**Procedure Qualification Record (PQR)**

PQR No.: 90-1884-6 Date: 4/4/1990 WPS No.: 1-F-1 

**JOINT DESIGN** (QW-402)
Weld Type: Groove weld
Groove Type: Single-V groove
Backing: Open butt, no back weld
Root Opening: 1/8 in. Root Face: 1/16 in.
Groove Angle: 60 °

**BASE METALS** (QW-403)
Specification Type and Grade:
SA-516, Grade 70 to SA-516, Grade 70
P-No. 1 Group No. 2 to P-No. 1 Group No. 2
Thickness (in.): 0.7500

**PREHEAT** (QW-406)
Minimum Preheat Temperature: 50 °F
Maximum Interpass Temperature: 400 °F
Preheat Maintenance: None after weldment

**POSTWELD HEAT TREATMENT** (QW-407)
Type: No PWHT performed
PWHT Temperature: None °F
PWHT Holding Time: None hr.

| | 1st Process<br>**FCAW / Semiautomatic** |
|---|---|
| Weld Process / Method | |
| **POSITION** (QW-405) | |
| Position of Joint | 1G - Flat |
| Weld Progression | N/A |
| **GAS** (QW-408) | |
| Shielding Gas / CFH | 75% Argon, 25% CO2 / 25 |
| Trailing Gas / CFH | None / - |
| Backing Gas / CFH | None / - |
| **FILLER METAL** (QW-404) | |
| AWS Classification | E71T-1 |
| SFA Spec. / F-No. | 5.20 / 6 |
| A-No. or Chemical Composition | 1 |
| Filler Metal Trade Name | n/r |
| Filler Metal Product Form | Flux cored |
| Supplemental Filler Metal | None |
| Weld Deposit 't' (in.) | 0.7500 |
| Pass Greater Than ½": | No |
| Filler Metal Size (in.) | 0.0450 \| - \| - |
| **ELECTRICAL** (QW-409) | |
| Amperage Used | 200-225 \| - \| - |
| Voltage Used | 20-24 \| - \| - |
| Travel Speed (in/min) | 12-22 \| - \| - |
| Max. Heat Input (J/in) | 27000 |
| Current Type and Polarity | DCEP (reverse) |
| Transfer Mode | Globular arc |
| **TECHNIQUE** (QW-410) | |
| Stringer or Weave Bead | Stringer and weave bead |
| Multiple / Single Pass (per side) | Multipass |
| Nozzle / Gas Cup Size | 5/8" |
| Contact Tube to Work Distance | 1/2"-1" |

(1) Peening was not used with this weld test.
No Pass > 1/2" t.
Added Impact Test per Lab#99-050033-1

INTEGRATED SERVICE COMPANY, L.L.C.

Procedure Qualification Record (PQR)

PQR No.: 90-1884-6



Tensile Test (QW-150)

| Specimen No. | Width (in.) | Thickness (in.) | Area ($in^2$) | Ultimate Total Load (lb) | Ultimate Unit Stress (PSI) | Failure Type and Location |
|---|---|---|---|---|---|---|
| 1 | 0.982 | 0.760 | 0.746 | 66200 | 88700 | Base metal |
| 2 | 0.982 | 0.755 | 0.741 | 65500 | 88400 | Base metal |

Hardness Test - Vickers hardness

| Location | Readings | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| SA-516 BM | 167 | 159 | 168 | 136 | 167 | 156 | | | |
| SA-516 HAZ | 174 | 170 | 170 | 173 | 170 | 173 | 175 | 170 | 168 |
| Weld Metal | 172 | 176 | 174 | 166 | 167 | 170 | 168 | 165 | |

Visual Examination: Satisfactory

Liquid Penetrant Test: Satisfactory

Deposit Chemistry:C=0.06,Mn=1.35,P=0.009,S=0.016,Si=0.58,Cu=0.01, Ni=0.05,Cr=0.03,Mo=0.02

No addition/deletion of supplemental filler metal or powder filler metal.

Vickers hardness test performed by Weeks Lab. 8-21-08 for Inserv.

Welder's Name: Ron Cody I.D.: Stamp No.: T

PQR was done and welding of coupon was witnessed by: Cust-O-Fab Inc

Test conducted by: Metlab Testing Services Lab Test No.: 90-1884-6

We certify that the statements in this record are correct and that the test welds were prepared, welded, and tested in accordance with the requirements of Section IX of the ASME Code.

By: David S. Glaves 8/21/2008 QC Manager

David S. Glaves — Date

INTEGRATED SERVICE COMPANY, L.L.C.
1900 N. 161st. E. AVENUE
TULSA, OKLAHOMA 74116

**Procedure Qualification Record (PQR)**

PQR No.: 92-2474 Date: 4/22/1992 WPS No.: 1-F-1 

**JOINT DESIGN** (QW-402)
Weld Type: Groove weld
Groove Type: Single-V groove
Backing: Open butt, no back weld
Root Opening: 1/8 in. Root Face: 1/16 in.
Groove Angle: 60 °

**BASE METALS** (QW-403)
Specification Type and Grade:
SA-516, Grade 70 to SA-516, Grade 70
P-No. 1 Group No. 2 to P-No. 1 Group No. 2
Thickness (in.): 0.3750

**PREHEAT** (QW-406)
Minimum Preheat Temperature: 60 °F
Maximum Interpass Temperature: 450 °F
Preheat Maintenance: None after weldment

**POSTWELD HEAT TREATMENT** (QW-407)
Type: No PWHT performed
PWHT Temperature: None °F
PWHT Holding Time: None hr.

| | 1st Process<br>**FCAW / Semiautomatic** | | |
|---|---|---|---|
| Weld Process / Method | | | |
| **POSITION** (QW-405) | | | |
| Position of Joint | 1G - Flat | | |
| Weld Progression | N/A | | |
| **GAS** (QW-408) | | | |
| Shielding Gas / CFH | 75% Argon, 25% CO2 / 25 | | |
| Trailing Gas / CFH | None / - | | |
| Backing Gas / CFH | None / - | | |
| **FILLER METAL** (QW-404) | | | |
| AWS Classification | E71T-1 | | |
| SFA Spec. / F-No. | 5.20 / 6 | | |
| A-No. or Chemical Composition | 1 | | |
| Filler Metal Trade Name | n/r | | |
| Filler Metal Product Form | Flux cored | | |
| Supplemental Filler Metal | None | | |
| Weld Deposit 't' (in.) | 0.3750 | | |
| Pass Greater Than ½": | No | | |
| Filler Metal Size (in.) | 0.0450 | - | - |
| **ELECTRICAL** (QW-409) | | | |
| Amperage Used | 170-270 | - | - |
| Voltage Used | 24-28 | - | - |
| Travel Speed (in/min) | Var. | - | - |
| Max. Heat Input (J/in) | None | | |
| Current Type and Polarity | DCEP (reverse) | | |
| Transfer Mode | Globular arc | | |
| **TECHNIQUE** (QW-410) | | | |
| Stringer or Weave Bead | Stringer and weave bead | | |
| Multiple / Single Pass (per side) | Multipass | | |
| Nozzle / Gas Cup Size | 5/8" | | |
| Contact Tube to Work Distance | 1/2"-3/4" | | |

(1) Peening was not used with this weld test.
Revised to indicate globular arc FCAW transfer mode.

INTEGRATED SERVICE COMPANY, L.L.C.

Procedure Qualification Record (PQR)

PQR No.: 92-2474



**Tensile Test (QW-150)**

| Specimen No. | Width (in.) | Thickness (in.) | Area ($in^2$) | Ultimate Total Load (lb) | Ultimate Unit Stress (PSI) | Failure Type and Location |
|---|---|---|---|---|---|---|
| 1 | 0.758 | 0.354 | 0.268 | 23800 | 88800 | Base metal |
| 2 | 0.756 | 0.334 | 0.253 | 22400 | 88500 | Base metal |

**Guided Bend Tests (QW-160)**

| Type and Figure No. | Result | Type and Figure No. | Result |
|---|---|---|---|
| QW-462.2 Side bend | Satisfactory | QW-462.2 Side bend | Satisfactory |
| QW-462.2 Side bend | Satisfactory | QW-462.2 Side bend | Satisfactory |

**Hardness Test - Brinell hardness**

| Location | Readings | | |
|---|---|---|---|
| SA-516 BM | 156 | 170 | 159 |
| SA-516 HAZ | 163 | 183 | 174 |
| Weld Metal | 187 | 192 | 200 |

Welder's Name: Rick Barbee I.D.: Stamp No.: YY

PQR was done and welding of coupon was witnessed by: Cust-O-Fab Inc

Test conducted by: Metlab Testing Services Lab Test No.: 92-2474

We certify that the statements in this record are correct and that the test welds were prepared, welded, and tested in accordance with the requirements of Section IX of the ASME Code.

By: David S. Glaves 4/22/1992 QC Manager

David S. Glaves — Date