Welding

49 CFR Part §192

Not applicable to welding during manufacture of pipe and components

Welding Terms

--- and other strange nomenclature

Welding

- A joining process that produces a coalescence of metals (or non-metals) by heating them to the welding temperature,
  - with or without the application of pressure, or by pressure alone, and
  - with or without the use of filler metals

Process

- A method of performing welding,
- such as:

  - shielded metal arc welding (Stick)
  - submerged arc welding (Sub Arc)
  - gas metal arc welding (MIG / Wire)
  - gas tungsten arc welding (TIG)
  - oxyacetylene welding (Gas)

Procedure

- A way of performing or effecting something; a course of action
- WPS - Welding Procedure Specification
- A document providing in detail the required variables for specific application to assure repeatability by properly trained welders

Shielded Metal Arc Welding (SMAW)

- An arc welding process that produces a coalescence of metals by heating with an arc between a covered metal electrode and the work pieces

"Stick" Welding

Shielded Metal Arc Welding (SMAW)

- Shielding is obtained from decomposition of the electrode covering.

- Filler metal is obtained from the electrode.

Submerged Arc Welding (SAW)

- An arc welding process that uses an arc between a bare metal electrode and the weld pool. The arc and molten metal are shielded by a blanket of granular flux.

Gas Metal Arc Welding (GMAW)

- An arc welding process that produces coalescence of metals by heating them with an arc between a continuous filler metal (consumable) electrode and the work.

"MIG" welding

Gas Metal Arc Welding (GMAW)

- Shielding is obtained entirely from an externally supplied gas or gas mixture.

Gas Tungsten Arc Welding (GTAW)

- An arc welding process that produces coalescence of metals by heating them with an arc between a tungsten (non-consumable) electrode and the work piece.

"TIG" welding

Gas Tungsten Arc Welding (GTAW)

- Shielding is obtained from an externally supplied gas or gas mixture

Oxyacetylene Welding (OAW)

- An oxy-fuel gas welding process that uses acetylene as the fuel gas

Base Metal

- The metal to be welded or cut. May be referred to as the "work piece"

Weld Metal

- The portion of the base metal that has been melted during welding

Heat-affected Zone (HAZ)

- That portion of the base metal that has not been melted during welding, but whose mechanical properties and/or microstructure have been altered by the heat of welding or cutting

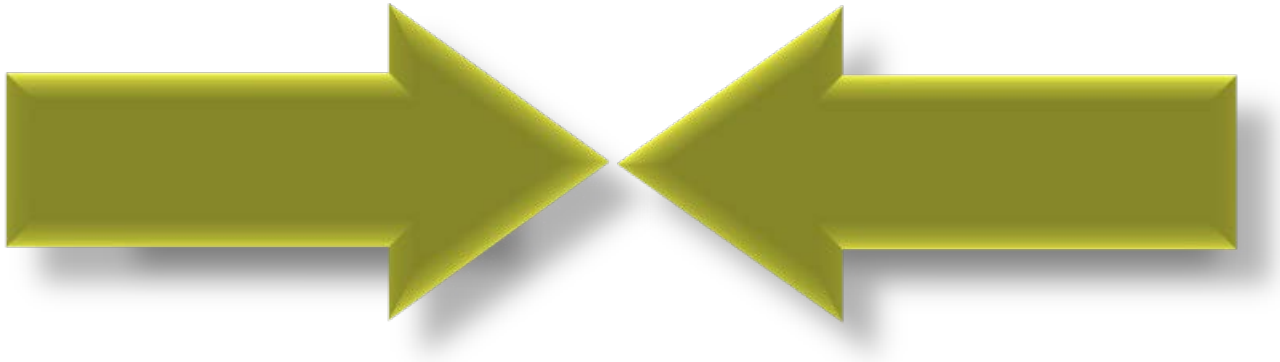
Joint

- The junction of members or the edge of members that are to be joined
- Usually beveled or otherwise designed for welding

"V" Groove or "U" Groove

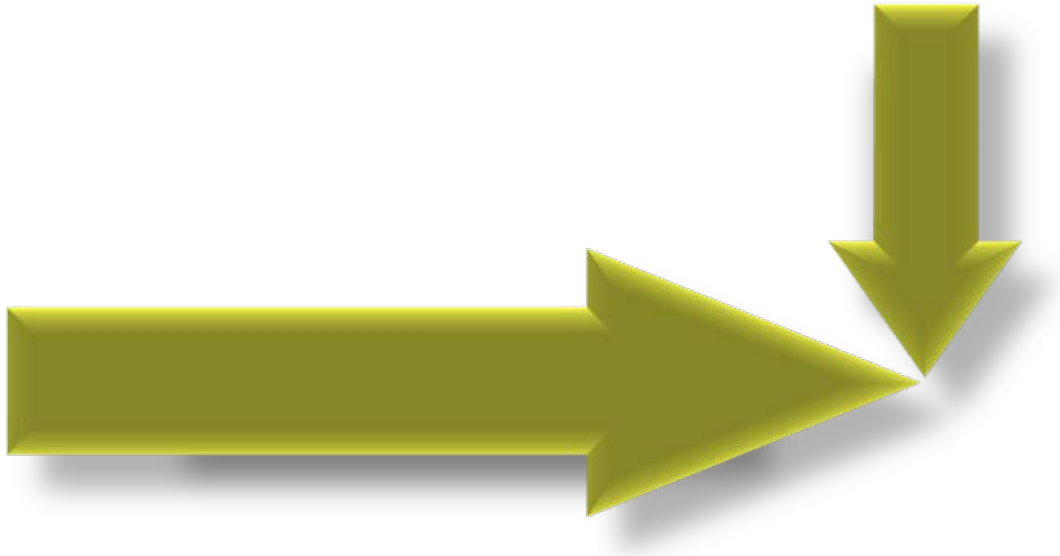
Butt Weld (joint)

- A joint between two members aligned approximately in the same plane



Fillet Weld

- A weld of approximately triangular cross section joining two surfaces at approximately right angles to each other



Welding Electrode

- A component of the welding circuit that terminates at the arc. May also be the source of filler metal

Polarity

- Manner in which the electrode holder and work piece connection are connected to the electrical supply

Polarity

- DCEN direct current electrode negative (straight polarity)
- DCEP direct current electrode positive (reverse polarity)

Welding Position

- flat
- horizontal
- vertical
- overhead
  - fixed
  - rolled

Weld Pass

- A single progression of welding along the joint
- The result of a pass is a weld bead

Stringer (root) Bead

- The first pass in the weld, usually made without any appreciable weaving motion

Hot Pass

- The weld pass that immediately follows the stringer (root) pass.

Filler Passes

- The weld passes that follow the hot pass and fill the weld groove flush or almost flush with the surface of the work pieces

Cover Pass

- The weld pass that finishes the welded joint
- The cover bead is higher than the adjacent surface and overlaps the groove

Arc Burn

- A metallurgical notch, caused by ground clamps or from striking an arc on the base metal at any point other than:
  - in the weld groove, or
  - the immediate surface next to the groove that will be covered by the weld cap

Welder or Welding Operator

- § 192.3 Definitions
  - Welder: means a person who performs manual or semi-automatic welding
  - Welding operator: means a person who operates machine or automatic welding equipment

(NEW) Added Amendment: PHMSA-2010-0026

Effective Date: October 1, 2015

Where Are the Welding Procedures?

- Procedures do not have to be with the welder and chances are the welder will not have them
- Inspectors are encouraged to have a copy of the procedure and verify that the welder is following the procedure

Can Operators Share?

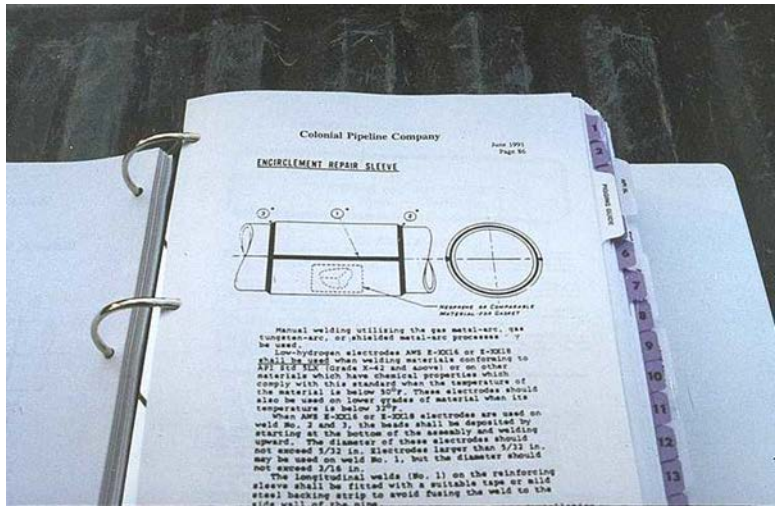
- Procedures
  - Yes, if the operator has the procedures and procedure qualification test records

- Qualified welders
  - Yes in API 1104 20th edition
    - Section 6.1 General - "The qualification of welders shall be conducted in the presence of a representative acceptable to the company."

§192.225 WELDING – GENERAL

- "Qualified Procedure" vs "Qualified Welder"
  - "qualified procedure test" verifies integrity/ metallurgy of that weld
  - "qualified welder test" verifies ability of that welder

§192.225 Welding Procedures



- Welding Performed by "Qualified" Welder
- Welding Procedures "Qualified" Using API 1104 Section 5, 12, Appendix "A", Appendix "B" or ASME B&PV Section IX
- Recorded in Detail and "Qualified" by Destructive Testing
- Followed when the Procedure is Used

§192.225 Welding Procedures

- (a) Welding must be performed by a qualified welder or welding operator in accordance with welding procedures qualified under section 5, section 12, or Appendix A, Appendix B of API Std 1104 (incorporated by reference, see § 192.7) or section IX ASME Boiler and Pressure Vessel Code (BPVC) (incorporated by reference, see § 192.7), to produce welds which meet the requirements of this subpart.

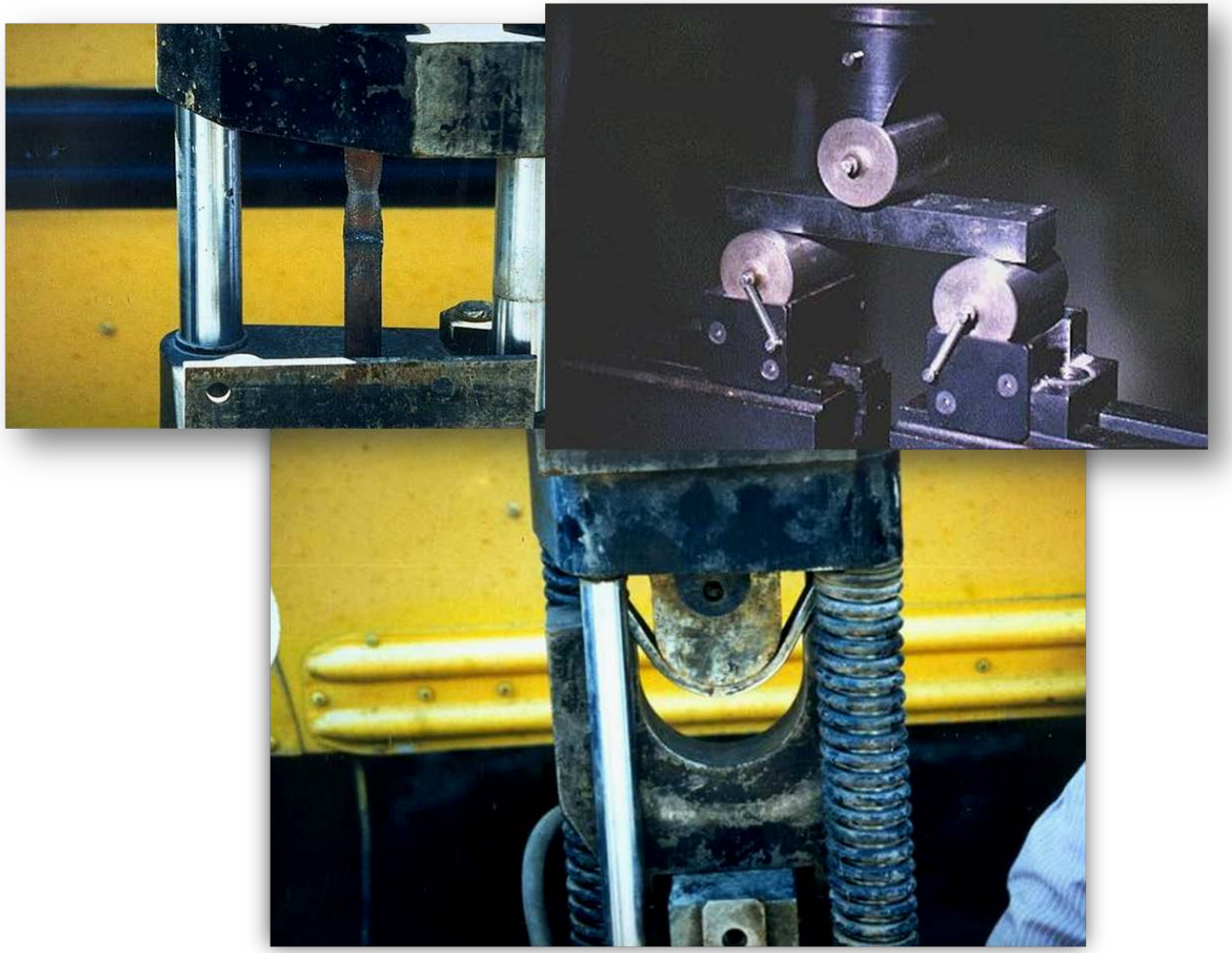
(NEW) Added Amendment: PHMSA-2010-0026
Effective Date: October 1, 2015

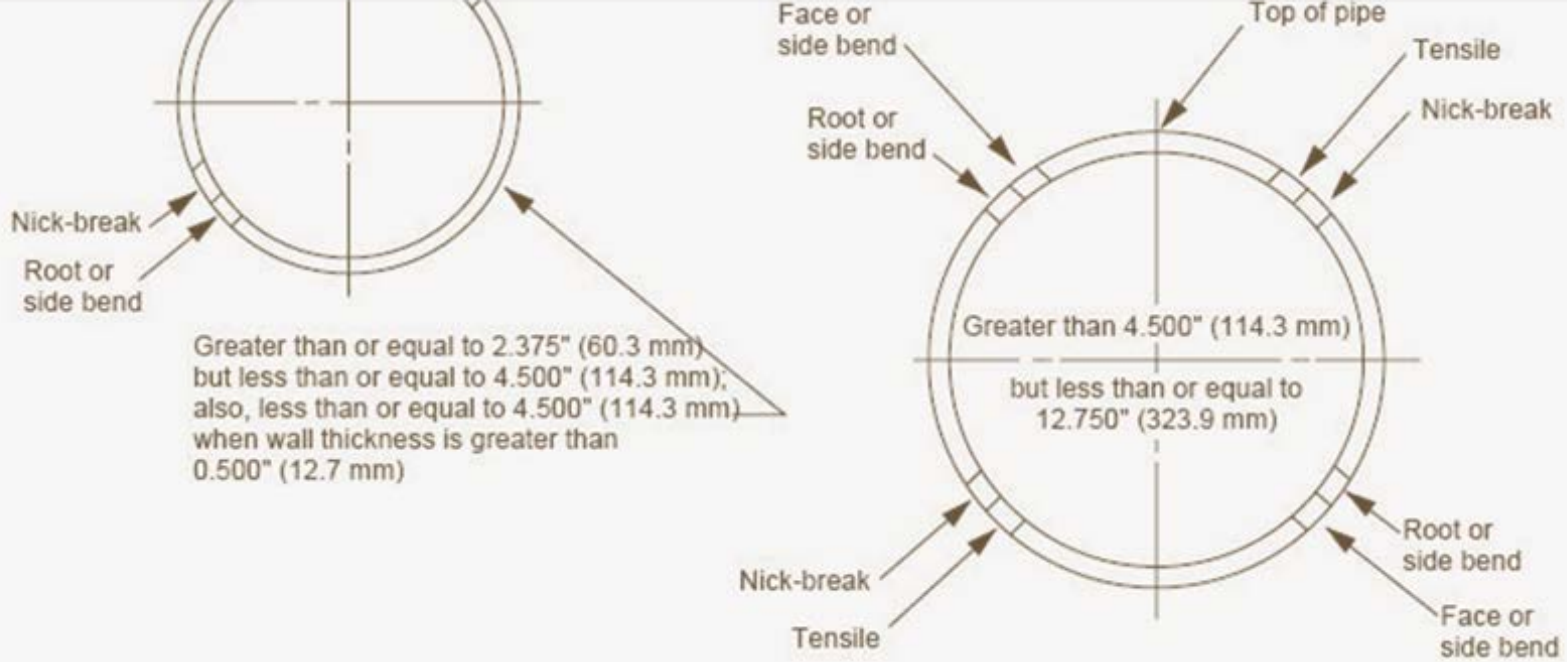
§192.225 Welding Procedures

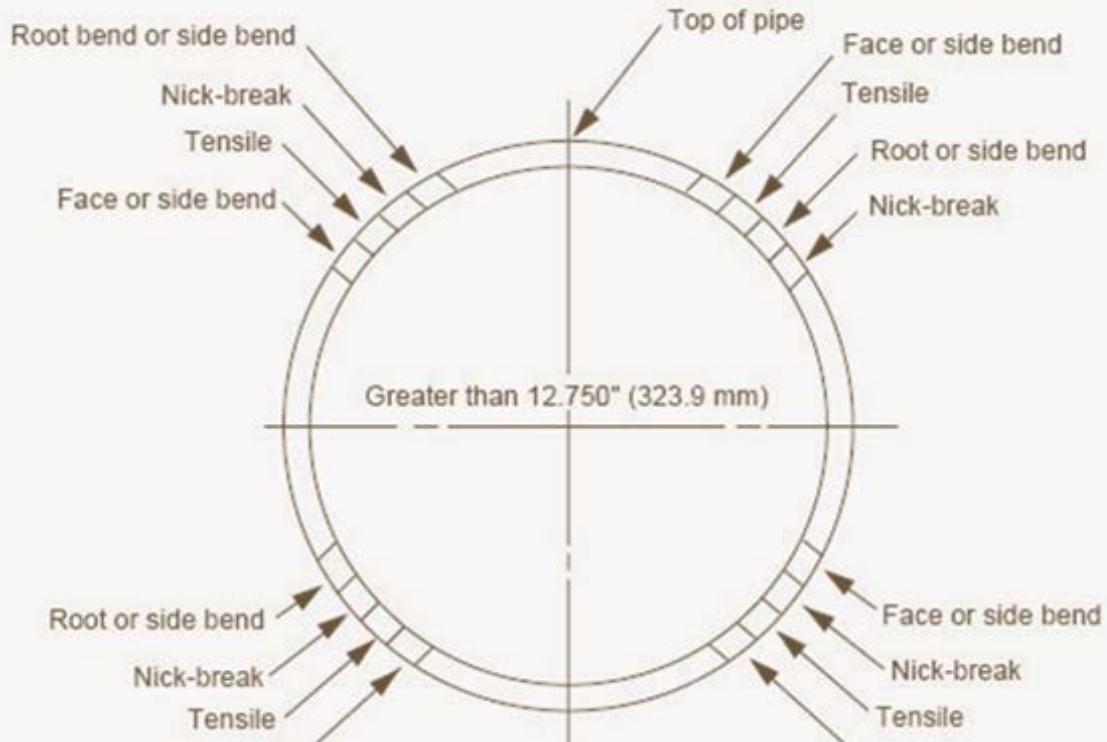
- The quality of the test welds used to qualify welding procedures must be determined by destructive testing in accordance with the referenced welding standard(s).

(NEW) Added Amendment: PHMSA-2010-0026
Effective Date: October 1, 2015

Procedure Must Be Qualified By Destructive Testing







API 1104 Procedure Qualification

Section 5, Figure 3

Number, type, and locations of test straps required for procedure qualification tests

PROCEDURE SPECIFICATION NO._____

For _____ Welding of _____ Pipe and Fittings
Process _____
Material _____
Diameter _____ Wall thickness _____
Joint design _____
Filler metal _____ Number of beads _____
Electrical or flame characteristics
Position _____
Direction of welding _____
No. of welders _____
Time lapse between passes _____
Type and removal of lineup clamp _____
Cleaning and/or grinding _____
Preheat stress relief _____
Shielding gas and flow rate _____
Shielding flux _____
Speed of travel _____
Sketches and tabulations attached _____

Date tested _____ Welder _____
Date approved Welding supervisor

Proce dures

Essential Variables API 1104 Procedure Qualification

- Change in Process or Method of Application
- Pipe Grades
  - ≤ 42,000 SMYS
  - > 42,000 but < 65,000
  - ≥ 65,000 - Separate Test for Each Grade

Essential Variables API 1104 Procedure Qualification

- Joint Design (U or V groove)
- Position (fixed or rolled, horizontal or tilted)
- Wall Thickness Group
  - < 3/16” (.188)
  - 3/16” - 3/4” (.188 - .750)
  - > 3/4” (.750)

Essential Variables API 1104 Procedure Qualification

- Time Between Passes
  - Max time between root and second
- Direction of welding
  - Uphill or downhill

Essential Variables API 1104 Procedure Qualification

- Shielding Gas and Flow Rate
- Shielding Flux
- Speed of Travel
- Filler Metal Group

Group	AWS Specification	Electrode
1	A5.1 A5.5	E6010 E6011 E7010 E7011
2	A5.5	E8010 E8011
3	A5.1 or A5.5 A5.5	E7015 E7016 E7018 E8015 E8016 E8018

§192.227 Qualification of Welders (And Welding Operators)

- Section 6, 12, Appendix "A" or Appendix B of API Standard 1104
- Section IX of ASME Boiler and Pressure Vessel Code

(NEW) Added Amendment: PHMSA-2010-0026
Effective Date: October 1, 2015

§192.227 Qualification of Welders (And Welding Operators)

- (§192 ONLY)

- Less than 20% SMYS
  - Appendix C

§192.227 Qualification of Welders (And Welding Operators)

- Welder Qualified under Earlier Edition of API 1104 or ASME Section IX
  - May Continue to Weld
  - May Not Re-qualify under that Edition

Qualified Welders

- Must have funny looking hats
- Must have helpers
- Must have BBQ grills & Ice chests

Qualified Welders

I Don’t Think So!

API 1104 - Welder Single Qualification (Butt or Fillet)

- If qualified on butt welds in fixed position @ 45° angle, qualified for butt welds and lap fillet welds in all positions

Essential Variables Welder Single Qualification

- Change in any one of:
  - Process
  - Direction of Welding
  - Filler-metal Classification
  - Outside Diameter Group
    - < 2.375”
    - 2.375 – 12.750”
    - > 12.750 “
  - Wall Thickness Group
  - Position
  - Joint Design

API 1104 - Welder Multiple Qualification

- Must Make Butt Weld First
- Layout, Cut & Fit Branch Connection
- Cut Hole in Run for Branch
- Make Fillet Weld on Branch/Run Joint

API 1104 - Welder Multiple Qualification

- Butt & Branch Welds Must Be Made on Pipe at Least 6.625”
- 12.75” Qualifies for all Pipe Diameters
- Butt Weld Made in Fixed Horizontal or 45° Angle Position

API 1104 - Welder Multiple Qualification

- Cut Full-Size Hole in Run Pipe
- Run Pipe Shall Be Horizontal
- Branch Shall Extend Vertically Downward From Run Pipe

Essential Variables Welder Multiple Qualification

- Change in welding processes
- Change in direction of welding
- Change in filler metal classifications

§192.229 Limitations on Welders (And Welding Operators)

- Welder or Welding Operator whose qualification is based on nondestructive testing may not weld on compressor station pipe and components
- Must have welded with particular process within the preceding 6 calendar months

§192.229 Additional Limitations

- Welder (And Welding Operator) qualified under Section 6 of API 1104 or Section IX of ASME
- To weld on pipe operating at 20% SMYS or more, must have weld tested:
  - Every 6 months per API 1104 Section 6, 9, 12, Appendix "A" or
  - Twice each CY at intervals not exceeding 7-1/2 months

§192.229 Additional Limitations

- Welder or Welding Operator qualified under Section 6 of API 1104 or Section IX of ASME
- To weld on pipe operating at less than 20% SMYS, must:
  - Have weld tested every 6 months per API 1104 Section 6, 9, 12, Appendix "A" or
  - Re-qualify under Appendix C every calendar year not to exceed 15 months, or
  - Cut out and test a production weld twice each calendar year

§192.229 Additional Limitations

- Welder or Welding Operator qualified under Appendix C
  - Must re-qualify under Appendix C every calendar year not to exceed 15 months, or
  - Must cut out and test a production weld twice each calendar year (interval cannot exceed 7 1/2 months), or
  - For service lines 2 inches and smaller only, 2 welds tested per App. C, Sec. III

§192.231 Protection from Weather

- The welding operation must be protected from weather conditions that would impair the quality of the completed weld.

§192.233 Miter Joints

- 30% or more SMYS, maximum of 3°
- >10% SMYS <30%, maximum of 121/2° must be one diameter from any other miter
- 10% or less SMYS, maximum of 90°

§192.235 Preparation for Welding

- Before beginning any welding, the welding surfaces must be clean and free of any material that may be detrimental to the weld, and
- Must be aligned to provide the most favorable condition for depositing the root bead. This alignment must be preserved while root is deposited.

§192.241 Inspection and Test of Welds

- Visual inspection (by individual qualified by training & experience) of the WELDING must be done to insure
  - Welding is done according to procedure, and
  - Weld is acceptable per API 1104 Section 9 or Appendix "A"
  - (Appendix "A" may not be used to accept cracks)

§192.241 Inspection and Test of Welds

- Welds on pipelines operating > 20% SMYS must be Non-destructively tested, except:
- Welds visually inspected and approved by a welding inspector qualified by training & experience if:
- Pipe is < 6” nom. dia.; or
- Line operates below 40% SMYS and welds are limited in number

§192 Alternative Acceptance Criteria

- API 1104 – appendix "A" (20th edition errata/addendum July 2007)
  - Appendix "A" is incorporated by reference in part 192.241 (c) and part 195.228 (b) as an alternative acceptance criteria for any reason other than a crack
  - Removed appendix "A" 20th edition (2005) and added new appendix "A" (2007) – alternate acceptance standards for girth welds

(NEW) Added Amendment: PHMSA-2010-0026

Effective Date: October 1, 2015

§192 Alternative Acceptance Criteria

- API 1104 – appendix "A" (20th edition errata/addendum July 2007)
  - Uses "fracture mechanics analysis" and "fitness-for-purpose criteria" to determine weld alternate acceptance criteria
  - Additional qualification tests, stress analysis, and inspection are required to use the "fitness-for-purpose" criteriaRestricted use, not applicable in all conditions

Inspection and Test of Welds

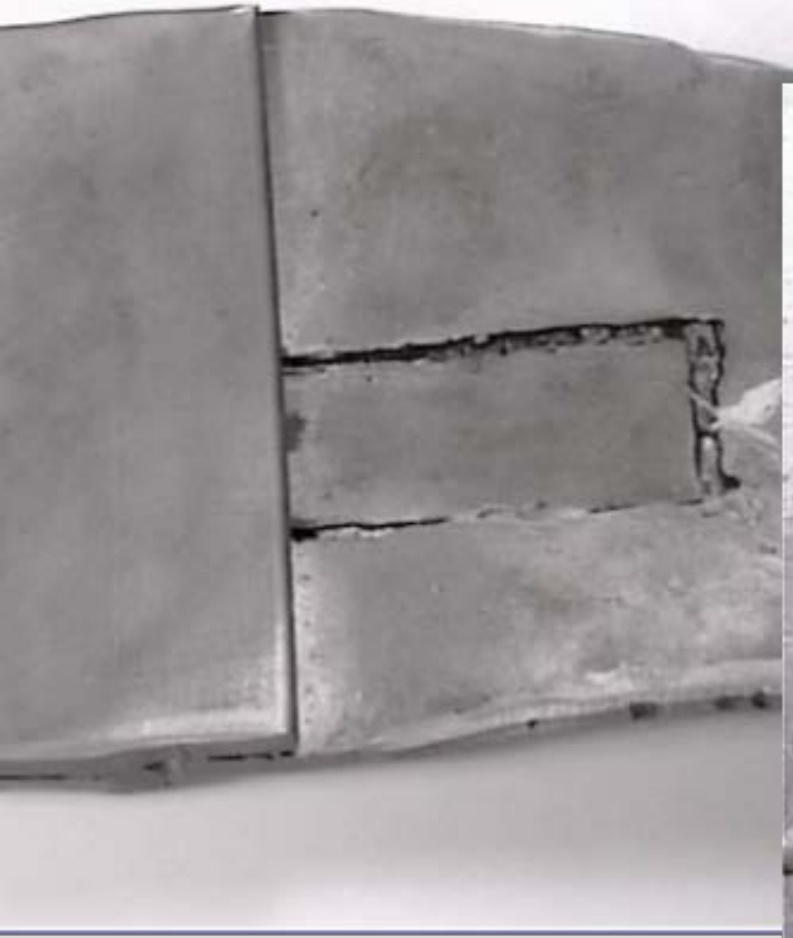
§192.241

§192.241

Inspection and Test of Welds

§192.243 Nondestructive Testing

- NDT must be performed by any process, other than trepanning, which will clearly indicate defects that may affect the integrity of the weld



§192.243

What is Trepanning?

§192.243 Nondestructive Testing

- NDT must be performed:
  - In accordance with written procedures; and
  - By persons trained and qualified in the procedures and with the equipment being utilized

§192.243 Nondestructive Testing

- Procedures must be established for interpretation of each test to ensure acceptability of the weld per API 1104 Section 9 or Appendix "A"

(NEW) Added Amendment: PHMSA-2010-0026
Effective Date: October 1, 2015

§192.243 Nondestructive Testing

- When required, random testing of each days welds must be tested at the following rates:
  - Class 1 areas - 10%
  - Class 2 areas - 15%
  - Class 3 & 4, offshore, rights-of-way - 100%, unless impracticable, then 90%
  - Tie-Ins (including replacement sections) 100%

§192.243 Nondestructive Testing

- Must test some of each welder or welding operators work each day
- Must retain for life:
  - Record by milepost, engineering station, etc.;
    - Number of welds
    - Number tested
    - Number rejected
    - Disposition of rejects

§192.245 Repair or Removal of Defects

- Each unacceptable weld under §192.241(c) or §195.228;
  - Must be removed or repaired
  - Removed if crack is > 8% of weld length
- For repairs, must remove defect down to sound metal, pre-heat if necessary, and re-inspect

§192.245 Repair or Removal of Defects

- Repair of a crack or defect in a previously repaired area must be done in accordance with written repair procedures that have been qualified under §192.225 or §195.214

§192.309 Repair of Steel Pipe

- (c) Each arc burn on steel pipe to be operated ≥ 40% SMYS must be repaired or removed. If repaired by grinding, must check remaining wall thickness
- If not repairable by grinding, a cylinder of the pipe containing the arc burn must be removed

§192 Appendix "C" Basic Test

- Test on pipe 12" or smaller
- Weld in horizontal, fixed position
- Weld according to a qualified, written procedure

§192 Appendix "C" Basic Test

- Cut weld into four coupons
- Subject to a root bend test
- If two or more have a crack >1/8", weld is unacceptable
- Successful test qualifies welder to weld on pipe diameters ≤ 12 inches

§192 Appendix "C" Service Connections To Mains

- Weld service connection to pipe of typical main size in same position as in field
- Test destructively

§192 Appendix "C" Small Service Lines

- Two samples 8" long are cut w/ weld in center
- Subject one to guided bend test
- Subject second to tensile test
  - If tensile machine not available, bend test

What About Maintenance/Hot Welding?

- Covered in API 1104 (20th ed.) Appendix "B" (prev. API RP 1107)
- Appendix "B" NOT incorporated by reference in Part 192 or 195
- Maintenance Welding includes OQ Covered Tasks
- Operators must qualify Welders for Maintenance Tasks

What should inspectors or operators check for compliance regarding Subparts "E" or "D"?

- Written welding procedures with qualifying test results available
- How welders or welding operators are qualified (API, ASME, Part 192 Appendix C)

What should inspectors or operators check for compliance regarding Subparts "E" or "D"?

- Verification of use of qualified welders or welding operators
- How welders or welding operators maintain qualification and re-qualify
- Qualifications of welding inspectors
- Adherence to welding procedures/code requirements/housekeeping during field welding

What should State/Federal inspectors or operators check for compliance regarding Subparts "E" or "D"?

- Use of N.D.T./N.D.T. procedures/qualifications of N.D.T. technicians
- Special procedures for "hot" or repair welding
- Repair criteria for defective welds
- Maintenance of required records

The End!

QUESTIONS?