SECTION 15230
GAS STEEL PIPELINE WELDING PROCEDURES

PART I: KUB WSP-1

SCOPE

The following welding procedure has been developed and qualified by Knoxville Utilities Board for welding of steel pipelines. This procedure was developed based on the API Standard 1104.

PROCEDURE:

A. PROCESS: Shielded Metal-Arc Welding (SMAW).

B. PIPE AND FITTING METALS: The pipe and fittings shall conform to API 5L grades less than or equal to X42, or other materials with similar chemical compositions and physical properties. This procedure particularly includes pipe and fittings conforming to API 5L grade A and API 5L grade B, ASTM A106, and ASTM A53.

C. DIAMETER: The pipe and fittings shall have outside diameters of less than 2-3/8".

D. WALL THICKNESS: The wall thickness of the pipe and fittings shall be less than 3/16" (0.188").

E. JOINT DESIGN:

1. Bevel and Spacing (see Figure 1)

   a. Beveled Ends - 30° plus 5° minus 0°.

   b. Root Face - 1/16" plus or minus 1/32".

   c. Root Opening - 1/16" plus or minus 1/32".

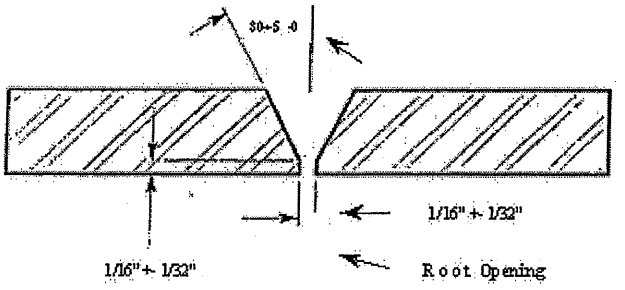

Figure I - Typical Butt Weld Bevel and Spacing

2. Completed weld (see figures 2 and 3)

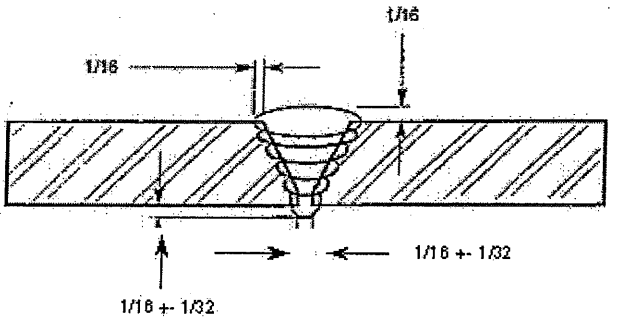

Figure 2 - Completed Butt Weld

a. Root Bead - Extend root bead 1/16" plus or minus 1/32" past the inner wall of the pipe.

b. Stripper Beads - Stripper beads or beads that do not extend around the circumference of the weld may be added to the filler heads to compensate for variations in the spacing of the joint.

c. Cover Beads - Extend cover bead on butt welds approximately 1/16" above the surface of the pipe and overlap cover bead approximately 1/16" on each side of bevel.

d. Cross Section - The completed weld shall have a uniform cross section around the pipe.

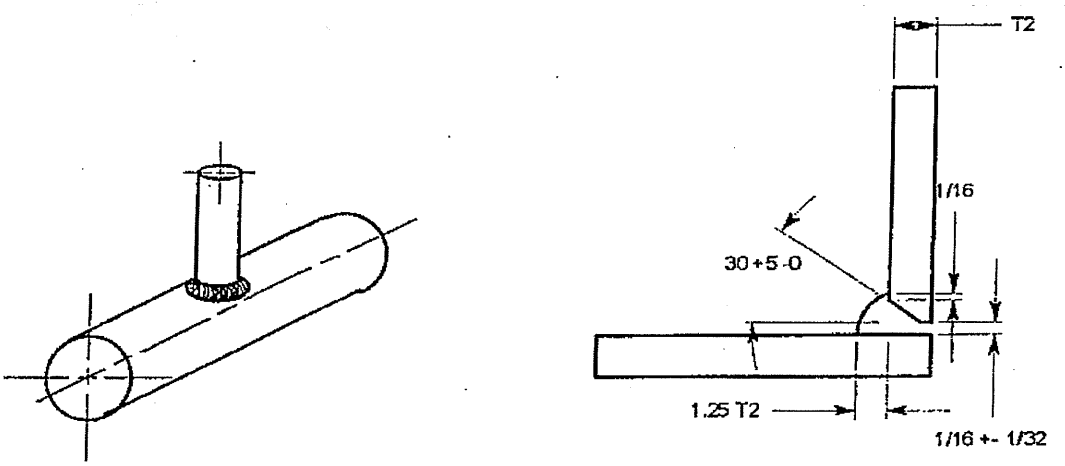

Figure 3 - Typical Fillet Weld

F. FILLER METAL:

1. Root Pass - E6010 5P+, or equal.

2. Hot Pass - E6010 5P+, or equal.

3. Cover Pass - E6010 5P+, or equal.

G. ELECTRODE (ROD) SIZE:

1. Root Pass – 3/32" or 1/8".

2. Hot Pass - 1/8" or 5/32".

3. Cover Pass - 1/8" or 5/32".

H. MINIMUM NUMBER OF PASSES: At least 3 passes shall be used.

I. ELECTRICAL CHARACTERISTICS: The welding current shall be direct current with reverse polarity (pipe negative and electrode positive). The arc voltage as measured between the electrode holder and the pipe shall not exceed 32 volts. The allowable amperage range for the various electrode diameters are shown below:

Electrode Diameter	Amperage Range
3/32"	40 - 70 amps
1/8"	65 - 130 amps
5/32"	90 - 195 amps

J. POSITION:

1. The axis of the pipe may be in any position.

2. At tie-ins, the pipe shall not be moved from the start of making the root pass (stringer bead) until the weld is completed.

3. At all other joints in line pipe, the pipe shall not be moved from the start of making the root pass (stringer bead) until the lineup clamps are removed. After the lineup clamps are removed, the pipe may be placed on skids; the pipe shall then remain in the fixed position until welding is complete. Pipe deflections during skidding shall be kept to a minimum.

4. A minimum clearance of 16" shall be provided in all directions from the weld.

K. DIRECTION OF WELDING: All welding by this procedure shall be by the downhill method starting at the top center of the pipe and stopping near the bottom center. Where the pipe is fixed in the vertical position, an imaginary top of pipe shall be established and maintained for the entire weld.

L. NUMBER OF WELDERS: Only one welder may be used for each pass.

M. TIME LAPSE BETWEEN PASSES: The maximum time interval between the completion of the root pass (stringer bead) and the beginning of the hot pass (first filler bead) shall not exceed five minutes.

N. LINEUP CLAMPS: External lineup clamps may be used.

O. LINEUP CLAMP REMOVAL: When external lineup clamps are used, they shall not be removed until the root pass (stringer bead) is at least 70% completed around the circumferential joint in equally spaced increments.

P. CLEANING AND/OR GRINDING:

1. Preparation - Welding surfaces shall be cleaned of all moisture, rust, scale, primer, oil, or other materials that may be detrimental to the finished weld. When coating must be removed, it shall be removed at least a distance equal to the cut back on new pipe of the same diameter.

2. Cleaning Weld - All slag, knots of filler metal, pinholes, and similar surface defects shall be removed before depositing the next pass.

3. Tools - Power tools such as a power grinder is the preferred tool for cleaning. Hand tools such as a file or a stiff brush may also be used. Chisels should never be used for removing pipe coatings.

Q. PREHEAT:

1. Whenever possible, welding shall be performed under conditions with ambient air at least 25°F. In some cases the ambient air can be warmed by use of a weather screen.

2. When ambient air is less than 25°F, preheating of the area to be welded shall be performed with a propane torch or similar source of heat so that the pipe surface is warm to the touch (approximately 100°F).

3. Since welding under conditions with ambient air less than 25°F is not common in KUB's operations, therefore, welders and welding procedures which have been qualified without preheating at ambient conditions 25°F or above are considered qualified with preheat.

R. SPEED OF TRAVEL: The speed of travel shall be approximately 8"-12" per minute.

S. ARC STRIKES: Striking the arc on the pipe at any point other than the welding groove shall not be permitted.

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SECTION 15230
GAS STEEL PIPELINE WELDING PROCEDURES

PART II: KUB WSP-2

SCOPE

The following welding procedure has been developed and qualified by Knoxville Utilities Board for welding of steel pipelines. This procedure was developed based on the API Standard 1104.

PROCEDURE:

A. PROCESS: Shielded Metal-Arc Welding (SMAW).

B. PIPE AND FITTING METALS: The pipe and fittings shall conform to API 5L grades less than or equal to X42, or other materials with similar chemical compositions and physical properties. This procedure particularly includes pipe and fittings conforming to API 5L grade A and API 5L grade B, ASTM A106, and ASTM A53.

C. DIAMETER: The pipe and fittings shall have outside diameters of 2-3/8" to 12-3/4".

D. WALL THICKNESS: The wall thickness of the pipe and fittings shall be in the range from 3/16" (0.188") to 3/4" (0.750").

E. JOINT DESIGN:

1. Bevel and Spacing (see Figure 1)

   a. Beveled Ends - 30° plus 5° minus 0°.

   b. Root Face - 1/16" plus or minus 1/32".

   c. Root Opening - 1/16" plus or minus 1/32".

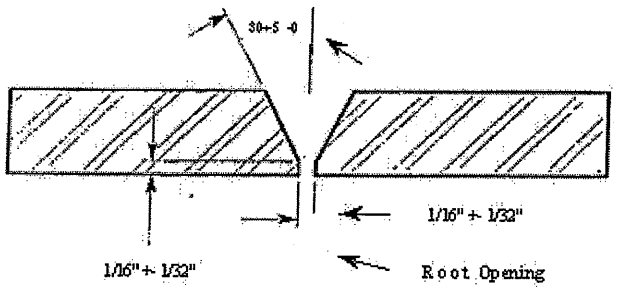

Figure I - Typical Butt Weld Bevel and Spacing

2. Completed weld (see figures 2 and 3)

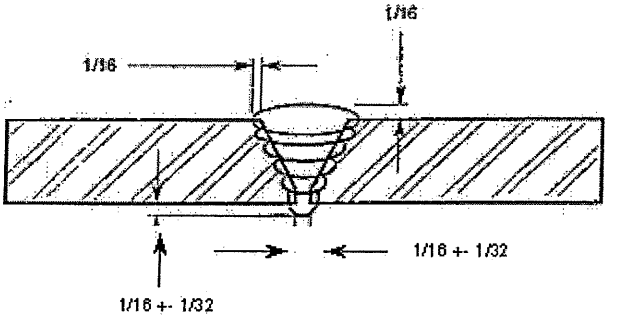

Figure 2 - Completed Butt Weld

a. Root Bead - Extend root bead 1/16" plus or minus 1/32" past the inner wall of the pipe.

b. Stripper Beads - Stripper beads or beads that do not extend around the circumference of the weld may be added to the filler heads to compensate for variations in the spacing of the joint.

c. Cover Beads - Extend cover bead on butt welds approximately 1/16" above the surface of the pipe and overlap cover bead approximately 1/16" on each side of bevel.

d. Cross Section - The completed weld shall have a uniform cross section around the pipe.

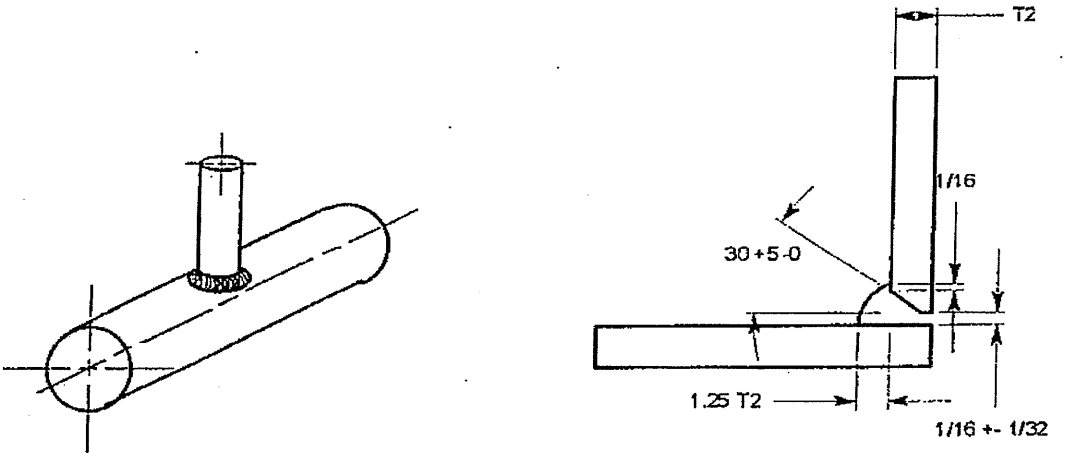

Figure 3 - Typical Fillet Weld

F. FILLER METAL:

1. Root Pass - E6010 5P+, or equal.
2. Hot Pass - E6010 5P+, or equal.
3. Cover Pass - E6010 5P+, or equal.

G. ELECTRODE (ROD) SIZE:

1. Root Pass - 1/8" or 5/32".
2. Hot Pass - 1/8" or 5/32".
3. Cover Pass - 1/8" or 5/32".

H. MINIMUM NUMBER OF PASSES: At least 3 passes shall be used.

I. ELECTRICAL CHARACTERISTICS: The welding current shall be direct current with reverse polarity (pipe negative and electrode positive). The arc voltage as measured between the electrode holder and the pipe shall not exceed 32 volts. The allowable amperage range for the various electrode diameters are shown below:

Electrode Diameter	Amperage Range
3/32"	40 - 130 amps
1/8"	90 - 195 amps
5/32"	140 - 225 amps

J. POSITION:

1. The axis of the pipe may be in any position.
2. At tie-ins, the pipe shall not be moved from the start of making the root pass (stringer bead) until the weld is completed.
3. At all other joints in line pipe, the pipe shall not be moved from the start of making the root pass (stringer bead) until the lineup clamps are removed. After the lineup clamps are removed, the pipe may be placed on skids; the pipe shall then remain in the fixed position until welding is complete. Pipe deflections during skidding shall be kept to a minimum.
4. A minimum clearance of 16" shall be provided in all directions from the weld.

K. DIRECTION OF WELDING: All welding by this procedure shall be by the downhill method starting at the top center of the pipe and stopping near the bottom center. Where the pipe is fixed in the vertical position, an imaginary top of pipe shall be established and maintained for the entire weld.

L. NUMBER OF WELDERS: One or more welders may be used for each pass.

M. TIME LAPSE BETWEEN PASSES: The maximum time interval between the completion of the root pass (stringer bead) and the beginning of the hot pass (first filler bead) shall not exceed five minutes.

N. LINEUP CLAMPS: External or internal lineup clamps may be used.

O. LINEUP CLAMP REMOVAL:

1. When external lineup clamps are used, they shall not be removed until the root pass (stringer bead) is at least 70% completed around the circumferential joint in equally spaced increments.

2. Internal line-up clamps when used shall not be removed until 80% of the root pass is complete.

P. CLEANING AND/OR GRINDING:

1. Preparation - Welding surfaces shall be cleaned of all moisture, rust, scale, primer, oil, or other materials that may be detrimental to the finished weld. When coating must be removed, it shall be removed at least a distance equal to the cut back on new pipe of the same diameter.

2. Cleaning Weld - All slag, knots of filler metal, pinholes, and similar surface defects shall be removed before depositing the next pass.

3. Tools - Power tools such as a power grinder is the preferred tool for cleaning. Hand tools such as a file or a stiff brush may also be used. Chisels should never be used for removing pipe coatings.

Q. PREHEAT:

1. Whenever possible, welding shall be performed under conditions with ambient air at least 25°F. In some cases the ambient air can be warmed by use of a weather screen.

2. When ambient air is less than 25°F, preheating of the area to be welded shall be performed with a propane torch or similar source of heat so that the pipe surface is warm to the touch (approximately 100°F).

3. Since welding under conditions with ambient air less than 25°F is not common in KUB's operations, therefore, welders and welding procedures which have been qualified without preheating at ambient conditions 25°F or above are considered qualified with preheat.

R. SPEED OF TRAVEL: The speed of travel shall be approximately 8"-12" per minute.

S. ARC STRIKES: Striking the arc on the pipe at any point other than the welding groove shall not be permitted.

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SECTION 15230
GAS STEEL PIPELINE WELDING PROCEDURES

PART III: KUB WSP-3

SCOPE

The following welding procedure has been developed and qualified by Knoxville Utilities Board for welding of steel pipelines. This procedure was developed based on the API Standard 1104.

PROCEDURE:

A. PROCESS: Shielded Metal-Arc Welding (SMAW).

B. PIPE AND FITTING METALS: The pipe and fittings shall conform to API 5L grades less than or equal to X42, or other materials with similar chemical compositions and physical properties. This procedure particularly includes pipe and fittings conforming to API 5L grade A and API 5L grade B, ASTM A106, and ASTM A53.

C. DIAMETER: The pipe and fittings shall have outside diameters greater than 12-3/4".

D. WALL THICKNESS: The wall thickness of the pipe and fittings shall be in the range from 3/16" (0.188") to 3/4" (0.750").

E. JOINT DESIGN:

1. Bevel and Spacing (see Figure 1)

   a. Beveled Ends - 30° plus 5° minus 0°.

   b. Root Face - 1/16" plus or minus 1/32".

   c. Root Opening - 1/16" plus or minus 1/32".

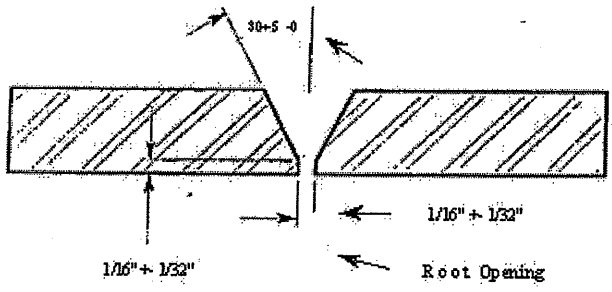

Figure I - Typical Butt Weld Bevel and Spacing

2. Completed weld (see figures 2 and 3)

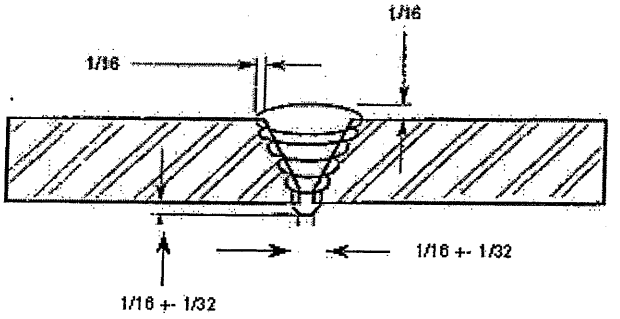

Figure 2 - Completed Butt Weld

a. Root Bead - Extend root bead 1/16" plus or minus 1/32" past the inner wall of the pipe.

b. Stripper Beads - Stripper beads or beads that do not extend around the circumference of the weld may be added to the filler heads to compensate for variations in the spacing of the joint.

c. Cover Beads - Extend cover bead on butt welds approximately 1/16" above the surface of the pipe and overlap cover bead approximately 1/16" on each side of bevel.

d. Cross Section - The completed weld shall have a uniform cross section around the pipe.

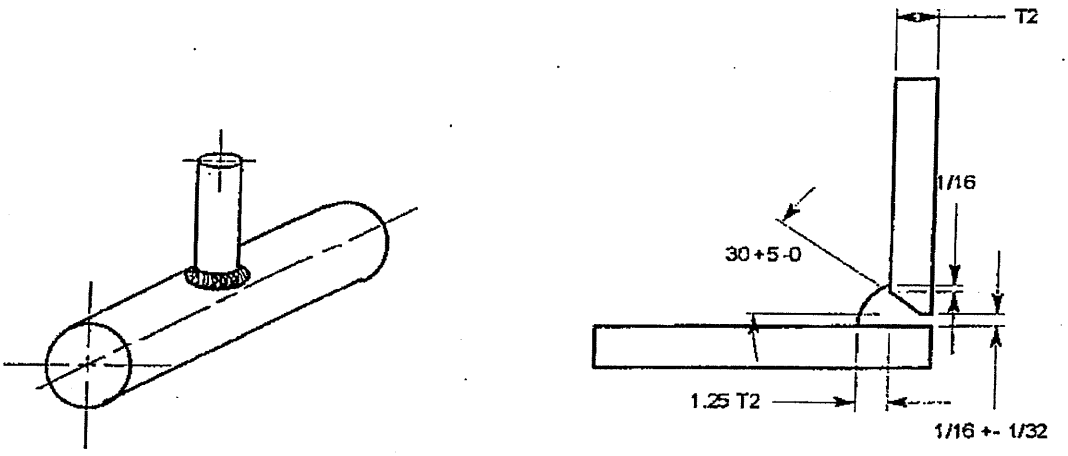

Figure 3 - Typical Fillet Weld

F. FILLER METAL:

1. Root Pass - E6010 5P+, or equal.

2. Hot Pass - E6010 5P+, or equal.

3. Filler - E8010 G 70+, or equal.

4. Cover Pass - E8010 G 70+, or equal.

G. ELECTRODE (ROD) SIZE:

1. Root Pass - 1/8" or 5/32".

2. Hot Pass - 5/32".

3. Filler - 5/32" or 3/16".

4. Cover Pass - 5/32" or 3/16".

H. MINIMUM NUMBER OF PASSES: At least 3 passes shall be used.

I. ELECTRICAL CHARACTERISTICS: The welding current shall be direct current with reverse polarity (pipe negative and electrode positive). The arc voltage as measured between the electrode holder and the pipe shall not exceed 32 volts. The allowable amperage range for the various electrode diameters are shown below:

Electrode Diameter	Amperage Range
3/32"	40 - 130 amps
1/8"	90 - 195 amps
5/32"	140 - 225 amps
3/16"	150 -235 amps

J. POSITION:

1. The axis of the pipe may be in any position.

2. At tie-ins, the pipe shall not be moved from the start of making the root pass (stringer bead) until the weld is completed.

3. At all other joints in line pipe, the pipe shall not be moved from the start of making the root pass (stringer bead) until the lineup clamps are removed. After the lineup clamps are removed, the pipe may be placed on skids; the pipe shall then remain in the fixed position until welding is complete. Pipe deflections during skidding shall be kept to a minimum.

4. A minimum clearance of 16" shall be provided in all directions from the weld.

K. DIRECTION OF WELDING: All welding by this procedure shall be by the downhill method starting at the top center of the pipe and stopping near the bottom center. Where the pipe is fixed in the vertical position, an imaginary top of pipe shall be established and maintained for the entire weld.

L. NUMBER OF WELDERS: One or more welders may be used for each pass.

M. TIME LAPSE BETWEEN PASSES: The maximum time interval between the completion of the root pass (stringer bead) and the beginning of the hot pass (first filler bead) shall not exceed five minutes.

N. LINEUP CLAMPS: External or internal lineup clamps may be used.

O. LINEUP CLAMP REMOVAL:

1. When external lineup clamps are used, they shall not be removed until the root pass (stringer bead) is at least 70% completed around the circumferential joint in equally spaced increments.

2. Internal line-up clamps when used shall not be removed until 80% of the root pass is complete.

P. CLEANING AND/OR GRINDING:

1. Preparation - Welding surfaces shall be cleaned of all moisture, rust, scale, primer, oil, or other materials that may be detrimental to the finished weld. When coating must be removed, it shall be removed at least a distance equal to the cut back on new pipe of the same diameter.

2. Cleaning Weld - All slag, knots of filler metal, pinholes, and similar surface defects shall be removed before depositing the next pass.

3. Tools - Power tools such as a power grinder is the preferred tool for cleaning. Hand tools such as a file or a stiff brush may also be used. Chisels should never be used for removing pipe coatings.

Q. PREHEAT:

1. Whenever possible, welding shall be performed under conditions with ambient air at least 25°F. In some cases the ambient air can be warmed by use of a weather screen.

2. When ambient air is less than 25°F, preheating of the area to be welded shall be performed with a propane torch or similar source of heat so that the pipe surface is warm to the touch (approximately 100°F).

3. Since welding under conditions with ambient air less than 25°F is not common in KUB's operations, therefore, welders and welding procedures which have been qualified without preheating at ambient conditions 25°F or above are considered qualified with preheat.

R. SPEED OF TRAVEL: The speed of travel shall be approximately 8"-12" per minute.

S. ARC STRIKES: Striking the arc on the pipe at any point other than the welding groove shall not be permitted.

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SECTION 15230
GAS STEEL PIPELINE WELDING PROCEDURES

PART IV: KUB WSP-4

SCOPE

The following welding procedure has been developed and qualified by Knoxville Utilities Board for welding of steel pipelines. This procedure was developed based on the API Standard 1104.

PROCEDURE:

A. PROCESS: Shielded Metal-Arc Welding (SMAW).

B. PIPE AND FITTING METALS: The pipe and fittings shall conform to API 5L grades greater than X42 but less than X65, or other materials with similar chemical compositions and physical properties. This procedure particularly includes pipe and fittings conforming to API 5L grade A and API 5L grade B, ASTM A106, and ASTM A53.

C. DIAMETER: The pipe and fittings shall have outside diameters of greater than 12-3/4".

D. WALL THICKNESS: The wall thickness of the pipe and fittings shall be in the range from 3/16" (0.188") to 3/4" (0.750").

E. JOINT DESIGN:

1. Bevel and Spacing (see Figure 1)

   a. Beveled Ends - 30° plus 5° minus 0°.

   b. Root Face - 1/16" plus or minus 1/32".

   c. Root Opening - 1/16" plus or minus 1/32".

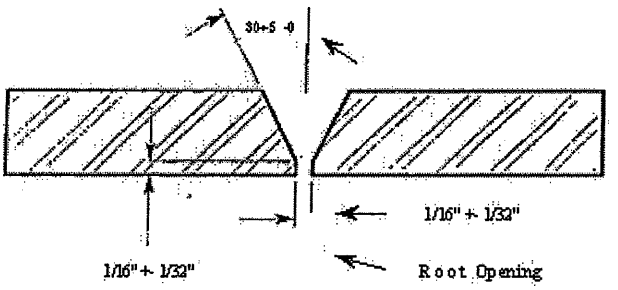

Figure I - Typical Butt Weld Bevel and Spacing

2. Completed weld (see figures 2 and 3)

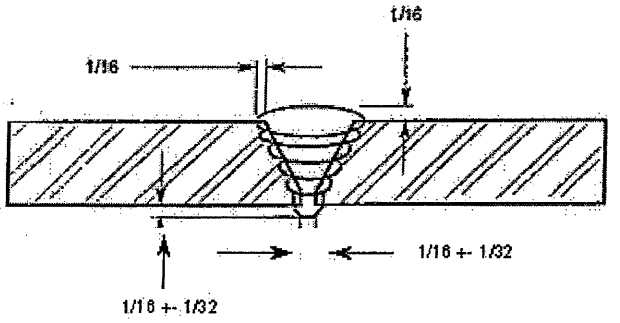

Figure 2 - Completed Butt Weld

a. Root Bead - Extend root bead 1/16" plus or minus 1/32" past the inner wall of the pipe.

b. Stripper Beads - Stripper beads or beads that do not extend around the circumference of the weld may be added to the filler heads to compensate for variations in the spacing of the joint.

c. Cover Beads - Extend cover bead on butt welds approximately 1/16" above the surface of the pipe and overlap cover bead approximately 1/16" on each side of bevel.

d. Cross Section - The completed weld shall have a uniform cross section around the pipe.

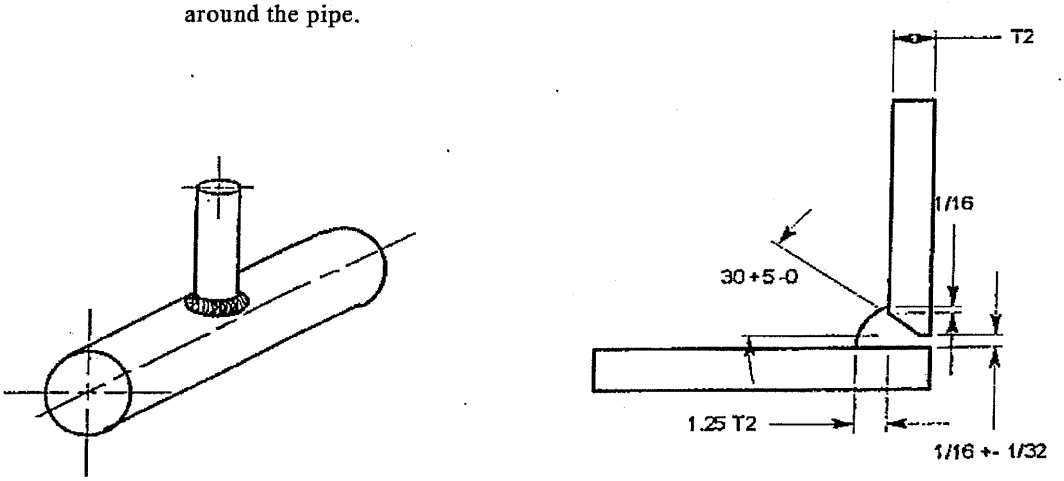

Figure 3 - Typical Fillet Weld

F. FILLER METAL:

1. Root Pass - E6010 5P+, or equal.
2. Hot Pass - E6010 5P+, or equal
3. Filler - E8010 G 70+, or equal.
4. Cover Pass - E8010 G 70+, or equal.

G. ELECTRODE (ROD) SIZE:

1. Root Pass - 1/8" or 5/32".
2. Hot Pass - 5/32"
3. Filler - 5/32" or 3/16"
4. Cover Pass - 5/32" or 3/16".

H. MINIMUM NUMBER OF PASSES: At least 3 passes shall be used.

I. ELECTRICAL CHARACTERISTICS: The welding current shall be direct current with reverse polarity (pipe negative and electrode positive). The arc voltage as measured between the electrode holder and the pipe shall not exceed 32 volts. The allowable amperage range for the various electrode diameters are shown below:

Electrode Diameter	Amperage Range
3/32"	40 - 130 amps
1/8"	90 - 195 amps
5/32"	140 - 225 amps
3/16"	150 -235amps

J. POSITION:

1. The axis of the pipe may be in any position.
2. At tie-ins, the pipe shall not be moved from the start of making the root pass (stringer bead) until the weld is completed.
3. At all other joints in line pipe, the pipe shall not be moved from the start of making the root pass (stringer bead) until the lineup clamps are removed. After the lineup clamps are removed, the pipe may be placed on skids; the pipe shall then remain in the fixed position until welding is complete. Pipe deflections during skidding shall be kept to a minimum.
4. A minimum clearance of 16" shall be provided in all directions from the weld.

K. DIRECTION OF WELDING: All welding by this procedure shall be by the downhill method starting at the top center of the pipe and stopping near the bottom center. Where the pipe is fixed in the vertical position, an imaginary top of pipe shall be established and maintained for the entire weld.

L. NUMBER OF WELDERS: One or more welders may be used for each pass.

M. TIME LAPSE BETWEEN PASSES: The maximum time interval between the completion of the root pass (stringer bead) and the beginning of the hot pass (first filler bead) shall not exceed five minutes.

N. LINEUP CLAMPS: External or internal lineup clamps may be used.

O. LINEUP CLAMP REMOVAL:

1. When external lineup clamps are used, they shall not be removed until the root pass (stringer bead) is at least 70% completed around the circumferential joint in equally spaced increments.

2. Internal line-up clamps when used shall not be removed until 80% of the root pass is complete.

P. CLEANING AND/OR GRINDING:

1. Preparation - Welding surfaces shall be cleaned of all moisture, rust, scale, primer, oil, or other materials that may be detrimental to the finished weld. When coating must be removed, it shall be removed at least a distance equal to the cut back on new pipe of the same diameter.

2. Cleaning Weld - All slag, knots of filler metal, pinholes, and similar surface defects shall be removed before depositing the next pass.

3. Tools - Power tools such as a power grinder is the preferred tool for cleaning. Hand tools such as a file or a stiff brush may also be used. Chisels should never be used for removing pipe coatings.

Q. PREHEAT:

1. Whenever possible, welding shall be performed under conditions with ambient air at least 25°F. In some cases the ambient air can be warmed by use of a weather screen.

2. When ambient air is less than 25°F, preheating of the area to be welded shall be performed with a propane torch or similar source of heat so that the pipe surface is warm to the touch (approximately 100°F).

3. Since welding under conditions with ambient air less than 25°F is not common in KUB's operations, therefore, welders and welding procedures which have been qualified without preheating at ambient conditions 25°F or above are considered qualified with preheat.

R. SPEED OF TRAVEL: The speed of travel shall be approximately 8"-12" per minute.

S. ARC STRIKES: Striking the arc on the pipe at any point other than the welding groove shall not be permitted.

_____ _____

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END OF SECTION