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August 29, 1985
ST-HL-AE-1333
File No.: G9.1, C36.8

Mr. George W. Knighton, Chief
Licensing Branch No. 3
Division of Licensing
U. S. Nuclear Regulatory Commission
Washington, DC 20555

South Texas Project
Units 1 & 2
Docket Nos. STN 50-498, STN 50-499
Visual Inspection Acceptance Criteria
for Structural Welding

Reference: (1) NRC letter from James P. Knight to Douglas E. Dutton
of Nuclear Construction Issues Group, dated 6/26/85.
Subject: Visual Weld Acceptance Criteria for
Structural Welding at Nuclear Power Plants (VWAC),
Revision 2.

Dear Mr. Knighton:

The attachment contains marked-up Final Safety Analysis Report (FSAR) pages indicating STP's revised welding acceptance criteria for structural and miscellaneous steel welding. As discussed with members of your staff (N. P. Kadambi and D. Smith) in a telephone conversation on August 14, 1985, HL&P is committing to the Visual Welding Acceptance Criteria for Structural Welding at Nuclear Power Plants (VWAC) Revision 2 as written by the Nuclear Construction Issues Group. The staff has recently completed review of the VWAC document as described in Reference (1), which states that the VWAC "...represents a technically acceptable approach for visual inspection of structural weldments of nuclear power plants that are under the purview of American Welding Society Standard D1.1 or other non-ASME class structures."

HL&P is committed to VWAC without exceptions. The attachment contains marked-up FSAR pages which reflect this new acceptance criteria. These revisions will be incorporated into a future FSAR amendment.

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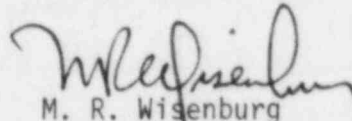
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Training on the implementation of VWAC Revision 2 is currently being provided to Quality Control (QC) inspectors at the jobsite. The training of the first group of QC inspectors was completed on August 14, 1985. The NRC regional site inspectors have been provided opportunities to review the training. The project proceeded with the implementation of this criteria on August 15, 1985.

If you should have any questions on this matter, please contact Mr. M. E. Powell at (713) 993-1328.

Very truly yours,



M. R. Wisenburg
Manager, Nuclear Licensing

CAA:yd

Attachment

cc:

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APPENDIX 3.8.B

VISUAL INSPECTION ACCEPTANCE
CRITERIA FOR STRUCTURAL STEEL AND MISCELLANEOUS
STEEL WELDING TO MEET DESIGN REQUIREMENTS

3.8.B.1 SCOPE

and AWS D1.1-85,
Section 1.1.1.1.

D1.1-75

This appendix provides the acceptance criteria for visual inspection of the welding of structural steel and miscellaneous steel. These criteria represent design requirements consistent with the engineering approval specified in AWS D1.1, Sections 1.1.2, 3.1.4, 3.7.4, and 3.7.5. The criteria also pertain to welding of light gauge material in HVAC ductwork and other systems which are not specifically covered by AWS D1.1. The criteria are applicable to structural systems subjected to static loading for which fracture resistance and fatigue resistance are not principal concerns. Where a question arises as to the classification of weld joints or the acceptance criteria, the Construction Manager shall be consulted for disposition.

Insert I

3.8.B.2 CLASSIFICATION OF WELD JOINTS (Applicable to 3.8.B.3 only)

The following classification of weld joints is determined by the intent of the engineering design and is based upon suitability for service requirements associated with each category.

3.8.B.2.1 CATEGORY A JOINTS. Category A Joints are part of the main building frame, including connections of the main building frame to embedded plates.

3.8.B.2.2 CATEGORY B JOINTS. Category B Joints are not part of the main building frame, but rather provide auxiliary support or framing for systems, components, and equipment. These joints are within the miscellaneous steel category, and shall include, but are not limited to, pipe supports (beyond the scope of ASME Codes), stairways, electrical tray and conduit supports, instrument supports, HVAC duct supports, heavy gauge HVAC ducts inside the RCB, and associated equipment. For connections of the foregoing items to the main building frame, to auxiliary steel and/or to embedded plates, when the connections consist of (1) gusset plates or flanges with continuous fillet welds on both sides of the plate element, or (2) members which are end-welded by all-around fillet welds to the attachment surface, the undercut criterion for Category A Joints shall apply for the whole connection. Typical cases of these connections subject to the Category A criterion for undercut are shown in Figure 3.8.B-2.

3.8.B.2.3 CATEGORY C JOINTS. Category C Joints are not part of the main building frame or auxiliary support system but rather perform a passive function. These joints may be within the miscellaneous steel category and may include, but are not limited to, doors, windows, hatch covers and frames, ledger, angles, handrails, kickplates, and grating.

3.8.B.2.4 CATEGORY D JOINTS. Category D Joints are limited to those welds used in ductwork welding of thin-walled gauge steel which are not specifically covered by AWS D1.1.

INSERT I

The criteria of Section 3.8.B.3 were used prior to August 15, 1985 and that of Section 3.8.B.4 is used subsequently. Section 3.8.B.2 delineating classification of weld joints is applicable to the criteria of Section 3.8.B.3 only; it is not applicable to the final acceptance criteria of Section 3.8.B.4. The criteria of Section 3.8.B.4 are the direct implementation for STP of the Nuclear Construction Issues Group Visual Weld Acceptance Criteria for Structural Welding at Nuclear Power Plants (VWAC Revision 2) dated May 7, 1985.

In addition to the welding of structural and miscellaneous steel, Section 3.8.B.3 also pertained to welding of light gauge material in HVAC ductwork and other systems which are not specifically covered by AWS D1.1. The criteria of Section 3.8.B.4 do not pertain to welding of light gauge material in HVAC ductwork not specifically covered by AWS D1.1. Subsequent to August 15, 1985, the acceptance criteria for welding of light gauge material in HVAC ductwork are as set forth in STP construction specifications.

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3.8.B.3 ACCEPTANCE CRITERIA Prior to August 15, 1985

Acceptance shall be based on the weld joint meeting each criterion listed for the applicable category. For welded connections between elements of two different joint categories, the integrity of the base metal of the elements of the more stringent joint category shall be protected by verifying that welding undercut and/or arc strikes, if any, do not exceed the limits prescribed for the more stringent of the two joint categories. This provision is applicable only to base metal thicknesses of less than 3/8 inch, unless otherwise noted on drawings or specifications.

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3.8.B.3.1 CATEGORY A JOINTS.

3.8.B.3.1.1 Oversize Fillet Welds: The weld meets or exceeds specified size requirements. Either or both fillet weld legs may exceed design size by 1/8 inch for welds up to and including 5/16 inch fillet, and 1/4 inch for welds larger than 5/16 inch fillet.

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Fillet welds exceeding the above limits may be considered acceptable if (1) the weld oversize is localized and cumulatively does not represent over 20 percent of the weld length or 2 inches, whichever is longer, or (2) the fillet weld underwent prior repair that required deposition of additional weld metal.

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Scalloping (intermittent melting of the plate edge) shall not be a cause for rejection of the weld as long as enough plate edge remains such that the fillet weld size can be verified.

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Welds may be longer than specified. Continuous welds may be accepted in place of intermittent welds.

Welds may have end returns of nominal length equal to 2 times the weld size. Maximum length of return shall not exceed three times the weld size.

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3.8.B.3.1.2 Undersize Fillet Welds: The fillet leg dimension may not underrun the nominal fillet size by more than 1/16 inch, and the length of the underrun shall not be more than 10 percent of the weld length. For flange to web joints, the undersize may not be within two flange widths of the weld end. Unequal leg fillet welds are acceptable, provided that the larger and smaller legs meet the prescribed oversize and undersize requirements.

3.8.B.3.1.3 Porosity: The weld may contain a maximum of 5 percent by surface area of unaligned, unclustered porosity. For aligned porosity, the sum of the diameters of piping porosity shall not exceed 3/8 inch in any linear inch of weld nor 3/4 inch in any 12 inch length of weld.

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3.8.B.3.1.4 Weld Profile: Convexity height and butt weld reinforcement shall not exceed 1/8 inch, except for welds 5/8 inch and over, where the

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convexity height or butt weld reinforcement shall not exceed 20 percent of weld size or thickness as long as the profile is smooth and free of sharp transitions.

3.8.B.3.1.5 Craters: The weld may have an underfilled crater, provided the underfill depth does not exceed 1/32 inch and the crater has a smooth contour blending gradually with the adjacent weld and base metal without acute notches.

3.8.B.3.1.6 Undercut: Undercut shall not exceed the value shown in Figure 3.8.B-1 for the Category A welds applicable to the area containing the undercut. Further, the undercut may be twice the value permitted by Figure 3.8.B-1 for an accumulated length of two inches in any 12 inches of weld, but in no case may undercut on one side be greater than 1/16 inch. For weld lengths less than 12 inches, the permitted undercut length shall be proportional to the actual length.

3.8.B.3.1.7 Cracks: Cracks are unacceptable.

3.8.B.3.1.8 Fusion: Incomplete fusion between weld metal and base metal is unacceptable. Overlap is acceptable only if full fusion at the weld toe is visible.

3.8.B.3.1.9 Weld Spatter: Adherent weld spatter is acceptable unless its removal is required for further processing such as painting.

3.8.B.3.1.10 Arc Strikes: Every reasonable precaution shall be taken to prevent arc strikes due to welding or NDE work. If the arc strike is discovered during the welding operation, it shall be repaired at that time as required by AWS D1.1, Section 4.4. For high-strength low-alloy steels (minimum yield strength greater than 60,000 psi), all arc strikes shall be removed by grinding. The ground area shall be visually inspected to assure complete removal of the arc strike.

For other steels, if an arc strike is found at some subsequent time, it shall be visually examined and accepted if no cracking is evident. If cracking is evident, the repair shall conform with Section 4.4 of AWS D1.1. In cleaning the arc strikes prior to visual examination, no power brushing or grinding shall be done.

3.8.B.3.2 CATEGORY B JOINTS.

3.8.B.3.2.1 Oversize Fillet Welds: Same as 3.8.B.3.1.1.

3.8.B.3.2.2 Undersize Fillet Welds: The fillet leg dimension may not underrun the nominal fillet size by more than 1/16 inch, and the length of the underrun shall not be more than 20 percent of the weld length.

3.8.B.3.2.3 Porosity: Same as 3.8.B.3.1.3.

3.8.B.3.2.4 Weld Profile: Same as 3.8.B.3.1.4.

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3.8.B.3.2.5 Craters: Underfilled groove weld craters are acceptable provided the depth of underfill is 1/16-inch or less. Underfilled single-pass fillet weld craters are acceptable provided the crater length is less than 10 percent of the weld length. On multi-pass fillet welds a crater depth of 1/16-inch or less is acceptable.

3.8.B.3.2.6 Undercut: Undercut not exceeding 1/32-inch may be acceptable for the full length of the weld. Undercut not exceeding 1/16-inch may be accepted provided the width is greater than the depth and the undercut does not have an acute intersection at its root. The cumulative length of 1/16-inch undercut shall not exceed 50 percent of the weld length. For members welded from both sides, the cumulative undercut depth or length for both sides shall not exceed the above criteria applied to one side.

3.8.B.3.2.7 Cracks: Same as 3.8.B.3.1.7.

3.8.B.3.2.8 Fusion: Same as 3.8.B.3.1.8.

3.8.B.3.2.9 Weld Spatter: Same as 3.8.B.3.1.9.

3.8.B.3.2.10 Misalignment: Misalignment in butt welds not exceeding one-half the thickness of the thinner member thickness or 1/4-inch, whichever is less, is acceptable.

3.8.B.3.2.11 Arc Strikes: Arc strikes are acceptable provided that the craters do not contain cracks as determined by visual examination. For high-strength low-alloy steels (minimum yield strength greater than 60,000 psi), all arc strikes shall be removed by grinding. The ground area shall be visually inspected to assure complete removal of the arc strike.

3.8.B.3.2.12 Backing Fit-up: The fit-up of a backing bar is not a basis for rejection. 32

3.8.B.3.3 CATEGORY C JOINTS.

3.8.B.3.3.1 Oversize Fillet Welds: Same as 3.8.B.3.1.1.

3.8.B.3.3.2 Undersize Fillet Welds: Same as 3.8.B.3.2.2.

3.8.B.3.3.3 Porosity and Slag Inclusions: Porosity and slag inclusions are not a basis for rejection.

3.8.B.3.3.4 Weld Profile: Convexity height and butt weld reinforcement shall not exceed 3/16-inch.

3.8.B.3.3.5 Craters: Same as 3.8.B.3.2.5.

3.8.B.3.3.6 Undercut: Undercut shall not exceed 3/32-inch or 25 percent of the material thickness, whichever is less.

3.8.B.3.3.7 Cracks: Same as 3.8.B.3.1.7.

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3.8.B.3.3.8 Fusion: Same as 3.8.B.3.1.8.

3.8.B.3.3.9 Weld Spatter: Same as 3.8.B.3.1.9.

3.8.B.3.3.10 Misalignment: Same as 3.8.B.3.2.10.

3.8.B.3.3.11 Arc Strikes: Arc strikes are acceptable provided that the craters do not contain any cracks as determined by visual examination.

3.8.B.3.3.12 Backing Fit-up: Same as 3.8.B.3.2.12.

3.8.B.3.4 CATEGORY D JOINTS.

3.8.B.3.4.1 Oversize Fillet Welds: Same as 3.8.B.3.1.1.

3.8.B.3.4.2 Undersize Fillet Welds: Same as 3.8.B.3.2.2.

3.8.B.3.4.3 Porosity and Slag Inclusions: Porosity and slag inclusions are not a basis for rejection, provided the weld does not leak.

3.8.B.3.4.4 Weld Profile: Convexity height, overlap, and butt weld reinforcement may not exceed 1/8-inch. Profile of butt welds shall be convex. Faces of fillet welds may be slightly convex, flat, or slightly concave. Concavity shall not reduce the weld throat beyond that required for weld size.

3.8.B.3.4.5 Undercut: Undercut shall not exceed 50 percent of the material thickness.

3.8.B.3.4.6 Cracks: Same as 3.8.B.3.1.7.

3.8.B.3.4.7 Fusion: Incomplete fusion between weld metal and the base metal is unacceptable.

Butt welded joints for ductwork shall develop full penetration for a minimum of 80 percent of the length of the joint.

Corner welds used to seal ductwork are designated partial penetration welds. Such welds do not require full fusion, and weld reinforcement greater than the material thickness may constitute adequacy of the weld, provided the toes of the weld have complete penetration.

3.8.B.3.4.8 Weld Spatter: Same as 3.8.B.3.1.9.

3.8.B.3.4.9 Misalignment: Faying surfaces shall not exceed a 3/16-inch gap between parts to be joined. The leg of the fillet welds shall be increased by the amount of the separation.

Abutting parts to be joined by butt welds shall be carefully aligned. Misalignment shall not exceed the thickness of the thinner material being welded, as measured from the highest abutting member, nor more than 1/8-inch.

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3.8.B.3.4.10 Arc Strikes and Scratching: Scratching of metal in fit-up and isolated arc strikes must be removed only to the extent necessary to remove sharp burrs. The intent of this stipulation is to preclude excessive grinding of the base metal, which shall not exceed 50 percent of the base metal thickness in the isolated areas.

3.8.B.3.4.11 Backing Fit-up: See paragraph 3.8.B.3.2.12.

3.8.B.3.4.12 Burn-through: Turning vanes and turning vane rails that are of light gauge material and welded to heavier gauge ductwork will be welded with a fillet weld as required by design drawings. Minor burn-through cannot be avoided on vanes and is permitted up to $\frac{1}{4}$ -inch in length, provided an equivalent length of fillet weld is added to compensate for the weld weakened by the burn-through.

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Burn-through is permitted provided leak-tight integrity is maintained. Metal flow on the inside of the duct is permitted, provided it is fused completely with the parent metal and the metal thickness is not reduced by greater than 50 percent.

3.8.B.3.4.13 Distortion: Distortion caused by welding longitudinal seams shall not exceed 2 percent of the nominal diameter measured from the cross-sectional cord of the distorted area.

Insert II

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3.8.B.4 ACCEPTANCE CRITERIA AFTER AUGUST 15, 1985

The following criteria are used for the acceptance inspection of welds in the uncoated condition. These criteria are also used for subsequent inspections after the welds have been coated, with the concurrence of the Engineer.

3.8.B.4.1 WELD CRACKS. The weld shall have no cracks.

3.8.B.4.2 FILLET WELD SIZE. A fillet weld shall be permitted to be less than the size specified by $1/16$ inch for $1/4$ the length of the weld. Oversized fillet welds shall be acceptable if the oversized weld does not interfere with mating parts.

3.8.B.4.3 INCOMPLETE FUSION. In fillet welds, incomplete fusion of $3/8$ inch in any 4 inch segment, and $1/4$ inch in welds less than 4 inches long, is acceptable. For groove welds, incomplete fusion is not acceptable. For fillet and groove welds, rounded end conditions that occur in welding (starts and stops) shall not be considered indications of incomplete fusion and are irrelevant.

3.8.B.4.4 WELD OVERLAP. Overlap is acceptable provided the criteria for weld size and fusion can be satisfied. When fusion in the overlap length cannot be verified, an overlap length of $3/8$ inch in any 4 inch segment, and $1/4$ inch in welds less than 4 inches long, is acceptable.

3.8.B.4.5 UNDERFILLED CRATERS. Underfilled craters shall be acceptable provided the criteria for weld size are met. Craters which occur outside the specified weld length are irrelevant provided there are no cracks.

3.8.B.4.6 WELD PROFILES. The faces of fillet welds may be convex, flat, or concave, provided the criteria for weld size are met.

The faces of groove welds may be flat or convex.

Convexity of fillet and groove welds are not criteria for acceptance and need not be measured.

The thickness of groove welds is permitted to be a maximum of $1/32$ inch less than the thinner member being joined.

3.8.B.4.7 UNDERCUT. For material $3/8$ inch and less nominal thickness, undercut depth of $1/32$ inch on one side for the full length of the weld, or $1/32$ inch on one side for $1/2$ the length of the weld and $1/16$ inch for $1/4$ the length of the weld on the same side of the member, is acceptable. For members welded on both sides where undercut exists in the same plane of a member, the cumulative lengths of undercut shall be limited to the lengths of undercut allowed on one side. Melt-through that results in a hole in the base metal is unacceptable.

INSERT II (Continued)

For materials greater than 3/8 inch nominal thickness, undercut depth of 1/32 inch for the full length of the weld and 1/16 inch for 1/4 the length of the weld on both sides of the member is acceptable. When either welds or undercut exist only on one side of the member or are not in the same plane, the allowable undercut depth of 1/32 inch may be increased to 1/16 inch for the full length of the weld.

3.8.B.4.8 SURFACE POROSITY. Only surface porosity whose major surface dimension exceeds 1/16 inch shall be considered relevant. Fillet and groove welds which contain surface porosity shall be considered unacceptable if:

The sum of diameters of random porosity exceeds 3/8 inch in any linear inch of weld or 3/4 inch in any 12 inches of weld; or

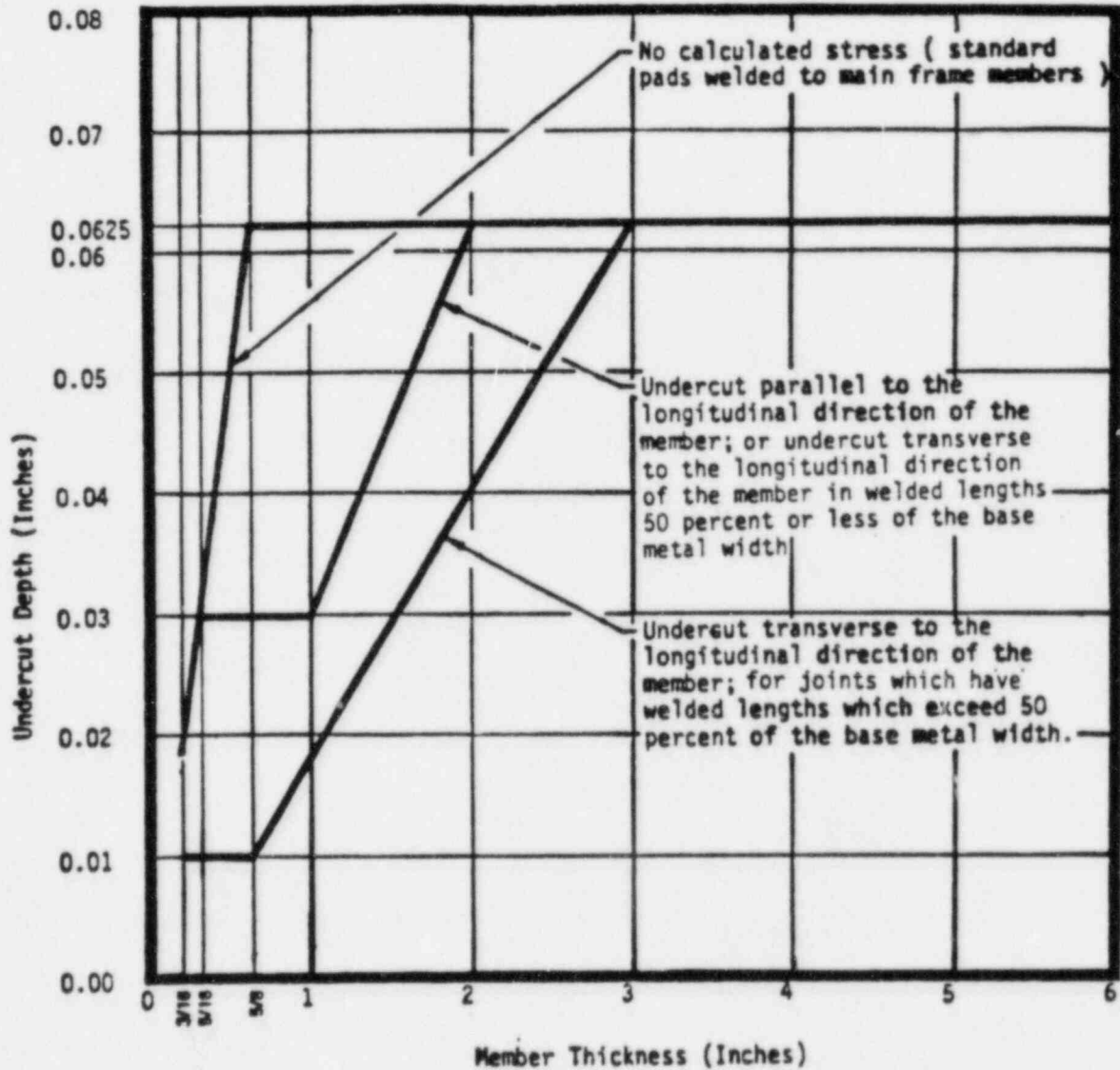
Four or more pores are aligned and the pores are separated by 1/16 inch or less, edge to edge.

3.8.B.4.9 WELD LENGTH AND LOCATION. The length and location of welds shall be as specified on the detail drawing, except that weld lengths may be longer than specified. For weld lengths less than 3 inches, the permissible underlength is 1/8 inch and for welds 3 inches and longer the permissible underlength is 1/4 inch. Intermittent welds shall be spaced within 1 inch of the specified location.

For the outstanding legs of clip angles in framed beam connections, the fillet welds may have end returns of nominal length equal to 2X (weld size), but the maximum length of return shall not exceed 3X (weld size) unless otherwise shown in the design drawing.

3.8.B.4.10 ARC STRIKES. Arc strikes and associated blemishes are acceptable provided no cracking is visually detected.

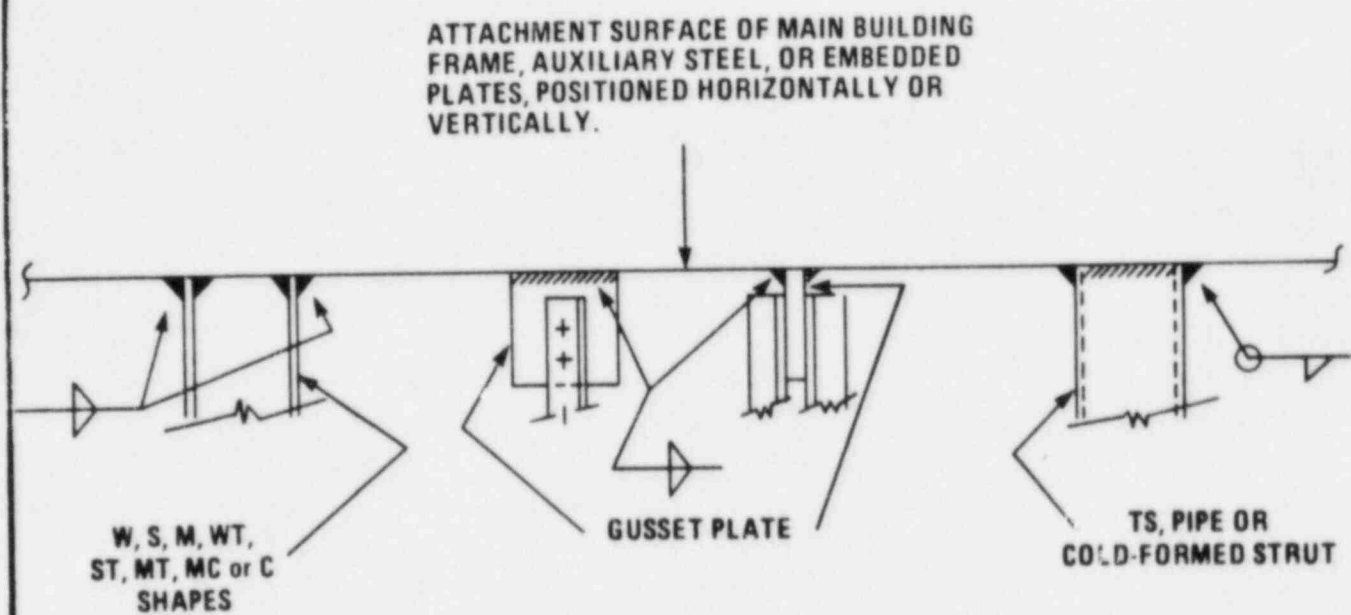
3.8.B.4.11 SURFACE SLAG AND WELD SPATTER. Slag whose major surface dimension is 1/8 inch or less is irrelevant. Isolated surface slag that remains after weld cleaning and which does not exceed 1/4 inch in its major surface dimension, is acceptable. (Slag is considered to be isolated when it does not occur more frequently than once per weld or more than once in a 3 inch weld segment.) Spatter remaining after the cleaning operation is acceptable.



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CATEGORY A WELDS,
PERMISSIBLE UNDERCUT
VALUES



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TYPICAL CASES OF OVERSIZE
FILLET WELDS SUBJECTED TO
CATEGORY A CRITERION

Figure 3.8.B-2

Amendment 40