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Southern California Edison Company

P. O. BOX 800
2244 WALNUT GROVE AVENUE
ROSEMEAD, CALIFORNIA 91770

J. M. CURRAN
MANAGER, QUALITY ASSURANCE

TELEPHONE
(213) 572-1695

November 3, 1982

Mr. D. F. Kirsch
U.S. Nuclear Regulatory Commission
Region V
1450 Maria Lane, Suite #210
Walnut Creek, CA 94596

Dear Mr. Kirsch:

SUBJECT: Response to NRC Letter Dated October 29, 1982, on Allegations Regarding Construction Quality at San Onofre Nuclear Generating Station, Units 2 & 3

Per your request at the November 3, 1982 site meeting, enclosed herein is Bechtel's response of October 29, 1982 from R. L. Patterson to J. M. Curran.

Please consider this as reference to our response of November 3, 1982 from Dr. L. T. Papay to Mr. R. H. Engelton.

Very truly yours,

D. Schone for

J. M. Curran
Manager, Quality Assurance

DBSchone:dsg

Enclosure

Bechtel Power Corporation
Engineers - Constructors
12400 East Imperial Highway
Norwalk, California 90650
MAIL ADDRESS
P.O. BOX 60860 · TERMINAL ANNEX LOS ANGELES CALIFORNIA 90060
TELEPHONE (213) 664-6011

October 29, 1982

Mr. J. M. Curran
Manager, Quality Assurance
Southern California Edison Company
2244 Walnut Grove Avenue
Rosemead, California 91770

Subject: San Onofre Nuclear Generating Station, Units 2 & 3
Bechtel Job 10079
Allegations Made by Mr. E. E. Kent

References:

(A) SCE QA Letter, Mr. J. M. Curran to Mr. R. L. Patterson, dated September 11, 1982, Subject: Same as above

(B) BPC Letter, R. L. Patterson to J. M. Curran, dated September 17, 1982, Subject: Same as above

(C) SCE QA Letter, Mr. J. M. Curran to Mr. R. L. Patterson, dated October 15, 1982, Subject: Same as above

(D) E. C. Rodabaugh, et. al., "Review and Assessment of Research Relevant to Design Aspects of Nuclear Power Plant Piping Systems", NUREG-0307, published July 1977, pp. 2-147

Enclosures:

(1) Response to Specific Allegations

(2) ASME Section III, Subsection NF, 1974 Edition, Summer 1974 Addendum, NF-5360

(3) ASME Section III, Subsection NF, 1974 Edition, Summer 1974 Addendum, NF-4427 and Figure NF-4427-1

(4) ASME Boiler and Pressure Vessels, Interpretation, No. 7, III-80-109

(5) ASME Boiler and Pressure Vessels, Interpretation, No. 6, III-1-79-176

(6) Photomicrographs of Vibro-Graved and Scribed Marks

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Mr. J. M. Curran, Manager, Quality Assurance
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Enclosures: (cont.)

(7) ASME Section III, Subsection NB, 1974 Edition, Summer 1974 Addendum, NB-4232.1, Figure NB-4233-1

(8) ASME Section III, Division I-Subsection NC, 1974 Edition, Summer 1974 Addendum, NC-4711, NC-4720

(9) Supplementary Data - Structural Welding Design and Construction Adequacy

Dear Mr. Curran:

This letter responds to twenty one allegations made by Mr. E. E. Kent pertaining to various aspects of welding, welder qualification and inspection procedures used by Bechtel Power Corporation in the design and construction of the San Onofre Units 2 and 3. Additional allegations made pertaining to a hydrogen line wall thinning and the use of ASTM A-7 steel on Unit 1 will be addressed separately.

The first four allegations were transmitted in Reference (A) and were responded to in Reference (B). The NRC has reviewed this information in NRC Report 82-27 and has closed these items. Additional information on one of these allegations developed as a result of the October 25, 1982 meeting with Mr. Kent is provided as Enclosure (9).

The remaining 17 allegations can be segregate[illegible]ix categories:

A. Five allegations were made regarding the [illegible]isual acceptance criteria employed in Bechtel's Constr[illegible]cification CS-P207 for American Society of Mechanical Engin[illegible]er Boiler and Pressure Vessel Code (ASME) Section III, Subsection NF, component supports and one allegation was made in relation to B31.1 (non-safety related piping). (Note, although not an allegation, Reference (C) requested that Bechtel review the remaining paragraphs of Section 5.6 of CS-P207 to show conformance with the ASME Code.)

B. Two allegations were made comparing the American Welding Society's (AWS) D.1.1 Structural Welding Code versus CS-C16, "Visual Inspection Criteria for Structural Steel and Miscellaneous Metal Welding to Meet Design Criteria."

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C. Three allegations were made relating to field operations. These were pipe damage due to pipe cutter scribe marks, inadequate flare bevel weld details, and inadequate welder qualification requirements.

D. Three allegations were made which question the structural adequacy of welded joints. These were the lack of prototype testing, the lack of precise knowledge of actual weld strengths, and the lack of fillet welds that completely surround the attached member.

E. One allegation related to the question of runoff plates for groove welding not being required either by BPC design or by our suppliers.

F. The final two allegations on Units 2 and 3 were expressed by Mr. Kent after the site tour on October 25, 1982. The first related to the slope requirements at either a valve to pipe joint or pipe to pipe joint where the schedules of the two components are different. The second related to thread engagement requirements on the bonnet of a check valve.

Before addressing each item in particular, Enclosure (1), we wish to state that the design and construction practices employed by BPC were governed by the appropriate code as defined in regulatory documents or as generally accepted as industry practice.

The applicable national standard that deals with welding of safety related pipe supports in nuclear power plants is the American Society of Mechanical Engineers Boiler and Pressure Vessel Code (ASME Code). Only the ASME Code provides definitions for acceptance of pipe support welds by visual examination. The Nuclear Regulatory Commission (NRC) in their Code of Federal Regulations, 10CFR50 (Domestic Licensing of Production and Utilization Facilities) and Regulatory Guide 1.26 (Quality Group Classifications and Standards for Water, Steam, and Radioactive Waste Containing Components of Nuclear Power Plants), specifically approves the use of ASME III for nuclear safety related elements of the plant. The portion of the ASME Code governing pipe supports is Subsection NF. For the San Onofre Units 2 and 3 the 1974 Edition Summer 1974 Addendum is the applicable code. Specifically, San Onofre 2 and 3 construction specifications for pipe supports provide detailed acceptance criteria for welding which comply with the ASME Code and interpretations of the Code written by the ASME.

Outside the NF boundary the American Institute of Steel Construction (AISC) specification and the American Welding Society's (AWS) Structural Welding Code are utilized.

Bechtel Power Corporation

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Mr. J. M. Curran, Manager, Quality Assurance October 29, 1982
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It is important that the detailed wording of particular paragraphs of the construction specification be evaluated in the context of the overall BPC quality program. The quality program used for the design and construction is comprised of documented criteria and guidelines that ensure the adequacy of the end product. These include design guides, National Standards and Codes, developmental work by our Materials and Quality Service (M and QS) Group, qualification of welds and materials, construction welding procedures, qualification of welders, and qualification of weld inspectors. For example, to respond to an NRC request relating to the criteria a welding inspector uses to inspect a weld, the following procedure is employed: (1) The code applicable boundaries are delineated on engineering drawings; (2) there are work plan procedures at the jobsite which precisely define what to do; (3) engineering documents such as construction specifications and Form 84 provide inspection criteria. Based on these documents NF welding (ASME III) would be visually inspected by Pipe Support QCE's in accordance with the acceptance criteria specified in CS-P207. Attachments to pressure boundaries would be inspected by Welding QCE's using visual and NDE procedures prescribed by engineering documents specified on FORM 84. Structural steel, where AWS welding is appropriate, would be inspected by QCE's to the requirements of CS-C16. All cognizant QCE's are certified in accordance with ANSI N45.2.6 or SNT-TC-1A, as applicable.

In general, any statements extracted from the BPC construction specification must be examined in the context of the overall quality program.

Bechtel Power Corporation has reviewed the allegations made by Mr. E. E. Kent and found them to be without substance. The design and construction practices employed by BPC are consistent with normally accepted practices, codes, and regulatory requirements.

Very truly yours,

BECHTEL POWER CORPORATION

R. L. Patterson

R. L. Patterson
Division Quality Assurance Manager

SHF:jv

cc: Mr. D. B. Schone, SCE (Jobsite)

Response to Specific Allegations

A. The first six allegations were that specific sections of CS-P207 are not in accordance with the AWS Code. As previously stated, the applicable code covering inspection of safety related pipe supports is ASME Section III, Subsection NF, not the AWS Code. The following discussion compares specific sections of CS-P207 versus the criteria of the ASME Code [items 1 through 6 and item 11 of Reference (C)].

1. In addressing porosity and slag inclusions in pipe support welds, Paragraph 5.6.1.3 of the specification states:

   "Porosity and slag shall not be cause for rejection."

   From Enclosure (2), ASME Code, Section III, Subarticle NF-5360, porosity and slag are not cited as bases for rejection of pipe support welds by visual examination. The ability to visually examine a pipe support weld is a function of the surface condition of the weld. This surface condition of the weld may be minimally obscured by overlying slag. Surface slag is not of itself a cause for rejection of the weld and does not limit the weld inspector's requirement to accept the weld. Removal of the surface slag then allows the inspector to judge the visual acceptability of the weld surface.

   Surface porosity also is not a cause for rejection of the weld. Minimal amount of surface porosity may result due to the metallurgical nature of the base metal and welding filler material and methods required by the ASME III Code, and as used with qualified welding procedures and welders. This resulting surface porosity is compensated for by the conservative weld metal allowable stresses required by the ASME III Code. Welding processes properly qualified and used in fabrication under a controlled quality program as have been implemented at San Onofre 2 and 3 will result in minimal porosity and slag in the weld metal.

   As stated previously, to take the construction specification acceptance criteria on porosity and slag out of context of the overall quality program is inappropriate.

2. Paragraph 5.6.1.4 of the construction specification for pipe supports discusses weld convexity height acceptance. It states:

   "Convexity height may be accepted without limit. Rollover (overlap) not exceeding 1/8 inch is acceptable provided the toe or fusion line of the weld remains visible for examination."

This paragraph from the specification deals only with fillet welds for pipe supports and not with piping pressure boundary. Paragraph 5.6.1.4 is consistent with the requirements of Subarticle NF-4427 of the ASME III Code, which is shown in Enclosure (3), and states that a weld may vary from concave to convex. Convexity of a fillet weld deals with additional weld metal deposited over what is required by the drawing and may enhance the ability of a weld to sustain greater design loads. Additionally, convexity is self-limiting by the nature and type of weld process used and will not cause significant stress concentration in the pipe support welds. In addition, Code Interpretation III-80-109, Question (1) [Enclosure (4)] confirms that convexity criteria are not addressed by the ASME III Code.

3. Paragraph 5.6.1.9 of the specification addresses underfilled groove weld craters. It states:

> "Underfilled groove weld craters shall be accepted provided the depth of underfill is 1/16 inch or less. Underfilled single-pass fillet weld craters shall be accepted provided the crater length is less than 10 percent of the weld length. On multipass fillet welds, crater depth 1/16 inch or less shall be accepted."

ASME Section III, Subsection NF does not specifically address acceptance criteria for underfilled groove craters. In response to a specific inquiry on underfill, the ASME issued Interpretation III-80-109, Question (4) [Enclosure (4)]. The Interpretation states that the Code, NF-5360, addresses weld metal indications only and is not concerned with underrun on fillet weld size or length. The margins inherent in the engineering design of welds account for underrun on fillet size or length defined by the visual inspection criteria. The size of welds shown on engineering drawings accommodate the underfill to the extent specified in the paragraph 5.6.1.9 and this will not affect the structural integrity of the weld.

4. Paragraph 5.6.1.10 of the specification addresses adherent weld spatter. It states:

> "Adherent weld spatter, not removable by wire brushing, is acceptable unless its complete removal is required for further processing such as coating."

Weld spatter on the surfaces of pipe support welds or base metal has no effect on the structural function or integrity of the support. The ASME III Code, Subsection NF, does not require weld spatter removal. The specific question of weld spatter removal has previously been asked of the ASME. Their written response to the inquiry is contained in Interpretation III-1-79-176 shown in Enclosure (5), and is consistent with the specification.

5. Paragraph 5.6.1.11 of CS-P207 states:

> "Arc strikes are acceptable, provided that the craters, (1) do not contain cracks (as determined by visual examination), and (2) maximum size does not exceed 3/8 inch plan nor 1/16 inch profile. Arc strikes shall be free of any foreign deposits which might interfere with the performance of visual examination."

Even though the ASME III Code, Subsection NF does not explicitly discuss arc strikes, the ASME Interpretation in III-80-109, Question (3) [Enclosure (4)] states that weldment surface defects are removed without regard to the cause of the surface defect. Arc strikes are of concern only if a crack is produced or the section size is reduced beyond that required design section thickness. Arc strikes are not likely to cause cracks in plain carbon steels used for pipe supports. Plain carbon steels are essentially non-hardenable steels. Further, paragraph 5.6.1.11 of the specification excludes, in particular, crater cracks from acceptability. Minor hardening that might result from arc strikes in plain carbon steel is easily accounted for in the massive surrounding matrix of the ductile material. Arc strikes might be of concern in alloyed steel materials. However, these types of materials are not used in pipe hangers, cable trays supports, or similar items.

Most codes and standards including many AWS standards do not treat arc strikes because of the essentially cosmetic nature of these discontinuities. These codes and standards include:

AWS D14.1 = "Specification for Welding Industrial and Mill Cranes."

AWS D14.2 = "Specification for Metal Cutting Tool Weldments."

AWS D10.5 = Report, "Welding Ferrous Materials for Nuclear Power Piping."

AWS D3.5 = "Hull Welding Manual"

ANSI B31.1 = Power Piping

ANSI B31.3 = Petroleum Refinery Piping

The Bechtel position on arc strikes permits grinding of arc strikes but does not require such grinding provided no crater cracks are present and a gentle or rounded profile exists which does not encroach on the minimum design thickness.

6. The last allegation in this category concerns the substitution of fillet welds for a weldment combining a full penetration groove weld with a fillet weld cover. Paragraph 5.7.2 of the specification states:

   "Pipe support drawings for B31.1 piping that indicate full-penetration groove welds with fillet covers may be welded as just fillet welds. The minimum fillet weld size for B31.1 pipe integral attachments shall be as follows:

   a. Fillet weld size = (0.7) x (the wall thickness of the thinner of the pipe wall or the dummy stub wall).

   b. If the attachment is tension loaded due to a snubber or variable spring hanger, engineering calculations must be performed to justify the strength of the weld."

   Since the reference is to B31.1 piping, the scope of this paragraph in the specification is limited to non-safety related piping systems. These non-safety related areas of the power plant do not affect the safe operation of the nuclear safety related systems or the ability of the nuclear systems to be safely shut down. The original design using all full penetration groove welds with fillet cover welds was found to be very conservative. Therefore, an alternate design using fillet welds was developed. Engineering evaluation has determined that the minimum fillet weld size of (0.7) x (the wall thickness of the thinner of the pipe wall or the dummy stub wall) is adequate for bearing type loads (5.7.2.a). Paragraph 5.7.2.b requires a substantiating calculation to assure the adequacy of the design when tension loads are applied.

   In addition, field procedures require the preparation of an FCR for any modification of the dummy stub to pipe welds. No FCR's were found in a search at the site for cases where this alternate procedure has been applied. It is therefore concluded that all dummy stubs installed with fillet welds have been authorized by engineering and properly sized to carry the imposed loads.

Reference (C), item 11, requested that BPC also review the remaining paragraphs of Section 5.6 for compliance with the ASME Code.

5.6.1.1 "The weld meets or exceeds specified size requirements. Either or both fillet weld legs may exceed design size by 3/16 inch for welds up to and including 5/16 inch fillet, and 1/4 inch for welds larger than 5/16 inch fillet. Welds may be longer than specified. Continuous welds may be accepted in place of intermittent welds."

Subsection NF of the Code is silent on this question. This criteria precludes weld rejection when the welder has provided oversized fillet welds within the bounds stated. It also permits acceptance of fillet welds which are longer than the drawing indicates. Both of these variances result in increased weld material deposition which can not reduce the strength of the weld but may increase its load carrying capability.

5.6.1.2 "The fillet leg dimension may not underrun the nominal fillet size by more than 1/16 inch for more than 10 percent of the weld length. For flange to web joints the undersize may not be within two flange thicknesses of the weld end."

Subsection NF of the Code is silent on this point. However, ASME Interpretation III-80-109 [Enclosure (4)] issued May 12, 1980 is as follows:

Question: Are undersized dimensions greater than 1/16 inch of a weld considered as relevant indications when detected by visual examination in accordance with NF-5360(a)?

Reply: NF-5360 addresses weld metal indications only. It does not address underrun on fillet size or length.

Engineering justification for allowing the fillet leg dimension to underrun the nominal fillet size is based upon the inherent margin in the design. For example, calculations on file demonstrate that when a 3/16 inch fillet weld (the smallest weld specified for use in construction of pipe supports) is undersized by 1/16 inch for 10 percent of its length, it has a usable strength of about .60 percent of the design limit load.

5.6.1.5 "The height of reinforcement of butt welds on each face of the weld shall not exceed the following:"

Nominal Thickness (inch)	Maximum Reinforcement (inch)
Up to 1, incl.	3/32
Over 1 to 2, incl.	1/8
Over 2 to 3, incl.	5/32
Over 3 to 4, incl.	7/32
Over 4 to 5, incl.	1/4
Over 5	5/16

This criteria is identical with the ASME III Code, NF-4426.

5.6.1.6 "There are no cracks or linear indications in the weld exceeding 1/16 inch."

This criteria is in accordance with the ASME III Code, Subsection NF, Subarticle 5360(a) which permits indications up to 1/16 inch. Subarticle 5360(b) precludes the acceptance of any cracks.

5.6.1.7 "Thorough fusion exists between the weld metal and base metal, except as permitted as rollover in paragraph 5.6.1.4."

Fusion is not specifically addressed by the Code. This paragraph gives additional criteria for inspection.

5.6.1.8 "Undercut (underfill) not exceeding 1/16 inch may be accepted for the full length of the weld provided it does not encroach on minimum design thickness. For members welded from both sides, the criteria shall be applied independently except that the cumulative depth shall not encroach on the minimum design thickness."

This criteria is more stringent than the requirements of NF-4424. The latter permits undercutting up to the minimum design thickness of the base metal while this criteria limits undercutting to 1/16 inch or up to the minimum design thickness of the base metal.

B. The next two allegations made concerned specific differences between the AWS D1.1 Code and BPC Construction Specification CS-C16.

The first question was given in Reference (C): "Reconcile the apparent differences between AWS D1.1 1972 paragraph 4.4 and CS-C16 paragraph 3.3.7, regarding arc strikes." This allegation is identical to that responded to previously in our discussion of paragraph 5.6.11 of CS-P207. The major difference is that AWS D1.1-74 paragraph 4.4 refers to arc strikes outside the area of permanent welds.

3.3.7 "Arc strikes are acceptable provided that the craters, (1) do not contain cracks (as determined by visual examination), and (2) maximum size does not exceed 3/8 inch plan nor 1/16 inch profile. Arc strikes shall be free of any foreign deposits which might interfere with the performance of proper visual inspection."

It should be noted that the application of Section 3.3.7 is confined only to miscellaneous steel and not the main building members. Arc strikes are harmful only if they produce a crack or diminish the required design thickness. For steels used in the construction of a nuclear power plant, arc strikes are not likely to produce a crack because these mild carbon and austentitic stainless steels are not appreciably hardenable. In addition, the steels used in the building structural framework and the piping system and electrical system supports are not susceptible to cracking resulting from arc strikes.

Because the significance of arc strikes in the carbon structural and piping steels is minimal, a "Nondestructive Examination" method which is likely to ~~detect~~ arc strikes is widely accepted and in common use throughout manufacturing and construction industries.

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The prod method of magnetic particle examination may also cause arc strikes on the component surface being examined. The fact is, that on carbon steels arc strikes are so insignificant that an "NDE" method which induces them is widely used.

The second allegation was presented by Mr. Dennis Kirsch in the October 19, 1982 meeting. He requested a reconciliation between CS-C16 and AWS D1.1-72 paragraphs 5.12.1.5(2)(b) and 8.15.1.3. Both of these sections refer to filling of craters.

5.12.1.5(2)(b) "All craters filled to the full cross section of the weld."

8.15.1.3 "All craters are filled to the full cross section of the weld."

3.3.3 "Underfilled groove weld craters shall be accepted provided the depth of underfill is 1/16 inch or less. Underfilled single-pass fillet weld craters shall be accepted provided the crater length is less than ten percent of the weld length. On multi-pass fillet welds crater depth 1/16 inch or less shall be accepted."

This Section 3.3.3 applies to miscellaneous steel only and not to the main building members.

Consideration of underfilled craters, grooves, subsize and concave fillet welds has been based upon conservative evaluation of decreased load carrying effective throat area. The weld metal has substantially higher minimum specified yield strength than does base metal, that is, 50,000 psi versus 36,000 psi.

Mr. Kirsch also requested SAR references for these and any other exceptions. CS-C16 in its entirety is in the San Onofre 2 and 3 FSAR as Appendix 3.8A.

C. The next three allegations related to field operations:

1. The first of these allegations was that pipe fitters used a pipe cutter to make scribe marks for socket weld fit-up, and these marks would cause stress concentrations. While perhaps not a particularly desirable method to use for scribe marks, any "mechanical damage" would be controlled under our overall quality program.

   Inspection and acceptance criteria are specified in Work Plan Procedure/Quality Control Instruction 400 (WPP/QCI-400). By procedure, minor surface defects not requiring corrective action are defined as, "Defects in pipe having a depth not exceeding 5% of the nominal pipe wall thickness, or 1/16", whichever is less." It should be noted that the 5% limitation is a more stringent requirement for small piping (2 inch and under) than the 1/16 inch requirement.

"Mechanical damage" is defined as scoring, gouges, pits, suspect lap, seams, and similar types of surface damage or defects that may exceed the "minor surface defects" above.

Visual inspections for physical damage on piping material are performed by certified QCE's and include the use of pit gauges to verify the depth of scribe marks.

All scribe marks, including those made by a pipe cutter on socket welded pipe are inspected to these criteria. Remedial action of non-conformances are dispositioned in NCR's.

As a design analogy to the effect of the groove on the integrity of the pipe, reference is made to the misalignment conditions permitted in Section III of the ASME Code. NUREG-0307 [Reference (D)], paragraph 2.9.2.2, "Girth Butt Welds" states in part,

> "It is recognized that thin wall pipe can have relatively high weld reinforcements; producing a significant "notch" at the weld. It is also recognized that misalignment can significantly increase the local stresses in the welds. Both of these aspects were considered in assigning the relatively high C_2 and K_2 indices of 1.4 and 2.5, respectively."

Therefore, the Stress Intensification Factor (SIF) of $(C_2 \times K_2)/2 = (1.4 \times 2.5)/2 = 1.8$ is considered acceptable for this significant notch effect and misalignment. Furthermore, Figure NC-3673.2(b)-1 of ASME Section III requires use of 1.8 SIF for girth butt weld (as welded). This 1.8 SIF requirement is also referenced in NUREG-0307 [Reference (D)]. The applicable SIF for the type of scribe marks under consideration and as shown in photographs of Figures 1 through 4 of Enclosure (6) are judged to be less severe than the misalignment and reinforcement covered in the referenced document and less than 1.8.

In accordance with Figure NC-3673.2(b)-1 of ASME Section III, SIF of 1.8 is applicable for girth butt welds with misalignment greater than 10 percent of the nominal wall thickness. Therefore, for the scribe mark depth limitation of 5 percent of the pipe wall thickness, use of SIF of 1.8 is conservative. The SIF used for socket welded connections is 2.1 (per Figure NC-3673.2(b)-1 of ASME Section III) which also includes the notch effect. The SIF of 2.1 is greater than the SIF of 1.8 developed above. For the San Onofre 2 and 3 project, a SIF of 2.1 is used in design for all socket welds and therefore the socket weld is the governing design factor and not the scribe mark. The moment loadings at the socket weld and the scribe mark (approximately 2 inches away) are essentially identical.

Generally, the pressure design is not the governing condition for small piping. As far as the pressure design is concerned, allowing for the 12.5 percent manufacturing tolerance, the nominal wall thickness provided exceeds the calculated wall thickness by at least 40 percent.

Therefore the 5 percent depth limitation is adequate for pressure design as well.

2. The second allegation in this series related to flare bevel welds. The allegation was unspecific.

   An apparent nonconforming condition was identified during a normal QC inspection of cable tray support installations. The nonconformance related to the underfill of a flare bevel weld associated with a particular support detail. No acceptance criteria existed to disposition a partial penetration flare bevel weld as specified on the engineering design drawings. The problem was determined to be programatical in nature and a Deficiency Evaluation Report was generated (DER No. 69, dated November 4, 1980). The following is a summary of the course of action which transpired to close out the referenced DER:

   a. The associated design disclosure documents (Construction Specification and SAR) were revised to incorporate the applicable acceptance criteria.

   b. All partial penetration flare bevel welds were reinspected to the revised criteria.

   c. Engineering performed a review of the original design and identified the minimum acceptable dimension for the partial penetration flare bevel weld.

   d. All nonconforming conditions were corrected and no further applications of this type of detail were identified.

3. The third allegation in this series related to welder qualification. Mr. Kent stated that sheet 20, note 1 of Welding Qualification document WQ-2 permits weld reinforcement of 1/3 inch contrary to paragraph 3.6.2 of AWS D1.1. Sheet 20 is not part of the welder qualification program used on San Onofre Units 2 and 3. Review of the document, however, concluded that the 1/3 inch was in fact a typographical error and should have been 1/8 inch. This is consistent with detail E also contained on sheet 20.

D. The additional allegations were made concerning the structural adequacy of structural joints. These allegations in particular were: the need for fully welded connection details, prototype testing of weld details, and methods utilized in the selection of actual weld strength.

1. Need for Fully Welded Connections

There are no provisions in any structural design code, nor is it standard design practice, to require fully welded details for use in all structural, pipe support, or cable tray support designs.

All structural design texts, specifications, codes, and technical references permit a broad variety of acceptable design details which have been shown to provide required structural integrity to meet the intended function of the supports. For example, the American Institute of Steel Construction (AISC) Specification is the national specification and design guide utilized by structural engineers for the design of structural steel components. In Section 1.2 of the AISC Specification three basic types of construction and associated design assumptions are permissible, utilizing design details which dictate the member sizes and corresponding strengths. These three types include:

Type 1 - "Rigid-frame" (continuous frame) details which possess sufficient rigidity to minimize angular movement between intersecting members. A fully welded or heavily bolted movement resistant connection is representative of this design type.

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Type 2 - "Simple" frame details which permit unrestrained, free-ended rotation for specified loading conditions, necessitating the design of the connections to resist shear loads only. A lightly welded or lightly bolted connection, or more heavily welded or bolted connection with details which have flexible rotational capability (e.g. double angle connections) are representative of this design type.

Type 3 - "Semi-rigid framing" which permits partial rigidity (partially restrained) for connections of structural components providing the moment resistant capacity can be technically supported through accepted procedural analysis to confirm the degree of restraint. This design type falls between Types 1 and 2.

The selection of the connection type from these three approved types has been made by Bechtel engineering based upon consideration including intended function, required design integrity, types of steel available, constructibility preferences, applicable codes, regulatory requirements, and other relevant aspects. The selection of a particular connection detail is made to assure structural consistency and technical compatibility with the analysis and design of the structural system. Any arbitrary alteration of the connection detail outside the bounds specified in the design drawings or construction specification could invalidate the basic design assumptions. It could also result in the overstress of structural components in excess of specified code allowables. The connections utilized for the San Onofre Units 2 and 3 project have been designed, reviewed and checked by qualified engineers consistent with NRC quality requirements. As such, complete technical consistency and design compatibility have been provided in the San Onofre 2 and 3 design throughout. See Enclosure (9) for additional information.

2. Prototype Testing of Weld Details

The design of weld details and welded connection details are based upon nationally recognized design procedures which are referenced in the project design criteria are specified in the SAR, FSAR and other regulatory documents. Such details utilize recognized analytical techniques which appear in standard textbooks as well as referenced codes. These designs are based upon accepted procedures which have evolved since the founding of the American Institute of Steel Construction in 1921. This organization establishes, through close interaction between industry and university development, extensive research and engineering studies programs to establish acceptable design procedures, economical and efficient design recommendations, and methods to improve and control the quality of structural steel.

The use of the AISC Specification and AWS Code in the selection of relevant weld details precludes the need for prototype testing, providing the material, weld rod and welding procedures conform to the stated code requirements, utilizing basic engineering mechanics principles. M and QS has performed over 800 welding qualification tests to substantiate various welding configurations, materials, and essential welding variables. The AISC Manual states, "The AISC Specification and the Structural Welding Code of the American Welding Society exempt from tests and qualification most of the common welded joints used in steel structures. Such exempt joints are designated as prequalified." The use of prototype testing for weld details is necessary only when unusual non-code weld rod or plate materials are selected, and prior research and testing utilized in code recommendations cannot be directly applied. Such prototype testing can be utilized to justify the use of the proposed design. In the San Onofre 2 and 3 design, no unusual materials or details are utilized. The San Onofre 2 and 3 design utilizes common industry and code accepted structural plate materials, and standard weld rod materials. As such, no prototype testing is required. All materials, procedures, and code applications are described in detail in the project design criteria and the San Onofre 2 and 3 SAR and FSAR.

3. Actual Strength of Welding Materials

The actual strength of welding materials is based specifically upon code allowables for the particular component and its function. The allowable stresses of weld rod material is based upon the specific electrode type (e.g. AWS A5.1 or ASME SA 5.1, E70XX) and the matching base metal comprising the joint detail (e.g. ASTM A-36 or A570). The strength calculations are based upon these allowable stresses, which are a percentage of the minimum specified material properties, and engineering mechanics behavior assumptions specified in code and textbook references. This approach results in significant tensile strength margins over allowable values. To assure that appropriate weld rod and connecting materials are utilized, the design specifications include provisions for material verification, material identification and control, and testing requirements to the minimum specified properties. The allowable stresses specified in the codes are based upon extensive university and industry testing and research, and years of shop and field experience. The selection of AISC and AWS welding materials and prequalified welding details results in a highly conservative welding design basis for the San Onofre 2 and 3 project.

E. The final allegation relates to the use or non-use by BPC and their suppliers of runoff plates for groove welding described in AWS D1.1, paragraph 4.6.1.

The use of runoff tabs or extended backing bars are referred to in the Structural Welding Code, AWS D1.1-74, Article 4.6.1 as follows:

> "Groove welds shall be terminated at the ends of a joint in a manner that will ensure sound welds. Where possible this shall be done by use of extension bars or runoff plates."

The allegation claims that Bechtel and its suppliers do not adhere to this portion of the Code.

The use of runoff tabs is usually restricted to high current density automated welding processes such as submerged arc and gas metal arc machine welding processes where the control of weld end fill is not possible. Since the bulk of the welding at power plant sites is shielded metal arc welding, the control of the weld end fill is of no concern because the process is one of low current density and can be readily controlled by the welder to ensure sound welding including complete filling of the groove weld ends.

As to weldments produced by suppliers of structural steel (fabricated beams, etc.) the same circumstances would control. Where the high current density processes are utilized, extension bars are generally used. Where extension bars are not used, the beam or structural material is cut off at a point where the weld is full section and meets the length requirements of the Purchase Order.

The Structural Welding Code AWS D1.1-77, Revision 2 recognized the fact that the article on groove weld termination should not be inclusive of all welding processes. For this reason Article 4.6.1 has been changed in the 1977 edition and reads as follows:

"Welds shall be terminated at the end of a joint in a manner that will ensure sound welds. Whenever necessary, this shall be done by use of extension bars and runoff plates."

This same wording continues through the latest edition of the AWS Code (D.1.1-82).

F. Mr. Kent alleged in the meeting between SCE, BPC and the NRC after his site tour that there existed cases where BPC did not meet the ASME Code requirements on a 3:1 slope in the body of several Kerotest valves at the valve to pipe joint. He also stated that this was true at the union of two different sized pipes. He stated that NB, NC, and ND-4232 requires this slope and that on the tour they had observed many cases where this slope was obviously steeper, approximately 1:1 or 45°. Our review of this allegation indicates again his superficial knowledge of the ASME III Code. Enclosure (7) extracted from Subsection NB of the ASME III Code specifically states that the 3:1 slope requirements is in the weld prep area and extends only for a distance of 1.5 times the thinner wall thickness. Thereafter the valve body or higher schedule pipe is flared up to a 45° angle. Enclosure (7), page 3, is a copy of a San Onofre Units 2 and 3 drawing showing the required slope details consistent with the ASME Code. Observation of two valves taken from spares and the valves and piping observed during the tour verified that all code requirements were met.

The last allegtion made by Mr. Kent on Units 2 and 3 concerned thread engagement on one of sixteen bonnet to body studs for swing check valve S3-1204-MU-037. The stud was recessed slightly into the upper nut. His allegation was that this indicated short studs were in use and the thread engagement did not meet the ASME Code. The valve in question was supplied by the manufacturer, Anchor Darling, in the same condition as installed. The bonnet has not been removed since the valve was received at the San Onofre site.

Requirements for installation or fabrication of mechanical joints are described in Subarticles NB/NC/ND-4700 [Enclosure (8), page 1] (since NB/NC/ND-4700 are identical, only NC-4700 is shown in the enclosure). Subarticle NC-4711 "Thread Engagement", required all bolts or studs to be engaged in accordance with the design. However, only Code Class 2 and 3 piping flanged joints are required to have bolts extend completely through the nuts, Subarticle NC-3647.6(a) [Enclosure (8), page 2]. In all other bolted connections used for pumps, valves, tanks and vessels, thread engagement is a matter of design.

It is our conclusion that Mr. Kent's allegation is without basis since the Code does not require bolts to be flush with the top of the nut (except for Code Class 2 and 3 piping flanged joints), the vendor did not require it in his maintenance manual, and the valve was designed to be used with the studs and nuts provided.

3 times the width. Rounded indications are indications which are circular or elliptical with the length less than 3 times the width.

NF-5352 Acceptance Standards

(a) Only indications with major dimensions greater than $\frac{1}{16}$ in. shall be considered relevant.

(b) Unless otherwise specified in this Subsection, the following relevant indications are unacceptable:

(1) Any cracks or linear indications,

(2) Rounded indications with dimensions greater than $\frac{3}{16}$ in.

(3) Four or more rounded indications whose major dimensions are greater than $\frac{1}{16}$ in. when the indications are in a line and are spearated by $\frac{1}{16}$ in. or less edge to edge.

(4) Ten or more rounded indications whose major dimensions are greater than $\frac{1}{16}$ in. when the indications are in any 6 sq in. of surface with the major dimensions of this area not to exceed 6 in., with the area taken in the most unfavorable location relative to the indications being evaluated.

NF-5360 ACCEPTANCE STANDARDS FOR VISUAL EXAMINATION OF WELDS

(a) Only indications with major dimensions greater than $\frac{1}{16}$ in. shall be considered relevant.

(b) Unless otherwise specified in this Subsection, cracks or other linear indications are unacceptable.

NF-5400 EXAMINATION OF SPRINGS FOR CLASS 1 COMPONENT STANDARD SUPPORTS

NF-5410 REQUIRED EXAMINATION AND ACCEPTANCE STANDARDS

Springs for Class 1 component standard supports shall be examined after coiling by either the magnetic particle or liquid pentetrant method. Springs with seams, slits, or quench cracks longer than 3% of the bar diameter shall be rejected.

NF-5500 QUALIFICATIONS OF NONDESTRUCTIVE EXAMINATION PERSONNEL

NF-5510 GENERAL REQUIREMENTS

It shall be the responsibility of the Manufacturer or Installer to assure that all personnel performing nondestructive examination operations under this Subsection are competent and knowledgeable of the applicable examination requirements to the degree specified in NF-5520. All nondestructive examinations required by this Subsection shall be performed and the results evaluated by qualified nondestructive examination personnel. The assignment of responsibilities to individual personnel will be at the discretion of the Manufacturer or Installer.

NF-5520 PERSONNEL QUALIFICATION

NF-5521 Qualification Procedure

(a) Personnel performing nondestructive examination under this Section shall be qualified in accordance with SNT-TC-1A,[1] Supplements and Appendices as applicable for the technique and methods used. For nondestructive examination methods not covered by SNT-TC-1A documents, personnel shall be qualified by the Manufacturer or Installer to comparable levels of competency by subjection to comparable examinations on the particular method involved. The practical portion of the qualification shall be performed using the Manufacturer's or Installer's procedure or part representative of the Manufacturer's products.

(b) The emphasis shall be on the individual's ability to perform the nondestructive examination in accordance with the applicable procedure for the intended application.

(c) For nondestructive examination methods that consist of more than one operation or type, it is permissible to use personnel qualified to perform one or more operations. As an example, one person may be used who is qualified to conduct the examination and another may be used who is qualified to interpret and evaluate the results.

NF-5530 RECORDS

Personnel qualification records shall be retained in accordance with NA-4900.

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[1]SNT-Tc-1A and Supplements is a *Recommended Practice for Nondestructive Testing Personnel Qualification and Certification* published by the American Society for Nondestructive Testing, 914 Chicago Avenue, Evanston, Illinois 60202.

NF-4400 RULES GOVERNING MAKING, EXAMINING, REPAIRING, AND HEAT TREATING WELDS

NF-4410 PRECAUTIONS TO BE TAKEN BEFORE WELDING

NF-4411 Identification, Storage, and Handling of Welding Materials

Each Manufacturer or Installer is responsible for control of the welding electrodes and other materials which are used in the fabrication and installation of components supports (NF-4120). Suitable identification, storage, and handling of electrodes, flux, and other welding materials shall be maintained. Precautions shall be taken to minimize absorption of moisture by electrodes and flux.

NF-4412 Cleanliness and Protection of Weld Surfaces

The method used to prepare the base metal shall leave the weld preparation with reasonably smooth surfaces. The surfaces for welding shall be free of scale, rust, oil, grease, and other deleterious foreign material. The work shall be protected from deleterious contamination and from rain, snow, and wind during welding. Welding shall not be performed on wet surfaces.

NF-4420 RULES FOR MAKING WELDED JOINTS

NF-4421 Backing Strips

The materials for backing strips, when used, shall be compatible with the base metal (NF-4240).

NF-4422 Peening

The weld metal may be peened when it is deemed necessary or helpful to control distortion.

NF-4423 Miscellaneous Welding Requirements

Before applying weld metal on the second side to be welded, the root of double welded joints shall be prepared by suitable methods, such as chipping, grinding, or thermal gouging to sound metal.

NF-4424 Surfaces of Welds

As welded surfaces are permitted. However, the surface of welds shall be sufficiently free from coarse ripples, grooves, overlaps, abrupt ridges, and valleys to meet the requirements of (a) through (d) below.

(a) The surface condition of the finished weld shall be suitable for the proper interpretation of radiographic and other required nondestructive examinations of the welds. In those cases where there is a question regarding the surface condition on the interpretation of a radiographic film, the film shall be compared to the actual weld surface for interpretation and determination of acceptability.

(b) Reinforcements are permitted in accordance with NF-4426.

(c) Undercuts shall not encroach on the required section thickness.

(d) If the surface of the weld requires grinding to meet the above criteria, care shall be taken to avoid reducing the weld or base material below the required thickness.

NF-4426 Reinforcement of Butt Welds

The surface of the reinforcement of all butt welded joints may be flush with the base material or may have uniform crowns. The height of reinforcement on each face of the weld shall not exceed the following thickness:

Nominal Thickness, in.	Maximum Reinforcement, in.
Up to 1, incl.	$\frac{3}{32}$
Over 1 to 2, incl.	$\frac{1}{8}$
Over 2 to 3, incl.	$\frac{5}{32}$
Over 3 to 4, incl.	$\frac{7}{32}$
Over 4 to 5, incl.	$\frac{1}{4}$
Over 5	$\frac{5}{16}$

NF-4427 Shape and Size of Fillet Welds

Fillet welds may vary from convex to concave. The size of the fillet weld shall be determined in accordance with Figure NF-4427-1.

NF-4429 Plug Welds

When plug welds are used on component supports, a fillet weld shall first be deposited around the circumference at the bottom of the hole.

NF-4440 EXAMINATION OF WELDS

All welds shall be examined in accordance with the requirements of NF-5000.

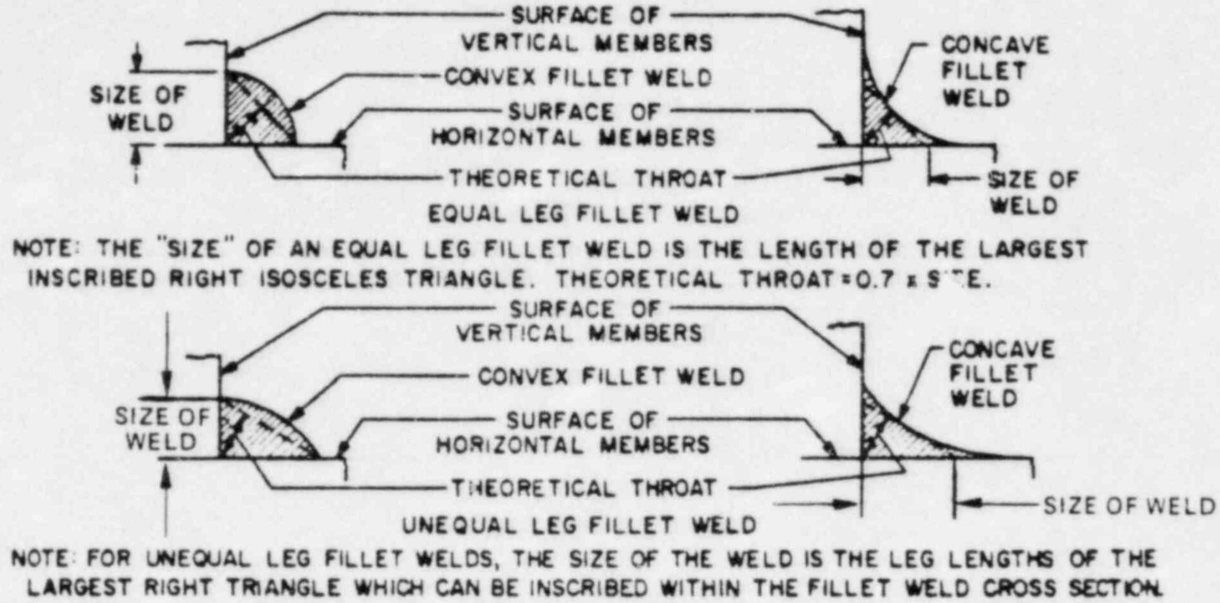


FIG. NF-4427-1 SIZE OF FILLET WELDS

NF-4450 REPAIR OF WELD METAL DEFECTS

NF-4451 General Requirements

Unacceptable defects in weld metal detected by examinations required by NF-5000 shall be eliminated and, when necessary, repaired in accordance with the requirements of this subsubarticle.

NF-4452 Elimination of Surface Defects

Weld metal surface defects may be removed by grinding or machining and need not be repaired by welding, provided that the requirements of (a), (b), and (c) are met.

(a) The remaining thickness of the section is not reduced below that required by NF-3000.

(b) The depression, after defect elimination, is blended uniformly into the surrounding surface.

(c) The area is examined by a magnetic particle or liquid penetrant method after blending to ensure that the defect has been removed or in indication reduced to an acceptable limit.

NF-4453 Requirements for Making Repairs to Welds

Excavated cavities in weld metal, whose depths reduce the section thickness below the requirements of NF-3000, shall be repaired in accordance with the following subparagraphs.

NF-4453.1 Defect Removal. Unacceptable defects detected by the examination or test required by NF-5000 shall be removed by mechanical means or by thermal gouging processes.

NF-4453.2 Requirements for Welding Materials, Procedures, and Welders. The weld repair shall be made using welding materials, welders, and welding procedures in accordance with NF-4125 and NF-4300.

NF-4453.3 Blending of Repaired Areas. After repair, the surface shall be blended uniformly into the surrounding surface.

NF-4453.4 Examination of Repair Welds. The examination of weld repairs shall be repeated as required for the original weld.

NF-4453.5 Heat Treatment of Repaired Areas. The repaired area shall be heat treated when required by NF-4640.

NF-4600 HEAT TREATMENT

NF-4610 WELDING PREHEAT AND INTERPASS REQUIREMENTS

NF-4611 When Preheat Is Necessary

The need for and temperature of preheat are dependent on a number of factors, such as the chemical analysis, degree of restraint of the parts being joined, elevated temperature, physical prop-

Interpretation: III-80-109

Subject: Section III, Division 1, NF-4427 Shape and Size of Fillet Welds, NF-4452 Elimination of Surface Defects, NF-5360 Acceptance Standards for Visual Examination, Appendix XVII-2454 Butt and Groove Welds

Date Issued: May 12, 1980

File: NI-80-12

Question (1): Does Section III, Subsection NF provide requirements for the maximum convexity of fillet welds?

Reply (1): No.

Question (2): Is the theoretical throat of a fillet weld the minimum effective throat?

Reply (2): Yes.

Question (3): Do weld metal surface defects (NF-4452) include arc strikes?

Reply (3): NF-4452 provides for elimination of weld metal surface defects without reference to the cause of the surface defect.

Question (4): Are undersize dimensions, greater than 1/16 in., of a weld considered as relevant indications when detected by visual examination in accordance with NF-5360(a)?

Reply (4): NF-5360 addresses weld metal indications only. It does not address underrun on fillet size or length.

Question (5): Does XVII-2454(c) of the 1977 Edition mean that a ½ in. double partial penetration groove weld joining 3 in. thick material together is unacceptable?

Reply (5): Yes.

Question (6): Is it permissible to use a single-bevel full penetration weld without the use of backing strips or back gouging in the fabrication of welded tee joints in linear type component supports?

Reply (6): Yes.

Interpretation: III-1-79-176

Subject: Section III, Division 1, Division 2 Weld Spatter

Date Issued: October 23, 1979

File: NI-79-202

Question: Is it required by Section III, Division 1 and/or Division 2, that weld spatter be removed for cosmetic purposes if it does not interfere with further processing or the use of the item in service, or if it does not interfere with subsequent NDE, or if paint or other protective coating is not required?

Reply: It is not required by Section III, Division 1 and/or Division 2 that weld spatter be removed provided it does not interfere or limit subsequent Code required activities.

Interpretation: III-1-79-177

Subject: Section III, Division 1, Appendix V, N-2 Data Report Form

Date Issued: October 23, 1979

File: NI-79-223

Question: When a Certificate of Authorization is extended to a field site, what data report form should be used for field fabricated parts and appurtenances such as containment vessel equipment hatches?

Reply: When a Certificate of Authorization is extended to a field site for field fabrication of parts or appurtenances, the N-2 Data Report Form shall be used for those parts and appurtenances intended to receive an NPT stamp. The Authorized Inspector at the field site who has the responsibility for assuring that Code requirements have been met shall so signify by completing the "Certification of Shop Inspection" portion of the N-2 Data Report Form. (Note: The text of the "Certification of Shop Inspection" box does not address the issue of where the inspection was made, i.e., shop or field. It does address the issues that inspection was performed by a duly authorized person at a point in time.)

Interpretation: III-1-79-178

Subject: Section III, Division 1, Case N-71 Additional Materials for Component Supports

Date Issued: October 23, 1979

File: NI-79-247

Question: How are the maximum allowable stresses to be calculated for SB-150 Grade 642 material used in accordance with Section III, Case N-71-8 for Class 1, 2, 3, and MC component supports?

Reply: The allowable stresses and stress intensities for Plate and Shell Type Component Supports are provided in Tables 1 and 2 of Code Case N-71-8. For Linear Type Component Supports for bars made from this material, Table 3 provides the S_y values needed for the applicable formulas of XVII-2200, and for bolting made to this specification and grade, the Ultimate Tensile Strength Values of Table 5 may be used with the equations applicable to austenitic steels from XVII-2460 of Appendix XVII.

Scribe Lines for Socket Welds

The attached photographs show four samples of 3/8 inch O.D. x 0.065 inch wall stainless steel tubing. Two of the samples were circumferentially marked with a scribing tool and the other two were circumferentially marked and numbered with a vibro-graving tool.

The depth of each type of mark was measured at 100x (magnifications) and the depth is reported below. The depth measurement represents the depression below the original surface.

Sample No.	Marked By	Depth of Circ. Mark (in.)	Depth of Numerals (in.)	Wall Thickness At Circ. Mark (in.)	Wall Thickness At Numbers (in.)
1	Vibro-Graving	0.0005 to 0.003	0.001 to 0.002	0.070	0.072
2	Vibro-Graving	Up to 0.003	Up to 0.003	0.068	0.067
3	Scribe	Up to 0.0015	---	0.070	---
4	Scribe	Up to 0.003	---	0.068	---

Figure 1 shows the as received smaples. Figure 2 shows the vibro-graving surface numbers at 10x and the cross section at 100x. Figure 3 shows the vibro-graved circumferential mark at 10x and the cross section at 100x. Figure 4 shows the scribed circumferential mark at 10x and the cross section at 100x. Although both of the marking techniques produced marks of approximately equal depth, (Samples 1, 2 and 4) the scribed surface marks are more uniform and not as sharp as those made with the vibro-graving tool.

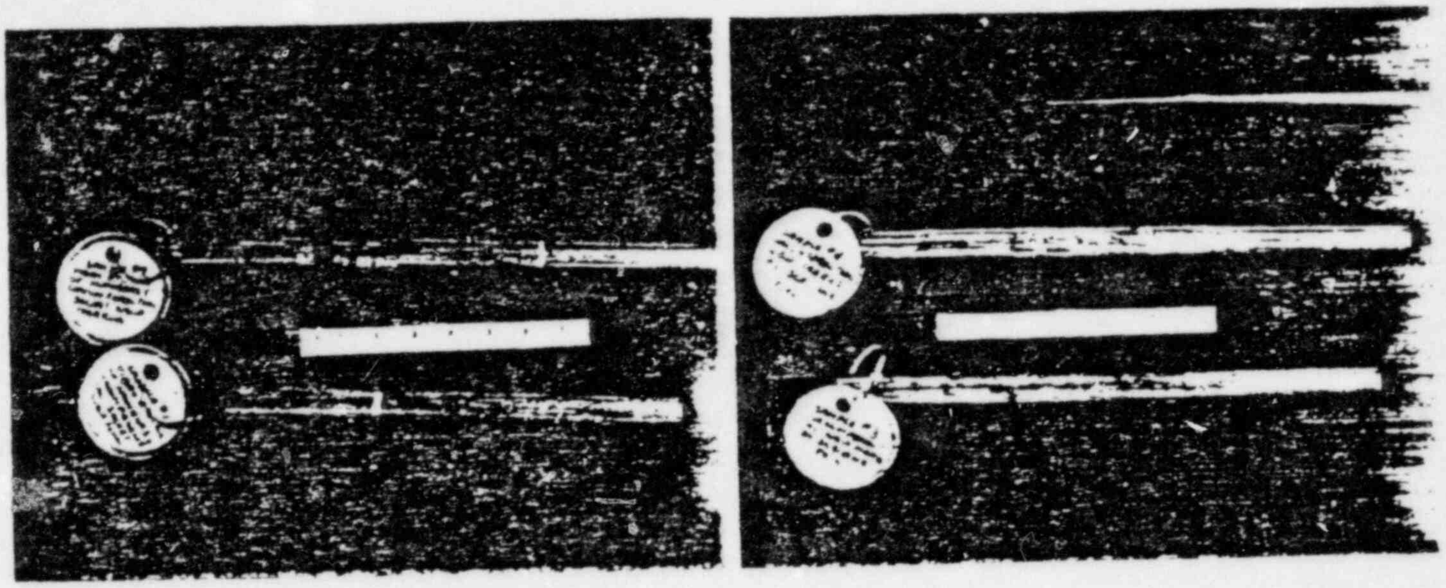
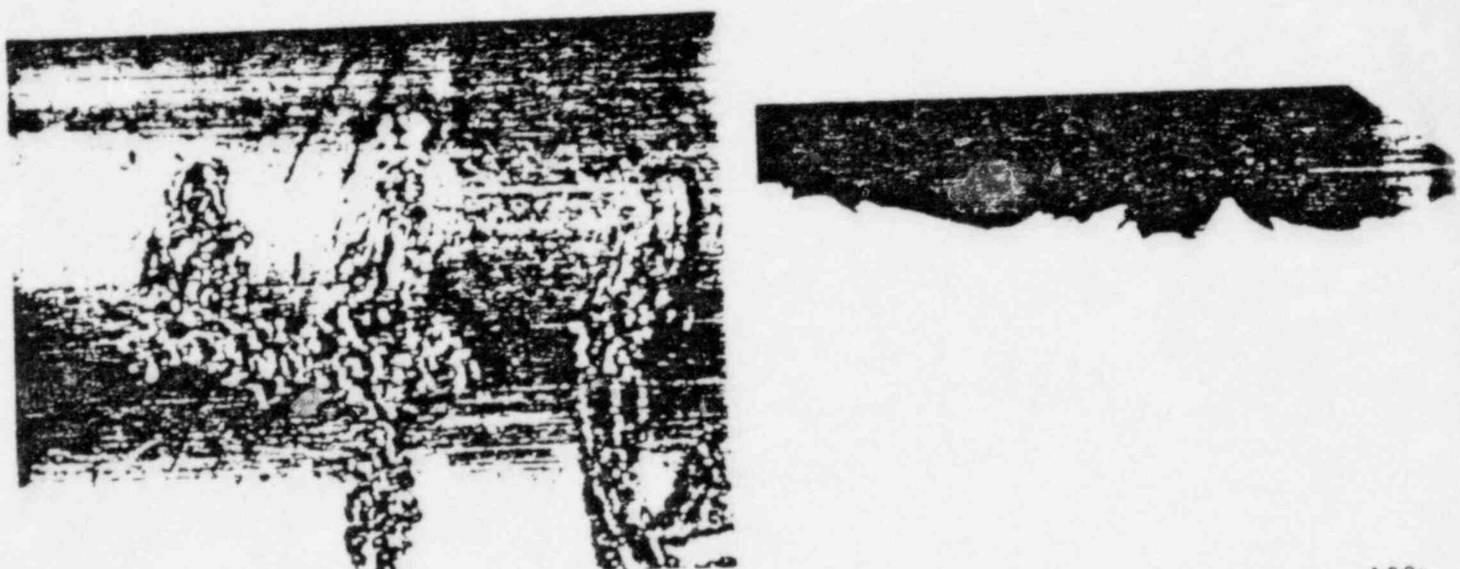


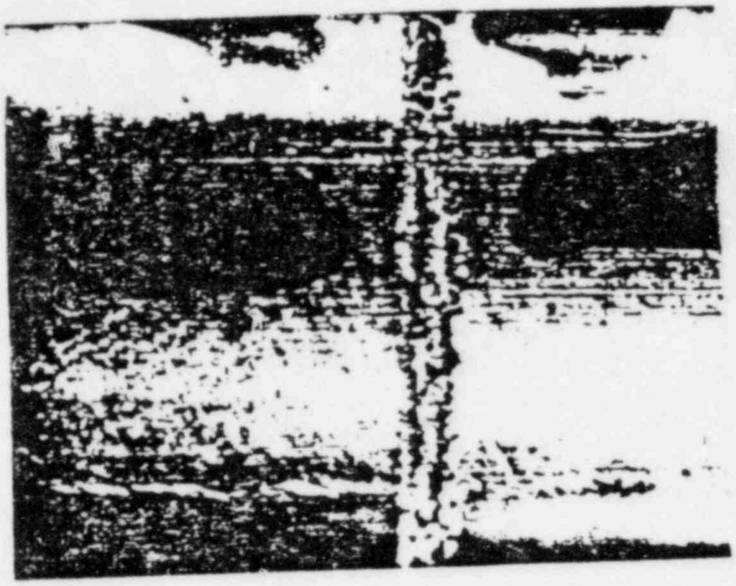
Figure 1 - As Received Samples



Surface 10x

Cross Section 100x

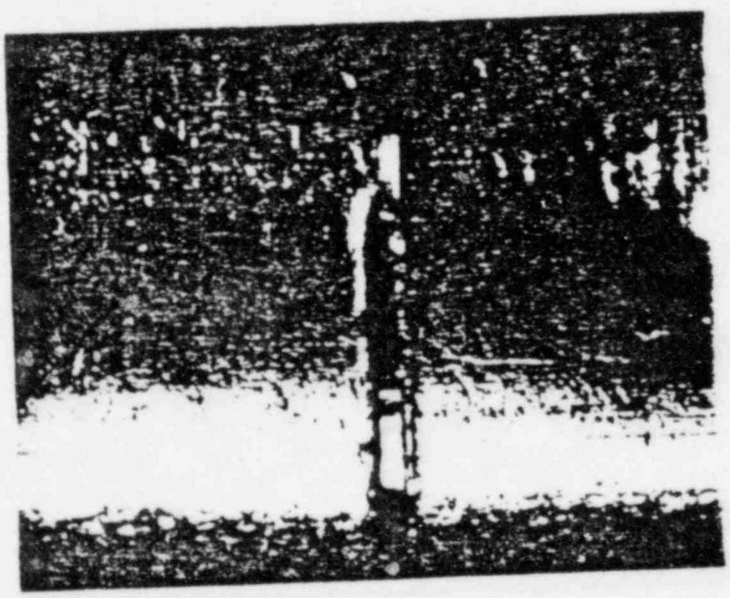
Figure 2 - Vibro-Graved Numerals



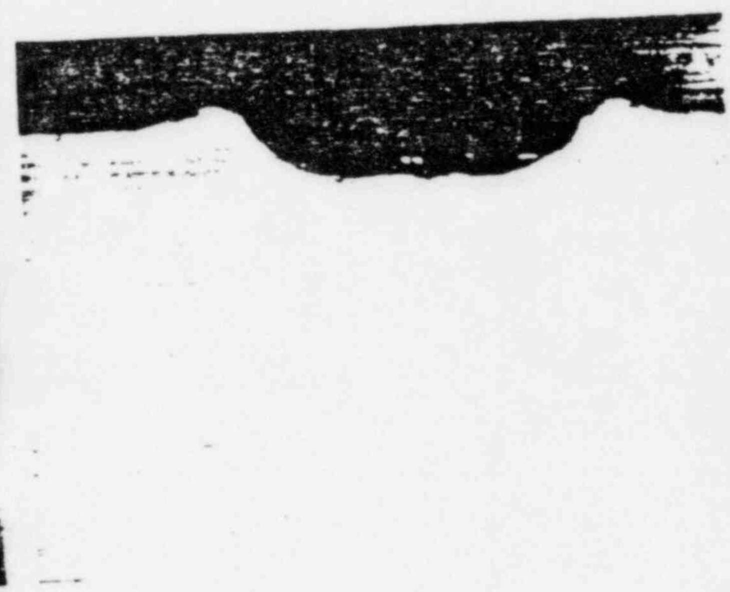
Surface 10x

Cross Section 100x

Figure 3 - Vibro-Graved Circumferential Mark



Surface 10x



Cross Section 100x

Figure 4 - Scribed Circumferential Mark

NB-4230 FITTING AND ALIGNING

NB-4231 Fitting and Aligning Methods

Parts that are to be joined by welding may be fitted, aligned, and retained in position during the welding operation by the use of bars, jacks, clamps, tack welds, or temporary attachments.

NB-4231.1 Tack Welds. Tack welds used to secure alignment shall either be removed completely, when they have served their purpose, or their stopping and starting ends shall be properly prepared by grinding or other suitable means so that they may be satisfactorily incorporated into the final weld. Tack welds shall be made by qualified welders using qualified welding procedures. When tack welds are to become part of the finished weld, they shall be visually examined and defective tack welds removed.

NB-4231.2 Temporary Attachments and Their Removal. Attachments which are welded to the component during construction but which are not incorporated into the final component, such as alignment lugs or straps, tie straps, braces, preheat equipment, postweld heat treatment equipment, are permitted, provided the requirements of (a) through (h) below are met.

(a) The material is identified and is suitable for welding but need not be certified material.

(b) The material is compatible for welding to the component material to which it is attached.

(c) The welding material is compatible with the base material and is certified in accordance with NB-2130;

(d) The welder and welding procedure are qualified in accordance with Section IX and the additional requirements of NB-4320.

(e) The immediate area around the temporary attachment is marked in a suitable manner so that after removal the area can be identified until after it has been examined in accordance with (g) below.

(f) The temporary attachment is completely removed in accordance with the procedures of NB-4211.

(g) After the temporary attachment has been removed, the marked area is examined by a magnetic particle or liquid penetrant method in accordance with the requirements of Articles 6 and 7 of Section V and meets the acceptance standards of NB-5340 or NB-5350, as applicable.

(h) The attachment weld or the area after removal of the attachment is postweld heat treated in accordance with NB-4600.

NB-4232 Maximum Offset of Aligned Sections

(a) Alignment of sections shall be such that the maximum offset of the finished weld will not be greater than the applicable amount listed in Table NB-4232-1, where t is the nominal thickness of the thinner section at the joint.

(b) Joints in spherical vessels, joints within heads, and joints between cylindrical shells and hemispherical heads shall meet the requirements in Table NB-4232-1 for longitudinal joints.

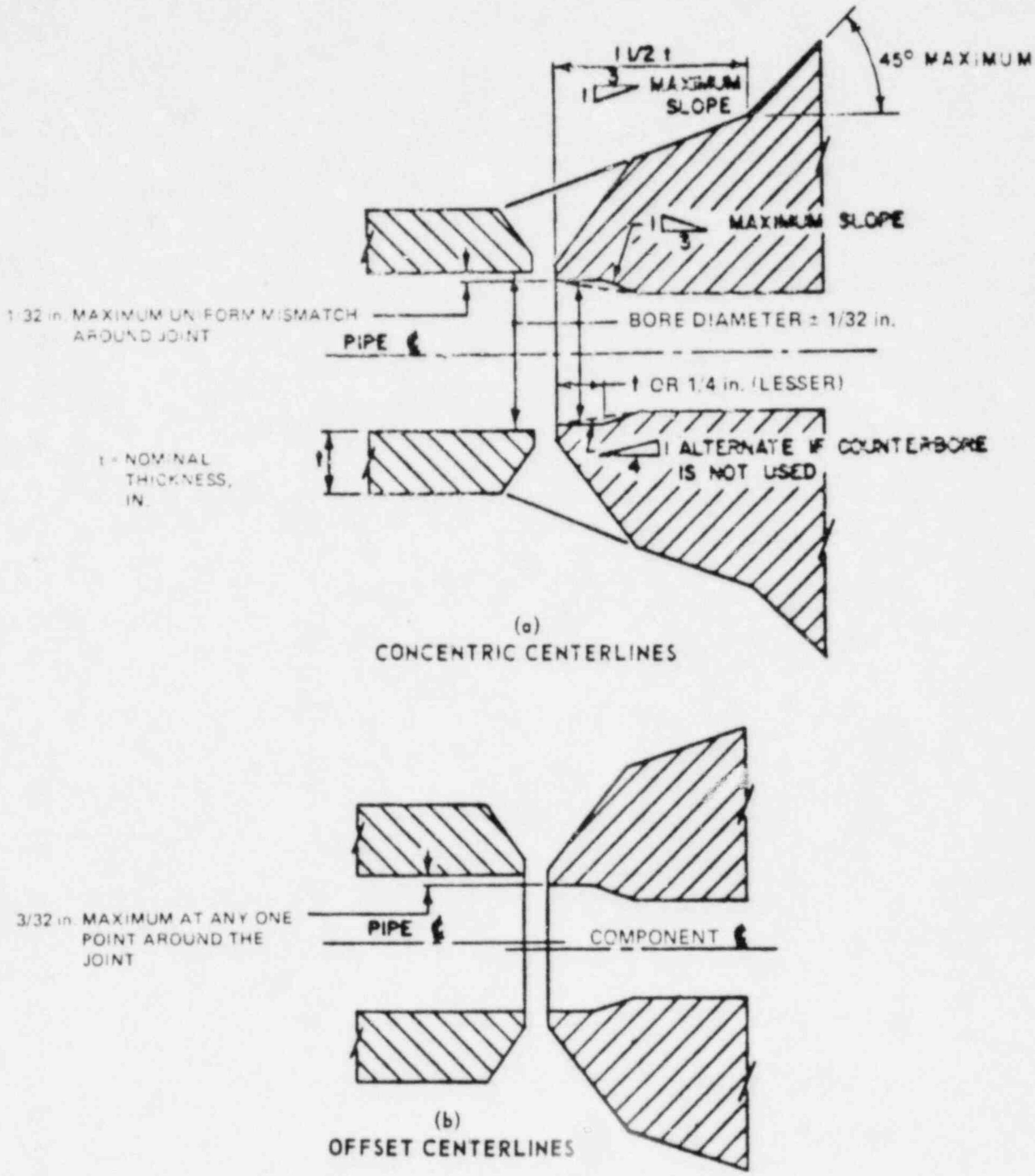
NB-4232.1 Fairing of Offsets. Any offset within the allowable tolerance provided above shall be faired to at least a 3 to 1 taper over the width of the finished weld or, if necessary, by adding additional weld metal beyond what would otherwise be the edge of the weld. In addition, offsets greater than those stated in Table NB-4232-1 are acceptable provided the requirements of NB-3200 are met.

NB-4233 Alignment Requirements When Component Inside Surfaces Are Inaccessible

When the inside surfaces of components are inaccessible for welding or fairing in accordance with NB-4232.1, the inside diameters shall match each other within $\frac{1}{16}$ in. When the components are aligned concentrically, a uniform mismatch of $\frac{1}{32}$ in. around the joint can result as shown in Fig. NB-4233-1 sk. (a). However, other variables not associated with the diameter of the component often result in alignments that are offset rather than concentric. In these cases, the maximum misalignment at any one point around the joint shall not exceed $\frac{3}{32}$ in., as shown in Fig. NB-4233-1 sk. (b). Should component tolerances such as diameter, wall thickness, out of roundness, result in inside diameter variations which do not meet these limits, the inside diameters shall be counterbored, sized, or ground to produce a bore within these limits.

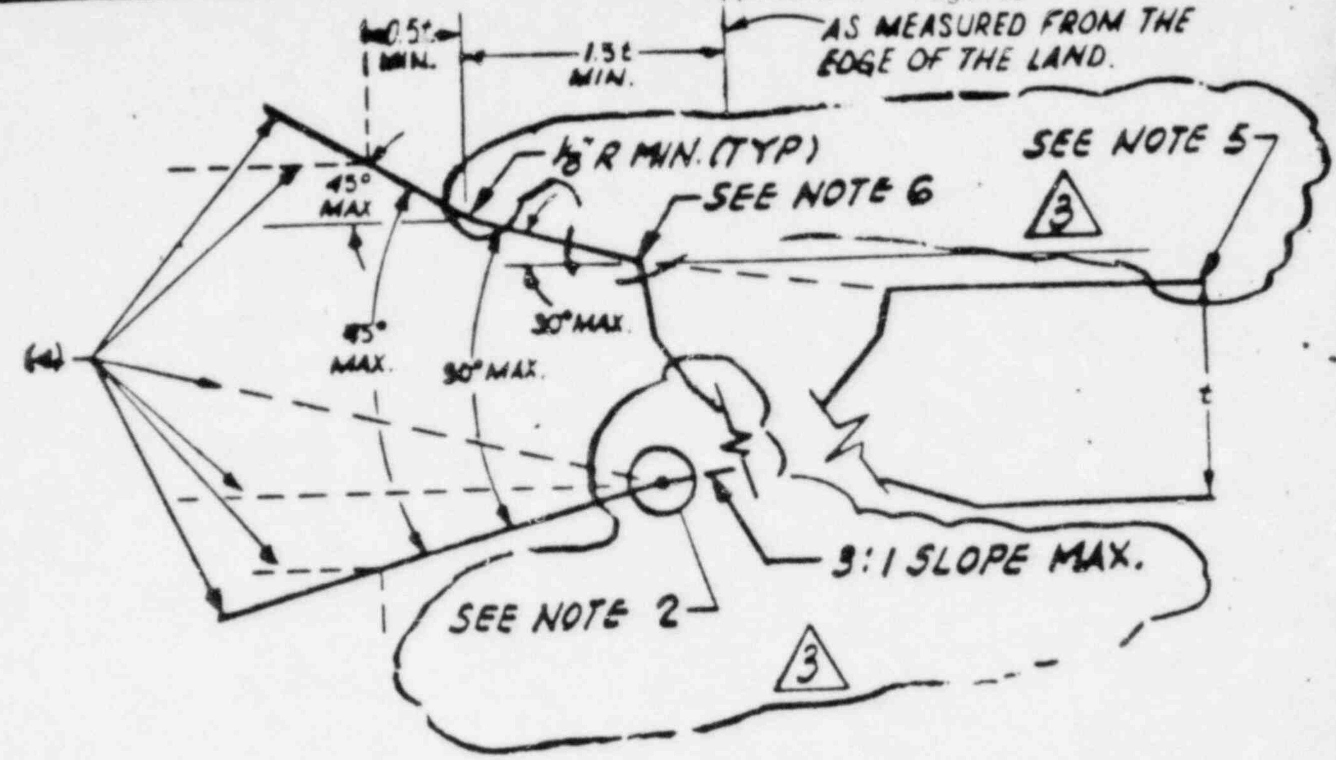
TABLE NB-4232-1
MAXIMUM ALLOWABLE OFFSET IN FINAL WELDED JOINTS

Section Thickness In In.	Direction of Joints: Longitudinal	Direction of Joints: Circumferential
Up to 1/2, incl.	1/4 t	1/4 t
Over 1/2 to 3/4, incl.	1/8 in.	1/4 t
Over 3/4 to 1 1/2, incl.	1/8 in.	3/16 in.
Over 1 1/2 to 2, incl.	1/8 in.	1/8 t
Over 2	Lesser of 1/16 t or 3/8 in.	Lesser of 1/8 t or 3/4 in.



NOTE
THE COMBINED INTERNAL AND EXTERNAL TRANSITION OF THICKNESS SHALL NOT EXCEED AN INCLUDED ANGLE OF 30° AT ANY POINT WITHIN 1½ t OF THE LAND

FIG. NB-4233-1 BUTTWELD ALIGNMENT TOLERANCES AND ACCEPTABLE SLOPES FOR UNEQUAL I.D. AND O. D. WHEN INSIDE SURFACE IS INACCESSIBLE FOR WELDING OR FAIRING



1. TRANSITIONS ARE FOR VALVES, FITTINGS, AND EQUIPMENT.
2. FOR WELD END PREPS SEE DRAWING 40048 OR 40049.
3. t = NOMINAL WALL THICKNESS.
4. INTERIOR AND EXTERIOR TRANSITION ANGLES SHALL NOT BE COMBINED SO AS TO DECREASE MINIMUM REQUIRED WALL THICKNESS.
5. THE VALUE OF t MIN. IS WHICHEVER OF THE FOLLOWING IS APPLICABLE:
   (a) THE MIN. ORDERED WALL THICKNESS OF THE PIPE
   (b) 0.875 TIMES NOM. WALL THICKNESS OF PIPE ORDERED TO A PIPE SCHEDULE WALL THICKNESS WHICH HAS AN UNDER TOLERANCE OF 12.5%.
   (c) THE MIN. ORDERED WALL THICKNESS OF THE CYLINDRICAL WELDING END OF A COMPONENT OR FITTING (OR THE THINNER OF THE TWO) WHEN THE JOINT IS BETWEEN TWO COMPONENT.
6. THE MAX. THICKNESS AT THE END OF THE COMPONENT IS:
   (a) THE GREATER OF (t MIN. + 0.15 IN.) OR 1.15 t MIN WHEN ORDERED ON A MIN. WALL BASIS.
   (b) THE GREATER OF (t MIN + 0.15 IN.) OR 1.10 t NOM, WHEN ORDERED ON A NOM. WALL BASIS.

3

QC I & II

PROFESSIONAL ... F. HA... No. 4462 3/31/75 ...HANICAL

NO.	REVISIONS	DATE	DR.	CHK.	E.G.S.	CHF. E.	P.E.	Q.A.
3	ADDED NOTES 5, 6 AND ADDITIONAL INFO	6-21-78	RM	GW				
2	5t MIN. REVISED TO .5t MIN.	6-12-75	LM	JRH			JDH	
1	REDRAWN FROM DWG. 40050 REV. "0"	4-2-75	LOMELI	JRH			JDH	

BECHTEL POWER CORPORATION NORWALK, CALIFORNIA	J.O. NO.	SAN ONOFRE NUCLEAR GENERATING STATION
	FILE	WELDED END TRANSITIONS FOR VALVES, FITTINGS, AND EQUIPMENT
JOB NO 10079-003 / DATE / APPROVED		SOUTHERN CALIFORNIA EDISON COMPANY LOS ANGELES, CALIF. SCALE

40050-3

PR-405 (1304) 8/73

NC-4650 HEAT TREATMENT AFTER BENDING OR FORMING FOR PIPE, PUMPS AND VALVES

NC-4651 Conditions Requiring Heat Treatment After Bending or Forming

(a) Ferritic alloy steel pipe or formed portions of pumps or valves that have been heated for bending or other forming operations shall receive a heat treatment in accordance with NC-4620 or a full anneal, a normalizing and tempering treatment or a quenching and tempering treatment.

(b) Carbon steel pipe or formed portions of pumps or valves with a wall thickness greater than ¾ in. included in group P-Number 1 in Section IX that have been cold bent or formed shall receive heat treatment in accordance with NC-4620.

(c) Ferritic alloy pipe or formed portions of pumps or valves with an outside diameter greater than 4 in. and a wall thickness greater than ½ in. included in groups P-Number 3 through P-Number 5 in Section IX that have been cold bent or formed shall require a heat treatment in accordance with NC-4620.

NC-4652 Exemptions From Heat Treatment After Bending or Forming

If the conditions described in (a) through (d) are met, heat treatment after bending or forming is not required.

(a) Carbon steel pipe or portions of pumps and valves that have been bent or formed at a temperature of 1650 F or higher shall require no subsequent heat treatment, providing the requirements of NC-4213 have been met.

(b) Austenitic stainless steel pipe, or portions of pumps or valves that have been heated for bending or other forming operations may be used in the absent condition unless the Design Specifications require a heat treatment following bending or forming.

(c) All austenitic stainless steel pipe, or portions of pumps or valves that have been cold bent or formed may be used in the as-bent condition unless the Design Specifications require a heat treatment following bending or forming.

(d) Carbon steel and ferritic alloy-steel pipe or portions of pumps or valves with size and wall thicknesses less than specified in NC-4651(b) and (c) may be cold bent or formed without a heat treatment following bending.

NC-4700 MECHANICAL JOINTS

NC-4710 BOLTING AND THREADING

NC-4711 Thread Engagement

All bolts or studs shall be engaged in accordance with the design.

NC-4712 Thread Lubricants

Any lubricant or compound used in threaded joints shall be suitable for the service conditions and shall not react unfavorably with either the service fluid or any component material in the system.

NC-4713 Removal of Thread Lubricants

All threading lubricants or compounds shall be removed from surfaces which are to be seal-welded.

NC-4720 BOLTING FLANGED JOINTS

In bolting gasketed flanged joints, the contact faces of the flanges shall bear uniformly on the gasket and the gasket shall be properly compressed in accordance with the design principles applicable to the type of gasket used. All flanged joints shall be made up with relatively uniform bolt stress.

NC-4730 ELECTRICAL AND MECHANICAL PENETRATION ASSEMBLIES

Electrical and mechanical penetration assemblies shall be constructed in accordance with the rules for components, except that the design and the materials performing the electrical conducting and insulating function of electrical penetrations need not meet the requirements of this Subsection. Tubes or pipes of 2 in. nominal pipe size and less may be joined to a penetration assembly in accordance with the rules of NC-4350.

NC-4800 EXPANSION JOINTS

NC-4820 FABRICATION AND INSTALLATION RULES FOR BELLOWS EXPANSION JOINTS

The requirements of (a) through (f) below shall be met.

(a) All welded joints shall comply with the requirements of NC-4000.

A = the sum of the mechanical allowances, in. (NC-3613)

$$t = d_6 \left(\frac{3P}{16S}\right)^{1/2} \quad (8)$$

where

d_6 = the inside diameter of the gasket for raised or flat face flanges or the pitch diameter of the gasket for retained gasketed flanges, in.

P = design pressure, psi

S = the allowable stress

NC-3647.3 Temporary Blanks. Blanks to be used for test purposes only shall have a minimum thickness not less than the pressure design thickness, t, calculated from Equation 8 above, except that P shall not be less than the test pressure and the allowable stress, S, may be taken as 95% of the specified minimum yield strength of the blank material (Tables I-2.0).

NC-3647.4 Flanges. Flanges shall be integral or be attached to pipe by welding, brazing, threading, or other means within the applicable standards specified in Table NC-3691-1.

NC-3647.5 Gaskets

(a) Gaskets shall be made of materials which are not injuriously affected by the fluid or by temperatures within the design temperature range.

(b) Only metallic or asbestos metallic gaskets may be used on flat or raised face flanges if the expected normal operating pressure exceeds 720 psi or the temperature exceeds 750 F. However, compressed sheet asbestos confined gaskets are not limited as to pressures provided the gasket material is suitable for the temperatures.

(c) The use of metal or metal asbestos gaskets is not limited as to pressure provided the gasket materials are suitable for the fluid design temperature.

NC-3647.6 Bolting

(a) Bolts, nuts and washers shall comply with applicable standards and specifications listed in Table NC-3691-1. Unless otherwise specified, bolting shall be in accordance with ANSI B16.5. Bolts shall extend completely through the nuts.

(b) Carbon steel bolts or bolt studs may be used if expected normal operating pressure does not exceed 300 psi for water or 250 psi for steam and the expected normal operating temperature does not exceed 450 F. Carbon steel bolts shall be ANSI Standard square or heavy hexagon head bolts and shall have ANSI Standard heavy semi-finished hexagon nuts.

(c) Alloy steel bolt studs shall be threaded full length or, if desired, may have reduced shanks of a diameter not less than that at the root of the threads. They shall have ANSI Standard heavy hexagonal nuts. Headed alloy bolts are not recommended.

(d) All alloy bolts or bolt studs and accompanying nuts are recommended to be threaded in accordance with ANSI B1.1 Class 2A external threads and Class 2B internal threads.

NC-3648 Reducers

Reducer fittings manufactured in accordance with the standards listed in Table NC-3691-1 shall be considered suitable for use. Where butt welding reducers are made to a nominal pipe thickness, the reducers shall be considered suitable for use with pipe of the same nominal thickness.

NC-3649 Pressure Design of Other Pressure Retaining Piping Products

Other pressure retaining piping products manufactured in accordance with the standards listed in Table NC-3691-1 shall be considered suitable for use in piping systems at the specified pressure-temperature ratings. Pressure retaining piping products not covered by the standards listed in Table NC-3691-1 and for which design formulas or procedures are not given in this Subsection may be used where the design of similarly shaped, proportioned, and sized components has been proved satisfactory by successful performance under comparable service conditions. Where such satisfactory service experience exists, interpolation may be made to other sized piping products with a geometrically similar shape. In the absence of such service experience, the pressure design shall be based on an analysis consistent with the general design philosophy of this Subsection and substantiated by at least one of the following:

(a) Proof tests as described in ANSI B16.9;

(b) Experimental stress analysis (Appendix II).

NC-3649.1 Expansion Joints—General Requirements. Expansion joints of the bellows, sliding, ball or swivel types may be used to provide flexibility for piping systems. The design of the piping systems and the design, material, fabrication, examination, and testing of the expansion joints shall conform to

Supplementary Data
Structural Welding Design and Construction Adequacy

Allegations:

In the walkdown of SONGS 2 and 3 conducted by Bechtel, Edison, and NRC representatives with Mr. E. Kent on October 25, 1982, several allegations were made concerning the subject of weld end returns, structural connections, and structural design adequacy in general. While the subjects addressed in Bechtel's original response to the NRC remain unchanged, this supplementary information is provided to address, to the fullest extent, these issues of concern to Mr. E. E. Kent which were identified in the walkdown on October 25, 1982.

These include:

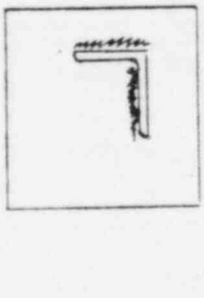
I. The weld return requirements of AISC, Specification §1.17.10 and AWS Code §8.8.6. Mr. Kent alleges that these requirements are not followed by Bechtel Power Corporation according to his interpretations.

II. The need for fully welded or fully bolted standard structural connections or box sections which can develop the full shear and bending capacity of the section. Mr. Kent alleges that connections used to resist seismic stress conditions should develop the full capacity of the section irrespective of load magnitude, direction, or other design considerations.

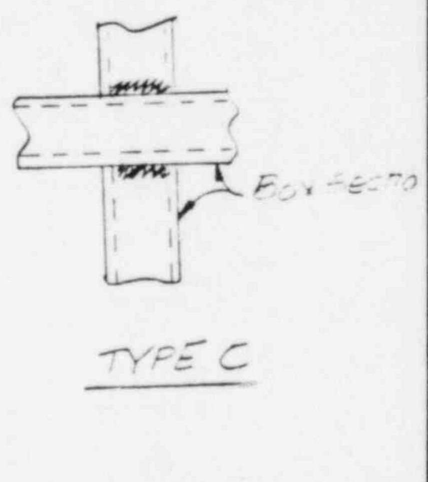
I. Weld End Returns

Mr. Kent interprets AISC §1.7.10 and AWS Code §8.8.6 as applicable to all structural details irrespective of load magnitude, direction, type of load (e.g. tension, compression, shear, bending), or actual stress condition. In particular, he has various concerns over the validity of not specifying weld end returns for three types of connection details as follows:

TYPE A



TYPE B



TYPE C

Bechtel Engineering Position

The design of all welded connections utilized on the SONGS 2 and 3 project are made in accordance with the relevant code for which the structure or component is classified, consistent with the design criteria and SAR requirements. The allegation concerning weld end requirements is incorrect and is based upon an inappropriate interpretation of the AISC Specification and the AWS Code. The AWS Code in its forward specifies the following:

> "This Code does not concern itself with such design considerations as arrangement of parts, loading and the computation of stresses for proportioning the load-carrying members of structure and their connection. Such considerations, it is assumed, are elsewhere covered in a general code or specifications such as a Building Code, AISC Specification for the Design, Fabrication an Erection of Structural Steel for Buildings, ..., or other specifications prescribed by the owner."

It is Bechtel's position that the AWS excludes from its jurisdiction the design responsibility of the weld details, and further directs the design function to the designing professional engineer who is required to adopt and interpret other appropriate design specifications including the AISC Specifications. In this regard, AISC §1.17.10 is considered in the Bechtel design and utilized accordingly. This AISC provision states as follows:

> "Side or end fillet welds terminating at ends or sides, respectively, of parts or members shall, whenever practicable, be returned continuously around the corners for a distance not less than twice the nominal size of the weld. This provision shall apply to side and top fillet welds connecting brackets, beam seats and similar connections, on the plane about which bending moments are computed. End returns shall be indicated on the design and detail drawings."

The provisions of this requirement are clearly specified to apply to structural components subject to bending where high stress concentrations due to high local weld stresses may exist in extreme edges of weld details. These include selected connection details subject to high stresses which warrant such consideration. The purpose of this provision is elaborated upon and discussed in considerable detail in technical references and textbooks used by practicing professional engineers internationally. For greater insight into this provision, several references are included in this response. The purpose of weld end returns are to assist in the redistribution of high local stresses when the following conditions apply:

1. Where vertical welds are subject to high stresses which are calculated to exist at extreme tips of a weld group, generally from large bending moments which have a tendency to "pry" the weld apart.

2. Where the weld stress is required to perform to its maximum allowable stress value, and further, where maximum loading conditions can readily carry the local weld stress intensity into yield conditions.

3. In applications for which the local tensile stress from extreme bending effects are required to be resisted by small, narrow weld details.

In the design of all structures and components in the SONGS 2 and 3 project, AISC §1.7.10 has been considered. Where the provisions of this section are appropriate, Bechtel has provided weld details, including weld end returns, which meet the provisions and intent of the AISC Specifications. As a whole, Bechtel has specified weld end returns for appropriate design applications when calculated weld stresses approach code allowable values. These weld end returns have been provided conservatively even though the San Onofre 2 and 3 design criteria limits the Design Basis Earthquake (DBE) combines stresses to 90% of yield. Typical types of details where weld ends have been specified include to enhance local stress conditions include:

1. Welded double angle structural connections with high weld stresses (e.g. weld stresses near code allowables) which are field welded to intersecting beams and columns and for which "prying" is a credible failure mechanism.

2. Special beam connections where beam brackets or seats are required designed for high stresses (e.g. weld stresses near code allowables) whose behavior has a tendency to "pry" the weld detail.

3. Special highly stressed design connections which are not resisted in tension by a large weld segment whose behavior could result in "prying" action.

As such, the San Onofre 2 and 3 structural design appropriately accounts for the provisions of AISC §1.7.10 and utilizes this provision for those specific conditions for which it is intended to apply.

Mr. Kent, however, has refused to recognize the clarification specified in the second sentence of AISC §1.7.10 which states ......"This provision shall apply to side and top fillet welds connecting brackets, beam seats, and similar connections, on the plane upon which bending moments are computed." His criticism extends not only Bechtel's interpretation of the provision, but also with the AISC with whom he apparently disagrees. He contends that full welding all-around is "optimum" and should be adopted for all details which are subject to seismic considerations. This feeling obviously extends his interpretation of weld end returns to conditions for which it is neither recommended by the code, nor required by the specific structural design conditions by the designing professional engineer.

Mr. Kent contends that weld end returns should be specified for Type A and B connection details. Bechtel disagrees for the following reasons:

1. The details are not appropriate for the types of connections for which AISC §1.7.10 is intended to apply.

2. The top and bottom welds (for Detail A) are designed to take the tension and compression loading components from bending with a weld sized to take the full load accordingly. The vertical welds are designed to take the full shear load. In essence, the top and bottom welds behave in a tension and compression mode, not one of "prying". If the weld is sized

to withstand the full design load at allowable stress levels the weld end return would be located below the extreme weld fiber and would have limited value. The weld end return, if provided according to his interpretation, would remain below the stresses at the top fiber until the section reached yield levels. Since this design condition is prohibited by the DBE criteria, the weld end return, if installed, would have no meaning provided that the top weld is sized to resist the full design force.

3. The full "2t" weld may not be constructible orthogonal to the top weld since the curvature of the weld at the tip of the structural member may prohibit its installation. This condition is prevalent for angle member extreme ends and certain structural shapes. In addition, the high stress concentration caused by the non-orthogonal weld end return may increase stress concentrations.

4. The entire weld detail must be proportioned in such a manner that adequate weld exists to withstand the loads. Beam sizing is often made utilizing stock size member selection which provides some uniformity in ordering steel and some consistency in field erection. It is, therefore, not unusual to see a member with oversize beam section properties connected by a weld detail which does not develop its full section. The important and relevant design consideration is that the weld detail should be sized to withstand all design loads imposed upon it. The arbitrary selection of weld details which develop all beam sections would lead to excessive costs for the plant, while adding nothing to the structural integrity of the design.

5. The detail utilized for tension and compression members (e.g. axial struts) do not require the same attention to weld end returns since "prying" is not, in general, a credible failure mechanism. In conversations held with Mr. Kent in the walkdown, it was evident that he did not comprehend the behavior of such members, and was unable to make such a determination.

In Detail C, Mr. Kent contends that the weld detail is inadequate and should be welded all around. This interpretation is not only highly subjective but in clear violation of the AWS Code §8.8.5. This section clearly prohibits an orthogonal weld detail fillet welded, which is welded from two independent directional planes, from being welded continuously. This section requires that the weld be broken at the junction of the two welding planes. This shows the lack of understanding of specific and relevant code provisions by Mr. Kent. In the application of the detail, the weld has been conservatively sized to maintain weld stresses considerably below allowables and the design meets the design criteria for the project. Here again the weld end interpretation by Mr. Kent is in error and clearly violates the specific provision of the AWS Code.

II. The Need for Fully Welded or Bolted Connections to Develop the Full Shear and Bending Capacity of Structural Sections

This contention by Mr. Kent addresses in a more direct manner his disagreement with the governing AISC Specification. He contends that all connections should be designed and constructed to develop the full shear and bending capacity of every beam section utilized in the plant. In essence, it is his contention that AISC §1.2 should not be applicable for structures in seismic zones.

Bechtel Engineering Position

It is Bechtel Engineering's position that this contention contradicts over 60 years of experience in the preparation of the AISC Specification and equivalent experience and design practice by practicing registered engineers throughout the industry internationally. AISC Specification §1.2 clearly permits the utilization of three primary design types which have been discussed in the previous response to the NRC. Some additional comments are warranted. Mr. Kent has thrust himself in a position of engineering decision-making, a position for which he is neither qualified academically, nor licensed professionally.

Bechtel has utilized highly qualified licensed professionals in the selection of weld details and such professionals have interpreted code requirements under the close scrutiny of the NRC. Mr. Kent's unqualified, subjective approach to design would have the following impact:

- Welding of all connections would result in a highly complex, highly indeterminate design which would be prohibitive to analyze and design. The use of full moment-resistant connections arbitrarily would invalidate all detailed analysis and design performed over 10 years.
- The project design and construction schedule would be increased several years.
- The use of full moment-resistant connections would add significant and prohibitive costs to the project, and not necessarily add to the safety or structural integrity of the plant. This design concept, if selected, is not optimum.

For these reasons, Mr. Kent's position is inappropriate and Bechtel disagrees with his contention emphatically.

In summary, Mr. Kent's contentions in the structural design and construction of the San Onofre 2 and 3 project are inaccurate and unjustified, and Bechtel rejects all of his unqualified allegations without reservation.

References

The following are technical and professional references which support the position taken by Bechtel in the applicability of Code provisions of AISC Specification §1.7.10 with respect to weld end returns and the need for welding all-around.

(A) Steel Construction Manual, 7th Edition, 1970, pp. 4-43, 4-50, 4-51, 4-53, 4-101, 4-102, 4-103, 4-104, 4-105, 5-113

(B) Structural Steel Design by Jack C. McCormac, International Textbook Company, Scranton, Pennsylvania, pp. 214-216, 253-267

(C) Steel Structures - Design and Behavior, 2nd Edition by Charles G. Salmon and John E. Johnson, Harper & Row Publishers, New York, pp. 213-242

(D) Design of Welded Structures by Omer W. Blodgett, James F. Lincoln Arc Welding Foundation, Cleveland, Ohio, pp. 3.3-1 to 3.3-18, 5.2-1 to 5.4-14

(E) Structural Steel Detailing, American Institute of Steel Construction, New York, pp. 6-27 to 6-30