EVALUATION RESEARCH CORPORATION

COMANCHE PEAK RESPONSE TEAM

QUALITY INSTRUCTION FOR ISSUE-SPECIFIC ACTION PLAN VII.c

INSTRUCTION NO.: QI-066

REVISION: 1

ISSUE DATE: 02/11/86

CONTROLLED COPY
CONTROL NO. QF-001

REINSPECTION OF EQUIPMENT SUPPORTS

Prepared by: John Peter Taberian Date: 1/31/86

Approved by: Albert A. Potts Date: 2/7/86
Issue Coordinator

Approved by: G. W. Rau Date: 2-10-86
On-Site QA Representative

Approved by: JO Christian for Date: 2/10/86
QA/QC Review Team Leader

1.0 PURPOSE

To provide the methods and accept/reject criteria for the visual reinspection of mechanical, electrical and HVAC equipment supports.

2.0 APPLICABILITY

This Quality Instruction applies the requirements of Action Plan VII.c to equipment supports for safety related mechanical, electrical and HVAC equipment in Units 1, 2 and common which has been QC accepted.

3.0 REFERENCES

3.1 Description Memorandum QA/QC-RT-1250, dated January 7, 1986 delineating documentation used in development of this instruction including specific sources for attributes and exclusions.

3.2 CPP-009, "Performance of Reinspections and Document Reviews."

3.3 Brown & Root Procedure, QI-QAP-10.2-4B, Revision 3 "Ultrasonic Examination of Hilti Bolts."

4.0 GENERAL

4.1 Responsibilities

A. QA/QC Discipline Engineers

The QA/QC Discipline Engineers prepare the quality instruction delineating reinspection requirements and attributes.

B. QA/QC Inspectors

QA/QC Inspectors perform reinspection/verification in accordance with this inspection procedure and record observation and deviation.

4.2 Policy

Activities performed under this procedure shall conform to the policies contained in the latest Comanche Peak Response Team Program Plan and Issue-Specific Action Plans.

5.0 INSTRUCTION

Using the information in Reference 3.2 and below, perform the reinspections on the items in this population. Use checklist (Attachment 6.1) to document the findings.

5.0 INSTRUCTION (Cont'd)

Measurements shall be made using standard inspection tools. Attachment 6.2 provides a list of standard inspection tools and their corresponding codes. Record on the checklist (Attachment 6.1) the tool code, serial number and calibration due date of the tool used to measure dimensions when applicable.

5.1 Identification (1.0)

Determine the physical identification of the piece of equipment which is being supported by reference to the mark or spin number on the equipment identification tag and/or by the location shown on the installation drawings. It is possible for the identification to be painted on a piece of equipment through stenciling.

Variations on the equipment mark number may exist. Should a different equipment mark number exist, note such in the remarks column and contact discipline engineer for further clarification.

5.2 Location and Orientation (2.0)

Verify that the equipment support location and orientation is in accordance with the installation drawings. Where no tolerance is given the dimensions on the installation drawings shall be plus or minus 12 inches. Measurements are not required to be taken to surveyor bench marks. They may be taken to wall surfaces, column faces or finished floor level.

5.3 Support Configuration (3.0)

Verify that the equipment support configuration is in accordance with the installation drawings as follows:

A. Structural components of the supports (plate, channel unistrut, etc.) are the shape, dimensions and configuration shown on the installation drawings.

- Cross-section dimensions of structural steel shapes are shown in Section 1 of the AISC Manual of Steel Construction.
- Cross-section dimensions of framing system channel (unistrut, etc.) are shown in vendor catalogs.
- Gage distances are as given in the AISC manual plus or minus 1/8 inch unless otherwise noted.

5.0 INSTRUCTION (Cont'd)

5.3 Support Configuration (3.0) (Cont'd)

B. Bolt and stud hole locations are as shown on the installation drawings. Gage distances are as given in the AISC manual, plus or minus 1/8 inch unless otherwise noted, provided minimum steel edge distance is maintained per AISC. For inspection purposes, gage distances shall be measured from the center of the bolt as holes are inaccessible.

C. The equipment is installed on its related support as shown on the installation drawings.

5.4 Welding

Prior to the start of inspection assure that welds are clean of any foreign material which would impede an adequate visual inspection. Coatings are not to be removed unless an inspector feels that due to excessive and/or uneven coating application he is unable to provide adequate inspection of the weld. Then he shall contact the Level III inspector and with his concurrence only then may the coating be removed.

When it is necessary to measure weld dimensions during the course of an inspection, such dimensions should be determined as accurately as is practically achievable using standard weld inspection tools.

A. AWS Welds (4A)

1. Location (i)

Verify the weld location is as specified on the detail drawing. Where welds exist but no location is specified note such in the remarks column and initiate a deviation report.

2. Size (ii)

Verify the weld size meets the drawing requirements with the following exceptions:

- Fillet welds may be undersized to a maximum of 1/16" provided that the undersized portion(s) do not exceed 1/4 of the total weld length.

- Oversize fillet welds shall be acceptable if the weld does not interfere with equipment or mating parts.

5.0 INSTRUCTION (Cont'd)

5.4 Welding (Cont'd)

- For bevel welds that are inaccessible from the backside, the size is verified by assuring that the joint is welded flush except as noted in Attachment 6.11.

3. Length (iii)

Verify the weld length complies with the referenced drawing and the following allowances:

- Where the specified weld length is less than 3" the permissible underlength is 1/8".
- Where the specified weld length is 3" or longer the permissible underlength is 1/4".
- The weld length may be longer than specified.
- Spacing of intermittent welds may vary within 1" of the location specified on the drawing.
- The required weld length for tube steel connections is the nominal tube width, unless otherwise noted on drawings or DCA's.

4. Fusion (iv)

Verify any incomplete fusion meets the following requirements of acceptability:

- For fillet weld, 3/8" maximum incomplete fusion in any 4 inch segment and 1/4 inch maximum incomplete fusion in welds less than 4 inches long.
- For groove welds no incomplete fusion is permitted.

5.0 INSTRUCTION (Cont'd)

5.4 Welding (Cont'd)

5. Craters (v)

Verify that the weld size is met on all welds with underfilled craters. Craters outside the specified weld length are irrelevant provided there are no cracks visible through the coated surface if the weld has been coated or on the uncoated surface if the coating has not been applied.

6. Weld Profiles (vi)

Verify, visually, that the weld profiles are acceptable per Attachment 6.11.

7. Undercut (vii)

Verify that any undercut present does not exceed the following criteria:

° For base material 3/8" and less the following requirements apply:

A) When the member is welded from both sides and the undercut is in the same plane, the following undercut is permitted.

i) 1/32" for 1/2 the length of the *total weld, or

ii) 1/32" for 1/4 the length of the *total weld and 1/16" for 1/8 the length of the *total weld.

*Total weld equals the cumulative length of both sides.

B) For all other welds the permitted undercut is:

i) 1/32" for the full length of the weld, or

ii) 1/32" for 1/2 the length of the weld and 1/16" for 1/4 the length of the weld.

5.0 INSTRUCTION (Cont'd)

5.4 Welding (Cont'd)

- For base material greater than 3/8" the following requirements apply:

A) For members welded on both sides, where the undercut is in the same plane the permitted undercut is 1/32" for 3/4 of the length of the weld and 1/16" for the remaining 1/4 of the length of the weld on both sides.

B) For members welded only on one side or where the undercut is not in the same plane the undercut may be 1/16" for the full length of the weld.

8. Porosity (viii)

Considering that only surface porosity whose major surface dimension exceeds 1/16" shall be considered relevant verify the following:

- The sum of the diameters of porosity do not exceed 3/8" in any linear inch of weld and shall not exceed 3/4" in any 12" of weld, and

- If 4 or more pores are aligned the edge to edge separation of the pores shall exceed 1/16".

9. Overlap (ix)

If overlap is present verify that the required weld size and the fusion acceptance criteria are met. If fusion in the overlap length cannot be verified then verify that the overlap length, whose fusion cannot be verified, does not exceed 3/8" in any 4" segment or 1/4" in welds less than 4" long.

10. Slag (x)

Verify the major surface dimension of the slag does not exceed 1/8" or 1/4" for any isolated surface slag. (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.

11. Cracks (xi)

Verify there are no cracks visible through the coated surface if the weld has been coated or on the uncoated surface if the coating has not been applied.

5.0 INSTRUCTION (Cont'd)

5.4 Welding (Cont'd)

B. NF Welds (4B)

1. Location (i)

Verify welds are located as shown on drawings. Record any additional welding performed on Attachment 6.3.

2. Size (ii)

Verify weld size meets or exceeds that shown on the drawing. The required weld length for tube steel connections is the nominal tube width, unless otherwise noted on drawings or DCA's.

3. Undercut (iii)

Verify undercut does not exceed 1/32 inch.

4. Surface Condition (iv)

Verify surface of welds are sufficiently free of overlap, abrupt ridges and ripples.

5. Cracks, Lack of Fusion (v)

Verify no lack of fusion or cracks are visible and that there are not any linear indications in excess of 1/16 inch.

6. Welder ID Symbol (vi)

Determine if a welder symbol is present and record such on Attachment 6.4. This information is required for document review only and has no accept/reject criteria.

5.5 Bolting (5.0)

Verify that bolting used in construction of the equipment support or attaching the support to the building structure or equipment meets the following criteria:

A. Attachments (5A)

Attachment points shall be the number, type and location shown on the installation drawing. Threaded stud locations may vary from theoretical locations, but

5.0 INSTRUCTION (Cont'd)

5.5 Bolting (5.0) (Cont'd)

must coincide with equipment base hole locations provided equipment location on base plate (centerline of equipment-to-centerline of baseplate) is maintained ±1/4". This is to say that there cannot be more bolt holes than required by drawing and those holes must line up with the attachment points on the equipment.

B. Materials (5B)

Bolting materials are heavy hex unless otherwise specified on the installation drawings. Bolting hardware (bolts, nuts and locking devices) is to be the size, material, type, grade and configuration as shown on the installation drawings. See Attachment 6.12 for standard markings.

The following substitutions are acceptable:

- ASTM A449 may be substituted for ASTM A325 bolts.
- ASTM A307, A325 and A449 may be substituted for Unistrut bolting.
- ASME SA-193 Gr. B7 threaded rods with SA-194 double nuts substituted for ASTM A325 bolts for use with Richmond inserts. Where threaded rod material is indeterminate, this attribute is still acceptable. State in the remarks column "ASME SA-193 Gr. B7 threaded rod is required."

C. Engagement (5C)

Verify that bolts or studs are engaged for the full thread of the nut. The minimum for this is with the top of the bolt flush with the top of the nut.

D. Surface Contact (5D)

Verify surfaces of bolted parts in contact with the bolt head and nut do not have a slope of more than 1:20 with respect to a plane normal to the bolt axis. Where the surface of a bolted part has a slope of more than 1:20, a beveled washer is used to compensate for the lack of parallelism. To ensure proper bearing, a bevel gauge shall be used for determining if the gap is less than or equal to 1:20.

5.0 INSTRUCTION (Cont'd)

5.5 Bolting (5.0) (Cont'd)

E. Torquing (5E)

For unpainted high strength bolts specified for use in friction type connections verify that there is no nut rotation relative to the bolt when the following torque value is applied:

Bolt Size (in.)	ASTM A325 Torque (Ft. lbs.)	ASTM A490
1/2	65	-
5/8	160	-
3/4	271	350
7/8	363	455
1	508	924
1 1/4	-	1834
1 1/2	-	3196

For painted connections note in the remarks column that the connection is painted and not verifiable.

Where torque values are shown on the drawing, the discipline engineer shall provide supplemental instructions.

For bearing type connections and connections specified as snug tight verify that the bolt/nut cannot be rotated by hand and that there are no visible gaps between the connected piles of the connection.

5.6 Concrete Expansion Anchors (Hilti) (6.0)

A. Anchor bolt size and type (6A)

Verify anchor bolt is in accordance with design documents provided in the package. This can be accomplished by using a gauge or rule to distinguish nominal diameter sizes ranging between 1/4" and 1-1/4 inch diameter in increments of 1/8 inch.

B. Anchor bolt length (6B)

Verify anchor bolt length by the letter designation stamped on top of the bolt. Attachment 6.5 gives lengths corresponding to letter designations. Super-kwik bolts are identified by a star stamp in addition to the letter designation.

Note: Hilti and Super-Kwik Hilti bolts 19 inches and longer may be stamped with numbers to indicate length.

5.0 INSTRUCTION (Cont'd)

5.6 Concrete Expansion Anchors (Hilti) (6.0) (Cont'd)

If length identification is not verifiable or visible, an ultrasonic examination shall be performed in accordance with TUGCO procedure QI-QAP-10.2-4B. Brown & Root shall perform UT and provide copy of results to inspector for inclusion in verification package.

Once ultrasonic examination is complete, record actual length on reinspection checklist and report as deviation.

C. Anchor bolt embedment (6C)

Verify that the Hilti anchor bolt embedment plus the nut thickness (from Attachment 6.5) for the anchor being measured is not less then the "Embedment Length" or "Minimum Embedment Length" identified on the drawings; or lacking such information the "Minimum Embedment" identified on Attachment 6.5.*

Determine and record the Hilti anchor bolt embedment by measuring the projected length of the anchor bolt from the structural concrete** surface. Subtract the anchor projected length from the designated anchor length to arrive at the Hilti anchor bolt embedment. The designated anchor length is that shown on Attachment 6.5, unless the stamp is indistinguishable in which case the U.T. recorded length should be used.

*Note: When the letter designation stamped on Hilti bolt is not identified by Attachment 6.5 the following Hilti bolt attributes regarding length of Hilti's can conservatively be inspected by using Attachment 6.13.

**Note: In floor and roof areas where topping has been placed, the thickness of the topping shall be taken into account in determinfng the projected length (unless shown on the DWG/CMC). In these areas the thickness of the topping shall be added to measured length taken from the concrete surface. The inspector shall ensure that measurement for topping is provided in the inspection package for all floor or roof slabs. This value may be "0" if floor or roof has been monolithically placed.

D. Anchor bolt spacing (6D)

(i) Verify for each Hilti, center-to-center spacing of adjacent anchors of the same size (not on the same attached fixture) is not

5.0 INSTRUCTION (Cont'd)

5.6 Concrete Expansion Anchors (Hilti) (6.0) (Cont'd)

less than 10 anchor diameters unless specified in the design documents. For unequal sized bolts, the minimum spacing (unless shown on design documents) is as shown on Attachment 6.6.

(ii) Verify spacing of each Hilti to existing Richmond inserts, concrete edges, abandoned holes, Hilti anchors or embedded anchor bolts that have been cut off meet the minimum spacing requirements specified in Attachment 6.7 unless shown on the design documents.

Note: Any items covered by baseplate/ equipment base will be checked by document review.

(iii) Verify that the minimum distance of each Hilti anchor to any adjacent embedded plate meets the requirements of Attachment 6.8 as follows:

1. Attachments located within 12 inches of a Hilti anchor bolt shall have spacing as shown on Attachment 6.8.

2. For embedment plates without any attachment within 12 inch clearance distance, the anchor may be as close as practical to the edge of the plate without damage to the plate.

E. Anchor bolt angularity (6E)

Verify each Hilti anchor installed has its longitudinal axis within 6° from the perpendicular of the surface it is set into. Attachment 6.9 gives inspection requirements.

F. Anchor bolt nut engagement and bearing (6F)

(i) Verify nut of each Hilti anchor has proper engagement such that the end of the anchor bolt is not lower than the top of the nut, unless otherwise shown on design document.

5.0 INSTRUCTION (Cont'd)

5.6 Concrete Expansion Anchors (Hilti) (6.0) (Cont'd)

(ii) Verify nut and washer of each Hilti anchor has proper bearing and that a minimum of one washer (standard or plate) has been provided. The washer shall completely cover the hole in the structure. A bevel gauge shall be used for determining if the gap is less than 1:20. (Attachment 6.10).

(iii) Verify no visible weld has been made to anchor bolt or nut.

(iv) Verify that the nut for each anchor has not bottomed out. Use thread length in Attachment 6.5 or 6.13 and measured projection to determine acceptance.

G. Concrete Damage (6G)

Verify structural concrete surrounding the fixture is not broken or spalled as a result of installing the Hilti anchor. If spalling exists, verify the depth does not exceed the following:

Hole Size	Maximum Acceptable* Spall Depth
5/8 inch and under	1/2"
3/4" to 1-1/4" inclusive	3/4"

*If the area in question includes a topping the maximum spall depth may be increased to the depth of the topping.

6.0 ATTACHMENTS

6.1 Reinspection Checklist

6.2 Inspection Tools and Codes

6.3 Additional Welds

6.4 Welder ID

6.5 Hilti Anchor Bolt Chart

6.6 Minimum Spacing Between Hilti Expansion Anchors

6.7 Minimum Anchor Clearances

6.8 Minimum Clearances to Embedded Plates

6.9 Anchor Angularity

6.10 Nut Bearing

6.11 Fillet Weld Profiles

6.12 Standard Bolt Identification

6.13 Hilti Length Identification

COMANCHE PEAK RESPONSE TEAM CHECKLIST		Attachment 6.1 QI-066 Rev. 1
POPULATION DESC Equipment Supports (EQSP)	VERIFICATION PKG NO. I-S-EQSP	PAGE 1 OF 3
QUALITY INSTRUCTION QI-066	[X] REINSPECTION	[ ] UNIT 1
EQUIPMENT MARK/TAG NO.	[ ] DOCUMENTATION REVIEW	[ ] UNIT 2 [ ] COMMON

ATTRIBUTE	VERIFICATION			REMARKS
	ACCEPT	REJECT	DATE	
1. Identification	N/A	N/A		
2. Location & Orientation				
3. Configuration				
4. Welding A. AWS Welds (i) Location				
(ii) Size				
(iii) Length				
(iv) Fusion				
(v) Craters				
(vi) Profiles				
(vii) Undercut				
(viii) Porosity				
(ix) Overlap				
(x) Slag				
(xi) Cracks				

PREPARED BY: DISCIPLINE ENGR. DATE	APPROVED BY: LEAD DISCIPLINE ENGR. DATE
INSPECTED BY: INSPECTOR DATE	APPROVED BY: LEAD INSPECTOR DATE

POPULATION DESC Equipment Supports (EQSP)	VERIFICATION PKG NO. I-S-EQSP			PAGE 2 OF 3
ATTRIBUTE	VERIFICATION			REMARKS
	ACCEPT	REJECT	DATE	
4. Welding (Cont'd) B. NF Welds (i) Location				
(ii) Size				
(iii) Undercut				
(iv) Surface Condition				
(v) Cracks, Lack of Fusion				
(vi) Welder ID Symbol	N/A	N/A		
5. Bolting A. Attachments				
B. Materials				Thd. Rod. =
C. Engagement				
D. Surface Contact				
E. Torquing				
6. Concrete Expansion Anchors A. Size & Type				
B. Length				
C. Embedment				
D. Spacing (i)				
(ii)				
(iii)				
E. Angularity				

COMANCHE PEAK RESPONSE TEAM CHECKLIST				Attachment 6.1 QI-066 Rev. 1
POPULATION DESC Equipment Supports (EQSP)	VERIFICATION PKG NO. I-S-EQSP			PAGE 3 OF 3
ATTRIBUTE	VERIFICATION			REMARKS
	ACCEPT	REJECT	DATE	
6. Conc.Exp.Anchr (Cont'd) F. Engagement & Bearing (i)				
(ii)				
(iii)				
(iv)				
G. Concrete Damage				

INSPECTION TOOLS AND CODES

CODE	TOOL
AF	Angle Finder
BL	Bubble Level
BS	Boroscope
BW	1/32", 1/16", 3/32", 1/8" Wire
CG	Contour Gage
DF	Dry Film Thickness Gage
FG	Feeler Gages
FL	Flashlight
FM	Fibre Metal Fillet Gages
GG	Gal Fillet Gages
HL	Hi-Low Gage
MG	Magnifying Glass
MI	Micrometers
MM	Mirror
MN	Magnet
PB	Plum Bob
PR	Protractor
SC	Slide Caliper
SR	6" Rule
ST	Steel Tape Measure
TG	Taper Gage
TW	Torque Wrench
UD	Undercut Gage (Dial)
UP	Undercut Gage (Pit)
VC	Vernier Caliper
VT	Visual Inspection

_____ _____
Inspector Date

COMANCHE PEAK REVIEW
INSPECTION CHECKLIST

VERIFICATION PACKAGE NO. _____

HANGER MARK NO. _____

ADDITIONAL WELDS

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____ _____
Inspector Date

COMANCHE PEAK REVIEW TEAM
INSPECTION CHECKLIST

WELDER IDENTIFICATION

VERIFICATION PACKAGE NO. _____

HANGER MARK NO. _____

WELDER IDENTIFICATION

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____ _____
Inspector Date

HILTI ANCHOR DESIGNATION AND SETTING REQUIREMENTS

Stamp on Anchor	Actual Bolts Sizes	Minimum Embedment KWIK	Minimum Embedment Super Kwik	Length of Threads	Nut Thickness
A.	1/4 x 1 5/8	1 1/8	-	3/4	7/32
B.	1/4 x 2 1/4	1 1/8	-	3/4	7 32
	3/8 x 1 1/8	1 5/8	-	7/8	11/32
C.	3/8 x 2 3/4	1 5/8	-	7/8	11/32
	1/2 x 2 3/4	2 1/4	-	1 1/4	7/16
D.	1/4 x 3	1 1/8	-	3/4	7/32
E.	3/8 x 3 1/2	1 5/8	-	1 1/8	11/32
	1/2 x 3 3/4	2 1/4	-	1 1/4	7/16
	5/8 x 3 1/2	2 3/4	-	1 1/2	17/32
F.	3/4 x 4 1/4	2 3/4	-	1 1/2	5/8
G.	5/8 x 4 1/2	2 3/4	-	1 1/2	17/32
	3/4 x 4 1/2	3 1/4	-	1 1/2	5/8
H.	3/8 x 5	1 5/8	-	1 1/8	11/32
I.	1/2 x 5 1/2	2 1/4	-	1 1/4	7/16
	3/4 x 5 1/2	3 1/4	-	1 1/2	5/8
J.	5/8 x 6	2 3/4	-	1 1/2	17/32
	1 x 6	4 1/2	-	2 1/4	27/32
K.	-	-	-	-	-
L.	1/2 x 7	2 1/4	3 1/4	1 1/4	7/16
	3/4 x 7	3 1/4	-	1 1/2	5/8
	1 x 7	4 1/2	-	2 1/4	27/32
M.	-	-	-	-	-
N.	-	-	-	-	-
O.	5/8 x 8 1/2	2 3/4	-	1 1/2	17/32
	3/4 x 8 1/2	3 1/4	-	1 1/2	5/8
P.	1/2 x 9		3 1/4	1 1/4	7/16
	1 x 9	4 1/2	6 1/2	2 1/4	27/32
	1 1/4 x 9	5 1/2		3 1/4	1 1/32
Q.	-	-	-	-	-

HILTI ANCHOR DESIGNATION AND SETTING REQUIREMENTS

Stamp on Anchor	Actual Bolts Sizes	Minimum Embedment KWIK	Minimum Embedment Super Kwik	Length of Threads	Nut Thickness
R.	3/4 x 10	3 1/4	-	1 1/2	5/8
S.	-	-	-	-	-
T.	1/2 x 12		3 1/4	1 1/4	7/16
	1 x 12	4 1/2	6 1/2	2 1/4	27/32
	1 1/4 x 12	5 1/2	8 1/8	3 1/4	1 1/32
U.	1 x 13 1/2	4 1/2	6 1/2	2 1/4	27/32
	1 1/4 x 13 1/2	5 1/2	8 1/8	3 1/4	1 1/32
V.	-	-	-	-	-
W.	1 x 15		6 1/2	2 1/4	27/32
	1 1/4 x 15	5 1/2	8 1/8	3 1/4	1 1/32
X.	1 1/4 x 16 1/2	5 1/2	8 1/8	3 1/4	1 1/32
Y.	-	-	-	-	-
Z.	1 1/4 x 18	5 1/2	8 1/8	3 1/4	1 1/32
DD.	1 1/4 x 22	-	8 1/8	3 1/4	1 1/32
EE.	1 1/4 x 23	-	8 1/8	3 1/4	1 1/32

* Bolts of 19-inch length and greater may be stamped with number corresponding to the bolt length in inches in the same manner instead of the stamped letters as listed ~~below~~ above.
→PT 2/6/86

MINIMUM SPACING BETWEEN HILTI EXPANSION ANCHORS*

Hilti Anchor Size	1/4" Hilti	3/8" Hilti	1/2" Hilti	5/8" Hilti	3/4" Hilti	1" Hilti	1 1/4" Hilti
1/4	2 1/2	3 1/8	3 3/4	4 3/8	5	6 1/4	7 1/2
5/16	2 13/16	2 7/16	4 1/16	4 11/16	5 5/16	6 9/16	7 13/16
3/8	3 1/8	3 3/4	4 3/8	5	5 5/8	6 7/8	8 1/8
1/2	3 3/4	4 3/8	5	5 5/8	6 1/4	7 1/2	8 3/4
5/8	4 3/8	5	5 5/8	6 1/4	6 7/8	8 1/8	9 3/8
3/4	5	5 5/8	6 1/4	6 7/8	7 1/2	8 3/4	10
7/8	5 5/8	6 1/4	6 7/8	7 1/2	8 1/8	9 3/8	10 5/8
1	6 1/4	6 7/8	7 1/2	8 1/8	8 3/4	10	11 1/4
1 1/4	7 1/2	8 1/8	8 3/4	9 3/8	10	11 1/4	12 1/2

Dimension in inches.

* The minimum spacing outlined in the above chart applies to Hilti anchors detailed on separate adjacent fixtures.

Hilti bolts details on an individual fixture drawing may have less than the minimum spacing tabulated above.

MINIMUM ANCHOR CLEARANCES*

Hilti Anchor Size	MINIMUM DISTANCE TO: Richmond Screw Anchors 1-inch	Richmond Screw Anchors 1 1/2-Inch	Concrete Edge* (Note 1)	Abandoned Hilti Anchors or Holes and Embedded Anchor Bolts that are Cut Off**
1/4	7 5/8	12 1/4	1 1/4	1/2
3/8	8 1/4	12 7/8	1 7/8	3/4
1/2	8 7/8	13 1/2	2 1/2	1
5/8	9 1/2	14 1/8	3 1/8	1 1/4
3/4	10 1/8	14 3/4	3 3/4	1 1/2
1	11 3/8	16	5	2
1 1/4	12 5/8	17 1/4	6 1/4	2 1/2

* Measured Center-to-Center of anchors and anchor center to edge of concrete in inches.

** Minimum spacing between holes covered by this column shall be measured center-to-center and based on size of hole being drilled. (e.g., Pilot hole spacing is based on pilot bit size.)

Hilti bolts may be installed as close as practical to unused Richmond Screw Anchors which have been plugged (i.e., grouted, Richmond Screw-in plug or snap-in plug, etc.).

NOTE 1: Where embedded angles are used for framing water tight door or removable block wall openings, the minimum clearance from center line of Hilti anchor to the opening edge is 5 inches + 5 times the Hilti anchor diameter.

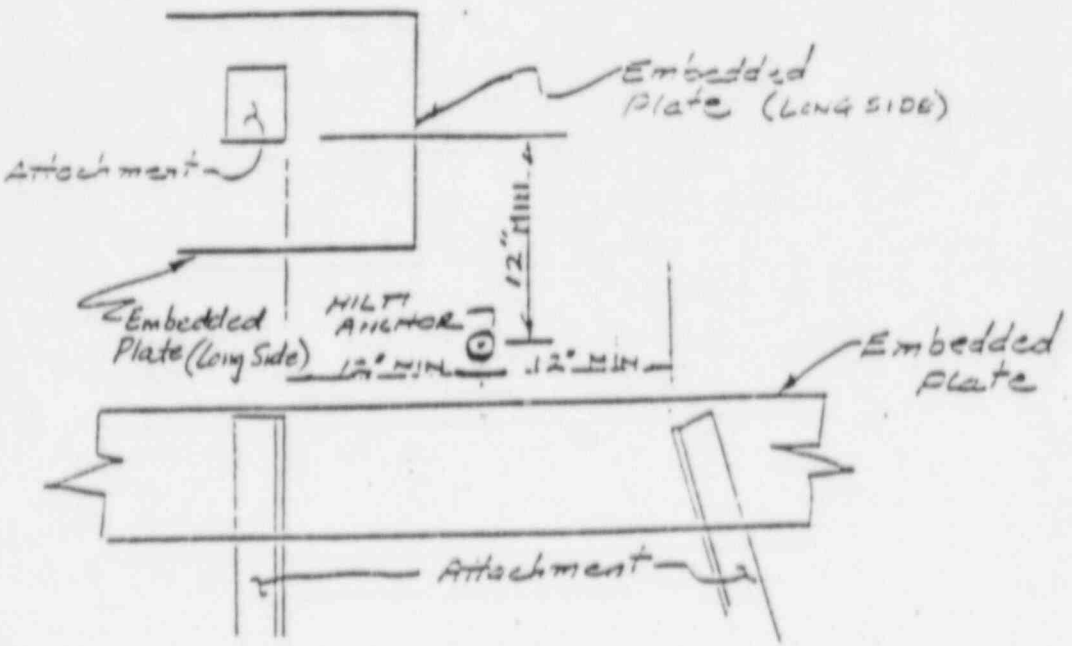
MINIMUM CLEARANCES TO EMBEDDED PLATES

Where the embedded steel plates are occupied by attachments within minimum distances shown below, the minimum clearance to Hilti Anchors shall be as follows:

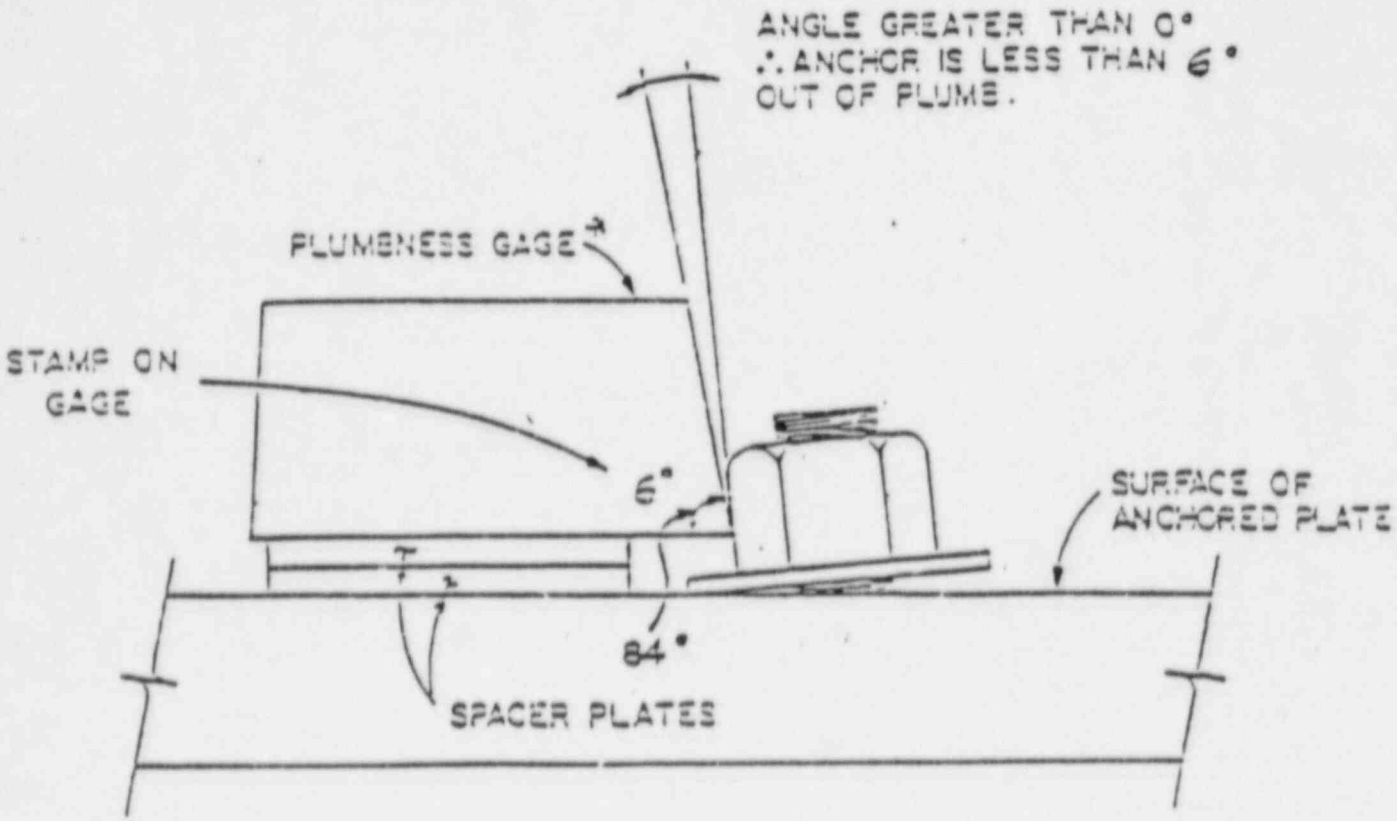
Hilti Anchor Size	Nelson Stud to Hilti Anchor	Edge of Plate to Hilti Anchor
1/4	5 1/4	3 3/4
3/8	5 7/8	4 3/8
1/2	6 1/2	5
5/8	7 1/8	5 5/8
3/4	7 3/4	6 1/4
1	9	7 1/2
1 1/4	10 1/4	8 3/4

Dimensions are in inches.
Distance measured with reference to center of bolts and studs.

Where location of the nearest Nelson Stud can be determined from the "S" stamps on the embedded steel plate, the minimum center-to-center clearance to the Hilti Anchor as shown above shall govern. Where location of the nearest Nelson Stud cannot be so determined, the minimum clearance to Edge of Plate as shown above shall govern.

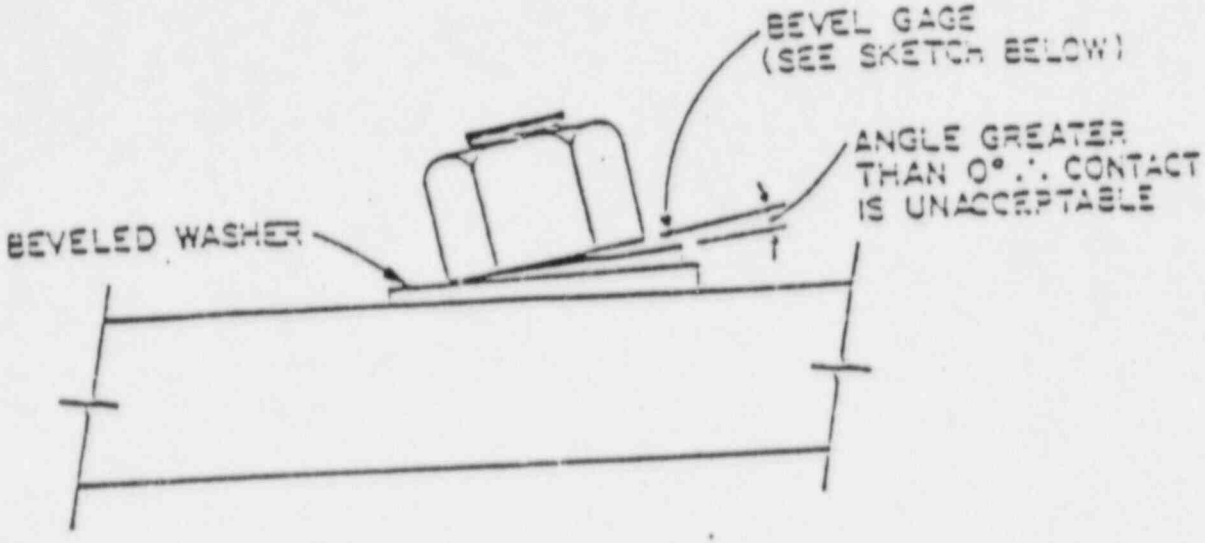


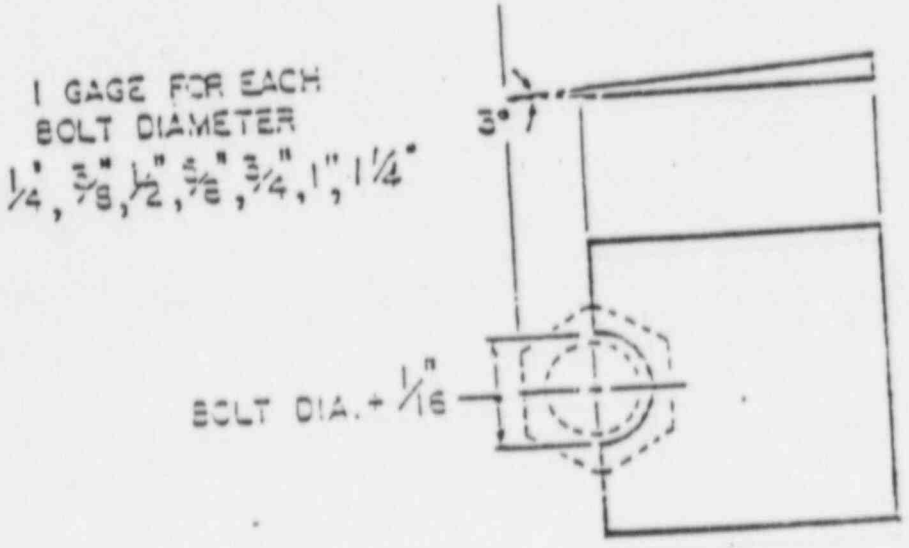
ANCHOR ANGULARITY



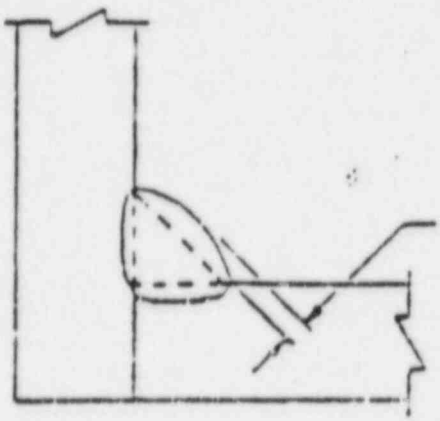
* Use this or other acceptable devise in determining acceptable angularity.

NUT BEARING

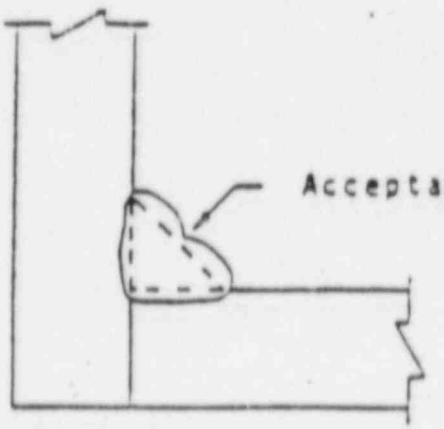

BEVEL GAGE
(SEE SKETCH BELOW)
ANGLE GREATER
THAN 0°.·. CONTACT
IS UNACCEPTABLE
BEVELED WASHER


1 GAGE FOR EACH
BOLT DIAMETER
1/4", 3/8", 1/2", 5/8", 3/4", 1", 1 1/4"
3°
BOLT DIA. + 1/16"

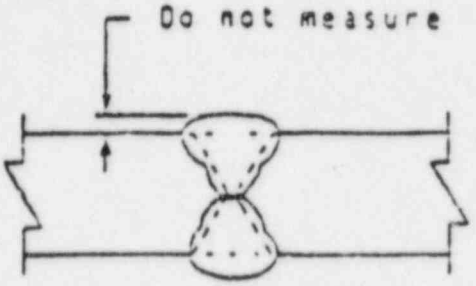
FILLET WELD PROFILES



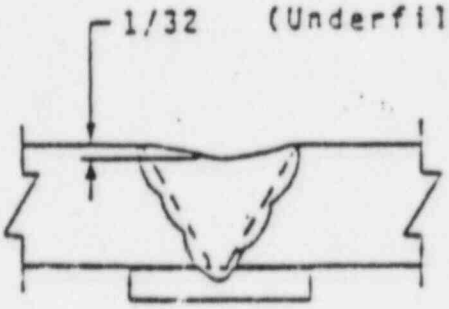
Acceptable Convexity



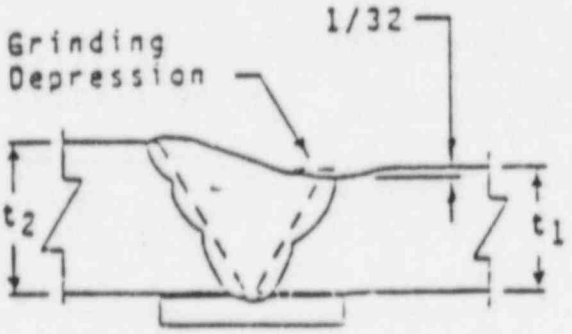
GROOVE WELD PROFILES



Acceptable Convexity

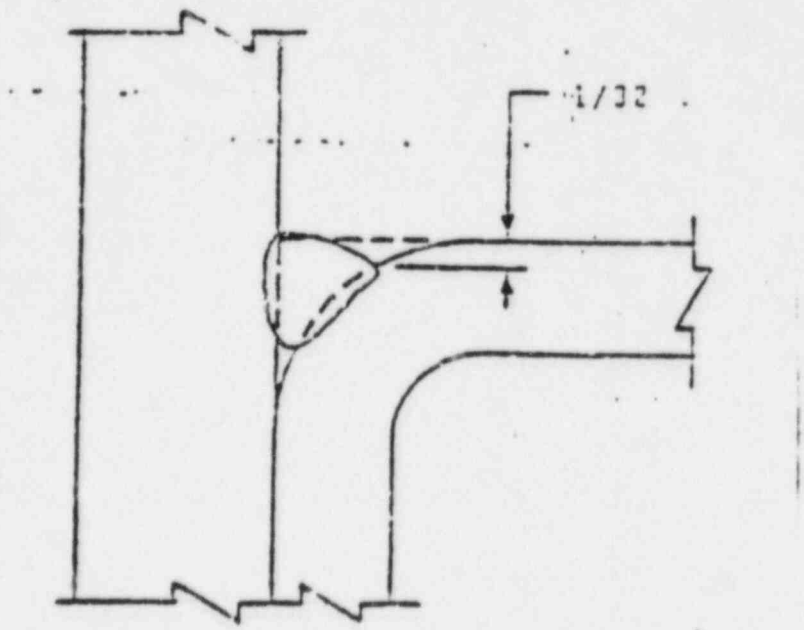


Acceptable Concavity
or Underfill



Acceptable

FLARE BEVEL PROFILE



Acceptable*

* NOTE: The profile show in acceptable for flare bevel welds specified to be flush. If other fill requirements are specified, refer to project specifications for acceptance requirements.

Attachment 6.12
QI-066
Rev. 1

STANDARD MARKING/STANDARD BOLTING COMPONENTS

Identification Grade Mark	Specification	Fastener Description
B7	ASTM A193 Grade B7	Bolts, Screws, Studs for High Temperature Service
B7	ASTM A193 Grade B7	
B7C	ASTM A193 Grade B7C	
B7M	ASTM A193 Grade B7M	
B7	ASTM A193 Grade B7	
L7	ASTM A320 Grade L7	Bolts, Screws, Studs for Low Temperature Service
L7A	ASTM A320 Grade L7A	
L7B	ASTM A320 Grade L7B	
L7C	ASTM A320 Grade L7C	
L43	ASTM A320 Grade L43	

Identification Grade Mark	Specification	Fastener Description
No Grade Mark	SAE J429 Grade 1	Bolts, Screws, Studs
	ASTM A307 Grades A & B	
	SAE J429 Grade 2	
No Grade Mark	SAE J429 Grade 4	Studs
B5	ASTM A193 Grade B5	Bolts, Screws, Studs for High Temperature Service
B6	ASTM A193 Grade B6	
B7	ASTM A193 Grade B7	
B8	ASTM A193 Grade B8	
B8	ASTM A193 Grade B8	
B8C	ASTM A193 Grade B8C	
B8M	ASTM A193 Grade B8M	

Identification Grade Mark	Specification	Fastener Description
No Grade Mark	SAE J429 Grade 8.1	Studs
A490	ASTM A490	High Strength Structural Bolts
No Grade Mark	ISO R898 Class 4.8	Bolts, Screws, Studs
No Grade Mark	ISO R898 Class 5.8	
8.8 or 88	ISO R898 Class 8.8	
10.9 or 109	ISO R898 Class 10.9	

Identification Grade Mark	Specification	Fastener Description
	SAE J429 Grade 1	Bolts, Screws, Studs
	ASTM A449	
	SAE J429 Grade 2	-Same
	SAE J429 Grade 5	Bolts, Screws, Studs
A325	ASTM A325 Type 1	High Strength Structural Bolts
A325	ASTM A325 Type 2	
A325	ASTM A325 Type 3	
8D	ASTM A354 Grade BD	Bolts, Studs
8C	ASTM A354 Grade BC	
	SAE J429 Grade 7	Bolts, Screws
	SAE J429 Grade 8	Bolts, Screws, Studs
	ASTM A354 Grade BD	

Identification Grade Mark	Specification	Fastener Description
B5	ASTM A320 Grade B5	Bolts, Screws, Studs for Low Temperature Service
B5C	ASTM A320 Grade B5C	
B5T	ASTM A320 Grade B5T	
B5F	ASTM A320 Grade B5F	
B5M	ASTM A320 Grade B5M	
B8	ASTM A320 Grade B8	
B8C	ASTM A320 Grade B8C	
B8F	ASTM A320 Grade B8F	
B8M	ASTM A320 Grade B8M	
B8T	ASTM A320 Grade B8T	

LENGTH IDENTIFICATION SYSTEM

Stamp On Anchor	Length of Anchor* (Inches)
A	1 1/2
B	2
C	2 1/2
D	3
E	3 1/2
F	4
G	4 1/2
H	5
I	5 1/2
J	6
K	6 1/2
L	7
M	7 1/2
N	8
O	8 1/2
P	9
Q	9 1/2
R	10
S	11
T	12
U	13
V	14
W	15
X	16
Y	17
Z	18

*To be used for checking embedment length only

STANDARD HILTI DATA

Bolt Diameter	Minimum Embedment KWIK (before torque)	Length of Threads
1/4	1 1/8	3/4
3/8	1 5/8	varies
1/2	2 1/4	1 1/4
5/8	2 3/4	1 1/2
3/4	3 1/4	1 1/2
1	4 1/2	2 1/4
1 1/4	5 1/2	3 1/4