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Docket Numbers 50-508 and 50-509

December 15, 1981
G03-81-2834

U. S. Nuclear Regulatory Commission, Region V
Office of Inspection and Enforcement
1450 Maria Lane, Suite 260
Walnut Creek, California 94596-5368

Attention: Mr. B. H. Faulkenberry
Chief, Reactor Construction Projects Branch

Subject: PROJECT NOS. 3 AND 5
DOCKET NUMBERS 50-508 AND 50-509
FINAL REPORT OF POTENTIAL 10CFR50.55(e)
ITT-GRINNELL PIPE HANGER STIFF CLAMPS (D/N #31)

In accordance with the provisions of 10CFR50.55(e), Region V was notified that potential deficiencies, associated with pipe hanger stiff clamps, were found.

Attached is the final report which is considered by the Supply System to satisfactorily resolve the subject condition. The report includes a response to additional items of concern raised by the NRC.

Should you have any questions or desire further information, please contact me directly.

R. S. Leddick/1000
Program Director, WNP-3/5

DRC/tt

Attachment

cc: J. Adams - NESCO-WO/A
D. Smithpeter - BPA-WO/A
Ebasco - New York-WO/A
WNP-3/5 Files - Richland-WO/A

FILE COPY

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FOR APPROVAL OF: JA PUZAUSKAS | JP SLUKA | OE TRAPP | JE WERLE | DE DOBSON
FOR SIGNATURE OF: RS LEDDICK

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WASHINGTON PUBLIC POWER SUPPLY SYSTEM

WPPSS NUCLEAR PROJECTS NO. 3 & 5

ENGINEERING FINAL REPORT

ITT-GRINNELL STIFF CLAMPS
DEVIATION/NON-COMPLIANCE 031

SEPTEMBER 15, 1981

REVISED
DECEMBER 8, 1981

PREPARED BY:

ML BAGALE

CM KIM

JP SLUKA

SUPPLEMENT NO. 1 - 11/3/81
(Incorporated as Revised 12/8/81) R1

INDEX

INTRODUCTION

On May 20, 1981 the installing contractor reported significant tie rod bending on the ITT-Grinnell Figure 215 stiff clamp assembly (MK No. FDC-1151 R1/R2) when installed in accordance with the manufacturer's instructions. Engineering assessment confirmed the tie rod bending and further revealed that a relaxation of the specified 240 ft. lb. torque had occurred after installation. Failure to achieve full and equal tension in the strap loop around the trunnion was also evident, as well as apparent binding between the tie rod and trunnion which resulted in a bending moment that caused deformation of the tie rod. (See Attachment 1 for original design configuration). These nonconforming conditions reoccurred in other stiff clamp assemblies during mockup installations performed under the supervision of the Engineer and ITT-Grinnell at the site on June 1 and 2, 1981.

Failure to achieve and maintain proper pretensioning of the straps will reduce the rigidity of the stiff clamp assembly thus impairing it's ability to perform it's design function. The Grinnell Figure 215 Stiff Clamp assembly is designed to provide a stiffness five (5) times greater than that of a snubber assembly. In the event that the stiff clamps do not function as designed the integrity of the piping system cannot be substantiated by the dynamic analysis methods utilized for the WNP-3/5 Project. Approximately 4,000 stiff clamp assemblies are employed in the design of safety and non-safety related support systems for each unit. These supports are located throughout the Turbine Building, Reactor Auxiliary Building and Reactor Building.

On June 4, 1981 the Engineer initiated NCR No. 14020 to formally notify the supplier of the nonconforming conditions (See Attachment 2). On June 11, 1981 the NRC was notified of the deficiencies in accordance with the provisions of 10CFR50.55(e).

During the course of the Engineering study other potential deficiencies and design questions arose. These additional items involved crack-like indications (tears) on the edges of some of the straps, and questions of ASME code material application. ITT-Grinnell has issued a complete detailed report on all identified deficiencies and items of concern. Copies of that report are available at the WNP-3/5 Project site. This report summarizes each of these items and their resolution. A cross reference of the attachments to this report and the appendixes in the ITT-Grinnell report is provided in Attachment 11.

Subsequent to the issuance of this report on September 15, 1981 additional items of concerns were raised by the Owner and the NRC. These additional items are addressed by Supplement and incorporated by revision to this report dated December 8, 1981. R1

CONCLUSION

In May 1981, during initial installation of the ITT-Grinnel stiff clamp Figure 215 at the WNP-3/5 site, the installing contractor experienced difficulties in achieving prescribed pretensioning of these pipe supports. The difficulties experienced involved bending of the tie rods and relaxation of the preload (torque). Subsequent evaluation by the Engineer (Ebasco Services, Inc.) and the Supplier (ITT-Grinnell) confirmed deficiencies involving tie rod bending and torque relaxation, and further revealed a potential for strap breakage. Tears were found in the edges on some of the clamp straps and questions arose as to ASME Code acceptability of the riveted strap connections and the material used in the fabrication of these straps.

A detailed Engineering assessment was made of the materials, design, fabrication, inspection, qualification testing and installation procedures. As a result of this assessment, modifications to the design were implemented, revised installation procedures were developed and code cases initiated to allay concerns for code applicability and acceptance of the rivet and strap materials application.

ITT-Grinnell has signified, and the Engineer has concurred, that with the satisfactory implementation of the remedial steps described in this Engineering Final Report, as revised December 8, 1981, the ITT-Grinnell stiff clamp Figure 215 will meet the intent of the applicable codes, NRC Directives and the Engineer's design specifications and is therefore acceptable for use on the WNP-3/5 Project. R1

THEORY OF OPERATION OF

FIG. 215 STIFF CLAMP

DESIGN REQUIREMENT | R1

Washington Public Power Supply System's Technical Specification 3240-4 for Piping and Piping Supports Paragraph 4.11y requires that "clamps used as the non-integral attachment to the piping component in a snubber/strut assembly shall have as a minimum a spring rate greater than five times the spring rate of the snubbing device."

ORIGINAL DESIGN | R1

In response to this requirement ITT-Grinnell designed the Fig. 215 Stiff clamp as shown in Attachment 1. To obtain the desired stiffness the strap assemblies are pre-loaded by torquing the hex nuts against the hardened rocker washer which pulls on the straps to provide enough pre-tension so that the load required to lift the yoke (Item #1) off the pipe is equal to the faulted load of the largest snubber/strut assembly that could be attached to that clamp. This means that the deflection caused by the load applied to the load pin (Item #8) will be a function of a load pin and yoke deflection until the faulted load of the clamp is exceeded.

Under normal conditions, the torquing process should cause the rocker washers and trunnions to rotate so that they align themselves on the tie rods. This ensures that the torque applied at the tie rods goes into supplying the required pre-tension to ensure proper function.

MODIFIED DESIGN

As a result of the concerns identified with the original design (described in Section A of this report) it was subsequently determined by ITT-Grinnell that a modification to the original stiff clamp configuration was required. This modification, as described in Section C and Attachment 6 of this report, meets the Design Requirements set forth above. | R1

A. DESCRIPTION OF THE DEFICIENCIES AND ITEMS OF CONCERN

1. BENDING OF THE TIE RODS

Tie Rod bending was identified during installation of initial stiff clamp assemblies and confirmed during subsequent mockups at the site. Bending was attributed to high friction between the strap loop, rocker washer and the trunnion. This friction locks the trunnion within the strap loop and prevents the trunnion from maintaining true alignment with the tie rod as the assembly is tightened. The trunnion rotates with the strap loop as the assembly is drawn together causing the trunnion to impart a bending moment to the tie rod.

2. TORQUE RELAXATION

Torque relaxation was identified during initial installation and subsequent mockups at the site. The cause of this relaxation is attributed to the high friction between the trunnion and the strap and between the rocker washer and strap. This high friction does not allow the strap loop to achieve equal loading beyond the points of tangency with the trunnion and rocker washer. Subsequent slippage of the strap between the trunnion and rocker washer will result in a loss of stiff clamp rigidity and attendent torque relaxation. ITT-Grinnell has advised that torque relaxation did not occur during original qualification testing.

3. BROKEN STRAPS

a. Strap failures (breaks) occurred during the mockup testing at the site and during subsequent investigative tests conducted by ITT-Grinnell at their facilities as follows:

(1) One (1) 0.080" thick Aeroquip strap failed during mockup testing at the site. The failure occurred at less than specified torque on a non-lubricated assembly while being installed in accordance with prescribed procedures.

(2) Further tests by ITT-Grinnell at their Warren facilities resulted in failure of 0.080" Aeroquip and RICO straps at less than specified torque values when lubricants were applied to friction surfaces other than tie rod thread surfaces.

b. All breaks at less than specified torque occurred at the line of rivet holes.

c. ITT-Grinnell has advised that no strap failures occurred at less than specified torque and rated load during original qualification tests.

4. EDGE INDICATIONS

Crack-like indications (tears) have been observed in some straps at both the site and in the ITT-Grinnell shop.

a. These indications were found on the outer edge of the strap in line with the rivet holes.

b. Indications were found with the unaided eye and only in 0.080" thick straps supplied by Aeroquip. (Attachment 3)

c. A careful study of the manufacturing procedures used by Aeroquip and RICO revealed a significant difference in the methods used by the two fabricators in producing the rivet holes. RICO drilled and machine counterbored for the rivet heads. Aeroquip punched rivet holes and "coined" the countersink. "Coining" is accomplished by cold impact which moves the material from the countersink area and displaces it outwardly. This creates a slight bulging at the edge of the strap in the area of the rivet pattern as shown in Attachment 3. This bulging and subsequent edge conditioning (grinding) is judged to be the source of the tears.

5. MATERIALS - CODE APPLICATIONS

During the detailed investigation of the originally identified deficiencies, additional questions arose concerning the code acceptability of the strap and rivet materials as specified in the stiff clamp design. (See Attachment 4).

a. The strap material was being purchased to ASTM A-693 GR 630 (a sheet and strip specification) in the annealed condition; and, due to the fact that ITT-Grinnell was performing operations (age hardening) which altered the material characteristics, it was then recertified to SA 564 GR 630 in the H 1075 condition. (Attachment 4) This specification is a bar specification, and ITT-Grinnell used the option provided in NF 2124 which allows the use of "materials outside the limits of size or thickness given in any specification in Section II..." for recertification of this material. Some concerns arose over the acceptability of this approach.

b. The rivet material called for in the ITT-Grinnell stiff clamp design drawings was SA 453 Grade 660. This material, which is a bolting specification, requires that the product be annealed

b. (con't)
at 1650°F for 2 hours (minimum) and hardened at 1325°F for 16 hours. The material received had been annealed and heat treated in accordance with National Aerospace Specification NAS-1199 (See Attachment 4) which is different from the requirements of SA 453. The material as provided is, because it is not fully hardened, easier to "head" and less likely to crack during the heading operation, and is therefore judged to be better suited as a rivet material.

B. ANALYSIS OF THE SAFETY IMPLICATIONS

1. TIE ROD BENDING

Tie rod bending, as identified in the field, was also observed during ITT-Grinnell's qualification of this product. This bending had no effect on the ability of the Figure 215 stiff clamp to meet the load rating of ASME Section III Subsection NF, or stiffness requirements of the Design Specification. Therefore, it is ITT-Grinnell's Engineering judgement that this item should not be considered a detriment to operation of this clamp. Also, because the clamp will be able to support the highest load it was designed for (the faulted load of the largest snubber/strut that could be attached to it) there are no safety implications due to bending of the tie rods.

2. TORQUE RELAXATION

a. The torque relaxation identified as a deficiency will also have no effect on the load carrying capability of the clamp, however, there would be a reduction in the stiffness of the clamp. The torque is applied to the tie rods to provide a pre-load in the straps that causes the straps to pull the yoke down onto the pipe with a force equal to the highest faulted load of the largest snubber/strut that could be attached to it. This pre-load establishes a stress level that is equivalent to the stress level that the straps would be subjected to if they were installed on the pipe untorqued and then subjected to the faulted load of the clamp. When properly installed, the yoke of the clamp does not lift off the pipe until the load applied to the clamp exceeds the faulted load. Thus, there is no additional strain in the straps until this load is reached, and the straps do not see any increase in tensile stress until the load applied to the clamp exceeds the faulted load. If there is a relaxation in the torque, the yoke of the clamp will lift off the pipe at some load lower than the faulted load of the clamp, but the stress in the straps at faulted load will be identical, regardless of torque level. Therefore, the ultimate failure load will be unchanged by differences in torque levels.

b. Although a relaxation of the pre-load would not reduce the ultimate load capacity of the assembly, the reduction in stiffness below the specified factor of 5 would impair the ability of the stiff clamp to perform its design function. In the event that the stiff clamps do not function as designed, the integrity of the piping system cannot be substantiated by the dynamic analysis methods utilized for the WNP-3/5 Project.

3. BROKEN STRAP

a. The broken strap in itself would appear to present an obvious safety problem; however, when reviewed in light of the information previously presented, the safety problem associated with a strap failure is essentially an installation problem. The reason for this is that if a clamp is fully pre-loaded by torquing to any pre-stress, (and it has been shown in ITT-Grinnell's qualification testing that the faulted load of the clamp - applied to the bands - will not cause a tensile failure), the straps will not see any additional tensile stress until the pre-load is exceeded. Therefore, if a clamp is installed at any torque level it will not fail at less than faulted load. If the installed torque is too high, the clamp will remain stiff over a higher range. If the installed torque is too low, the stiffness over the desired range may be lower than specification requirements. However, if a clamp can be installed, and it has been proven that the failure that occurred is a low probability event, it will be able to hold the design load; therefore, from a support failure point of view there is no safety implication associated with a broken strap, once installed.

b. Three (3) randomly selected straps and one (1) broken strap were tested for mechanical properties and found to conform to the requirements of the material specification (SA 564 Type 630 Age Hardened at 1075°). Test results are shown in Attachment 5. Although these properties as measured are noticeably higher than the minimum values required by the specification, they are reasonably close to the values typically displayed by this material according to information received from ARMCO. This can be seen from the following comparison:

	SA 564 (req'd min.)	As tested (average)	Typical (ARMCO)
Ultimate Strenth (KSI)	145	173	165
Yield Strength (KSI)	125	161	150
Elongation (%)	13 (min)	11	8
Hardness (Rc)	31 (min)	36-40	37

c. The strap assemblies were age hardened at approximately 1050°F to 1075°F as evidenced by the furnace chart and heat treatment certification in Attachment 4.

d. The stiff clamp assembly is load rated in accordance with the requirements of ASME Section III Subsection NF using code allowable stresses, not actuals. Thus, the stiff clamp load rating will be valid regardless of the overstrength displayed by individual straps. R1

4. EDGE INDICATIONS

Edge indications were detected by visual examination after strap failure occurred during torquing in the field. It has now been determined that these indications are surficial tears that have no detectable effect on the overall strength or integrity of the strap. This determination has been established based on the following:

a. NDE using flourescent magnetic particle methods has shown the tears do not extend beyond the edge of the strap to any significant degree.

b. Some of these tears have been ground out to determine their depth. On these samples the depth of the tear was 0.011 inch into the overall band width of 1.75 inches.

c. Two (2) metallurgical specimens have been mounted flat, polished from the strap top surface down and etched to clearly establish the depth of the tear from the edge inward. These specimens show the tears are in fact surficial.

d. Straps with these tears have been tested and in all cases the straps developed their load rating. One assembly was deliberately tested with all four (4) straps having edge tears. The assembly developed its full load rating without failure.

e. Straps with edge tears have been tested to failure. In some cases failure occurred in locations without edge indications, that is, the failure occurred outside the riveted section.

f. Tear propagation due to fatigue (cycling) has been evaluated and determined to not be a problem. Cyclic stresses will not occur because the straps are prestressed by torquing to a level that precludes additional strain until the faulted load is exceeded.

g. Tear propagation due to corrosion should not be a problem since the strap material has good corrosion resistance in this environment (normal building air atmosphere).

5. MATERIALS - CODE APPLICATION

The concern regarding the code acceptability of the strap and rivet materials, when reviewed in light of the testing results and the load rating analysis performed, does not present a safety concern in that all frame sizes have been tested to insure that they meet the strength requirements of the Code and the Design Specification. R1

C. CORRECTIVE ACTIONS TAKEN

1. MODIFIED DESIGN

a. DESCRIPTION OF NEW DESIGN

As a result of the concerns identified with the original Figure 215 stiff clamp design, it was subsequently determined by ITT-Grinnell that a modification to the original stiff clamp design was required. (Attachment 6)

The design modification proposed was as follows:

1. The rocker washer assembly was removed.

2. The trunnion design was modified so that the two (2) straps on each side of the clamp assembly utilized a single trunnion rather than two (2) separate trunnions.

3. The trunnion material was changed from SA-36 to SA-193 Gr. B7.

4. The location of the tie rods was changed so that pre-torque is applied in-board to the straps.

5. Hardened steel washers were added under the tie-rod hex nuts.

Because of this proposed modification to the original design, ITT-Grinnell performed requalification testing on the new design to insure that the changes made to eliminate the identified problems would also maintain the integrity of the overall design and stiffness characteristics required by the Project Design Specification. In addition, because of the modified method of applying the pre-load straps in the new design, new torque levels had to be established which would obtain the necessary pre-load and stiffness requirements. Details of ITT-Grinnell's requalification test results and procedures are provided in Attachment 7.

b. BENDING OF TIE RODS

Tie Rod bending discovered during installation and subsequent testing of the original Figure 215 clamp has been eliminated with the modified clamp design described above. Removal of the rocker washer eliminates the binding between the trunnion and straps and reduces the excessive friction at this point which was preventing the trunnion from rotating freely about the rocker washer and causing the tie rod to bend. In addition, it was found during ITT-Grinnell's requalification test, that the applied torque needed to achieve design requirements was significantly less than those originally specified (due to removal of the binding/friction problem), which is also a factor in eliminating the tie rod bending. A comparison of the torque values specified for the original and modified Figure 215 stiff clamps shows the following:

REQUIRED TORQUE VALUES (Ft. Lbs.)

FRAME SIZE	ORIGINAL DESIGN	MODIFIED DESIGN
1	70	25
2	70	35
3	70	40
4	240	120
5	240	130
6	240	170

c. TORQUE RELAXATION

Torque relaxation identified during installation and subsequent testing of the original Figure 215 stiff clamp design has been eliminated with the modified clamp design described above. Removal of the rocker washer and modification of the trunnion and tie rod design relieves the excessive friction forces brought about from binding of the strap between the rocker washer and trunnion. This allows for equal strap tensioning and load distribution with essentially no resultant torque relaxation. For clamp sizes where normal torque relaxation may occur, ITT-Grinnell has added additional torque to the straps to insure that specified stiffness requirements are met. Details of the requalification test results and procedures regarding torque relaxation are provided in Attachment 8.

d. BROKEN STRAPS

The strap failure which occurred during a mockup installation in the field is postulated to have resulted from a sudden relaxation of the excessive friction forces between the trunnion and tie rod which in turn caused a tensile overload at the rivet pattern. The potential for a strap failure to occur during installation has been eliminated with the

d. (con't)
modified design through the removal of the excessive friction forces at the trunnion and strap loop location, reduction of the applied torque values and a revised installation procedure. The significant reduction in required installation torques are as evidenced in C.1.b. above. Attachment 9 shows that if the modified installation procedure is followed significant safety margins will exist between the required installation torque and the failure torque.

2. EDGE INDICATIONS

Although the edge indications have been evaluated as surficial tears and thus not significant, all 0.080 inch thick straps produced by Aeroquip will be visually inspected with the unaided eye and indications (tears) so disclosed will not be acceptable. All 0.080 inch straps now on site with these tears will be replaced. ITT-Grinnell has initiated action to specifically inspect all 0.080 inch straps produced by Aeroquip and has committed to ship only those straps which have been inspected and found to be free of these tears. The program for inspection, change-out and documentation is set forth in Attachment 10.

3. WNP-3/5 STIFF CLAMP CHANGE-OUT PROGRAM

The deficiencies identified in this report for the ITT-Grinnell Figure 215 stiff clamp furnished to the WNP-3/5 project will be corrected and documented in accordance with the program set forth in Attachment 10 for all ASME Section III, Subsection NF and seismically analyzed ANSI B31.1 stiff clamp component supports.

4. MATERIALS - CODE APPLICATIONS

To allay any concerns relative to ASME Code acceptability for the strap and rivet materials as used in these stiff clamp assemblies, ITT-Grinnell has requested ASME Code approval as follows:

a. For the strap material as purchased. ITT-Grinnell has requested that the sheet and strip material (ASTM A 693 Type 630, solution annealed, subsequently age hardened by ITT-Grinnell or sub-contractors to the H1075 condition) be added to code case N-279 Revision 2. This is being done to remove any concern that may exist over the re-certification to SA 564 type 630.

b. The rivet material supplied, while not conforming to the material specification called out on the drawings (SA453 Grade 660 Type A or B), conforms to a National Aerospace Standard NAS-1199 which is included in Attachment 4. This

b. (con't)
Standard is specifically for rivets and the basic difference in the materials supplied from what was ordered is the heat treating. The material received is in a softer condition and is judged to be better suited to the riveting process. Therefore, the corrective action in process is to have the 660 type material added to Code Case N-249 in the "as-received" heat treat condition, specifically, A286 Hi-Temperature Alloy Heading Stock per Specification AMS 5737. Typical Certified Material Test Reports and heat treatment records are included in Attachment 4 to this report.

SUPPLEMENT

This supplementary section is added to address comments received from the Owner following the issuance of the Engineering Final Report dated September 15, 1981. Comments received from the Owner reflected items of Owner's concern and a request from the NRC to address issues posed to the NRC by an independent consultant (Reference letter to Owen C Shackleton, Jr., "WPPSS No. 3 and 5 Stiff Clamp Non-Compliance," dated September 8, 1981). The following Owner and NRC items are responded to in this supplement:

A. Evaluation of the Combined Effects of Differential Thermal Expansion and Pre-Load on the Stiffness of Figure 215 Stiff Clamp.

B. Toughness Properties of SA564, TP630 Material at Elevated Temperatures R1

C. Localized Pipe Wall Stresses

D. Probabilistic/Reliability Analysis

E. Code Cases.

A. Evaluation of the Combined Effects of Differential Thermal Expansion And Pre-Load on the Stiffness of the Figure 215 Stiff Clamp R1

1. Introduction

The SA564, TP630 strap material is a ferritic stainless steel having a thermal coefficient of expansion similar to that of carbon steel. When installed with pretorquing on a stainless steel pipe having a higher coefficient of thermal expansion, it will be subjected to increased tensile loading as the pipe temperature rises to the service temperature. The maximum service temperature for stainless steel piping for WNP-3/5 is 653°F. In accordance with the design rules of ASME Section III, Subsection NF-3000, the stresses due to thermal expansion are treated as secondary stresses and may be combined within the limit of $3S_m$. However, concerns arose over the possibility that the thermal stresses, when combined with the stress due to the applied pre-load, may cause a condition where the actual yield strength of the strap material at the design temperature may be exceeded. If this were to happen, the stiffness of the clamp would be somewhat lower than anticipated in the cold condition, which may present a piping analysis problem.

To evaluate this condition, ITT-Grinnell has performed a detailed analysis of the combined thermal and pre-load strap stresses in order to substantiate that for all Figure 215 stiff clamp applications on WNP-3/5 the yield value, and therefore the stiffness requirement of the device, has not been violated. R1

A. Evaluation of the Combined Effects of Differential Thermal Expansion And Pre-Load on the Stiffness of the Figure 215 Stiff Clamp (Cont'd)

2. Method of Analysis

a. Thermal stresses were calculated using the cross-sectional area of the strap at the rivet pattern, or the cross-sectional area at the location of the actual failure in the ultimate tests performed as part of ITT Grinnell's qualification of this product. Specifically, in the ultimate test, the Frame Size 1 Figure 215 failed not in the strap, but through the yoke body at the load pin hole; however, for the purpose of this analysis, the failure was assumed to have occurred in the slotted area of the strap. For the Size 4 Frame the failure occurred in the slotted area of the strap, and for the Size 5 Frame the ultimate failure occurred at the rivet line. The actual strap cross-sectional areas at these locations were used for analysis purposes.

b. To calculate stresses due to pre-load (the initial pre-torque applied to the clamp) actual test data was utilized by ITT-Grinnell in their analysis. The pre-load applied to the clamp (via the straps) supplied enough force to preclude separation of the clamp yoke and pipe until the faulted load was reached. This means that the stresses induced into the straps by torquing are equivalent to the stresses that would be induced by applying the faulted load with no pre-torque. Therefore, by knowing the ultimate capacity of the clamp and assuming all failures occur in the straps, the applied prestress can be obtained by a linear relationship of faulted load to failure load. Changes in area need not be incorporated because failure will occur when the stress reaches its ultimate value, which is a function of the area of the failure location. Also, changes in geometry are neglected because the outside surface of the pipe physically constrains the geometry of the strap assembly everywhere but at the attachment to the strap pin, and changes in this area will be insignificant. R1

c. The stresses calculated, thermal and mechanical pre-stress, were then combined and compared to the actual yield strength of the strap material for the purpose of determining whether any spring rate (stiffness) changes had occurred. Lowest actual room temperature yield strengths were utilized in the ITT-Grinnell thermal calculations as determined by a review of all .040" and .080" strap material test records and then adjusted for temperature, as shown below:

Lowest Actual Yield Strength at Room Temperature:

For .040" Material: 150,950 psi $= \sigma_y$

For .080" Material: 147,300 psi $= \sigma_y$

A. Evaluation of the Combined Effects of Differential Thermal Expansion And Pre-Load on the Stiffness of the Figure 215 Stiff Clamp (Cont'd)

2. Method of Analysis (Cont'd)

Lowest Actual Yield Strength:

when adjusted for temperature:

for .040" straps

$$\sigma_y \Big|_{650^\circ F} = \frac{99.5}{125} \times 150{,}950 = 120{,}156 \text{ psi}$$ R1

for .080" straps

$$\sigma_y \Big|_{650^\circ F} = \frac{99.5}{125} \times 147{,}300 = 117{,}251 \text{ psi}$$

A. Evaluation of the Combined Effects of Differential Thermal Expansion And Pre-Load on the Stiffness of the Figure 215 Stiff Clamp (Cont'd)

3. Results of Analysis

a. Stresses in the straps due to preload (the torque needed to develop design stiffness) were calculated for each frame size, with the following results:

Frame Size	Pre-Stress (psi)
1	45616
2	46777
3	57806
4	62484
5	78348
6	82046

This pre-stress represents the stress present in the straps, due to the torquing process, at room temperature. It is independent of piping material and constant throughout the pipe sizes for a specific frame size, with the largest frame size having the highest preload (torque) stress.

b. Stresses in the straps due to differential thermal expansion of the pipe and clamp material were calculated by ITT-Grinnell. These calculations show that:

(1) Heavy wall piping, due to its higher radial stiffness, produces higher thermal expansion stress in the straps than thin wall pipe of the same size. R1

(2) The largest pipe size in any frame group produces the highest thermal stresses.

From the findings established in (1) and (2) above thermal stresses were calculated for the largest frame sizes utilizing carbon steel and stainless steel heavy wall piping. The cases shown below were selected as bounding conditions for Figure 215 Stiff Clamp applications on WNP-3/5.

Frame Size	Strap Thickness	Pipe Dia/Sched	Pipe Mat'l	Oper Temp	Thermal Stress
6	.080"	24/160	SS	350°F	29,931 psi
6	.080"	24/160	CS	650°F	26,635 psi

A. Evaluation of the Combined Effects of Differential Thermal Expansion And Pre-Load on the Stiffness of the Figure 215 Stiff Clamp (Cont'd)

3. Results of Analysis (Cont'd)

c. Combining the preload stresses from A.3.a above and the thermal expansion stresses from A.3.b above produces the following results for the WNP-3/5 bounding cases:

Frame Size	Strip Thickness	Pipe Dia/Sch	Pipe Mat'l	Oper Temp	Combined Stresses Thermal + Preload	Lowest Actual Yield @ Temp*
6	.080"	24/160	SS	350°F	111,977 psi	117,251 psi
6	.080"	24/160	CS	650°F	108,681 psi	117,251 psi

*Values calculated from lowest room temperature values in Certified Test Reports.

d. Also, to validate the stress analysis performed it was necessary to establish the effective cross sectional area of the straps. This was accomplished based on evaluation of actual tensile test results, consistent with load rating methods, instead of those analytical methods outlined in Appendix XVII Paragraph 2283.2. Actual strap strengths were established by tensile testing to failure with the following results:

Test	.040 Straps	.080 Straps
1	10700 lbs	15400 lbs
2	10700 lbs	15200 lbs
3	10650 lbs	15400 lbs
4	10900 lbs	15200 lbs
5	10800 lbs	15300 lbs
6	9700 lbs	15300 lbs
7	---	15300 lbs
8	---	15750 lbs
9	---	16050 lbs
10	---	16600 lbs
11	---	15750 lbs
12	---	15750 lbs

R1

The actual effective cross sectional area of the straps was established by using the lowest values obtained from the tensile tests divided by the lowest ultimate strengths for the strap materials. In both cases (0.040" and 0.080" straps) the effective cross sectional area so determined was greater than the cross sectional areas used in the stress analysis.

A. Evaluation of the Combined Effects of Differential Thermal Expansion And Pre-Load of the Stiffness of the Figure 215 Stiff Clamp (Cont'd)

4. Conclusion

Based on ITT-Grinnell's evaluation of the combined stresses in the Figure 215 Stiff Clamp strap due to thermal and pre-load conditions for WNP-3/5 bounding case conditions, it has been found that the yield strength of the strap will not be exceeded and there will be no reduction in the required stiffness of the clamp as a result of these combined stresses. R1

B. Toughness Properties of SA564, TP630 Material at Elevated Temperatures

The consultant's letter of the NRC alluded to some experience that indicates that SA564, TP630 material in long term use has experienced degradation in its impact properties and therefore should be limited to a maximum service temperature of 300°F. We find no such limitation in the ASME Code nor in the literature published by the material suppliers. Consequently, we are unable to respond to this point due to lack of specificity.

C. Localized Pipe Wall Stresses

A detailed study of the local pipe wall stresses resulting from Stiff Clamp preload and differential thermal expansion is being performed utilizing finite element analysis methods. These calculated stresses are being evaluated with other piping loads in accordance with the piping design requirements of the applicable code. Since this matter relates to piping design and not to the design of the Stiff Clamp, the concern will not be addressed in this report but will be treated in accordance with the rules governing the design of the piping systems. R1

D. Probabilistic/Reliability Analysis

This product is classified as a standard component that has been load rated in accordance with the procedures defined in ASME Section III Subsection NF-3262. In compliance with that procedure the weakest element has been identified for each frame size and the product has been load rated based on the limiting element as prescribed by the ASME Code. Therefor, a reliability analysis is not required and is outside the scope of the Code.

E. Code Cases

At the September 1981 ASME Code Meeting in New York, Code Cases N-71-11 and N-249-2 were submitted for ASME approval of the rivet and strap material specifications shown on the ITT-Grinnell Load Data Sheet Revision 3. Since formal ASME approval of these code cases may not occur until January 1982, Revision 4 of the LCD has been issued with annotations of these pending cases. (See Attachment No. 6) R1

ATTACHMENT 1

ITT-GRINNELL INSTALLATION INSTRUCTIONS

FIG. 215 STIFF CLAMP

ORIGINAL DESIGN

ATTACHMENT 1

INSTALLATION INSTRUCTIONS

FIGURE 215 STIFF CLAMP

1. See the hanger sketch for the full assembly.

2. Place the clamp frame (1) against the pipe, in its approximate location. The straps should be attached to the frame with the strap pins (2), and the trunnion (3) ends loose.

3. Draw the trunnions together enough to pass the tie rods (4) through both trunnions. Place a rocker washer (5) then a hex nut (6) on each end of the tie rods. Finger tighten all the hex nuts until an equal amount of tie rod is exposed outside of the hex nut. Repeat this procedure for each set of straps attached to the clamp frame.

4. Wrench tighten the hex nuts in sequence until the straps are snug against pipe. (Ensure that an equal amount of tie rod is exposed on the outside of each hex nut so there will be equal force on each strap.

5. Using a torque wrench, tighten a hex nut to ten percent (10%) of the required torque. Then tighten the hex nut at the opposite end of that tie rod the same amount. Complete these steps on each of the remaining sets of straps attached to the clamp frame.

6. Repeating the sequence of hex nuts tightened in Step 5, tighten the nuts to the required torque using 10% increments. (This will ensure equal strap tension throughout the entire tightening procedure).*

7. Place one jam nut (7) on the end of each tie rod and tighten to the required torque.

8. Attach the applicable attachment to the clamp frame with the load pin (8).

* It will be evident that there is bending of the tie rod during the torquing process. The amount of bending is in direct relation with the amount of torque applied to the hex nut, and unless an interference problem occurs, this bending is allowable. This was accounted for during the qualification testing and does not affect the stiffness or strength of the clamp.

SUBSECTION NF
LOAD CAPACITY DATA SHEET

1. GENERAL INFORMATION

SUPPORT NAME: PE-41 Pipe Clamp Size 1-6 WPPSS Units 3 & 5	ENGINEERING PARTS LIST(S): A-PE41-00000
SUPPORT TYPE: Component Standard	CODE CLASSIFICATION: Class 1,2,3&MC
DESIGN PROCEDURE: Load Rating	DESIGN TEMPERATURE: 650°

SERVICE LIMITS: Levels A,B,C,D & Design Loading

2. CERTIFICATION

ENGINEER: [illegible] DATE: 1-30-81	THE LOAD CAPACITY OF THIS COMPONENT SUPPORT IS RATED IN ACCORDANCE WITH SUBSECTION NF
CHECKED: [illegible] DATE: 1-30-81	ROBERT B. MULCAHEY NO. [illegible] REGISTERED PROFESSIONAL ENGINEER
LOCATION OF SUBSTANTIATION DATA Research, Development & Engineering Pipe Hanger Division, Prov., R.I.	REGISTERED PROFESSIONAL ENGINEER

3. REVISION AND RECERTIFICATION

LCDS REV. NO.	DATE	EPL LOG SH REV. NO.	DATE	RECERTIFICATION
2	1/30/81	--	1/30/81	[illegible]

ASME SECTION III

SUBSECTION NF

LOAD CAPACITY DATA SHEET

4. COMPONENT SUPPORT INFORMATION

ITEM	MATERIAL SPECIFICATION	ANALYSIS
Frame	SA515 GR 65 or SA36	Load Rating
Load Pin	SA 193 GR B7, SA 564 Type 630 Age Hardened @ 1075°F (Fig.306/307Size 35 only)	Load Rating
Spacer	SA 36 or AISI 1010 Exempt per NF 2121 (b)	Secondary Member
Retaining Ring	Truarc ® Exempt per NF-2121 (b)	Secondary Member
Strap Pins	SA 193 GR B7	Load Rating
Straps	ASME SA 564 Type 630 Condition 1075	Load Rating
Trunnion	SA 36 or ASTM A 103 GR 1018*	Load Rating
Rocker Washer	SA36 or C1018 Case Hardened to Rockwell C-35-38	Load Rating
Nuts	SA307 GR B or ASTM 307 GR A*	Load Rating
Tie Rods	SA 193 GR B7	Load Rating
Rivets	ASME SA453 GR 660 Condition A or B	Load Rating
A1-3		
	*Code Case 1644	

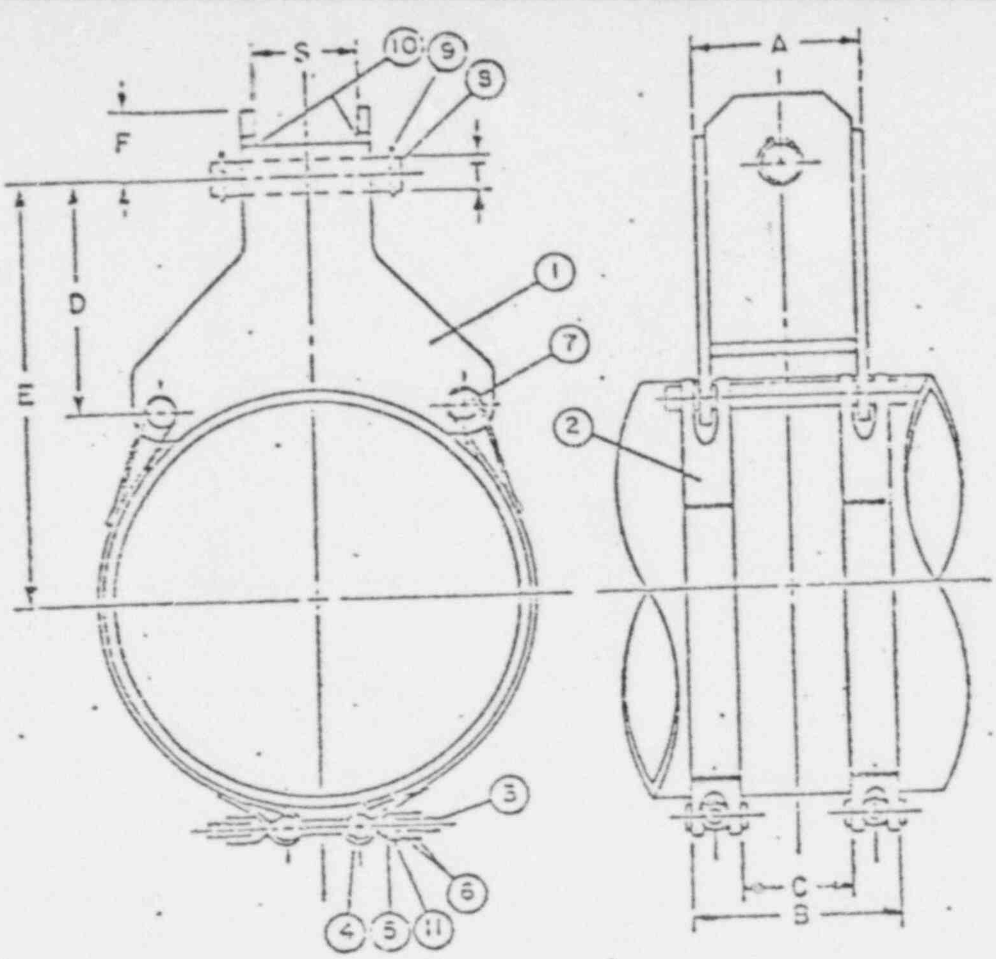
ITT GRINNELL

PIPE HANGER DIVISION

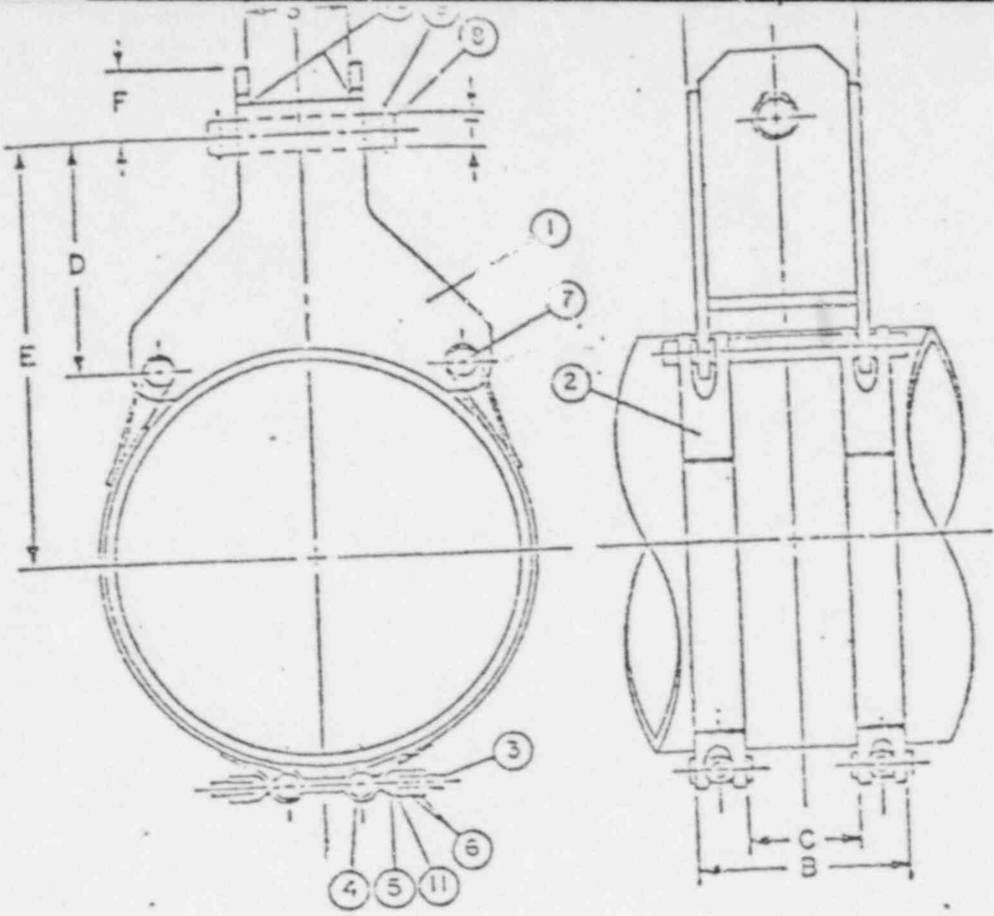
QUALIFIED PRODUCTS

LOAD RATING

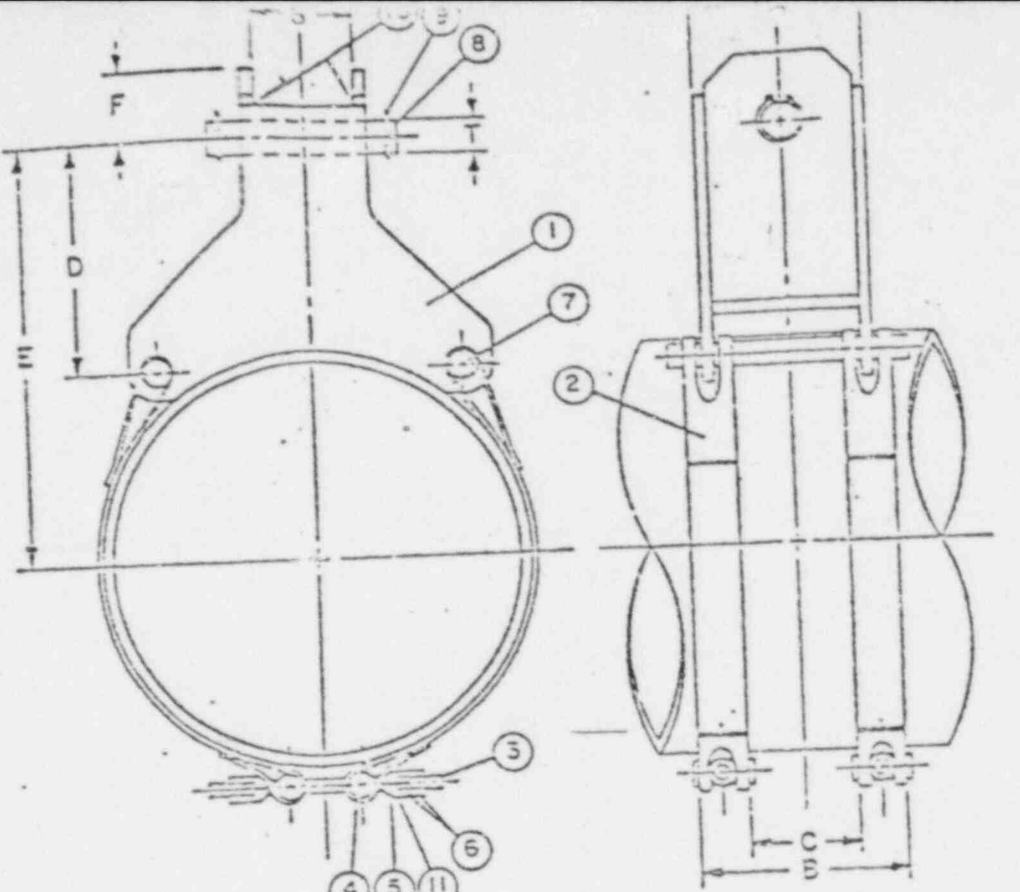
FRAME SIZE	MAXIMUM LOAD LBS.			MINIMUM SPRING RATE KIPS/IN
	LEVEL A & B	LEVEL C	LEVEL D	
1	6000	8610	11520	325
2	6000	8610	11520	325
3	6000	8610	11520	325
4	20700	24840	26700	1000
5	20700	24340	26700	1000
6	20700	24840	26700	1000



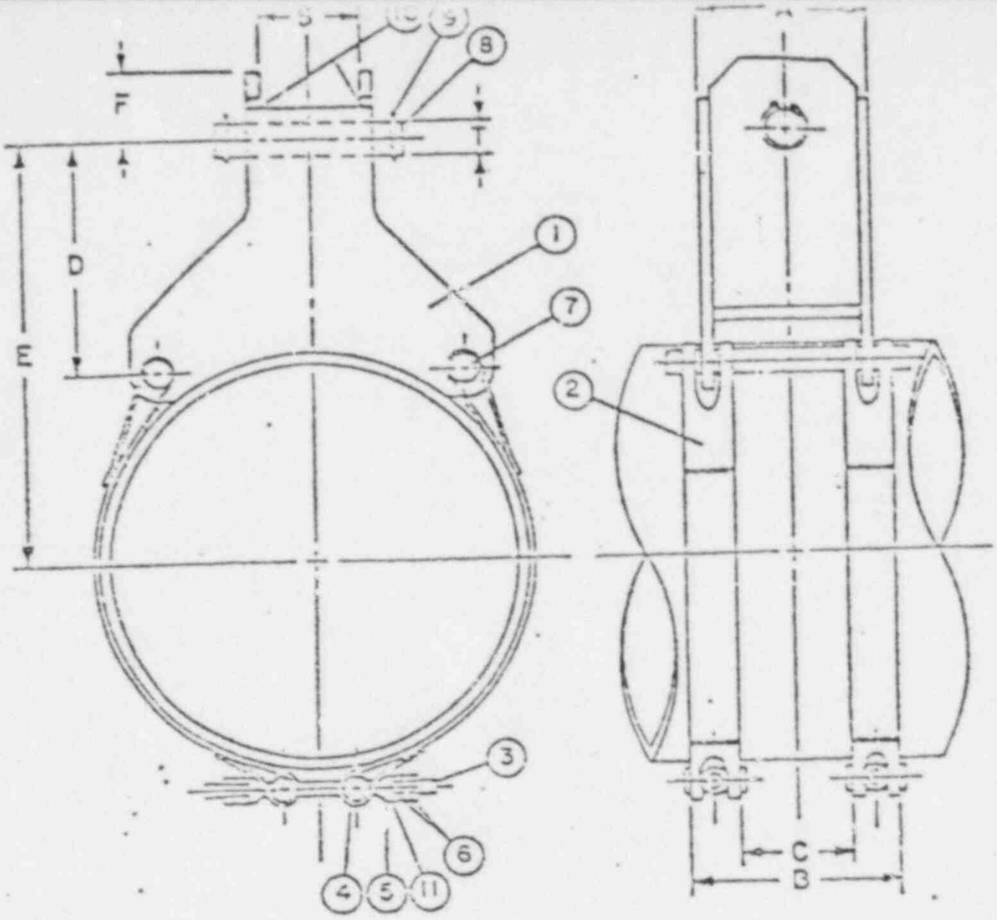
FRAME SIZE	PIPE SIZE	[illegible] LOAD PIN DIA	FOR USE WITH FIG. 306	FIG. 660	FIG. 211	A	B	C	D	E	F	S
1A	2½ [illegible] 3½ 4 5 [illegible]	.374 .372	½ & ¾	--	A	4½	5 3/4	2½	3 11/16	5 9/16 5 7/8 6 3/[illegible] 6 7/16 6 15/16 7½	[illegible]	1
1B	2½ 3 3½ 4 5 6	.499 .497	1	--	--	4½	5 3/4	2½	3 7/16	5 13/16 6 1/8 6 [illegible] 6 [illegible] 7 3/16 7 3/4	3/4	1
1C	2½ 3 3½ 4 5 6	.749 .747	3	1	B & C	4½	5 3/4	2½	3 3/16	6 1/16 6 3/8 6 7/8 6 15/16 7 7/16 8	1	1
2A	8 10 12 14	.374 .372	½ & ¾	--	A	4½	5 3/4	2½	6 3/16	10 13/16 11 13/16 12 13/16 13 9/16	¾	1
2B	8 10 12 14	.499 .497	1	--	--	4½	5 3/4	2½	5 15/16	11 1/16 12 3/16 13 3/16 13 15/16	3/4	1
2C	8 10 12 14	.749 .747	3	1	B & C	4½	5 3/4	2½	5 11/16	11 5/16 12 7/16 13 7/16 14 [illegible]	1	1



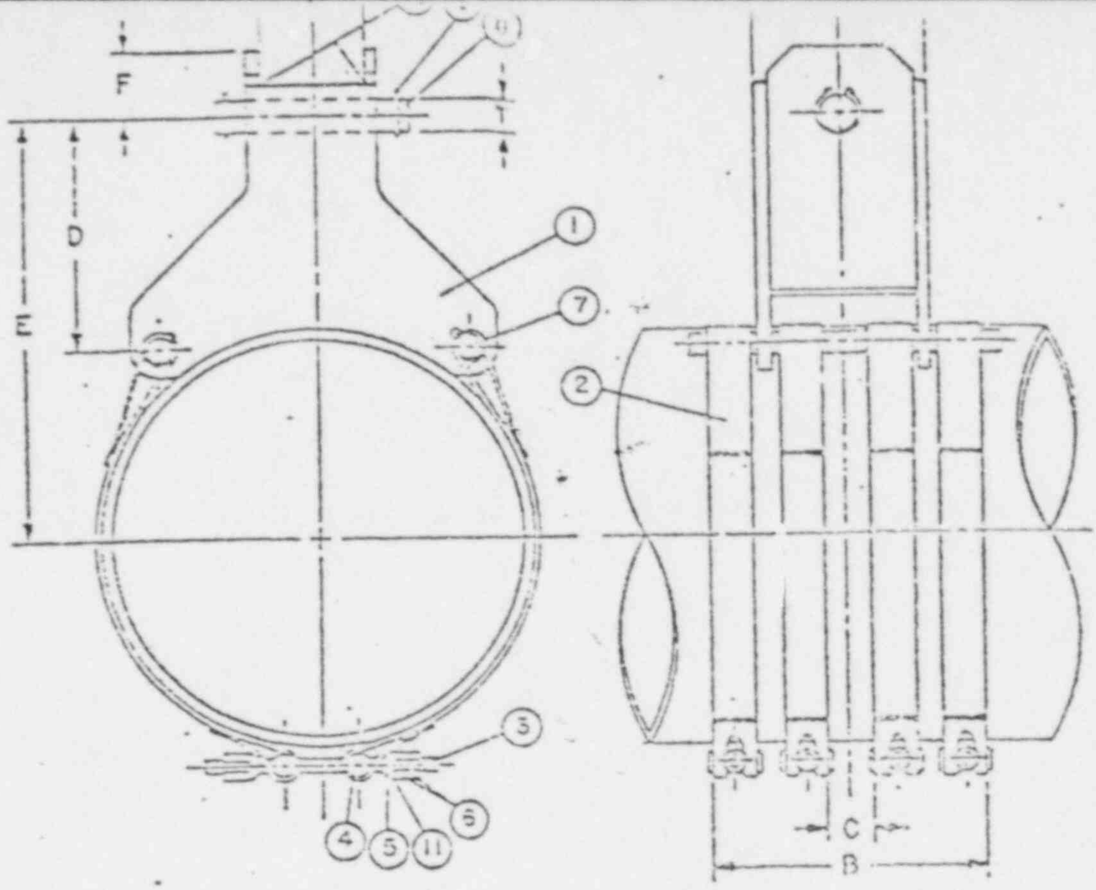
FRAME SIZE	PIPE SIZE	LOAD PIN DIA.	* FOR USE WITH FIG. 306	FIG. 660	FIG. 211	A	B	C	D	E	F	S
3A	16 18 20 22 24	.374 .372	½ & ½	--	A	4½	5 3/4	2½	10 3/16	17 7/8 18 7/8 19 7/8 20 15/16 21 15/16	½	1
3B	16 18 20 22 24	.499 .497	2	--	--	4½	5 3/4	2½	9 15/16	18 1/8 19 1/8 20 1/8 21 3/16 22 3/16	3/4	1
3C	16 18 20 22 24	.749 .747	3	1	B & C	4½	5 3/4	2½	9 11/16	18 3/8 19 3/8 20 3/8 21 7/16 22 7/16	1	1
4A	3 3½ 4 5 6	.999 .997	10	2+3	1+2	5½	6 3/4	3½	3½	5 11/16 6 6½ 6 3/4 7 5/16	1½	1½
4B	3 3½ 4 5 6	1.249 1.247	--	4+5	3+4	5½	6 3/4	3½	3½	5 11/16 6 6½ 6 3/4 7 5/16	1½	1½



FRAME SIZE	PIPE SIZE	T LOAD PIN DIA	FOR USE WITH FIG. 305	FIG. [illegible]	FIG. 211	A	B	C	D	E	F	S
5A	5 [illegible] [illegible] [illegible]	.999 .997	10	2&3	1&2	5½	6 3/4	3½	6½	11 1/8 12 1/4 13 1/4 13 7/8	1½	1½
5B	8 10 [illegible] [illegible]	1.249 [illegible]	--	4&5	3&4	5½	6 3/4	3½	6½	11 1/8 12 1/4 13 1/4 13 7/8	1½	1½
6A	[illegible] [illegible] [illegible] [illegible] 24	.999 .997	10	2&3	1&2	5½	6 3/4	3½	9 15/16	17 5/8 18 5/8 19 5/8 20 5/8 21 5/8	1½	1½
6B	16 [illegible] [illegible] [illegible] 24	1.249 [illegible]	--	4&5	3&4	5½	6 3/4	3½	9 15/16	17 5/8 18 5/8 19 5/8 20 5/8 21 5/8	1½	1½
7A	[illegible] [illegible] [illegible] [illegible] [illegible]	1.499 [illegible]	--	6	5	7 5/8	8 5/8	5 3[illegible]	7 5/8	13 1/8 14 3/16 15 [illegible] 15 13/16 16 13/16	2½	2
7B	8 [illegible] [illegible] [illegible] [illegible]	1.749 [illegible]	--	7	6	7 5/8	8 5/8	5 [illegible]	7 5/8	13 1/5 14 3/16 [illegible] 15 [illegible] 16 13/16	2½	2



FRAME SIZE	PIPE SIZE	T LOAD PIN DIA	FOR USE WITH FIG. 306	FIG. 660	FIG. 211	A	B	C	D	E	F	S
8A	18 20 22	1.499 1.497	--	6	5	7 5/8	8 5/8	5 3/8	10 1/2	20 21 1/4 22 1/4	2½	2
8B	18 20 22	1.749 1.747	--	7	6	7 5/8	8 5/8	5 3/8	10 1/2	20 21 1/4 22 1/4	2½	2
9A	24 26 28 30 32 34 36	1.499 1.497	--	6	5	7 5/8	8 5/8	5 3/8	15 9/16	27 1/16 28 1/16 29 1/16 30 1/16 31 1/16 32 1/16 33 1/8	2½	2
9B	24 26 28 30 32 34 36	1.749 1.747	--	7	6	7 5/8	8 5/8	5 3/8	15 9/16	27 1/16 28 1/16 29 1/16 30 1/16 31 1/16 32 1/16 33 1/8	2½	2



FRAME SIZE	PIPE SIZE	T LOAD PIN DIA	FOR USE WITH FIG. 306	FIG. 660	FIG. 211	A	B	C	D	E	F	S
70	8 [illegible] 12 14 16	1.499 1.497	35	--	--	7 5/8	11 1/8	3 1/8	7 5/8	13 1/8 14 3/16 15 3/16 15 13/16 16 13/16	2½	2
80	18 20 [illegible]	1.499 1.497	35	--	--	7 5/8	11 1/8	3 1/8	10 1/2	20 21½ 22½	2½	2
90	[illegible] [illegible] 26 30 32 [illegible] 36	1.499 1.497	35	--	--	7 5/8	11 1/8	3 1/8	15 9/16	27 1/16 28 1/16 29 1/16 30 1/16 31 1/16 32 1/16 33 1/8	2½	2
10	16 [illegible] 20 [illegible]	1.999 1.997	--	8	7	10½	14½	5	8½	17 7/16 18 7/16 19 7/16 20 1/2	2 5/8	2½
11	24 [illegible] [illegible] [illegible] 32 34 36	1.999 1.997	--	8	7	10½	14½	5	13 3/16	25 5/16 26 5/16 27 5/16 28 3/8 29 3/8 30 3/8 31 7/16	2 5/8	2½

ATTACHMENT #2

STIFF CLAMP NCR NO. 14020

INSTRUCTIONS (SEE BACK OF FORM) PROJECT NO. (3) 3 5 3

DESCRIPTION OF COMPONENT, PART OR SYSTEM (4): GRINNELL FIG. 215 STIFF CLAMPS
LOCATION (5): TB, RAB, & WRSE
DRAWING/SPEC./CODE/STANDARD NO. (6): ALL S/R DWG. W/ 215 STIFF CL
RESPONSIBLE CONTRACT (7): QC
ACTION TAKEN TO CONTROL NONCONFORMANCE (8): HOLD TAGS
SUBSEQUENT ITEMS OR AREAS AFFECTED (9): N/A

DESCRIPTION OF NONCONFORMANCE: (10)
During installation of pipe restraint 3G-FDC-1151 R1-R2 in RAB #3 it was discovered that the Fig. 215 stiff clamp tie rod (Item #4 on attached sketch) was bent during the torquing operation. Upon subsequent investigation by the Engineer it was found that in addition to the tie rod bending under applied torque, the stiff clamp (Item #9 on attached sketch

NAME, SIGNATURE, COMPANY & CONTRACT NO. (11): ML BAGALE, EBASCO
TITLE: LEAD ESSE S/R ENGINEER 6-18-81
DATE: 6-4-81

RECOMMENDED DISPOSITION: (12) DESIGN DOCUMENT CHANGE REQUIRED (13) ☐ YES ☒ NO.

(14) ☐ USE-AS-IS ☐ REPAIR ☐ REWORK ON PREPURCHASED ITEMS WITHOUT APPROVED PROCEDURE IDENTIFIED

(15) ☐ REJECT ☒ OTHER REWORK

(16) CORRECTIVE ACTION: INTERIM DISPOSITION

All WNP-3/5 supports and restraints involving ITT-GRINNELL Fig. 215 stiff clamp assemblies are to be identified and marked as non-conforming items until vendor resolution has been completed and verified. NCR Attachments #2 & #3 (pg. 4&5 of 5) shall be used for identification of non-conforming items. Non-clamp portions of affected supports and restraints can be installed to final condition. Final installation of clamps shall be completed and verified in accordance with the approved final dispostion of this NCR.

ACTION TO PREVENT REOCCURRENCE (IF APPLICABLE): (17) Vendor Engineering to provide appropriate course of action including necessary procedures, modifications, etc. required to prevent reoccurence.

RECOMMENDED VERIFICATION BY: (18) CONTRACTOR QC

☐ EBASCO Q.A ☐ EBASCO ENGINEERING ☒ CONTRACT NO. 3240-251/228 & 224 ☐ OTHER ☐ NOT REQUIRED

NAME AND SIGNATURE OF PERSON RECOMMENDING DISPOSITION: (19) ML BAGALE, EBASCO
TITLE: LEAD ESSE S/R ENGINEER
DATE: 6-4-81

EVALUATION OF DISPOSITION: (21)
Interim disposition is acceptable. This ... final disposition is ... by engineering in accordance with ...

NRS (20) ☒ REQUIRED ☐ NOT REQUIRED

ANI CONCURRANCE ☒ REQUIRED ☐ NOT REQUIRED

BY NAME TITLE DATE

ANI CONCURRANCE BY NAME TITLE DATE 6-5-81

☐ RESIDENT ENGINEER ☐ MATERIALS MANAGEMENT ☒ ESSE ☐ QUALITY ASSURANCE ☒ OTHER AUTHORIZED PERSONNEL ☒ OTHER AUTHORIZED PERSONNEL

NAME (SIGNATURE)	NAME (SIGNATURE)	NAME (SIGNATURE)	NAME (SIGNATURE)
DATE	DATE 6/4/81	DATE 6-18-81	DATE 6-18-81
☒ ACCEPTED ☐ REJECTED ☐ ACCEPTED WITH COMMENTS	☒ ACCEPTED ☐ REJECTED ☐ ACCEPTED WITH COMMENTS	☐ ACCEPTED ☐ REJECTED ☒ ACCEPTED WITH COMMENTS	☒ ACCEPTED ☐ REJECTED ☐ ACCEPTED WITH COMMENTS

CONFIRMATION OF COMPLETION OF APPROVED DISPOSITION: (22)

NAME, SIGNATURE, COMPANY & CONTRACT NO. ______ TITLE ______ DATE ______

VERIFICATION OF COMPLETION OF APPROVED DISPOSITION: (23)

NAME, SIGNATURE, COMPANY & CONTRACT NO. ______ TITLE ______ DATE ______

FINAL REVIEW SATISFACTORY: (24)

ANI ACCEPTANCE: NAME ______ TITLE ______ DATE ______

BY ______ SIGNATURE ______ TITLE ______ DATE ______

CONTINUATION SHEET

INSTRUCTIONS (SEE BACK OF FORM)

DESCRIPTION OF COMPONENT, PART OR SYSTEM (4)	LOCATION (5)	DRAWING/SPEC./CODE/STANDARD NO. (6)
ITT-GRINNELL FIG. 215 STIFF CLAMPS	MB, RAB, & WHSE	ALL S/R DWGS W/ 215 STIFF C

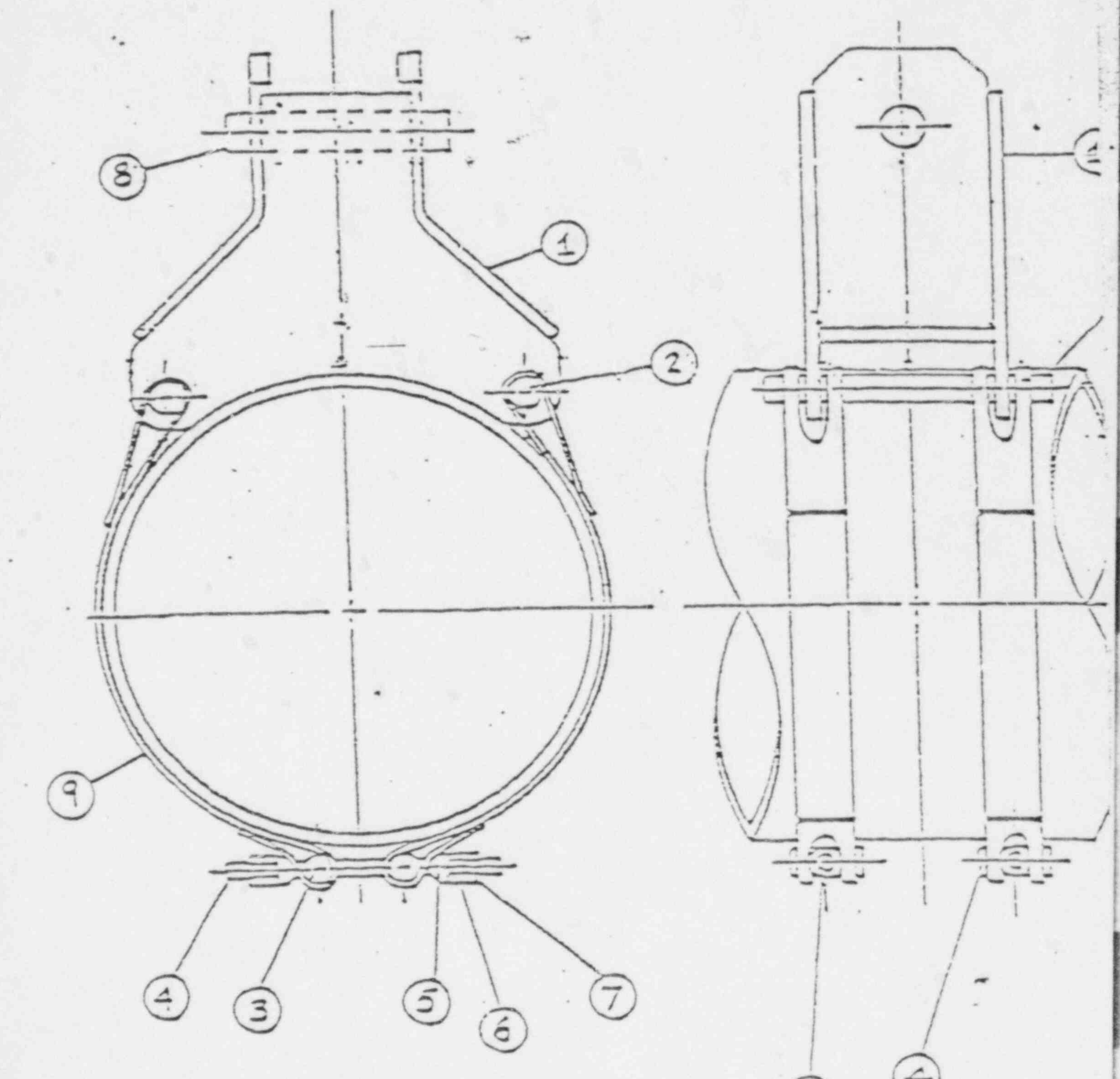
RESPONSIBLE CONTRACT (7)	ACTION TAKEN TO CONTROL NONCONFORMANCE (8)	SUBSEQUENT ITEMS OR AREAS AFFECTED (9)
0-04	HOLD TAGS	N/A

1. DESCRIPTION OF NONCONFORMANCE (con't)

underwent a tension relaxation resulting in a measurable loss of original torque value. As a result of these findings it appears that a generic problem exists with all ITT-GRINN Fig. 215 Stiff Clamps.

CS-AO-464 B (7-19-79)

STIFF CLAMP



NOTE: Items 1-8 are the non-conforming portions of those supports and restraints containing [illegible] Stiff Clamp components.

SHIPPED MARKED NO. (NCR SEC. I)	HOLD TAG PLACED (NCR SEC. I)	FINAL INSTALLED (NCR SEC. IV)	ENGINEERS' QA VERIFICATION (NCR SEC. V)	REMARKS

1	2	3	4	5
SHIPPED MARKED NO. (NCR SEC. I)	HOLD TAG PLACED (NCR SEC. I)	FINAL INSTALLED (NCR SEC. IV)	ENGINEERS' QA VERIFICATION (NCR SEC. V)	REMARKS

REPORT No. 1-022

SITE NONCONFORMANCE REPORT
REDISPOSITION

INSTRUCTIONS: (SEE BACK OF FORM)

QUALITY CLASS: [x] I [x] II [ ] G

PROJECT No.: [ ] 1 [ ] 5 [ ] 3 E

DESCRIPTION OF COMPONENT, PART OR SYSTEM: Support MS-27-R2-Fam 1, Fig. 215 Stiff Clamp

LOCATION: TSSF, Mod 6

DRAWING/SPEC/CODE/STANDARD: A-140101-27, Fam 1

RESPONSIBLE CONTACT: 240-04

ACTION TAKEN TO CONTROL NONCONFORMANCE: Hold Tag (1)

SUBSEQUENT ITEMS OR AREAS AFFECTED: A-140101-27 (TTT) Fam 01-03

REASON FOR REDISPOSITION: Subsequent to issuance of original NCR. Support MS-27 R2 was tested by the Eng. on 6-1-81. While being torqued to design load of 240 ft/lbs the stiff clamp strap broke. Failure occured at 225 ft/lbs. 2) On 6-10-81 another stiff clamp mock-up installation was performed by the

I. RECOMMENDED DISPOSITION:

DESIGN DOCUMENT CHANGE REQUIRED [ ] YES [x] NO

[ ] USE-AS-IS [ ] REPAIR [ ] REWORK ON PREPURCHASED ITEMS WITHOUT APPROVED PROCEDURE IDENTIFIED

[ ] REJECT [x] OTHER REWORK

CORRECTIVE ACTION: INTERIM DISPOSITION: This redisposition is to provide additional documentation concerning the presently identified Figure 215 (PE-41 series) stiff clamp problem. Referenced clamps shall be scrapped after problem is resolved by vendor.

II. EVALUATION OF DISPOSITION:

Interim disposition is acceptable.

NRB [x] REQUIRED [ ] NOT REQUIRED

ANI CONCURRANCE [x] REQUIRED [ ] NOT REQUIRED

Michael WH Strahley/Lead Mat Eng. 6-?

NAME TITLE DATE

ANI CONCURRANCE BY (signature) 6-22-

NAME TITLE DATE

[ ] RESIDENT ENGINEERING [x] MATERIALS MANAGEMENT [ ] ESSE	[x] QUALITY ASSURANCE	[x] OTHER AUTHORIZED PERSONNEL	[x] OTHER AUTHORIZED PERSONNEL
NAME (SIGNATURE): John [illegible]	NAME (SIGNATURE): (signature)	NAME (SIGNATURE): R.C. Foster	NAME (SIGNATURE): (signature)
DATE: 6/17/81	DATE: 6/22/81	DATE: 6-18-81	DATE: 6-18-81
[x] ACCEPTED [ ] REJECTED [ ] ACCEPTED WITH COMMENTS	[ ] ACCEPTED [ ] REJECTED [ ] ACCEPTED WITH COMMENTS	[x] ACCEPTED [ ] REJECTED [ ] ACCEPTED WITH COMMENTS	[x] ACCEPTED [ ] REJECTED [ ] ACCEPTED WITH COMMENTS

III. CONFIRMATION OF COMPLETION OF APPROVED DISPOSITION

NAME, SIGNATURE, COMPANY AND CONTRACT No. — TITLE — DATE

IV. VERIFICATION OF COMPLETION OF APPROVED DISPOSITION:

-25-

NAME, SIGNATURE, COMPANY AND CONTRACT No. — TITLE — DATE

V. FINAL REVIEW SATISFACTORY:

ANI ACCEPTANCE: NAME ______ TITLE ______ DATE ______

BY ______ SIGNATURE ______ TITLE ______ DATE ______

-AD-4640 (8 8 80) R1 (11.19.80) R2 (12.11.80)

CONTINUATION SHEET

INSTRUCTIONS: (SEE BACK OF FORM)

DESCRIPTION OF COMPONENT, PART, OR SYSTEM (4)	LOCATION (5)	DRAWING/SPEC./CODE/STANDARD NO. (6)
MS-27-R2-Rev 1, Fig. 115 Stiff Clamp	ESSE, Mod 6	A-140101-27, Rev 1
RESPONSIBLE CONTRACT (7) 01	ACTION TAKEN TO CONTROL NONCONFORMANCE (8) Hold Tag (1)	A-140101-27 (...) Rev "01-03"

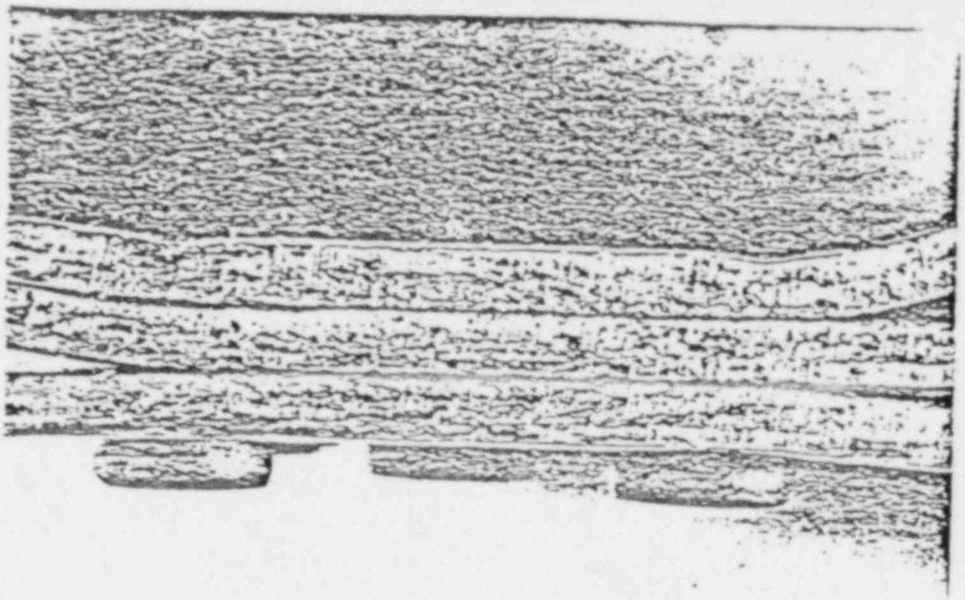
Reason for Dispostion: (con't)

Engineer. Two (2) clamps - 16" CC-179 R2, Rev 1 and 14" FS-12R Rev 0, were utilized by taking two (2) straps from each assembly, combining these with FS-12R 14" clamp yoke and attaching this assembly to a 14" pipe spool. At 200 ft./lbs torque one (1) 16" strap from the CC-179 parent assembly failed.

3-40-464 B (7-19-79) R1 (11.19.80)

ATTACHMENT #3

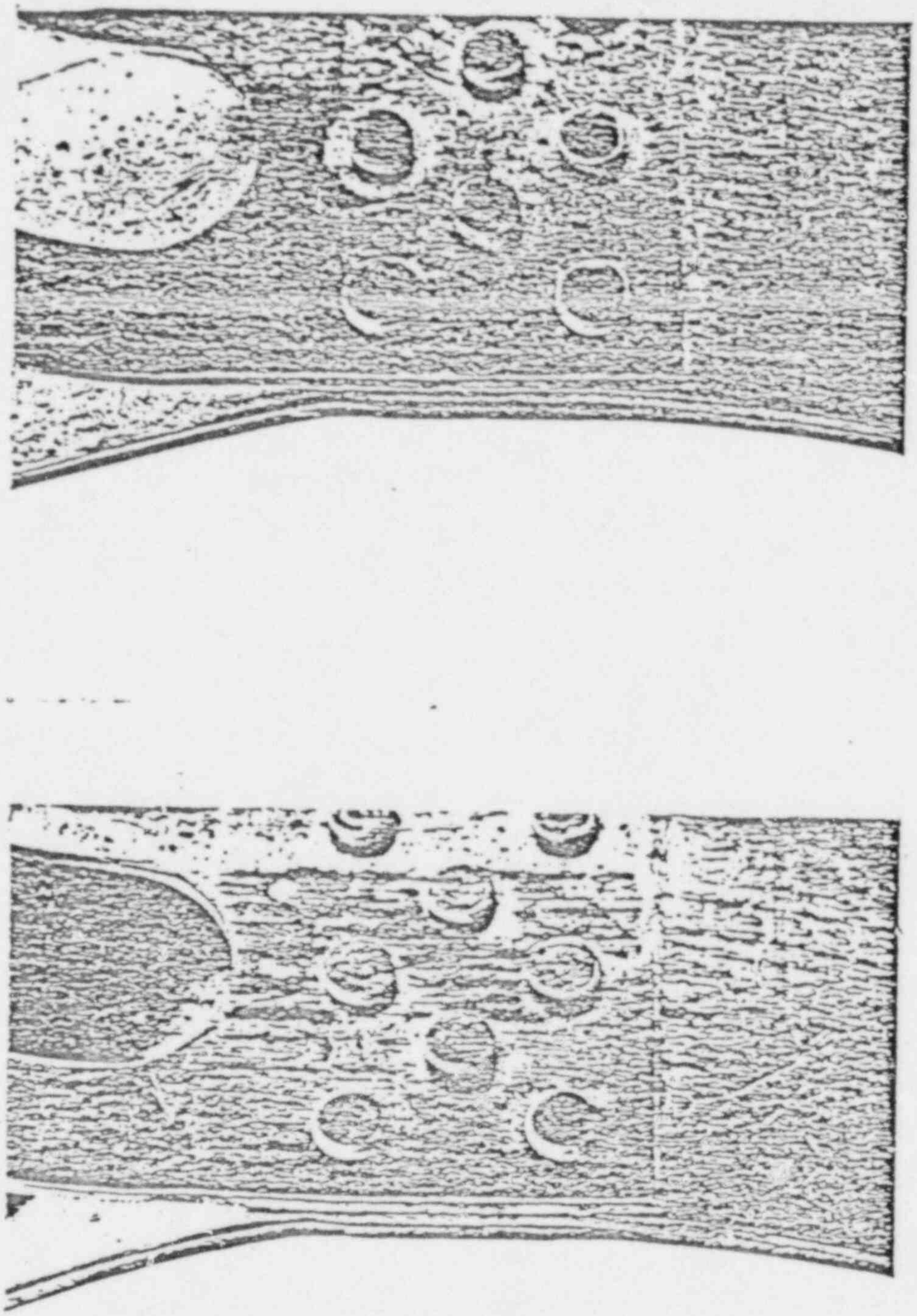
RESULTS OF STIFF CLAMP
STRAP INSPECTION AT
WNP-3/5 SITE & WARREN FACILITY



MAGNIFICATION 4X

MAGNIFICATION 4X

TYPICAL EDGE INDICATIONS



TYPICAL "BULGING" CAUSED BY AEROQUIPS
COINING PROCESS

INSPECTION RESULTS
STIFF CLAMP STRAPS
AT WNP-3/5 SITE
JULY 7-21, 1981

DESCRIPTION		NUMBER INSPECTED	NUMBER WITH INDICATIONS
AEROQUIP	0.040"	216	0
AEROQUIP	0.080"	1040	40
RICO	0.040"	216	0
RICO	0.080"	872	0
TOTAL:		2344	40

ITT Grinnell INTER OFFICE CORRESPONDENCE

TO: [redacted] DATE: 7-2-81

FROM: P. STANISH - PROVIDENCE

SUBJECT: WPPSS 3 & 5
STIFF CLAMP STRAP INSPECTION

ATTACHMENT A
ONE PAGE

THE FOLLOWING CRITERIA/GUIDELINES SHOULD BE USED FOR INSPECTING AEROQUIP AND RICO STRAPS CONTAINED ON THE FIG. 215 AT THE WPPSS SITE:

1) INSPECTION WILL BE VISUAL EXAM WITH NO MAGNIFICATION.

2) IDENTIFICATION OF RICO VS. AEROQUIP STRAPS MUST BE MAINTAINED.

3) IDENTIFICATION OF STRAP THICKNESS (EITHER .040 OR .080) MUST BE MAINTAINED.

4) MARK NUMBERS AND NPT SERIAL NUMBERS OF CLAMPS INSPECTED MUST BE MAINTAINED.

5) A THREE (3) LEVEL INSPECTION CRITERIA SHOULD BE USED -

   A. ANY STRAP WITH EDGE INDICATIONS WILL BE IDENTIFIED.

   B. ANY STRAP WITH INDICATIONS ON INSIDE FACE (AREA THAT BEARS AGAINST PIPE) WILL BE IDENTIFIED.

   C. STRAPS WITH "NO" INDICATIONS WILL BE IDENTIFIED.

   A SEPARATE LIST FOR EACH TYPE OF FINDING WILL BE MAINTAINED.

6) IF THE PIPE SIZE OF THE CLAMP IS EASILY AVAILABLE, THIS SHOULD ALSO BE IDENTIFIED.

JHH/M

CC: J. W. HARE - PROVIDENCE
R. MULCAHEY - PROVIDENCE
M. GROSSO - PROVIDENCE

RECEIVED
JUL - 3 1981
DIV. Q. A. MGR.

AT WARREN FACILITY

AREOQUIP Size	W/O	With	Total	RICO Size	W/O	With	Total
#1 - 3"	16	0	16	#1 - 3"	3	0	3
#1 - 4"	2	0	2	#1 - 4"	0	0	0
#2 - 8"	0	0	0	#2 - 8"	12	0	12
#2 - 8" thru 14"	*125	0	*125	#2 - 8" thru 14"	0	0	0
#3 - 20"	143	0	143	#3 - 20"	1	0	1
#3 - 24"	34	0	34	#3 - 24"	0	0	0
#4 - 3"	0	72	72	#4 - 3"	0	0	0
#4 - 4"	17	11	28	#4 - 4"	0	0	0
#4 - 6"	191	0	191	#4 - 6"	115	0	115
#5 - 8"	223	34	257	#5 - 8"	0	0	0
#5 - 10"	137	58	195	#5 - 10"	0	0	0
#5 - 12"	190	660	850	#5 - 12"	38	0	38
#5 - 14"	0	397	397	#5 - 14"	61	0	61
#6 - 16"	146	90	236	#6 - 16"	6	0	6
#6 - 18"	3	52	55	#6 - 18"	0	0	0
#6 - 20"	135	123	258	#6 - 20"	49	0	49
#6 - 24"	3	134	137	#6 - 24"	1	0	1

*NOTE - 2,459 PCS. OF THESE SIZES SHOWN ON INVENTORY. Q.C. INSPECTED A SAMPLE OF 125 PCS. ALL PCS. HAD NO EDGE INDICATIONS. NO RICO STRAPS NOTED.

TOTALS

AREOQUIP:	W/O	With	Total	RICO:	W/O	With	T
	1365	1631	2996		286	0	286

54.4% With Edge Indications — 0% With Edge Indications

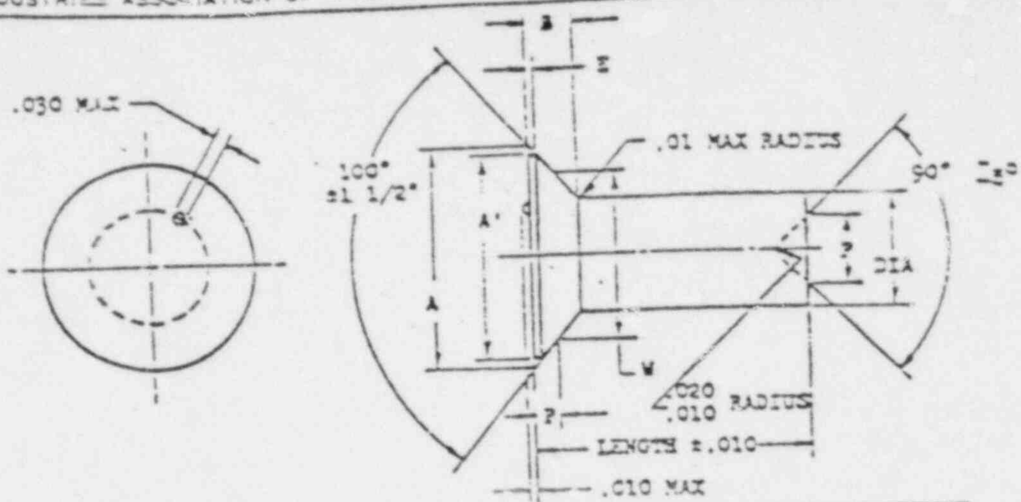
	AEROQUIP W/O	With	Total	%	RICO W/O	With	Total	%
.040 Material	320	0	320	0	16	0	16	0
.080 Material	1046	1631	2676	61	270	0	270	0

W/O - No edge indications, With - With edge indications.

cc: D. Sewell
B. Gaat

ATTACHMENT #4

MATERIAL CERTIFICATIONS



DIA	HEAD DIAMETER		B MAX	E MAX	F ±.005	P		W	
	A MAX	A' MIN				MAX	MIN	MAX	MIN
.062 +.003 −.001	.1346	.0898	.0317	.008	No Recess	.0165	.0105	.0842	.0840
.094 +.003 −.001	.1900	.1548	.0418	.008	No Recess	.0179	.0118	.1162	.1160
.125 +.003 −.001	.2360	.2006	.0483	.008	.070	.0191	.0130	.1892	.1890
.156 +.004 −.001	.2976	.2566	.0614	.010	.080	.0226	.0163	.2122	.2120
.187 +.004 −.001	.3654	.3234	.0769	.010	.100	.0252	.0185	.3038	.3036
.250 +.004 −.001	.4290	.4412	.1034	.012	.125	.0289	.0220	.4182	.4180

LENGTHS AND DASH NUMBERS

BASIC PART NUMBER	DIA	.125	.188	.250	.312	.375	.438	.500	.563	.625	.688	.750	.813	.875	.938	1.000	1.125	1.250	1.375	1.500	1.750	2.000
NAS1199-2	.062	-2	-3	-4	-5	-6	-7	-8	-9	-10	-11	-12										
NAS1199-3	.094		-3	-4	-5	-6	-7	-8	-9	-10	-11	-12	-13	-14	-15	-16	-18	-20				
NAS1199-4	.125		-3	-4	-5	-6	-7	-8	-9	-10	-11	-12	-13	-14	-15	-16	-18	-20	-22	-24	-28	-32
NAS1199-5	.156			-4	-5	-6	-7	-8	-9	-10	-11	-12	-13	-14	-15	-16	-18	-20	-22	-24	-28	-32
NAS1199-6	.187			-4	-5	-6	-7	-8	-9	-10	-11	-12	-13	-14	-15	-16	-18	-20	-22	-24	-28	-32
NAS1199-8	.250				-5	-6	-7	-8	-9	-10	-11	-12	-13	-14	-15	-16	-18					

MATERIAL: A286 HI-TEMPERATURE ALLOY HEADING STOCK PER SPEC AMS5737.

SHEAR STRENGTH AT ROOM TEMPERATURE: 85,000 PSI TO 95,000 AS HEAT-TREATED.
90,000 PSI MINIMUM AFTER DRIVING.

HEAT TREAT: SOLUTION TREAT AND PARTIALLY PRECIPITATION HEAT TREAT AFTER HEADING AS FOLLOWS:
HEAT AT 1650° F ±25° FOR 25 MINUTES - OIL QUENCH.
AGE AT 1250°F TO 1350°F FOR 30 TO 90 MINUTES AS NECESSARY TO MEET SHEAR REQUIREMENTS.
AIR COOL.

EXAMPLE OF PART: NAS1199-4-8
LENGTH .500
DIAMETER .125

(3) EDITORIALLY UPDATED

(3) FINISH: PASSIVATE PER QQ-P-35

TOLERANCES: UNLESS OTHERWISE SPECIFIED ±.010.

NOTES:
1. .001 SHANK DIAMETER INCREASE PERMISSIBLE WITHIN .10" OF BASE OF HEAD.
2. SHANK AND HEAD DIAMETERS SHALL BE CONCENTRIC WITHIN .010 FOR RIVETS THRU .125 WITHIN .015 FOR .156 AND .187 RIVETS, AND WITHIN .020 FOR .250 RIVETS, T.I.R.
3. RIVETS SHALL DRIVE COLD SATISFACTORILY WITH FULL HEADS FREE FROM CRACKS. SUGGESTED SHANK LENGTH PROTRUSION 1 1/4 TO 1 1/3 TIMES RIVET DIA.
4. RIVETS MUST BE OF UNIFORM QUALITY AND FREE FROM SCALE, PITS, SEAMS, CLINCH OR DIE MARKS, COLD SHUTS, OR OTHER INJURIOUS DEFECTS.
5. HEAD COCKING ANGLE RELATIVE TO AXIS OF RIVET 1/2° MAX.
6. MAXIMUM HEAD DIAMETERS ARE TO THEORETICAL SHARP CORNERS AS MEASURED BY PROJECTION.
7. SEE NAS527 FOR THE RECOMMENDED PRACTICE FOR INSPECTING HEAD CHARACTERISTICS.
8. THE HEAD PERIPHERY MAY BE ROUNDED WITHIN THE "E" DIMENSION.

CUSTODIAN: NATIONAL AEROSPACE STANDARDS COMMITTEE

PROCUREMENT SPECIFICATION	TITLE	CLASSIFICATION STANDARD PART
(3) NONE	RIVET - SOLID - 100° FLUSH HEAD A286 CORROSION RESISTANT STEEL	NAS 1199

AIA AND ITS COMMITTEE WILL NOT INVESTIGATE THE APPLICABILITY OF PATENTS TO THE SUBJECT MATTER OF NAS STANDARDS AND IN RESPECT THEREOF DO NOT ASSUME ANY LIABILITY TO PATENT OWNERS OR TO PROSPECTIVE USERS

THIS DRAWING SUPERSEDES ALL AFFECTED STANDARD DRAWINGS FOR THE SAME PRODUCT AND SHALL BECOME EFFECTIVE NO LATER THAN SIX MONTHS FROM THE LAST DATE OF APPROVAL SHOWN HEREON

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LINDBERG HEAT TREATING COMPANY

Division of LINDBERG CORPORATION

6111 COCHRAN ROAD • SOLON, OHIO 44139 • 216/248-4000

ITT Grinnell
621 Dana Avenue
Warren, OH 44481

HEAT TREAT CERTIFICATION

Date: 9-30-80

This is to certify that under date of 9-24-80 .

We entered your Order No. WAR 26117, S. O. No. ______

covering the heat treating of the following material: 17-4PH

21 Straps PT# PE41-50526
11 Straps PT# PE41-50520

Processed on our Shop Order No. C 12833 C 12786, as follows:
Age Hardened to condition H 1075

Referance Report # 80-1712

Furnace Charts Attached

Resultant Hardness: 37-38 R/C

Lindberg Heat Treating Company
Division of Lindberg Corporation

By: [signature]
ALLAN S. EMLEY

"We make'em - We break'em"

TENSILE TESTING

A Division of J.T. Adams Co., Inc.

7809 HARVARD AVENUE • CLEVELAND, OHIO 44105 • TELEPHONE (216) 641-3200

LINDBERG HEAT TREATING COMPANY
6111 COCHRAN ROAD
SOLON, OHIO 44139

Report No. 80-1712 Date 9-29-80

Job No. 8923 Cust. P.O. No. C52780

Description STRAP
SO#C12786, C12833

Material 17-4 PH STAINLESS STEEL

Spec. ______

CERTIFIED TEST REPORT

TEST RESULTS	TENSILE				IMPACT				Hardness
ITEM	TENSILE PSI	YIELD PSI 2%	ELONG % in 4D	RED. AREA %	ITEM	LOAD FT/LBS	LATERAL EXP	%SHEAR	Rc BHN
1712	171,095	160,417	13.4						

ITT GRINNELL CORP.
Warren Quality Assurance
OCT 03 1980
REVIEWED BY J.C.

REMARKS

THE ABOVE TESTS CONFORM XXXXXXXXXXXX TO THE REQUIREMENTS OF THE SPECIFICATIONS LISTED

THIS CERTIFICATE NOTARIZED ONLY WHEN REQUIRED

I ______ a Notary Public do hereby certify that this affidavit was subscribed and sworn to before me by a duly authorized agent of Tensile Testing this ______ day of ______

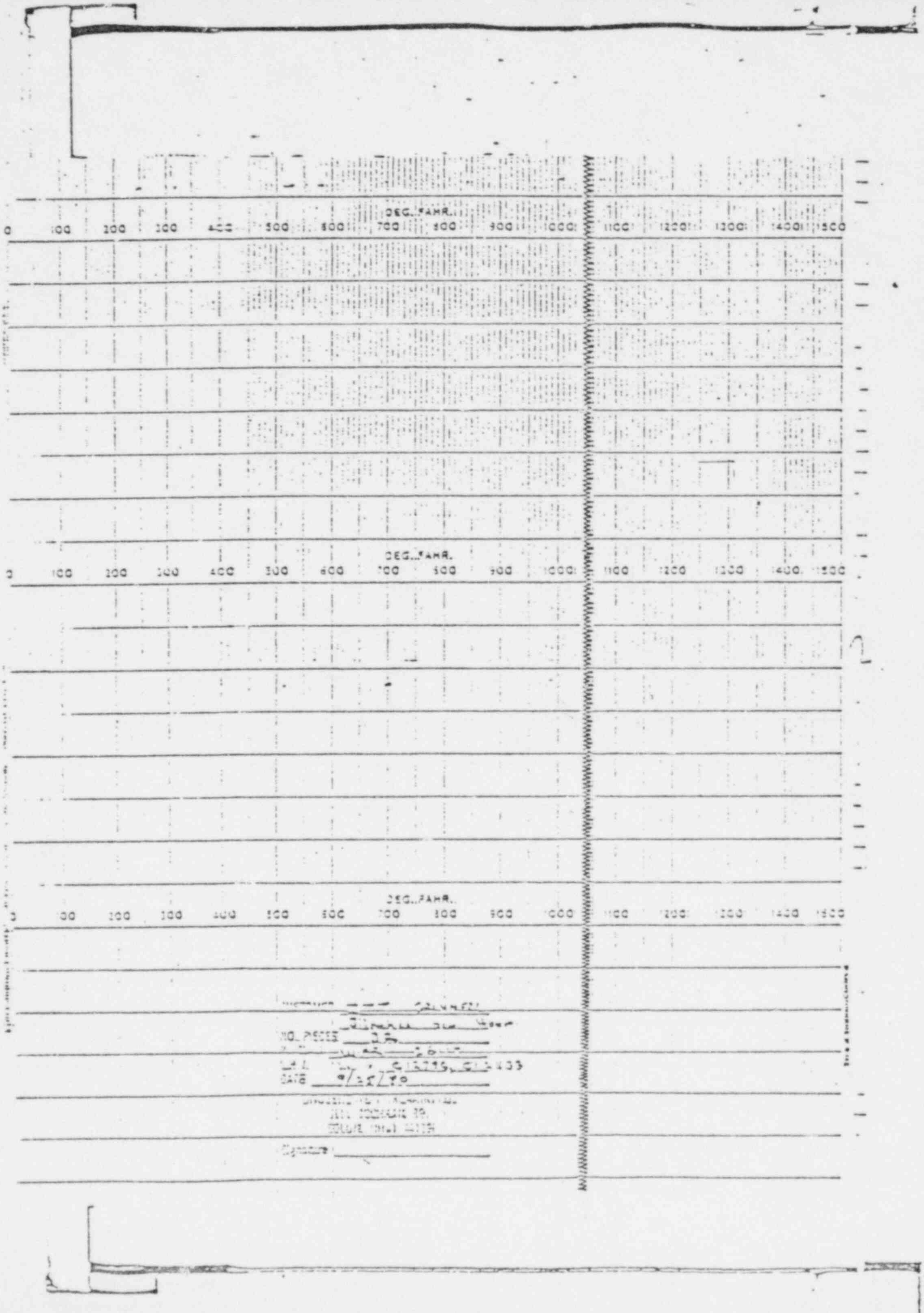
MY COMMISSION EXPIRES

NOTARY PUBLIC

We hereby certify that the foregoing data is a true copy of the data furnished us by the producing mill or the data resulting from tests performed in the Laboratory...

AUTHORIZED AGENT

We hereby certify the parts listed have been tested in conformance with the specification noted. This report represents Tensile Testing interpretation of the results obtained from the test and is not to be construed as a Guaranty or Warranty of the condition of the materials tested. Tensile Testing shall not be held liable for misinterpretation of conditions, loss, damage, injury or death arising from or attributable to delay preceding a test or subsequent to performance of a test.


DEG. FAHR.
0
100
200
300
400
500
600
700
800
900
1000
1100
1200
1300
1400
1500
NO. PIECES
DATE
Signature

CERTIFICATE OF CHEMICAL ANALYSES AND TESTS

BUYER'S DATE 06/12/80 — BUYER'S ORDER NO WAR-25527-H

VENDOR:
ARMCO INC.
BOX 600
MIDDLETOWN, OHIO 45042

SHIP REF NO 2048400 — MILL ORDER NO 093929933-8002 — SHIPPING DATE 10/03/80

SOLD TO:
ITT GRINNELL
621 DANA AVE
WARREN OH 44481
ATTN: TONY SHIELDS

SHIPPED TO:
ITT GRINNELL
621 DANA AVE
WARREN OH 44481
ATTN:

PRODUCT: 17-4PH CR STRIP STNLS NO 1 FINISH COND A NO 5 SQR EDGE.*
ASTM A693-77 TYPE 630 ASME SECTION III NCA 3800 Q C V 001 REV 3 DTD 6/15/78 EX PARA A Q C V 002 REV 2 DTD 6/21/78 EX PARA B

ITEM	FIN CODE	CKD	COILS	GAUGE	WIDTH	LENGTH	NET WT	THEO WT	
02	2214	7	72	.0800	1.75000	COIL	12,380		ENG

RECERTIFIED TO CORRECT ANALYSIS

MECHANICAL PROPERTIES

COIL #	HEAT	DIR	COND	LBS PER SQ IN .2% YS	LBS PER SQ IN UTS	%ELONG	ROCK	ANGLE OF BEND	EMBRIT
	400670	L	A	108,000	160,000	10.0	C34	OK	
		T	A	108,500	160,300	9.0	C34	180-9T	
		L	H900	170,900	190,900	12.0	C42		
		T	H900	173,900	190,500	11.0	C42		
		L	H925	165,900	179,600	11.0	C39		
		T	H925	165,400	177,700	10.0	C39		
		L	H1075	140,800	160,500	12.0	C35		
		T	H1075	138,800	160,900	10.0	C35		
		L	H1150	115,000	150,000	15.0	C31		
		T	H1150	114,000	152,300	13.0	C31		

CHEMICAL ANALYSES

HEAT	C	MN	P	S	SI	CR	NI	CU	MO	CO	CB	TA
400670	.040	.72	.027	.005	.57	16.03	4.56	3.31	.19	.07	.27	.01

SUBSCRIBED AND SWORN TO BEFORE ME THIS 19TH DAY OF JANUARY ,1981

MY COMMISSION EXPIRES 11/ 24/ 84

THE CHEMICAL ANALYSES AND PHYSICAL OR MECHANICAL TESTS REPORTED ABOVE ARE CORRECT AS CONTAINED IN THE RECORDS OF THE CORPORATION.

CERTIFIED BY [signature]

Advanced Materials Division
Butler, Pennsylvania 16001

CERTIFICATE OF CHEMICAL ANALYSES AND TESTS

VENDOR:
ARMCO INC.
BOX 600
MIDDLETOWN, OHIO 45042

BUYER'S DATE 06/12/80

BUYER'S ORDER NO WAR-25527-N

SHIP REF NO 2046400

MILL ORDER NO 093929933-8002

SHIPPING DATE 10/03/80

SOLD TO:
ITT GRINNELL
621 DANA AVE
WARREN OH 44481
ATTN: TONY SHIELDS

SHIPPED TO:
ITT GRINNELL
621 DANA AVE
WARREN OH 44481
ATTN:

PRODUCT: 17-4PH CR STRIP STNLS NO 1 FINISH COND A NO 5 SQR EDGE. * ASTM A693-77 TYPE 630 ASME SECTION III NCA 3800 Q C V 001 REV 3 DTD 6/15/79 EX PARA A Q C V 002 REV 2 DTD 6/21/78 EX PARA B

ITEM	FIN CODE	SKD	COILS	GAUGE	WIDTH	LENGTH	NET WT	THEO WT
01	2214	4	38	04010	1.750000	COIL	9,985	ENG

****RECERTIFIED TO CORRECT HEAT ANALYSIS****

MECHANICAL PROPERTIES

COIL #	HEAT	DIR	COND	LBS PER SQ IN .2% YS	UTS	%ELONG	ROCK	ANGLE OF BEND	EMBRIT
	400670	L	A	106,300	165,900	9.0	C33	OK	
		T	A	105,400	166,000	3.0	C33	180-9T	
		L	H900	190,500	197,100	10.0	C43		
		T	H900	192,000	199,500	9.0	C43		
		L	H925	170,700	180,500	11.0	C41		
		T	H925	173,700	181,900	10.0	C41		
		L	H1075	151,200	165,900	12.0	C36		
		T	H1075	153,200	167,000	10.0	C36		
		L	H1150	117,100	151,200	15.0	C32		
		T	H1150	118,500	152,200	13.0	C32		

CHEMICAL ANALYSES

HEAT	C	MN	P	S	SI	CR	NI	CU	MO	CO	CB	TA
400670	.040	.72	.027	.005	.57	16.03	4.56	3.31	.19	.07	.27	.01

SUBSCRIBED AND SWORN TO BEFORE ME
THIS 17TH DAY OF JANUARY ,1981

MY COMMISSION EXPIRES 11/24/84

THE CHEMICAL ANALYSES AND PHYSICAL OR MECHANICAL TESTS REPORTED ABOVE ARE CORRECT AS CONTAINED IN THE RECORDS OF THE CORPORATION.

CERTIFIED BY [signature]

JOHN HASSALL, INC. · WESTBURY · LONG ISLAND · N.Y. · 11590

516 · 334-6200

August 19, 1980

ITT Grinnell
Sub of Itt
621 Dana Ave.
Warren, Ohio 44481
Gentlemen:

We herewith certify that the below items were manufactured and inspected in accordance with required specifications.

PART NUMBER	PURCHASE ORDER NO.	DESCRIPTION
NAS 1199-5-6	Your: G26061-N	.375" X .156" CSK Hd
17,600 pcs.	Our: 9183/80	ASTM A453 Grade 660
		A286 SS RIVETS Annealed.

Chemical analysis as follows:

NI	24.80	VA	.25
CR	14.06	TI	2.22
C	.052	B	.0059
MN	.15		
SI	.18		
S	.006		
P	.010		
MO	1.13		
FE			
AL	.21		
CO			
CU			
TA/CB			

Heat No. 6L5274K2 Brown Pacific.

Shear Strength: 87,634/87,896/86,326 PSI.

Sworn to before me this
19th date of AUGUST 1980
mp

Very truly yours,

JOHN HASSALL, INC.

Original Signed by
MARIANNE PETERS
Certification Clerk

Original Signed by
CATHERINE A. MALEY
NOTARY PUBLIC

ATTACHMENT 5

MECHANICAL PROPERTIES OF

STRAP MATERIAL

ROOM TEMPERATURE TENSILE PROPERTIES
AS TESTED BY ITT GRINNELL

Sample 1 - Aeroquip strap from Warren stock

Sample 2 - Rico Tool strap from Warren stock

Sample 3 - Aeroquip strap returned from the jobsite (unbroken)

Sample 4 - Aeroquip strap returned from the jobsite (the strap that failed).

SAMPLE NO.	1	2	3	4
Size (in.)	.075x1.247	.079x1.248	.079x1.245	.075x1.247
Area (Sq.in.)	.0935	.0986	.0983	.0935
Yield (0.2% Offset)	15300 lb.	15750 lb.	15450 lb.	15250 lb.
Yeild Stress	163600 psi	159700 psi	157100 psi	163000 psi
Ultimate Load	16100 lb	17160 lb.	16680 lb.	16650 lb.
Ultimate Stress	172100 psi	174000 psi	169600 psi	178100 psi
Elongation in 2"	11%	11%	11%	11%
	Aeroquip Warren	Rico Warren	Aeroquip Field Unbroken	Aeroquip Field Broke

HARDNESS DATA

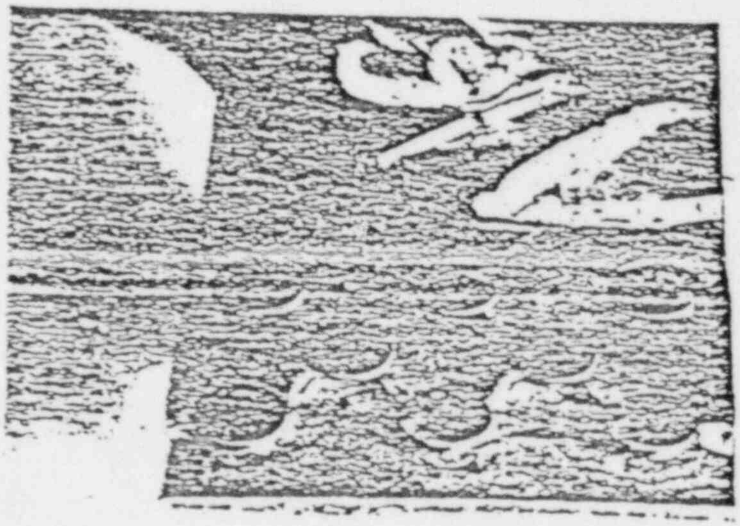
Rockwell "C"

	1	2	3	4
1.	C40	38	40	36
2.	C38	40	39	38
3.	C40	40	39	39
4.	---	---	---	38
5.	---	---	---	38

EVALUATION OF RESULTS

The results obtained are consistant with those that would be required for this material (SA 564 Type 630 Age Hardened at 1075°F) specifically:

Tensile Strength (Ultimate)	145000 psi minimum
Yield Strength (0.2% offset)	125000 psi minimum
Elongation in 2"	5% minimum
Hardness	C31 minimum
	C40 maximum



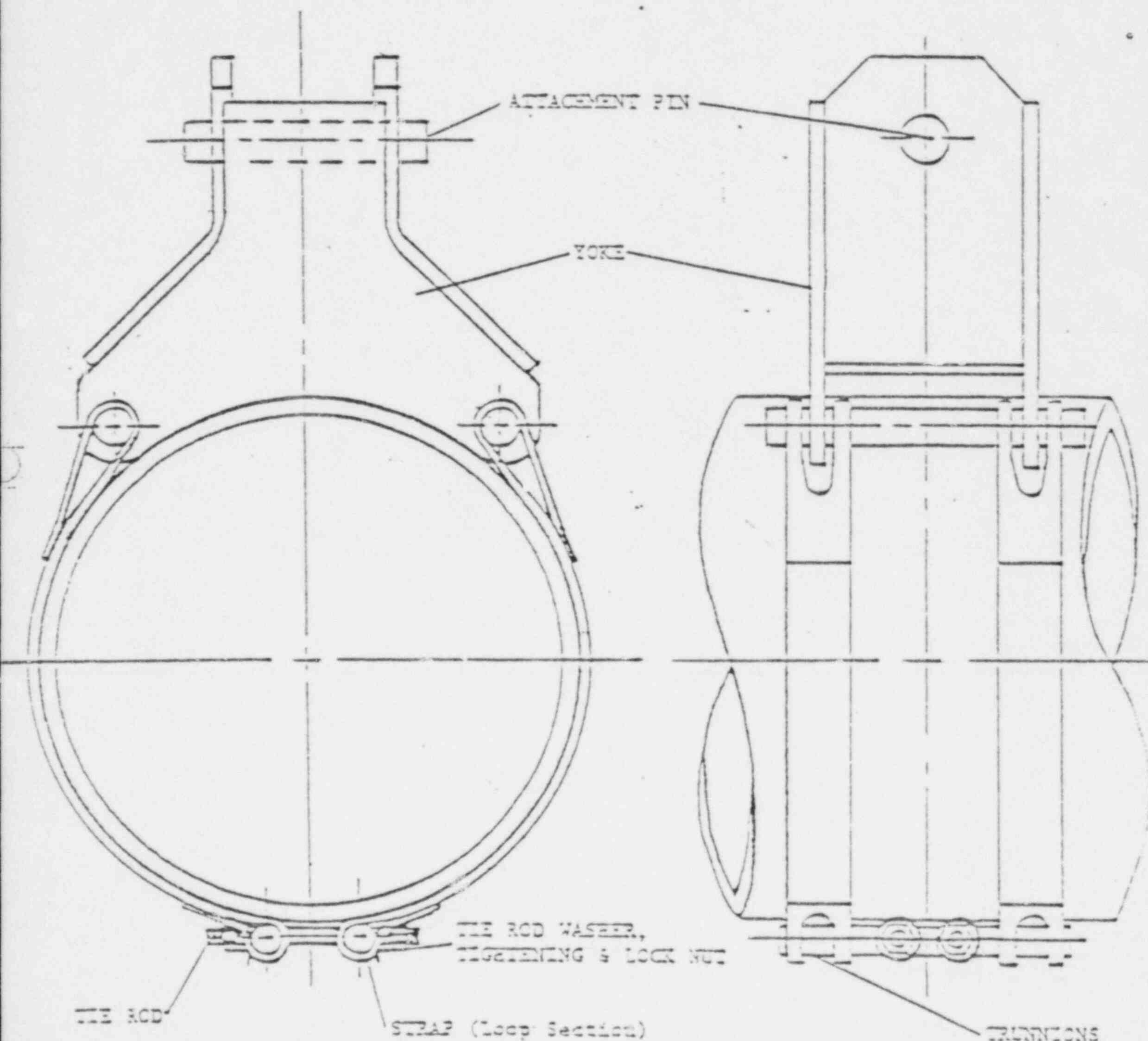
TYPICAL TENSILE FAILURE CAUSED BY
OVER TORQUING STRAPS

ATTACHMENT 6

MODIFIED FIGURE 215 STIFF CLAMP
REVISED INSTALLATION PROCEDURE AND
LOAD CAPACITY DATA SHEET REV 4

R1

ITT-GRINNELL MODIFIED FIGURE 215 STIFF CLAMP ASSEMBLY



BY: R. C. [signature]

CHECKED: [signature]

DATE: 8-31-81

INSTALLATION INSTRUCTIONS

FIGURE 215 STIFF CLAMP

1) See the hanger sketch for the full assembly.

2) Ensure that the correct trunnion assembly is installed in the straps. Refer to attached sketch for detail of clamp.

3) Ensure that the mark number in the clamp matches the mark number on the assembly sketch.

4) Place the clamp frame (1) against the pipe, in its proper location and orientation. The straps should be attached to the frame with the strap pins (2), and the trunnion (4) ends loose.

5) Draw the trunnions together enough to pass the tie rods (3) through both trunnions. Place a tie rod washer (5) then all the hex nuts until an equal amount of tie rod is exposed outside of the hex nut. Repeat this procedure for each set of straps attached to the clamp frame.

6) Wrench tighten the hex nuts in sequence until the straps are snug against pipe. (Ensure that the trunnions remain parallel with each other during the tightening process. This will provide equal force on each strap.

7) Using a torque wrench, tighten a hex nut to twenty percent (20%) of the required torque. Then tighten the hex nut at the opposite end of that tie rod the same amount. Complete these steps on each of the remaining sets of straps attached to the clamp frame.

8) Repeating the sequence of hex nuts tightened in Step 7, tighten the nuts to the required torque using 20% increments. (This will ensure equal strap tension throughout the entire tightening procedure).

9) Place one jam nut (7) on the end of each tie rod and tighten to the required torque.

10) Attached the applicable attachment to the clamp frame with the load pin (8).

Notes:

1) During, and at the completion of the tightening process, the trunnions must be parallel to each other. This will prevent any twisting and uneven loading nodes on the straps and any bending in the trunnions which could cause a strap failure.

2) At the completion of the tightening of the straps, no trunnions

Notes: (Continued)

2). are allowed to be touching each other. Contact between the trunnions would negate the effect of the applied torque. There may be some minor deformation of the trunnion; this will in no way affect the performance of the clamp.

REQUIRED TORQUE VALUES

FRAME SIZE	TORQUE VALUES (FT.-LBS.)
1	25
2	35
3	40
4	120
5	130
6	170

ASME SECTION III
SUBSECTION NF
LOAD CAPACITY DATA SHEET

1. GENERAL INFORMATION

SUPPORT NAME: PE-41 Pipe Clamp Size 1-6 WPPSS Units 3 & 5	ENGINEERING PARTS LIST(S): A-PE41-00000
SUPPORT TYPE: Component Standard	CODE CLASSIFICATION: Class 1,2,3&M
DESIGN PROCEDURE: Load Rating	DESIGN TEMPERATURE: 650°
SERVICE LIMITS: Levels A,B,C,D & Design Loading	

2. CERTIFICATION

ENGINEER: Richard C. Sherman DATE: 1-30-81	THE LOAD CAPACITY OF THIS COMPONENT SUPPORT IS RATED IN ACCORDANCE WITH SUBSECTION NF
CHECKED: James A. Williams DATE: 1-30-81	
LOCATION OF SUBSTANTIATION DATA: Research, Development & Engineering Pipe Hanger Division, Prov., R.I.	REGISTERED PROFESSIONAL ENGINEER

3. REVISION AND RECERTIFICATION

LCDS REV. NO.	DATE	EPL LOG SH REV. NO.	DATE	RECERTIFICATION
2	1/30/81	--	1/30/81	[signature]
3	8/1/81	--	9/4/81	[signature]
4	10/29/81		10/29/81	[signature]

4. COMPONENT SUPPORT INFORMATION

ITEM	MATERIAL SPECIFICATION	ANALYSIS
Frame	SA515 GR 65-70 or SA36	Load Rating
Load Pin (Except Sz. 35 Fig. 306/307)	SA 193 GR B7 or SA 564 Type 630 Age Hardened @ 1075°F	Load Rating
Load Pin (Sz. 35 Fig. 306/307)	SA 564 Type 630 Age Hardened @ 1075°F	Load Rating
Spacer	SA36 or AISI 1010 Exempt per NF 2121 (b)	Secondary Member
Retaining Ring	Truarc ® Exempt per NF-2121 (b)	Load Rating
Strap Pins	SA 193 GR B7	Load Rating
Straps	ASTM A 693 Type 630 Condition H 1075**	Load Rating
Trunnion	SA 193 GR B7	Load Rating
Tie Rod Washer	SA36 or C1018 Case Hardened to Rockwell C-35-38. Exempt per NF2121 (b)	Load Rating
Nuts	SA307 GR B or ASTM A307 GR A*	Load Rating
Tie Rods	SA 193 GR B7	Load Rating
Rivets	AMS 5737**	Load Rating
* Code Case 1644 ** Pending Approval of Code Case N-71-11 and N-249-2.		

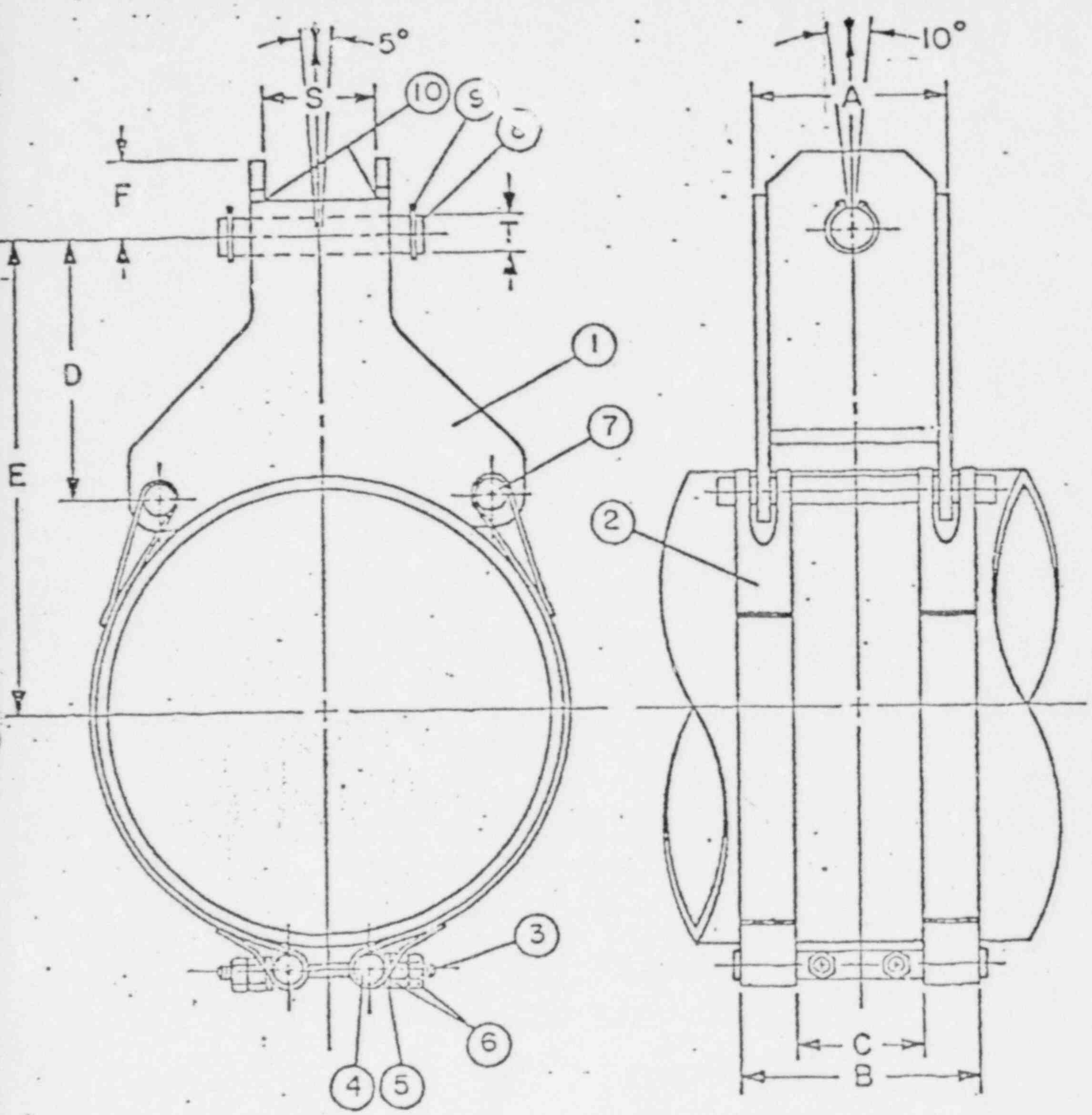
ITT GRINNELL

PIPE HANGER DIVISION

QUALIFIED PRODUCTS

LOAD RATING

FRAME SIZE	MAXIMUM LOAD LBS.			MINIMUM SPRING RATE KIPS/IN
	LEVEL A & B	LEVEL C	LEVEL D	
1	6000	8610	11520	325
2	6000	8610	11520	325
3	6000	8610	11520	325
4	20700	24840	26700	1000
5	20700	24840	26700	1000
6	20700	24840	26700	1000


5°
S
10
9
8
F
T
D
E
1
7
2
3
6
4
5
10°
A
C
B

APPENDIX #7

STIFFNESS AND QUALIFICATION
TESTING OF THE MODIFIED FIG. 215
STIFF CLAMP

DISCUSSION

The following procedure is designed to accomplish two separate and distinct goals. The first is to meet the stiffness requirement set forth in the WPPSS Design Specification 3240-4 paragraph 4.11 y which requires that "clamps used as the non-integral attachment to the piping component in a snubber/strut assembly shall have as a minimum a spring rate greater than five times the spring rate of the snubbing device". To do this it is necessary to input a pre-load to the assembly so that the yoke is held in contact with the pipe until a pre-determined load is applied to the load pin. In this application to achieve the necessary pre-load, we are torquing the tie rods which causes enough pre-stress in the strap assembly to preclude gapping between the yoke and the pipe until the faulted load of the clamp is exceeded.

The faulted load on the clamps was determined by the highest faulted load of the largest snubber or strut that can be attached to it.

To determine the torque that must be applied to obtain the necessary pre-load we tested the largest pipe size included in the frame size (e.g. size 1 frame 6" pipe). The reason for this approach is that within a frame size there is only one variable which will affect the amount of pre-load required - that is, the angle from the direction of the applied load where the strap attaches to the strap pin. Since the pre-load required at the strap pin is a load parallel to the applied load, for sake of argument, assume the load is applied vertically as the angle from vertical increases, the pre-load in the strap must increase to compensate for it. Because the deviation from vertical is largest for the largest pipe size in that frame size and that combination of frame and pipe size would require the largest pre-load to meet the stiffness. And, since the variation in pipe size within a frame size is not that great, we have elected to set one torque value per frame size based on this worst case.

The other aim in this testing is to meet the load rating requirements of ASME Section III Subsection NF. To do this the clamp used to establish the torque value is subjected to both tensile and compressive load until it fails. Then the failure load is factored in accordance with the rules of NF 3260.

The effects of thermal expansion have been evaluated analytically and that information is contained in the attached report. As can be seen from this report the stress induced due to the different amount of thermal expansion of the piping and the clamp materials causes an additional tensile stress in the straps. When evaluated with the effects of the applied mechanical stress and compared to code allowables for this combination of primary (mechanical) and secondary (thermal) stress, the results show that the thermal stresses induced are acceptable.

APPROVED BY: *[signature]*

DATE: *6-15-81*

TEST PROCEDURE

FIG. 215 STIFF CLAMP

PURPOSE: The purpose of this procedure is for the testing of the modified Fig. 215 Stiff Clamp. This clamp was modified to allow the reduction of torquing values on the tie rods and trunnions of the strap assemblies. This modification can be seen on the attached diagram.

TESTING APPARATUS: Riehle Tensile Test Machine, Model F-S 300W, 300,000 lb. capacity, annual inspection month July, Serial Number R-82889.

TEST SET-UP: The clamp shall be secured around a pipe spool and placed in the fixture. The fixture is attached to the moveable head of the test machine with a nut and rod assembly. A solid rod end is placed in the stationary head of the machine and is attached to the pipe clamp. See Figure 1.

When the straps are secured on the spool, the tie rods must be torqued to a predetermined value in sequence. (The final torque value must be reached in 25 ft.-lb. increments. Each of the four hex nuts must be at the 25 ft.-lb. value before raising to the next level of torque. This will ensure equal and proper tension on all four straps).

PROCEDURE:

1) The specimen shall be loaded and torqued as described in the test set-up.

2) A 100 lb. pre-load shall be applied. A check of the basic set-up and dial indicators shall be made to ensure proper functioning during the test.

3) The loading shall be stopped and the indicator readings shall be taken at a predetermined value and at the faulted load to test for stiffness. (During loading, a visual check shall be done to look for clamp - pipe separation).

4) Upon unloading, the torque values shall be taken and recorded.

5) If either there is separation before the faulted load is reached, or the stiffness does not meet the required values, the straps are retorqued to a higher value and the test repeated. This will be done until the clamp meets all requirements of acceptable test results.

6) When the desired results are obtained, a new pipe clamp shall be tested with the final torque values. This test shall be conducted to duplicate field conditions. Acceptable results must be obtained on a single test.

7) The sample on which acceptable stiffness results were obtained will now be loaded in tension to failure and the failure load will be recorded for load rating purposes.

8) The compressive data generated in previous qualification testing is unaffected by the modification in design and is therefore still valid for use.

CONCLUSION

As can be seen from the test results obtained in all cases, we were able to meet the stiffness requirements of the project Design Specification, and also all load rating requirements of the code were also met. Also, the analytical data generated to show the effects of thermal expansion of the piping show that this secondary stress will cause no functional problem when combined with the applied mechanical effects.

LOAD RATING REQUIREMENTS
PER NF 3262.4

LEVEL A LIMITS

LOAD RATING = T.L. x 1.0 (F_{ALL} / S_u)

LEVEL B LIMITS

LOAD RATING = 1.2 (LEVEL A LOAD RATING)

LEVEL C LIMITS

LOAD RATING = 1.33 (LEVEL A LOAD RATING)

T.L. = TEST LOAD

F_{ALL} = ALLOWABLE STRESS PER XVII - 1100

S_u = MATERIAL MINIMUM TENSILE STRENGTH

BASED ON COMPRESSIVE TEST RESULTS THE FORMULA GIVEN ABOVE WILL YIELD LOWEST LOAD RATINGS

FRAME SIZE 1

FAILURE LOAD 38,900#

FAILURE MODE - FRAME FAILED AT LOAD PIN HOLE - TENSION

MATERIAL: SA-36 OR SA 515 GR 65 OR 70

MATERIAL PROPERTIES:

SA-36: S_y @ 650°F 26.1 ksi

S_u @ 650°F 58.0 ksi

SA515 GR 65: S_y @ 650°F 25.4 ksi

S_u @ 650°F 65.0 ksi

SA 515 GR 70: S_y @ 650°F 27.6 ksi

S_u @ 650°F 70. ksi

$F_{ALL} = F_t = .6 S_y$

FOR SA-36:

LEVEL A LIMITS

LOAD RATING = T.L × 1.0 (F_{ALL}/S_u)

LOAD RATING = 38900 × 1.0 [.6(26.1)/58]

LOAD RATING = 10503#

LEVEL B LIMITS

LOAD RATING = 1.2 (LEVEL A LOAD RATING)

LOAD RATING = 1.2 (10503)

LOAD RATING = 12604#

LEVEL C LIMITS

LOAD RATING = 1.33 (LEVEL A LOAD RATING)

LOAD RATING = 1.33 (10503)

LOAD RATING = 13969#

FOR SA 515 GR 65

LEVEL A LIMIT

LOAD RATING = TL × 1.0 (Fall / Su)

LOAD RATING = 37900 × 1.0 (.6(25.4)/65.0)

LOAD RATING = 9121#

LEVEL B LIMIT

LOAD RATING = 1.2 (LEVEL A LOAD RATING)

LOAD RATING = 1.2 (9121)

LOAD RATING = 10945#

LEVEL C LIMIT

LOAD RATING = 1.33 (LEVEL A LOAD RATING)

LOAD RATING = 1.33 (9121)

LOAD RATING = 12131 #

FOR SA 515 GR 70

$F_{ALL}/S_u = \frac{27.6}{70} = .3943$ SINCE THIS VALUE IS HIGHER THAN $\frac{F_{ALL}}{S_u}$ FOR SA515 GR 65 THE ASSOCIATED LOAD RATINGS WILL BE HIGHER THEREFORE THE LOAD RATINGS FOR SA 515 GR 65 WILL GOVERN.

FRAME SIZE 2

FAILURE LOAD - 38000#

FAILURE MODE - STRAP FAILED AT SHEAR PIN LOCATION

MATERIAL SA 564 GR 630 AGE HARDENED @ 1075°F

MATERIAL PROPERTIES:

SA 564 GR. 630 1075° CONDITION

S_y @ 650°F - 99.5 KSI

S_u @ 650°F - 136.1 KSI

LEVEL A LIMITS

LOAD RATING = T.L. X 1.0 (FALL/S_u)

LOAD RATING = T.L. X 1.0 [.6 (99.5)/136.1]

LOAD RATING = 16669#

LEVEL B LIMITS

LOAD RATING = 1.2 (LEVEL A LOAD RATING)

LOAD RATING = 1.2 (16669)

LOAD RATING = 20003#

LEVEL C LIMITS

LOAD RATING = 1.33 (LEVEL A LOAD RATING)

LOAD RATING = 1.33(16669)

LOAD RATING = 22170#

FRAME SIZE 3

FAILURE LOAD 30,750 #

FAILURE MODE - FRAME FAILED AT LOAD PIN HOLE

MATERIAL: SA-36 OR SA 515 GR 65 OR 70

FOR MATERIAL PROPERTIES SEE FRAME SIZE 1

FOR SERVICE LEVEL LOAD LIMITS BECAUSE THE PROPERTIES FOR SA 515 GR 65 WILL YIELD THE LOWEST LOAD RATINGS (SEE FRAME SIZE 1 RESULTS) ONLY THESE PROPERTIES WILL BE USED.

LEVEL A LIMITS

LOAD RATING = T.L. × 1.0 (FALL/SU)

LOAD RATING = 30,750 × 1.0 [(.6)(25.4)/65]

LOAD RATING = 7210 #

LEVEL B LIMIT

LOAD RATING = 1.2 (LEVEL A LOAD RATING)

LOAD RATING = 1.2 (7210)

LOAD RATING = 8652 #

LEVEL C LIMIT

LOAD RATING = 1.33 (LEVEL A LOAD RATING)

LOAD RATING = 1.33 (7210)

LOAD RATING = 9589 #

FRAME SIZE 4

FAILURE LOAD - 70,250#

FAILURE MODE - STRAP FAILED AT STRAP PIN

MATERIAL: SA564 GR 630 AGE HARDENED AT 1075°F

MATERIAL PROPERTIES

S_y @ 650°F = 99.5 ksi

S_u @ 650°F = 136.1 ksi

LEVEL A LIMITS

LOAD RATING = T.L. × 1.0 (F_{all}/S_u)

LOAD RATING = 70,250 × 1.0 [(1.6)(99.5)/136.1]

LOAD RATING = 30,815#

LEVEL B LIMITS

LOAD RATING = 1.2 (LEVEL A LOAD RATING)

LOAD RATING = 1.2 (30815)

LOAD RATING = 36978#

LEVEL C LIMITS

LOAD RATING = 1.33 (LEVEL A LOAD RATING)

LOAD RATING = 1.33 (30815)

LOAD RATING = 40984#

ITT Grinnell Corporation — PIPE HANGER ENGINEERING DIVISION

BY: [illegible] DATE: 8/5/81 SUBJECT: FIG 215 QUAL TEST SHEET NO. 10 OF 16

CHKD. BY: NEW DATE: 8/20/81 CUSTOMER ______ SYSTEM ______

PROJECT ______ PROJECT NO. ______

FRAME SIZE E

FAILURE LOAD - 56000 #

FAILURE MODE - STRAP FAILED AT SHEAR PINS

MATERIAL. SA564 GR 630 AGE HARDENED @ 1075°F

MATERIAL PROPERTIES:

S_y @ 650°F = 99.5 KSI

S_u @ 650°F = 126.1 KSI

LEVEL A LIMITS

LOAD RATING = TL × 1.0 (F_{ALL}/S_u)

LOAD RATING = 56000 × 1.0 [(.6)(99.5)/126.1]

LOAD RATING = 24564 #

LEVEL B LIMITS

LOAD RATING = 1.2 (LEVEL A LOAD RATING)

LOAD RATING = 1.2 (24564)

LOAD RATING = 29477 #

LEVEL C LIMITS

LOAD RATING = 1.33 (LEVEL A LOAD RATING)

LOAD RATING = 1.33 (24564)

LOAD RATING = 32670 #

PHE NO. 4

FRAME SIZE 6

FAILURE LOAD 53500#.

FAILURE MODE - STRAP FAILED AT SHEAR PINS

MATERIAL: SA 564 GR 630 AGE HARDENED @ 1075°F

MATERIAL PROPERTIES:

Sy @ 650°F 99.5 KSI
Su @ 650°F 136.1 KSI

LEVEL A LIMITS

LOAD RATING = TL × 1.0 (Fall / Su)

LOAD RATING = 53500 × 1.0 [(.6)(99.5)/136.1]

LOAD RATING = 23468#

LEVEL B LIMITS

LOAD RATING = 1.2 (LEVEL A LOAD RATING)

LOAD RATING = 1.2 (23468)

LOAD RATING = 28162#

LEVEL C LIMITS

LOAD RATING = 1.33 (LEVEL A LOAD RATING)

LOAD RATING = 1.33 (23468)

LOAD RATING = 31212#

LEVEL D LOADINGS

APPENDIX F F-1370

FACTORS - THE LOWER OF $1.2\,(S_y/F_t)$ OR $0.7\,(S_u/F_t)$

S_u = ULTIMATE TENSILE STRENGTH AT TEMPERATURE

S_y = YIELD STRENGTH AT TEMPERATURE

F_t = ALLOWABLE TENSILE STRESS PER APPENDIX XVII

FOR COMPRESSION STRENGTH LOAD RATING = .67 x T.L

FACTORS

FRAME:

SA515 GR 65

$$1.2\left(\frac{S_u}{F_t}\right) = 1.2\ \frac{25.4}{(.6)(25.4)} = 2.0 \quad \text{OR,}$$

$$0.7\left(\frac{S_u}{F_t}\right) = 0.7\left(\frac{65}{(.6)(25.4)}\right) = 2.99$$

USE 2.0

STRAP

SA 564 GR 630 COND 1075°F

ITT Grinnell Corporation — PIPE HANGER ENGINEERING DIVISION

BY: [illegible] DATE: 8/3/81 SUBJECT: FIG 215 QUAL TEST SHEET NO. 13 OF 16

CHKD. BY: NEW DATE: 8/20/81 CUSTOMER: SYSTEM:

PROJECT: PROJECT NO:

$$1.2\left[\frac{S_y}{F_t}\right] = 1.2\left[\frac{99.5}{(.6)(99.5)}\right] = 2.0 \quad \text{OR}$$

$$0.7\left[\frac{S_u}{F_t}\right] = 0.7\left[\frac{136.1}{(.6)(99.5)}\right] = 1.6$$

USE 1.6

THE SIZE 1 AND 3 FRAMES FAILED DURING TENSILE ULTIMATE LOADING, THE LOWEST FAILURE LOAD WAS FOR THE SIZE 3 WHICH EQUALED A LOAD RATING (LEVEL A) OF 8652# THEREFORE THE FAULTED LOAD RATING FOR THESE FRAMES IN TENSION WOULD BE:

TENSILE FAULTED LOAD RATING = 2.0 [8652]

TENSILE FAULTED LOAD RATING 17304# .

FOR THE SIZE 2 THE STRAP FAILED THEREFORE THE LOAD RATING ON THIS SIZE IS:

TENSILE FAULTED LOAD RATING = 1.6 (16669#)

TENSILE FAULTED LOAD RATING = 26670#

IN COMPRESSION THE LOWEST FAILURE LOAD IN THE SIZE 1 THRU 3 GROUPING WAS 55800# THEREFORE THE LOAD RATING IS:

COMPRESSIVE FAULTED LOAD RATING = .67 (55800) = 37327#

FORM NO. 4

ITT Grinnell Corporation PIPE HANGER ENGINEERING DIVISION

BY: B DATE 8/5/81 SUBJECT FIG 215 QUAL TEST SHEET NO. 2 OF 16

CHKD. BY NEW DATE 8/20/81 CUSTOMER SYSTEM

PROJECT PROJECT NO.

FOR THE FRAME SIZES 4 THRU 6 THE TENSILE FAILURES ALL OCCURRED IN THE STRAP MATERIAL AND THE LOWEST FAILURE LOAD PRODUCED A LEVEL A LOAD RATING OF 23468# THEREFORE THE MINIMUM TENSILE LOAD RATING WOULD BE

TENSILE FAULTED LOAD RATING = 1.6 (23468) = 37549#

IN COMPRESSION FOR FRAME SIZES 4 THRU 6 THE LOWEST COMPRESSION FAILURE LOAD WAS 110000# THEREFORE THE LOWEST FAULTED COMPRESSIVE LOAD IN THE GROUP WOULD BE:

COMPRESSIVE FAULTED LOAD RATING = .67 (110000) = 73700#

SUMMARY OF LOAD RATINGS

FRAME SIZE	LEVEL A	LEVEL B	LEVEL C	LEVEL D
1	9121	10945	12131	17304
2	16669	20003	22170	17304
3	7210	8652	9589	17304
4	30815	36978	37549	37549
5	24564	29477	32670	37549
6	23468	28162	31212	37549

PUBLISHED LOAD RATINGS FOR LOAD CAPACITY DATA SHEETS

FRAME SIZE	LEVEL A & B	LEVEL C	LEVEL D
1	6000	8610	11520
2	6000	8610	11520
3	6000	8610	11520
4	20700	24840	26700
5	20700	24840	26700
6	20700	24840	26700

BY /B DATE 8/5/81 SUBJECT FIG 215 QUAL TEST SHEET NO. 16 OF 16
CHKD. BY NEW DATE 8/20/81 CUSTOMER SYSTEM
PROJECT PROJECT NO.

AS CAN BE SEEN THE LOAD RATINGS OBTAINED THROUGH TESTING EXCEED THE REQUIRED LOAD RATINGS OF THE SNUBBERS OR STRUTS THAT ARE ATTACHED TO THEM.

FRAME SIZE	MINIMUM SPRING RATE REQUIRED BY DESIGN SPECIFICATION	SPRING RATE OBTAINED THROUGH TESTING
1	325 KIPS/IN.	1033 KIPS/IN.
2	325 "	1236 "
3	325 "	512 "
4	1000 "	1799 "
5	1000 "	1202 "
6	1000 "	1295 "

PHE NO. 1

ATTACHMENT 8

FIG. 215 STIFF CLAMP

MODIFIED DESIGN

TORQUE RELAXATION TEST

APPROVED BY: [signature]

DATE: 7-10-81

TEST PROCEDURE

FIG. 215 STIFF CLAMP

TORQUE RELAXATION TEST

Purpose: The purpose of this procedure is for testing of the modified Fig. 215 Stiff clamp to determine if the torque value necessary to insure the required torque to maintain the specified stiffness.

Testing Apparatus: No special equipment required other than a calibrated torque wrench.

Test Set-Up: The clamp shall be secured around a pipe spool and torqued in accordance with the attached procedure.

Test Procedure: Install the specified clamps to the torque required to meet the stiffness and store so that the torque can be re-checked and recorded at the following intervals:

a) One Day

b) Two Days

c) One Week

d) Two Weeks

e) Three Weeks

f) One Month

g) Two Months

If the torque value does not change at two successive readings, discontinue checking that frame.

RESULTS

One clamp of each strap thickness grouping was assembled in accordance with the attached procedure, because the same pre-load is applied to the clamp yoke by the straps within that group (i.e., the faulted load remains the same with a frame grouping). The test results show that minor relaxation (approximately 10%) can be expected with the 0.040" Straps and the required torque values have this amount over the torque necessary to meet the required stiffness. On the 0.080" straps no relaxation was detected.

FRAME SIZE 1

Initial Torque:	25 Ft.-#
After one day:	22 Ft.-#
After two days:	22 Ft.-#
After one week:	22 Ft.-#
After two weeks:	22 Ft.-#

FRAME SIZE 4

Initial Torque:	120 Ft.-#
After one day:	120 Ft.-#
After two days:	120 Ft.-#
After one week:	120 Ft.-#

ATTACHMENT 9

FIG. 215 STIFF CLAMP

MODIFIED DESIGN

ULITMATE TORQUE TEST

DATE: 10-14-81

TEST PROCEDURE

FIG. 215 STIFF CLAMP

ULTIMATE TORQUE TEST

Purpose: The purpose of this procedure is for determining the torque necessary to cause the failure of a strap assembly of the modified Fig. 215 Stiff Clamp.

Testing Apparatus: The only special equipment needed is a calibrated torque wrench.

Test Set Up: The clamp shall be secured around a pipe spool and placed in a test fixture. When the straps are secured on the spool, the straps must be torqued by tightening one hex nut 10 percent of the required torque, then tightening the hex nut at the other end of the tie rod the same amount then proceed to the other tie rod and tighten similarily. Then repeat this sequence using 10 percent increments until a strap failure occurs. Record the failure loads.

Clamps to be Tested:

Frame Size	Pipe Size
1	2½"
1	6"
2	14"
4	3"
4	6"
5	14"

Note: To expedite the testing in some cases to simulate the test for the smallest pipe size in a frame, the largest pipe on the frame immediately preceeding in size was used. For example, the frame size 2 encompasses the pipe size range from 8" thru 14", to simulate the test for the frame size 2, 8" pipe; we tested the size 1 frame with straps for a 6" pipe. This is a representative example because of the minimal difference in length.

RESULTS OF ULTIMATE TORQUE TEST

FRAME SIZE	PIPE SIZE	REQUIRED INSTALLATION TORQUE	FAILURE TORQUE	FACTOR OF SAFETY
1	2½"	25 Ft.-#	170 #	6.8
1*	6"	35 " *	300 "	8.57
2**	14"	40 " **	160 "	4.0
4	3"	120 "	325 "	2.71
4+	6"	130 " +	400 "	3.08
5++	14"	170 " ++	300 "	1.76

* Represents the Frame 2 - 8" pipe

** Represents the Frame 3 - 16" pipe

\+ Represents the Frame 5 - 8" pipe

++ Represents the Frame 6 - 16" pipe

Above results show that, if the installation procedures provided are followed, that significant safety margins exist.

ATTACHMENT #10

FIGURE 215 MATERIAL CHANGE-OUT PROGRAM
FOR WNP-3/5 PROJECT

FIGURE 215 MATERIAL CHANGE-OUT PROGRAM FOR WNP-3/5 PROJECT

1.0 SCOPE

This program shall be implemented to affect and document the change-out of all nonconforming ITT Grinnell Figure 215 stiff clamps for WNP-3/5 Project as identified in NCR No. 14020.

2.0 CLAMPS IN VENDOR SHOP

For clamps which have not been shipped to site and require replacement parts per the new design, ITT Grinnell will perform this change-out prior to shipment. Clamp straps with visible edge tears will not be shipped to site.

3.0 CLAMP ASSEMBLIES AT WNP-3/5 SITE

3.1 GENERAL

3.1.1 For clamps received at site, the program for identifying, tracking and verifying that all nonconforming stiff clamps have been properly changed-out and documented will be as described below.

3.1.2 A listing of all stiff clamps at site will be compiled by the Engineer and transmitted to the vendor in order to establish quantities required for replacement material.

3.1.3 Upon receipt of this list the vendor will ship all replacement parts required for the modified clamp design based on quantities established from the above list. All replacement parts will be shipped in bulk form as "material", and will be segregated by type of part and corresponding clamp size (i.e. trunnion for Figure 215 clamp - size 4 for 16" pipe o.d.). All replacement parts shipped by vendor will be accompanied with proper documentation.

3.1.4 Upon receipt of the vendor replacement parts the Owner/Engineer will assure that all material and corresponding documentation has been received and processed according to approved site procedures. This information will be entered into the site computer program for tracking purposes.

3.1.5 Upon final acceptance of vendor replacement parts, the material change-out process will proceed as described below.

4.0 CLAMPS IN WAREHOUSE

4.1 For clamps currently in the warehouse the Owner/Engineer will assure that all components and corresponding replacement parts have been changed out in conformance to the latest clamp design and in accordance with the vendor's written instructions, and that all inspection, documentation and verification for this operation has been performed and accepted by the appropriate personnel. All nonconforming clamp parts from the old design that are not utilized in the modified design will be identified and surplused after change-out.

4.2 In addition to the process described above, each clamp strap will be inspected for evidence of edge tears at the time of change-out, and any strap found to have such indications will be identified and returned to the vendor for replacement. Inspection for strap edge tears will be by visual (unaided eye) method only.

4.3 The existing installation procedure plate affixed to the Figure 215 yoke body will also be removed. Removal shall be in accordance with the vendor's written instructions.

4.4 The mechanism for assuring that all required actions have been completed for this change-out process will be implemented through the use of a manual check list. This information will in turn be entered into the site computer program for future tracking and maintenance of a history file. Upon completion of each clamp assembly change-out and final check list approval, the clamp will be acceptable for issuance and field installation.

5.0 CLAMPS IN FIELD

5.1 For clamps which have been requisitioned in the field (either installed or in contractor storage), the installing contractor will be responsible for requisitioning new replacement parts from the Owner's warehouse, assuring that all clamps and corresponding replacement parts have been changed-out in conformance to the latest clamp design and in accordance with the vendor's written instructions, and that all inspection, documentation and verification for this operation has been performed and accepted by the appropriate contractor personnel. All nonconforming parts from the old design will be identified after change-out of each clamp and returned to the Owner/Engineer's warehouse.

5.2 Each clamp strap will be inspected for evidence of edge tears at the time of change-out, and any strap found to have such indications will be returned to the Owner/Engineer's warehouse for replacement. Inspection for edge tears will be by visual (unaided eye) method only.

5.3 The existing installation procedure plate affixed to the Figure 215 yoke body will also be removed. Removal will be in accordance with the vendor's written instructions.

5.4 The mechanism for assuring that all required actions have been completed for this change-out process will be implemented through the contractor's use of the manual check list described in 4.4 above. Upon completion of each clamp assembly change-out and check list sign-off, the installing contractor will forward a copy of this form to the Owner/Engineer for verification and closeout of NCR No. 14020.

6.0 CLOSE OUT

Upon completion of the material change-out program described above, including final acceptance of all documentation and verification packages, the Figure 215 NCR will be closed out.

ATTACHMENT 11

CROSS REFERENCE

ITT GRINNELL AND WNP 3/5 ENGINEERING REPORTS

CROSS REFERENCE

ITT-GRINNELL & WNP-3/5 ENGINEERING REPORTS

	ITT-G APPENDIX	WNP-3/5 ATTACHMENT
ITT-Grinnell Installation Instructions Fig. 215 Stiff Clamp - Original Design	1	1
Site Non Conformance Report 14020 Based on Original Design	2	2
Photo of Trunnion Damaged During Torquing Causing Tie-Rod Bending	3	---
Torque Testing of Original Fig. 215 Stiff Clamp to Simulate Field Failure	4	---
Photographs of the Revised Trunnion Design for the Fig. 215	5	---
Stiffness and Qualification Testing of the Modified Fig. 215 Stiff Clamp	6	7
Fig. 215 Stiff Clamp Modified Design Ultimate Torque Test	7	9
Fig. 215 Stiff Clamp Modified Design Torque Relaxation Test	8	8
Mechanical Properties of Strap Material	9	5
Results of Strap Inspection at the Warren Plant	10	3
Aeroquip's Metallurgical Analysis of 17-4 PH H1075 Material	11	---
Results of Stiff Clamp Strap Inspection at the WPPSS 3/5 Site	12	3
Aeroquip Corporation Manufacturing and Inspection Procedures	13	---
Revised Installation Procedure for the modified Fig. 215 Stiff Clamp	14	6
Typical Material Certification	15	4
Fig. 215 Material Change-Out Program For WNP-3/5 Project	—	10
Cross reference ITT-Grinnell and WNP-3/5 Engineering Final Report	—	11