FILE:RET-R-90-167

STUDY REPORT

FOR

RNP BURIED SERVICE WATER PIPING

CORROSION ISSUE

JANUARY 1991

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RNP SW BURIED PIPE CORROSION INFORMATION PAPER

1. PURPOSE AND ISSUE DESCRIPTION

I. PURPOSE: THE PURPOSE OF THIS STUDY REPORT IS TO OUTLINE THE ISSUE OF CORROSION IN THE JOINT AREAS OF THE BURIED SW PIPING AT THE ROBINSON NUCLEAR PLANT, OUTLINE CODE BASIS AND REQUIREMENTS AND PROVIDE RECOMMENDATIONS FOR RESOLUTION. THE OVERRIDING OBJECTIVE IS TO MAKE ANY REQUIRED SW PIPING REPAIRS PERMANENT, CODE REPAIRS, AND BRING THE PIPING SYSTEM TO A STATE OF LONG TERM ACCEPTABILITY.

II: ISSUE DESCRIPTION: THE RNP BURIED SW PIPING IS A 31.375" OD BY 0.188" NOMINAL WALL, CEMENT LINED PIPE DIVIDED INTO TWO HEADERS APPROXIMATELY 900 FEET LONG EACH. THE PIPING WAS PURCHASED AND INSTALLED IN 1968 UNDER THE AMERICAN WATER WORKS ASSOCIATION SPECIFICATIONS. A VISUAL AND UT INSPECTION OF THE PIPING WAS UNDERTAKEN DURING THE 1990 REFUELING OUTAGE. THAT INSPECTION REVEALED LOSS OF CROSS-SECTION IN THE AREAS OF THE PIPE NOT COATED INTERNALLY WITH CEMENT LINING, PRIMARILY IN THE BELL AND SPIGOT REGIONS (SEE ATTACHMENT A). A PROGRAM WAS UNDERTAKEN TO:

- DEFINE "WORST CASE" AREAS FOR EVALUATION AND/OR FIX
- ESTABLISH CODES & STANDARDS TO BE ADDRESSED
- INSURE PROVISIONS OF NRC GENERIC LETTER 90-05 WERE ADDRESSED USING ASME CODE CASE N-480

RNP SW BURIED PIPE CORROSION INFORMATION PAPER
2. CODE POSITION DETERMINATION AND EVALUATION

I. <u>BACKGROUND:</u> THE ROBINSON PLANT UNIT 2 BURIED SW PIPING (LINE NOS. CW-11, CW-12 AND CW-5) EXTENDING FROM THE SERVICE WATER INTAKE STRUCTURE TO THE RAB WAS ORIGINALLY ORDERED TO SPECIFICATIONS AWWA-C-202-64, AWWA-C-205-62T AND AWWA-C-203-66. SPECIFICATION 202-64 PERTAINS TO MILL-TYPE STEEL WATER PIPE, 205-62T PERTAINS TO CEMENT-MORTAR PROTECTIVE LINING AND COATING FOR STEEL WATER PIPE--4 IN. AND LARGER--SHOP APPLIED AND 203-66 PERTAINS TO COAL-TAR PROTECTIVE COATINGS AND LININGS FOR STEEL WATER PIPELINES--ENAMEL AND TAPE--HOT APPLIED. SPECIFICATION C202-64 DICTATED THE REQUIREMENTS FOR THE PHYSICAL AND CHEMICAL PROPERTIES OF THE COMPLETED PIPE, THE MANNER IN WHICH THE PHYSICAL TESTING WAS TO BE PERFORMED, AS WELL AS THE REQUIREMENTS TO WHICH REPAIRS TO INJURIOUS DEFECTS HAD TO CONFORM. IN SECTION 1.3 OF C202-64, "SUPPLEMENTARY DETAILS TO BE SPECIFIED BY PURCHASER", TWO SUPPLEMENTARY ITEMS REQUIRED TO BE SUPPLIED WHEN PURCHASING PIPE UNDER THIS STANDARD WERE PIPE OUTSIDE DIAMETER AND WALL THICKNESS. SINCE THIS AWWA STANDARD DID NOT PROVIDE ANY GUIDANCE IN THE DESIGN OF PIPING SYSTEMS, ASA B31.1-1955 WAS UTILIZED. THIS IS VERIFIED BY AEC LETTER, QUESTIONS ON FSAR 11/05/69 AND CP&L RESPONSE: QUESTION 9-5, AND AS DOCUMENTED IN THE RNP UFSAR TABLE 3.2.2-9. THE PIPE WAS INSTALLED IN 1968.

II. <u>CLASSIFICATION OF SW SYSTEM:</u> AS STATED IN LETTER CWE-753 (FROM WESTINGHOUSE TO EBASCO DATED 2/2/68) "INSPECTION OF CLASS I PIPING SYSTEMS IN THE SECONDARY PLANT", AND TABLE 3.2.1-2 OF HBR 2 UFSAR, THE SERVICE WATER PUMPS AND PIPING ARE GIVEN THE CLASSIFICATION OF CLASS I. ALL SYSTEMS AND COMPONENTS DESIGNATED CLASS I WERE DESIGNED SO THAT THERE WOULD BE NO LOSS OF FUNCTION IN THE EVENT OF THE MAXIMUM HYPOTHETICAL GROUND ACCELERATION ACTING IN THE HORIZONTAL AND VERTICAL DIRECTIONS SIMULTANEOUSLY. SINCE ASA B31.1-1955 DID NOT ADDRESS SEISMIC DESIGN, PIPING STRESS ANALYSIS FOR HBR-2 IS GOVERNED BY THE USE OF USAS B31.1-1967. THE BURIED CLASS I PIPES ARE QUALIFIED NOT WITH CRITERIA BASED CALCULATIONS BUT AS STATED IN THE ANSWER TO AEC QUESTION IIIB10c, SEPT.17,1969, "<u>THE BURIED CLASS I PIPE IS DESIGNED TO MOVE WITH THE GROUND AND ASSUME A SINUSOIDAL SHAPE CORRESPONDING TO THE GROUND WAVE WITHOUT EXCEEDING ALLOWABLE STRESSES OR OPENING OF JOINTS. THE DESIGN CRITERIA FOR THE PLANT DOES NOT INCLUDE PROVISIONS FOR GROUND FISSURES OR OTHER GROSS PERMANENT GROUND</u>

DISPLACEMENTS." THIS INCLUDES THE MECHANICAL COUPLINGS, WHICH ARE INSTALLED TO REDUCE THE LOADS ON THE INTAKE STRUCTURE AND STRAINERS DUE TO SEISMIC AND THERMAL CONDITIONS.THESE COUPLINGS BASICALLY ACT AS A TIED EXPANSION JOINT. A RELATIVE DISPLACEMENT EVALUATION WAS PERFORMED WHICH DETERMINED THE AMOUNT OF JOINT DISPLACEMENT REQUIRED TO EXIST UNDER MAXIMUM EXPECTED GROUND MOVEMENT TO BE NEGLIGIBLE (SEE ATTACHMENTS I & J). **BASICALLY, THE ORIGINAL LICENSING BASED ASSUMPTION IS THAT THE PIPE WOULD FLEX DURING AN EARTHQUAKE WITH NO LOSS OF FUNCTION.**

III. CODE POSITION: ASME SECTION XI ALLOWS ANY REPAIRS OR REPLACEMENTS TO BE PERFORMED IN ACCORDANCE WITH THE OWNER'S DESIGN SPECIFICATION AND THE ORIGINAL CONSTRUCTION CODE OF THE COMPONENT OR SYSTEM. LATER EDITIONS AND ADDENDA OF THE CONSTRUCTION CODE OR OF SECTION III, EITHER IN THEIR ENTIRETY OR PORTIONS THEREOF, AND CODE CASES MAY BE USED. REPLACEMENT OF THE CORRODED STEEL PIPE JOINTS SHALL BE IN ACCORDANCE WITH THE ORIGINAL PIPE DESIGN, ASA B31.1-1955 EDITION, "CODE FOR PRESSURE PIPING", AND AWWA STANDARD, ANSI/AWWA C206-88, TITLED "FIELD WELDING OF STEEL WATER PIPE". THE WELDING PROCEDURES, WELDERS AND QUALIFICATIONS SHALL BE IN ACCORDANCE WITH THE CP&L CORPORATE WELDING MANUAL AND WELD JOINT INSPECTION SHALL BE VISUAL IN ACCORDANCE WITH AWWA C206-88, SECTION 5.8. UPON COMPLETION OF ALL NECESSARY REPAIRS/REPLACEMENTS, THE SYSTEM HYDROTEST SHALL BE IN ACCORDANCE WITH ASME SECTION XI, IWA-5000, 1977 EDITION, SUMMER 1978 ADDENDA.

IV. BACKGROUND AND SUMMARY OF MIN. WALL CALCULATIONS: DURING THE 1990 RNP FALL OUTAGE, THE BURIED SW PIPING WAS INSPECTED AS A RESULT OF THE SCHEDULED ISI PROGRAM. THIS INSPECTION FOUND AREAS WHERE THE PIPE WALL THICKNESS HAD DECREASED TO LESS THAN THE MINIMUM REQUIRED (SEE CALCULATION, ATTACHMENT K) DUE PRIMARILY TO CORROSION. THE MINIMUM REQUIRED WALL THICKNESS, BASED ON HOOP STRESS CALCULATIONS, WAS 0.13", AS DETERMINED FROM ASA B31.1-1955. BENDING STRESS DUE TO SEISMIC CONSIDERATIONS WAS EVALUATED PER ATTACHMENT J AND FOUND TO BE NEGLIGIBLE.
NRC GENERIC LETTER 90-05 DISCUSSED GUIDANCE FOR PERFORMING TEMPORARY NON-CODE REPAIRS AND AS STATED IN THE LETTER FOR OLDER PLANTS, SAFETY RELATED PIPING IS RECLASSIFIED AS CODE CLASS 1, 2 AND 3 FOR THE PURPOSE OF INSERVICE INSPECTIONS SPECIFIED IN SECTION XI ACCORDING TO REG. GUIDE 1.26. A TYPICAL EXAMPLE OF A CODE CLASS 3 PIPING SYSTEM IS THE COOLING WATER (SERVICE WATER) SYSTEM.

IN ADDITION TO DISCUSSING TEMPORARY NON-CODE REPAIR RELIEF, THE LETTER ALSO MAKES REFERENCE TO EVALUATION TECHNIQUES FOR ASSESSING THE STRUCTURAL INTEGRITY OF FLAWED PIPING BY A FLAW EVALUATION AND ASSESSING THE OVERALL DEGRADATION OF THE SYSTEM BY AN AUGMENTED INSPECTION. THE EVALUATION TECHNIQUE, "WALL-THINNING" APPROACH, ASSUMES WALL THINNING AND EVALUATES THE STRUCTURAL STRENGTH OF THE FLAWED PIPING BASED ON THE ACCEPTANCE STANDARDS IN ARTICLE 3000 OF CODE CASE N-480. ASME CODE CASE N-480 SPECIFICALLY ADDRESSES WALL THINNING AS A RESULT OF EROSION/CORROSION.
SUBARTICLE 3400 OF ASME CODE CASE N-480 PROVIDES ACCEPTANCE STANDARDS FOR AN ERODED OR CORRODED PIPING ITEM FOR CONTINUED SERVICE WITH OR WITHOUT FURTHER EVALUATION. ALSO, THE MINIMUM WALL THICKNESS AT WHICH TIME FURTHER EVALUATION IS NOT PERMITTED IS DEFINED. THIS VALUE IS .3(Tnom.), AND FOR THIS SITUATION, THIS VALUE BECOMES .3(.188)=.0564".
SUBARTICLE 3600 OF CODE CASE N-480 DEFINES THE EVALUATION PROCEDURE AND ACCEPTANCE CRITERIA REQUIRED TO BE MET IN ORDER FOR PIPING ITEMS TO BE DETERMINED ACCEPTABLE FOR CONTINUED SERVICE. THE EVALUATION IS A TWO PART PROCEDURE. COMPLIANCE WITH THE CRITERIA OF THE FIRST PART DEMONSTRATES ADEQUACY FOR CONTINUED SERVICE WITHOUT FURTHER EVALUATION. THE FIRST CRITERION IS THAT NO FURTHER EVALUATION IS REQUIRED IF Tp (THE MINIMUM PREDICTED WALL THICKNESS) SHALL NOT BE LESS THAN Tmin.=.13". THE SECOND PART EVALUATES PIPING WITH WALL DEGRADATION DEEPER THAN THAT PERMITTED BY SUBSUBARTICLE -3610 FOR CONTINUED SERVICE, WHERE Tp<Tmin. FOR PURPOSES OF THIS EVALUATION Tp IS ASSUMED TO EQUAL Tmeasured(ACTUAL MEASURED WALL THICKNESS) SINCE THE AREAS OF WALL THINNING WILL BE COATED IN SUCH A MANNER AS TO INHIBIT FURTHER WALL EROSION/CORROSION (SEE SECTION V.).
SAMPLING PLAN AND JOINT EVALUATION: ALL STEEL EXPOSED IN THE BELL & SPIGOT JOINT AREAS WERE VISUALLY EXAMINED IN BOTH HEADERS. PRELIMINARY INTERNAL U.T.'S TAKEN ON SELECTED AREAS IN THE NORTH HEADER (AS WELL AS SOUTH HEADER) SUGGESTED MINIMUM WALL IN ALL CASES TO EXCEED Tmin (.130).THE NORTH HEADER BELL & SPIGOT JOINTS WERE THEN GROUTED. UPON CLOSER EXAMINATION OF FOUR (4) "ATYPICAL" JOINTS (NOT BELL & SPIGOT) NEAR THE INTAKE ON THE NORTH HEADER REVEALED THE PRELIMINARY U.T. METHOD TO BE IN ERROR. THE CLOSER EXAMINATION WAS BASED ON VISUAL SCREENING THAT THE "ATYPICAL" JOINTS WERE MUCH MORE CORRODED THAN THE BELL & SPIGOT JOINTS, BUT HAD SIMILAR INTERNAL U.T. READINGS. SUBSEQUENT EXTERNAL U.T.'S SHOWED THE WALL THICKNESS IN THE WORST LOCATIONS OF THE "ATYPICAL" JOINTS TO BE <.07".

THE NORTH HEADER BELL & SPIGOT JOINTS HOWEVER, HAD VISUALLY LESS CORROSION THAN THE SOUTH HEADER FOR TWO REASONS:

a. BETTER FIT-UP (ie. REDUCED GAP OF CEMENT LINING @ JOINTS) AND

b. FEWER TURNS (ie.ELBOWS)

IT WAS DETERMINED BY CP&L PERSONNEL THAT MANY JOINTS IN THE SOUTH HEADER EXHIBITED MORE SEVERE CORROSION THAN THE WORST CASE JOINT SEEN IN THE NORTH HEADER. A SAMPLE OF TWELVE (12) SOUTH HEADER JOINTS WERE CHOSEN TO REPRESENT THE OVERALL SYSTEM WORST CASES. THE SAMPLING BASIS WAS SUBSUBARTICLE -2220 OF CODE CASE N-480, WHICH OUTLINES 10% OR 10 ITEMS OF THE TOTAL POPULATION, WHICHEVER IS LESS. SINCE THE "ATYPICAL" JOINTS WERE BEING REVIEWED (AND SUBSEQUENTLY REPLACED), THE TOTAL SAMPLE POPULATION WAS REDUCED TO FORTY-FOUR (44 NORTH HEADER) PLUS FIFTY-FOUR (54 SOUTH HEADER) FOR A TOTAL OF NINETY-EIGHT (98) JOINTS. A VISUAL SCREENING WAS MADE TO DETERMINE THE WORST CASE JOINTS AND 12 WERE CHOSEN TO BE EXAMINED (ALL IN THE SOUTH HEADER INCLUDING ONE BUTT-WELDED JOINT).THIS CHOSEN POPULATION SATISFIES THE REQUIREMENT OF N-480. THE WORST PITTED AREAS IN THESE JOINTS WERE LOCALLY EXAMINED BY CONTOURING WITH PROXIMITY INFORMATION GATHERED TO INPUT INTO THE CODE EVALUATION. OF THOSE, JOINTS S-10 AND S-42 EXHIBITED MIN. WALL BELOW 0.3(Tnom.). ALL OTHERS ARE EVALUATED PER CALCULATIONS AND FORMULAS PER CODE CASE N-480. THE WORST CASE CORRODED AREA EVALUATED AND ACCEPTED WAS JOINT #32 IN WHICH THE REDUCED WALL AREA WAS < 1.5" X < 4.5" REDUCED TO A THICKNESS OF .10". IT WAS CONFIRMED BY SITE PERSONNEL THAT THIS EXTENT OF CORRODED AREA DID NOT EXIST IN THE NORTH HEADER BELL & SPIGOT JOINTS.

THIS EVALUATION PROCEDURE IS A FUNCTION OF THE DEPTH AND THE EXTENT OF THE AFFECTED AREA. AN EROSION-CORROSION AREA AND THE PARAMETERS WHICH DEFINE THE DEPTH AND EXTENT OF THINNING ARE ILLUSTRATED IN FIGURE -3621-1 OF ASME CODE CASE N-480. THE ALLOWABLE LOCAL WALL THICKNESS, Taloc, IS DETERMINED FROM SUBSUBARTICLES -3622.1, -3622.2 AND 3622.3 OF THE SAME REFERENCE, BASED ON THE EXTENT AND SHAPE OF THE THINNED AREA.

THE CALCULATION, CALC. NUMBER RNP-C/STRS-1114 (ATTACHMENT K), DETERMINES Tmin. AND PROVIDES AN EVALUATION OF THE EXISTING EROSION/CORROSION THICKNESS TO THE ALLOWABLE LOCAL WALL THICKNESS AS PERMITTED BY ASME CODE CASE N-480.

V. BASIS FOR ACCEPTANCE:

a. NORTH HEADER: THE BELL AND SPIGOT JOINTS

IN THE NORTH HEADER WERE GROUTED BASED ON INITIAL INTERNAL UT INFORMATION AND VISUAL INSPECTION. SUBSEQUENTLY, THE INTERNAL METHOD OF U.T. WAS DEEMED SUSPECT SO THE JOINTS WERE INSPECTED PRIOR TO COVERAGE BY TECH SUPPORT PERSONNEL AND FOUND TO BE IN GOOD SHAPE (NO VISUALLY HIGH CORROSION AREAS). THE FOUR ATYPICAL JOINTS FROM THE INTAKE STRUCTURE ARE BEING REPAIRED/REPLACED BASED ON THE SEVERITY OF THE CORROSION ON THOSE JOINTS. IN ADDITION, A BULGE WAS FOUND TO EXIST IN LINE 30CW-11, WHERE THE LINE CROSSES OVER THE 126.0" DIAM. CW DISCHARGE PIPE, AT APPROXIMATELY N 10+16, E 11+54. THE BULGE HAS RESTRICTED THE PIPE TO AN OVAL INTERNAL METAL TO METAL DIAMETER OF 28.75" VERTICAL, 30.5" HORIZONTAL. SINCE NO CRACKS WERE OBSERVED IN THE PIPING AND IT IS UNCERTAIN WHEN THIS CONDITION OCCURRED, DURING CONSTRUCTION OR CREEP OVER TIME, THE CONDITION IS DEEMED ACCEPTABLE AND WILL BE MONITORED AT THE NEXT REFUELING OUTAGE. THE FLOW RESTRICTION HAS ALSO BEEN DETERMINED TO BE ACCEPTABLE TO THE RNP MECHANICAL GROUP.

b. <u>SOUTH HEADER:</u> THE BELL AND SPIGOT JOINTS S-10 AND S-42, OF THE SOUTH HEADER ARE BEING REPAIRED/REPLACED BASED ON THE EVALUATIONS PERFORMED USING THE UT INFORMATION PROVIDED. OTHER MISC. JOINT REPAIR INFORMATION IS PROVIDED ON THE PIPING ISOMETRICS, ATTACHMENTS "F" AND "G".

c. <u>ACCEPTANCE OF WELDED SLEEVE AS CODE REPAIR:</u> THE BELL AND SPIGOT JOINTS, WHERE CORROSION HAS REDUCED THE WALL THICKNESS BELOW ACCEPTABLE LIMITS, SHALL BE REPLACED USING A BUTT-STRAP DESIGN WELD JOINT IN ACCORDANCE WITH AWWA C206-88 AND AWWA MANUAL M-11, CHAPTER 8, PARAGRAPH 8.2, TITLED "WELDED JOINTS". THE BUTT-STRAP DESIGN PROVIDES 2 NEW PRESSURE BOUNDARIES TO REPLACE THE CORRODED JOINT. THIS JOINT CHANGE SHALL BE IN ACCORDANCE WITH ASME SECTION XI, IWA-7000, WHICH PERMITS WORK TO BE PERFORMED TO THE REQUIREMENTS OF THE ORIGINAL CONSTRUCTION CODE, ASA B31.1-1955.

d. <u>ACCEPTANCE OF EFFECT OF WELDING ON COAL TAR COATING:</u> THE SMALL FILLET AND BUTT WELDING OF THE BUTT-STRAP JOINT WILL REMELT THE PRESENT O.D. COATING, DUE TO THE HEAT THROUGH THE PIPE WALL, AND WILL RESOLIDIFY AFTERWARDS WITHOUT DETRIMENTAL LONG TERM EFFECTS. THIS WILL BE ACCOMPLISHED BY LIMITING THE WELD HEAT INPUT BY USE OF STRINGER BEADS, LOW HEAT INPUT AND CONTROL OF THE WELD ROD USED. TO VERIFY THIS EFFECT, ONE JOINT WILL BE EXCAVATED TO EXAMINE THE O.D. AFTER WELDING, FOR ASSURANCE THAT THE RESTRICTIONS TO HEAT INPUT WERE ADEQUATE.

e. <u>ACCEPTANCE OF INTERNAL COATING TO INHIBIT FUTURE CORROSION:</u> SPEED CRETE BLUE LINE IS AN ACCEPTABLE

REPAIR FOR CEMENT LINING, WHICH CURRENTLY MEETS AWWA PIPE STANDARDS, SINCE IT IS A MORTAR CEMENT MIX FORMULATED FOR REPAIRS TO CEMENT LINED STEEL PIPING. THE STEEL SURFACES COVERED WITH CEMENT MORTAR ARE PROTECTED BY THE ALKALINE CEMENT ENVIRONMENT WHICH PASSIVATES THE STEEL AND PREVENTS IRON CORROSION IN MOST NATURAL ENVIRONMENTS. THE SURFACE PASSIVATION OCCURS QUICKLY IN NEWLY COATED SURFACES AND IS NOT DESTROYED BY MOISTURE AND OXYGEN ABSORBED THROUGH THE MORTAR COATING. ANY LEACHED PRODUCTS FROM THE CEMENT LINING CARRYING SERVICE WATER ARE ANTI-CORROSIVE. THEREFORE, THE SERVICE WATER JOINTS TO WHICH THE SPEED CRETE BLUE LINE COATING IS APPLIED WILL BE PROTECTED FROM FUTURE CORROSION ATTACK BY THE FORMATION OF A PROTECTIVE PASSIVATED FILM DUE TO THE ALKALINE CEMENT IN CONTACT WITH THE STEEL SURFACE. THE PROTECTION PROVIDED BY THIS MECHANISM WAS ADEQUATELY VERIFIED DURING THIS OUTAGE BY THE REMOVAL OF EXISTING CEMENT LINING ADJACENT TO THE UNCOATED JOINTS. UPON REMOVAL OF THE CEMENT, IT WAS SEEN THAT AFTER OVER 20 YEARS OF SERVICE, THE COATED STEEL PIPE EXHIBITED NO WALL THINNING DUE TO CORROSION ON THE INSIDE SURFACE IN CONTACT WITH THE CEMENT.

3. WALL THICKNESS MEASUREMENTS AND RESULTS

I. SEE ATTACHMENT "H" FOR WALL THICKNESS DATA AND RESULTS OF UT INSPECTIONS.

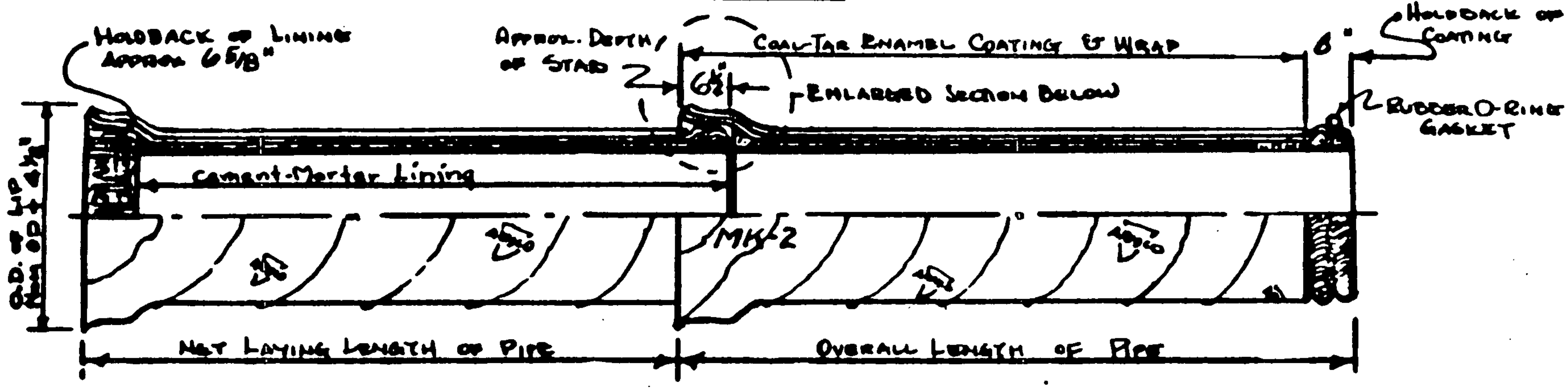
RNP SW BURIED PIPE CORROSION INFORMATION PAPER

4. CONCLUSIONS AND RECOMMENDATIONS

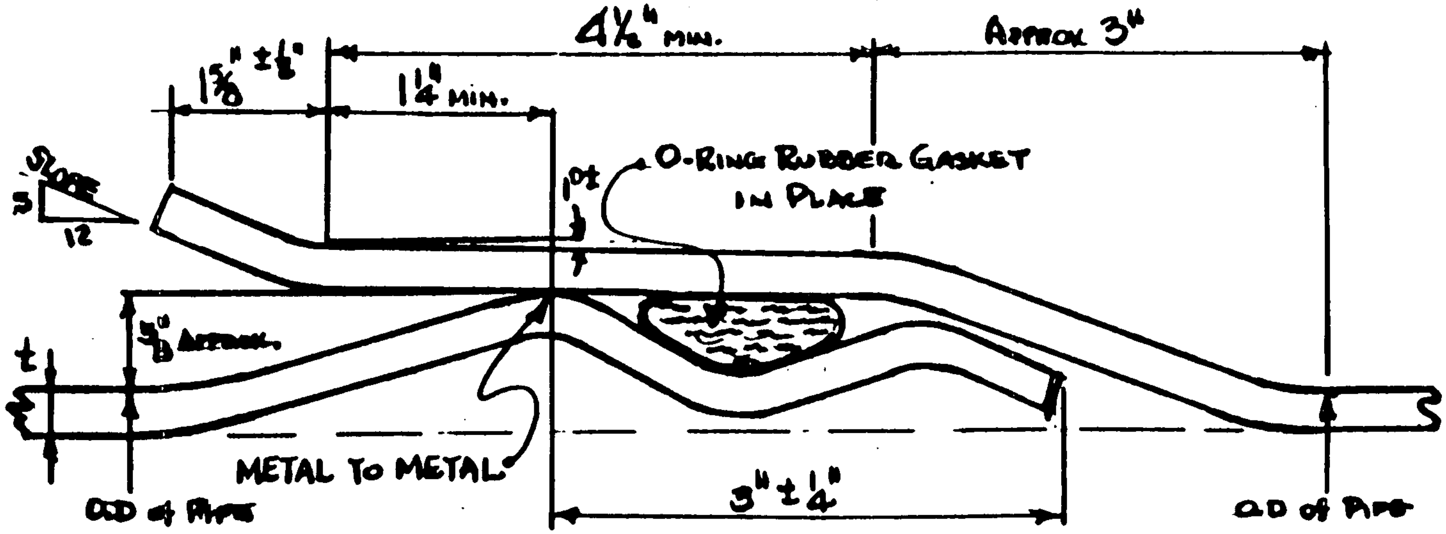
I. CONCLUSION: AS CAN BE SEEN IN THE PREVIOUS EVALUATIONS, THE BURIED SW PIPE IS ACCEPTABLE FOR CONTINUED SERVICE IN THE EXISTING CONDITION WITH THE EXCEPTION OF JOINTS S-10 AND S-42, SOUTH HEADER, AS WELL AS N-1 THRU N-4 IN THE NORTH HEADER WHICH ARE BEING REPAIRED/REPLACED. THEREFORE, ALL PIPE IS BEING RETURNED TO LONG TERM CODE COMPLIANCE IN ACCORDANCE WITH CODE CASE N-480 AND NRC GENERIC LETTER 90-05. IN ADDITION TO THE FOREGONE EVALUATION, APPROXIMATELY FIVE (5) JOINTS WERE EXCAVATED AND NONE OF THESE AREAS EXHIBITED SIGNS OF SOIL SETTLEMENT UNDER THE PIPING (i.e. NO VOID AREAS UNDER THE PIPE). ALSO, AS STATED IN ATTACHMENT L, LIQUEFACTION IS NOT A CONCERN FOR THE H.B. ROBINSON PLANT.

II. RECOMMENDATIONS: ATTACHMENTS "F" AND "G" TO THIS REPORT INDICATE THE TYPES OF REPAIRS/REPLACEMENTS WHICH ARE TO BE PERFORMED TO THE JOINTS REFERENCED IN THE ABOVE SECTION, "CONCLUSIONS".

FIGURE 1



~ SCHEMATIC DRAWING OF PIPE ~

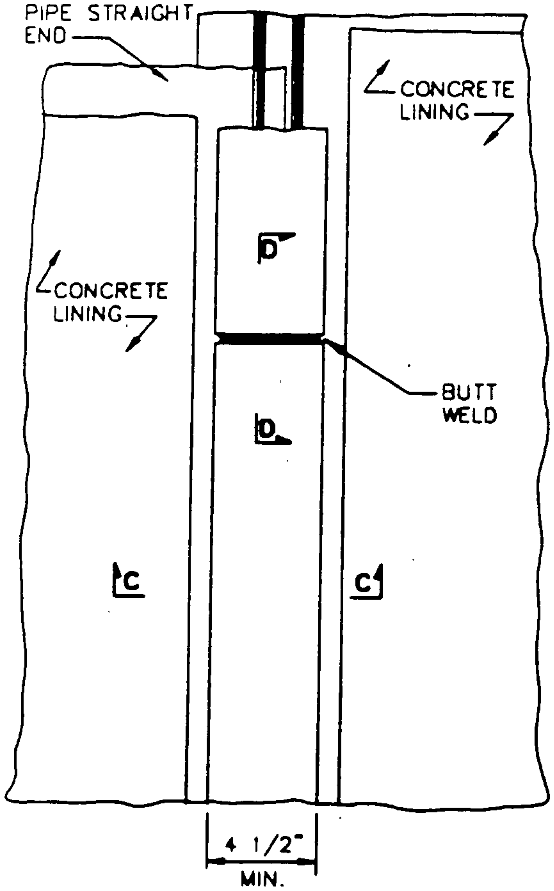


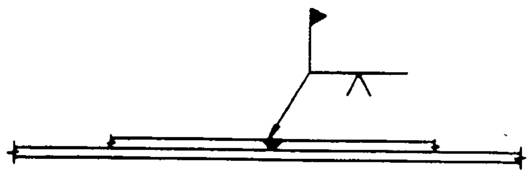
DETAILS OF BELL-AND-SPIGOT JOINT
~ COATINGS NOT SHOWN ~

ATTACHMENT "D"
1 SHEET

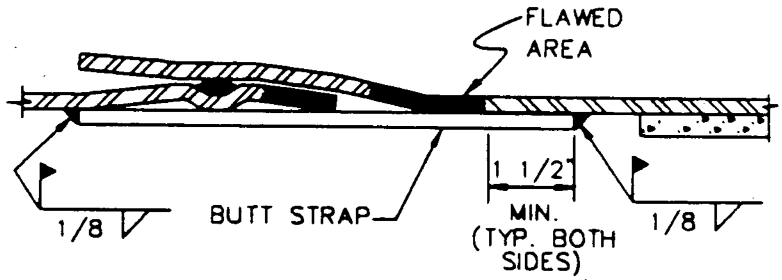
ATTACHMENT "B"
1 SHEET

BUTT STRAP DETAIL





SECTION D–D
(PLATE BUTT WELD)



SECTION C–C

NOTES:

1) PLATE TO BE SIZED TO EXTEND MIN. 1 1/2" BEYOND FLAWED AREA (4 1/2" MIN).
2) STRAP MAY BE INSTALLED IN UP TO 3 PIECES (IE, 3 BUTT WELD JOINTS).
3) STRAP MATERIAL SHALL BE ASTM A-139 GR. B OR A-36.
4) ALL WELDING TO BE IN ACCORDANCE W/ CORP. WELDING MANUAL.
5) WELDS SHALL BE APPLIED BY MEANS OF CONTINUOUS STRINGER BEADS.
6) STRAP BUTT WELD SHOULD NOT BE ALIGNED OVER EXISTING SPIRAL PIPE WELD. (*) D
7) AT LOCATION WHERE STRAP WILL FIT OVER EXISTING SPIRAL PIPE WELD, THE SPIRAL PIPE WELD CAN BE GROUND SMOOTH TO ALLOW PROPER FIT UP OF BUTT STRAP.
8) MAX. 1/8" FIT-UP TOLERANCE ALLOWED BETWEEN PIPE AND BUTT-STRAP.
9) BUTT STRAP JOINT SHALL BE COVERED BY APPROXIMATELY 3/16" GROUT.

* SEE PARA. 2.4.1 OF C206 (AWWA) D

REV	DATE	DESCRIPTION	DWN / CK	RE / DPE	DPPE	LE
D	[illegible]	INCORP. PLANT COMMENTS	DWS / [illegible]	[illegible]	[illegible]	
C	[illegible]	INCORP. PLANT COMMENTS	DWS / AMW	JCH / VKS	VKS	
B	[illegible]	ADDED NOTE 7	DWS / AMW	JCH / VKS	HLW	
A	[illegible]	BUTT STRAP DETAIL	DWS / AMW	JCH / VKS	HLW	

DPE

PROFESSIONAL ENGINEER

CAROLINA POWER & LIGHT COMPANY
NUCLEAR ENGINEERING DEPARTMENT–RALEIGH, N.C.

PLANT: H.B. ROBINSON

TITLE: BUTT STRAP JOINT DETAIL FOR BURIED SW PIPE

DWG. NO. SK-RET-R-90-167-001 | SCALE: NONE | SHEET 1 OF 1 | REV. NO. D

ATTACHMENT "C"
9 SHEETS

Approval Date: May 10, 1990

See Numerical Index for expiration and any reaffirmation dates.

Case N-480
Examination Requirements for Pipe Wall Thinning Due to Single Phase Erosion and Corrosion
Section XI, Division 1

Inquiry: What rules may be used for analytical evaluation, inservice inspection, repair and replacement of Class 1, 2, and 3 carbon and low alloy steel piping items susceptible to wall thinning as a result of the single-phase (water) erosion-corrosion phenomena?

Reply: It is the opinion of the Committee that the following rules be used.

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-1000 SCOPE AND RESPONSIBILITIES

-1100 SCOPE

This Subsection provides the rules and requirements for analytical evaluation, inservice inspection, repair, and replacement of Class 1, 2, and 3 carbon and low alloy steel piping items susceptible to wall thinning as a result of the single-phase (water) erosion-corrosion phenomena.

[1]Examples of piping items susceptible to wall thinning are elbows, tees, reducers, sections of piping, and individual pumps or valves within the piping system. Piping items do not include vessels, piping systems, or components supports.

-1200 PIPING ITEMS SUBJECT TO EXAMINATION

-1210 Examination Requirements

The examination requirements of this Subsection apply to Class 1, 2, and 3 piping items[1] in single-phase systems considered susceptible to pipe wall thinning, in accordance with -2300.

-1220 Systems Susceptible to Wall Thinning

Piping systems shall be evaluated in accordance with -2300 to determine their susceptibility to wall thinning as a result of single-phase erosion-corrosion. Single-phase systems that have experienced wall thinning as a result of erosion-corrosion include but are not limited to the following:

Main Feedwater
Auxiliary Feedwater (PWR)
Feedwater Recirculation Lines
Reactor Water Cleanup (BWR)
Steam Generator Blowdown Lines (PWR)

-2000 EXAMINATION AND INSPECTION

-2200 INITIAL EXAMINATION

-2210 Preservice Examination

(a) Examination of piping items listed in Table -2500-1 shall be completed prior to commerical service. These examinations shall include at least 10% of all those piping items identified in Table -2500-1 and considered susceptible to erosion-corrosion, but not less than 10 piping items. Determination of susceptibility shall be in accordance with -2300.

(b) Preservice examination may be conducted prior to field installation provided that examination records are documented and identified in a form consistent with those required in -6000.

-2220 Initial Examinations Conducted During Commercial Service

(a) Initial examinations of piping items listed in Table -2500-1 shall consist of 10% or 10 piping items, whichever is less, but not less than 3 piping items, identified as susceptible to erosion-corrosion.

(b) When initial examinations reveal wall thinning, additional examinations shall be performed in accordance with -2430.

-2300 SELECTION OF EXAMINATION AREAS

(a) An analytical evaluation of Class 1, 2, and 3 systems subject to single-phase flow shall be conducted to determine susceptibility to wall thinning as a result of single-phase erosion-corrosion. This evaluation shall consider the effects of nominal or actual, chemical composition, of materials, when available, system water chemistry, system temperature, system flow rate and geometry. The method of evaluation shall be made available to the regulatory and enforcement authorities having jurisdiction at the plant site. Guidance for performing this evaluation is in the course of preparation.

(b) Piping items shall be ranked both in order of predicted erosion-corrosion rate and in order of time remaining to reach minimum acceptable wall thickness. A sample of the most susceptible piping items shall be selected for examination using the rankings of -2300(b).

(c) Computer models may be used in conjunction with engineering judgment for ranking and sample selection.

(d) For piping items within a system with identical configurations and variables, and judged to be of equal susceptibility of wall thinning, only one of these items need be included in the required sample.

-2400 INSPECTION SCHEDULE

-2410 Inspection Program

The sample size established for the first inservice examination following the initial examination (-2200) shall be in accordance with Table -2500-1. These examinations shall be conducted within 12 to 24 months following the initial examination. When an evaluation of the initial examination results predicts that unacceptable wall thickness will occur prior to the planned first inservice examination, a shorter time interval shall be established.

-2420 Successive Inspections

Scheduling successive examinations shall be based on an evaluation of the results of previous examinations. The evaluation shall take into consideration changes in plant operating and design conditions since the previous evaluation and changes expected before the next examination. The frequency of examination shall be based on the predicted erosion-corrosion rate and the time remaining to reach 70% of nominal wall thickness or t_{min}, whichever is greater.

-2430 Additional Examinations

(a) Evaluations that predict the wall thickness at the next inservice examination less than 70% of nominal wall thickness or t_{min}, whichever is greater, shall require additional examinations. The additional examinations shall include the following:

(1) Equivalent piping items in other trains when the system containing the subject piping item consists of more than one train.

(2) The next two most susceptible piping items form the ranking of -2300(b) in the same train or system as the subject piping item.

(b) Evaluations of examinations required by (a) above that reveal additional piping items with predicted wall thicknesses at the next inservice examination of less than 70% of nominal wall thickness or t_{min}, whichever is greater, shall require more additional examinations shall include the next two most susceptible piping items in the same train or system as the subject piping items.

(c) When evaluation of the examinations required by (b) above reveal a piping item with predicted wall thickness at the next inservice examination of less than 70% of the nominal wall thickness or t_{min}, whichever is greater, (b) above shall be repeated until no additional wall thinning below 70% of nominal wall thickness or t_{min}, whichever is greater, is predicted.

-2500 EXAMINATION REQUIREMENTS

Piping items shall be examined as specified in Table -2500-1, except when alternative examinations are used in accordance with -2240.

-2510 Volumetric Examination

The volumetric examination required by -2500 shall be conducted from either the inside or outside surface of a piping item. It shall be demonstrated to the Inspector and documented that the examination technique is capable of measuring a wall loss with an accuracy of ±5% of nominal wall thickness of the piping item to be measured. A range of piping items is qualified when demonstration is performed using the minimum and maximum diameters to be examined. The area of wall loss used for this demonstration shall have its largest surface dimension (diameter, length, or width) less than $\sqrt{Rt}$, where R is the outside radius and t is the nominal wall thickness of the piping item. It must also be oriented in the most unfavorable direction to be encountered during the examination. Straight sections of pipe may be used for this demonstration in lieu of using the actual piping item configuration to be examined. Alternative demonstration samples may be used, provided they can be shown to produce equivalent or better examination results.

-2520 Layout of Examination Areas

A reference system shall be established for each examination that permits identification and location of each examination area. Ultrasonic examinations shall require the use of a grid pattern unless automated examination methods are applied. The grid pattern shall permit identification of each examination point. Grid sizes shall be no greater than $2\sqrt{Rt}$, except that grid sizes need not be smaller than 1 in. and shall not be larger than 6 in. Thickness readings shall be recorded at the grid intersection points, except for grid sizes 3 in. and larger, when an additional reading at the approximate center of the square defined by grid intersection points shall also be performed. The additional readings need not be recorded when they are representative of reading recorded at the intersecting points.

-2530 Supplemental Examinations

When an evaluation is performed in accordance with -3620 supplemental thickness readings shall be obtained. These thickness readings shall be recorded to map local wall thickness and the extent of thinning.

TABLE -2500-1
EXAMINATION CATEGORY

EXAMINATION CATEGORY T-A, WALL THICKNESS IN PIPING ITEMS SUSCEPTIBLE TO EROSION-CORROSION							
Item No.	Piping Items[1]	Examination Requirements	Examination Method	Acceptance Standard	Extent of Examination[2,4]	Frequency of Examination[3]	
						First Examination	Successive Examination
T1.10	Elbows, 180° Returns & Tees	Wall Thickness Measurement	Volumetric	-3000	Items and 6 in. Downstream	12-24 Months	-2420
T1.20	Curved Pipe	Wall Thickness Measurement	Volumetric	-3000	Item and 6 in. Downstream of Tangent Point	12-24 Months	-2420
T1.30	Reducers, Expanders Reducing and Expanding Elbows	Wall Thickness Measurement	Volumetric	-3000	Item and 6 in. Downstream for Reducers and Reducing Elbows. Item and 6 in. Upstream and Downstream for Expanders and Expanding Elbows.	12-24 Months	-2420
T1.40	Valves or Pumps	Wall Thickness Measurement of Piping Downstream of Valve or Pump	Volumetric	-3000	2 Pipe Diameters Downstream of Valve or Pump	12-24 Months	-2420
T1.50	Orifices	Wall Thickness Measurement of Piping Downstream of Orifice	Volumetric	-3000	2 Pipe Diameters Downstream of Orifice	12-24 Months	-2420
T1.60	Other	Wall Thickness Measurement	Volumetric	-3000	Item and 6 in. Downstream	12-24 Months	-2420

NOTES:
See Notes at end of Examination Category T-A.

TABLE -2500-1 (CONT'D)
EXAMINATION CATEGORY

EXAMINATION CATEGORY T-A, WALL THICKNESS IN PIPING ITEMS SUSCEPTIBLE TO EROSION-CORROSION

NOTES:

(1) Examination is limited to those piping items evaluated as suseptible to wall thinning. Examples of Item T1.60 are nozzles, Wyes and laterals.

(2) The piping items selected for examination shall include 10% or 10 piping items, whichever is less, but not less than 3 piping items, of those identified as being susceptible to erosion-corrosion. These items shall be distributed as follows:

(a) the examinations shall be distributed among Class 1, 2, and 3 systems, to the degree practical, with consideration given to erosion-corrosion rates and to piping items with the least time required to reach 70% of nominal wall thickness or t_{min} whichever is greater;

(b) the examinations shall be distributed among the piping items with the highest erosion rates and the least time required to reach 70% of nominal wall thickness or t_{min} whichever is greater. Not all piping item configurations need be represented in the examination sample, where either the piping item configuration is not present or is of a relatively low ranking susceptibility;

(c) for piping items within a system with identical configurations and variables and with the same susceptibility ranking, only one of these need be selected for inservice examination.

(3) The piping items selected for examination shall be re-examined within 12-24 months of completion of the Initial Examination. Subsequent examinations shall be in accordance with an examination cycle based upon the erosion-corrosion rate and the least time remaining to 70% of nominal wall thickness or t_{min} whichever is greater.

(4) If wall thickness is decreasing in downstream piping, continue extent of examination until an increasing thickness trend is established and thickness readings are greater than 70% of nominal wall thickness, or t_{min} whichever is greater.

-3000 ACCEPTANCE STANDARDS

-3100 INITIAL EXAMINATION

-3110 Preservice Examination

A predicted erosion-corrosion rate and the time remaining before the piping item reaches minimum acceptable wall thickness shall be calculated upon completion of preservice examination. A piping item predicted to be less than minimum acceptable wall thickness prior to the first examination cycle shall be evaluated in accordance with -3400.

-3120 Initial Examination Conducted During Commercial Service

(a) When the initial examination of piping item reveals a wall thickness less than 87.5% of the nominal wall thickness, that is determined to be a result of erosion-corrosion, the item shall be repaired or replaced unless an evaluation shows that an acceptable safety margin exists. This evaluation shall meet the requirements of -3400.

(b) When a predicted (calculated) erosion rate indicates that a piping item could reach minimum acceptable wall thickness prior to the first inservice examination, the item shall be repaired, replaced, or evaluated as acceptable for continued service in accordance with -3400.

-3200 INSERVICE EXAMINATION

A predicted erosion-corrosion rate and the time remaining before a piping item reached minimum acceptable wall thickness shall be calculated upon completion of the examinations performed during each outage. The effects of future changes in plant operating and design conditions that may affect the susceptibility of the piping item shall be considered in the calculations. Piping items with wall thinning shall be dispositioned in accordance with -3210.

-3210 Acceptance

(a) Piping items whose examination reveal a wall thickness less than 87.5% of the nominal wall thickness determined to be a result of erosion-corrosion, shall be repaired or replaced unless evaluation is performed which shows that an acceptable safety margin exists for continued system operation. This evaluation shall meet the requirements of -3400.

(b) When a predicted (calculated) erosion rate indicates that a piping item could reach minimum acceptable wall thickness prior to the next inservice examination, the item shall be repaired, replaced, or evaluated as acceptable for continued service, in accordance with -3400.

-3400 ACCEPTANCE STANDARDS

To accept an eroded or corroded piping item for continued service without further evaluation, the minimum predicted wall thickness (t_p), projected to the next inservice examination, shall not be less than 0.875 times the nominal thickness of the piping item, t_{nom}, as given in the design documentation. When t_p is less than $0.875t_{nom}$, the acceptability of the piping item for continued service shall be evaluated using the criteria defined in -3410 and -3420.

-3410 Evaluation for Repair or Replacement

When t_p is not greater than $0.3t_{nom}$, further evaluation is not permitted, and the piping item shall be repaired or replaced.

-3420 Evaluation for Continued Service

When t_p is less than $0.875t_{nom}$ but greater than $0.3t_{nom}$, the piping item shall be repaired, replaced, or evaluated for acceptability for continued service. An acceptable evaluation method and criteria are given in -3600. Alternative evaluation methods and criteria may be used. When alternative methods or criteria are used, the evaluation methods, the criteria, and the evaluation shall be the responsibility of the Owner and shall be subject to review by the regulatory and enforcement authorities having jurisdiction at the plant site.

-3600 ANALYTICAL EVALUATION

(a) Piping items with predicted erosion-corrosion wall thinning exceeding the standards of -3400 may be evaluated to determine their acceptability for continued service in accordance with the evaluation pro-

cedures and acceptance criteria of -3610 and -3620. The evaluation is a two part procedure. Compliance with the criteria of the first part demonstrates adequacy for continued service without further evaluation. The second part evaluates piping with deeper wall degradation.

(b) The analytical evaluation shall be the responsibility of the Owner and shall be subject to review by the regulatory and enforcement authorities having jurisdiction at the plant site.

(c) For piping items with predicted erosion-corrosion wall thinning that exceeds the acceptance standards of -3400, and satisfies the acceptance criteria of -3600, the areas containing the degradation shall be examined during three successive inservice examinations. The examination frequency shall be determined by the predicted erosion-corrosion rate in accordance with -2420. The frequency of further examinations shall be determined by the erosion-corrosion rate calculated from inservice inspection data.

-3610 Evaluation Procedure and Acceptance Criteria — Step 1

(a) For acceptance of an affected piping item for continued service without further evaluation, t_p shall not be less than t_{min}, where t_{min} is the calculated minimum wall thickness for the piping item determined from the primary stress equations of the Construction Code. Both hoop and axial stress directions shall be considered and bending load shall be included. Design pressure and design mechanical loads shall be be used at design temperature. When bending loads are not available, bounding values shall be used. Alternatively, assume t_{min} equals $0.875t_{nom}$ and proceed with Step 2, below.

(b) When t_p is less than t_{min}, an evaluation shall be performed in accordance with Step 2 below.

-3620 Evaluation Procedure and Acceptance Criteria — Step 2

-3621 Acceptance Criteria

For acceptance of an eroded or corroded piping item with degradation deeper than that permitted by -3610 for continued service, or for which it has been assumed that t_{min} equal $0.875t_{nom}$, t_p, predicted to the end of the evaluation period shall not be less than t_{aloc}, the allowable local wall thickness. The extent of degradation as measured by L_m, $L_{m(t)}$ and $L_{m(a)}$, defined in Fig. -3621-1, shall not exceed the requirements of -3622.

-3622 Evaluation Procedure

The evaluation procedure is a function of the depth and the extent of the affected area. An erosion-corrosion area and the parameters which define the depth and extent of thinning are illustrated in Fig. -3621-1. The allowable local wall thickness, t_{aloc}, is determined from -3622.1, -3622.2 and -3622.3, based on the extent and shape of the thinned area.

-3622.1 Local Thinning (Case 1). When the transverse extent of wall thinning that exceeds t_{min}, $L_{m(t)}$, is not greater than $\sqrt{Rt_{min}}$, t_{aloc} is determined from Curve 1 of Fig. -3622-1, where R is the pipe outside radius and $L_{m(t)}$ is defined in Fig. -3621-1. When the above requirement is not satisfied, -3622.2 shall be met.

-3622.2 Local Thinning (Case 2). When the maximum extent of wall thinning that exceeds t_{min}, L_m, is not greater than $2.65\sqrt{Rt_{min}}$ and t_{nom} is greater than $1.13t_{min}$, t_{aloc} is determined by satisfying both of the following equations:

$$\frac{t_{aloc}}{t_{min}} \geqslant \frac{1.5\sqrt{Rt_{min}}}{L}\left[1 - \frac{t_{nom}}{t_{min}}\right] + 1.0 \qquad (1)$$

$$\frac{t_{aloc}}{t_{min}} \geqslant \frac{0.353L_m}{\sqrt{Rt_{min}}} \qquad (2)$$

When the above requirements are not satisfied, -3622.3 shall be met.

-3622.3 Local Thinning (Case 3)

When the requirements of both -3622.1 and -3622.2 are not satisfied, t_{aloc} is determined from

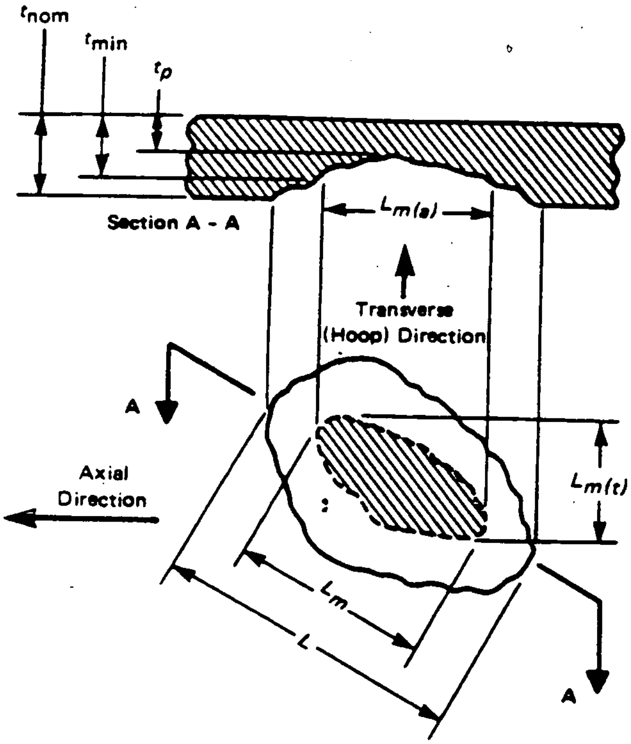

FIG. -3621-1 ILLUSTRATION OF EROSION-CORROSION WALL THINNING

Curve 2 of Fig. -3622-1. In addition, t_{aloc} shall satisfy the applicable Construction Code equation:

For Section III and B31.7, Class 1 piping systems

$$\frac{t_{aloc}}{t_{min}} \geqslant \frac{\left[B_1 + \left(\frac{t_{nom}}{t_{min}}\right)\left(\frac{P_b}{S_m}\right)\right]}{1.5} \qquad (3)$$

For Section III, Class 2 and 3 piping systems

$$\frac{t_{aloc}}{t_{min}} \geqslant \frac{\left[B_1 + \left(\frac{t_{nom}}{t_{min}}\right)\left(\frac{P_b}{S_h}\right)\right]}{1.8} \qquad (4)$$

For B31.7, Class 2 and 3, and B31.1 piping systems

$$\frac{t_{aloc}}{t_{min}} \geqslant \frac{\left[0.5 + \left(\frac{t_{nom}}{t_{min}}\right)\left(\frac{P_b}{S_h}\right)\right]}{1.2} \qquad (5)$$

where P_b is the pipe longitudinal bending stress resulting from all primary pipe loadings. The other terms are defined in the applicable Construction Code.

-4000 REPAIR PROCEDURES

-4100 GENERAL REQUIREMENTS

Repairs shall be made in accordance with Section XI, Division 1, IWA-4000 and IWB-4000, IWC-4000 or IWD-4000, as applicable.

-7000 REPLACEMENT PROCEDURES

-7100 GENERAL REQUIREMENTS

Replacements shall be made in accordance with Section XI, Division 1, IWA-7000 and IWB-7000, IWC-7000 and IWD-7100 as applicable.

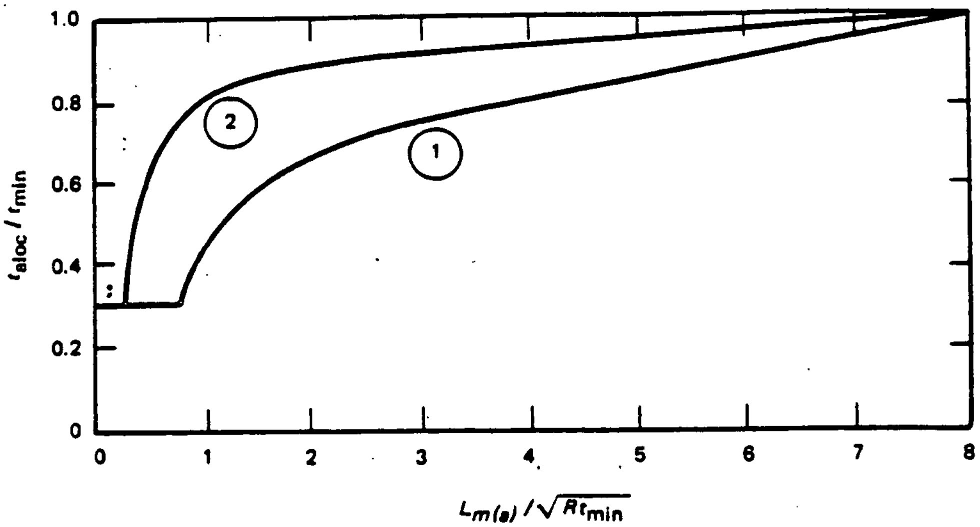

FIG. -3622-1 ALLOWABLE DEPTH AND LENGTH OF LOCALLY THINNED AREA

ATTACHMENT "D"
14 SHEETS

~~DFB~~ MAH
p/s list

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

June 15, 1990

TO: ALL HOLDERS OF OPERATING LICENSES FOR NUCLEAR POWER PLANTS

SUBJECT: GUIDANCE FOR PERFORMING TEMPORARY NON-CODE REPAIR OF ASME CODE CLASS 1, 2, AND 3 PIPING (GENERIC LETTER 90-05)

INTRODUCTION

Section XI of the ASME Boiler and Pressure Vessel Code (hereafter called the code) specifies code-acceptable repair methods for flaws that exceed code acceptance limits in piping that is in service. A code repair is required to restore the structural integrity of flawed ASME Code piping, independent of the operational mode of the plant when the flaw is detected. Those repairs not in compliance with Section XI of the ASME Code are non-code repairs. However, the required code repair may be impractical for a flaw detected during plant operation unless the facility is shut down. Pursuant to 10 CFR 50.55a(g)(6)(i), the Commission will evaluate determinations of impracticality, and may grant relief and may impose alternative requirements. The staff has developed a position on temporary non-code repairs depending on the ASME Code class of the piping. The staff continues to find temporary non-code repairs of code Class 1, 2 and 3 piping unacceptable without specific written relief granted by the NRC. However, this generic letter provides guidance that will be considered by the NRC staff in evaluating relief requests submitted by licensees for temporary non-code repairs of code Class 3 piping.

Temporary non-code repairs are applicable until the next scheduled outage exceeding 30 days, but no later than the next scheduled refueling outage. This guideline applies when a flaw is detected during plant operation. If a flaw is detected during a scheduled shutdown, a code repair is required before plant restart.

Code Repair Versus Temporary Non-Code Repair

Article IWA-4000 of Section XI of the ASME Code describes the code repair procedures. A code repair requires the removal of the flaw and a subsequent weld repair. The repair weld is subject to post-repair nondestructive examination and a post-repair pressure test may also be required. A code repair is practical during a scheduled shutdown. If a flaw is detected during plant operation, the plant may have to be shut down to perform a code repair. To avoid a plant shutdown and to limit the leakage from a through-wall flaw, some licensees have used temporary non-code repairs such as clamps with rubber gasketing, encapsulation of leaking pipes in cans using liquid sealants, or weld overlays. Temporary non-code repairs are not permitted on ASME Code piping without prior relief from the NRC.

STAFF POSITION

This staff guidance on temporary non-code repairs depends on the ASME Code class of the piping. Safety-related piping for recent plants is classified as code Class 1, 2, and 3, according to Regulatory Guide 1.26. For older plants, safety-related piping is reclassified as code Class 1, 2, and 3 for the purpose of inservice inspection specified in Section XI according to Regulatory Guide 1.26. Piping in the reactor coolant pressure boundary is code Class 1. Typical examples of code Class 2 piping are those in engineered safety feature systems connected to the reactor coolant pressure boundary that are designed for emergency core cooling, residual heat removal, reactor shutdown, and containment heat removal. Typical examples of code Class 3 piping are those in the cooling water, seal water, and auxiliary feedwater systems.

ASME Code Class 1 and 2 Piping

For code Class 1 and 2 piping, a licensee is required to perform code repairs or request NRC to grant relief for temporary non-code repairs on a case-by-case basis regardless of pipe size. Temporary non-code repairs of code Class 1 and 2 piping must have load-bearing capability similar to that provided by engineered weld overlays or engineered mechanical clamps. Licensee requests based on repairs such as encapsulation of leaking pipes in cans using liquid sealants, clamps with rubber gasketing, or non-engineered weld overlays (patches) will not be approved by the staff.

Engineered weld overlays or engineered mechanical clamps are designed to meet the load-bearing requirements of the piping, assuming that the flaw is completely through the wall for 360^{o}, that is, all around the pipe circumference, at the location of the flaw. Engineered weld overlays and engineered mechanical clamps are discussed in Generic Letter 88-01, "NRC Position on IGSCC in BWR Austenitic Stainless Steel Piping."

ASME Code Class 3 Piping

For code Class 3 piping, a licensee is also required to perform code repairs or request NRC to grant relief for temporary non-code repairs on a case-by-case basis regardless of pipe size. Because of the rather frequent instances of small leaks in some Class 3 systems, such as service water systems, the staff is providing guidance in Enclosure 1 that will be considered by the staff in evaluating relief requests for temporary non-code repairs of code Class 3 piping. The guidance for code Class 3 piping in Enclosure 1 consists of assessing the structural integrity of the flawed piping by a flaw evaluation and assessing the overall degradation of the system by an augmented inspection. In addition, licensee evaluation should consider system interactions such as flooding, spraying water on equipment, and loss of flow. Furthermore, temporary non-code repairs should be evaluated for design loading conditions.

Temporary non-code repairs of code Class 3 piping in high energy systems, that is, the maximum operating temperature exceeds 200^{o}F or the maximum operating pressure exceeds 275 psig, must have load-bearing capability similar to that provided by engineered weld overlays or engineered mechanical clamps. Licensee requests for high energy Class 3 piping based on repairs such as encapsulation of leaking pipes in cans using liquid sealants, clamps with rubber gasketing, or non-engineered weld overlays (patches) will not be approved by the staff. For temporary non-code repairs of code Class 3 piping in moderate energy systems, that is, other than high energy systems, the licensee may consider non-welded repairs. Furthermore, the structural integrity of the temporary non-code repair of code Class 3 piping should be assessed periodically.

For code Class 3 piping, two specific flaw evaluation approaches as discussed in Enclosure 1 should be considered, namely, the "through-wall flaw" and the "wall thinning" approaches. If the flaw is found acceptable by the "through-wall flaw" approach, a temporary non-code repair may be proposed. If the flaw is found acceptable by the "wall thinning" approach, immediate repair is not required but the licensee should comply with the guideline for repair and monitoring. An augmented inspection is a part of the relief acceptance criteria. The extent of the augmented inspection is more stringent for high energy lines than for moderate energy lines because of the potential for more severe failure consequences.

CONCLUSIONS

The staff concludes that adherence to the guidance provided in this generic letter will reasonably assure structural integrity and protect public health and safety. The staff has determined that an ASME Code repair is required for code Class 1, 2 and 3 piping unless specific written relief has been granted by the NRC. However, the staff has determined that temporary non-code repair of Class 3 piping that cannot be isolated without a plant shutdown is justified in some instances. The rather frequent instances of small leaks in some Class 3 systems, such as service water systems, could lead to an excessive number of plant start-up and shutdown cycles with undue and unnecessary stress on facility systems and components if the facilites were to perform a code repair when the leakage is identified. For the purpose of this generic letter, impracticality is defined to exist if the flaw detected during plant operation is in a section of Class 3 piping that cannot be isolated for completing a code repair within the time period permitted by the limiting condition for operation (LCO) of the affected system as specified in the plant Technical Specifications, and performance of code repair necessitates a plant shutdown. Pursuant to 10 CFR 50.55a(g)(6)(i), the Commission may grant relief for temporary non-code repair of code Class 3 piping, where impracticality exists in performing an ASME Code repair while the facility is operating, based on a staff evaluation considering the guidance in this generic letter.

Backfit Discussion

The objective of this generic letter is to maintain structural integrity of repaired ASME Code piping. The staff is not imposing a new or different position. However, this generic letter provides guidance that will be considered by the NRC staff in evaluating relief requests submitted by licensees for temporary non-code repairs of code Class 3 piping. Compliance with the staff guidance is not required. Because the implementation of the guidance for Class 3 piping is voluntary, 10 CFR 50.109 does not apply.

This generic letter consists of guidance and does not require a response. Therefore, an OMB clearance number is not necessary.

If you have any questions about this matter, please contact one of the NRC technical contacts listed below.

Sincerely,

James G. Partlow
Associate Director for Projects
Office of Nuclear Reactor Regulation

Enclosures:
1. Staff Guidance in Evaluating Relief Requests for Temporary Non-Code Repair of ASME Code Class 3 Piping
2. Listing of Recently Issued Generic Letters

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STAFF GUIDANCE IN EVALUATING RELIEF REQUESTS FOR TEMPORARY NON-CODE REPAIR OF ASME CODE CLASS 3 PIPING

A. INTRODUCTION

The guidance provided herein will be considered by the NRC staff in evaluating relief requests submitted by licensees for temporary non-code repairs of ASME Code Class 3 piping. The guidance is restricted in scope and has limitations and specific considerations. The guidance consists of assessing the structural integrity of the flawed piping by a flaw evaluation and assessing the overall degradation of the system by an augmented inspection. For a relief request prepared according to criteria different from those set out in this guidance, the staff will evaluate case-by-case the basis provided by the licensee.

B. SCOPE, LIMITATIONS, AND SPECIFIC CONSIDERATIONS

1. Scope

Only ASME Code Class 3 piping fabricated from ferritic steel or austenitic stainless steel are within the scope of this guidance. However, leakage through a flange gasket is not considered to be a flaw in the piping by Section XI of the ASME Code and is excluded. Furthermore, pumps, valves, heat exchangers, and components other than piping are excluded. For materials other than ferritic steel and austenitic stainless steel, a licensee should justify the material properties used in the flaw evaluation of Section C.3.a below.

2. Limitations

This guideline for temporary non-code repair of code Class 3 piping applies when a flaw, which originates in the inner diameter of the pipe, is detected during plant operation. If a flaw is detected during a scheduled shutdown, a code repair is required before plant restart. A temporary non-code repair is applicable until the next scheduled outage exceeding 30 days, but no later than the next scheduled refueling outage. The temporary non-code repair should then be replaced with a code repair.

3. Specific Considerations

System interactions such as the consequences of flooding and spraying water on equipment should be considered. The potential significance of a loss of flow to the system should also be considered. Furthermore, temporary non-code repairs should be evaluated for design loading conditions, such as deadweight, pressure, thermal expansion, and seismic loads.

The integrity of the temporary non-code repair of code Class 3 piping should be assessed at least every 3 months by a suitable nondestructive examination (NDE) method. This examination should involve the application of ultrasonic testing (UT) or radiographic testing (RT). Furthermore, a qualitative assessment of leakage through the temporary non-code repair should be performed at least every week during plant walkdown inspections to determine any degradation of structural integrity. The licensee should perform an engineering evaluation to assess the rate and extent of the degradation to determine what remedial measures are required. A temporary non-code repair is no longer valid if the structural integrity is not assured.

ASME Code Class 3 piping encompasses both high energy systems, that is, the maximum operating temperature exceeds 200°F or the maximum operating pressure exceeds 275 psig, and moderate energy systems, that is, other than high energy systems. Temporary non-code repairs of code Class 3 piping in high energy systems must have load-bearing capability similar to that provided by engineered weld overlays or engineered mechanical clamps. Licensee requests based on repairs such as encapsulation of leaking pipes in cans using liquid sealants, clamps with rubber gasketing, or non-engineered weld overlays (patches) will not be approved by the staff.

Engineered weld overlays or engineered mechanical clamps are designed to meet the load-bearing requirements of the piping, assuming that the flaw is completely through the wall for 360°, that is, all around the pipe circumference, at the location of the flaw. The staff position on engineered weld overlays is provided in Generic Letter 88-01, "NRC Position on IGSCC in BWR Austenitic Stainless Steel Piping." For engineered weld overlays of ferritic steel piping, the calculation method described in ASME Code Case N-463 is recommended. Furthermore, overlay welding on ferritic piping may be performed according to the "half bead" technique described in Section XI or the "temper bead" technique described in ASME Code Case N-432 without the specified post-weld heat treatment (PWHT) requirements of Article NB-4622 of Section III of the ASME Code. The staff position on engineered mechanical clamps is also provided in Generic Letter 88-01, and such devices require staff review on an individual case basis.

For temporary non-code repairs of code Class 3 piping in moderate energy systems, the licensee may consider (1) non-welded repairs, and (2) leaving the piping as-is if there is no leakage and the flaw is found acceptable by the "through-wall flaw" approach discussed in Section C.3.a below.

C. EVALUATION GUIDELINE

Figure 1 shows a flow chart for the staff evaluation guideline on temporary non-code repairs of code Class 3 piping. The flow chart consists of (1) flaw detection during plant operation and impracticality determination, (2) root cause determination and flaw characterization, (3) flaw evaluation, and (4) augmented inspection.

1. Flaw Detection During Plant Operation and Impracticality Determination

The initiating event is the detection of a flaw in code Class 3 piping during plant operation. An example would be the discovery of a leak in a service water system pipe by maintenance personnel during plant operation. The licensee should determine the existence of any impracticality in performing a code repair. If practical, that is, if the affected section of piping can be isolated for completing a code repair within the time period permitted by the limiting condition for operation (LCO) without a plant shutdown, the licensee is required to perform a code repair.

2. Root Cause Determination and Flaw Characterization

The root cause of the piping degradation should be determined. The flaw evaluation criteria in the staff guidance assume a localized flaw. The flaw geometry should be characterized by a suitable NDE method for subsequent flaw evaluation. This examination should involve the application of UT or RT techniques. The flaw geometry should be suitably bounded to account for NDE uncertainties and limitations. Figure 2a shows a schematic of a generalized flaw in a pipe wall originating in the inner diameter of the pipe. The flaw may or may not be through-wall.

3. Flaw Evaluation

The structural integrity of the flawed piping should be assessed by a flaw evaluation. Two specific flaw evaluation approaches as discussed below should be considered, namely, the "through-wall flaw" and the "wall thinning" approaches. The flawed piping should satisfy the criteria of either of these two approaches. The licensee may select either approach for flaw evaluation, except that the "wall thinning" approach is not applicable to (1) a through-wall flaw, including a pinhole leaking flaw, and (2) a crack-like flaw. It is noted that the "through-wall flaw" approach may be applied to a flaw that is not through-wall.

a. "Through-Wall Flaw" Approach

This approach assumes a through-wall flaw and evaluates the flaw stability by a linear elastic fracture mechanics methodology. Figure 2b shows some geometric parameters used in the evaluation. The code-required minimum wall thickness "t_{min}" should be determined. The maximum length of the portion of the flaw that extends beyond "t_{min}", independent of orientation with respect to the pipe, is the through-wall flaw length "2a". As shown in Figure 2b, the flaw does not have to be through-wall for the application of this approach. The length "2a" can be determined according to Figure 2b for a flaw that may or may not be through-wall.

If the length "2a" exceeds either 3 inches or 15 percent of the length of the pipe circumference, the flaw is not acceptable by this approach.

The stress "s" at the flawed location should be determined from the combination of deadweight, pressure, thermal expansion, and safe-shutdown earthquake (SSE). For evaluation purposes, the through-wall flaw length "2a" should be conservatively assumed to be in the circumferential direction and the stress "s" should be assumed to be a bending stress. A safety factor of 1.4 should be applied to the stress as shown in equation (1) below. This safety factor is consistent with the factor of a square root of two on the stress intensity for flaw evaluation under faulted loads in Article IWB-3600 of Section XI of the ASME Code.

Based on linear elastic fracture mechanics and assuming a pipe thickness of "t_{min}", the stress intensity factor "K" resulting from the flaw under the applied load is given in Reference 1 as

$$K = 1.4 \ s \ F \ (3.1416 \ a)^{0.5} \qquad (1)$$

where the geometry factor "F" is

$$F = 1 + A \ c^{1.5} + B \ c^{2.5} + C \ c^{3.5} \qquad (2)$$

where

$$c = a / (3.1416 \ R) \qquad (3)$$

R = mean pipe radius

$$A = -3.26543 + 1.52784 \ r - 0.072698 \ r^2 + 0.0016011 \ r^3 \qquad (4)$$

$$B = 11.36322 - 3.91412 \ r + 0.18619 \ r^2 - 0.004099 \ r^3 \qquad (5)$$

$$C = -3.18609 + 3.84763 \ r - 0.18304 \ r^2 + 0.00403 \ r^3 \qquad (6)$$

$$r = R / t_{min} \qquad (7)$$

For flaw stability, linear elastic fracture mechanics methodology specifies "K" to be less than the critical stress intensity factor which represents the fracture toughness of the material.

For ferritic steel, the value of "K" from equation (1) should be less than 35 $ksi(in)^{0.5}$, which is consistent with the lower-bound fracture toughness property in ASME Code Case N-463.

For austenitic stainless steel, the value of "K" from equation (1) should be less than 135 $ksi(in)^{0.5}$, which is consistent with the lower-bound fracture toughness property used in Article IWB-3640 of Section XI of the ASME Code.

If the flaw satisfies the criteria of this evaluation approach, a temporary non-code repair of the code Class 3 piping may be proposed. It is noted that the rate of degradation is not considered in this approach because the flaw is assumed to have grown through the pipe wall and the temporary non-code repair is applicable, at maximum, until the next scheduled refueling outage.

b. "Wall Thinning" Approach

This approach assumes wall thinning and evaluates the structural strength of the flawed piping based on the acceptance standards in Article 3000 of ASME Code Case N-480. Although ASME Code Case N-480 addresses wall thinning as a result of erosion/corrosion, the acceptance standards in ASME Code Case N-480 are extended by the staff to all wall thinning mechanisms such as microbiologically induced corrosion (MIC) for applications within the scope of this generic letter.

Figure 2c shows some geometric parameters used in the evaluation. The code-required minimum wall thickness "t_{min}" should be determined. The minimum measured wall thickness "t_{meas}" should be determined by NDE. Based on an estimated wall thinning rate and "t_{meas}", the minimum predicted wall thickness "t_p" projected to the next inservice examination should be determined. ASME Code Case N-480 provides rules for determining the allowable local wall thickness "t_{aloc}" for the measured length of the flaw. Local wall thinning is acceptable if "t_p" exceeds "t_{aloc}".

If the flaw satisfies the criteria of this evaluation approach, immediate repair of the code Class 3 piping is not required. However, the licensee should comply with the repair and monitoring guideline in ASME Code Case N-480.

c. Single Versus Multiple Flaws

If multiple proximate flaws are detected, they may have to be considered in the flaw evaluation as a single flaw. The guideline discussed in this section is based on Article IWA-3330 of Section XI of the ASME Code.

Figure 3a shows the geometric parameters used in the evaluation for the "wall thinning" approach. The minimum spacing "S", independent of orientation relative to the pipe, between two flaws of depths "d_1" and "d_2" are shown. For "d_2" larger than "d_1", the two flaws should be treated as a single flaw if "S" is less than or equal to two times "d_2".

Figure 3b shows the geometric parameters used in the evaluation for the "through-wall flaw" approach. The difference between Figure 3a and Figure 3b is that the parameters are measured from "t_{min}" in Figure 3b. The minimum spacing "S^*", independent of orientation relative to the pipe, between two flaws of depths "d_1^*" and "d_2^*" is shown. For "d_2^*" larger than "d_1^*", the two flaws should be treated as a single flaw if "S^*" is less than or equal to two times "d_2^*".

4. Augmented Inspection

If the flaw is evaluated and found acceptable by one of the above evaluation approaches, the licensee should perform an augmented inspection via UT or RT to assess the overall degradation of the affected system. The augmented inspection, performed within 15 days of detection of the flaw which results in a temporary non-code repair, is a part of the relief acceptance criteria of the temporary non-code repair of code Class 3 piping.

From the root cause determination, the most susceptible locations should be identified. The extent of the augmented inspection depends on whether the line is high energy or moderate energy. The failure of a high energy line may have more severe consequences than the failure of a moderate energy line because of the energy content. Thus, a more extensive augmented inspection should be performed for high energy lines. As shown in Figure 1, the inspection of at least 10 most susceptible (and accessible) locations for high energy lines and at least 5 most susceptible (and accessible) locations for moderate energy lines should be performed. Flaws detected in the augmented inspection should be characterized and evaluated. If any flaw is detected having a minimum measured wall thickness "t_{meas}" less than the code-required minimum wall thickness "t_{min}" in the augmented inspection sample, inspection of an additional sample of the same size should be performed. This process should be repeated within 15 days of each other until no flaw having "t_{meas}" less than "t_{min}" is detected in the additional inspection sample or until 100 percent of susceptible (and accessible) locations have been inspected.

D. REFERENCES

1. "NRC Leak-Before-Break (LBB.NRC) Analysis Method for Circumferentially Through-Wall Cracked Pipes Under Axial Plus Bending Loads," NUREG/CR-4572, May 1986.

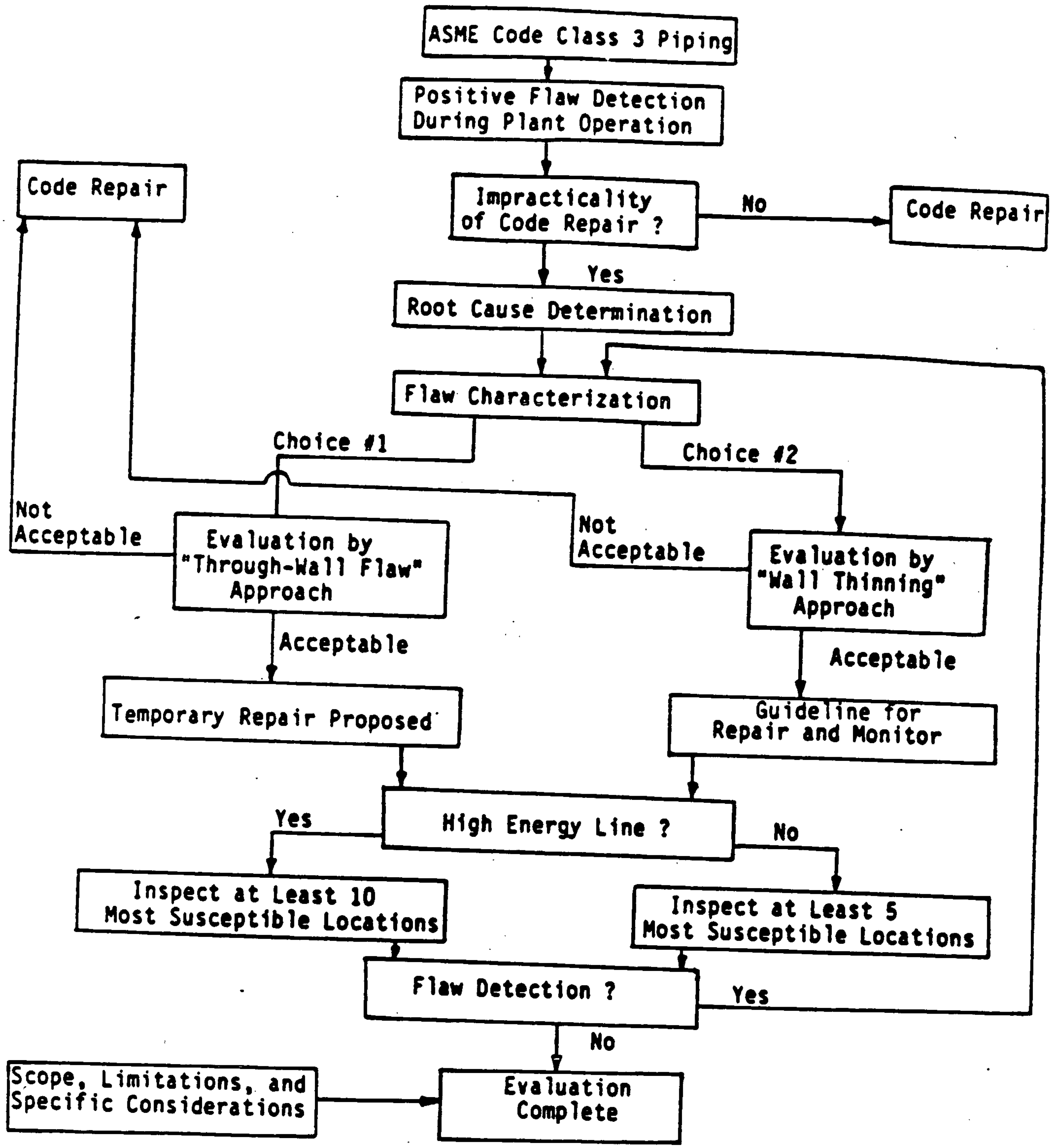


Fig. 1 Flow chart of staff guidance in evaluating relief requests for temporary non-code repair of ASME Code Class 3 piping.

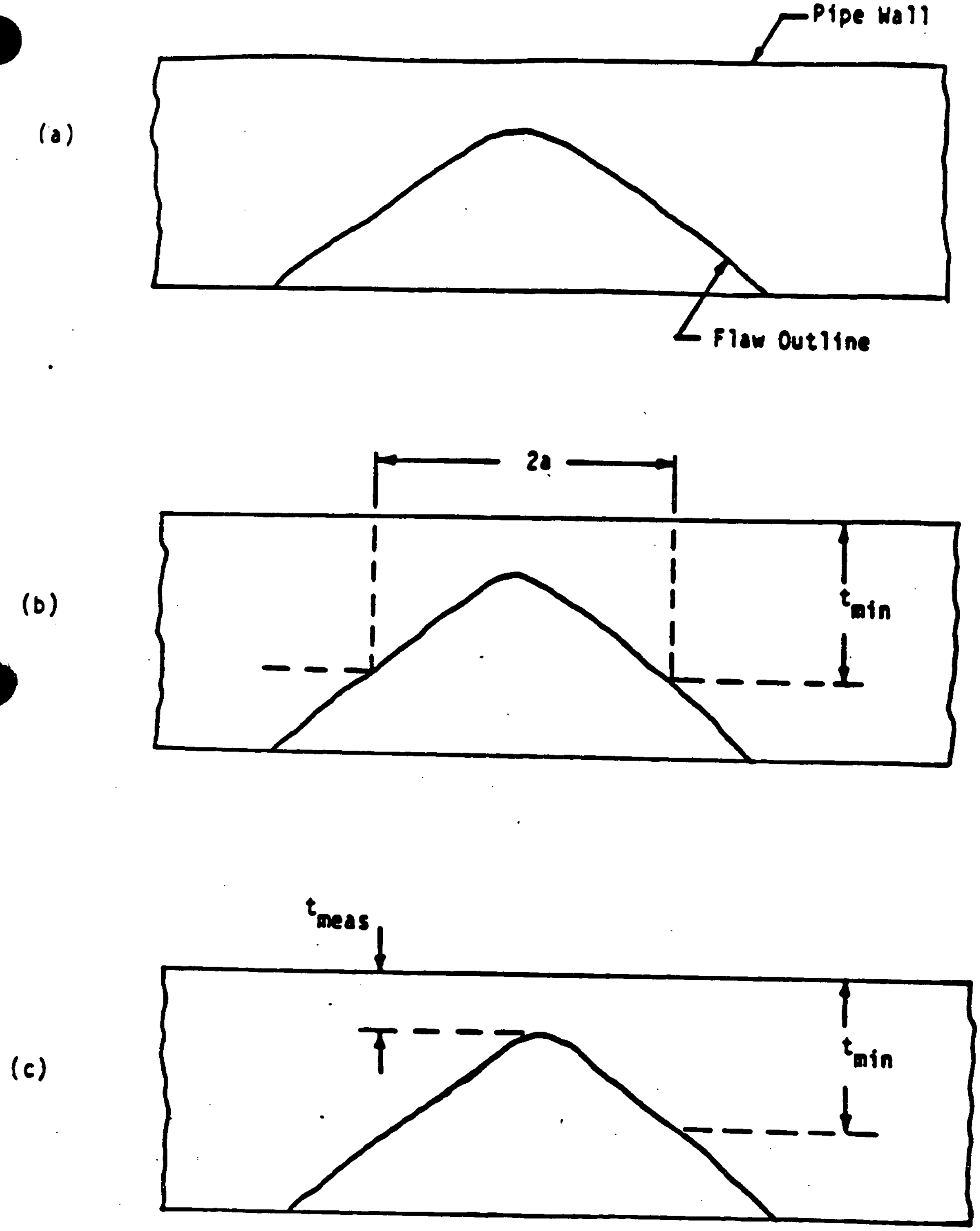


Fig. 2 Schematic of (a) generalized flaw, (b) parameters in "through-wall flaw" approach, and (c) parameters in "wall thinning" approach.

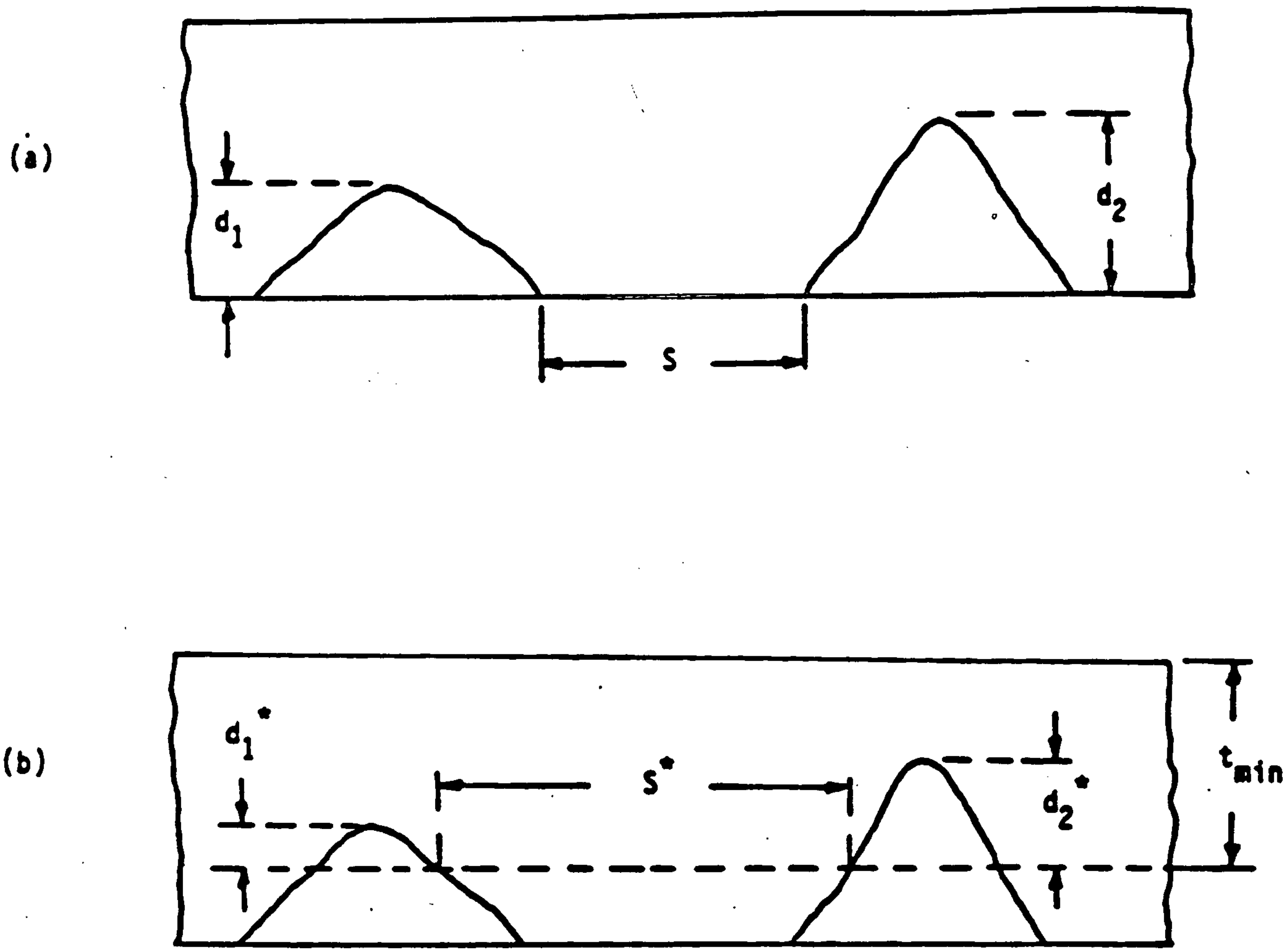


Fig. 3 Schematic indicating parameters in determining single versus multiple flaws for (a) "wall thinning" approach and (b) "through-wall flaw" approach.

LIST OF RECENTLY ISSUED GENERIC LETTERS

Generic Letter No.	Subject	Date of Issuance	Issued To
89-10 SUPP. 1	RESULTS OF THE PUBLIC WORK-SHOP	06/13/90	ALL LICENSEES OF OPERATING NPPs AND HOLDERS OF CPs
90-03 SUPP. 1	RELAXATION OF STAFF POSITION IN GL 83-28, ITEM 2.2 PART 2, "VENDOR INTERFACE FOR SAFETY-RELATED COMPONENTS"	05/14/90	ALL POWER REACTOR LICENSEES AND APPLICANTS
90-04	REQUEST FOR INFORMATION ON THE STATUS OF LICENSEE IMPLEMENTATION OF GENERIC SAFETY ISSUES RESOLVED WITH IMPOSITION OF REQUIREMENTS OR CORRECTIVE ACTIONS	04/25/90	ALL HOLDERS OF OLs AND CPs FOR NUCLEAR POWER PLANTS
89-13 SUPP. 1	SERVICE WATER SYSTEM PROBLEMS AFFECTING SAFETY-RELATED EQUIPMENT	04/04/90	ALL HOLDERS OF OLs OR CPs FOR NUCLEAR POWER PLANTS
88-20, SUPP. 2	ACCIDENT MANAGEMENT STRATEGIES FOR CONSIDERATION IN THE INDIVIDUAL PLANT EXAM PROCESS	04/04/90	ALL HOLDERS OF OLs AND CPs FOR NUCLEAR POWER REACTOR FACILITIES
90-03	RELAXATION OF STAFF POSITION IN GL 83-28, ITEM 2.2, PART 2 "VENDOR INTER-FACE FOR SAFETY-RELATED COMPONENTS"	03/20/90	ALL POWER REACTOR LICENSEES AND APPLICANTS
90-02	ALTERNATIVE REQUIREMENTS FOR FUEL ASSEMBLIES IN THE DESIGN FEATURES SECTION OF TECHNICAL SPECIFICATIONS	02/01/90	ALL LWR LICENSEES AND APPLICANTS
90-01	REQUEST FOR VOLUNTARY PARTICIPATION IN NRC REGULATORY IMPAC SURVEY	01/18/90	ALL LICENSEES OF OPERATING REACTORS & CONSTRUCTION PERMITS FOR LWR NUCLEAR POWER PLANTS

ATTACHMENT "E"
4 SHEETS

Chapter 8

Pipe Joints

The pipe joint selected and the care with which it is installed are important considerations for the design engineer and inspector. Many kinds of joints are used with steel water pipe. Common types are bell-and-spigot rubber-gasket joints, field-welded joints (both illustrated in Figure 8-1), sleeve couplings, grooved-and-shouldered couplings, and flanges. All of these joints are covered in this chapter. Patented joints obtainable from some pipe manufacturers include, among others, the integral mechanical-compression gasket of stuffing-box type and the roll-on gasket type. Recommended use and design data for patented joints may be obtained from the manufacturer of the joint.

8.1 BELL-AND-SPIGOT JOINT WITH RUBBER GASKET

Several types of rubber-gasket field joints (shown in Figures 8-1E, 8-1F, 8-1G, 8-1H, and 8-1I) have been developed for steel water-pipe service. Gasketed joints permit rapid installation in the field and, when properly manufactured and installed, they provide a watertight joint that will give long service without maintenance. The design of the joints allows flexibility in the line, permitting certain angular and longitudinal movement due to settlement of the ground or other conditions while allowing the joints to remain watertight. The joints are easy to assemble and consequently reduce the cost of laying the pipe. Any type of coating can be applied to the pipe in the shop and not be damaged at the joint during laying operations. The joint is self-centering and economical. Because of potential problems in maintaining joint integrity, caution should be exercised in the manufacture of gasketed joints to maintain tight clearance between the bell and spigot.

The rubber gasket should conform to AWWA standards. Consideration should be given to thrust at elbows, tees, laterals, wyes, reducers, valves, and dead ends. Joints should be restrained by welding (Figure 8-1), by harnessing, by anchors, or by thrust blocks (Chapter 13). Calculations should consider the anchoring effect of soil friction (Sec. 8.7 and Sec. 13.8).

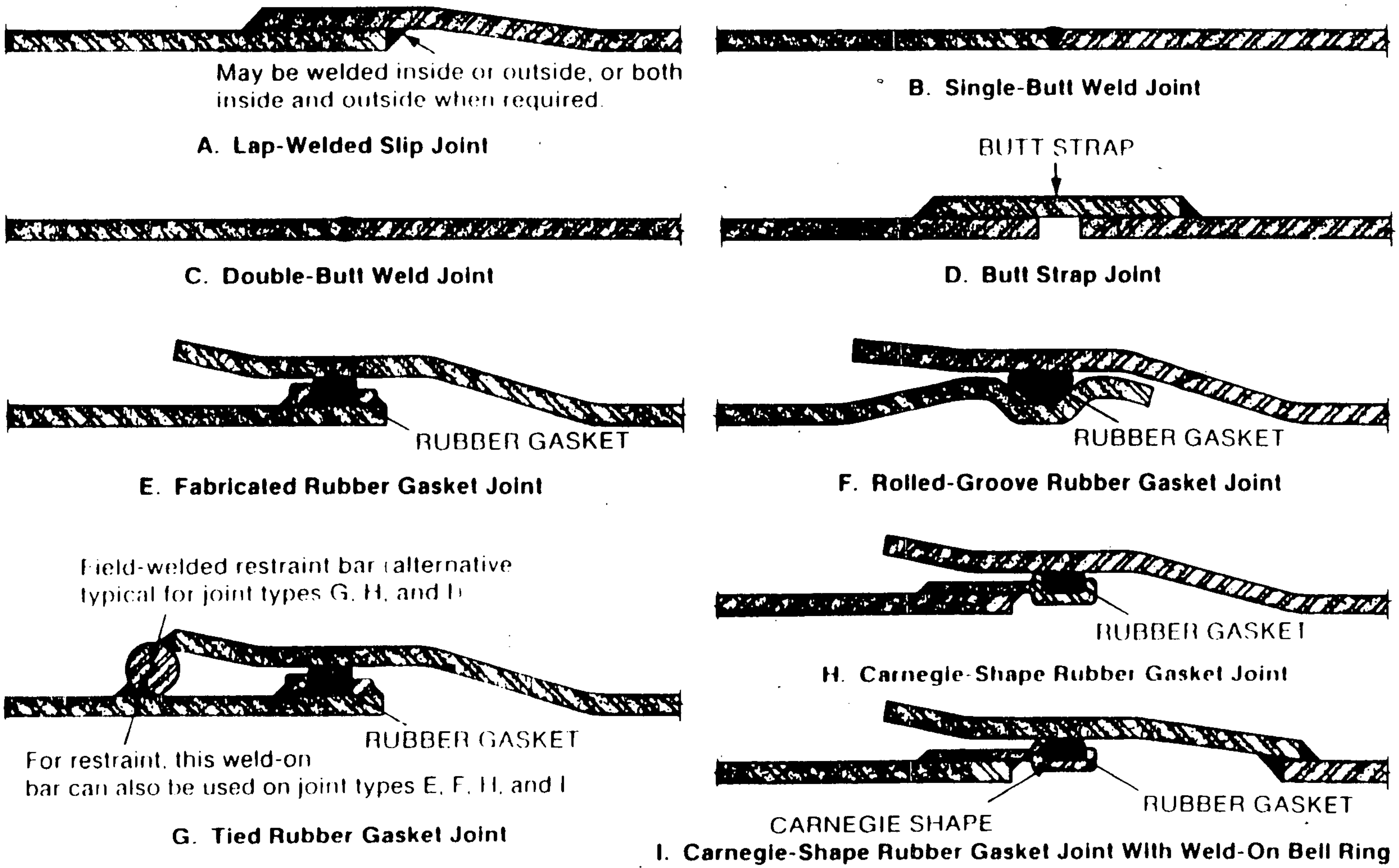


Figure 8-1 Welded and Rubber-Gasketed Field Joints

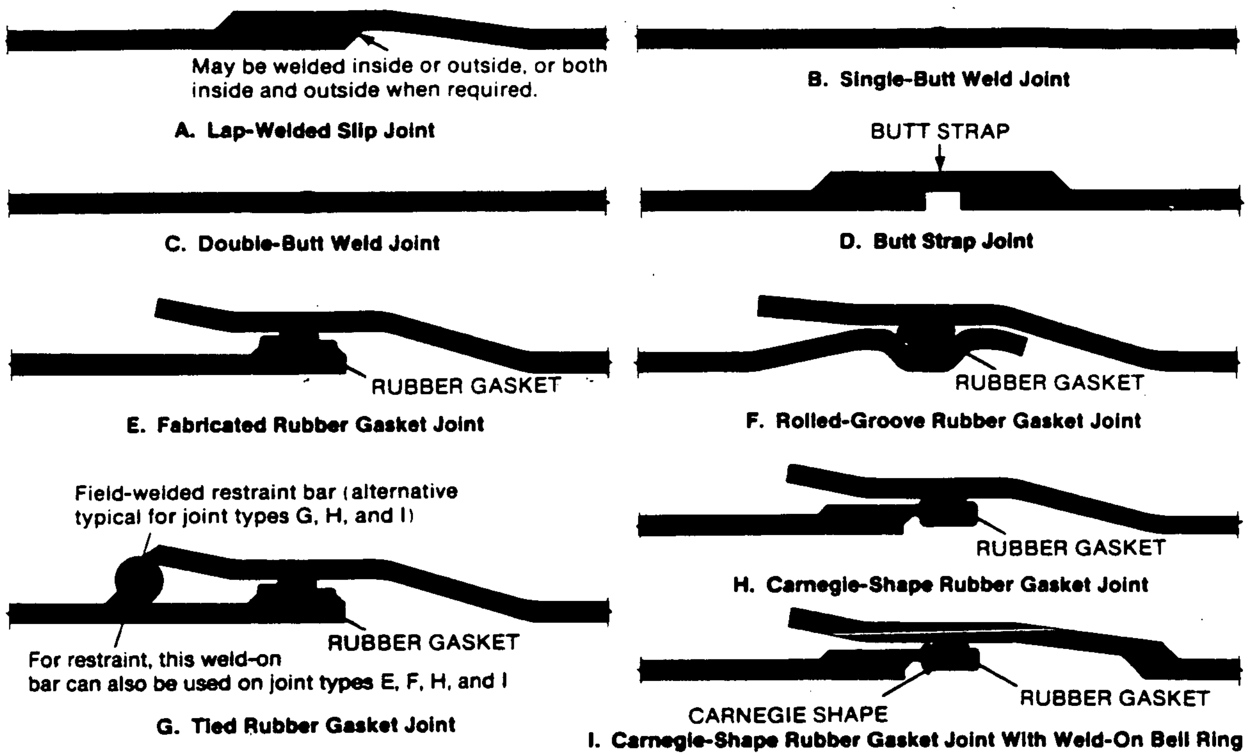


Figure 8-1 Welded and Rubber-Gasketed Field Joints

8.2 WELDED JOINTS

Field welding of joints in steel water pipe 24 in. in diameter and larger is a frequently used jointing method that results in strong, permanently tight joints. Slip joints for lap welding having a single fillet weld (Figure 8-1A) have proved satisfactory for most installations. Single-butt welds (Figure 8-1B) and double-butt welds (Figure 8-1C) should withstand, to the limit of pipe-wall strength, longitudinal extension loading that may be caused by settlement, washouts, and other disjointing forces. No other common water-pipe joint will withstand such loading. Where welded joints are used, the pipe should be left bare a sufficient distance back from the ends to avoid damaging the protective coatings by the heat produced during welding. These joints should be field-coated after welding. Field-welding in the interior of steel pipe with lining is ordinarily limited to 24-in. or larger pipe, because a worker must enter the pipe after welding to apply lining to the inside at the welded joints. Forced ventilation must be provided to ensure adequate air exchange when men are working inside the pipe.

The slip joint is commonly used because of its flexibility, ease in forming and laying, watertight quality, and simplicity. Small angle changes can be made in this joint. It may be welded on the outside only, or if the diameter permits, on the inside only. In certain special conditions, it may be desirable to weld both on the inside and outside, in which case a method of field testing described in AWWA C206, Standard for Field Welding of Steel Water Pipe,[1] may be employed advantageously.

AWWA C206 fully covers the requirements and techniques for satisfactory field welding. Where the pipe wall is thicker than ½ in. and the pipe is subject to temperatures below 40°F (4°C), the steel and welding procedures should be carefully selected to accommodate these adverse conditions.

8.3 SLEEVE COUPLINGS

Sleeve couplings are used on pipelines of all diameters and especially on lined pipe too small for a person to enter. Very complete technical data have been published.[2] A typical sleeve coupling is shown in Figure 8-2.

Sleeve couplings provide tightness and strength with flexibility. They relieve expansion and contraction forces in a pipeline and provide sufficient flexibility so that pipe may be laid on long radius curves and grades without the use of specials. The rubber gaskets are firmly held between the coupling parts and the pipe, and they join the lengths securely against high pressure, low pressure, or vacuum. The completely enclosed rubber gaskets are protected from damage and decay. These joints have been used successfully since 1891.

Acceptable axial movement in flexible sleeve couplings results from shear displacement of the rubber gaskets rather than from sliding of the gaskets on the mating surface of the pipe. If greater displacement is needed, true expansion joints should be provided rather than sleeve couplings.

Sleeve couplings transmit only minor tension or shear stresses across pipe joints, and they will not permit differential settlement at the joints when used alone. However, a degree of flexibility is possible when used in conjunction with another adjacent flexible joint. Sleeve couplings are suitable for joining buried or exposed anchored pipes that are laid on curves established using deflections up to the maximum permitted at the coupling.

Restrained, harnessed, flanged, or welded joints may be needed to resist the unbalanced thrust at tees, elbows, valves, and fittings, or to resist the line pull in underwater crossings, if such forces are not resisted by external forces provided by thrust blocks or anchors. Calculations should consider the anchoring effect of soil friction on buried pipe, discussed in Sec. 8.7 and Sec. 13.8. Details of joint harness are given in Chapter 13.

Pipe Layout When Using Sleeve Couplings

When laying sleeve-coupled pipe on curves, the amount of separation measured on the pipe centerline should be determined using data supplied by the coupling manufacturer. Extreme accuracy is necessary only in plant layout work and other very special projects. When these cases occur, the data supplied by the coupling manufacturer will aid layout technicians and checkers in reaching agreement on dimensions.

Data for Pipe Layouts

The profile and alignment of pipelines is frequently staked on a curve. It is useful to know what pipe lengths are needed to negotiate such curves and to know the offset necessary to

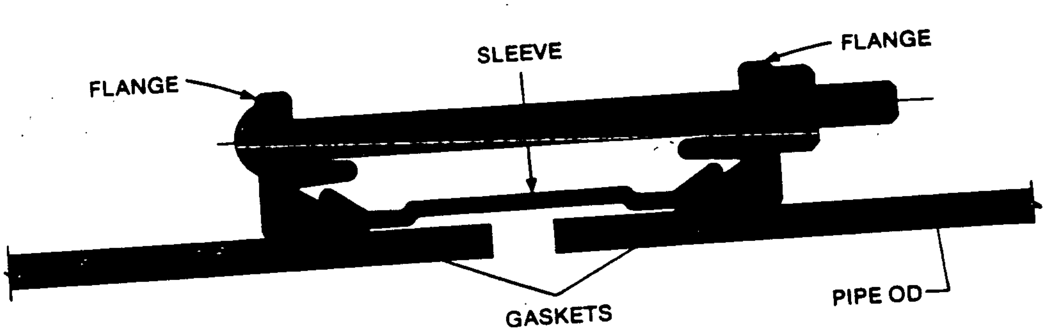
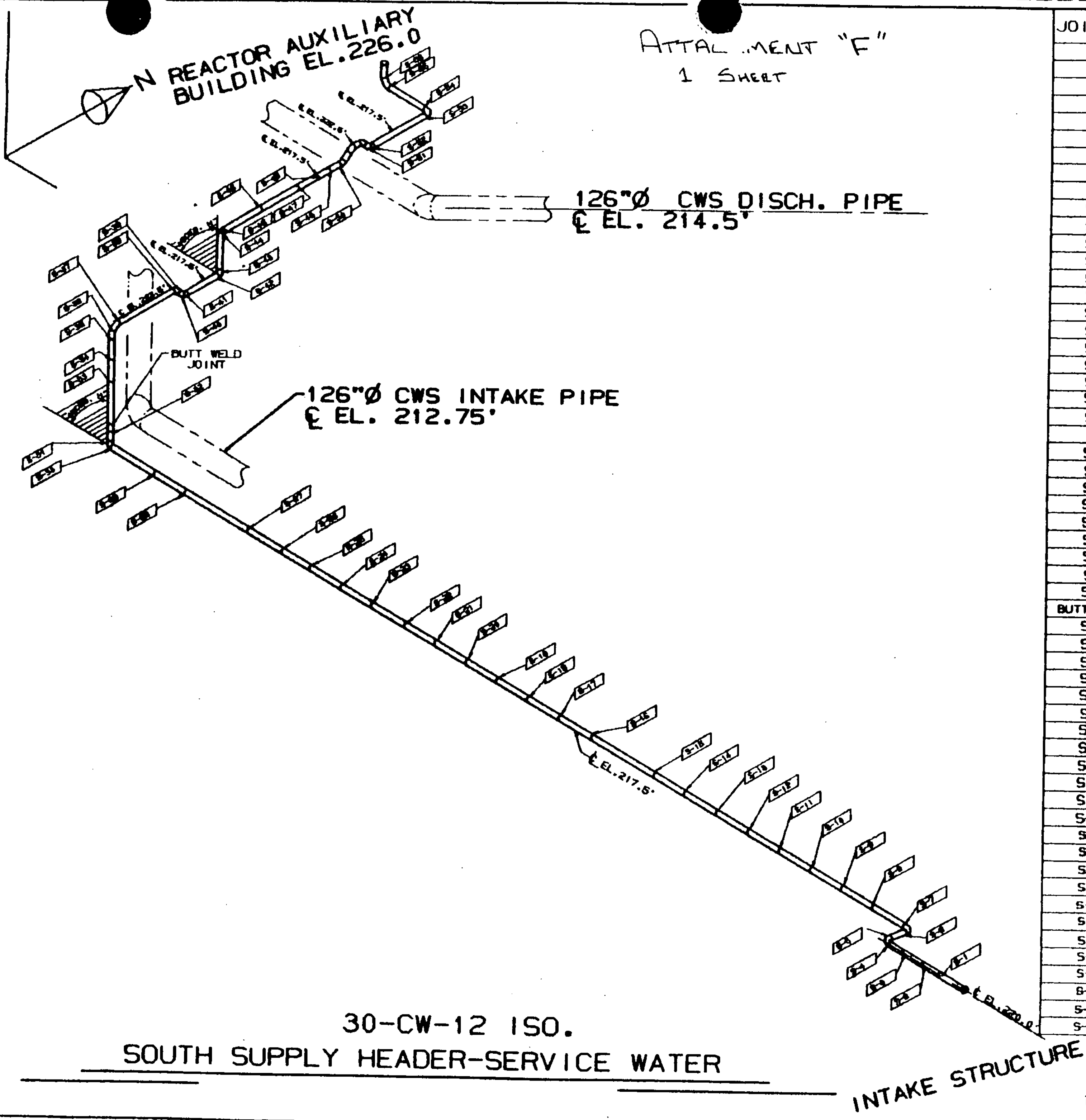


Figure 8-2 Sleeve Coupling

ATTACHMENT "F"
1 Sheet



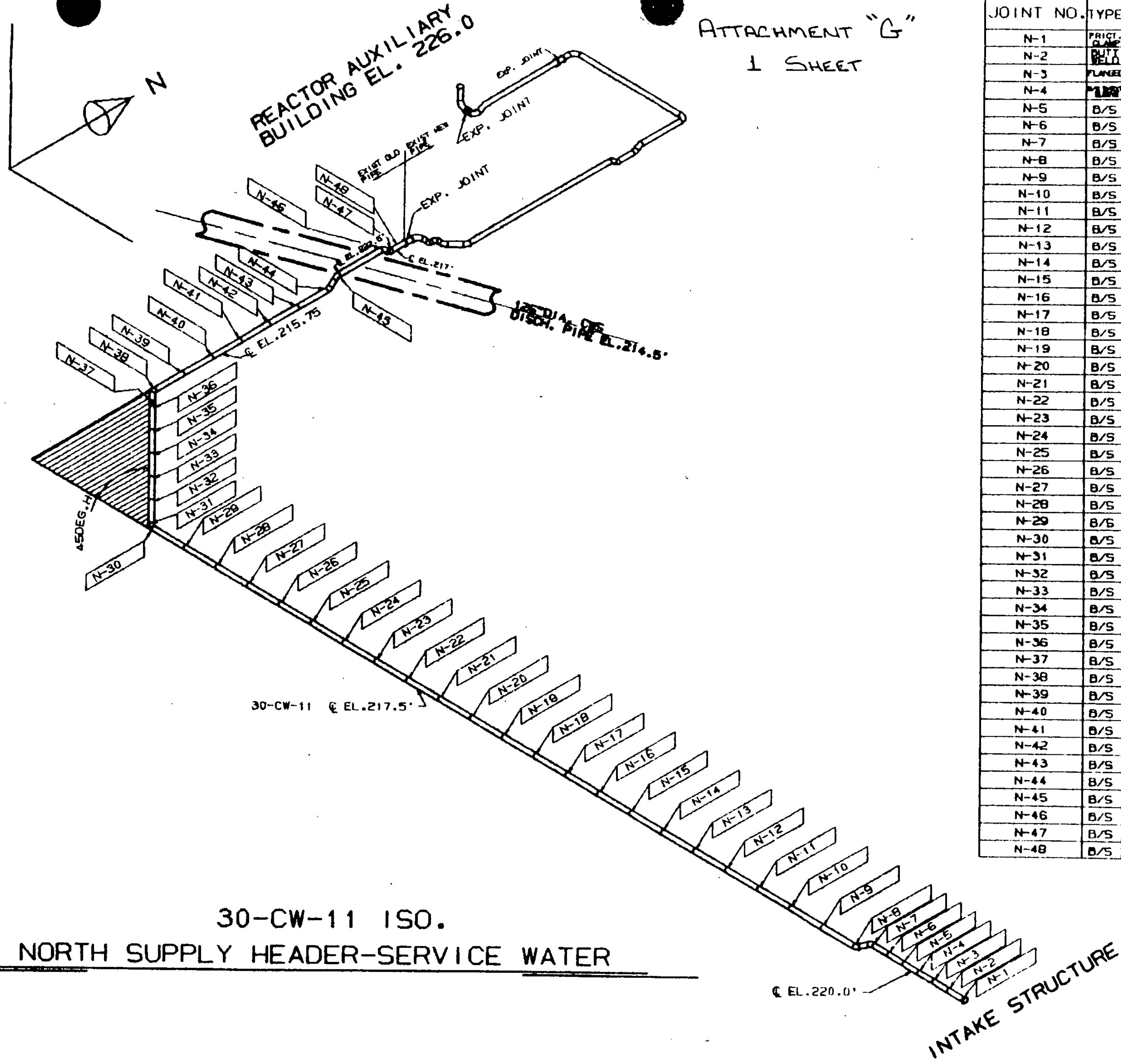
JOINT NO.	TYPE	FIX	EXT.		CONTOUR MEASUREMENT
S-1	[illegible]	GROUT	NO	N	NO
S-2	B/S	GROUT	NO	NO	NO
S-3	B/S	GROUT	NO	NO	NO
S-4	B/S	GROUT	NO	NO	NO
S-5	B/S	GROUT	NO	NO	NO
S-6	B/S	WELD/ GROUT	YES	YES	YES
S-7	B/S	GROUT	YES	YES	YES
S-8	B/S	GROUT	NO	NO	NO
S-9	B/S	GROUT	NO	YES	YES
S-10	B/S	BUTT STRAP	NO	YES	YES (<.05)
S-11	B/S	GROUT	NO	YES	YES
S-12	B/S	GROUT	NO	YES	YES
S-13	B/S	GROUT	NO	NO	NO
S-14	B/S	GROUT	NO	NO	NO
S-15	B/S	GROUT	NO	NO	NO
S-16	B/S	GROUT	NO	NO	NO
S-17	B/S	GROUT	NO	NO	NO
S-18	B/S	GROUT	NO	NO	NO
S-19	B/S	GROUT	NO	NO	NO
S-20	B/S	GROUT	NO	NO	NO
S-21	B/S	GROUT	NO	NO	NO
S-22	B/S	GROUT	NO	YES	YES
S-23	B/S	GROUT	NO	NO	NO
S-24	B/S	GROUT	NO	NO	NO
S-25	B/S	GROUT	NO	NO	NO
S-26	B/S	GROUT	NO	NO	NO
S-27	B/S	GROUT	NO	NO	NO
S-28	B/S	GROUT	NO	NO	NO
S-29	B/S	GROUT	NO	NO	NO
S-30	B/S	GROUT	NO	NO	NO
S-31	B/S	BUTT STRAP	NO	NO	NO
S-32	B/S	GROUT	YES	NO	NO
BUTT WELD JOINT		WELD REPAIR	YES	NO	NO
S-33	B/S	GROUT	NO	NO	NO
S-34	B/S	GROUT	NO	NO	NO
S-35	B/S	GROUT	NO	NO	NO
S-36	B/S	GROUT	NO	NO	NO
S-37	B/S	GROUT	NO	NO	NO
S-38	B/S	GROUT	NO	NO	NO
S-39	B/S	GROUT	NO	YES	YES
S-40	B/S	GROUT	NO	NO	NO
S-41	B/S	GROUT	NO	NO	NO
S-42	B/S	BUTT STRAP	NO	YES	YES (<.05)
S-43	B/S	GROUT	NO	YES	YES
S-44	B/S	GROUT	NO	NO	NO
S-45	B/S	GROUT	NO	NO	NO
S-46	B/S	GROUT	NO	NO	NO
S-47	B/S	GROUT	NO	NO	NO
S-48	B/S	GROUT	NO	NO	NO
S-49	B/S	GROUT	NO	NO	NO
S-50	B/S	GROUT	NO	NO	NO
S-51	B/S	GROUT	NO	NO	NO
S-52	B/S	GROUT	NO	NO	NO
S-53	B/S	GROUT	NO	NO	NO
S-54	B/S	GROUT	NO	NO	NO
S-55	B/S	GROUT	NO	NO	NO
S-56	B/S	GROUT	NO	NO	NO

30-CW-12 ISO.

SOUTH SUPPLY HEADER-SERVICE WATER

Attachment "G"

1 Sheet



30-CW-11 ISO.

NORTH SUPPLY HEADER-SERVICE WATER

JOINT NO.	TYPE	FIX	JT[illegible] EXT.		CONTOUR [illegible]ASUREMENT
N-1	FRICT. CLAMP	REPAIR REPLACE	YES	Y	YES
N-2	BUTT WELD	BUTT STRAP	NO	NO	NO
N-3	FLANGED	REPLACE	YES	NO	NO
N-4	[illegible]	REPLACE	YES	NO	NO
N-5	B/S	GROUT	NO	NO	NO
N-6	B/S	GROUT	NO	NO	NO
N-7	B/S	GROUT	NO	NO	NO
N-8	B/S	GROUT	NO	NO	NO
N-9	B/S	GROUT	NO	NO	NO
N-10	B/S	GROUT	NO	NO	NO
N-11	B/S	GROUT	NO	NO	NO
N-12	B/S	GROUT	NO	NO	NO
N-13	B/S	GROUT	NO	NO	NO
N-14	B/S	GROUT	NO	NO	NO
N-15	B/S	GROUT	NO	NO	NO
N-16	B/S	GROUT	NO	NO	NO
N-17	B/S	GROUT	NO	NO	NO
N-18	B/S	GROUT	NO	NO	NO
N-19	B/S	GROUT	NO	NO	NO
N-20	B/S	GROUT	NO	NO	NO
N-21	B/S	GROUT	NO	NO	NO
N-22	B/S	GROUT	NO	NO	NO
N-23	B/S	GROUT	NO	NO	NO
N-24	B/S	GROUT	NO	NO	NO
N-25	B/S	GROUT	NO	NO	NO
N-26	B/S	GROUT	NO	NO	NO
N-27	B/S	GROUT	NO	NO	NO
N-28	B/S	GROUT	NO	NO	NO
N-29	B/S	GROUT	NO	NO	NO
N-30	B/S	GROUT	NO	NO	NO
N-31	B/S	GROUT	NO	NO	NO
N-32	B/S	GROUT	NO	NO	NO
N-33	B/S	GROUT	NO	NO	NO
N-34	B/S	GROUT	NO	NO	NO
N-35	B/S	GROUT	NO	NO	NO
N-36	B/S	GROUT	NO	NO	NO
N-37	B/S	GROUT	NO	NO	NO
N-38	B/S	GROUT	NO	NO	NO
N-39	B/S	GROUT	NO	NO	NO
N-40	B/S	GROUT	NO	NO	NO
N-41	B/S	GROUT	NO	NO	NO
N-42	B/S	GROUT	NO	NO	NO
N-43	B/S	GROUT	NO	NO	NO
N-44	B/S	GROUT	NO	NO	NO
N-45	B/S	GROUT	NO	NO	NO
N-46	B/S	GROUT	NO	NO	NO
N-47	B/S	GROUT	NO	NO	NO
N-48	B/S	GROUT	NO	NO	NO

ATTACHMENT "H"
40 SHEETS

H.B.ROBINSON UNIT 2
SERVICE WATER WALL THICKNESS MEASUREMENTS
28 NOVEMBER,1990

THE ATTACHED INSIDE SURFACE PROFILES WERE OBTAINED FROM THE SOUTH SERVICE WATER HEADER (DWG 30-CW-12) AT THE BELL AND SPIGOT JOINTS. A CONTOUR GAUGE WAS USED TO PRODUCE THE PROFILES.

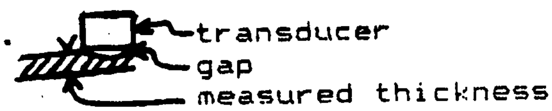
DATUM POINT ZERO DEGREE IS LOCATED TOP DEAD CENTER OF EACH JOINT WITH DEGREE PROGRESSION IN A CLOCKWISE DIRECTION FACING DOWNSTREAM.

THE PIT DEPTHS WERE DETERMINED BY TAKING ULTRASONIC THICKNESS (UT) MEASUREMENTS ADJACENT TO AND INSIDE THE PITS WHERE POSSIBLE AND BY SUPERIMPOSING THESE MEASUREMENTS ONTO THE PROFILES (UT MEASUREMENTS ARE INDICATED BY A ".XX" ON THE ATTACHED SKETCHES. THE REMAINING WALL THICKNESS DIMENSIONS WERE EXTRAPOLATED/INTERPOLATED.

PROFILES AT EACH AREA WERE TAKEN ALONG THE X AXIS (LONGITUDINAL) AND THE Y AXIS (CIRCUMFERENTIAL) AT AREAS WHERE THE DAMAGE SEEMED MOST SEVERE.

"LIFT OFF" AS NOTED ON SOME OF THE ATTACHED SKETCHES INDICATE AN AREA WHERE THE TRANSDUCER WOULD NOT SEAT FLATLY AGAINST THE SURFACE OF THE PIPE. THEREFORE,THE GAP BETWEEN THE TRANSDUCER FACE AND THE I.D. SURFACE WAS SUBTRACTED FROM THE MEASURED THICKNESS.

E.G.



SIGNED: [signature]
CP&L, UT LEV II
11/28/90

ATTACHMENT "H"

CP&L
Carolina Power & Light Company

NDE DRAWING ATTACHMENT

PAGE__ OF__

PROJECT HBR   JOB NO. N/A   UNIT 1☐ 2☒ 3☐ 4☐   DATE 11/20/90

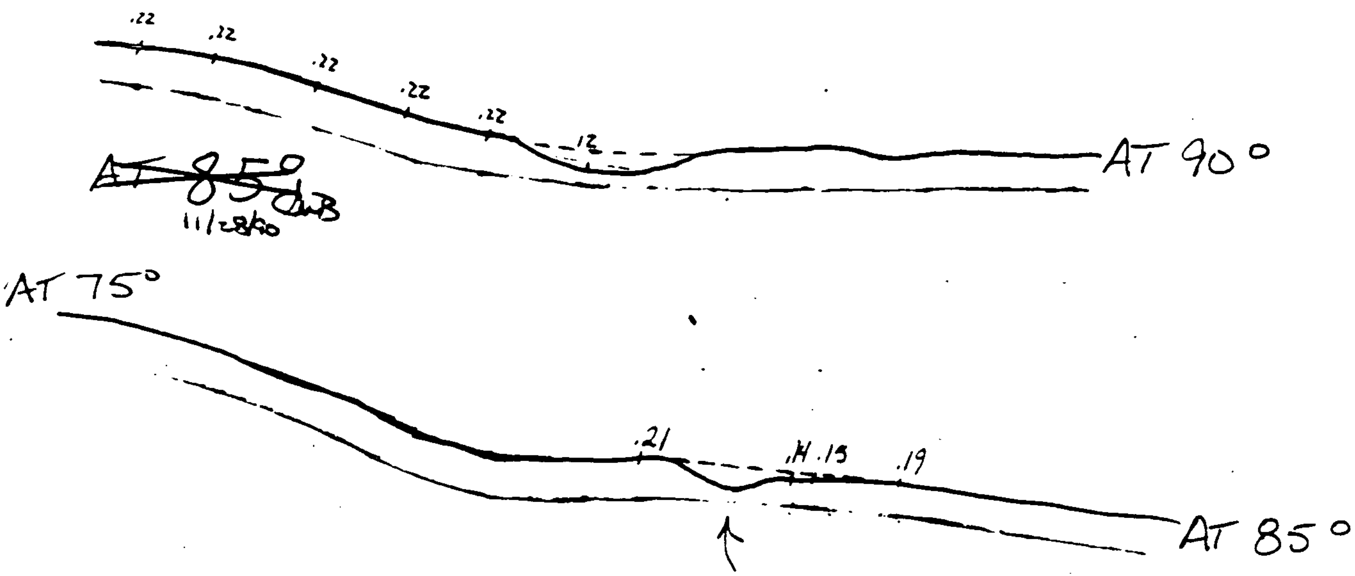
DRAWING	SYSTEM	LINE	WELD/ITEM NUMBER
3D-CW-12 ISO	Service Water	SOUTH HEADER	JOINT S-6

Joint 6

X AXIS (LONGITUDINAL)

90°

Flow ←



LEV II

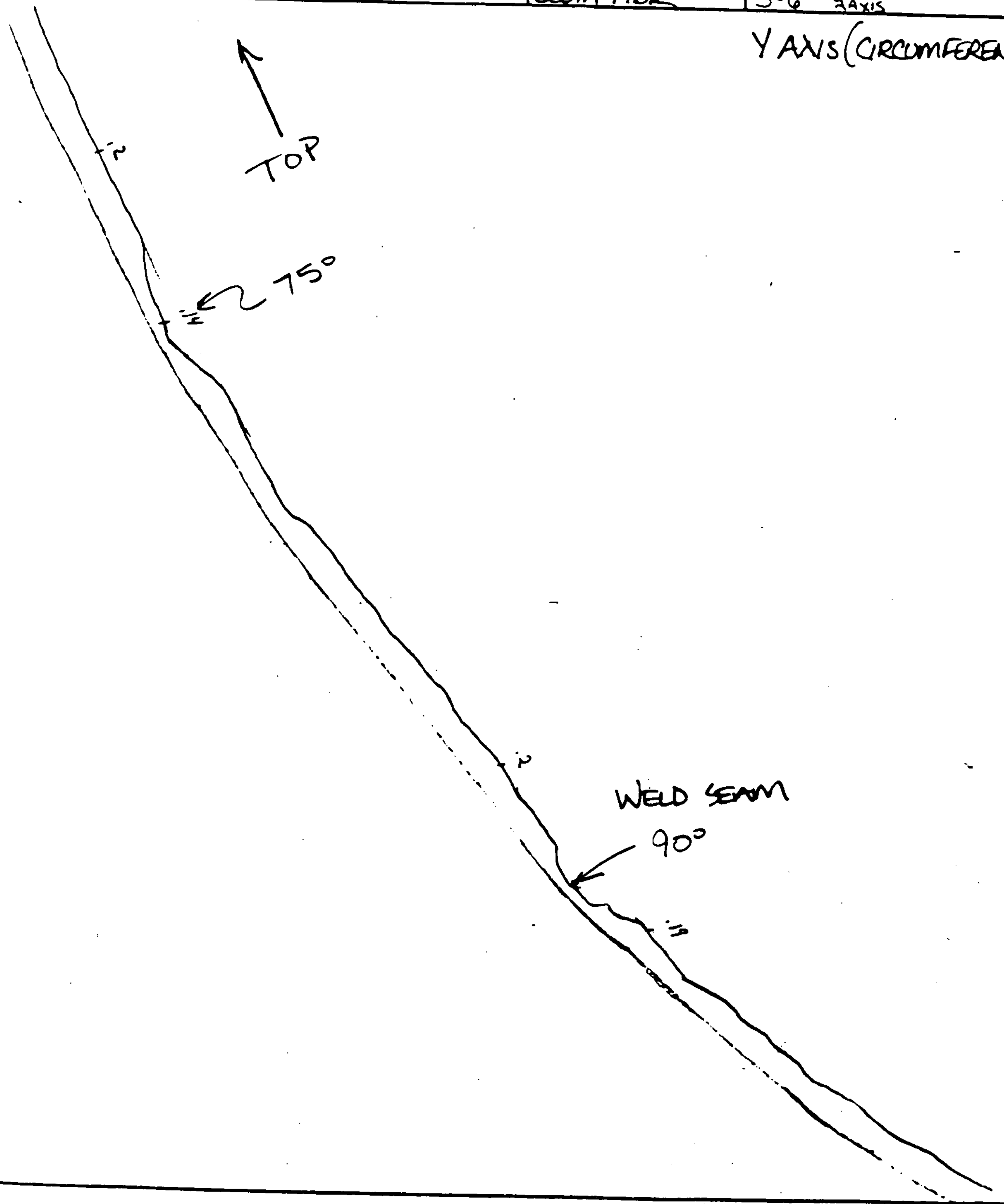
Carolina Power & Light Company

NDE DRAWING ATTACHMENT

PAGE__ OF__

PROJECT HBR	JOB NO.	UNIT 1☐ 2☑ 3☐ 4☐	DATE 11/27/90
DRAWING 30-CW-12 ISO	SYSTEM SERVICE WATER	LINE SOUTH HDR	WELD/ITEM NUMBER 5-6 Y AXIS

Y AXIS (CIRCUMFERENTIAL)



[signature] LEV II

CP&L
Carolina Power & Light Company

NDE DRAWING ATTACHMENT

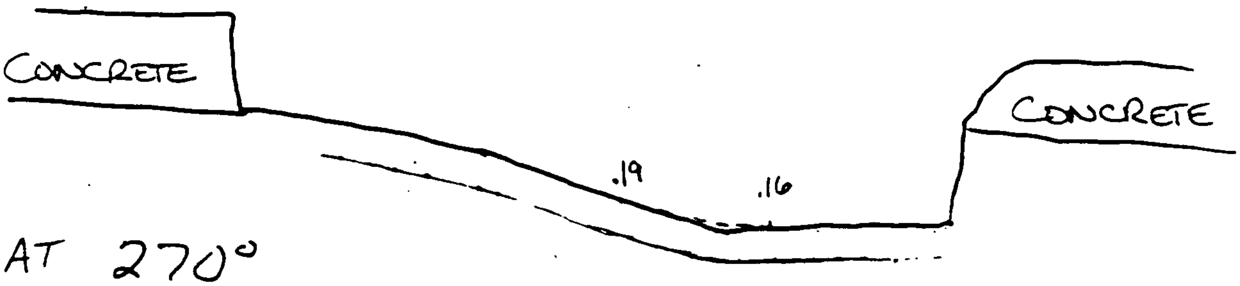
PAGE __ OF __

PROJECT HBR	JOB NO.	UNIT 1☐ 2☑ 3☐ 4☐	DATE 11/20/90
DRAWING 30-CW-12 ISO	SYSTEM SERVICE WATER	LINE SOUTH HEADER	WELD/ITEM NUMBER JOINT #S-7

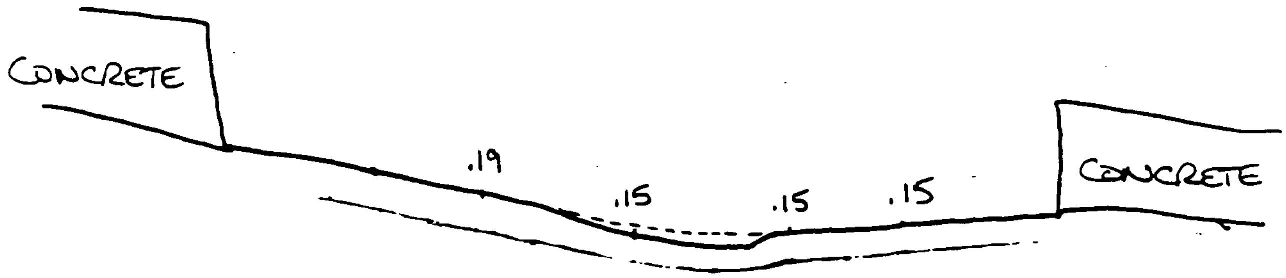
X AXIS (LONGITUDINAL)

Joint 7 Elbow Flow ←

AT 90°



AT 270°



[signature] LEV II

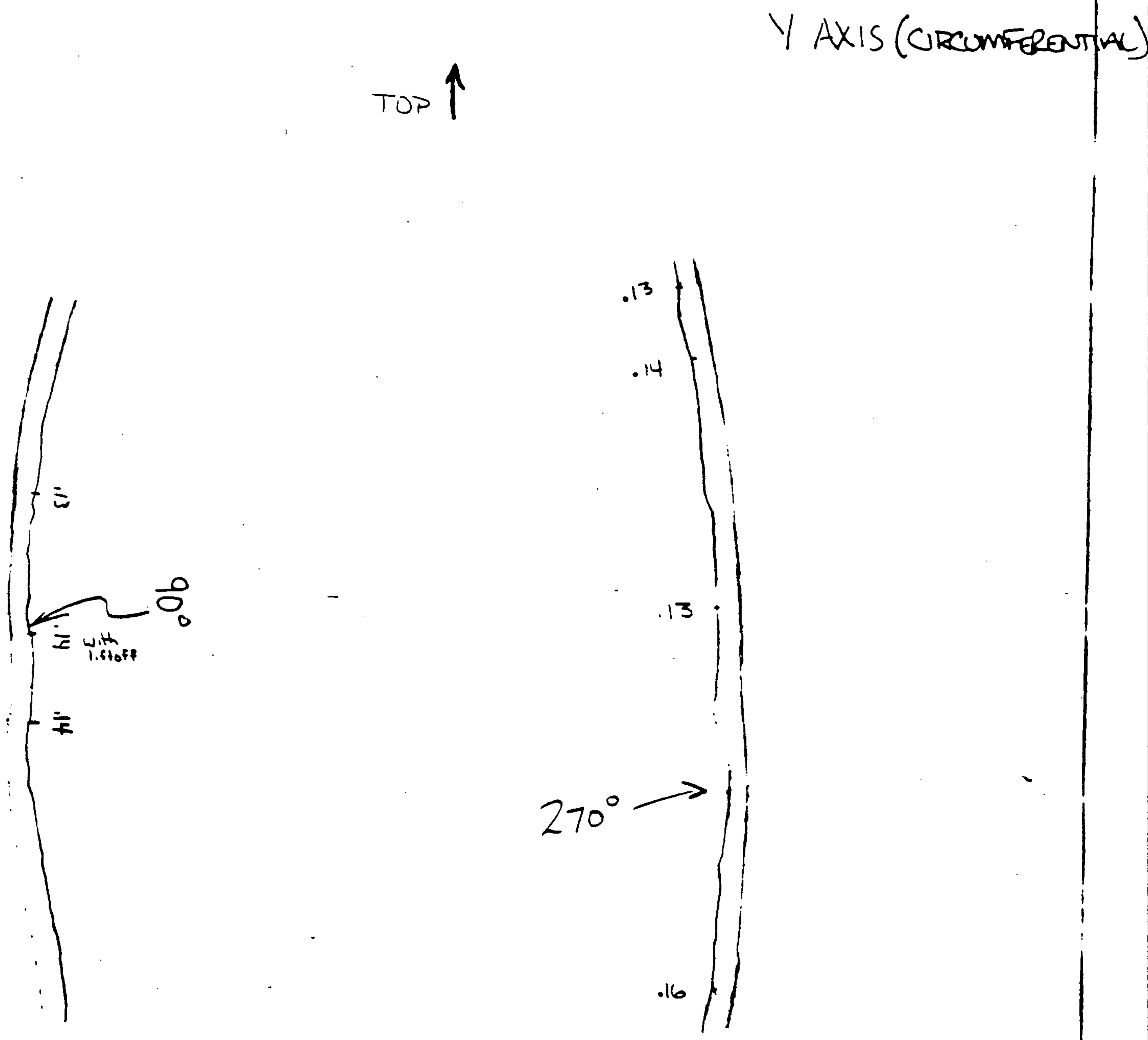
Carolina Power & Light Company

NDE DRAWING ATTACHMENT

PAGE__ OF__

PROJECT HBR JOB NO. UNIT 1☐ 2☒ 3☐ 4☐ DATE 11/27/90

DRAWING	SYSTEM	LINE	WELD/ITEM NUMBER
30-CW-12 ISO	SERVICE WATER	SOUTH HDR	S-7 Y AXIS



L II

6/83

CP&L

Carolina Power & Light Company

NDE DRAWING ATTACHMENT

PAGE __ OF __

PROJECT HBR JOB NO. N/A UNIT 1☐ 2☒ 3☐ 4☐ DATE 11/20/90

DRAWING	SYSTEM	LINE	WELD/ITEM NUMBER
30-CW-12 ISO	Service Water	SOUTH HEADER	JOINT S-9

XAXIS (LONGITUDINAL)

JT # 9

← FLOW

90°

[signature] LEV II

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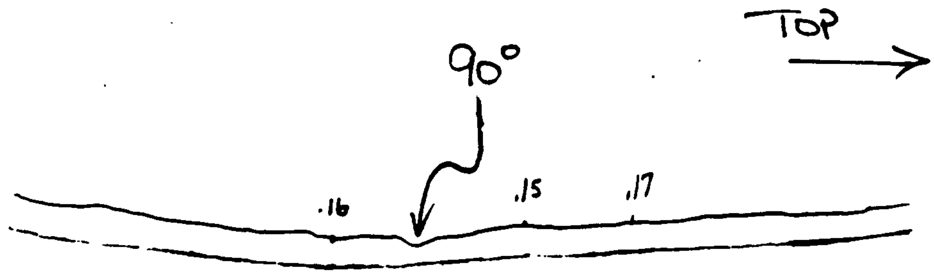
NDE DRAWING ATTACHMENT

PAGE __ OF __

PROJECT HBR	JOB NO. N/A	UNIT 1☐ 2☒ 3☐ 4☐	DATE 11/27/90
DRAWING 30-CW-12 ISO	SYSTEM SERVICE WATER	LINE SOUTH HDR	WELD/ITEM NUMBER S9 Y AXIS

Y AXIS (CIRCUMFERENTIAL)



[signature]

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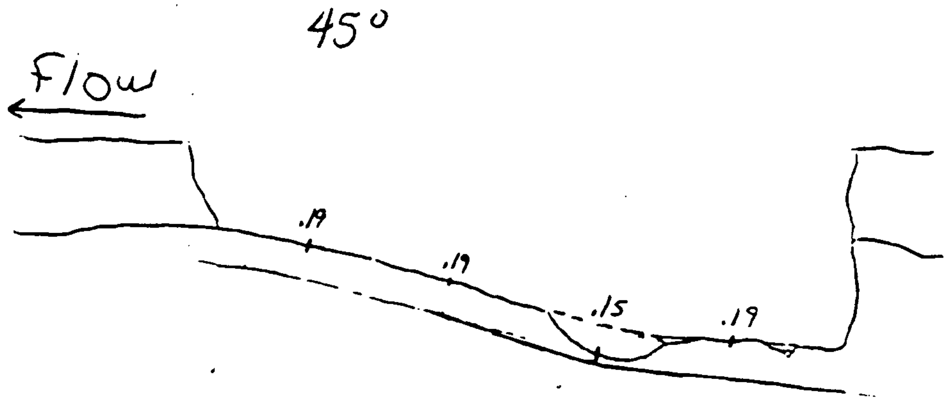
NDE DRAWING ATTACHMENT

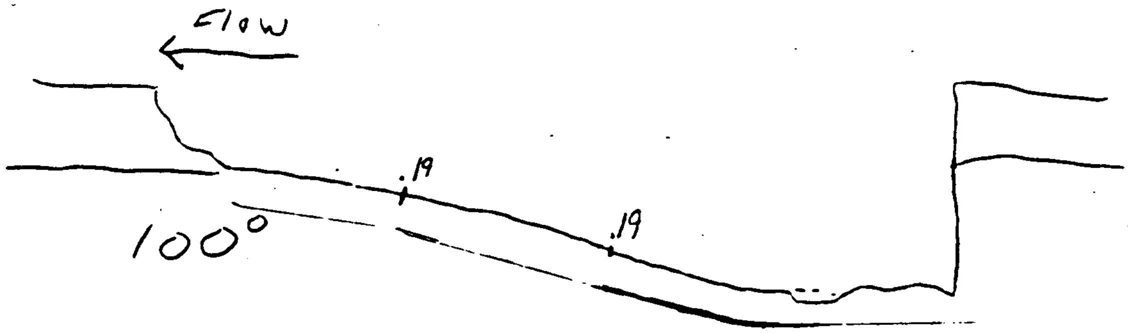
PAGE__ OF__

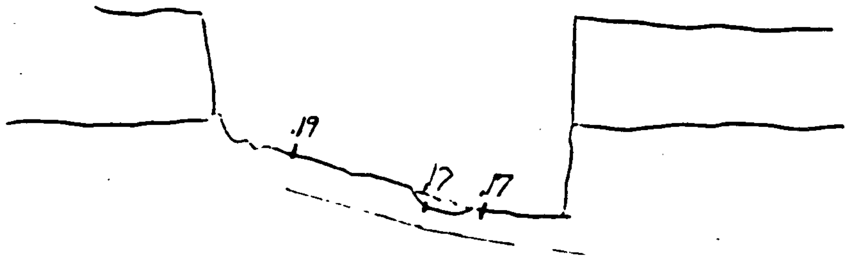
PROJECT HBR	JOB NO. N/A	UNIT 1☐ 2☒ 3☐ 4☐	DATE 11/22/9_
DRAWING 30-CW-12 ISO	SYSTEM SERVICE WATER	LINE SOUTH HEADER	WELD/ITEM NUMBER JT. S-10

X AXIS (LONGITUDINAL)

JT #10







[signature] LEV II

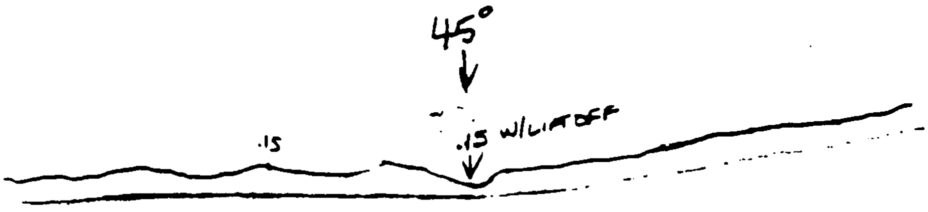
Carolina Power & Light Company

NDE DRAWING ATTACHMENT

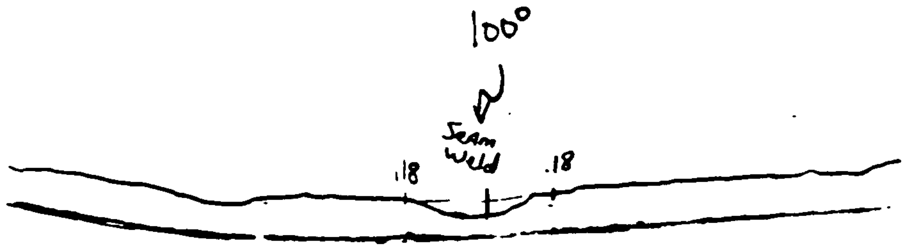
PAGE __ OF __

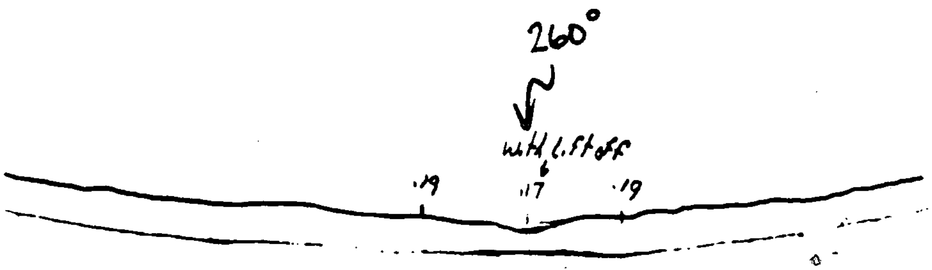
PROJECT HBR	JOB NO. N/A	UNIT 1☐ 2☒ 3☐ 4☐	DATE 11/27/90
DRAWING 3D-CW-12 ISO	SYSTEM SERVICE WATER	LINE SOUTH HEADER	WELD/ITEM NUMBER S-10 Y AXIS

Y AXIS (CIRCUMFERENTIA



TOP →





J M Black LEV II

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NDE DRAWING ATTACHMENT

PAGE __ OF __

PROJECT HBR JOB NO. N/A UNIT 1☐ 2☒ 3☐ 4☐ DATE 11/20/90

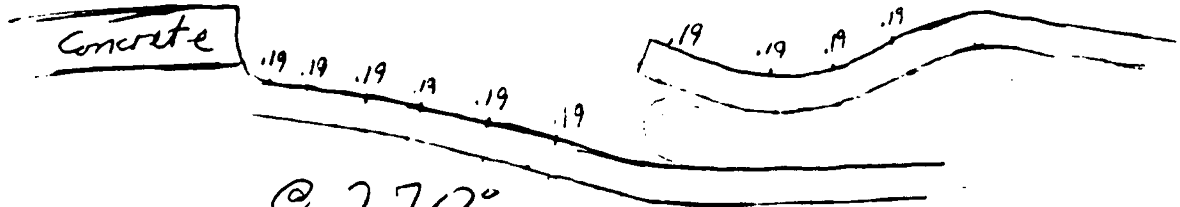
DRAWING	SYSTEM	LINE	WELD/ITEM NUMBER
30-CW-12 ISO	Service Water	SOUTH HEADER	S-11

XAXIS (LONGITUDINAL)

Joint 11

Flow ←

AT 270°



@ 270°

AT 90°

AT 10°

CA NDE CS 1 Rev. 0 6/83

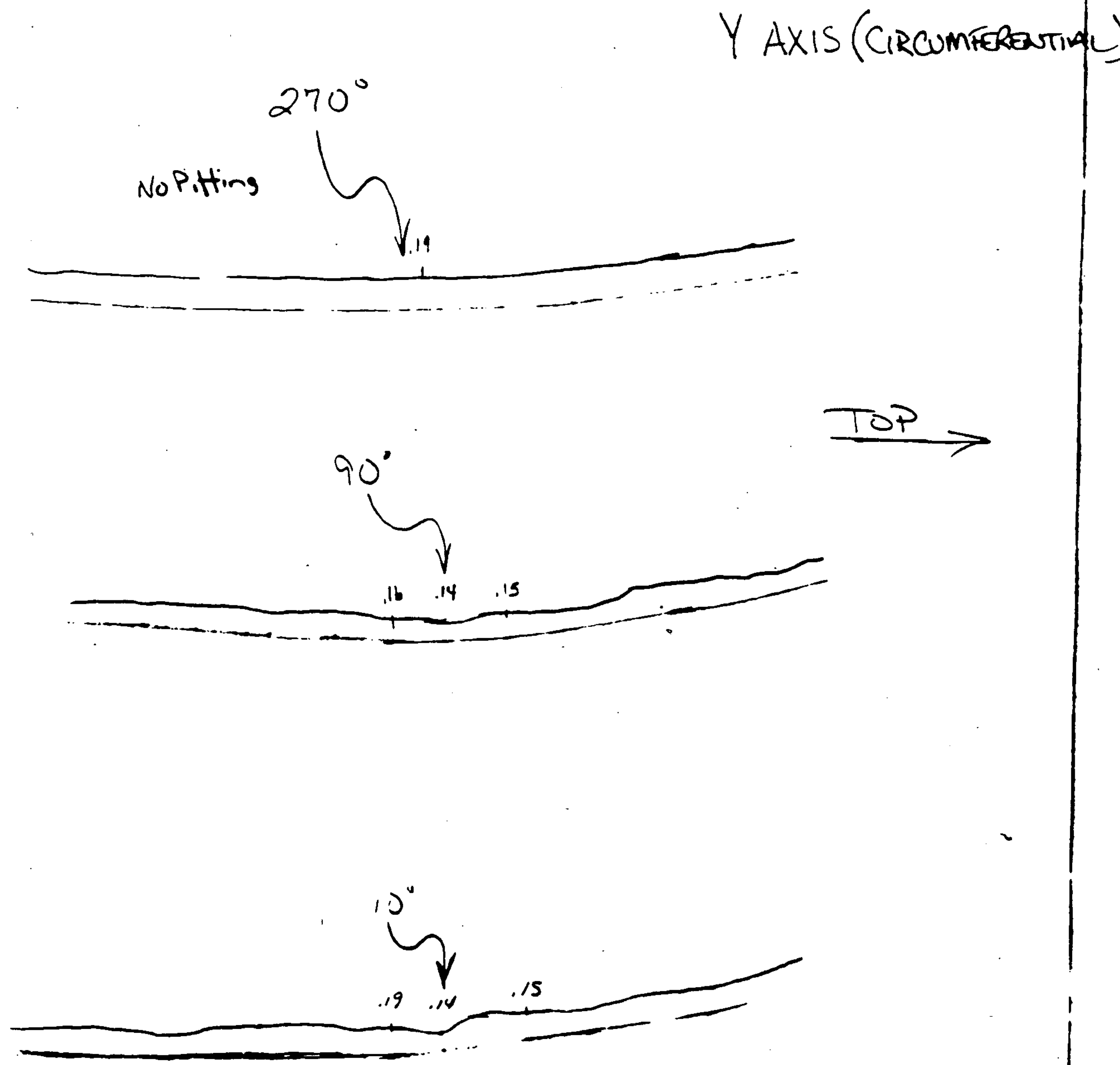
[signature] UT LEV II

Carolina Power & Light Company

NDE DRAWING ATTACHMENT

PAGE __ OF __

PROJECT HBR	JOB NO.	UNIT 1☐ 2☒ 3☐ 4☐		DATE 11/27/90
DRAWING 30-CW-12 ISO	SYSTEM SERVICE WATER	LINE SOUTH HDR	WELD/ITEM NUMBER S-11 Y AXIS	



J. A. Black L-II

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NDE DRAWING ATTACHMENT

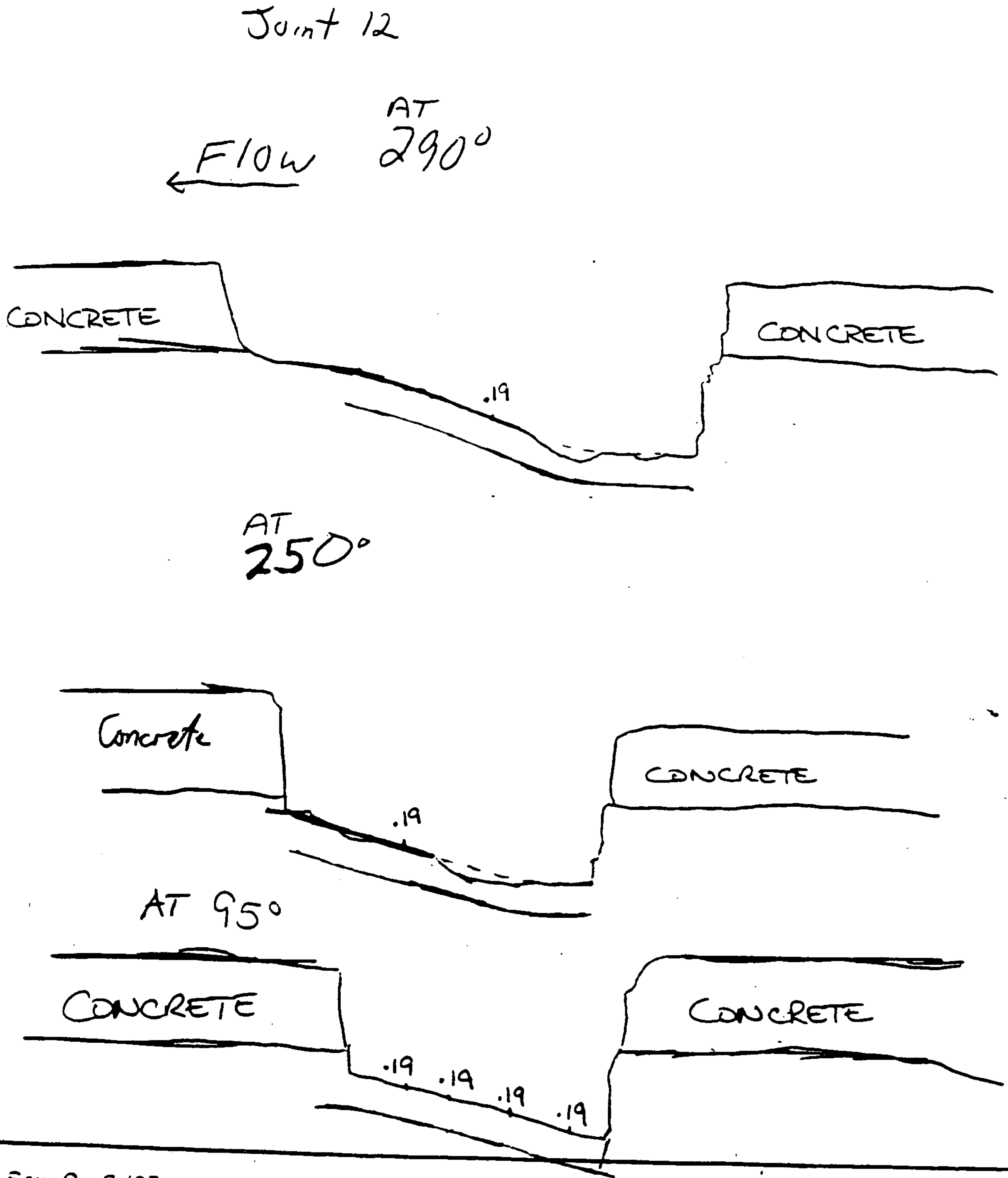
PAGE __ OF __

PROJECT H.B. ROBINSON JOB NO.

UNIT 1☐ 2☑ 3☐ 4☐ DATE 11/20/90

DRAWING	SYSTEM	LINE	WELD/ITEM NUMBER
30-CW-12 ISO	SERVICE WATER	SOUTH HDR U/G PIPE	JOINTS-12

X AXIS (LONGITUDINAL)



CA NDE US 1 Rev. 0 6/33

J.M. Black LEV II

Carolina Power & Light Company

NDE DRAWING ATTACHMENT

PAGE __ OF __

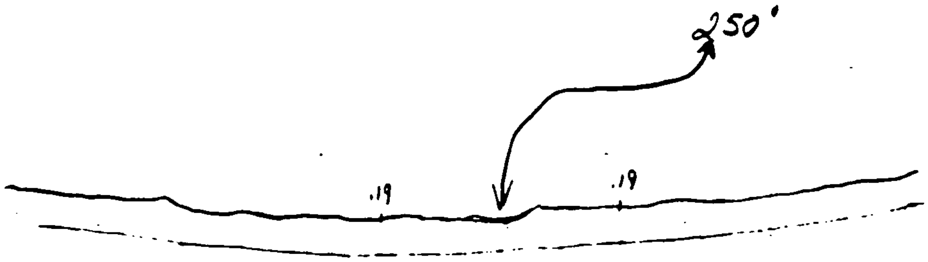
PROJECT HBR　　JOB NO.

UNIT 1☐ 2☑ 3☐ 4☐　　DATE 1/27/90

DRAWING	SYSTEM	LINE	WELD/ITEM NUMBER
30-CW-12 ISO	SERVICE WATER	SOUTH HDR	S-12 Y AXIS

Y AXIS (CIRCUMFERENT

Top →



[signature] LEVII

Carolina Power & Light Company

NDE DRAWING ATTACHMENT

PAGE __ OF __

PROJECT HBR	JOB NO. N/A	UNIT 1☐ 2☒ 3☐ 4☐	DATE 11/20/90
DRAWING 30-CW-12 ISO	SYSTEM SERVICE WATER	LINE SOUTH HEADER	WELD/ITEM NUMBER JOINT S-22

Joint 22

X AXIS (LONGITUDINAL)

170°

← Flow

@ 200°

JMBlack LEV II

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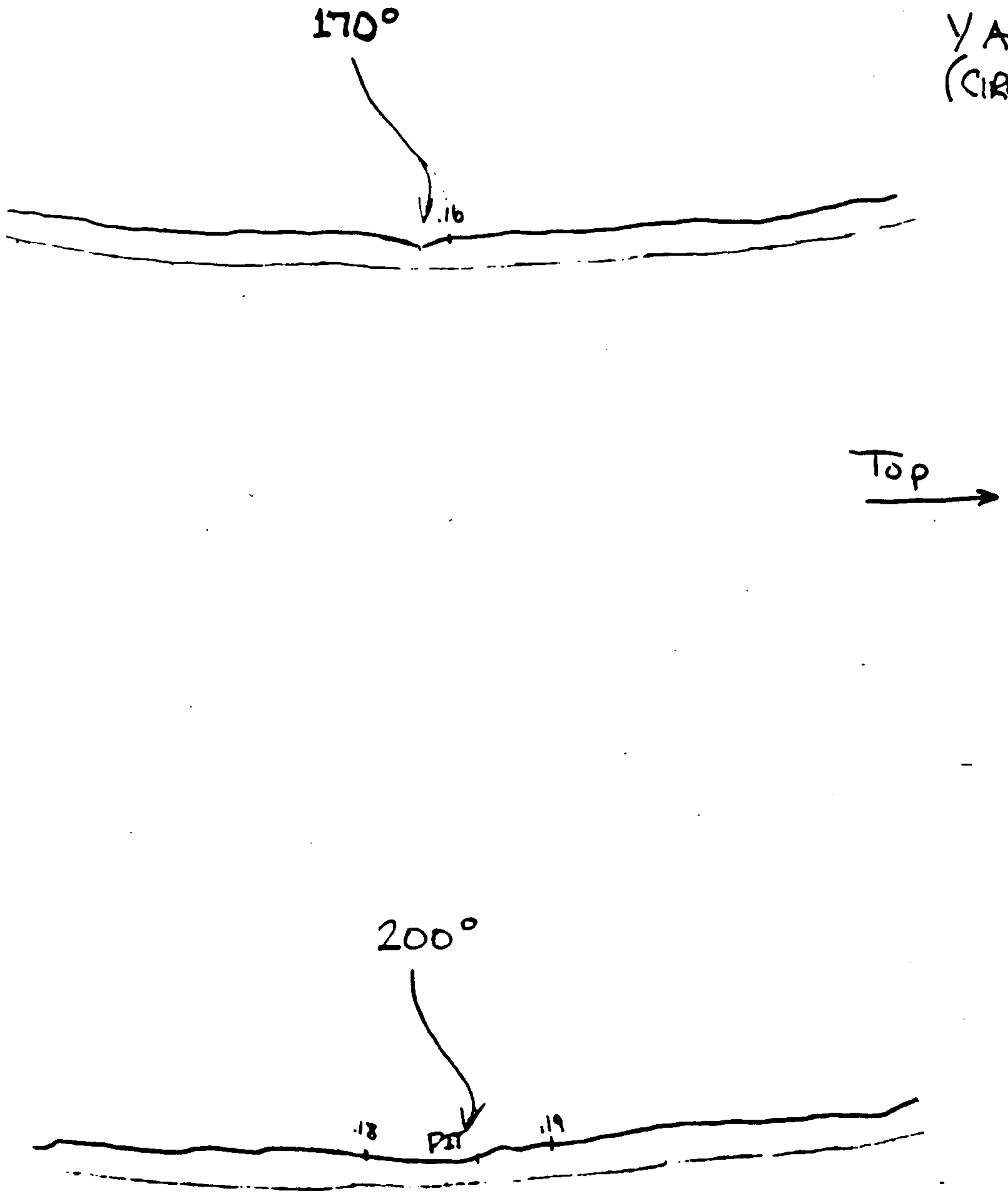
NDE DRAWING ATTACHMENT

PAGE __ OF __

PROJECT HBR JOB NO. N/A UNIT 1☐ 2☒ 3☐ 4☐ DATE 11/27/90

DRAWING	SYSTEM	LINE	WELD/ITEM NUMBER
30-CW-12 ISO	SERVICE WATER	SOUTH HDR	S22 Y AXIS

Y AXIS (CIRCUMFERENTIAL)



J M Black LevII

CP&L

Carolina Power & Light Company

NDE DRAWING ATTACHMENT

PAGE __ OF __

PROJECT HBR JOB NO. N/A UNIT 1☐ 2☒ 3☐ 4☐ DATE 11/20/9?

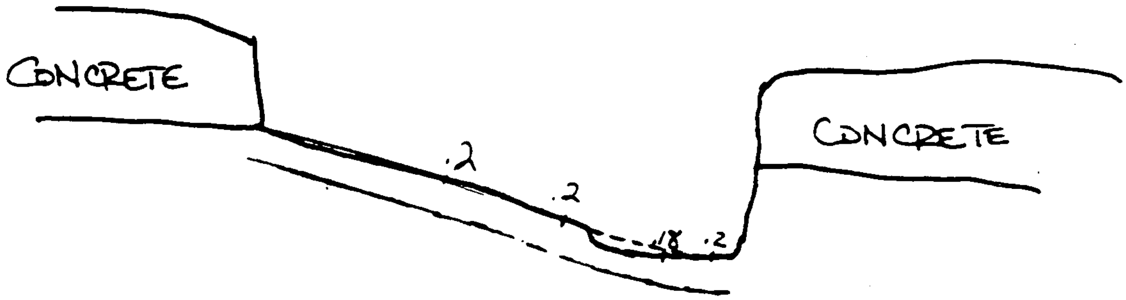
DRAWING	SYSTEM	LINE	WELD/ITEM NUMBER
5D-CW-12 ISO	Service Water	SOUTH HEADER	JOINT S-39

Joint 39

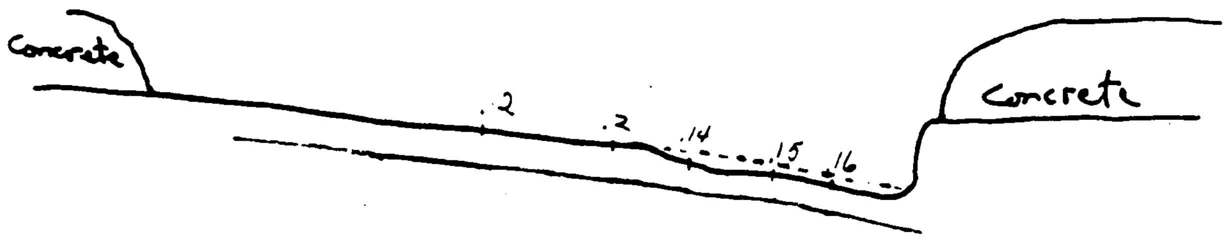
X AXIS (LONGITUDINAL)

AT 95°

← Flow



AT 10°



[signature] LEV II

Carolina Power & Light Company

NDE DRAWING ATTACHMENT

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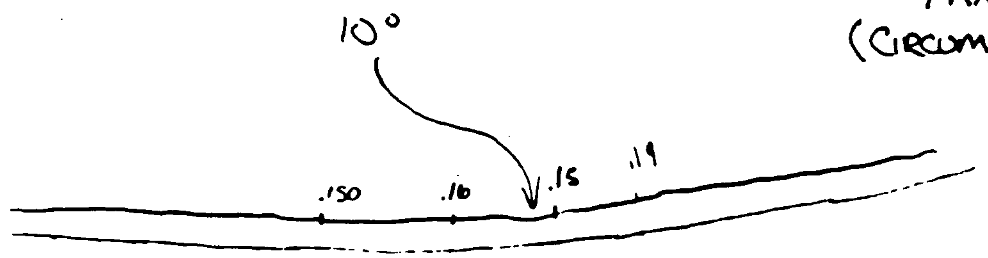
PROJECT HBR JOB NO. N/A UNIT 1☐ 2☒ 3☐ 4☐ DATE 11/27/90

DRAWING	SYSTEM	LINE	WELD/ITEM NUMBER
3D-CW-12 ISO	SERVICE WATER	SOUTH HEADER	S-39 Y AXIS

Y AXIS
(CIRCUMFERENTIAL)



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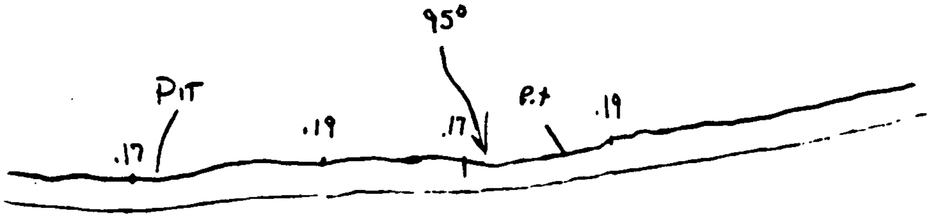


J.M. Block LEV II

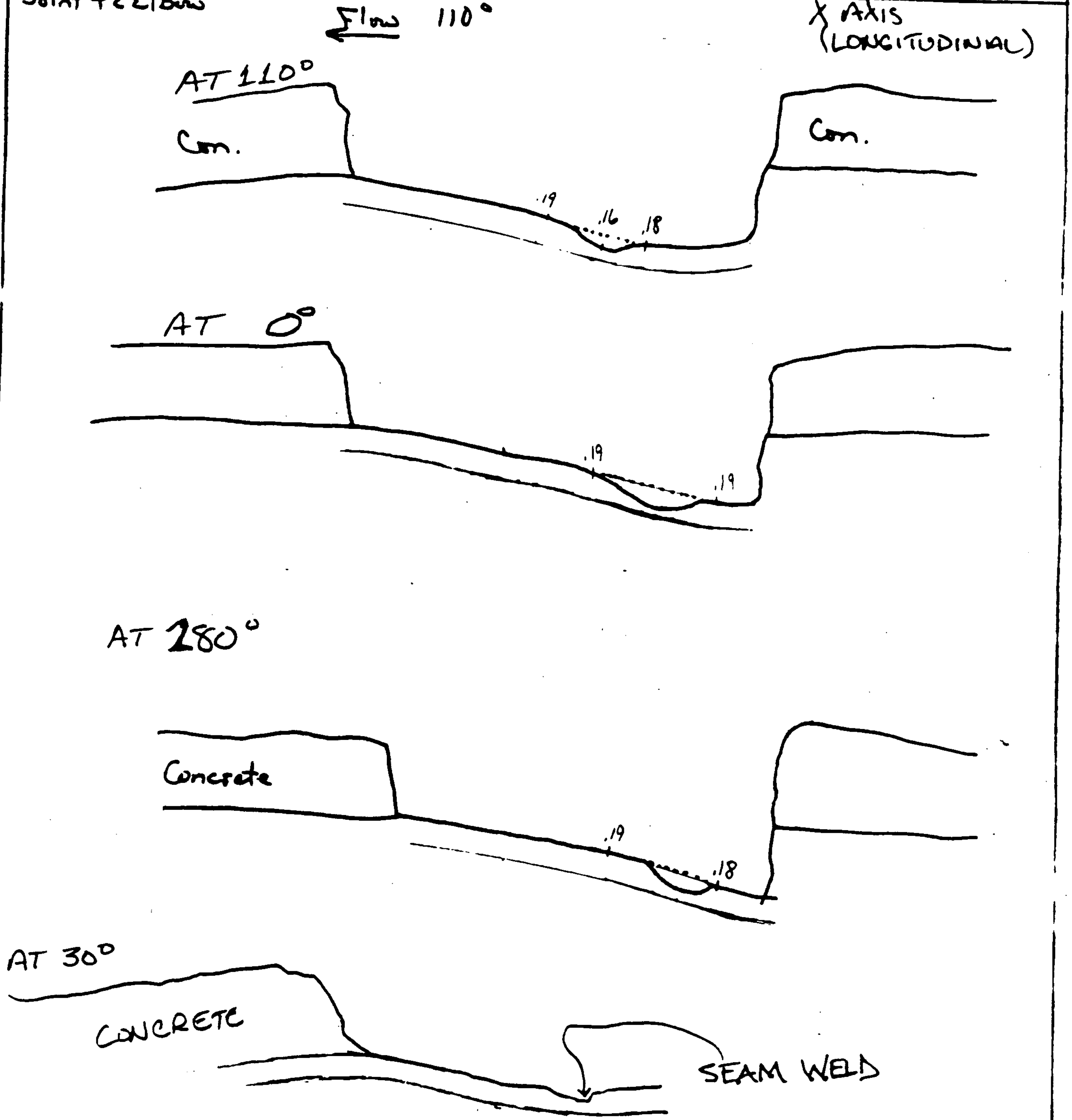
NDE DRAWING ATTACHMENT

PAGE __ OF __

PROJECT HBR   JOB NO. N/A   UNIT 1☐ 2☒ 3☐ 4☐   DATE 11/20/9

DRAWING	SYSTEM	LINE	WELD/ITEM NUMBER
30-CW-12 ISO	Service Water	SOUTH HEADER	JOINT S-42

Joint 42 Elbow



CA NDE ... 6/93

J M Black
LEV II

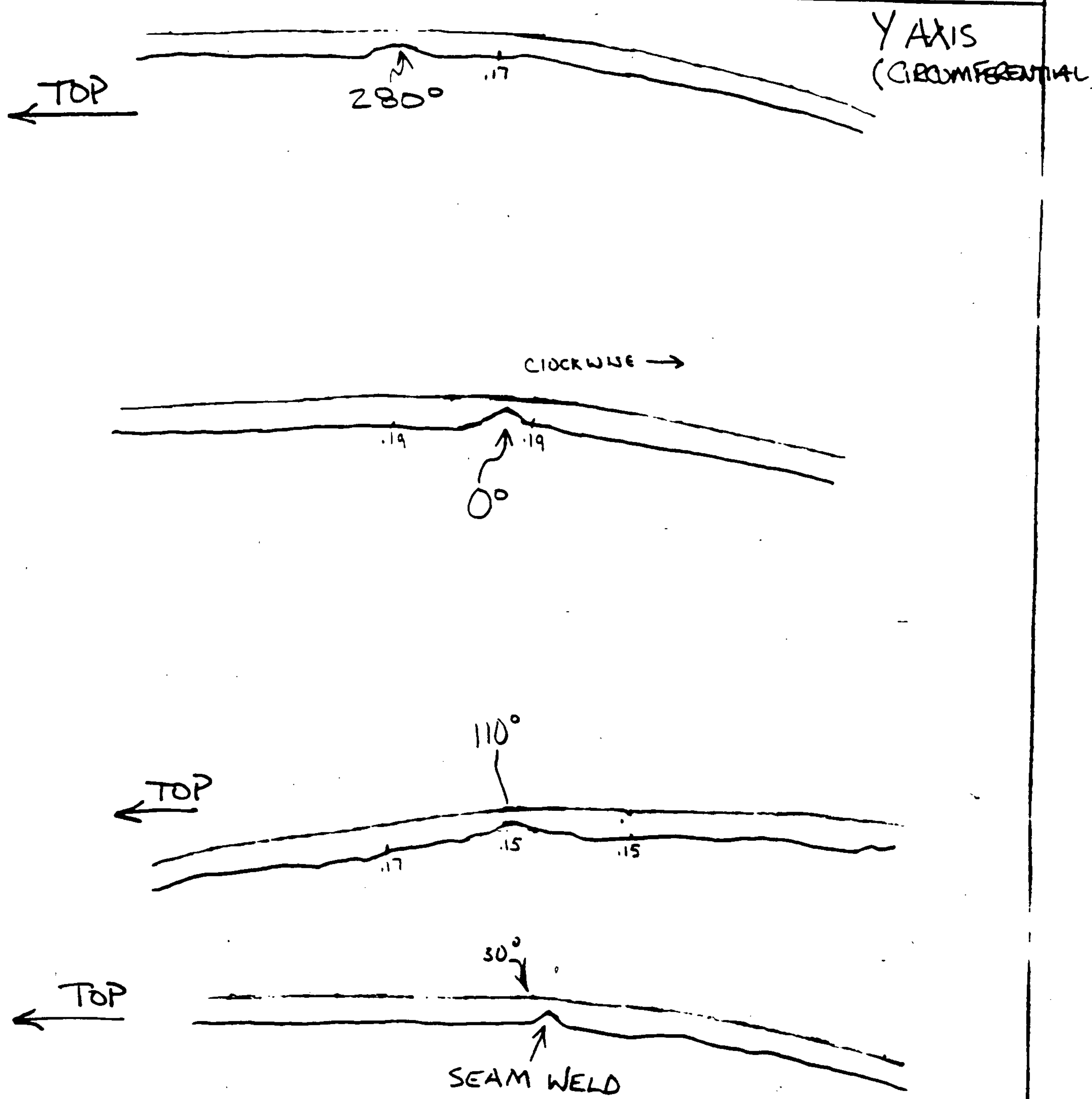
Carolina Power & Light Company

NDE DRAWING ATTACHMENT

PAGE__ OF__

PROJECT HBR JOB NO. UNIT 1☐ 2☑ 3☐ 4☐ DATE 11/27/90

DRAWING	SYSTEM	LINE	WELD/ITEM NUMBER
30-CW-12 ISO	SERVICE WATER	SOUTH HDR	542 Y AXIS



QA NDE CS 1 Rev. 0 6/83

LEV II

Carolina Power & Light Company

NDE DRAWING ATTACHMENT

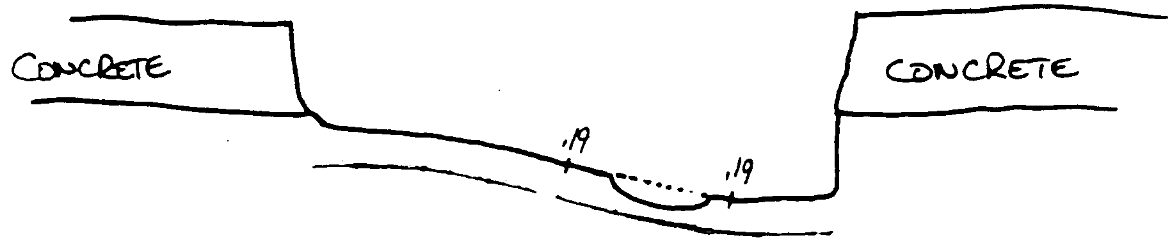
PAGE __ OF __

PROJECT HBR	JOB NO. N/A	UNIT 1☐ 2☒ 3☐ 4☐	DATE 11/20/90
DRAWING 30-CW-12 ISO	SYSTEM Service Water	LINE SOUTH HEADER	WELD/ITEM NUMBER JOINT S-43

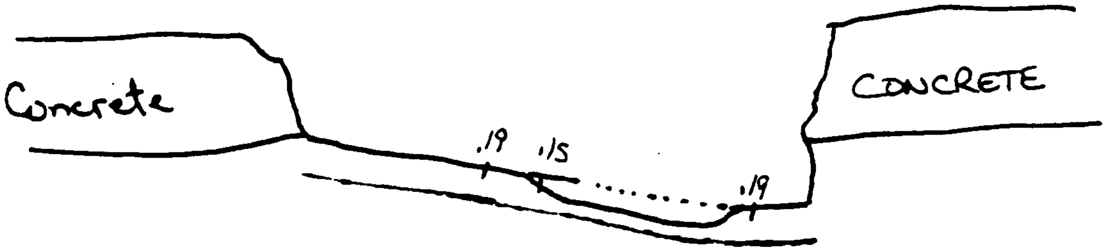
Joint 43 Elbow

X AXIS (LONGITUDINAL)

AT 90°



AT 0°



J.R. Black LEV II

Carolina Power & Light Company

NDE DRAWING ATTACHMENT

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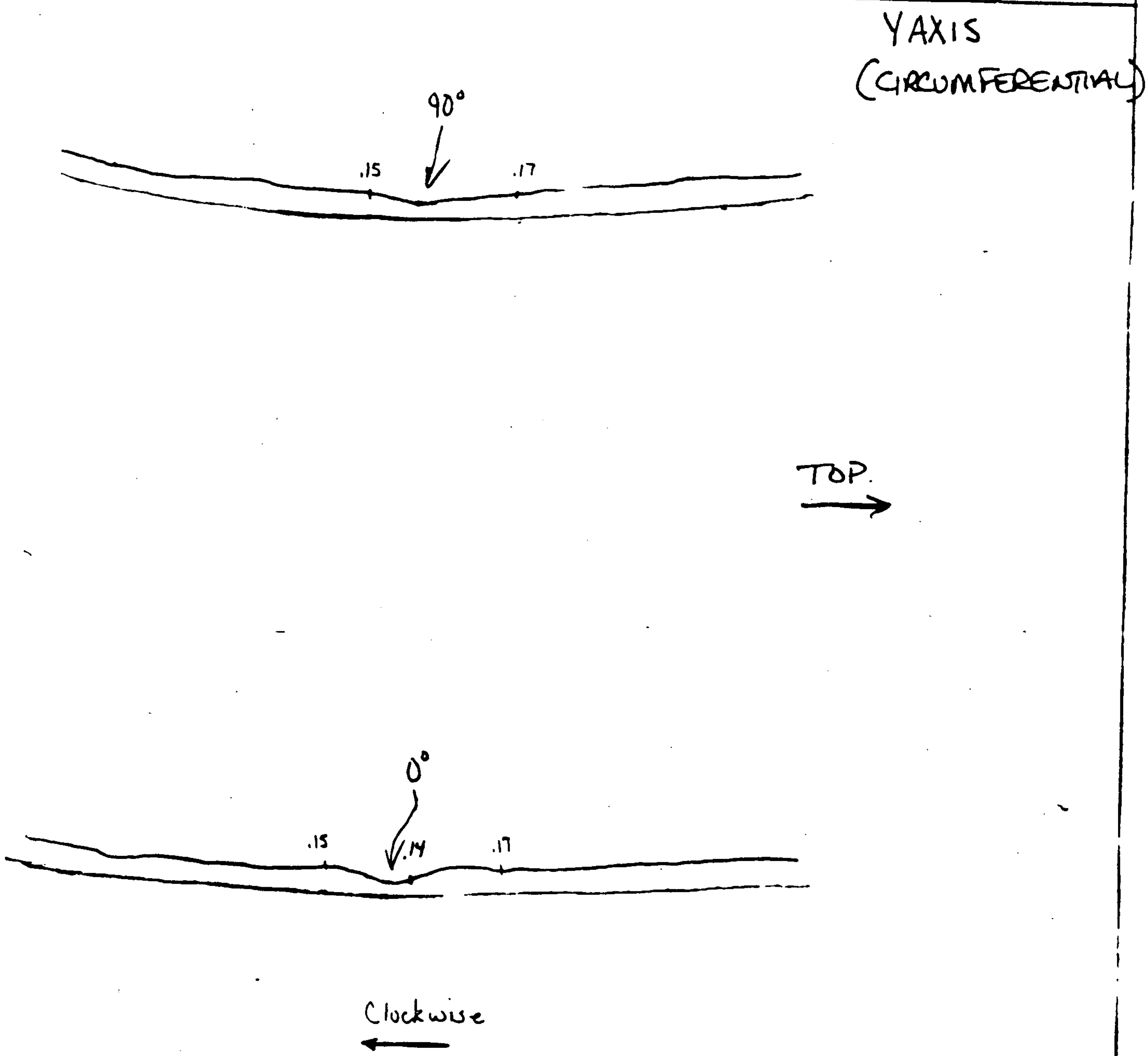
PROJECT HBR JOB NO. N/A UNIT 1☐ 2☒ 3☐ 4☐ DATE 11/27/90

DRAWING	SYSTEM	LINE	WELD/ITEM NUMBER
30-CW-12 ISO	SERVICE WATER	SOUTH HDR	543 YAXIS



C. Black (III/II)

APPENDIX A

WALL THICKNESS MEASUREMENT RECORD SHEET

PLANT: H.B. ROBINSON UNIT: 2

COMPONENT: S-6 NOM. SIZE O.D.: 30" NOM. WALL: ______ MIN. WALL: ______ ZONE: ______

LINEAR SPACING: 1" RADIAL SPACING: 1" STARTING AT: 1" FROM EDGE OF BELL - UPSTREAM ENDING AT: 12" DOWNSTREAM

FLOW ↓

LINEAR INCREMENT / RADIAL INCREMENT (← CLOCKWISE)

LINEAR INCREMENT	-1"	0"	1"	2"	3"	4"	5"	6"	7"	8"	9"	10"	11"	12"	13"
A	.20	.22	.21	.21	.21	.21	.21	.22	.22	.22	.21	.21	.21	.22	.21
B	.21	.20	.21	.21	.20	.20	.20	.20	.20	.20	.20	.20	.20	.21	.21
C	.20	.20	.20	.20	.20	.20	.20	.20	.20	.20	.20	.20	.20	.20	.21
D	.16	.15	.19	.20	.20	.19	.20	.20	.20	.20	.20	.19	.19	.20	.20
E	.20	.19	.18	.20	.20	.20	.18	.18	.18	.17	.18	.18	.19	.20	.20
F	.18	.19	.20	.20	.15	.18	.20	.20	.18	.20	.17	.17	.16	.19	.20
G	.20	.21	.20	.20	.20	.20	.20	.20	.19	.20	.20	.19	.18	.20	.19
H	.21	.22	.22	.22	.20	.21	.21	.21	.21	.21	.22	.21	.21	.23	.21
I	.21	.21	.21	.21	.21	.21	.21	.22	.21	.21	.21	.21	.21	.21	.21
J	.21	.21	.21	.21	.21	.21	.21	.21	.21	.21	.21	.21	.23	.21	.21
K	.21	.21	.21	.21	.21	.21	.21	.21	.22	.21	.21	.31	.21	.22	.22
L	.22	.22	.23	.23	24	23	23	.23	.23	.22	.22	.23	.22	.22	.23

N/A

LOWEST MEASUREMENT: .15 AT LOCATION: (LIN. D F RAD. 0 3) COMMENTS: ① 0" IS TOP DEAD CENTER

② MEASUREMENTS MADE FROM O.D. SURFACE

③ SEE PAGE 3 FOR GRID SCHEME

PERFORMED BY: James Phillips DATE: 11/15/90

APPENDIX A

WALL THICKNESS MEASUREMENT RECORD SHEET

PLANT: H.B. ROBINSON UNIT: 2

COMPONENT: S-6 NOM. SIZE O.D.: 30" NOM. WALL: ______ MIN. WALL: ______ ZONE: ______

LINEAR SPACING: 1" RADIAL SPACING: 1" STARTING AT: 1" FROM EDGE OF BELL - UPSTREAM ENDING AT: 12" DOWNSTREAM

← CLOCKWISE

FLOW ↓

LINEAR INCREMENT / RADIAL INCREMENT	-21"	-20"	-19"	-18"	-17"	-16"	-15"	-14"	-13"	-12"	-11"	-10"	-9"	-8"	-7"	-6"	-5"	-4"	-3"	-2"
A	.22	.21	.20	.20	.20	.20	.21	.21	.21	.21	.21	.19	.21	.21	.21	.21	.21	.20	.21	.21
B	.20	.19	.19	.20	.20	.20	.21	.20	.20	.20	.20	.20	.20	.19	.19	.21	.20	.20	.20	.20
C	.19	.19	.20	.20	.19	.20	.20	.19	.19	.20	.19	.19	.20	.19	.19	.20	.19	.19	.19	.19
D	.17	.19	.18	.19	.13	.18	.19	.18	.19	.18	.18	.18	.20	.16	.16	.18	.19	.17	.17	.17
E	.19	.07	.20	.21	.20	.21	.19	.19	.20	.19	.18	.20	.20	.13	.13	.16	.19	.19	.19	.19
F	.14	.14	.14	.15	.14	.16	.18	.18	.17	.17	.18	.19	.20	.16	.16	.17	.17	.16	.18	.15
G	.23	.22	.22	.21	.20	.21	.21	.21	.20	.20	.20	.20	.19	.19	.19	.19	.20	.19	.20	.20
H	NA	.23	.22	.23	.22	.22	.22	.22	.21	.21	.21	.21	.20	.20	.20	.21	.21	.21	.21	.21
I	NA	.24	.24	.23	.22	.22	.21	.22	.21	.21	.21	.21	.22	.19	.19	.20	.21	.21	.21	.21
J	NA	NA	.22	.22	.22	.21	.22	.21	.22	.21	.21	.21	.21	.20	.20	.20	.21	.21	.21	.21
K	NA	NA	NA	.21	.22	.21	.22	.22	.22	.22	.22	.21	.21	.21	.21	.21	.21	.21	.21	.21
L	NA	NA	NA	.22	.21	.23	.23	.23	.21	.22	.21	.21	.21	.21	.21	.20	.22	.21	.21	.21

LOWEST MEASUREMENT: .13 AT LOCATION: (LIN. E / D RAD. -8,-7 / -17) COMMENTS: ______

PERFORMED BY: [signature] DATE: 11/15/90

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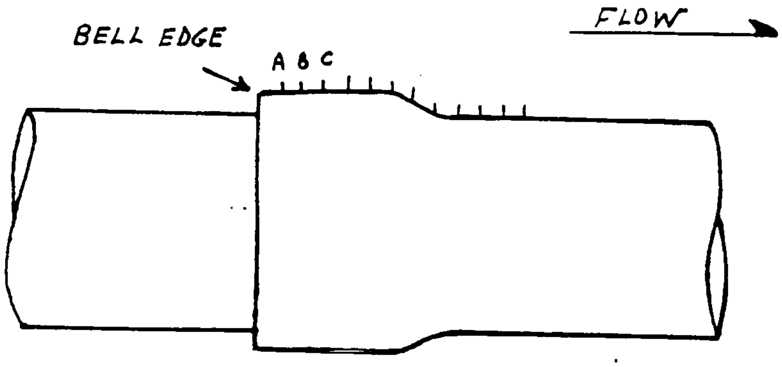
Carolina Power & Light Company

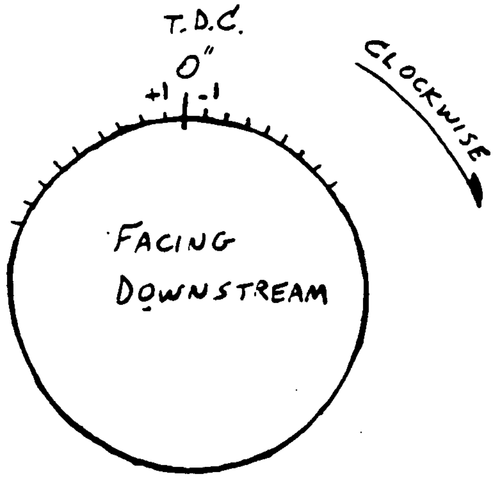
NDE DRAWING ATTACHMENT

PROJECT HBR JOB NO. UNIT 1☐ 2☒ 3☐ 4☐ DATE 11-15-90

DRAWING	SYSTEM	LINE	WELD/ITEM NUMBER
	SERVICE WATER		S-6



LINEAR INCREMENTS ARE SPACED 1" APART



CIRCUMFERENTIAL INCREMENTS ARE SPACED 1" APART.

James Phillips II-T
11-15-90

THICKNESS CALIBRATION SHEET

PLANT/UNIT: HBR - 2 COMPONENT: SERVICE WATER

PROCEDURE #: NDEP - 408 REV. 6

CALIBRATION BLOCK #1 NDE 89-03 BLOCK THICKNESS .05" To .25"

#2 NA BLOCK THICKNESS NA

INSTRUMENT: USK-7

CAL. DUE DATE: 12-12-90

SERIAL NUMBER: 27276 - 4182

SWEEP: 0.50

DELAY: 7.21

RANGE: .5"

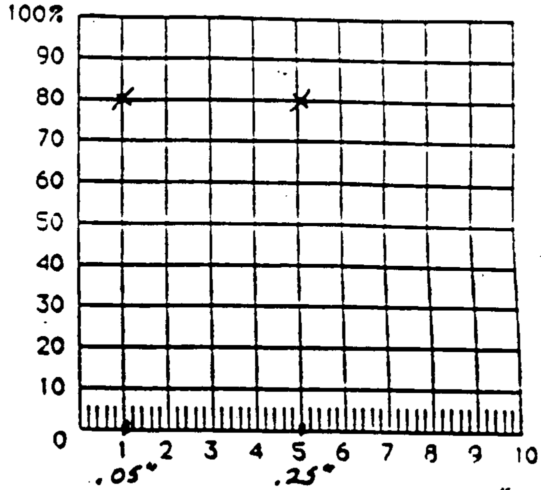
TRANSDUCER FREQUENCY: 5 MHz

TRANSDUCER SERIAL NO.: G 31043

TRANSDUCER BRAND: KB AEROTECH

TRANSDUCER SIZE: .25"

TRANSDUCER ELEMENT: SINGLE OR (DUAL)



EACH MAJOR SCREEN DIVISION: .05"

CALIBRATION VER. / CHECK	
INITIAL	TIME
JP	08:15
JP	11:00
JP	13:30
JP	16:45
N/A	

COMMENTS:

REF. GAIN = 80%

S-10

HORIZONTAL LINEARITY VERIFIED

EXAMINERS 1 [signature] DATE 11-15-90 LEVEL II-T

2 ________ DATE ________ LEVEL ________

REVIEWERS 1 ________ DATE ________

2 ________ DATE ________

3 ________ DATE ________

ADDITIONAL SHEETS: YES NO

APPENDIX A

WALL THICKNESS MEASUREMENT RECORD SHEET

PLANT: HB ROBINSON UNIT: 2

Page 1 of 3

COMPONENT: S-7 NOM. SIZE O.D.: ______ NOM. WALL: ______ MIN. WALL: ______ ZONE: ______

LINEAR SPACING: 1" RADIAL SPACING: 1" STARTING AT: 0" @ TDC 3" DOWNSTREAM OF BELL EDGE ENDING AT: -10" + +11" CIRCUM. AND 11" DOWNSTREAM OF BELL EDGE

← CLOCKWISE

FLOW ↓

LINEAR INCREMENT \ RADIAL INCREMENT	-10"	-9"	-8"	-7"	-6"	-5"	-4"	-3"	-2"	-1"	0"	1"	2"	3"	4"	5"	6"	7"	8"	9"	10"	11"
A	.16	.17	.18	.18	.18	.18	.18	.18	.18	.17	.18	.18	.17	.18	.18	.17	.17	.17	.18	.18	.18	.18
B	.17	.17	.16	.17	.17	.17	.16	.17	.16	.17	.17	.18	.17	.17	.17	.17	.17	.17	.16	.17	.17	.17
C	.14	.12	.13	.11	.15	.15	.16	.15	.14	.14	.12	.15	.15	.13	.12	.15	.15	.15	.15	.14	.15	.14
D	.12	.14	.10	.11	.12	.12	.13	.15	.11	.15	.15	.15	.12	.10	.11	.15	.14	.15	.13	.11	.11	.15
E	.17	.17	.16	.17	.18	.18	.18	.17	.18	.18	.18	.18	.18	.18	.18	.17	.18	.17	.18	.16	.15	.19
F	.20	.20	.20	.20	.20	.20	.20	.20	.20	.20	.20	.19	.19	.20	.19	.19	.19	.19	.19	.19	.18	.18
G	.19	.20	.19	.19	.19	.19	.19	.19	.19	.19	.19	.19	.19	.19	.19	.19	.19	.19	.19	.19	.20	.19
H	.19	.19	.19	.19	.19	.19	.19	.19	.19	.19	.19	.19	.19	.19	.19	.19	.19	.19	.19	.19	.19	.19
I	.19	.19	.19	.19	.19	.19	.19	.19	.19	.19	.19	.19	.19	.19	.19	.19	.19	.19	.19	.19	.19	.18

FLOW ↑

-A	RANGE FROM .18 TO .20 →																			
-B	↓																			
-C	↓																			
-D	↓																			
-E	↓																			
NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓
NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

LOWEST MEASUREMENT: ~~.11~~ .10 (PT 11/26/90) AT LOCATION: (LIN. ~~C~~ D (PT 11/26/90) RAD. ~~-8~~, 3)

COMMENTS: ① 0" IS TOP DEAD CENTER
② Measurements made from OD Surface
③ See pg 2 for Grid scheme

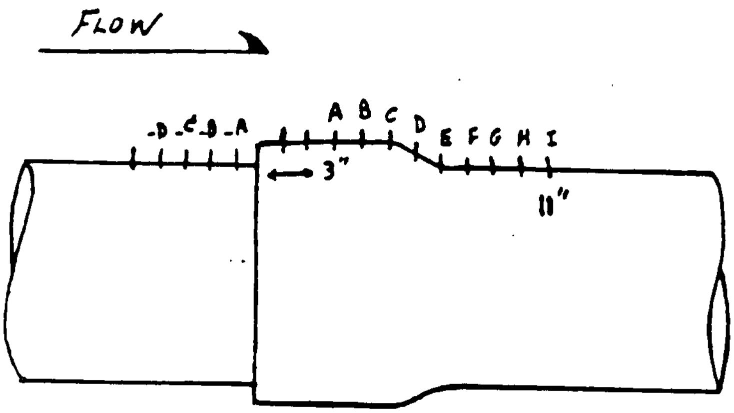
PERFORMED BY: [signature] DATE: 11/14/90

CP&L

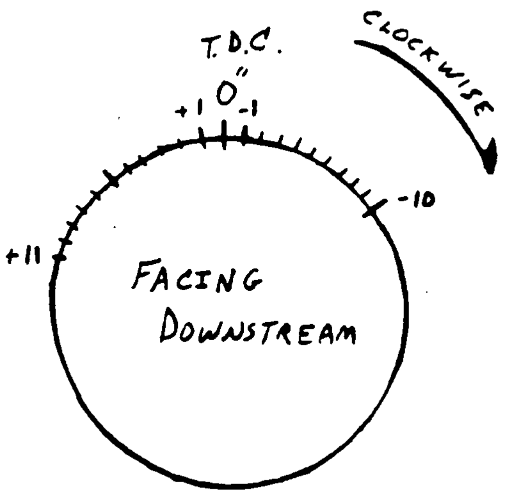
Carolina Power & Light Company

NDE DRAWING ATTACHMENT

PROJECT HBR	JOB NO.	UNIT 1☐ 2☒ 3☐ 4☐	DATE 11-14-90
DRAWING	SYSTEM SERVICE WATER	LINE	WELD/ITEM NUMBER S-7



LINEAR INCREMENTS ARE SPACED 1" APART



CIRCUMFERENTIAL INCREMENTS ARE SPACED 1" APART

James Phillips II-T
11-14-90

THICKNESS CALIBRATION SHEET

PLANT/UNIT: H.B. ROBINSON COMPONENT: SERVICE WATER

PROCEDURE #: NDEP - 408 REV. 6

CALIBRATION BLOCK #1 NDE 89-03 BLOCK THICKNESS .05" TO .25"

#2 NA BLOCK THICKNESS NA

INSTRUMENT: USK - 7

CAL. DUE DATE: 12-12-90

SERIAL NUMBER: 27276 - 4182

SWEEP: 0.50

DELAY: 7.21

RANGE: .5"

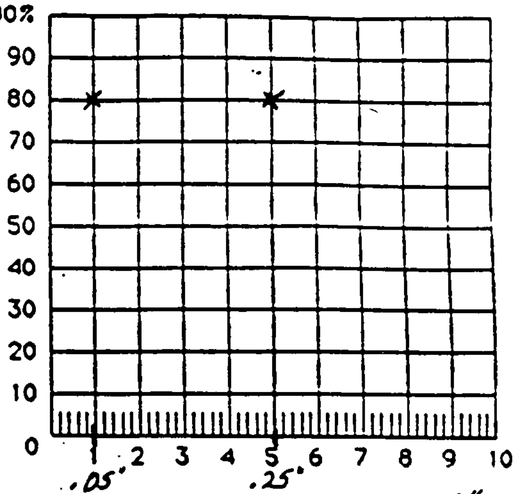
TRANSDUCER FREQUENCY: 5.0 MHZ

TRANSDUCER SERIAL NO.: G 31043

TRANSDUCER BRAND: KB AEROTECH

TRANSDUCER SIZE: .25"

TRANSDUCER ELEMENT: SINGLE OR (DUAL)



EACH MAJOR SCREEN DIVISION: .05"

CALIBRATION VER. / CHECK	
INITIAL	TIME
JP	08:15
JP	11:00
JP	13:00
JP	16:15

COMMENTS: S-7

HORIZONTAL LINEARITY VERIFIED

EXAMINERS 1 [signature] DATE 11-14-90 LEVEL II-T

2 ____ DATE ____ LEVEL ____

REVIEWERS 1 ____ DATE ____

2 ____ DATE ____

3 ____ DATE ____

ADDITIONAL SHEETS: YES NO

APPENDIX A

WALL THICKNESS MEASUREMENT RECORD SHEET

PLANT: H.B. ROBINSON UNIT: 2

Page 1 of 7

COMPONENT: SOUTH HEADER S-32 NOM. SIZE O.D.: 30" NOM. WALL: ______ MIN. WALL: ______ ZONE: ______

LINEAR SPACING: 1" RADIAL SPACING: 1" STARTING AT: 3" DOWNSTREAM OF BELL EDGE. ENDING AT: 12" DOWNSTREAM OF BELL EDGE.

LINEAR INCREMENT / RADIAL INCREMENT — CLOCKWISE →

FLOW ↓

LINEAR INCREMENT	1"	2"	3"	4"	5"	6"	7"	8"	9"	10"	11"	12"	13"	14"	15"	16"	17"	18"	19"	20"
A																				
B																				
C	.19	←																	→	.19
D	.19	TO	.20	←																→
E	.19	←		→	.19	.18	.19	.19	.18	.19	←							→	.19	.18
F	.17	.17	.18	.18	.18	.17	.18	.17	.17	.19	.19	.17	.17	.18	.19	.17	.19	.16	.16	.17
G	.18	.17	.18	.19	.19	.19	.19	.19	.19	.19	.19	←							→	.19
H	.20	.20	.20	.20	.20	.20	.20	.20	.20	.20	.20	.20	.20	.20	.20	.20	.20	.20	.20	.20
I	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓
J	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓
K	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓
L	.20	.20	.20	.20	.20	.20	.20	.20	.20	.20	.20	.20	.20	.20	.20	.20	.20	.20	.20	.20
-A	(.20	TO	.21)	→																→
-B	↓																			
-C	↓																			
-D	↓																			
-E	↓																			
-F	↓																			→

FLOW ↑

LOWEST MEASUREMENT: .16" AT LOCATION: (LIN. F RAD. 18,19) COMMENTS: (1) 1" IS DEAD TOP CENTER

PERFORMED BY: James Phillips DATE: 11/15/90

(2) MEASUREMENTS MADE FROM O.D. SURFACE

(3) SEE PAGE 6 FOR GRID SCHEME

APPENDIX A

WALL THICKNESS MEASUREMENT RECORD SHEET

PLANT: H.B. ROBINSON UNIT: 2

Page 2 of 7

COMPONENT: SOUTH HEADER S-32 NOM. SIZE O.D.: 30" NOM. WALL: ______ MIN. WALL: ______ ZONE: ______

LINEAR SPACING: 1" RADIAL SPACING: 1" STARTING AT: 3" DOWNSTREAM OF BELL EDGE. ENDING AT: 12" DOWNSTREAM OF BELL EDGE

LINEAR INCREMENT / RADIAL INCREMENT — CLOCKWISE →

FLOW ↓

LINEAR INCREMENT	21"	22"	23"	24"	25"	26"	27"	28"	29"	30"	31"	32"	33"	34"	35"	36"	37"	38"	39"	40"
A																				
B																				
C	.18	.18	.19	.18	.19	.19	.19	.19	.19	.18	.18	.18	.18	.18	.18	.18	.18	.18	.18	.18
D	.19	.19	.19	.19	.19	.19	.19	.19	.19	.18	.18	.18	.18	.18	.19	.18	.19	.18	.18	.19
E	.18	.18	.18	.18	.18	.19	.19	.18	.18	.18	.17	.18	.18	.18	.18	.18	.17	.18	.19	.18
F	.18	.17	.15	.17	.17	.17	.17	.17	.17	.17	.16	.17	.17	.17	.17	.17	.15	.18	.16	.16
G	.19	.19	.18	.19	.18	.19	.19	.18	.19	.18	.18	.18	.18	.18	.18	.18	.18	.18	.18	.19
H	.20	.20	.20	.20	.20	.20	.20	.20	.20	.19	.19	.19	.19	.19	.19	.19	.19	.20	.20	.20
I	.19	→																		.19
J	↓																			↓
K	↓																			↓
L	.19	→																		.19

LOWEST MEASUREMENT: .15 AT LOCATION: (LIN. F RAD. 23,37) COMMENTS: ______

PERFORMED BY: [signature] DATE: 11/15/90

APPENDIX A

WALL THICKNESS MEASUREMENT RECORD SHEET

SOUTH HEADER

PLANT: H.B. ROBINSON UNIT: 2

Page 3 of 7

COMPONENT: S-32 NOM. SIZE O.D.: 30" NOM. WALL: ______ MIN. WALL: ______ ZONE: ______

LINEAR SPACING: 1" RADIAL SPACING: 1" STARTING AT: 3" DOWNSTREAM OF BELL EDGE. ENDING AT: 12" DOWNSTREAM OF BELL EDGE.

CLOCKWISE →

FLOW ↓

LINEAR INCREMENT / RADIAL INCREMENT	41"	42"	43"	44"	45"	46"	47"	48"	49"	50"	51"	52"	53"	54"	55"	56"	57"	58"	59"	60"
A																				
B																				
C	.17	.17	.18	.18	.18	.17	.17	.17	.16	.18	.19	.18	.18	.18	.18	.18	.18	.18	.18	.18
D	.18	.18	.18	.19	.18	.18	.18	.18	.17	.18	.18	.18	.17	.18	.17	.18	.18	.17	.18	.18
E	.17	.18	.18	.17	.18	.18	.18	.17	.17	.17	.18	.18	.17	.18	.16	.17	.16	.16	.16	.16
F	.15	.17	.18	.15	.17	.17	.17	.18	.18	.18	.17	.17	.17	.18	.16	.11 (.08)	.12	.15	.12	.09 (.08)
G	.18	.18	.19	.19	.20	.18	.20	.20	.18	.19	.20	.19	.18	.19	.19	.19	.19	.16	.18	.19
H	.20	.20	.20	.20	.20	.20	.20	.19	.19	.19	.20	.19	.19	.19	.20	.20	.20	.20	.20	.20
I	(.19 TO .20) →																			
J	↕																			↕
K																				
L	↔																			→

LOWEST MEASUREMENT: .09 AT LOCATION: (LIN. G [F written above] RAD. 59 [56 written above]) COMMENTS: ______

PERFORMED BY: [signature] DATE: 11/15/90

APPENDIX A

WALL THICKNESS MEASUREMENT RECORD SHEET

PLANT: H. B. ROBINSON UNIT: 2

Page 4 of 7

COMPONENT: SOUTH HEADER S-32 NOM. SIZE O.D.: 30" NOM. WALL: ______ MIN. WALL: ______ ZONE: ______

LINEAR SPACING: 1" RADIAL SPACING: 1" STARTING AT: 3" DOWNSTREAM OF BELL EDGE. ENDING AT: 12" DOWNSTREAM OF BELL EDGE

CLOCKWISE →

FLOW ↓

LINEAR INCREMENT	RADIAL INCREMENT 61"	62"	63"	64"	65"	66"	67"	68"	69"	70"	71"	72"	73"	74"	75"	76"	77"	78"	79"	80"
A	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
B	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
C	.18	.18	.18	.18	.18	.18	.18	.18	.18	.19	.18	.19	.20	.19	NA	.19	.18	.18	.18	.17
D	.18	.17	.18	.18	.17	.16 8	.17	.18	.18	.19	.18	.19	.19	.19	.19	.18	.19	.18	.19	.18
E	.16	.16	.18	.18	.16	.15	.12	.10	.17	.15	.12	.19	.18	.20	.18	NA	.17	.18	.19	.18
F	.12	.14	.14	.13	.14	.15	.13	.10	.10	.10	.10	.15	.14	.15	.14	.15	.12	.15	.14	.12
G	.14	.19	.14	.17	.18	.19	.19	.19	.18	.20	.20	.15	.14	.15	.19	NA	.20	.19	.19	.17
H	.20	.20	.20	.19	—	.19	.19	.19	—	.20	.20	.20	.21	.20	.20	.20	.20	.19	.20	.20
I	.19	.20	NA	.19	.19	.19	.19	.19	—	.20	.20	.20	.20	.20	.20	.20	.20	.19	.20	.19
J	.19	.19	.19	.19	.19	—	.19	.19	—	.20	.20	.20	.20	.20	.20	.20	.20	.20	—	.19
K	.19	.19	.19	.19	.19	—	.19	.19	—	.20	.20	—	.20	.20	.20	.20	.20	—	—	—
L	.19	.19	.19	.19	.19	—	.19	.19	—	.20	.20	—	.20	.20	.20	.20	.20	—	—	—

LOWEST MEASUREMENT: .09 AT LOCATION: (LIN. D RAD. 66) COMMENTS: ______

PERFORMED BY: [illegible signature] DATE: 11 / 15 / 90

APPENDIX A

WALL THICKNESS MEASUREMENT RECORD SHEET

SOUTH HEADER

PLANT: H.B. ROBINSON UNIT: 2

COMPONENT: S-32 NOM. SIZE O.D.: 30" NOM. WALL: ______ MIN. WALL: ______ ZONE: ______

LINEAR SPACING: 1" RADIAL SPACING: 1" STARTING AT: 3" DOWNSTREAM OF BELL EDGE. ENDING AT: 12" DOWNSTREAM OF BELL EDGE.

LINEAR INCREMENT / RADIAL INCREMENT — CLOCKWISE →

FLOW ↓

	81"	82"	83"	84"	85"	86"	87"	88"	89"	90"	91"	92"	93"	94"	95"	96"	97"	98"	99"	100"
A	.19	.14	.14	.16	.16	.16	.16	.16	.15	.16	.19	.19	.20	.20	.20	.20	.20	.20	.20	.19
B	.19	.18	.18	.18	.18	.17	.17	.17	.18	.18	.19	.19	.19	.19	.19	.19	.19	.19	.19	.18
C	.18	.18	.18	.18	.18	.19	.17	.18	.17	.18	.18	.18	.19	.17	.18	.19	.19	.18	.18	.18
D	.19	.19	.18	.19	.19	.19	.18	.19	.19	.18	.19	.18	.19	.19	.19	.19	.19	.19	.18	.18
E	.18	.18	.18	.18	.18	.18	.20	.18	.18	.18	.18	.18	.18	.18	.18	.18	.19	.18	.17	.18
F	.13	.14	.16	.14	.17	.15	.13	.16	.15	.12	.16	.13	.17	.12	.16	.16	.18	.17	.16	.17
G	.18	.18	.19	.19	.19	.19	.19	.19	.19	.18	.18	.18	.19	.18	.20	.20	.16	.18	.18	.19
H	.20	.20	.20	.20	.20	.20	.20	.20	.20	.20	.20	.20	.20	.20	.20	.20	.18	.20	.19	.19
I	.20	.20	↓	↓	↓	↓	↓	↓	↓	.20	.19	.19	.20	.20	.20	.20	.20	.20	.20	.20
J	.20	.20	↓	↓	↓	↓	↓	↓	↓	.19	.19	.19	.19	.20	.19	.20	.18	.19	.19	.19
K	.20	.20	↓	↓	↓	↓	↓	↓	↓	.20	.20	.20	.20	.20	.20	.19	.19	.19	.19	.19
L	.20	.20	.20	.20	.20	.20	.20	.20	.20	.20	.20	.20	.20	.20	.20	.19	.19	.19	.19	.19

FLOW ↑

-A	(.2 TO .21) →																			
-B	↓																			
-C	↓																			
-D	↓																			
-E	↓																			
-F	↓																			

LOWEST MEASUREMENT: .12 AT LOCATION: (LIN. F RAD. ~~94~~ 90) COMMENTS: ______

PERFORMED BY: [signature] DATE: 11/15/90

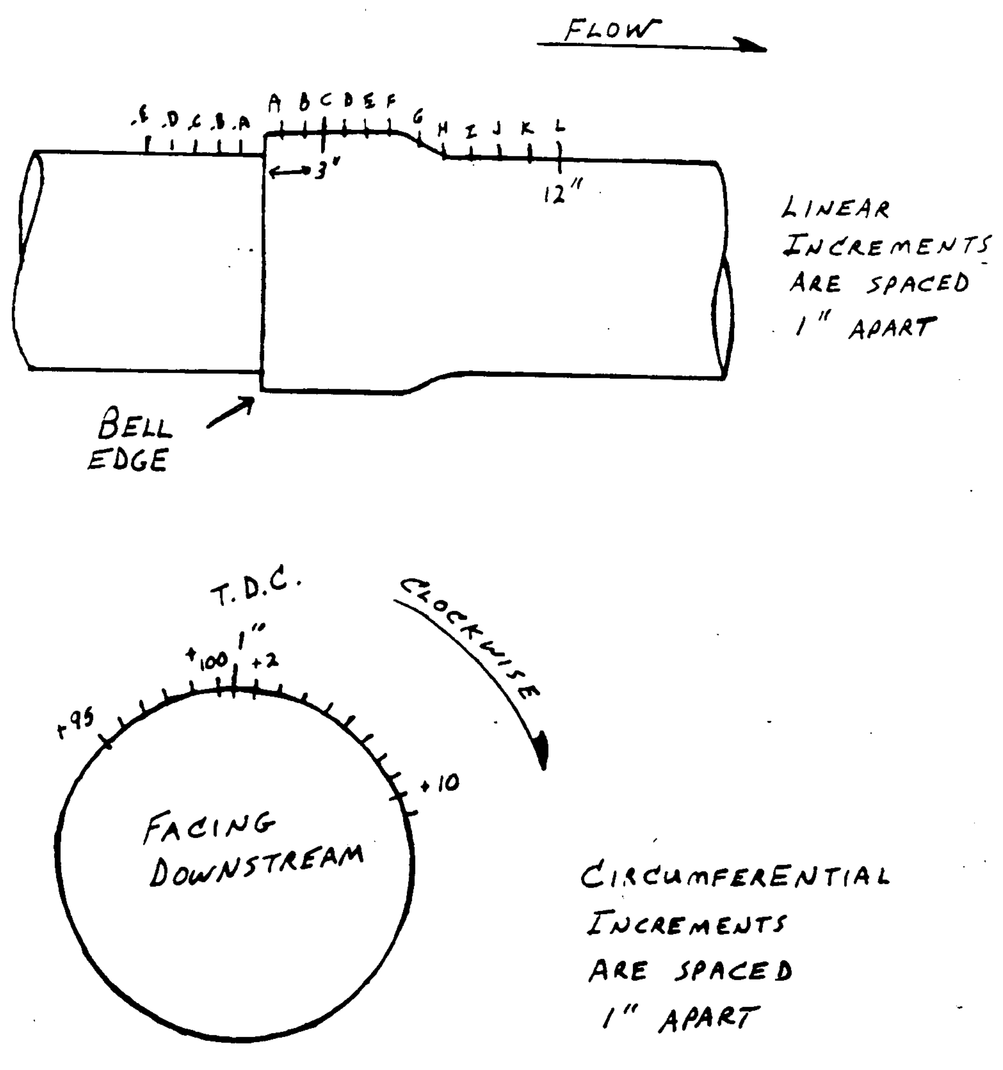
CP&L

Carolina Power & Light Company

NDE DRAWING ATTACHMENT

PROJECT HBR JOB NO. UNIT 1☐ 2☒ 3☐ 4☐ DATE 11-15-90

DRAWING	SYSTEM	LINE	WELD/ITEM NUMBER
3D-CW-12 ISO	Service Water	SOUTH HEADER	S-32



James Phillips II-T
11-15-90

APPENDIX A

THICKNESS CALIBRATION SHEET

PLANT/UNIT: HBR - 2 COMPONENT: S-32 SERVICE WATER

PROCEDURE #: NDEP - 408 REV. 6

CALIBRATION BLOCK #1 NDE 89-03 BLOCK THICKNESS .05" TO .25"

#2 NA BLOCK THICKNESS NA

INSTRUMENT: USK-7

CAL. DUE DATE: 12-12-90

SERIAL NUMBER: 27276 - 4182

SWEEP: 0.50

DELAY: 7.21

RANGE: .5"

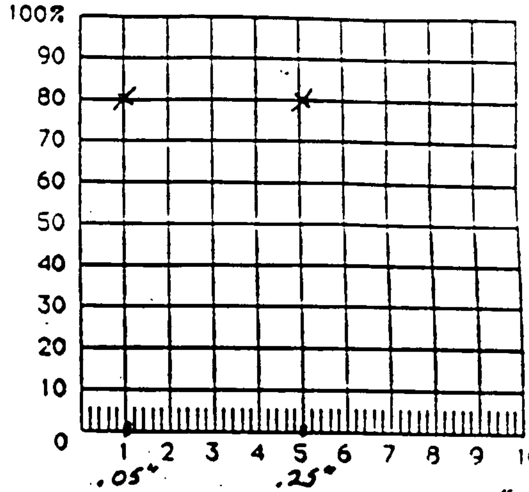
TRANSDUCER FREQUENCY: 5 MHz

TRANSDUCER SERIAL NO.: G 31043

TRANSDUCER BRAND: KB AEROTECH

TRANSDUCER SIZE: .25"

TRANSDUCER ELEMENT: SINGLE OR (DUAL)



EACH MAJOR SCREEN DIVISION: .05"

CALIBRATION VER. / CHECK	
INITIAL	TIME
JP	08:15
JP	11:00
JP	13:30
JP	16:45
N/A	

COMMENTS:

REF. GAIN = 80%

HORIZONTAL LINEARITY VERIFIED

EXAMINERS 1 [signature] DATE 11-15-90 LEVEL II-T

2 ______ DATE ______ LEVEL ______

REVIEWERS 1 ______ DATE ______

2 ______ DATE ______

3 ______ DATE ______

ADDITIONAL SHEETS: YES NO

JOINT EXCAVATED
BEHIND CANTEEN

APPENDIX A

WALL THICKNESS MEASUREMENT RECORD SHEET

PLANT: H B ROBINSON UNIT: 2

COMPONENT: AT WELD D/S OF JOINT S-32 SOUTH SUPPLY HDR - SERVICE WATER NOM. SIZE O.D.: 30" NOM. WALL: ______ MIN. WALL: ______ ZONE: ______

LINEAR SPACING: 1" RADIAL SPACING: 1" STARTING AT: 4" U/S OF WELD PREP ENDING AT: 3" D/S OF WELD PREP

LINEAR INCREMENT	RADIAL INCREMENT -A	-B	-C	-D	-E	+A	+B	+C	+D		-A	-B	-C	-D	-E	+A	+B	+C	+D	
+0	.18	.20	.20	.20	.20	.18	.19	.20	.20											
+1	.18	.20	.20	.20	.20	.18	.19	.20	.20	+(20)	.19	.19	.20	.20	.20	.18	.20	.20	.20	
+2	.19	.20	.20	.20	.20	.19	.19	.20	.20	+(21)	.17	.19	.20	.20	.20	.18	.19	.20	.20	
+3	.19	.20	.20	.20	.20	.18	.20	.20	.20	+(22)	.16	.19	.20	.20	.20	.17	.20	.20	.20	
+4	.18	.19	.20	.20	.20	.18	.19	.20	.20	+(23)	.16	.19	.19	.20	.20	.17	.19	.20	.20	
+5	.17	.20	.20	.20	.20	.14	.17	.20	.20	+(24)	.14	.18	.18	.20	.20	.16	.18	.20	.20	
+6	.19	.19	.20	.20	.20	.12	.20	.20	.20	+(25)	.16	.18	.19	.20	.20	.15	.18	.20	.19	
+7	.17	.18	.19	.20	.20	.16	.19	.20	.20	+(26)	.16	.20	.20	.20	.20	.15	.20	.20	.18	
+8	.16	.19	.20	.20	.20	.18	.20	.20	.20	+(27)	.17	.20	.20	.20	.20	.18	.20	.20	.20	
+9	.17	.19	.20	.20	.20	.12	.19	.20	.20	+(28)	.17	.19	.20	.20	.20	.18	.18	.20	.20	
+10	.18	.19	.20	.20	.20	.18	~~.20~~ .19 Pr[illegible]	.20	.20	+(29)	.20	.20	.20	.20	.20	.19	.20	.20	.20	
+11	.17	.19	.20	.20	.20	.17	.20	.20	.20	+(30)	.17	.19	.20	.28	—	.18	.20	.20	.20	
+12	.16	.19	.20	.20	.20	.18	.20	.20	.20	+(31)	.20	.19	.27	.20	—	.18	.20	.20	.20	
+13	.17	.20	.20	.20	.20	.18	.20	.20	.20	+(32)	.19	.20	.20	.19	—	.19	.18	.20	.20	
+14	.17	.20	.20	.20	.20	.17	.20	.20	.20	+(33)	.18	.30	.20	.20	—	.21	.20	.21	.20	
+15	.17	.19	.19	.20	.20	.18	.20	.20	.20	+(34)	.24	.20	.20	.20	—	.18	.20	.20	.20	
+16	.16	.19	.20	.20	.20	.18	.20	.20	.20	+(35)	.20	.20	.20	.20	—	.18	.19	.20	.20	
+17	.16	.19	.20	.20	.20	.17	.20	.20	.20	+(36)	.18	.20	.20	.20	—	.15	.18	.18	.18	
+18	.16	.19	.20	.20	.20	.18	.19	.20	.20	+(37)	N/C	N/C	N/C	N/C	—	.18	.20	.17	.18	
+19	.18	.19	.20	.20	.20	.19	.20	.20	.20	+(38)	N/C	N/C	N/C	N/C	—	N/C	N/C	N/C	N/C	

LOWEST MEASUREMENT: [illegible]" AT LOCATION: (LIN. +A RAD. +10) COMMENTS: ______

PERFORMED BY: [illegible signature] DATE: 11 /20 /90

JOINT EXCAVATED BEHIND CANTEEN

APPENDIX A

WALL THICKNESS MEASUREMENT RECORD SHEET

PLANT: H.B. ROBINSON UNIT: 2

COMPONENT: AT WELD D/S OF JOINT S-32 SOUTH SUPPLY HDR - SERVICE WATER NOM. SIZE O.D.: 30" NOM. WALL: ______ MIN. WALL: ______ Page 2 of 5

LINEAR SPACING: 1" RADIAL SPACING: 1" STARTING AT: 4" U/S OF WELD PREP ENDING AT: 3" D/S OF WELD PREP ZONE: ______

LINEAR INCREMENT	RADIAL INCREMENT -A	-B	-C	-D	-E	+A	+B	+C	+D
+39	—	—	—	—	—	—	—	—	—
+40	THIS AREA EXHIBITS GROSS							—	—
+41	PITTING ON O.D. -					—	—	—	—
+42	UNABLE TO MEASURE WITH							—	—
+43	UT FROM O.D				—	—	—	—	—
+44	SEE MEASUREMENTS FROM I.D.								—
+45	—	—	—	—	—	—	—	—	—
+46	—	—	—	—	—	—	—	—	—
+47	—	—	—	—	—	—	—	—	—
+48	—	—	—	—	—	—	—	—	—
+49	—	—	—	—	—	—	—	—	—
+50	—	—	—	—	—	—	—	—	—
-1	.18	.19	.19	.19	.19	~~.18~~ Pit loc'n .16	.18	.19	~~.20~~ Pit loc'n .19
-2	.18	.19	.19	.19	.20	.17	.18	.19	.19
-3	.18	.20	.20	.20	.20	.17	.18	.18	.30
-4	.18	.19	.19	.19	.20	.18	.19	.20	.19
-5	.18	.19	.19	.20	.20	.17	.18	.29	.19
-6	.19	.20	.20	.20	—	.17	.18	.18	.19
-7	.17	.19	.19	.19	—	.17	.26	.19	.19

LINEAR INCREMENT	-A	-B	-C	-D	-E	+A	+B	+C	+D	
(-8)	.16	.19	.19	.19	—	.23	.19	.19	.19	—
(-9)	.16	.19	.20	.20	—	.19	.19	.19	.19	—
(-10)	.18	.19	.19	.19	—	.17	.19	.19	.19	—
(-11)	.17	.19	.20	.19	—	.17	.19	.19	.19	—
(-12)	.16	.19	.19	.19	—	.18	.18	.19	.19	—
(-13)	.18	.19	.19	.19	—	.18	.19	.19	.19	—
(-14)	.16	.19	.19	.19	—	.18	.19	.19	.19	—
(-15)	.18	.19	.19	.19	—	.17	.19	.19	.19	—
(-16)	.17	.19	.19	.19	—	.16	.19	.19	.19	—
(-17)	.16	.19	.19	.20	—	.17	.18	.19	.20	—
(-18)	.18	.18	.19	.20	—	.18	.18	.19	.20	—
(-19)	.19	.19	.17	.18	—	.18	.17	.19	.20	—
(-20)	.17	.19	.17	.19	—	.18	.18	.19	.20	—
(-21)	.18	.19	.18	.18	—	.19	.19	.19	.19	—
(-22)	.17	.19	.17	.18	—	.18	.18	.19	.19	—
(-23)	.17	.20	.18	.18	—	.17	.18	.20	.19	—
(-24)	NC	.19	.19	.19	—	.18	.19	.19	.19	—
(-25)	.15	.19	.19	.19	—	.18	.20	.18	.20	—
(-26)	.15	.18	.19	.18	—	.19	NC	.17	.17	—

LOWEST MEASUREMENT: .150" AT LOCATION: (LIN. -25 RAD. -A) COMMENTS: (1) N/C = NOT CLEAN

PERFORMED BY: [signature] DATE: 11/20/90 (2) MEASUREMENTS TAKEN FROM O.D. SURFACE

APPENDIX A

WALL THICKNESS MEASUREMENT RECORD SHEET

PLANT: H.B. ROBINSON UNIT: 2

COMPONENT: AT WELD D/S OF JOINT S-32 SOUTH SUPPLY HDR - SERVICE WATER NOM. SIZE O.D.: 30" NOM. WALL: ______ MIN. WALL: ______ Page 3 of 5

LINEAR SPACING: 1" RADIAL SPACING: 1" STARTING AT: 4" U/S OF WELD PREP ENDING AT: 3" D/S OF WELD PREP ZONE: ______

LINEAR INCREMENT	RADIAL INCREMENT -A	-B	-C	-D	-E	+A	+B	+C	+D		-A	-B	+A	+B		-A	-B	+A	+B	
-27										(-27)	.15	.18	.15	.17	(+38)	.19	.19	.13	.19	
-28	THIS AREA EXHIBITS GROSS									(-28)	N/A	.18	.16	.19	(+39)	.18	.18	.17	.19	
-29	PITTING ON O.D. -									(-29)	.10	.16	.15	.18	(+40)	.16	.18	.17	.19	
-30	UNABLE TO MEASURE WITH									(-30)	.09	.17	.16	.18	(+41)	.18	.18	.18	.19	
-31	UT FROM O.D.									(-31)	.10	.18	.17	.17	(+42)	.15	.16	.16	.18	
-32	SEE MEASUREMENTS TAKEN									(-32)	<.1	.16	.15	.18	(+43)	.12	.17	.15	.17	
-33	FROM I.D. →									(-33)	.14	.17	.15	.19	(+44)	.13	.15	.15	.17	
-34										(-34)	.15	.17	.16	.18	(+45)	.14	.15	.15	.15	
-35										(-35)	.14	.16	.17	.16	(+46)	.12	.13	<.10	.15	
-36										(-36)	.15	.18	.13	.17	(+47)	.12	.12	.15	.15	
-37										(-37)	.14	.17	.17	.18	(+48)	.15	.13	.15	.14	
-38										(-38)	.15	.17	.19	.16	(+49)	<.10	.13	.13	.15	
-39										(-39)	.17	.17	.16	.17	(+50)	.12	.14	.12	.14	
-40										(-40)	.13	.17	.14	.18						
-41										(-41)	.15	.16	.14	.16						
-42										(-42)	N/A	.15	.16	.16						
-43										(-43)	.15	.16	.15	.17						
-44										(-44)	.10	.14	.12	.13						

DUE TO O.D. PITTING THESE MEASUREMENTS TAKEN FROM I.D. OF PIPE

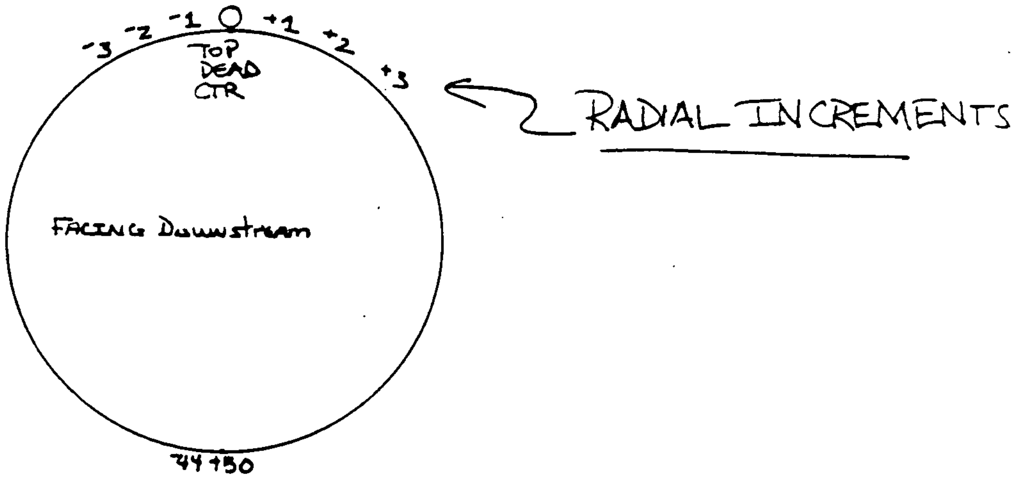
LOWEST MEASUREMENT: <.100 AT LOCATION: (LIN. -32 / +46 RAD. -A / +A)

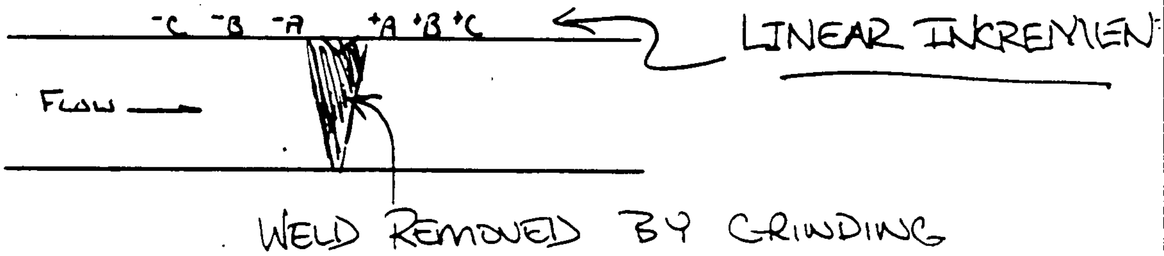
COMMENTS: ① PROFILE TAKEN AT +43-E SEE PAGE 4
② PROFILE TAKEN AT -44 +C SEE PAGE 4

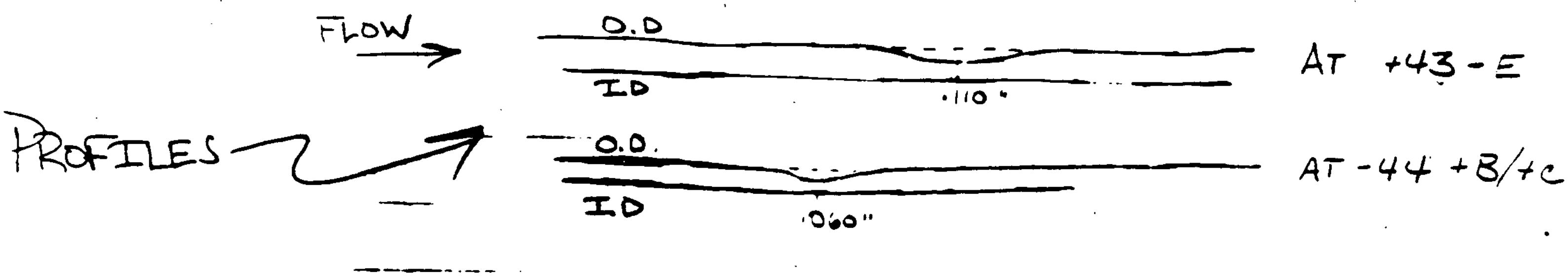
PERFORMED BY: [signature] DATE: 11/20/90

H.B. ROBINSON UNIT 2

AT WELD DOWNSTREAM OF JOINT S-32:
SOUTH SUPPLY HEADER -- SERVICE WATER







[signature] 11/20/90

APPENDIX A

THICKNESS CALIBRATION SHEET

PLANT/UNIT: HBR u/2 COMPONENT: ServiceWater

PROCEDURE #: 408 REV. 6

CALIBRATION BLOCK #1 8903 BLOCK THICKNESS .250 (.050" Incr.)

#2 ________ BLOCK THICKNESS ________

INSTRUMENT: K-B USK7

CAL. DUE DATE: 12-12-90

SERIAL NUMBER: 27276-4182

SWEEP: 0.94

DELAY: 7.22

RANGE: 0.5

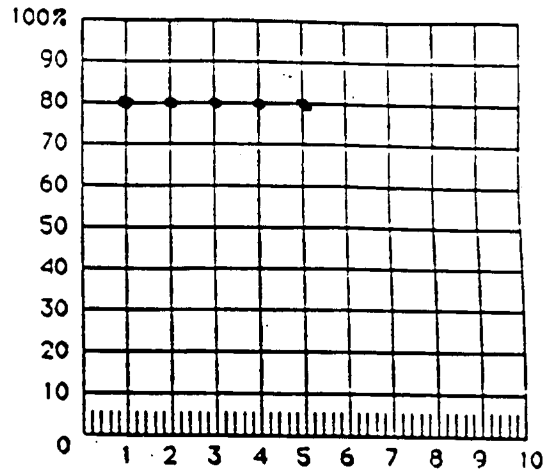
TRANSDUCER FREQUENCY: 5.0

TRANSDUCER SERIAL NO.: G31043

TRANSDUCER BRAND: KBA

TRANSDUCER SIZE: 1/4"

TRANSDUCER ELEMENT: SINGLE OR (DUAL)



EACH MAJOR SCREEN DIVISION: .050"

CALIBRATION VER. / CHECK	
INITIAL	TIME
JWB	0930
JWB	1200
JWB	1245
JWB	1600

COMMENTS: Ref. Gain = 80% FSH

EXAMINERS 1 [signature] DATE 11/20/90 LEVEL II

2 ________ DATE ________ LEVEL ________

REVIEWERS 1 ________ DATE ________

2 ________ DATE ________

3 ________ DATE ________

ADDITIONAL SHEETS: YES NO

ATTACHMENT "I"
26 SHEETS

EQE

AN APPROACH FOR EVALUATING THE RESPONSE OF BURIED JOINTED PIPE TO SEISMIC WAVE PROPAGATION

Prepared for

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November 16, 1990

EXECUTIVE SUMMARY

A procedure for estimating the response of a buried segmented pipeline is presented in this report. The procedure is based upon an assumption that the joints connecting the pipe segments are much softer than the surrounding soil. This assumption is considered valid even for concrete lined pipe that may have mortared joints because the integrity of the mortar is not essential for prevention of short term loss of functionality. With this assumption, evaluation of the ability of the pipeline to respond to ground motions is reduced to a problem of confirming that the play in the joints is sufficient to accommodate relative motions between adjacent pipe segments. A procedure is also presented for calculating an upperbound estimate of the soil loads on individual pipe segments.

1.0 INTRODUCTION TO PROBLEM

Buried pipelines may be subject to many hazards related to earthquakes. Two general classification of hazard are appropriate: hazards related to permanent ground deformation and hazards related to ground shaking. Permanent ground deformation can result from a variety of causes including differential fault movement, liquefaction, lateral spreads, vibratory compaction, and landslides. The amount of permanent ground deformation can be several feet and thus has a great potential to cause breaks in the pipeline. The potential for large permanent ground deformations is extremely low for nuclear power plant sites because of the requirements for siting and geotechnical stability (Ref. 2).

Relative movements between a buried pipe and the surrounding soil can result from seismic wave passage. Also, aboveground structures may be excited by the ground shaking and produce relative displacements at piping connections. This paper neglects the impact of relative structural displacements and focuses on the free-field condition. Furthermore, this paper addresses the impact of seismic wave propagation on buried jointed pipelines.

Jointed pipelines commonly make up the vast majority of municipal water and sewage lines and are still in use in many older natural gas distribution systems. Experience in past earthquakes has demonstrated that jointed pipelines are susceptible to damage. Available information shows that most observed earthquake damage has occurred in lines where corrosion was extensive or in lines that traversed areas of permanent ground deformation. These two conditions are unlikely in nuclear power plant cases given the requirements for site investigation, pipeline inspection and maintenance. Seismic wave propagation has been investigated by many researchers as a mechanism that can impose strains in continuous piping and piping with intermittant joints (Ref. 3, 5, 16, 17). In addition, several experiments have attempted to quantify the impact of seismic wave propagation on buried piping and tunnels (Ref. 4, 6, 8, 13). Recent design guidelines for buried piping recognize certain features typical of buried pipeline response to seismic wave propagation:

1) The free-field response of buried pipes and conduits indicates that they move with the ground.
2) Axial strain is predominant for pipes in the free field.

3) Bending strain is predominant at connections to structures, but a short distance away axial strain becomes predominant

Wave propagation effects manifest themselves in buried pipelines as a result of incoherence in the ground displacement field. Incoherence results from the difference in time for a wave to propagate between two points on the pipeline. Incoherence is affected by changes in local soil conditions, changes in pipeline orientation with respect to the direction of wave propagation, and connections to other structures that are responding to the ground motion. Other factors leading to incoherence in ground motion are the randomness of the excitation, the change in wave propagation velocity with frequency, and the attenuation of wave amplitude with distance. The consideration of incoherence in ground motion is a fundamental difference between the analysis of long continuous systems and buildings.

2.0 RELATIVE DISPLACEMENTS FROM WAVE PROPAGATION

Relationships for ground strain resulting from the propagation of shear and compression waves are well established. The following discussion provides a brief review of the basic equations. Some summary observations of numerical investigations into the response of jointed pipelines is included. Results of the numerical studies will be used to estimate requirements for joint displacements and rotations. Free-field strains will be used to provide upperbound estimates of relative motion between the pipe and soil.

2.1 COMPONENTS OF GROUND STRAIN FROM SHEAR AND COMPRESSION WAVES

A common assumption made in analyzing the impact of seismic wave propagation on buried pipelines is that the deformation in the pipeline is the same as the ground. The problem then reverts to one of determining the maximum ground strains. Newmark (Ref. 11, 12) showed that this problem is readily simplified for the assumption of a compression wave travelling in a particular direction of interest.

$$\epsilon = V_{max}/c \qquad (1)$$

ϵ = maximum ground strain in direction of propagation
V_{max} = maximum ground velocity
c = propagation velocity of seismic wave .

This relationship was developed by considering the case of a a wave travelling between points two points with a time varying motion in the direction of propagation. This situation is represented by Figure 1. The basic equations used to derive equation (1) are provided in Figure 1.

By examining the second derivative of the motions described in Figure 1, maximum ground curvature for a shear wave can be obtained from the following relation.

$$a = A_{max}/c^2 \qquad (2)$$

a = maximum ground curvature
A_{max} = maximum ground acceleration

Shear waves also produce shear strains normal to the direction of propagation. The greatest shear strain in the ground is also given by equation (1) with the appropriate value of propagation velocity.

For waves propagating at some angle, ß, to the direction of interest, relationships for strains parallel and perpendicular to the direction can be derived by substituting the apparent propagation velocity for the actual propagation velocity and the component of ground velocity in the direction of interest for the maximum ground velocity.

The apparent propagation velocity of the seismic wave is the speed at which a disturbance moves along the pipeline and is dependent upon the angle between the pipeline and the direction of wave propagation. For waves travelling normal to the direction of the pipeline, all points along the line experience motion at the same time. In this case the apparent propagation velocity is infinite. Wave propagation in the same direction as the pipeline has an apparent propagation velocity equal to the free-field wave velocity. It is readily shown that the relationship between apparent and true wave propagation velocities can be determined from the expression below.

$$C = c/\cos\beta \qquad (3)$$

c = true propagation velocity
ß = angle of incidence ($0 \leq \beta \leq \pi/2$)

The apparent propagation velocity decreases with increasing angle. For compression waves it is conservative to assume that propagation is along the pipeline as this gives the lowest value for C and, hence, highest estimate of ϵ.

As an example of the approach above, consider the maximum value for of longitudinal strain from a shear wave along a line at an angle of ß to the direction of wave propagation. Equation (3) gives the apparent propagation velocity. The component of ground motion in the ß direction is sinß times the maximum component. The resulting expression for longitudinal strain is given by equation (4).

$$\epsilon = (V_{max}/c)\ \sin\beta\ \cos\beta \leq V_{max}/(2\ c) \qquad (4)$$

The same expression applies to the shear strain on a segment oriented at an angle of ß to the direction of wave propagation for a compressive wave.

The assumption that the pipeline strain is identical to that of the ground implies that the stiffness of the pipe is negligible compared to the stiffness of the interface bond between the soil and the surface of the pipe. In reality, strain of the pipe is limited to what can be developed through friction (Ref. 1, 12). For continuous buried pipe, the surface friction forces induce strain in the pipe which is restrained at branch connections or attachments to structures.

The maximum amount of pipe strain is related to the friction at the pipe-soil interface and the characteristic length of the seismic waves, and the length of the pipe. Increased friction causes pipe strains to more closely match those in the ground. Pipe strain also increases as the characteristic wavelength of the seismic wave increases. Longer wavelengths impose soil friction forces on longer sections of pipe. Similarly increasing pipe length increases pipe strains for pipe lengths less than half of the characteristic wavelength.

Jointed pipe differs fundamentally in its response since the much weaker joints can act as locations of strain relief. If it is assumed that the joints are much softer than the pipe in both tension and compression, the maximum joint displacement can be estimated assuming the pipe moves with the soil. Maximum joint displacement is then estimated as the maximum ground strain multiplied by the length of the pipe segment. As with continuous pipe, the amount of strain-related displacement is limited by the friction forces developed along the pipe segment.

Upperbound estimates of the axial and bending forces induced in a pipe segment can be computed assuming that the pipe is fixed with respect to the ground. Approximate methods for estimating the magnitude of axial and lateral soil forces on a buried pipeline are discussed in more detail in Section 3.

2.2 USE OF INTERFERENCE RESPONSE SPECTRA

A significant amount of investigation on segmented pipeline response was carried out by Weidlinger Associates in the mid to late 1970's (Ref. 7, 9, 10, 14, 15, 18, 19). Their results quantified the response of jointed pipelines subject to wave propagation effects by performing dynamic analysis of jointed pipeline systems. Sensitivity studies investigated the impact of varying stiffness and damping ratios for the pipe, pipe joint and surrounding soil mass. A product of these numerical investigations is the concept of an interference response (IR) spectrum to describe the relative displacement of joints as a function of a normalized frequency. Relative stiffness and damping of the pipe, joint, and surrounding soil influence the normalized frequency value.

Several key conclusions resulted from investigation into the application of IR spectra to evaluate the dynamic behavior of a buried jointed pipeline:

1) Dynamic response characteristics of a particular pipe joint are not sensitive to the response of segments more than a few joints away. As a result, the number of pipe segments, end conditions or gradual variation in joint displacement do not have a great impact on the joint under consideration.
2) Utilizing the interference response (IR) spectrum approach at the lowest antisymmetric frequency correlates well with rigorous of peak response. IR spectra values at the lower-bound frequency can be used directly in design for pipe joint stiffnesses as large as 25% of the surrounding soil stiffness.

Based upon the IR spectrum approach, investigators have proposed a simple bounding relationship for the relative displacement of two jointed pipe segments. This relationship is valid for lower-bound frequencies (pipe joint to soil stiffness ratio less than .25). Numerical analysis of idealized segmented pipelines subjected to actual earthquake time histories confirmed the bounding nature of the approximate expression for incoherent displacement (Ref. 10). Calculation of the bounding relative joint displacement requires estimates for maximum ground velocity, maximum ground displacement, apparent wave propagation velocity and separation between pipe segments. The expression for maximum joint displacement is given below.

$$z_{max} = 2\, D_{max} \sin\{ \tfrac{1}{2} (V_{max}/D_{max})(l/c)\} \qquad (5)$$

z_{max} = maximum relative joint displacement
D_{max} = maximum free-field displacement
V_{max} = maximum free-field velocity
l = pipe segment length
c = apparent wave propagation velocity

For comparison, the relative displacement calculated by assuming the pipe moves with the free-field can be calculated as the product of the free-field strain and the pipe segment length as in equation (6).

$$z_{max} = l\epsilon \qquad (6)$$

Equation (6) is most often used in published approaches to determining relative displacements. A reason for the preference may be the relatively simple concepts upon which equation (6) is based. Another reason may be that equation (6) generally bounds equation (5) and is selected as a conservative value. Calculating z_{max} using equation (5) appears reasonable. Selection of an expression for z_{max} should first compare the two values.

Evaluation of the response of a jointed pipeline system to seismic wave propagation should focus on two key questions.

1) Are axial joint displacements and joint rotations within acceptable limits?
2) Are the axial and lateral soil loads within acceptable limits for the pipe segments?

These questions are addressed in the approach presented here by applying two different sets of assumption. In estimating joint displacements and rotations are assumed to result from rigid motion of adjacent pipe segments. The pipe joints are assumed to have no strength compared to the pipe and soil. Soil forces are estimated by assuming that all soil strain along the pipe segment occurs relative to a fixed pipe.

These assumptions are not self consistent. However, they do provide an upperbound estimate of the quantities of interest.

3.0 DESCRIPTION OF METHODOLOGY

The preceding discussion has focused primarily on the mechanics of wave propagation and approximate means to estimate the maximum relative ground deformation. This section presents the means to incorporate estimates of the effects of wave propagation into an evaluation of a buried pipeline.

3.1 ESTIMATION OF MAXIMUM INCOHERENT MOTION

The first step in evaluating the impact of seismic wave propagation is to determine the appropriate maximum ground motion parameters, D_{max} and V_{max}, and the wave propagation velocity, c. Maximum ground motion values can commonly be found in the description of the site seismicity. If response spectra are available for the site, values of D_{max} and A_{max} can be taken to be the response spectra values at very low and very high frequencies, respectively. V_{max} can then be determined using approximate relationships for the ratio of V_{max}/A_{max}. In the absence of other information, a relatively high value of .75 can be used.

Wave propagation velocity varies with the type of wave, the stiffness and density of the soil or rock, and with the frequency of the wave. Site investigations for critical facilities will generally provide seismic wave velocities for one or more strata of geologic formation at the site. For buried pipelines, propagation velocities in the near surface layers (less than 20 feet below grade) are of importance. Compression and shear wave velocities are generally reported. If these values are only available for deep deposits, some reduction in propagation velocity should be considered. The amount of reduction can be estimated by comparing the values of bulk modulus, shear modulus and density between the depth investigated and the depth of interest. Assuming elastic wave propagation theory applies, a correction factor can be calculated using the relationship below.

3.2 SELECTION OF CHARACTERISTIC JOINT LENGTH

Few pipelines are placed in a straight line for their entire length. Bends and branches are typically necessary to avoid other lines, provide service to multiple locations and connect to surface structures. Selection of the pipe joint length directly affects the magnitude of the joint displacements allowed and the estimation of maximum soil forces on the pipe segment. Guidelines are provided below for selection of appropriate segment lengths for straight runs and at bends.

3.2.1 Straight Runs of Segmented Pipe

Straight runs of pipe will normally be constructed using standard pipe segments with a typical length for segments. In the absence of any mechanical joint attachment that restricts the tensile or compressive movement of one or more joints, the standard segment length can be used to determine displacements. This approach assumes that the motion of the pipe segments at the joint is represented by the relative displacement between the mid-points of the pipe segments.

Conditions that restrain joint movement force adjacent joints to accommodate any relative displacement between pipe segments. The equivalent pipe segment formed by joint restraint is often longer than the typical pipe segments. A simple approach is to treat the resulting distance between free joints as the equivalent pipe segment length. This is a conservative assumption as long as the pipe segments adjacent to the segment under consideration are shorter than the equivalent pipe segment containing the restrained joint. If this is not the case, the longest adjacent pipe segment can be used as the typical pipe segment length. The same approach applies for cases in which pipe segments of varying length are used. Bounding displacements for all joints can be estimated by assuming the longest span of pipe between free joints is the typical pipe segment length. The options for selection of pipe segment length for displacement calculation are illustrated in Figure 2.

3.2.2 Pipe Segments Forming Bends

Relative displacements at pipe bends differ only in the selection of typical pipe segment length. In the case of a bend, movement of the bend can result in both axial and rotational components of joint displacement. Axial and rotational displacement components are determined by the angular change in the bend, the distance between the midpoint of the bend and the next joint and the assumed direction of wave propagation. As with straight pipe, mechanical connections that restrict joint movement eliminate that joint as a location for relief of relative motion.

The bend is assumed to displace with the corner of the bend rather than the mid-point of the bend. These are generally the same unless mechanical joints are used to facilitate construction. Maximum displacements and rotations at joints adjacent to bends are estimated by assuming wave propagation along each of the two legs forming the bend. Rotational displacements are determined by assuming the calculated axial displacement along one leg of the bend is accommodated by a rigid rotation of the other leg. The assumed displacement conditions are illustrated in Figure 3.

3.3 ESTIMATION OF SOIL FORCES ON THE PIPE SEGMENTS

Relative movement between the pipe segment and the surrounding soil leads to some loading of the pipe. An upperbound estimate of the soil force transmitted to the pipe can be obtained by assuming the pipe to be fixed and using the relative soil displacements of the free field to determine soil forces. Axial soil friction and lateral soil pressure are usually of primary interest for buried pipelines subjected to horizontally propagating ground motions. The first step in estimating the magnitude of the soil forces requires calculating an equivalent soil stiffness. A linear soil stiffness can be obtained by dividing the ultimate soil force by the displacement necessary to attain that force. Soil forces on the pipe segment can then be estimated by multiplying the soil stiffness by the relative free field displacements. Methods for calculating maximum axial and lateral soil forces for buried pipelines are well established in the geotechnical field. The approaches described below are typically used in performing evaluations of pipelines subjected to permanent ground deformations (Ref. 1).

3.3.1 Axial Soil Friction Forces

Ultimate axial force can be estimated from the following relationships.

For clay: $t_u = \pi D \alpha S_u$ (7a)

For sand: $t_u = \frac{1}{2} \pi D H d_e (1 + K_o) \tan\delta$ (7b)

t_u = ultimate axial soil force (force/length)

D = pipe outside diameter

H = distance from pipe centerline to surface

α = adhesion coefficient

S_u = undrained shear strength

d_e = effective unit weight of soil

K_o = coefficient of soil pressure at rest

δ = interface angle of friction between soil and pipe

Two key parameters in the above relationships are the interface friction angle, δ, and the adhesion coefficient, α. Values of δ may vary from 0.5ϕ to 1.0ϕ, where ϕ is the internal soil friction angle. Values of δ recommended for general use are provided below.

CONDITION	RANGE OF δ
Sand and smooth steel	0.5ϕ - 0.7ϕ
Sand and rough steel	0.7ϕ - 1.0ϕ
Plastic	0.6ϕ
Sand and soft wrapping	1.0ϕ

Adhesion values vary with the undrained shear strength of the clay. Figure 4 presents values for α extracted from Reference 1. Ultimate axial friction force is developed at relative displacements of approximately .1 to .2 inches in sand and .2 to .4 inches in clay. For greater relative displacements, soil friction force can be assumed constant at the ultimate value.

3.3.2 Lateral Soil Forces

The maximum lateral force developed on a buried pipeline can be estimated using the following relationships.

For clay: $p_u = D\, N_{ch}\, S_u$ (8a)

For sand: $p_u = D\, d_e\, N_{qh}$ (8b)

p_u = maximum lateral soil force on pipeline (force/length)

N_{ch}, N_{qh} = lateral bearing capacity factors

Values for N_{ch} and N_{qh} vary with pipe depth as shown in Figure 5. Development of the ultimate lateral force requires substantially more displacement than the axial force. Values for displacement at ultimate force range from 3% to 10% of the depth to the bottom of the pipe. Suggested values for different soil conditions are listed below (Ref. 1).

Dense Sand	.02 to .03 (H+D/2)
Medium Sand	.03 to .05 (H+D/2)
Soft Sand	.07 to .10 (H+D/2)
Clay	.03 to .05 (H+D/2)

3.4 SOIL LOAD DISTRIBUTION ON STRAIGHT RUNS AND BENDS

Assuming a rigidly fixed pipe, soil forces will vary linearly from zero at one end of the pipe segment to the maximum computed value base on soil stiffness. Soil forces on individual pipe segments will generally be quite small so that it is not overly conservative to assume a constant soil force distribution.

3.4.1 Straight Pipe Sections

For straight sections of pipe, axial lateral soil forces produce axial and bending stresses, respectively in the straight section of pipe. These stresses are typically less than 5 ksi for common lengths and diameters of pipe segments (less than 20 feet long and less than 30 inches in diameter). The process for computing upperbound axial and bending stresses is illustrated in Figure 6 and listed below.

Step 1. Calculate the ultimate values for axial and lateral soil force.

Step 2. Using the length of the pipe segment, calculate a free-field displacement along the axis of the pipe. The largest displacement will normally occur for the assumption of a compressive wave travelling along the axis of the pipe.

Step 3. Calculate the relative free-field displacement normal to the pipe axis.

Step 4. Scale the ultimate axial and lateral forces by the ratio of the calculated free-field displacements to the displacements necessary to develop the ultimate soil force. These are the forces to be applied to the pipe segment.

Step 5. Assume the axial soil force is constant over the length of the element and calculate the axial stress as the total soil force divided by the pipe cross-sectional area.

Step 6. Assume the lateral force is constant over the length of the pipe segment and that simply supported end conditions apply. Calculate the bending stress as the bending moment divided by the section modulus of the pipe.

3.4.2 Bends

Evaluation of bends for soil forces is treated by examining each leg of the bend and determining the displacements for subsequent computation of axial force and bending moment in the bend. Bending stresses are computed using equation (10)

$$\sigma_b = iM/Z \qquad (9)$$

σ_b = bending stress in bend
i = stress intensification factor
M = bending moment
Z = section modulus of bend

Several lateral load cases for the leg of bend are estimated based upon a series of separate assumptions. The assumptions deal with the direction of wave propagation and the wave type. Compression waves and shear waves are assumed to be spatially separated so that they act as separate load conditions. Wave propagation is assumed to act on only one leg at a time.

The process for determining maximum bending moment is shown in Figure 7 for leg 1. Free-field longitudinal displacement along leg 1 of the bend is assumed to act as a rigid relative displacement of leg 2. The bending moment can be calculated by assuming a constant lateral load on leg 2. For a 90° bend, the lateral displacement used to estimate the lateral load on leg 2 is equal to the axial free-field displacement in leg 1. For bend angles less than 90° the lateral displacement will be

$$\delta L_2 = \delta A_1 \cos\Theta \qquad (10)$$

δL_2 = relative lateral displacement of leg 2 for computing soil forces

δA_1 = free-field displacement along axis of leg 1

Θ = bend angle

Lateral displacements resulting from a shear wave travelling along leg 1 can be used to estimate bending of leg 1. The procedure for calculating the moment is the same as that for a straight segment of pipe.

If the legs of the bend are different in length, each leg needs to be examined to determine the largest moment in the bend. Mechanical connections at bend joints can conservatively be treated as extensions of the legs of the bend. This can be overly conservative if several joints are mechanically connected in series.

The above discussion focusses on the lateral load on leg 2 as a result of compression or shear waves travelling along leg 1. These motions are predominant. Note that axial displacements in leg 2 are also generated by wave passage along leg 1. These axial components are shown in Figure 7 for completeness.

In general, the seismic waves can be travelling in an arbitrary direction relative to leg 1. In this general case, each types of wave produces axial and lateral ground deformations relative to the orientation of leg 1 and leg 2. This case is of little practical importance as the greatest components of displacement arise from considering wave propagation along one of the legs of the bend.

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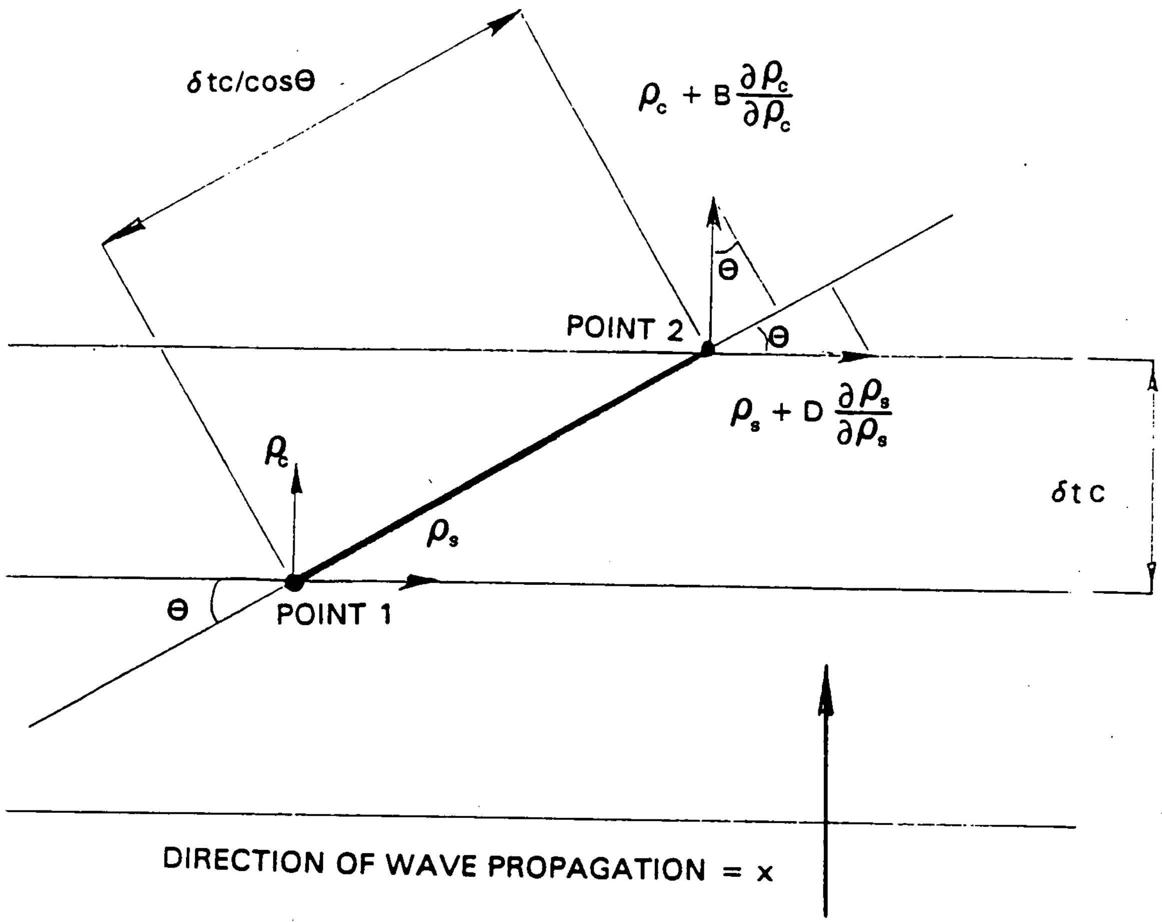


$$\rho = f(x-ct)$$

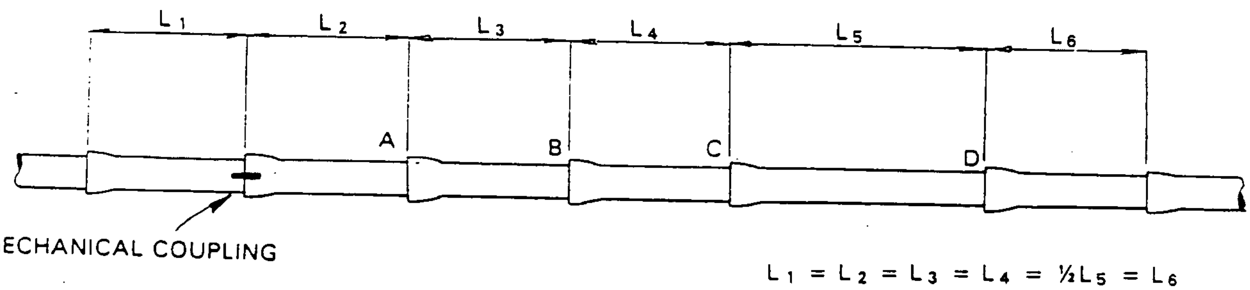
$$\partial\rho/\partial x = f'(x-ct) = \epsilon$$

$$\partial^2\rho/\partial x^2 = f''(x-ct) = \alpha$$

$$\partial\rho/\partial t = -cf'(x-ct) = v$$

$$\partial^2\rho/\partial t^2 = c^2 f''(x-ct) = a$$

FIGURE 1. GROUND STRAINS GENERATED FROM WAVE PROPAGATION



	RECOMMENDED UPPER BOUND LENGTH FOR CALCULATING z_{max}
A	$L_1 + L_2$
B	L_3
C	L_5
D	L_5

FIGURE 2. SELECTION OF STRAIGHT PIPE SEGMENT LENGTH AND CALCULATION OF JOINT DISPLACEMENT AND ROTATION

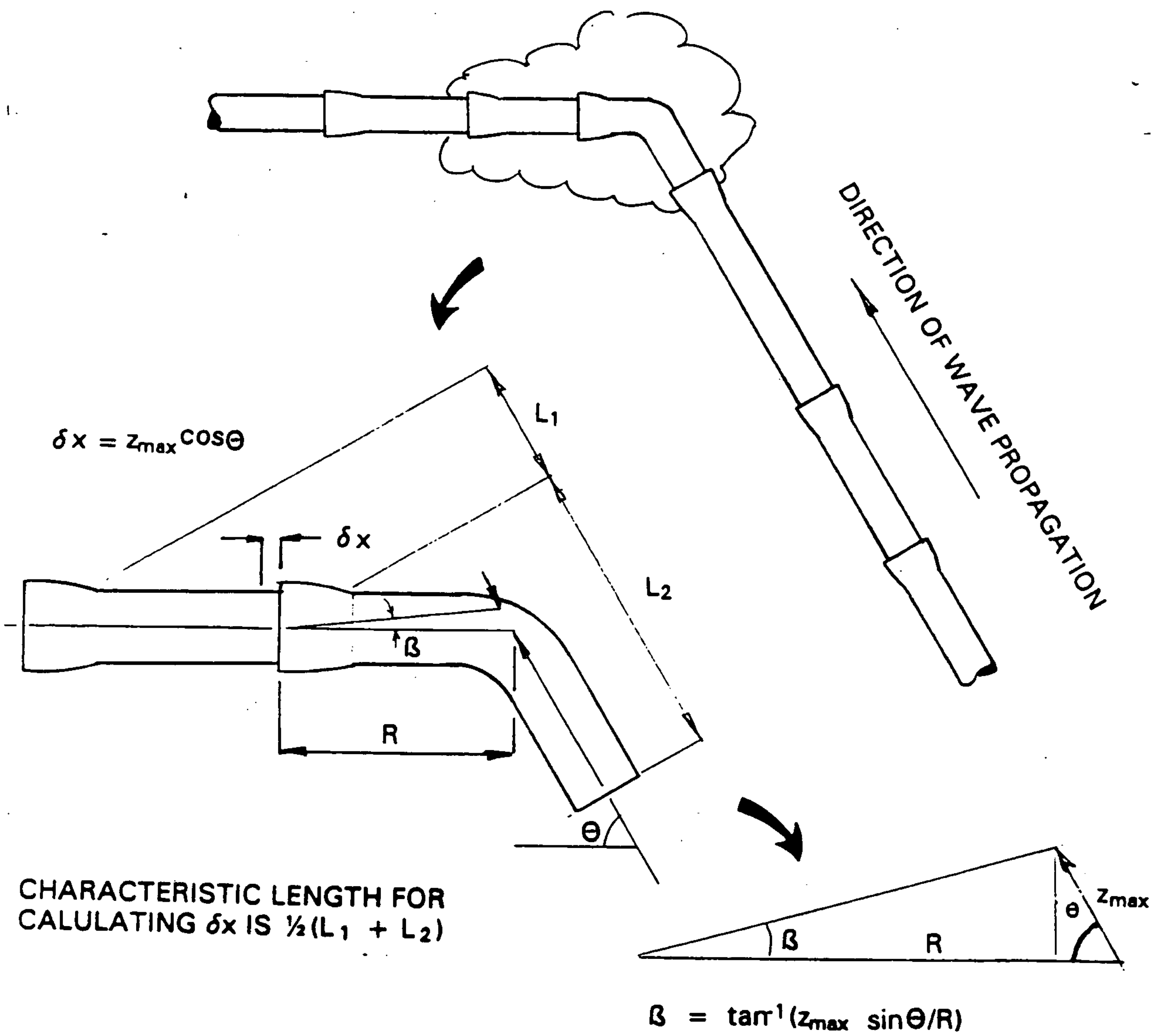


FIGURE 3. SELECTION OF PIPE SEGMENT LENGTH AND CALCULATION OF JOINT DISPLACEMENT AND ROTATIONS AT BENDS

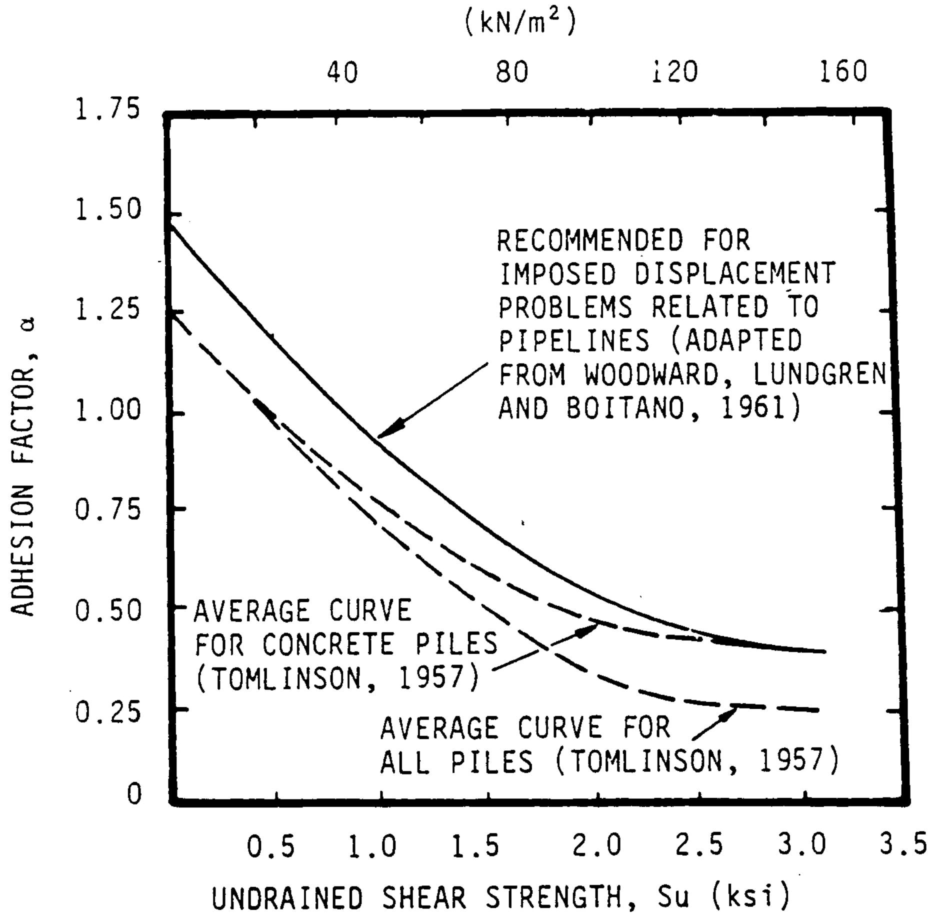


FIGURE 4. ADHESION FACTORS AS A FUNCTION OF UNDRAINED SHEAR STRENGTH

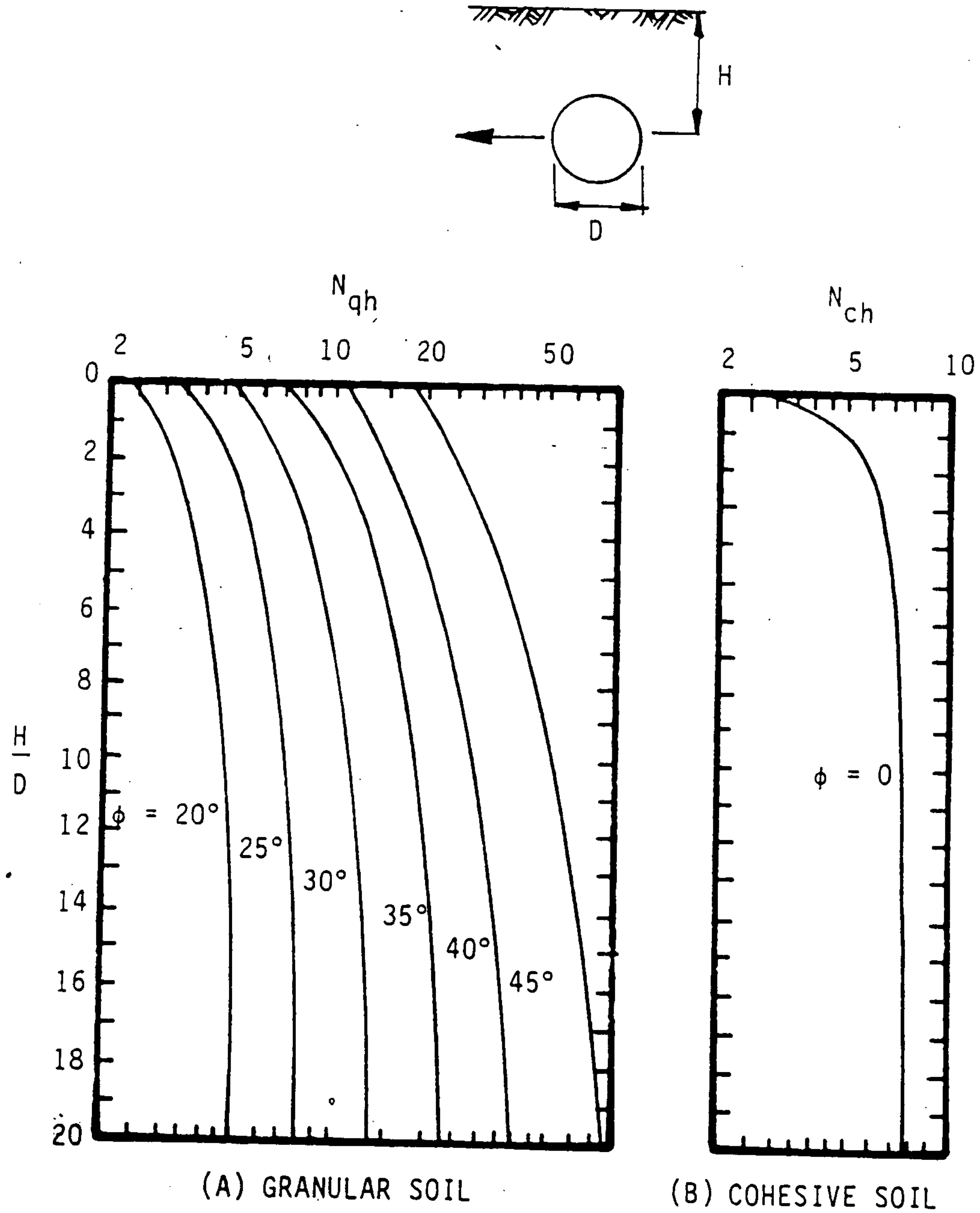


FIGURE 5. LATERAL SOIL BEARING CAPACITY VALUES

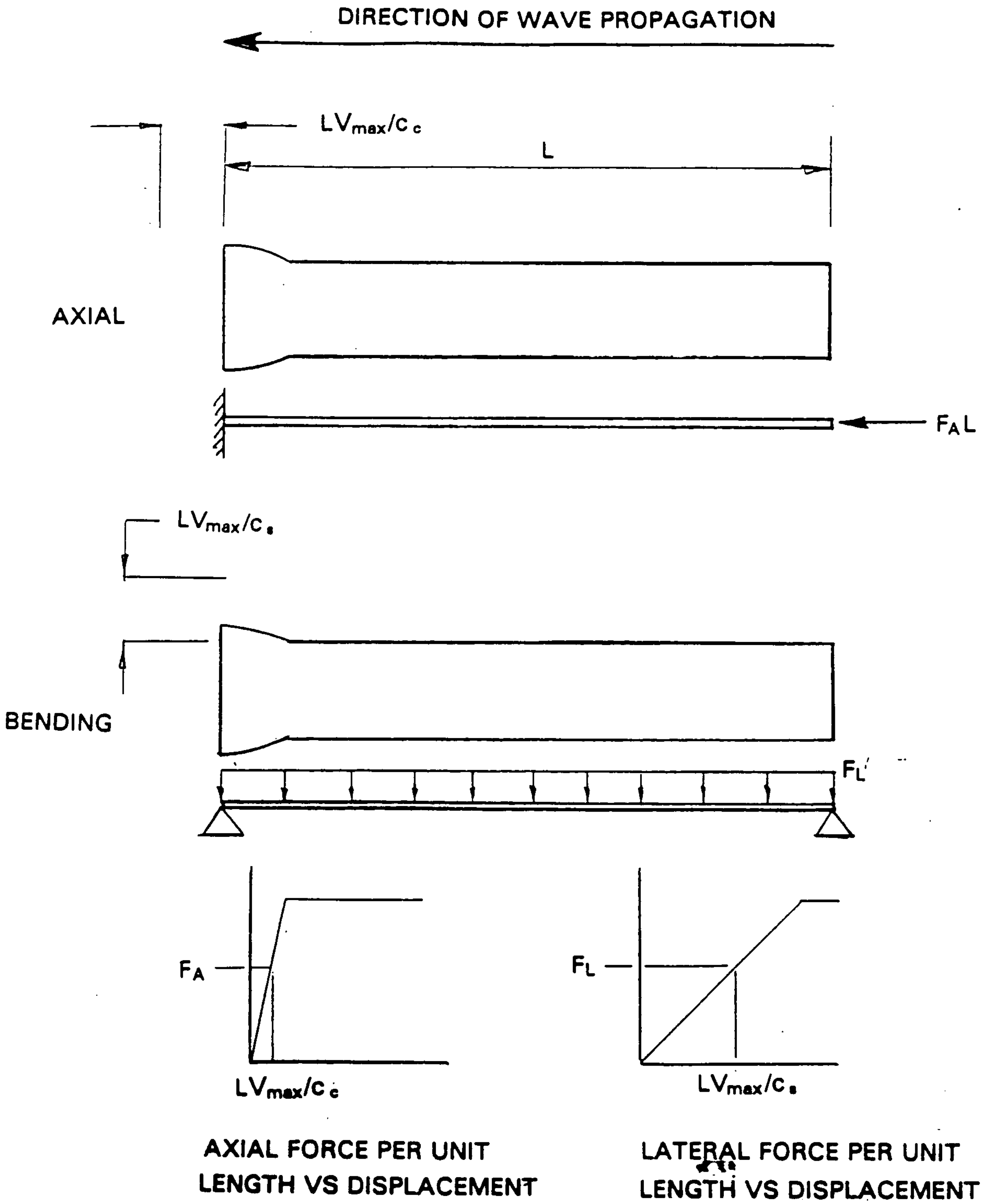


FIGURE 6. SOIL LOADING CONDITIONS PRODUCING AXIAL AND BENDING STRESSES IN STRAIGHT SEGMENTS OF PIPE

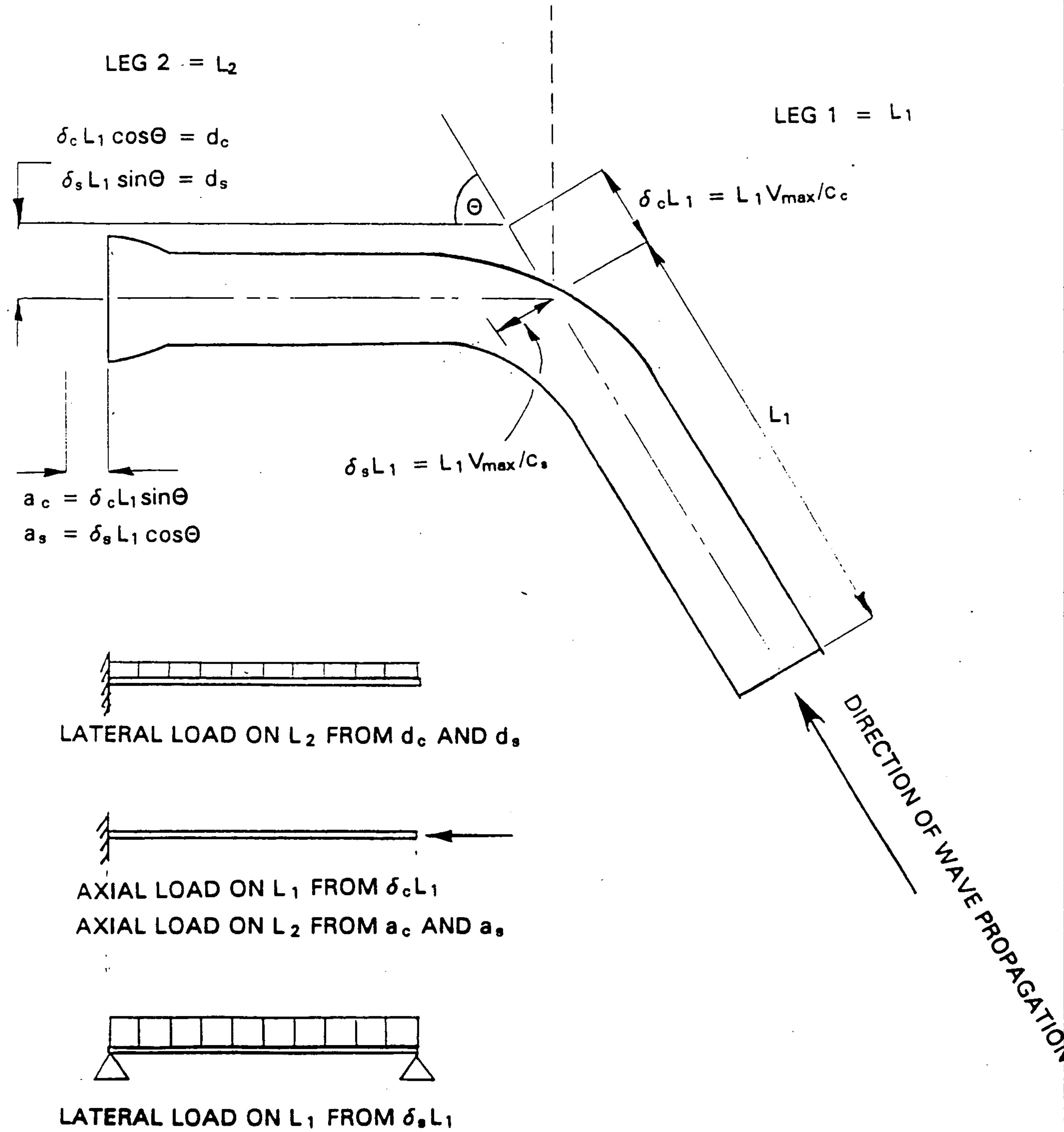


FIGURE 7. SOIL LOADING CONDITIONS PRODUCING AXIAL AND BENDING STRESSES AT PIPE BENDS

ATTACHMENT "J"

112 SHEETS

CALCULATION COVER SHEET

CALCULATION NO. CCL-CA-352 GROUP Structural Mechanics Project No. 90-2271

SUBJECT Geometric Displacements Analysis of H.B. Robinson Steam Electric Plant Service Water Piping, Line Number CW-11

___ NUCLEAR SAFETY RELATED ___ COMPUTER OUTPUT LISTING(S) ON FILE

___ NON-NUCLEAR SAFETY RELATED ___ NO COMPUTER OUTPUT LISTING

ORIGINAL: NO. OF SHEETS 11 ORIGINATOR D. Lindley DATE 12-4-90

Attachment A1 17
Attachment A2 17
Attachment A3 17
Attachment A4 17
Attachment A5 17
Attachment B 3

CHECKER [signature] DATE 12-7-90

APPROVAL Thomas J. [signature] DATE 12-7-90

REVISION NO.	PAGES ADDED	PAGES DELETED	PAGES REVISED	NO. OF SHEETS	ORIG./ DATE	CHECKER/ DATE	APPROVED/ DATE

ABSTRACT: Analyses are performed to determine the displacement behavior of buried service water piping in response to seismic ground displacement.

Job Number: 90-2271
Sheet: ' of:
Calculated By: DWL Date: 12-4-90
Checked By: [signature] Date: 12-7-90
Calculation Number: CCL-CA-352

1.0 PURPOSE

This calculation package presents the investigation of the effect of seismic ground displacement on the underground service water piping used at the H. B. Robinson Steam Electric Plant. A finite element model is used to determine the maximum pipe joint rotation due to a four-inch vertical ground displacement peaking at the mid span of the piping run. The joint rotations are determined for different joint stiffness assumptions that range from a pinned condition to a stiffness equal to that of the pipe.

Job Number: 90-2271
Sheet: 2 of:
Calculated By: DWL Date: 12-4-90
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2.0 REFERENCES

1. H. B. Robinson Final Safety Analysis Report, Unit 2, Carolina Power and Light Company.

2. Special Procedure SP-968, Cement Lining Repairs Using "Speed Crete Blue Line, Revision 0, H. B. Robinson SEG Plant, Carolina Power and Light Company.

3. AWWA Standard C602-83, Cement-Mortar Lining of Water Pipelines - 4 In. (100 mm) and Larger - In Place.

4. ASTM A211, Spiral-Welded Steel or Iron Pipe.

5. ASTM A570, Steel, Sheet and Strip, Carbon, Hot-Rolled, Structural Quality.

6. EZHANG Users Manual, CCL Report C-018-84-09, Corporate Consulting and Development Company, Ltd., 1988.

3.0 ASSUMPTIONS

1. The end of the piping run at the radwaste facility is modeled as free due to the presence of an expansion joint.

2. The end of the piping run at the service water intake structure is modeled as fixed for all six degrees-of-freedom.

3. Vertical displacements are applied using a one-half sine wave shape, peaking at four inches at the mid span of the piping run.

4. Piping segment joints are modeled with 19.5-foot spacing.

5. Piping run number CW-11 is modeled as being representative of both service water piping runs.

4.0 SUMMARY OF RESULTS

Modeled Stiffness		Model Results (Maximums)		Modeled Joint Condition
K_T (lb_f/in)	K_R (in-lb_f/rad)	θ (radians)	δ (inches)	
1.0E+02	1.0E+02	6.8E-04	0.0107	pinned
1.0E+07	1.0E+09	2.0E-04	0.0031	-
1.5E+08	2.0E+10	1.4E-05	0.0002	-
3.0E+08	4.0E+10	7.1E-06	0.0001	-
6.3E+08	7.6E+10	3.7E-06	-	~pipe

Where:

K_T = Translational spring constant of each pipe joint (used in the axial direction),

K_R = Rotational spring constant of each point joint (used in torsional and about both bending directions),

θ = Maximum relative rotation between pipe segments (SRSS of the two principal-direction θ's at the pipe joint), and

δ = Gap created by θ at the surface of the pipe along the axis of the pipe.

Note: The translational and rotational spring constants are modeled onto both ends of the pipe joint, resulting in two springs arranged in series between each pipe segment.

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5.0 DESIGN INPUT

1. CP&L Drawings:

   Yard Piping - Sheet 1, Ebasco Drawing Number G-190778, Revision 11, and
   Yard Piping - Sheet 2, Ebasco Drawing Number G-190779, Revision 4.

2. Coefficient of horizontal subsoil reaction:
   H. B. Robinson, Unit 2, Updated Final Safety Analysis Report, Section 3.8.5.3, Design and Analysis Procedures.

3. Ground movement:
   H. B. Robinson, Unit 2, Initial Final Safety Analysis Report, Question IIIB10c, Page 1.

4. Patching material strength:
   Tammstech Speed Crete Blue Line Fast Setting Underwater Patching Material, Technical Data Sheet.

5. Pipe yield strength:
   ASTM A211 - Spiral-Welded Steel or Iron Pipe, and
   ASTM A570 - Steel, Sheet and Strip, Carbon, Hot Rolled, Structural Quality.

6.0 CALCULATIONS

Pertinent information and various calculations pertaining to the finite element model are presented in the following sections.

6.1 EZHANG Model

The finite element model was constructed and analyzed with the EZHANG program. The EZHANG model is shown in Figure 6.1. Node 43 represents the piping/pump connection in the service water intake structure, and is modeled as a fully-fixed end. Node 1 represents the first identified expansion joint in the piping run, and is modeled as a free end.

6.2 Ground Springs

The piping model is supported by ground springs at every node. The ground springs provide stiffness in the pipe-transverse directions (perpendicular to the cross-section of the pipe). The stiffness value of each ground spring is based on information obtained from the updated FSAR, which indicates that the K-value, or coefficient of horizontal subsoil reaction, is equal to 140 kip/ft^3. When used in combination with the profile area of the piping (19.5 feet long by 2.5 feet tall), an equivalent spring stiffness is:

$$K_{ground} = \text{(K-value)(profile area)}$$

$$K_{ground} = (140{,}000\ lb_f/ft^3)[(19.5\ ft)(2.5\ ft)](1\ ft/12\ in)$$

$$K_{ground} \approx 5.7E{+}05\ lb_f/in$$

The ground springs are included in the model through the use of the EZHANG baseplate option.

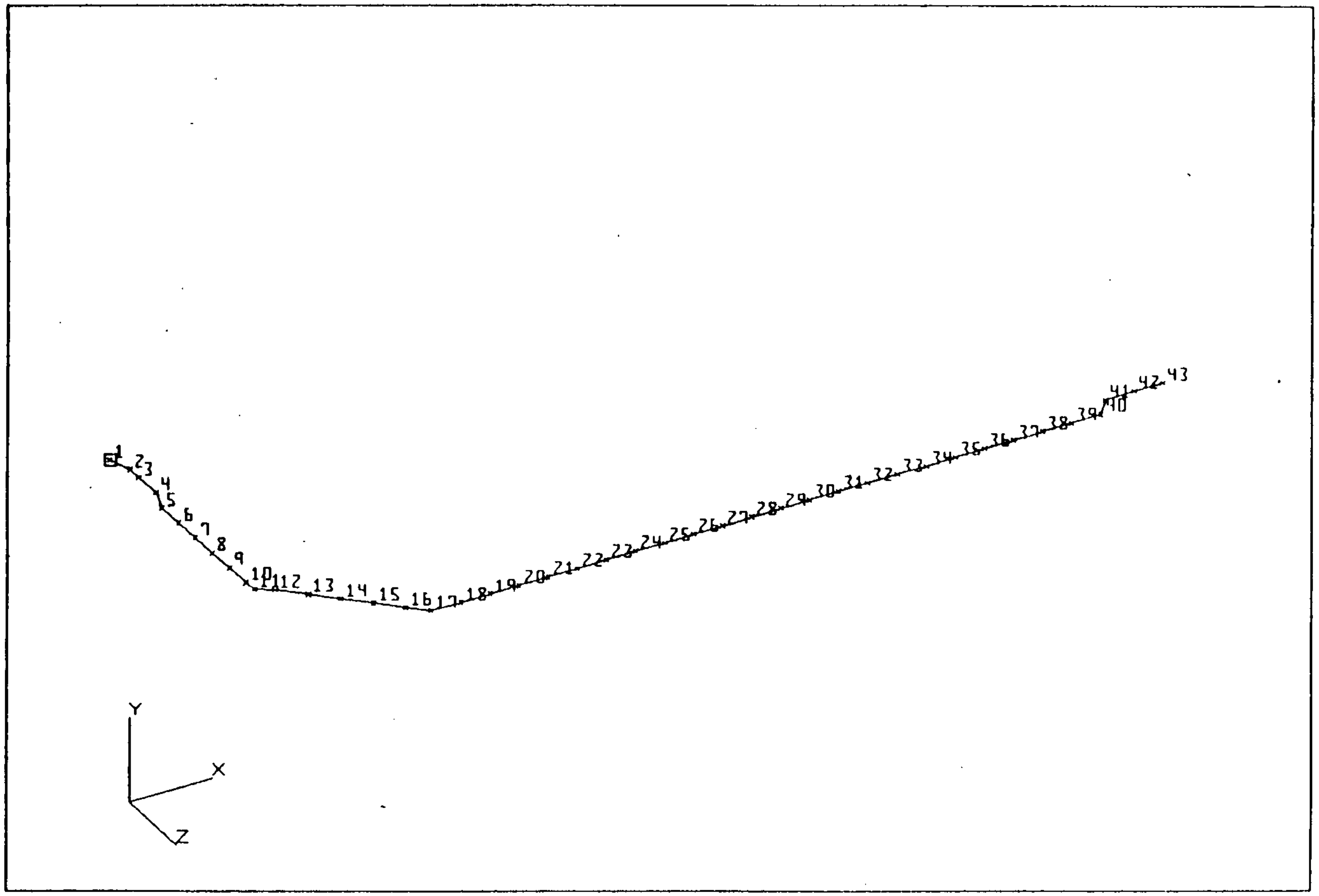

Figure 6.1 EZHANG Model of the CW-11 Service Water Piping Run

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6.3 Pipe Properties

The physical properties of the piping run are calculated to take into account participation of both the steel pipe and concrete liner.

The area moment of inertia for a hollow circular section is:

$$I = \pi[(D_o)^4 - (D_i)^4]/64,$$

where D_o and D_i are the outside and inside diameters, respectively. The steel pipe has an outside diameter of 31.375 inches, with a 0.188 inch thick wall. The concrete liner is nominally 1/2 inch thick. Therefore:

$$I_{steel} = \pi[(31.375)^4 - (30.999)^4]/64 = 2240 \text{ in}^4, \text{ and}$$

$$I_{concrete} = \pi[(30.999)^4 - (29.999)^4]/64 = 5572 \text{ in}^4.$$

The product of I (area moment of inertia) and E (modulus of elasticity) for both the steel and concrete portions of the piping is used to determine an equivalent value for I:

$$(EI)_{total} = (EI)_{steel} + (EI)_{concrete}$$

$$(EI)_{total} = (29E+06)(2240) + (2E+06)(5572) = 7.61E+10 \text{ lb}_f\text{-in}^2$$

When E is input with a value of 29E+06, I_{total} is:

$$I_{total} = 7.61E+10/29E+06 = 2624 \text{ in}^4.$$

The area for a hollow circular section is:

$$A = \pi[(D_o)^2 - (D_i)^2]/4, \text{ therefore:}$$

$$A_{steel} = \pi[(31.375)^2 - (30.999)^2]/4 = 18.4 \text{ in}^2, \text{ and}$$

$$A_{concrete} = \pi[(30.999)^2 - (29.999)^2]/4 = 47.9 \text{ in}^2.$$

The product of A (area) and E (modulus of elasticity) for both the steel and concrete portions of the piping is used to determine an equivalent value for A:

$$(EA)_{total} = (EA)_{steel} + (EA)_{concrete}$$

$$(EA)_{total} = (29E+06)(18.4) + (2E+06)(47.9) = 6.29E+08\ lb_f$$

When E is input with a value of 29E+06, A_{total} is:

$$A_{total} = 6.29E+08/29E+06 = 21.6\ in^2.$$

6.4 Joint Properties

The EZHANG joint properties were adjusted to reflect the various joint configurations being analyzed with this model.

- The shear translational springs were set to a rigid value,
- The pipe-axial direction spring was varied, depending upon joint configuration,
- The rotational springs were varied, depending upon joint configuration,
- The joint weight was set to zero, and
- Interaction equation number 10 was used.

The joint allowable values were also adjusted to reflect the goals of the analysis:

- Joint allowable values for bending moments were set to a value such that the EZHANG failure coefficient reported in the summary table is equal to the actual rotation:

  Just as $F = K_T\delta$, $M = K_R\theta$, by setting the rotational joint allowable value to K_R, the resulting coefficient is: $M/K_R = \theta$.

- The joint allowable values for all other degrees of freedom other than bending moments were set to high values, so that when interaction equation number 10 was used the failure coefficient would be:

$$F.C. = [(M_{2actual}/M_{2allowable})^2 + (M_{3actual}/M_{3allowable})^2]^{1/2},$$

and if $M_{2allowable} = M_{3allowable} = K_R$, then

$$F.C. = [(\theta_2)^2 + (\theta_3)^2]^{1/2}.$$

6.5 Spring Stiffness Limits

A variety of both translational and rotational spring constants were used to evaluate the model. The values used in the analysis are summarized in Section 4.0 of this calculation. The first set of spring constants used were chosen to be arbitrarily low, representing a pinned end condition between each piping segment.

Another set of spring constants were used to simulate the condition of continuous pipe stiffness. The spring constants used for this condition are:

- Rotational: $K_R = EI/L$, and assuming a 1 inch length,

  $K_R = (29.0E+06\ lb_f/in^2)(2624\ in^4)/(1\ inch)$

  $K_R = 7.6E+10\ in\text{-}lb_f/rad$

- Translational: $K_T = AE/L$, and assuming a 1 inch length,

  $K_T = (21.6\ in^2)(29.0E+06\ lb_f/in^2)/(1\ inch)$

  $K_T = 6.3E+08\ lb_f/in$

Other translational and rotational spring constants were selected to represent conditions that are in-between the pinned-end condition and the continuous-end condition.

7.0 ANALYSIS RESULTS

The results of the EZHANG analyses with varying joint stiffness properties are presented as Attachment A to this calculation package. Included are:

- Attachment A1 - All piping segments are joined with weak springs in the axial, torsion, and both bending directions.
- Attachment A2 - All piping segments begin and end with axial spring constants of 1.0E+07 lb_f/in, and torsional and bending spring constants of 1.0E+09 in-lb_f/rad.
- Attachment A3 - All piping segments begin and end with axial spring constants of 1.5E+08 lb_f/in, and torsional and bending spring constants of 2.0E+10 in-lb_f/rad.
- Attachment A4 - All piping segments begin and end with axial spring constants of 3.0E+08 lb_f/in, and torsional and bending spring constants of 4.0E+10 in-lb_f/rad.
- Attachment A5 - All piping segments begin and end with axial spring constants of 6.3E+08 lb_f/in, and torsional and bending spring constants of 7.6E+10 in-lb_f/rad.

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Calculated By: DWL Date: 12-4-90
Checked By: [illegible] Date: 12-7-90
Calculation Number: CCL-CA-352

ATTACHMENT A

EZHANG ANALYSIS RESULTS

Job Number: 90-2271
Sheet: - of: -
Calculated By: DWL Date: 12-4-90
Checked By: JP Date: 12-7-90
Calculation Number: CCL-CA-352

ATTACHMENT A1

All piping segments are joined with weak springs in the axial, torsional, and both bending directions.

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*   CORPORATE CONSULTING AND DEVELOPMENT COMPANY, LTD.  *
*                 P. O. BOX 12728                       *
*                 RESEARCH TRIANGLE PARK,               *
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* ANALYSIS BY: D Lindley       DATE: 12-4-90 *
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M   8   8   9   1  44
M   9   9  10   1  44
M  10  10  11   1  44
M  11  11  12   1  44
M  12  12  13   1  44
M  13  13  14   1  44
M  14  14  15   1  44
M  15  15  16   1  44
M  16  16  17   1  44
M  17  17  18   1  44
M  18  18  19   1  44
M  19  19  20   1  44
M  20  20  21   1  44
M  21  21  22   1  44
M  22  22  23   1  44
M  23  23  24   1  44
M  24  24  25   1  44
M  25  25  26   1  44
M  26  26  27   1  44
M  27  27  28   1  44
M  28  28  29   1  44
M  29  29  30   1  44
M  30  30  31   1  44
M  31  31  32   1  44
M  32  32  33   1  44
M  33  33  34   1  44
M  34  34  35   1  44
M  35  35  36   1  44
M  36  36  37   1  44
M  37  37  38   1  44
M  38  38  39   1  44
M  39  39  40   1  44
M  40  40  41   1  44
M  41  41  42   1  44
M  42  42  43   2  44
P 1 21.6 1.61 5248 2624 2624 15.7 31.4 31.4 29E6
Q 1 -5 11E6 6E-6 .44 .44 2.27 2.27 30E15
P 2 21.6 1.61 5248 2624 2624 15.7 31.4 31.4 29E6
Q 2  0 11E6 6E-6 .44 .44 2.27 2.27 30E15
X -2 0 5.7E5 5.7E5 10 10 10 10
Y -2 0 10 10 10 10 10 10 0
X -3 0 5.7E5 5.7E5 5.7E5 10 10 10
Y -3 0 10 10 10 10 10 10 0
X -4 0 0 5.7E5 5.7E5 10 10 10
Y -4 0 10 10 10 10 10 10 0
X -5 0 100 -1 -1 100 100 100
Y -5 2 10E12 10E12 10E12 10E12 100 100   10
T H.B. ROBINSON 30 CW-11 UNDERGROUND WATER PIPE
E END GEOM
STATIC
T VERTICAL 4 INCH RELATIVE GROND DISPLACEMENT MIDSPAN
D   1     .00     .00     .00
D   2     .00     .00     .00
D   3     .00     .00     .00
D   4     .00     .00     .00
D   5     .00     .00     .00
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D   6     .00     .00     .00
D   7     .00     .00     .00
D   8     .00     .00     .00
D   9     .00     .00     .00
D  10     .00     .00     .00
D  11     .00     .00     .00
D  12     .00     .20     .00
D  13     .00     .50     .00
D  14     .00     .80     .00
D  15     .00    1.10     .00
D  16     .00    1.39     .00
D  17     .00    1.61     .00
D  18     .00    2.00     .00
D  19     .00    2.36     .00
D  20     .00    2.69     .00
D  21     .00    3.00     .00
D  22     .00    3.26     .00
D  23     .00    3.49     .00
D  24     .00    3.68     .00
D  25     .00    3.83     .00
D  26     .00    3.93     .00
D  27     .00    3.99     .00
D  28     .00    4.00     .00
D  29     .00    3.96     .00
D  30     .00    3.88     .00
D  31     .00    3.75     .00
D  32     .00    3.58     .00
D  33     .00    3.37     .00
D  34     .00    3.12     .00
D  35     .00    2.83     .00
D  36     .00    2.51     .00
D  37     .00    2.16     .00
D  38     .00    1.78     .00
D  39     .00    1.39     .00
D  40     .00     .97     .00
D  41     .00     .86     .00
D  42     .00     .43     .00
E END CASE
E END STATIC
COMBINE
T VERTICAL SEISMIC (1/2 SINE WAVE END TO END)
O OUTPUT
C CASE 1 1 1 0
E END OUTPUT
REPORT 1
A CPL
B H.B.ROBINSON
J VERTICAL 4 INCH MIDSPAN DISPLACEMENT OF PIPE RUN
K JOINT MAX. FRACTION = REALATIVE JOINT ROTATION (RAD.)
L JOINT HAS WEAK SPRINGS IN AXIAL,TORSION,AND BOTH BENDING DIRECTIONS
M....GROUND SPRING PER 19.5 FT. PIPE SEGMENT SET AT 5.7E5 LB/IN.
M....DISPLACEMENTS ARE IMPOSED ON GROUNDED END OF NODAL GROUND SPRINGS.
M....JOINT KTRANS=100 LB/IN   JOINT KROT=100 IN-LB
E END REPORT
ENDRUN
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NODAL DATA TABLE

H.B. ROBINSON 30 CW-11 UNDERGROUND WATER PIPE

	--- NODAL COORDINATES ---			--- NODAL WEIGHTS ---		
NODE	X	Y	Z	XWT	YWT	ZWT
1	0.0000E0	1.5000E1	0.0000E0	5.138E3	5.138E3	5.138E3
2	0.0000E0	8.1000E1	2.8800E2	7.328E3	7.328E3	7.328E3
3	0.0000E0	8.1000E1	4.1400E2	6.260E3	6.260E3	6.260E3
4	0.0000E0	8.1000E1	6.4800E2	6.098E3	6.098E3	6.098E3
5	0.0000E0	0.0000E0	7.3200E2	6.098E3	6.098E3	6.098E3
6	0.0000E0	0.0000E0	9.6600E2	8.138E3	8.138E3	8.138E3
7	0.0000E0	0.0000E0	1.2000E3	8.138E3	8.138E3	8.138E3
8	0.0000E0	0.0000E0	1.4340E3	8.138E3	8.138E3	8.138E3
9	0.0000E0	0.0000E0	1.6680E3	8.138E3	8.138E3	8.138E3
10	0.0000E0	0.0000E0	1.9020E3	6.051E3	6.051E3	6.051E3
11	0.0000E0	0.0000E0	2.0160E3	4.663E3	4.663E3	4.663E3
12	1.0800E2	2.1000E1	2.1240E3	6.763E3	6.763E3	6.763E3
13	2.7400E2	2.1000E1	2.2900E3	8.139E3	8.139E3	8.139E3
14	4.3900E2	2.1000E1	2.4550E3	8.139E3	8.139E3	8.139E3
15	6.0500E2	2.1000E1	2.6210E3	8.139E3	8.139E3	8.139E3
16	7.7000E2	2.1000E1	2.7860E3	7.254E3	7.254E3	7.254E3
17	9.0000E2	2.1000E1	2.9160E3	7.266E3	7.266E3	7.266E3
18	1.1340E3	2.1000E1	2.9160E3	8.138E3	8.138E3	8.138E3
19	1.3680E3	2.1000E1	2.9160E3	8.138E3	8.138E3	8.138E3
20	1.6020E3	2.1000E1	2.9160E3	8.138E3	8.138E3	8.138E3
21	1.8360E3	2.1000E1	2.9160E3	8.138E3	8.138E3	8.138E3
22	2.0700E3	2.1000E1	2.9160E3	8.138E3	8.138E3	8.138E3
23	2.3040E3	2.1000E1	2.9160E3	8.138E3	8.138E3	8.138E3
24	2.5380E3	2.1000E1	2.9160E3	8.138E3	8.138E3	8.138E3
25	2.7720E3	2.1000E1	2.9160E3	8.138E3	8.138E3	8.138E3
26	3.0060E3	2.1000E1	2.9160E3	8.138E3	8.138E3	8.138E3
27	3.2400E3	2.1000E1	2.9160E3	8.138E3	8.138E3	8.138E3
28	3.4740E3	2.1000E1	2.9160E3	8.138E3	8.138E3	8.138E3
29	3.7080E3	2.1000E1	2.9160E3	8.138E3	8.138E3	8.138E3
30	3.9420E3	2.1000E1	2.9160E3	8.138E3	8.138E3	8.138E3
31	4.1760E3	2.1000E1	2.9160E3	8.138E3	8.138E3	8.138E3
32	4.4100E3	2.1000E1	2.9160E3	8.138E3	8.138E3	8.138E3
33	4.6440E3	2.1000E1	2.9160E3	8.138E3	8.138E3	8.138E3
34	4.8780E3	2.1000E1	2.9160E3	8.138E3	8.138E3	8.138E3
35	5.1120E3	2.1000E1	2.9160E3	8.138E3	8.138E3	8.138E3
36	5.3460E3	2.1000E1	2.9160E3	8.138E3	8.138E3	8.138E3
37	5.5800E3	2.1000E1	2.9160E3	8.138E3	8.138E3	8.138E3
38	5.8140E3	2.1000E1	2.9160E3	8.138E3	8.138E3	8.138E3
39	6.0480E3	2.1000E1	2.9160E3	8.138E3	8.138E3	8.138E3
40	6.2820E3	2.1000E1	2.9160E3	5.927E3	5.927E3	5.927E3
41	6.3480E3	8.7000E1	2.8640E3	5.927E3	5.927E3	5.927E3
42	6.5820E3	8.7000E1	2.8640E3	8.138E3	8.138E3	8.138E3
43	6.8160E3	8.7000E1	2.8640E3	4.069E3	4.069E3	4.069E3
44	5.0000E2	2.1000E1	5.0000E2	0.000E0	0.000E0	0.000E0
				3.230E5	3.230E5	3.230E5

--NODAL CONSTRAINTS-- BASEPLATE DATA

NODE XT YT ZT XR YR ZR JTYPE BXYZ CALC BANDWIDTH: 12

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BANDWIDTH: 12

NODE	XT	YT	ZT	XR	YR	ZR	JTYPE	BXYZ	CALC
1	0	0	0	0	0	0	-2	B123	0
2	0	0	0	0	0	0	-2	B123	0
3	0	0	0	0	0	0	-2	B123	0
4	0	0	0	0	0	0	-2	B123	0
5	0	0	0	0	0	0	-2	B123	0
6	0	0	0	0	0	0	-2	B123	0
7	0	0	0	0	0	0	-2	B123	0
8	0	0	0	0	0	0	-2	B123	0
9	0	0	0	0	0	0	-2	B123	0
10	0	0	0	0	0	0	-2	B123	0
11	0	0	0	0	0	0	-2	B123	0
12	0	0	0	0	0	0	-3	B123	0
13	0	0	0	0	0	0	-3	B123	0
14	0	0	0	0	0	0	-3	B123	0
15	0	0	0	0	0	0	-3	B123	0
16	0	0	0	0	0	0	-3	B123	0
17	0	0	0	0	0	0	-4	B123	0
18	0	0	0	0	0	0	-4	B123	0
19	0	0	0	0	0	0	-4	B123	0
20	0	0	0	0	0	0	-4	B123	0
21	0	0	0	0	0	0	-4	B123	0
22	0	0	0	0	0	0	-4	B123	0
23	0	0	0	0	0	0	-4	B123	0
24	0	0	0	0	0	0	-4	B123	0
25	0	0	0	0	0	0	-4	B123	0
26	0	0	0	0	0	0	-4	B123	0
27	0	0	0	0	0	0	-4	B123	0
28	0	0	0	0	0	0	-4	B123	0
29	0	0	0	0	0	0	-4	B123	0
30	0	0	0	0	0	0	-4	B123	0
31	0	0	0	0	0	0	-4	B123	0
32	0	0	0	0	0	0	-4	B123	0
33	0	0	0	0	0	0	-4	B123	0
34	0	0	0	0	0	0	-4	B123	0
35	0	0	0	0	0	0	-4	B123	0
36	0	0	0	0	0	0	-4	B123	0
37	0	0	0	0	0	0	-4	B123	0
38	0	0	0	0	0	0	-4	B123	0
39	0	0	0	0	0	0	-4	B123	0
40	0	0	0	0	0	0	-4	B123	0
41	0	0	0	0	0	0	-4	B123	0
42	0	0	0	0	0	0	-4	B123	0
43	-1	-1	-1	-1	-1	-1	0	B 0	0
44	-1	-1	-1	-1	-1	-1	0	B 0	0

JOINT AND SPRING DATA TABLE

H.B. ROBINSON 30 CW-11 UNDERGROUND WATER PIPE

--- JOINT SPRING RATES ---

JTYPE	K1	K2	K3	K4	K5	K6
-5	1.000E2	-1.000E0	-1.000E0	1.000E2	1.000E2	1.000E2

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JTYPE	K1	K2	K3	K4	K5	K6
-4	0.000E0	5.700E5	5.700E5	1.000E1	1.000E1	1.000E1
-3	5.700E5	5.700E5	5.700E5	1.000E1	1.000E1	1.000E1
-2	5.700E5	5.700E5	1.000E1	1.000E1	1.000E1	1.000E1

--- JOINT ALLOWABLE LOADS ---

JTYPE	A1	A2	A3	A4	A5	A6
-5	1.000E13	1.000E13	1.000E13	1.000E13	1.000E2	1.000E2
-4	1.000E1	1.000E1	1.000E1	1.000E1	1.000E1	1.000E1
-3	1.000E1	1.000E1	1.000E1	1.000E1	1.000E1	1.000E1
-2	1.000E1	1.000E1	1.000E1	1.000E1	1.000E1	1.000E1

---- JOINT WEIGHT AND CALC X VALUE ----

JTYPE	JOINT WT.	X VALUE
-5	0.000E0	2.000E0
-4	0.000E0	0.000E0
-3	0.000E0	0.000E0
-2	0.000E0	0.000E0

MEMBER DATA TABLE

H.B. ROBINSON 30 CW-11 UNDERGROUND WATER PIPE

--- PRIMARY MEMBER DATA ---

MEM	FROM	TO	PTYPE	RNODE	BANK	KFAC	QFAC	LENGTH
1	1	2	1	44	0.00E0	0.00E0	1.00E0	2.955E2
2	2	3	1	44	0.00E0	0.00E0	1.00E0	1.260E2
3	3	4	1	44	0.00E0	0.00E0	1.00E0	2.340E2
4	4	5	1	44	0.00E0	0.00E0	1.00E0	1.167E2
5	5	6	1	44	0.00E0	0.00E0	1.00E0	2.340E2
6	6	7	1	44	0.00E0	0.00E0	1.00E0	2.340E2
7	7	8	1	44	0.00E0	0.00E0	1.00E0	2.340E2
8	8	9	1	44	0.00E0	0.00E0	1.00E0	2.340E2
9	9	10	1	44	0.00E0	0.00E0	1.00E0	2.340E2
10	10	11	1	44	0.00E0	0.00E0	1.00E0	1.140E2
11	11	12	1	44	0.00E0	0.00E0	1.00E0	1.542E2
12	12	13	1	44	0.00E0	0.00E0	1.00E0	2.348E2
13	13	14	1	44	0.00E0	0.00E0	1.00E0	2.333E2
14	14	15	1	44	0.00E0	0.00E0	1.00E0	2.348E2
15	15	16	1	44	0.00E0	0.00E0	1.00E0	2.333E2
16	16	17	1	44	0.00E0	0.00E0	1.00E0	1.838E2
17	17	18	1	44	0.00E0	0.00E0	1.00E0	2.340E2
18	18	19	1	44	0.00E0	0.00E0	1.00E0	2.340E2
19	19	20	1	44	0.00E0	0.00E0	1.00E0	2.340E2
20	20	21	1	44	0.00E0	0.00E0	1.00E0	2.340E2
21	21	22	1	44	0.00E0	0.00E0	1.00E0	2.340E2
22	22	23	1	44	0.00E0	0.00E0	1.00E0	2.340E2
23	23	24	1	44	0.00E0	0.00E0	1.00E0	2.340E2
24	24	25	1	44	0.00E0	0.00E0	1.00E0	2.340E2
25	25	26	1	44	0.00E0	0.00E0	1.00E0	2.340E2
26	26	27	1	44	0.00E0	0.00E0	1.00E0	2.340E2
27	27	28	1	44	0.00E0	0.00E0	1.00E0	2.340E2
28	28	29	1	44	0.00E0	0.00E0	1.00E0	2.340E2

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M	MEM	FROM	TO	PTYPE	RNODE	BANK	KFAC	QFAC	LENGTH	M
M	29	29	30	1	44	0.00E0	0.00E0	1.00E0	2.340E2	M
M	30	30	31	1	44	0.00E0	0.00E0	1.00E0	2.340E2	M
M	31	31	32	1	44	0.00E0	0.00E0	1.00E0	2.340E2	M
M	32	32	33	1	44	0.00E0	0.00E0	1.00E0	2.340E2	M
M	33	33	34	1	44	0.00E0	0.00E0	1.00E0	2.340E2	M
M	34	34	35	1	44	0.00E0	0.00E0	1.00E0	2.340E2	M
M	35	35	36	1	44	0.00E0	0.00E0	1.00E0	2.340E2	M
M	36	36	37	1	44	0.00E0	0.00E0	1.00E0	2.340E2	M
M	37	37	38	1	44	0.00E0	0.00E0	1.00E0	2.340E2	M
M	38	38	39	1	44	0.00E0	0.00E0	1.00E0	2.340E2	M
M	39	39	40	1	44	0.00E0	0.00E0	1.00E0	2.340E2	M
M	40	40	41	1	44	0.00E0	0.00E0	1.00E0	1.068E2	M
M	41	41	42	1	44	0.00E0	0.00E0	1.00E0	2.340E2	M
M	42	42	43	2	44	0.00E0	0.00E0	1.00E0	2.340E2	M
M										M

M		--- FROM JOINT DATA ---			--- TO JOINT DATA ---			M
M	MEM	TYPE	HINGE	CALC	TYPE	HINGE	CALC	M
M	1	-5	111111	10	-5	111111	10	M
M	2	-5	111111	10	-5	111111	10	M
M	3	-5	111111	10	-5	111111	10	M
M	4	-5	111111	10	-5	111111	10	M
M	5	-5	111111	10	-5	111111	10	M
M	6	-5	111111	10	-5	111111	10	M
M	7	-5	111111	10	-5	111111	10	M
M	8	-5	111111	10	-5	111111	10	M
M	9	-5	111111	10	-5	111111	10	M
M	10	-5	111111	10	-5	111111	10	M
M	11	-5	111111	10	-5	111111	10	M
M	12	-5	111111	10	-5	111111	10	M
M	13	-5	111111	10	-5	111111	10	M
M	14	-5	111111	10	-5	111111	10	M
M	15	-5	111111	10	-5	111111	10	M
M	16	-5	111111	10	-5	111111	10	M
M	17	-5	111111	10	-5	111111	10	M
M	18	-5	111111	10	-5	111111	10	M
M	19	-5	111111	10	-5	111111	10	M
M	20	-5	111111	10	-5	111111	10	M
M	21	-5	111111	10	-5	111111	10	M
M	22	-5	111111	10	-5	111111	10	M
M	23	-5	111111	10	-5	111111	10	M
M	24	-5	111111	10	-5	111111	10	M
M	25	-5	111111	10	-5	111111	10	M
M	26	-5	111111	10	-5	111111	10	M
M	27	-5	111111	10	-5	111111	10	M
M	28	-5	111111	10	-5	111111	10	M
M	29	-5	111111	10	-5	111111	10	M
M	30	-5	111111	10	-5	111111	10	M
M	31	-5	111111	10	-5	111111	10	M
M	32	-5	111111	10	-5	111111	10	M
M	33	-5	111111	10	-5	111111	10	M
M	34	-5	111111	10	-5	111111	10	M
M	35	-5	111111	10	-5	111111	10	M
M	36	-5	111111	10	-5	111111	10	M
M	37	-5	111111	10	-5	111111	10	M
M	38	-5	111111	10	-5	111111	10	M
M	39	-5	111111	10	-5	111111	10	M

M	MEM	TYPE	HINGE	CALC	TYPE	HINGE	CALC	M
M	40	-5	111111	10	-5	111111	10	M
M	41	-5	111111	10	-5	111111	10	M

--- MEMBER PROPERTY DATA ---

PTYPE	AREA	J	I2	I3	H2	H3
1	2.160E1	5.248E3	2.624E3	2.624E3	3.140E1	3.140E1
2	2.160E1	5.248E3	2.624E3	2.624E3	3.140E1	3.140E1

--- MEMBER PROPERTY DATA ---

PTYPE	JRADIUS	SHAPE2	SHAPE3	STRESSF2	STRESSF3	DJPROP
1	1.570E1	4.400E-1	4.400E-1	2.270E0	2.270E0	-5
2	1.570E1	4.400E-1	4.400E-1	2.270E0	2.270E0	0

--- MEMBER PROPERTY DATA ---

PTYPE	EMOD	SMOD	YIELD	DENSITY	ALPHA
1	2.900E7	1.100E7	3.000E16	1.610E0	6.000E-6
2	2.900E7	1.100E7	3.000E16	1.610E0	6.000E-6

DESIGN PARAMETERS

H.B. ROBINSON 30 CW-11 UNDERGROUND WATER PIPE

MEMBER DESIGN FACTOR:9.000E-1 ALLOWABLE X DISPLACEMENT:1.0000E5

BPLATE DESIGN FACTOR:1.000E0 ALLOWABLE Y DISPLACEMENT:1.0000E5

JOINT DESIGN FACTOR:1.000E0 ALLOWABLE Z DISPLACEMENT:1.0000E5

SHEAR DESIGN FACTOR:6.000E-1 BUCKLING FACTOR:1.3300E0

GRAVITATIONAL CONSTANT:3.864E2 DIR. PENDULUM PIVOT:

APPLIED LOADS FOR STAT CASE 1

H.B. ROBINSON 30 CW-11 UNDERGROUND WATER PIPE
VERTICAL 4 INCH RELATIVE GROND DISPLACEMENT MIDSPAN

---GENERIC LOADS---

GX= 0.00E0 GY= 0.00E0 GZ= 0.00E0 GRAV=3.86E2 TDEL= 0.00E0

---IMPOSED GROUND DISPLACEMENTS---

NODE	XT	YT	ZT	XR	YR	ZR
1	0E0	0E0	0E0	0E0	0E0	0E0
2	0E0	0E0	0E0	0E0	0E0	0E0
3	0E0	0E0	0E0	0E0	0E0	0E0
4	0E0	0E0	0E0	0E0	0E0	0E0
5	0E0	0E0	0E0	0E0	0E0	0E0
6	0E0	0E0	0E0	0E0	0E0	0E0

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C NODE	XT	YT	ZT	XR	YR	ZR	C
C 7	0E0	0E0	0E0	0E0	0E0	0E0	C
C 8	0E0	0E0	0E0	0E0	0E0	0E0	C
C 9	0E0	0E0	0E0	0E0	0E0	0E0	C
C 10	0E0	0E0	0E0	0E0	0E0	0E0	C
C 11	0E0	0E0	0E0	0E0	0E0	0E0	C
C 12	0E0	2E-1	0E0	0E0	0E0	0E0	C
C 13	0E0	5E-1	0E0	0E0	0E0	0E0	C
C 14	0E0	8E-1	0E0	0E0	0E0	0E0	C
C 15	0E0	1E0	0E0	0E0	0E0	0E0	C
C 16	0E0	1E0	0E0	0E0	0E0	0E0	C
C 17	0E0	2E0	0E0	0E0	0E0	0E0	C
C 18	0E0	2E0	0E0	0E0	0E0	0E0	C
C 19	0E0	2E0	0E0	0E0	0E0	0E0	C
C 20	0E0	3E0	0E0	0E0	0E0	0E0	C
C 21	0E0	3E0	0E0	0E0	0E0	0E0	C
C 22	0E0	3E0	0E0	0E0	0E0	0E0	C
C 23	0E0	3E0	0E0	0E0	0E0	0E0	C
C 24	0E0	4E0	0E0	0E0	0E0	0E0	C
C 25	0E0	4E0	0E0	0E0	0E0	0E0	C
C 26	0E0	4E0	0E0	0E0	0E0	0E0	C
C 27	0E0	4E0	0E0	0E0	0E0	0E0	C
C 28	0E0	4E0	0E0	0E0	0E0	0E0	C
C 29	0E0	4E0	0E0	0E0	0E0	0E0	C
C 30	0E0	4E0	0E0	0E0	0E0	0E0	C
C 31	0E0	4E0	0E0	0E0	0E0	0E0	C
C 32	0E0	4E0	0E0	0E0	0E0	0E0	C
C 33	0E0	3E0	0E0	0E0	0E0	0E0	C
C 34	0E0	3E0	0E0	0E0	0E0	0E0	C
C 35	0E0	3E0	0E0	0E0	0E0	0E0	C
C 36	0E0	3E0	0E0	0E0	0E0	0E0	C
C 37	0E0	2E0	0E0	0E0	0E0	0E0	C
C 38	0E0	2E0	0E0	0E0	0E0	0E0	C
C 39	0E0	1E0	0E0	0E0	0E0	0E0	C
C 40	0E0	1E0	0E0	0E0	0E0	0E0	C
C 41	0E0	9E-1	0E0	0E0	0E0	0E0	C
C 42	0E0	4E-1	0E0	0E0	0E0	0E0	C

C C
C==C

A==A
A=== ANCHOR ANALYSIS OF COMBINED CASE 1 ===A
A==A
A A
A H.B. ROBINSON 30 CW-11 UNDERGROUND WATER PIPE A
A VERTICAL SEISMIC (1/2 SINE WAVE END TO END) A
A A
A ---NODAL DEFLECTIONS--- A

A NODE	XT	YT	ZT	XR	YR	ZR	A
A 1	4.637E-13	1.180E-9	2.935E-4	4.248E-8	1.126E-6	4.912E-6	A
A 2	-1.285E-12	-1.180E-9	3.553E-4	2.225E-8	5.897E-7	6.069E-6	A
A 3	6.434E-12	-1.544E-12	4.851E-4	5.911E-11	9.718E-14	8.615E-6	A
A 4	-4.002E-11	-3.122E-8	7.119E-4	-2.018E-6	-7.487E-6	1.288E-5	A
A 5	4.002E-11	3.122E-8	1.424E-3	-2.018E-6	-7.487E-6	3.561E-5	A
A 6	-5.613E-12	1.513E-12	2.078E-3	6.357E-11	8.672E-14	8.135E-5	A
A 7	2.905E-20	-4.765E-17	3.148E-3	3.078E-15	1.142E-14	1.433E-4	A
A 8	1.572E-19	7.429E-19	4.848E-3	9.950E-19	-5.673E-18	2.340E-4	A

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\	NODE	XT	YT	ZT	XR	YR	ZR	A
A	9	-2.790E-15	-5.476E-16	7.517E-3	9.939E-13	-1.983E-13	3.715E-4	A
A	10	-9.739E-11	-4.884E-10	1.169E-2	-7.262E-10	3.720E-9	5.833E-4	A
A	11	8.906E-7	1.742E-7	1.820E-2	-3.174E-4	6.330E-5	9.117E-4	A
A	12	-8.905E-7	2.000E-1	-8.902E-7	-6.499E-4	6.330E-5	1.084E-3	A
A	13	-4.464E-11	5.000E-1	-1.115E-10	-6.695E-4	-1.007E-12	1.057E-3	A
A	14	-9.442E-15	8.000E-1	-9.441E-15	-6.540E-4	-7.506E-14	1.072E-3	A
A	15	-2.208E-11	1.100E0	-3.705E-11	-5.822E-4	2.331E-13	1.115E-3	A
A	16	-3.371E-7	1.390E0	-3.371E-7	-4.442E-4	-1.408E-5	1.199E-3	A
A	17	-7.687E-3	1.610E0	3.371E-7	-2.938E-4	-1.408E-5	1.421E-3	A
A	18	-1.153E-2	2.000E0	1.056E-11	-1.886E-4	6.863E-10	1.526E-3	A
A	19	-1.537E-2	2.360E0	-5.145E-16	-1.210E-4	2.147E-14	1.404E-3	A
A	20	-1.922E-2	2.690E0	-1.610E-20	-7.766E-5	-1.047E-18	1.302E-3	A
A	21	-2.306E-2	3.000E0	7.852E-25	-4.984E-5	-3.274E-23	1.160E-3	A
A	22	-2.690E-2	3.260E0	2.455E-29	-3.198E-5	1.599E-27	9.972E-4	A
A	23	-3.075E-2	3.490E0	-1.198E-33	-2.052E-5	4.993E-32	8.547E-4	A
A	24	-3.459E-2	3.680E0	-3.744E-38	-1.317E-5	-2.440E-36	6.919E-4	A
A	25	-3.843E-2	3.830E0	1.829E-42	-8.450E-6	-7.614E-41	5.088E-4	A
A	26	-4.228E-2	3.930E0	5.709E-47	-5.420E-6	3.724E-45	3.256E-4	A
A	27	-4.612E-2	3.990E0	-2.791E-51	-3.473E-6	1.161E-49	1.425E-4	A
A	28	-4.997E-2	4.000E0	-8.706E-56	-2.222E-6	-5.683E-54	-6.105E-5	A
A	29	-5.381E-2	3.960E0	-1.446E-55	-1.415E-6	4.486E-54	-2.442E-4	A
A	30	-5.765E-2	3.880E0	-2.202E-51	-8.905E-7	-1.929E-49	-4.274E-4	A
A	31	-6.150E-2	3.750E0	9.482E-47	-5.444E-7	-2.938E-45	-6.105E-4	A
A	32	-6.534E-2	3.580E0	1.442E-42	-3.072E-7	1.265E-40	-7.733E-4	A
A	33	-6.918E-2	3.370E0	-6.216E-38	-1.314E-7	1.925E-36	-9.361E-4	A
A	34	-7.303E-2	3.120E0	-9.448E-34	1.816E-8	-8.290E-32	-1.099E-3	A
A	35	-7.687E-2	2.830E0	4.075E-29	1.713E-7	-1.261E-27	-1.241E-3	A
A	36	-8.071E-2	2.510E0	6.188E-25	3.587E-7	5.435E-23	-1.363E-3	A
A	37	-8.456E-2	2.160E0	-2.672E-20	6.179E-7	8.256E-19	-1.486E-3	A
A	38	-8.840E-2	1.780E0	-4.053E-16	1.001E-6	-3.563E-14	-1.567E-3	A
A	39	-9.224E-2	1.390E0	1.751E-11	1.583E-6	-5.408E-10	-1.648E-3	A
A	40	-9.609E-2	9.700E-1	2.655E-7	2.483E-6	2.336E-5	-1.622E-3	A
A	41	3.843E-3	8.600E-1	-2.655E-7	1.988E-6	2.336E-5	-1.668E-3	A
A	42	7.179E-8	4.175E-1	-1.700E-11	4.030E-13	-1.049E-13	-2.573E-3	A
A	43	0.000E0	0.000E0	0.000E0	0.000E0	0.000E0	0.000E0	A
A	44	0.000E0	0.000E0	0.000E0	0.000E0	0.000E0	0.000E0	A

A ---REACTION LOADS AT FIXED DEGREES OF FREEDOM--- A

A	NODE	XF	YF	ZF	XM	YM	ZM	A
A	43	-1.922E-1	-7.153E3	2.907E-7	-9.941E-5	6.813E-5	1.674E6	A
A	44	0.000E0	0.000E0	0.000E0	0.000E0	0.000E0	0.000E0	A

A ---BASEPLATE LOADS--- A

A	NODE	XF	YF	ZF	XM	YM	ZM	A
A	1	2.643E-7	6.727E-4	2.935E-3	4.248E-7	1.126E-5	4.912E-5	A
A	2	-7.323E-7	-6.727E-4	3.553E-3	2.225E-7	5.897E-6	6.069E-5	A
A	3	3.668E-6	-8.803E-7	4.851E-3	5.911E-10	9.718E-13	8.615E-5	A
A	4	-2.281E-5	-1.779E-2	7.119E-3	-2.018E-5	-7.487E-5	1.288E-4	A
A	5	2.281E-5	1.779E-2	1.424E-2	-2.018E-5	-7.487E-5	3.561E-4	A
A	6	-3.200E-6	8.626E-7	2.078E-2	6.357E-10	8.672E-13	8.135E-4	A
A	7	1.656E-14	-2.716E-11	3.148E-2	3.078E-14	1.142E-13	1.433E-3	A
A	8	8.961E-14	4.234E-13	4.848E-2	9.950E-18	-5.673E-17	2.340E-3	A
A	9	-1.590E-9	-3.121E-10	7.517E-2	9.939E-12	-1.983E-12	3.715E-3	A
A	10	-5.551E-5	-2.784E-4	1.169E-1	-7.262E-9	3.720E-8	5.833E-3	A
A	11	5.077E-1	9.929E-2	1.820E-1	-3.174E-3	6.330E-4	9.117E-3	A
A	12	-5.076E-1	-9.897E-2	-5.074E-1	-6.499E-3	6.330E-4	1.084E-2	A

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NODE	XF	YF	ZF	XM	YM	ZM
13	-2.544E-5	9.140E-6	-6.357E-5	-6.695E-3	-1.007E-11	1.057E-2
14	-5.382E-9	1.760E-6	-5.381E-9	-6.540E-3	-7.506E-13	1.072E-2
15	-1.258E-5	-4.416E-6	-2.112E-5	-5.822E-3	2.331E-12	1.115E-2
16	-1.922E-1	-4.242E-5	-1.921E-1	-4.442E-3	-1.408E-4	1.199E-2
17	0.000E0	1.546E-4	1.921E-1	-2.938E-3	-1.408E-4	1.421E-2
18	0.000E0	-1.026E-4	6.018E-6	-1.886E-3	6.863E-9	1.526E-2
19	0.000E0	-1.391E-5	-2.932E-10	-1.210E-3	2.147E-13	1.404E-2
20	0.000E0	3.131E-5	-9.177E-15	-7.766E-4	-1.047E-17	1.302E-2
21	0.000E0	-5.218E-5	4.476E-19	-4.984E-4	-3.274E-22	1.160E-2
22	0.000E0	2.087E-5	1.399E-23	-3.198E-4	1.599E-26	9.972E-3
23	0.000E0	-1.565E-5	-6.831E-28	-2.052E-4	4.993E-31	8.547E-3
24	0.000E0	1.740E-6	-2.134E-32	-1.317E-4	-2.440E-35	6.919E-3
25	0.000E0	-2.609E-5	1.043E-36	-8.450E-5	-7.614E-40	5.088E-3
26	0.000E0	1.044E-5	3.254E-41	-5.420E-5	3.724E-44	3.256E-3
27	0.000E0	-1.739E-5	-1.591E-45	-3.473E-5	1.161E-48	1.425E-3
28	0.000E0	-1.739E-5	-4.962E-50	-2.222E-5	-5.683E-53	-6.105E-4
29	0.000E0	1.044E-5	-8.243E-50	-1.415E-5	4.486E-53	-2.442E-3
30	0.000E0	-2.609E-5	-1.255E-45	-8.905E-6	-1.929E-48	-4.274E-3
31	0.000E0	1.740E-6	5.404E-41	-5.444E-6	-2.938E-44	-6.105E-3
32	0.000E0	-6.957E-6	8.222E-37	-3.072E-6	1.265E-39	-7.733E-3
33	0.000E0	-6.957E-6	-3.543E-32	-1.314E-6	1.925E-35	-9.361E-3
34	0.000E0	-1.565E-5	-5.385E-28	1.816E-7	-8.290E-31	-1.099E-2
35	0.000E0	3.479E-6	2.323E-23	1.713E-6	-1.261E-26	-1.241E-2
36	0.000E0	-5.218E-6	3.527E-19	3.587E-6	5.435E-22	-1.363E-2
37	0.000E0	-2.261E-5	-1.523E-14	6.179E-6	8.256E-18	-1.486E-2
38	0.000E0	3.305E-5	-2.310E-10	1.001E-5	-3.563E-13	-1.567E-2
39	0.000E0	-8.613E-5	9.983E-6	1.583E-5	-5.408E-9	-1.648E-2
40	0.000E0	-1.919E-1	1.513E-1	2.483E-5	2.336E-4	-1.622E-2
41	0.000E0	1.923E-1	-1.513E-1	1.988E-5	2.336E-4	-1.668E-2
42	0.000E0	-7.153E3	-9.693E-6	4.030E-12	-1.049E-12	-2.573E-2

MEMBER LOADS OF COMBINED CASE 1

H.B. ROBINSON 30 CW-11 UNDERGROUND WATER PIPE
VERTICAL SEISMIC (1/2 SINE WAVE END TO END)

---LOCAL MEMBER END LOADS---

M	N	AXIAL	X2SHEAR	X3SHEAR	TORSN	X2MOM	X3MOM
1	1	-3.012E-3	-2.606E-7	-4.523E-8	-5.040E-5	-4.156E-7	-8.797E-8
1	2	3.012E-3	2.606E-7	4.523E-8	5.040E-5	1.378E-5	-7.691E-5
2	2	-6.489E-3	4.668E-7	3.817E-8	-1.273E-4	-4.816E-6	5.881E-5
2	3	6.489E-3	-4.668E-7	-3.817E-8	1.273E-4	6.798E-9	8.205E-10
3	3	-1.134E-2	-3.280E-6	4.752E-7	-2.134E-4	-7.384E-9	-8.919E-10
3	4	1.134E-2	3.280E-6	-4.752E-7	2.134E-4	-1.112E-4	-7.674E-4
4	4	-2.564E-2	1.989E-5	1.841E-6	-8.180E-4	1.136E-4	4.033E-4
4	5	2.564E-2	-1.989E-5	-1.841E-6	8.180E-4	-3.284E-4	1.918E-3
5	5	-3.270E-2	-3.161E-6	9.961E-7	-2.287E-3	-2.331E-4	-7.396E-4
5	6	3.270E-2	3.161E-6	-9.961E-7	2.287E-3	-6.986E-9	2.863E-10
6	6	-5.349E-2	-1.118E-12	-2.714E-11	-3.100E-3	6.351E-9	-2.605E-10
6	7	5.349E-2	1.118E-12	2.714E-11	3.100E-3	-3.910E-13	-1.241E-12
7	7	-8.497E-2	4.820E-15	-1.520E-15	-4.534E-3	3.555E-13	1.128E-12
7	8	8.497E-2	-4.820E-15	1.520E-15	4.534E-3	9.628E-17	-5.718E-16

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L	M	N	AXIAL	X2SHEAR	X3SHEAR	TORSN	X2MOM	X3MOM	L
L	8	8	-1.334E-1	-1.025E-13	-4.208E-13	-6.874E-3	-1.038E-16	6.289E-16	L
L	8	9	1.334E-1	1.025E-13	4.208E-13	6.874E-3	9.847E-11	-2.398E-11	L
L	9	9	-2.086E-1	1.602E-9	2.447E-10	-1.059E-2	-1.083E-10	2.638E-11	L
L	9	10	2.086E-1	-1.602E-9	-2.447E-10	1.059E-2	-5.715E-8	3.748E-7	L
L	10	10	-3.255E-1	6.715E-5	2.758E-4	-1.642E-2	6.285E-8	-4.122E-7	L
L	10	11	3.255E-1	-6.715E-5	-2.758E-4	1.642E-2	-3.144E-2	7.655E-3	L
L	11	11	-7.246E-1	-1.177E-4	-3.144E-4	5.617E-3	4.195E-2	-1.132E-2	L
L	11	12	7.246E-1	1.177E-4	3.144E-4	-5.617E-3	6.518E-3	-6.820E-3	L
L	12	12	-6.295E-5	2.696E-5	-4.649E-5	1.644E-3	5.198E-3	6.330E-3	L
L	12	13	6.295E-5	-2.696E-5	4.649E-5	-1.644E-3	5.716E-3	9.051E-11	L
L	13	13	-5.521E-9	-2.900E-13	-5.563E-5	-1.096E-3	6.491E-3	-8.044E-11	L
L	13	14	5.521E-9	2.900E-13	5.563E-5	1.096E-3	6.491E-3	1.277E-11	L
L	14	14	2.090E-9	2.892E-14	-5.739E-5	-4.055E-3	5.716E-3	-1.201E-11	L
L	14	15	-2.090E-9	-2.892E-14	5.739E-5	4.055E-3	7.757E-3	1.880E-11	L
L	15	15	2.383E-5	-6.034E-6	-5.298E-5	-7.825E-3	4.246E-3	-2.113E-11	L
L	15	16	-2.383E-5	6.034E-6	5.298E-5	7.825E-3	8.116E-3	-1.408E-3	L
L	16	16	2.717E-1	1.685E-5	-1.055E-5	-1.316E-2	3.501E-3	1.549E-3	L
L	16	17	-2.717E-1	-1.685E-5	1.055E-5	1.316E-2	-1.560E-3	1.549E-3	L
L	17	17	1.922E-1	-6.018E-6	-1.652E-4	-5.264E-3	2.461E-2	-1.408E-3	L
L	17	18	-1.922E-1	6.018E-6	1.652E-4	5.264E-3	1.404E-2	-7.549E-8	L
L	18	18	1.922E-1	2.933E-10	-6.262E-5	-3.378E-3	1.221E-3	6.862E-8	L
L	18	19	-1.922E-1	-2.933E-10	6.262E-5	3.378E-3	1.343E-2	-2.362E-12	L
L	19	19	1.922E-1	9.177E-15	-4.870E-5	-2.168E-3	6.105E-4	2.147E-12	L
L	19	20	-1.922E-1	-9.177E-15	4.870E-5	2.168E-3	1.079E-2	1.152E-16	L
L	20	20	1.922E-1	-4.476E-19	-8.001E-5	-1.391E-3	2.239E-3	-1.047E-16	L
L	20	21	-1.922E-1	4.476E-19	8.001E-5	1.391E-3	1.648E-2	3.602E-21	L
L	21	21	1.922E-1	-1.399E-23	-2.783E-5	-8.928E-4	-4.884E-3	-3.274E-21	L
L	21	22	-1.922E-1	1.399E-23	2.783E-5	8.928E-4	1.140E-2	-1.758E-25	L
L	22	22	1.922E-1	6.831E-28	-4.870E-5	-5.729E-4	-1.425E-3	1.598E-25	L
L	22	23	-1.922E-1	-6.831E-28	4.870E-5	5.729E-4	1.282E-2	-5.492E-30	L
L	23	23	1.922E-1	2.134E-32	-3.305E-5	-3.677E-4	-4.274E-3	4.993E-30	L
L	23	24	-1.922E-1	-2.134E-32	3.305E-5	3.677E-4	1.201E-2	2.684E-34	L
L	24	24	1.922E-1	-1.043E-36	-3.479E-5	-2.360E-4	-5.088E-3	-2.440E-34	L
L	24	25	-1.922E-1	1.043E-36	3.479E-5	2.360E-4	1.323E-2	8.376E-39	L
L	25	25	1.922E-1	-3.254E-41	-8.697E-6	-1.515E-4	-8.140E-3	-7.614E-39	L
L	25	26	-1.922E-1	3.254E-41	8.697E-6	1.515E-4	1.018E-2	-4.096E-43	L
L	26	26	1.922E-1	1.591E-45	-1.913E-5	-9.731E-5	-6.919E-3	3.723E-43	L
L	26	27	-1.922E-1	-1.591E-45	1.913E-5	9.731E-5	1.140E-2	-1.277E-47	L
L	27	27	1.922E-1	4.962E-50	-1.739E-6	-6.258E-5	-9.972E-3	1.161E-47	L
L	27	28	-1.922E-1	-4.962E-50	1.739E-6	6.258E-5	1.038E-2	6.251E-52	L
L	28	28	1.922E-1	-5.117E-55	1.565E-5	-4.036E-5	-1.099E-2	-5.683E-52	L
L	28	29	-1.922E-1	5.117E-55	-1.565E-5	4.036E-5	7.326E-3	4.486E-52	L
L	29	29	1.922E-1	-8.243E-50	5.218E-6	-2.621E-5	-9.768E-3	-4.934E-52	L
L	29	30	-1.922E-1	8.243E-50	-5.218E-6	2.621E-5	8.547E-3	-1.929E-47	L
L	30	30	1.922E-1	-1.255E-45	3.131E-5	-1.731E-5	-1.282E-2	2.122E-47	L
L	30	31	-1.922E-1	1.255E-45	-3.131E-5	1.731E-5	5.495E-3	-2.938E-43	L
L	31	31	1.922E-1	5.404E-41	2.957E-5	-1.186E-5	-1.160E-2	3.232E-43	L
L	31	32	-1.922E-1	-5.404E-41	-2.957E-5	1.186E-5	4.681E-3	1.265E-38	L
L	32	32	1.922E-1	8.223E-37	3.653E-5	-8.790E-6	-1.241E-2	-1.391E-38	L
L	32	33	-1.922E-1	-8.223E-37	-3.653E-5	8.790E-6	3.867E-3	1.924E-34	L
L	33	33	1.922E-1	-3.543E-32	4.348E-5	-7.476E-6	-1.323E-2	-2.117E-34	L
L	33	34	-1.922E-1	3.543E-32	-4.348E-5	7.476E-6	3.053E-3	-8.290E-30	L
L	34	34	1.922E-1	-5.386E-28	5.914E-5	-7.658E-6	-1.404E-2	9.119E-30	L
L	34	35	-1.922E-1	5.386E-28	-5.914E-5	7.658E-6	2.035E-4	-1.260E-25	L
L	35	35	1.922E-1	2.323E-23	5.566E-5	-9.371E-6	-1.262E-2	1.386E-25	L
L	35	36	-1.922E-1	-2.323E-23	-5.566E-5	9.371E-6	-4.070E-4	5.435E-21	L

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L	M	N	AXIAL	X2SHEAR	X3SHEAR	TORSN	X2MOM	X3MOM	L
L	36	36	1.922E-1	3.527E-19	6.088E-5	-1.296E-5	-1.323E-2	-5.979E-21	L
L	36	37	-1.922E-1	-3.527E-19	-6.088E-5	1.296E-5	-1.018E-3	8.255E-17	L
L	37	37	1.922E-1	-1.523E-14	8.349E-5	-1.914E-5	-1.384E-2	-9.081E-17	L
L	37	38	-1.922E-1	1.523E-14	-8.349E-5	1.914E-5	-5.698E-3	-3.563E-12	L
L	38	38	1.922E-1	-2.310E-10	5.044E-5	-2.914E-5	-9.972E-3	3.920E-12	L
L	38	39	-1.922E-1	2.310E-10	-5.044E-5	2.914E-5	-1.831E-3	-5.407E-8	L
L	39	39	1.922E-1	9.983E-6	1.366E-4	-4.498E-5	-1.465E-2	5.948E-8	L
L	39	40	-1.922E-1	-9.983E-6	-1.366E-4	4.498E-5	-1.731E-2	2.336E-3	L
L	40	40	3.110E-1	-7.436E-5	-2.818E-5	-1.101E-3	6.764E-5	-2.564E-3	L
L	40	41	-3.110E-1	7.436E-5	2.818E-5	1.101E-3	2.943E-3	-5.381E-3	L
L	41	41	1.922E-1	1.545E-5	-1.956E-4	9.941E-5	-2.241E-2	1.711E-3	L
L	41	42	-1.922E-1	-1.545E-5	1.956E-4	-9.941E-5	6.818E-2	1.904E-3	L
L	42	42	1.922E-1	-1.996E2	7.150E3	9.941E-5	-9.391E-2	-2.622E-3	L
L	42	43	-1.922E-1	1.996E2	-7.150E3	-9.941E-5	-1.673E6	-4.671E4	L

MEMBER STRESSES OF COMBINED CASE 1

H.B. ROBINSON 30 CW-11 UNDERGROUND WATER PIPE
VERTICAL SEISMIC (1/2 SINE WAVE END TO END)

---LOCAL MEMBER END STRESSES---

S	M	N	AXIAL	X2SHEAR	X3SHEAR	TORSN	X2BEND	X3BEND	S
S	1	1	1.394E-4	-2.739E-8	-4.753E-9	1.508E-7	2.486E-9	-5.263E-10	S
S	1	2	1.394E-4	-2.739E-8	-4.753E-9	1.508E-7	8.244E-8	4.602E-7	S
S	2	2	3.004E-4	4.906E-8	4.011E-9	3.807E-7	2.882E-8	3.519E-7	S
S	2	3	3.004E-4	4.906E-8	4.011E-9	3.807E-7	4.067E-11	-4.909E-12	S
S	3	3	5.250E-4	-3.447E-7	4.994E-8	6.384E-7	4.418E-11	-5.337E-12	S
S	3	4	5.250E-4	-3.447E-7	4.994E-8	6.384E-7	-6.652E-7	4.592E-6	S
S	4	4	1.187E-3	2.090E-6	1.935E-7	2.447E-6	-6.796E-7	2.413E-6	S
S	4	5	1.187E-3	2.090E-6	1.935E-7	2.447E-6	-1.965E-6	-1.147E-5	S
S	5	5	1.514E-3	-3.322E-7	1.047E-7	6.841E-6	1.395E-6	-4.425E-6	S
S	5	6	1.514E-3	-3.322E-7	1.047E-7	6.841E-6	-4.180E-11	-1.713E-12	S
S	6	6	2.476E-3	-1.175E-13	-2.852E-12	9.274E-6	-3.800E-11	-1.558E-12	S
S	6	7	2.476E-3	-1.175E-13	-2.852E-12	9.274E-6	-2.340E-15	7.427E-15	S
S	7	7	3.934E-3	5.065E-16	-1.597E-16	1.356E-5	-2.127E-15	6.752E-15	S
S	7	8	3.934E-3	5.065E-16	-1.597E-16	1.356E-5	5.761E-19	3.421E-18	S
S	8	8	6.178E-3	-1.077E-14	-4.423E-14	2.056E-5	6.213E-19	3.763E-18	S
S	8	9	6.178E-3	-1.077E-14	-4.423E-14	2.056E-5	5.892E-13	1.435E-13	S
S	9	9	9.658E-3	1.683E-10	2.572E-11	3.168E-5	6.481E-13	1.578E-13	S
S	9	10	9.658E-3	1.683E-10	2.572E-11	3.168E-5	-3.420E-10	-2.242E-9	S
S	10	10	1.507E-2	7.057E-6	2.899E-5	4.913E-5	-3.760E-10	-2.467E-9	S
S	10	11	1.507E-2	7.057E-6	2.899E-5	4.913E-5	-1.881E-4	-4.580E-5	S
S	11	11	3.355E-2	-1.236E-5	-3.304E-5	-1.680E-5	-2.510E-4	-6.772E-5	S
S	11	12	3.355E-2	-1.236E-5	-3.304E-5	-1.680E-5	3.900E-5	4.080E-5	S
S	12	12	2.914E-6	2.833E-6	-4.886E-6	-4.918E-6	-3.110E-5	3.787E-5	S
S	12	13	2.914E-6	2.833E-6	-4.886E-6	-4.918E-6	3.420E-5	-5.416E-13	S
S	13	13	2.556E-10	-3.048E-14	-5.847E-6	3.278E-6	-3.884E-5	-4.813E-13	S
S	13	14	2.556E-10	-3.048E-14	-5.847E-6	3.278E-6	3.884E-5	-7.638E-14	S
S	14	14	-9.675E-11	3.039E-15	-6.032E-6	1.213E-5	-3.420E-5	-7.189E-14	S
S	14	15	-9.675E-11	3.039E-15	-6.032E-6	1.213E-5	4.641E-5	-1.125E-13	S
S	15	15	-1.103E-6	-6.341E-7	-5.567E-6	2.341E-5	-2.541E-5	-1.265E-13	S
S	15	16	-1.103E-6	-6.341E-7	-5.567E-6	2.341E-5	4.856E-5	8.424E-6	S

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S	M	N	AXIAL	X2SHEAR	X3SHEAR	TORSN	X2BEND	X3BEND	S
S	16	16	-1.258E-2	1.771E-6	-1.109E-6	3.937E-5	-2.094E-5	9.267E-6	S
S	16	17	-1.258E-2	1.771E-6	-1.109E-6	3.937E-5	-9.335E-6	-9.267E-6	S
S	17	17	-8.897E-3	-6.324E-7	-1.736E-5	1.575E-5	-1.473E-4	-8.425E-6	S
S	17	18	-8.897E-3	-6.324E-7	-1.736E-5	1.575E-5	8.401E-5	4.517E-10	S
S	18	18	-8.897E-3	3.082E-11	-6.580E-6	1.011E-5	-7.306E-6	4.106E-10	S
S	18	19	-8.897E-3	3.082E-11	-6.580E-6	1.011E-5	8.036E-5	1.413E-14	S
S	19	19	-8.897E-3	9.644E-16	-5.118E-6	6.485E-6	-3.653E-6	1.285E-14	S
S	19	20	-8.897E-3	9.644E-16	-5.118E-6	6.485E-6	6.453E-5	-6.893E-19	S
S	20	20	-8.897E-3	-4.704E-20	-8.408E-6	4.162E-6	-1.339E-5	-6.267E-19	S
S	20	21	-8.897E-3	-4.704E-20	-8.408E-6	4.162E-6	9.862E-5	-2.155E-23	S
S	21	21	-8.897E-3	-1.471E-24	-2.925E-6	2.671E-6	2.922E-5	-1.959E-23	S
S	21	22	-8.897E-3	-1.471E-24	-2.925E-6	2.671E-6	6.818E-5	1.052E-27	S
S	22	22	-8.897E-3	7.179E-29	-5.118E-6	1.714E-6	8.523E-6	9.564E-28	S
S	22	23	-8.897E-3	7.179E-29	-5.118E-6	1.714E-6	7.671E-5	3.286E-32	S
S	23	23	-8.897E-3	2.243E-33	-3.473E-6	1.100E-6	2.557E-5	2.988E-32	S
S	23	24	-8.897E-3	2.243E-33	-3.473E-6	1.100E-6	7.184E-5	-1.606E-36	S
S	24	24	-8.897E-3	-1.096E-37	-3.656E-6	7.060E-7	3.044E-5	-1.460E-36	S
S	24	25	-8.897E-3	-1.096E-37	-3.656E-6	7.060E-7	7.914E-5	-5.011E-41	S
S	25	25	-8.897E-3	-3.420E-42	-9.139E-7	4.532E-7	4.870E-5	-4.556E-41	S
S	25	26	-8.897E-3	-3.420E-42	-9.139E-7	4.532E-7	6.088E-5	2.451E-45	S
S	26	26	-8.897E-3	1.672E-46	-2.011E-6	2.911E-7	4.140E-5	2.228E-45	S
S	26	27	-8.897E-3	1.672E-46	-2.011E-6	2.911E-7	6.818E-5	7.642E-50	S
S	27	27	-8.897E-3	5.215E-51	-1.828E-7	1.872E-7	5.966E-5	6.947E-50	S
S	27	28	-8.897E-3	5.215E-51	-1.828E-7	1.872E-7	6.210E-5	-3.740E-54	S
S	28	28	-8.897E-3	-5.378E-56	1.645E-6	1.207E-7	6.575E-5	-3.400E-54	S
S	28	29	-8.897E-3	-5.378E-56	1.645E-6	1.207E-7	4.383E-5	-2.684E-54	S
S	29	29	-8.897E-3	-8.663E-51	5.484E-7	7.841E-8	5.844E-5	-2.952E-54	S
S	29	30	-8.897E-3	-8.663E-51	5.484E-7	7.841E-8	5.114E-5	1.154E-49	S
S	30	30	-8.897E-3	-1.319E-46	3.290E-6	5.177E-8	7.671E-5	1.270E-49	S
S	30	31	-8.897E-3	-1.319E-46	3.290E-6	5.177E-8	3.287E-5	1.758E-45	S
S	31	31	-8.897E-3	5.680E-42	3.107E-6	3.548E-8	6.940E-5	1.934E-45	S
S	31	32	-8.897E-3	5.680E-42	3.107E-6	3.548E-8	2.800E-5	-7.566E-41	S
S	32	32	-8.897E-3	8.641E-38	3.839E-6	2.630E-8	7.427E-5	-8.323E-41	S
S	32	33	-8.897E-3	8.641E-38	3.839E-6	2.630E-8	2.313E-5	-1.151E-36	S
S	33	33	-8.897E-3	-3.723E-33	4.570E-6	2.237E-8	7.914E-5	-1.266E-36	S
S	33	34	-8.897E-3	-3.723E-33	4.570E-6	2.237E-8	1.826E-5	4.960E-32	S
S	34	34	-8.897E-3	-5.660E-29	6.215E-6	2.291E-8	8.401E-5	5.456E-32	S
S	34	35	-8.897E-3	-5.660E-29	6.215E-6	2.291E-8	1.218E-6	7.541E-28	S
S	35	35	-8.897E-3	2.441E-24	5.849E-6	2.803E-8	7.549E-5	8.295E-28	S
S	35	36	-8.897E-3	2.441E-24	5.849E-6	2.803E-8	-2.435E-6	-3.252E-23	S
S	36	36	-8.897E-3	3.707E-20	6.398E-6	3.877E-8	7.914E-5	-3.577E-23	S
S	36	37	-8.897E-3	3.707E-20	6.398E-6	3.877E-8	-6.088E-6	-4.939E-19	S
S	37	37	-8.897E-3	-1.600E-15	8.774E-6	5.725E-8	8.280E-5	-5.433E-19	S
S	37	38	-8.897E-3	-1.600E-15	8.774E-6	5.725E-8	-3.409E-5	2.132E-14	S
S	38	38	-8.897E-3	-2.428E-11	5.301E-6	8.719E-8	5.966E-5	2.345E-14	S
S	38	39	-8.897E-3	-2.428E-11	5.301E-6	8.719E-8	-1.096E-5	3.235E-10	S
S	39	39	-8.897E-3	1.049E-6	1.435E-5	1.346E-7	8.767E-5	3.559E-10	S
S	39	40	-8.897E-3	1.049E-6	1.435E-5	1.346E-7	-1.035E-4	-1.398E-5	S
S	40	40	-1.440E-2	-7.814E-6	-2.961E-6	3.295E-6	-4.047E-7	-1.534E-5	S
S	40	41	-1.440E-2	-7.814E-6	-2.961E-6	3.295E-6	1.761E-5	3.220E-5	S
S	41	41	-8.897E-3	1.624E-6	-2.056E-5	-2.974E-7	1.341E-4	1.024E-5	S
S	41	42	-8.897E-3	1.624E-6	-2.056E-5	-2.974E-7	4.080E-4	-1.139E-5	S
S	42	42	-8.897E-3	-2.098E1	7.514E2	-2.974E-7	5.619E-4	-1.569E-5	S
S	42	43	-8.897E-3	-2.098E1	7.514E2	-2.974E-7	-1.001E4	2.795E2	S
S									S

S==S

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FRACTION OF SYSTEM NODE ALLOWABLES: COMBINED CASE 1

H.B. ROBINSON 30 CW-11 UNDERGROUND WATER PIPE
VERTICAL SEISMIC (1/2 SINE WAVE END TO END)

---SUMMARY OF FRACTION OF ALLOWABLE FOR EACH NODE---

N	DISPLACEMENT X	DISPLACEMENT Y	DISPLACEMENT Z	BASEPLATE COEFFICIENT
1	4.637E-18	1.180E-14	2.935E-9	0.000E0
2	1.285E-17	1.180E-14	3.553E-9	0.000E0
3	6.434E-17	1.544E-17	4.851E-9	0.000E0
4	4.002E-16	3.122E-13	7.119E-9	0.000E0
5	4.002E-16	3.122E-13	1.424E-8	0.000E0
6	5.613E-17	1.513E-17	2.078E-8	0.000E0
7	2.905E-25	4.765E-22	3.148E-8	0.000E0
8	1.572E-24	7.429E-24	4.848E-8	0.000E0
9	2.790E-20	5.476E-21	7.517E-8	0.000E0
10	9.739E-16	4.884E-15	1.169E-7	0.000E0
11	8.906E-12	1.742E-12	1.820E-7	0.000E0
12	8.905E-12	2.000E-6	8.902E-12	0.000E0
13	4.464E-16	5.000E-6	1.115E-15	0.000E0
14	9.442E-20	8.000E-6	9.441E-20	0.000E0
15	2.208E-16	1.100E-5	3.705E-16	0.000E0
16	3.371E-12	1.390E-5	3.371E-12	0.000E0
17	7.687E-8	1.610E-5	3.371E-12	0.000E0
18	1.153E-7	2.000E-5	1.056E-16	0.000E0
19	1.537E-7	2.360E-5	5.145E-21	0.000E0
20	1.922E-7	2.690E-5	1.610E-25	0.000E0
21	2.306E-7	3.000E-5	7.852E-30	0.000E0
22	2.690E-7	3.260E-5	2.455E-34	0.000E0
23	3.075E-7	3.490E-5	1.198E-38	0.000E0
24	3.459E-7	3.680E-5	3.744E-43	0.000E0
25	3.843E-7	3.830E-5	1.829E-47	0.000E0
26	4.228E-7	3.930E-5	5.709E-52	0.000E0
27	4.612E-7	3.990E-5	2.791E-56	0.000E0
28	4.997E-7	4.000E-5	8.706E-61	0.000E0
29	5.381E-7	3.960E-5	1.446E-60	0.000E0
30	5.765E-7	3.880E-5	2.202E-56	0.000E0
31	6.150E-7	3.750E-5	9.482E-52	0.000E0
32	6.534E-7	3.580E-5	1.442E-47	0.000E0
33	6.918E-7	3.370E-5	6.216E-43	0.000E0
34	7.303E-7	3.120E-5	9.448E-39	0.000E0
35	7.687E-7	2.830E-5	4.075E-34	0.000E0
36	8.071E-7	2.510E-5	6.188E-30	0.000E0
37	8.456E-7	2.160E-5	2.672E-25	0.000E0
38	8.840E-7	1.780E-5	4.053E-21	0.000E0
39	9.224E-7	1.390E-5	1.751E-16	0.000E0
40	9.609E-7	9.700E-6	2.655E-12	0.000E0
41	3.843E-8	8.600E-6	2.655E-12	0.000E0
42	7.179E-13	4.175E-6	1.700E-16	0.000E0
43	0.000E0	0.000E0	0.000E0	0.000E0
44	0.000E0	0.000E0	0.000E0	0.000E0

FRACTION OF SYSTEM MEMBER ALLOWABLES: COMBINED CASE 1

H.B. ROBINSON 30 CW-11 UNDERGROUND WATER PIPE
VERTICAL SEISMIC (1/2 SINE WAVE END TO END)

---SUMMARY OF FRACTION OF ALLOWABLE FOR EACH MEMBER---

	STRESS		BUCKLING		JOINT COEF.	
M	START	END	START	END	START	END
1	5.164E-21	5.184E-21	0.000E0	0.000E0	4.248E-9	7.814E-7
2	1.114E-20	1.113E-20	0.000E0	0.000E0	5.901E-7	6.847E-11
3	1.944E-20	1.964E-20	0.000E0	0.000E0	7.438E-11	7.754E-6
4	4.408E-20	4.446E-20	0.000E0	0.000E0	4.190E-6	1.946E-5
5	5.629E-20	5.607E-20	0.000E0	0.000E0	7.754E-6	6.992E-11
6	9.171E-20	9.171E-20	0.000E0	0.000E0	6.357E-11	1.407E-14
7	1.457E-19	1.457E-19	0.000E0	0.000E0	1.457E-14	8.509E-15
8	2.288E-19	2.288E-19	0.000E0	0.000E0	1.336E-14	1.014E-12
9	3.577E-19	3.577E-19	0.000E0	0.000E0	1.115E-12	3.791E-9
10	5.581E-19	5.668E-19	0.000E0	0.000E0	4.170E-9	3.236E-4
11	1.254E-18	1.245E-18	0.000E0	0.000E0	4.345E-4	9.433E-5
12	2.663E-21	1.375E-21	0.000E0	0.000E0	8.191E-5	5.716E-5
13	1.438E-21	1.438E-21	0.000E0	0.000E0	6.491E-5	6.491E-5
14	1.267E-21	1.719E-21	0.000E0	0.000E0	5.716E-5	7.757E-5
15	1.612E-21	2.151E-21	0.000E0	0.000E0	4.246E-5	8.237E-5
16	4.671E-19	4.667E-19	0.000E0	0.000E0	3.828E-5	2.198E-5
17	3.353E-19	3.326E-19	0.000E0	0.000E0	2.465E-4	1.404E-4
18	3.298E-19	3.325E-19	0.000E0	0.000E0	1.221E-5	1.343E-4
19	3.296E-19	3.319E-19	0.000E0	0.000E0	6.105E-6	1.079E-4
20	3.300E-19	3.332E-19	0.000E0	0.000E0	2.239E-5	1.648E-4
21	3.306E-19	3.320E-19	0.000E0	0.000E0	4.884E-5	1.140E-4
22	3.298E-19	3.323E-19	0.000E0	0.000E0	1.425E-5	1.282E-4
23	3.305E-19	3.322E-19	0.000E0	0.000E0	4.274E-5	1.201E-4
24	3.306E-19	3.324E-19	0.000E0	0.000E0	5.088E-5	1.323E-4
25	3.313E-19	3.318E-19	0.000E0	0.000E0	8.140E-5	1.018E-4
26	3.310E-19	3.320E-19	0.000E0	0.000E0	6.919E-5	1.140E-4
27	3.317E-19	3.318E-19	0.000E0	0.000E0	9.972E-5	1.038E-4
28	3.319E-19	3.311E-19	0.000E0	0.000E0	1.099E-4	7.326E-5
29	3.317E-19	3.314E-19	0.000E0	0.000E0	9.768E-5	8.547E-5
30	3.323E-19	3.307E-19	0.000E0	0.000E0	1.282E-4	5.495E-5
31	3.321E-19	3.305E-19	0.000E0	0.000E0	1.160E-4	4.681E-5
32	3.323E-19	3.304E-19	0.000E0	0.000E0	1.241E-4	3.867E-5
33	3.324E-19	3.302E-19	0.000E0	0.000E0	1.323E-4	3.053E-5
34	3.326E-19	3.296E-19	0.000E0	0.000E0	1.404E-4	2.035E-6
35	3.323E-19	3.296E-19	0.000E0	0.000E0	1.262E-4	4.070E-6
36	3.324E-19	3.297E-19	0.000E0	0.000E0	1.323E-4	1.018E-5
37	3.326E-19	3.308E-19	0.000E0	0.000E0	1.384E-4	5.698E-5
38	3.317E-19	3.299E-19	0.000E0	0.000E0	9.972E-5	1.831E-5
39	3.328E-19	3.339E-19	0.000E0	0.000E0	1.465E-4	1.746E-4
40	5.338E-19	5.351E-19	0.000E0	0.000E0	2.565E-5	6.133E-5
41	3.349E-19	3.450E-19	0.000E0	0.000E0	2.247E-4	6.821E-4
42	4.176E-14	3.811E-13	0.000E0	0.000E0	0.000E0	0.000E0

CCL-CA-352

QUALIFICATION SUMMARY REPORT

H.B. ROBINSON 30 CW-11 UNDERGROUND WATER PIPE

---PLANT IDENTIFICATION---

UTILITY: CPL   PLANT: H.B.ROBINSON   PWR_____
NSSS: A/E: BWR_____

---EQUIPMENT IDENTIFICATION---

SYSTEM: DRAWING NO.:
BUILDING: ELEVATION:
ADDITIONAL IDENTIFICATION:

---APPLIED LOADS---

DEADWEIGHT:_____   THERMAL:_____   RELATIVE DISP.:_____
SEISMIC:_____   HYDRODYNAMIC:_____

---LOAD COMBINATION---

VERTICAL 4 INCH MIDSPAN DISPLACEMENT OF PIPE RUN

---SUMMARY OF RESULTS---

---MAXIMUM FRACTION OF ALLOWABLE---

COMPONENT	FAILURE MODE	ALLOWABLE	MAX. FRACTION	PASS/FAIL
SYSTEM	JOINT	1.000E0	6.821E-4	PASS

COMMENTS:
JOINT MAX. FRACTION = REALATIVE JOINT ROTATION (RAD.)
JOINT HAS WEAK SPRINGS IN AXIAL,TORSION,AND BOTH BENDING DIRECTIONS
....GROUND SPRING PER 19.5 FT. PIPE SEGMENT SET AT 5.7E5 LB/IN.
....DISPLACEMENTS ARE IMPOSED ON GROUNDED END OF NODAL GROUND SPRINGS.
....JOINT KTRANS=100 LB/IN   JOINT KROT=100 IN-LB

PREPARED BY: D Lindley   CO: CCL   DATE: 12-4-90

VERIFIED BY: [signature]   CO: CCL   DATE: 12-7-90

Job Number: 90-2271
Sheet: - of: -
Calculated By: DWL Date: 12-4-90
Checked By: [illegible] Date: 12-7-90
Calculation Number: CCL-CA-352

ATTACHMENT A2

All piping segments begin and end with axial spring constants of 1.0E+07 lb_f/in, and torsional and bending spring constants of 1.0E+09 in-lb_f/rad.

```
***************************************************************************
*                                                                         *
* ***********  ***********  **      **     *******     *      **    ********  *
* ***********  ***********  **      **    *********    **     **   *********  *
* **                  ***   **      **    **     **    ***    **   **         *
* **                 ***    **      **    **     **    ****   **   **         *
* ***********       ***     *********     *********    *****  **   **  *****  *
* ***********      ***      *********     *********    ** *** **   **  ****** *
* **              ***       **      **    **     **    **  *****   **      ** *
* **             ***        **      **    **     **    **   ****   **      ** *
* **            ***         **      **    **     **    **    ***   **      ** *
* ***********  ***********  **      **    **     **    **     **   ********** *
* ***********  ***********  **      **    **     **    **      *    ********  *
*                                                                         *
***************************************************************************
```

```
*********************************************************
*                                                       *
*              *** EZHANG RELEASE 8.1 ***               *
*                    COPYRIGHT 1990                     *
* USER:        1                          WA: 3012236  *
*-------------------------------------------------------*
*   CORPORATE CONSULTING AND DEVELOPMENT COMPANY, LTD.  *
*                  P. O. BOX 12728                      *
*                  RESEARCH TRIANGLE PARK,              *
*                  N. C. 27709-9998                     *
*********************************************************
```

```
**********************************************
* PROJECT:  90-2271                          *
*                                            *
* TITLE:                                     *
*                                            *
*                                            *
* ANALYSIS BY: D Lindley    DATE: 12-4-90    *
*                                            *
* CHECKED BY: [signature]   DATE: 12-7-90    *
**********************************************
```

INPUT ECHO

```
SYSTEM 2000000
I 386.4 1 1.33 10E12 10E12 10E12
IDF .9 .6 1 1
N   1     0   15     0  0  0  0  0  0  0  -2 123 -1
N   2     0   81   288  0  0  0  0  0  0  -2 123 -1
N   3     0   81   414  0  0  0  0  0  0  -2 123 -1
N   4     0   81   648  0  0  0  0  0  0  -2 123 -1
N   5     0    0   732  0  0  0  0  0  0  -2 123 -1
N   6     0    0   966  0  0  0  0  0  0  -2 123 -1
N   7     0    0  1200  0  0  0  0  0  0  -2 123 -1
N   8     0    0  1434  0  0  0  0  0  0  -2 123 -1
N   9     0    0  1668  0  0  0  0  0  0  -2 123 -1
N  10     0    0  1902  0  0  0  0  0  0  -2 123 -1
N  11     0    0  2016  0  0  0  0  0  0  -2 123 -1
N  12   108   21  2124  0  0  0  0  0  0  -3 123 -1
N  13   274   21  2290  0  0  0  0  0  0  -3 123 -1
N  14   439   21  2455  0  0  0  0  0  0  -3 123 -1
N  15   605   21  2621  0  0  0  0  0  0  -3 123 -1
N  16   770   21  2786  0  0  0  0  0  0  -3 123 -1
N  17   900   21  2916  0  0  0  0  0  0  -4 123 -1
N  18  1134   21  2916  0  0  0  0  0  0  -4 123 -1
N  19  1368   21  2916  0  0  0  0  0  0  -4 123 -1
N  20  1602   21  2916  0  0  0  0  0  0  -4 123 -1
N  21  1836   21  2916  0  0  0  0  0  0  -4 123 -1
N  22  2070   21  2916  0  0  0  0  0  0  -4 123 -1
N  23  2304   21  2916  0  0  0  0  0  0  -4 123 -1
N  24  2538   21  2916  0  0  0  0  0  0  -4 123 -1
N  25  2772   21  2916  0  0  0  0  0  0  -4 123 -1
N  26  3006   21  2916  0  0  0  0  0  0  -4 123 -1
N  27  3240   21  2916  0  0  0  0  0  0  -4 123 -1
N  28  3474   21  2916  0  0  0  0  0  0  -4 123 -1
N  29  3708   21  2916  0  0  0  0  0  0  -4 123 -1
N  30  3942   21  2916  0  0  0  0  0  0  -4 123 -1
N  31  4176   21  2916  0  0  0  0  0  0  -4 123 -1
N  32  4410   21  2916  0  0  0  0  0  0  -4 123 -1
N  33  4644   21  2916  0  0  0  0  0  0  -4 123 -1
N  34  4878   21  2916  0  0  0  0  0  0  -4 123 -1
N  35  5112   21  2916  0  0  0  0  0  0  -4 123 -1
N  36  5346   21  2916  0  0  0  0  0  0  -4 123 -1
N  37  5580   21  2916  0  0  0  0  0  0  -4 123 -1
N  38  5814   21  2916  0  0  0  0  0  0  -4 123 -1
N  39  6048   21  2916  0  0  0  0  0  0  -4 123 -1
N  40  6282   21  2916  0  0  0  0  0  0  -4 123 -1
N  41  6348   87  2864  0  0  0  0  0  0  -4 123 -1
N  42  6582   87  2864  0  0  0  0  0  0  -4 123 -1
N  43  6816   87  2864 -1 -1 -1 -1 -1 -1
N  44   500   21   500 -1 -1 -1 -1 -1 -1
M   1     1    2     1 44
M   2     2    3     1 44
M   3     3    4     1 44
M   4     4    5     1 44
M   5     5    6     1 44
M   6     6    7     1 44
M   7     7    8     1 44
```

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```
M    8    8    9   1  44
M    9    9   10   1  44
M   10   10   11   1  44
M   11   11   12   1  44
M   12   12   13   1  44
M   13   13   14   1  44
M   14   14   15   1  44
M   15   15   16   1  44
M   16   16   17   1  44
M   17   17   18   1  44
M   18   18   19   1  44
M   19   19   20   1  44
M   20   20   21   1  44
M   21   21   22   1  44
M   22   22   23   1  44
M   23   23   24   1  44
M   24   24   25   1  44
M   25   25   26   1  44
M   26   26   27   1  44
M   27   27   28   1  44
M   28   28   29   1  44
M   29   29   30   1  44
M   30   30   31   1  44
M   31   31   32   1  44
M   32   32   33   1  44
M   33   33   34   1  44
M   34   34   35   1  44
M   35   35   36   1  44
M   36   36   37   1  44
M   37   37   38   1  44
M   38   38   39   1  44
M   39   39   40   1  44
M   40   40   41   1  44
M   41   41   42   1  44
M   42   42   43   2  44
P 1 21.6 1.61 5248 2624 2624 15.7 31.4 31.4 29E6
Q 1 -5 11E6 6E-6 .44 .44 2.27 2.27 30E15
P 2 21.6 1.61 5248 2624 2624 15.7 31.4 31.4 29E6
Q 2  0 11E6 6E-6 .44 .44 2.27 2.27 30E15
X -2 0 5.7E5 5.7E5 10 10 10 10
Y -2 0 10 10 10 10 10 10 0
X -3 0 5.7E5 5.7E5 5.7E5 10 10 10
Y -3 0 10 10 10 10 10 10 0
X -4 0 0 5.7E5 5.7E5 10 10 10
Y -4 0 10 10 10 10 10 10 0
X -5 0 1E7 -1 -1 1E9 1E9 1E9
Y -5 2 10E18 10E12 10E12 10E18 1E9 1E9 10
T H.B. ROBINSON 30 CW-11 UNDERGROUND WATER PIPE
E END GEOM
STATIC
T VERTICAL 4 INCH RELATIVE GROND DISPLACEMENT MIDSPAN
D   1      .00      .00      .00
D   2      .00      .00      .00
D   3      .00      .00      .00
D   4      .00      .00      .00
D   5      .00      .00      .00
```

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```
D   6      .00     .00     .00
D   7      .00     .00     .00
D   8      .00     .00     .00
D   9      .00     .00     .00
D  10      .00     .00     .00
D  11      .00     .00     .00
D  12      .00     .20     .00
D  13      .00     .50     .00
D  14      .00     .80     .00
D  15      .00    1.10     .00
D  16      .00    1.39     .00
D  17      .00    1.61     .00
D  18      .00    2.00     .00
D  19      .00    2.36     .00
D  20      .00    2.69     .00
D  21      .00    3.00     .00
D  22      .00    3.26     .00
D  23      .00    3.49     .00
D  24      .00    3.68     .00
D  25      .00    3.83     .00
D  26      .00    3.93     .00
D  27      .00    3.99     .00
D  28      .00    4.00     .00
D  29      .00    3.96     .00
D  30      .00    3.88     .00
D  31      .00    3.75     .00
D  32      .00    3.58     .00
D  33      .00    3.37     .00
D  34      .00    3.12     .00
D  35      .00    2.83     .00
D  36      .00    2.51     .00
D  37      .00    2.16     .00
D  38      .00    1.78     .00
D  39      .00    1.39     .00
D  40      .00     .97     .00
D  41      .00     .86     .00
D  42      .00     .43     .00
E END CASE
E END STATIC
COMBINE
T VERTICAL SEISMIC (1/2 SINE WAVE END TO END)
O OUTPUT
C CASE 1 1 1 0
E END OUTPUT
REPORT 1
A CPL
B H.B.ROBINSON
J VERTICAL 4 INCH MIDSPAN DISPLACEMENT OF PIPE RUN
K JOINT MAX. FRACTION = REALATIVE JOINT ROTATION (RAD.)
L JOINT KAXIAL=1E7 LB/IN  JOINT KTORS,KROT2,KROT3=1E9 IN-LB.
M....GROUND SPRING PER 19.5 FT. PIPE SEGMENT SET AT 5.7E5 LB/IN.
M....DISPLACEMENTS ARE IMPOSED ON GROUNDED END OF NODAL GROUND SPRINGS.
E END REPORT
ENDRUN
```

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NODAL DATA TABLE

H.B. ROBINSON 30 CW-11 UNDERGROUND WATER PIPE

	--- NODAL COORDINATES ---			--- NODAL WEIGHTS ---		
NODE	X	Y	Z	XWT	YWT	ZWT
1	0.0000E0	1.5000E1	0.0000E0	5.138E3	5.138E3	5.138E3
2	0.0000E0	8.1000E1	2.8800E2	7.328E3	7.328E3	7.328E3
3	0.0000E0	8.1000E1	4.1400E2	6.260E3	6.260E3	6.260E3
4	0.0000E0	8.1000E1	6.4800E2	6.098E3	6.098E3	6.098E3
5	0.0000E0	0.0000E0	7.3200E2	6.098E3	6.098E3	6.098E3
6	0.0000E0	0.0000E0	9.6600E2	8.138E3	8.138E3	8.138E3
7	0.0000E0	0.0000E0	1.2000E3	8.138E3	8.138E3	8.138E3
8	0.0000E0	0.0000E0	1.4340E3	8.138E3	8.138E3	8.138E3
9	0.0000E0	0.0000E0	1.6680E3	8.138E3	8.138E3	8.138E3
10	0.0000E0	0.0000E0	1.9020E3	6.051E3	6.051E3	6.051E3
11	0.0000E0	0.0000E0	2.0160E3	4.663E3	4.663E3	4.663E3
12	1.0800E2	2.1000E1	2.1240E3	6.763E3	6.763E3	6.763E3
13	2.7400E2	2.1000E1	2.2900E3	8.139E3	8.139E3	8.139E3
14	4.3900E2	2.1000E1	2.4550E3	8.139E3	8.139E3	8.139E3
15	6.0500E2	2.1000E1	2.6210E3	8.139E3	8.139E3	8.139E3
16	7.7000E2	2.1000E1	2.7860E3	7.254E3	7.254E3	7.254E3
17	9.0000E2	2.1000E1	2.9160E3	7.266E3	7.266E3	7.266E3
18	1.1340E3	2.1000E1	2.9160E3	8.138E3	8.138E3	8.138E3
19	1.3680E3	2.1000E1	2.9160E3	8.138E3	8.138E3	8.138E3
20	1.6020E3	2.1000E1	2.9160E3	8.138E3	8.138E3	8.138E3
21	1.8360E3	2.1000E1	2.9160E3	8.138E3	8.138E3	8.138E3
22	2.0700E3	2.1000E1	2.9160E3	8.138E3	8.138E3	8.138E3
23	2.3040E3	2.1000E1	2.9160E3	8.138E3	8.138E3	8.138E3
24	2.5380E3	2.1000E1	2.9160E3	8.138E3	8.138E3	8.138E3
25	2.7720E3	2.1000E1	2.9160E3	8.138E3	8.138E3	8.138E3
26	3.0060E3	2.1000E1	2.9160E3	8.138E3	8.138E3	8.138E3
27	3.2400E3	2.1000E1	2.9160E3	8.138E3	8.138E3	8.138E3
28	3.4740E3	2.1000E1	2.9160E3	8.138E3	8.138E3	8.138E3
29	3.7080E3	2.1000E1	2.9160E3	8.138E3	8.138E3	8.138E3
30	3.9420E3	2.1000E1	2.9160E3	8.138E3	8.138E3	8.138E3
31	4.1760E3	2.1000E1	2.9160E3	8.138E3	8.138E3	8.138E3
32	4.4100E3	2.1000E1	2.9160E3	8.138E3	8.138E3	8.138E3
33	4.6440E3	2.1000E1	2.9160E3	8.138E3	8.138E3	8.138E3
34	4.8780E3	2.1000E1	2.9160E3	8.138E3	8.138E3	8.138E3
35	5.1120E3	2.1000E1	2.9160E3	8.138E3	8.138E3	8.138E3
36	5.3460E3	2.1000E1	2.9160E3	8.138E3	8.138E3	8.138E3
37	5.5800E3	2.1000E1	2.9160E3	8.138E3	8.138E3	8.138E3
38	5.8140E3	2.1000E1	2.9160E3	8.138E3	8.138E3	8.138E3
39	6.0480E3	2.1000E1	2.9160E3	8.138E3	8.138E3	8.138E3
40	6.2820E3	2.1000E1	2.9160E3	5.927E3	5.927E3	5.927E3
41	6.3480E3	8.7000E1	2.8640E3	5.927E3	5.927E3	5.927E3
42	6.5820E3	8.7000E1	2.8640E3	8.138E3	8.138E3	8.138E3
43	6.8160E3	8.7000E1	2.8640E3	4.069E3	4.069E3	4.069E3
44	5.0000E2	2.1000E1	5.0000E2	0.000E0	0.000E0	0.000E0
				3.230E5	3.230E5	3.230E5

--NODAL CONSTRAINTS-- BASEPLATE DATA

NODE XT YT ZT XR YR ZR JTYPE BXYZ CALC BANDWIDTH: 12

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BANDWIDTH: 12

N	NODE	XT	YT	ZT	XR	YR	ZR	JTYPE	BXYZ	CALC
N	1	0	0	0	0	0	0	-2	B123	0
N	2	0	0	0	0	0	0	-2	B123	0
N	3	0	0	0	0	0	0	-2	B123	0
N	4	0	0	0	0	0	0	-2	B123	0
N	5	0	0	0	0	0	0	-2	B123	0
N	6	0	0	0	0	0	0	-2	B123	0
N	7	0	0	0	0	0	0	-2	B123	0
N	8	0	0	0	0	0	0	-2	B123	0
N	9	0	0	0	0	0	0	-2	B123	0
N	10	0	0	0	0	0	0	-2	B123	0
N	11	0	0	0	0	0	0	-2	B123	0
N	12	0	0	0	0	0	0	-3	B123	0
N	13	0	0	0	0	0	0	-3	B123	0
N	14	0	0	0	0	0	0	-3	B123	0
N	15	0	0	0	0	0	0	-3	B123	0
N	16	0	0	0	0	0	0	-3	B123	0
N	17	0	0	0	0	0	0	-4	B123	0
N	18	0	0	0	0	0	0	-4	B123	0
N	19	0	0	0	0	0	0	-4	B123	0
N	20	0	0	0	0	0	0	-4	B123	0
N	21	0	0	0	0	0	0	-4	B123	0
N	22	0	0	0	0	0	0	-4	B123	0
N	23	0	0	0	0	0	0	-4	B123	0
N	24	0	0	0	0	0	0	-4	B123	0
N	25	0	0	0	0	0	0	-4	B123	0
N	26	0	0	0	0	0	0	-4	B123	0
N	27	0	0	0	0	0	0	-4	B123	0
N	28	0	0	0	0	0	0	-4	B123	0
N	29	0	0	0	0	0	0	-4	B123	0
N	30	0	0	0	0	0	0	-4	B123	0
N	31	0	0	0	0	0	0	-4	B123	0
N	32	0	0	0	0	0	0	-4	B123	0
N	33	0	0	0	0	0	0	-4	B123	0
N	34	0	0	0	0	0	0	-4	B123	0
N	35	0	0	0	0	0	0	-4	B123	0
N	36	0	0	0	0	0	0	-4	B123	0
N	37	0	0	0	0	0	0	-4	B123	0
N	38	0	0	0	0	0	0	-4	B123	0
N	39	0	0	0	0	0	0	-4	B123	0
N	40	0	0	0	0	0	0	-4	B123	0
N	41	0	0	0	0	0	0	-4	B123	0
N	42	0	0	0	0	0	0	-4	B123	0
N	43	-1	-1	-1	-1	-1	-1	0	B 0	0
N	44	-1	-1	-1	-1	-1	-1	0	B 0	0

JOINT AND SPRING DATA TABLE

H.B. ROBINSON 30 CW-11 UNDERGROUND WATER PIPE

--- JOINT SPRING RATES ---

JTYPE	K1	K2	K3	K4	K5	K6
-5	1.000E7	-1.000E0	-1.000E0	1.000E9	1.000E9	1.000E9

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JTYPE	K1	K2	K3	K4	K5	K6
-4	0.000E0	5.700E5	5.700E5	1.000E1	1.000E1	1.000E1
-3	5.700E5	5.700E5	5.700E5	1.000E1	1.000E1	1.000E1
-2	5.700E5	5.700E5	1.000E1	1.000E1	1.000E1	1.000E1

--- JOINT ALLOWABLE LOADS ---

JTYPE	A1	A2	A3	A4	A5	A6
-5	1.000E19	1.000E13	1.000E13	1.000E19	1.000E9	1.000E9
-4	1.000E1	1.000E1	1.000E1	1.000E1	1.000E1	1.000E1
-3	1.000E1	1.000E1	1.000E1	1.000E1	1.000E1	1.000E1
-2	1.000E1	1.000E1	1.000E1	1.000E1	1.000E1	1.000E1

---- JOINT WEIGHT AND CALC X VALUE ----

JTYPE	JOINT WT.	X VALUE
-5	0.000E0	2.000E0
-4	0.000E0	0.000E0
-3	0.000E0	0.000E0
-2	0.000E0	0.000E0

MEMBER DATA TABLE

H.B. ROBINSON 30 CW-11 UNDERGROUND WATER PIPE

--- PRIMARY MEMBER DATA ---

MEM	FROM	TO	PTYPE	RNODE	BANK	KFAC	QFAC	LENGTH
1	1	2	1	44	0.00E0	0.00E0	1.00E0	2.955E2
2	2	3	1	44	0.00E0	0.00E0	1.00E0	1.260E2
3	3	4	1	44	0.00E0	0.00E0	1.00E0	2.340E2
4	4	5	1	44	0.00E0	0.00E0	1.00E0	1.167E2
5	5	6	1	44	0.00E0	0.00E0	1.00E0	2.340E2
6	6	7	1	44	0.00E0	0.00E0	1.00E0	2.340E2
7	7	8	1	44	0.00E0	0.00E0	1.00E0	2.340E2
8	8	9	1	44	0.00E0	0.00E0	1.00E0	2.340E2
9	9	10	1	44	0.00E0	0.00E0	1.00E0	2.340E2
10	10	11	1	44	0.00E0	0.00E0	1.00E0	1.140E2
11	11	12	1	44	0.00E0	0.00E0	1.00E0	1.542E2
12	12	13	1	44	0.00E0	0.00E0	1.00E0	2.348E2
13	13	14	1	44	0.00E0	0.00E0	1.00E0	2.333E2
14	14	15	1	44	0.00E0	0.00E0	1.00E0	2.348E2
15	15	16	1	44	0.00E0	0.00E0	1.00E0	2.333E2
16	16	17	1	44	0.00E0	0.00E0	1.00E0	1.838E2
17	17	18	1	44	0.00E0	0.00E0	1.00E0	2.340E2
18	18	19	1	44	0.00E0	0.00E0	1.00E0	2.340E2
19	19	20	1	44	0.00E0	0.00E0	1.00E0	2.340E2
20	20	21	1	44	0.00E0	0.00E0	1.00E0	2.340E2
21	21	22	1	44	0.00E0	0.00E0	1.00E0	2.340E2
22	22	23	1	44	0.00E0	0.00E0	1.00E0	2.340E2
23	23	24	1	44	0.00E0	0.00E0	1.00E0	2.340E2
24	24	25	1	44	0.00E0	0.00E0	1.00E0	2.340E2
25	25	26	1	44	0.00E0	0.00E0	1.00E0	2.340E2
26	26	27	1	44	0.00E0	0.00E0	1.00E0	2.340E2
27	27	28	1	44	0.00E0	0.00E0	1.00E0	2.340E2
28	28	29	1	44	0.00E0	0.00E0	1.00E0	2.340E2

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M	MEM	FROM	TO	PTYPE	RNODE	BANK	KFAC	QFAC	LENGTH	M
M	29	29	30	1	44	0.00E0	0.00E0	1.00E0	2.340E2	M
M	30	30	31	1	44	0.00E0	0.00E0	1.00E0	2.340E2	M
M	31	31	32	1	44	0.00E0	0.00E0	1.00E0	2.340E2	M
M	32	32	33	1	44	0.00E0	0.00E0	1.00E0	2.340E2	M
M	33	33	34	1	44	0.00E0	0.00E0	1.00E0	2.340E2	M
M	34	34	35	1	44	0.00E0	0.00E0	1.00E0	2.340E2	M
M	35	35	36	1	44	0.00E0	0.00E0	1.00E0	2.340E2	M
M	36	36	37	1	44	0.00E0	0.00E0	1.00E0	2.340E2	M
M	37	37	38	1	44	0.00E0	0.00E0	1.00E0	2.340E2	M
M	38	38	39	1	44	0.00E0	0.00E0	1.00E0	2.340E2	M
M	39	39	40	1	44	0.00E0	0.00E0	1.00E0	2.340E2	M
M	40	40	41	1	44	0.00E0	0.00E0	1.00E0	1.068E2	M
M	41	41	42	1	44	0.00E0	0.00E0	1.00E0	2.340E2	M
M	42	42	43	2	44	0.00E0	0.00E0	1.00E0	2.340E2	M
M										M

M		--- FROM JOINT DATA ---			--- TO JOINT DATA ---			M
M	MEM	TYPE	HINGE	CALC	TYPE	HINGE	CALC	M
M	1	-5	111111	10	-5	111111	10	M
M	2	-5	111111	10	-5	111111	10	M
M	3	-5	111111	10	-5	111111	10	M
M	4	-5	111111	10	-5	111111	10	M
M	5	-5	111111	10	-5	111111	10	M
M	6	-5	111111	10	-5	111111	10	M
M	7	-5	111111	10	-5	111111	10	M
M	8	-5	111111	10	-5	111111	10	M
M	9	-5	111111	10	-5	111111	10	M
M	10	-5	111111	10	-5	111111	10	M
M	11	-5	111111	10	-5	111111	10	M
M	12	-5	111111	10	-5	111111	10	M
M	13	-5	111111	10	-5	111111	10	M
M	14	-5	111111	10	-5	111111	10	M
M	15	-5	111111	10	-5	111111	10	M
M	16	-5	111111	10	-5	111111	10	M
M	17	-5	111111	10	-5	111111	10	M
M	18	-5	111111	10	-5	111111	10	M
M	19	-5	111111	10	-5	111111	10	M
M	20	-5	111111	10	-5	111111	10	M
M	21	-5	111111	10	-5	111111	10	M
M	22	-5	111111	10	-5	111111	10	M
M	23	-5	111111	10	-5	111111	10	M
M	24	-5	111111	10	-5	111111	10	M
M	25	-5	111111	10	-5	111111	10	M
M	26	-5	111111	10	-5	111111	10	M
M	27	-5	111111	10	-5	111111	10	M
M	28	-5	111111	10	-5	111111	10	M
M	29	-5	111111	10	-5	111111	10	M
M	30	-5	111111	10	-5	111111	10	M
M	31	-5	111111	10	-5	111111	10	M
M	32	-5	111111	10	-5	111111	10	M
M	33	-5	111111	10	-5	111111	10	M
M	34	-5	111111	10	-5	111111	10	M
M	35	-5	111111	10	-5	111111	10	M
M	36	-5	111111	10	-5	111111	10	M
M	37	-5	111111	10	-5	111111	10	M
M	38	-5	111111	10	-5	111111	10	M
M	39	-5	111111	10	-5	111111	10	M

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MEM	TYPE	HINGE	CALC	TYPE	HINGE	CALC
40	-5	111111	10	-5	111111	10
41	-5	111111	10	-5	111111	10

--- MEMBER PROPERTY DATA ---

PTYPE	AREA	J	I2	I3	H2	H3
1	2.160E1	5.248E3	2.624E3	2.624E3	3.140E1	3.140E1
2	2.160E1	5.248E3	2.624E3	2.624E3	3.140E1	3.140E1

--- MEMBER PROPERTY DATA ---

PTYPE	JRADIUS	SHAPE2	SHAPE3	STRESSF2	STRESSF3	DJPROP
1	1.570E1	4.400E-1	4.400E-1	2.270E0	2.270E0	-5
2	1.570E1	4.400E-1	4.400E-1	2.270E0	2.270E0	0

--- MEMBER PROPERTY DATA ---

PTYPE	EMOD	SMOD	YIELD	DENSITY	ALPHA
1	2.900E7	1.100E7	3.000E16	1.610E0	6.000E-6
2	2.900E7	1.100E7	3.000E16	1.610E0	6.000E-6

DESIGN PARAMETERS

H.B. ROBINSON 30 CW-11 UNDERGROUND WATER PIPE

MEMBER DESIGN FACTOR:9.000E-1   ALLOWABLE X DISPLACEMENT:1.0000E13

BPLATE DESIGN FACTOR:1.000E0   ALLOWABLE Y DISPLACEMENT:1.0000E13

JOINT DESIGN FACTOR:1.000E0   ALLOWABLE Z DISPLACEMENT:1.0000E13

SHEAR DESIGN FACTOR:6.000E-1   BUCKLING FACTOR:1.3300E0

GRAVITATIONAL CONSTANT:3.864E2   DIR. PENDULUM PIVOT:

APPLIED LOADS FOR STAT CASE 1

H.B. ROBINSON 30 CW-11 UNDERGROUND WATER PIPE
VERTICAL 4 INCH RELATIVE GROND DISPLACEMENT MIDSPAN

---GENERIC LOADS---

GX= 0.00E0   GY= 0.00E0   GZ= 0.00E0   GRAV=3.86E2   TDEL= 0.00E0

---IMPOSED GROUND DISPLACEMENTS---

NODE	XT	YT	ZT	XR	YR	ZR
1	0E0	0E0	0E0	0E0	0E0	0E0
2	0E0	0E0	0E0	0E0	0E0	0E0
3	0E0	0E0	0E0	0E0	0E0	0E0
4	0E0	0E0	0E0	0E0	0E0	0E0
5	0E0	0E0	0E0	0E0	0E0	0E0
6	0E0	0E0	0E0	0E0	0E0	0E0

C	NODE	XT	YT	ZT	XR	YR	ZR	C
C	7	0E0	0E0	0E0	0E0	0E0	0E0	C
C	8	0E0	0E0	0E0	0E0	0E0	0E0	C
C	9	0E0	0E0	0E0	0E0	0E0	0E0	C
C	10	0E0	0E0	0E0	0E0	0E0	0E0	C
C	11	0E0	0E0	0E0	0E0	0E0	0E0	C
C	12	0E0	2E-1	0E0	0E0	0E0	0E0	C
C	13	0E0	5E-1	0E0	0E0	0E0	0E0	C
C	14	0E0	8E-1	0E0	0E0	0E0	0E0	C
C	15	0E0	1E0	0E0	0E0	0E0	0E0	C
C	16	0E0	1E0	0E0	0E0	0E0	0E0	C
C	17	0E0	2E0	0E0	0E0	0E0	0E0	C
C	18	0E0	2E0	0E0	0E0	0E0	0E0	C
C	19	0E0	2E0	0E0	0E0	0E0	0E0	C
C	20	0E0	3E0	0E0	0E0	0E0	0E0	C
C	21	0E0	3E0	0E0	0E0	0E0	0E0	C
C	22	0E0	3E0	0E0	0E0	0E0	0E0	C
C	23	0E0	3E0	0E0	0E0	0E0	0E0	C
C	24	0E0	4E0	0E0	0E0	0E0	0E0	C
C	25	0E0	4E0	0E0	0E0	0E0	0E0	C
C	26	0E0	4E0	0E0	0E0	0E0	0E0	C
C	27	0E0	4E0	0E0	0E0	0E0	0E0	C
C	28	0E0	4E0	0E0	0E0	0E0	0E0	C
C	29	0E0	4E0	0E0	0E0	0E0	0E0	C
C	30	0E0	4E0	0E0	0E0	0E0	0E0	C
C	31	0E0	4E0	0E0	0E0	0E0	0E0	C
C	32	0E0	4E0	0E0	0E0	0E0	0E0	C
C	33	0E0	3E0	0E0	0E0	0E0	0E0	C
C	34	0E0	3E0	0E0	0E0	0E0	0E0	C
C	35	0E0	3E0	0E0	0E0	0E0	0E0	C
C	36	0E0	3E0	0E0	0E0	0E0	0E0	C
C	37	0E0	2E0	0E0	0E0	0E0	0E0	C
C	38	0E0	2E0	0E0	0E0	0E0	0E0	C
C	39	0E0	1E0	0E0	0E0	0E0	0E0	C
C	40	0E0	1E0	0E0	0E0	0E0	0E0	C
C	41	0E0	9E-1	0E0	0E0	0E0	0E0	C
C	42	0E0	4E-1	0E0	0E0	0E0	0E0	C

C==C

A==A

A=== ANCHOR ANALYSIS OF COMBINED CASE 1 ===A

A==A

A H.B. ROBINSON 30 CW-11 UNDERGROUND WATER PIPE A

A VERTICAL SEISMIC (1/2 SINE WAVE END TO END) A

---NODAL DEFLECTIONS---

A	NODE	XT	YT	ZT	XR	YR	ZR	A
A	1	2.423E-5	1.281E-7	3.218E-2	1.030E-9	2.046E-5	7.977E-5	A
A	2	-8.872E-5	-8.236E-8	3.218E-2	4.230E-10	8.762E-6	8.245E-5	A
A	3	2.159E-4	-1.710E-7	3.218E-2	5.675E-9	2.687E-6	8.626E-5	A
A	4	-9.953E-4	-1.484E-6	3.218E-2	-2.108E-8	-4.523E-5	9.178E-5	A
A	5	1.008E-3	1.493E-6	3.218E-2	-2.117E-8	-4.769E-5	1.688E-4	A
A	6	-1.705E-4	9.947E-8	3.218E-2	8.300E-9	2.797E-6	4.102E-4	A
A	7	5.578E-6	-4.252E-7	3.219E-2	-7.441E-9	1.451E-7	6.516E-4	A
A	8	1.422E-5	1.034E-5	3.219E-2	-1.786E-7	1.798E-7	8.930E-4	A

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A	NODE	XT	YT	ZT	XR	YR	ZR	A
A	9	-8.489E-5	-5.605E-5	3.219E-2	2.851E-6	-3.800E-6	1.134E-3	A
A	10	-8.985E-4	-7.905E-4	3.219E-2	-6.387E-6	1.212E-5	1.376E-3	A
A	11	3.256E-3	1.942E-3	3.219E-2	-1.186E-4	1.501E-4	1.534E-3	A
A	12	-2.630E-3	1.988E-1	4.298E-4	-2.222E-4	1.531E-4	1.611E-3	A
A	13	-6.726E-4	5.001E-1	-1.497E-3	-1.888E-4	-1.195E-5	1.626E-3	A
A	14	-1.454E-3	8.000E-1	-1.393E-3	-1.654E-4	-1.205E-7	1.650E-3	A
A	15	-2.063E-3	1.100E0	-2.398E-3	-1.262E-4	4.959E-6	1.659E-3	A
A	16	-4.366E-3	1.390E0	-3.159E-3	-7.072E-5	-6.212E-5	1.651E-3	A
A	17	-1.993E-2	1.610E0	7.646E-3	-4.107E-5	-4.156E-5	1.662E-3	A
A	18	-2.284E-2	2.000E0	4.545E-4	-3.633E-5	2.525E-5	1.609E-3	A
A	19	-2.575E-2	2.360E0	-9.308E-5	-3.159E-5	-1.694E-6	1.472E-3	A
A	20	-2.866E-2	2.690E0	3.996E-6	-2.685E-5	-5.390E-8	1.372E-3	A
A	21	-3.157E-2	3.000E0	3.770E-7	-2.211E-5	1.691E-8	1.220E-3	A
A	22	-3.448E-2	3.260E0	-5.971E-8	-1.737E-5	-9.394E-10	1.045E-3	A
A	23	-3.739E-2	3.490E0	1.927E-9	-1.263E-5	-5.152E-11	8.994E-4	A
A	24	-4.030E-2	3.680E0	2.924E-10	-7.886E-6	1.109E-11	7.285E-4	A
A	25	-4.321E-2	3.830E0	-3.757E-11	-3.146E-6	-4.960E-13	5.342E-4	A
A	26	-4.612E-2	3.930E0	8.005E-13	1.595E-6	-4.336E-14	3.419E-4	A
A	27	-4.902E-2	3.990E0	2.168E-13	6.335E-6	7.136E-15	1.516E-4	A
A	28	-5.193E-2	4.000E0	-2.350E-14	1.108E-5	-2.078E-16	-6.612E-5	A
A	29	-5.484E-2	3.960E0	-1.502E-14	1.582E-5	1.360E-17	-2.564E-4	A
A	30	-5.775E-2	3.880E0	2.081E-13	2.056E-5	-5.236E-15	-4.487E-4	A
A	31	-6.066E-2	3.750E0	-1.686E-13	2.530E-5	4.939E-14	-6.430E-4	A
A	32	-6.357E-2	3.580E0	-2.609E-11	3.004E-5	1.773E-13	-8.120E-4	A
A	33	-6.648E-2	3.370E0	3.002E-10	3.478E-5	-8.509E-12	-9.829E-4	A
A	34	-6.939E-2	3.120E0	3.043E-10	3.952E-5	6.677E-11	-1.156E-3	A
A	35	-7.230E-2	2.830E0	-4.350E-8	4.426E-5	4.306E-10	-1.305E-3	A
A	36	-7.521E-2	2.510E0	4.221E-7	4.900E-5	-1.354E-8	-1.432E-3	A
A	37	-7.812E-2	2.160E0	1.342E-6	5.374E-5	8.629E-8	-1.564E-3	A
A	38	-8.103E-2	1.780E0	-7.089E-5	5.848E-5	8.971E-7	-1.644E-3	A
A	39	-8.394E-2	1.389E0	5.743E-4	6.322E-5	-2.112E-5	-1.759E-3	A
A	40	-8.685E-2	9.662E-1	3.396E-3	6.796E-5	1.044E-4	-1.665E-3	A
A	41	4.805E-3	8.656E-1	-3.371E-3	5.904E-5	1.037E-4	-1.669E-3	A
A	42	1.895E-3	4.144E-1	-6.417E-4	2.368E-5	-1.432E-5	-2.382E-3	A
A	43	0.000E0	0.000E0	0.000E0	0.000E0	0.000E0	0.000E0	A
A	44	0.000E0	0.000E0	0.000E0	0.000E0	0.000E0	0.000E0	A

A A

A ---REACTION LOADS AT FIXED DEGREES OF FREEDOM--- A

A	NODE	XF	YF	ZF	XM	YM	ZM	A
A	43	-5.073E3	-8.343E3	-6.356E1	-5.842E3	-2.779E3	1.751E6	A
A	44	0.000E0	0.000E0	0.000E0	0.000E0	0.000E0	0.000E0	A

A A

A ---BASEPLATE LOADS--- A

A	NODE	XF	YF	ZF	XM	YM	ZM	A
A	1	1.381E1	7.303E-2	3.218E-1	1.030E-8	2.046E-4	7.977E-4	A
A	2	-5.057E1	-4.695E-2	3.218E-1	4.230E-9	8.762E-5	8.245E-4	A
A	3	1.231E2	-9.746E-2	3.218E-1	5.675E-8	2.687E-5	8.626E-4	A
A	4	-5.673E2	-8.460E-1	3.218E-1	-2.108E-7	-4.523E-4	9.178E-4	A
A	5	5.744E2	8.509E-1	3.218E-1	-2.117E-7	-4.769E-4	1.688E-3	A
A	6	-9.720E1	5.670E-2	3.218E-1	8.300E-8	2.797E-5	4.102E-3	A
A	7	3.179E0	-2.424E-1	3.219E-1	-7.441E-8	1.451E-6	6.516E-3	A
A	8	8.106E0	5.896E0	3.219E-1	-1.786E-6	1.798E-6	8.930E-3	A
A	9	-4.839E1	-3.195E1	3.219E-1	2.851E-5	-3.800E-5	1.134E-2	A
A	10	-5.122E2	-4.506E2	3.219E-1	-6.387E-5	1.212E-4	1.376E-2	A
A	11	1.856E3	1.107E3	3.219E-1	-1.186E-3	1.501E-3	1.534E-2	A
A	12	-1.499E3	-6.645E2	2.450E2	-2.222E-3	1.531E-3	1.611E-2	A

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A	NODE	XF	YF	ZF	XM	YM	ZM	A
A	13	-3.834E2	4.594E1	-8.534E2	-1.888E-3	-1.195E-4	1.626E-2	A
A	14	-8.290E2	1.463E1	-7.942E2	-1.654E-3	-1.205E-6	1.650E-2	A
A	15	-1.176E3	-1.274E1	-1.367E3	-1.262E-3	4.959E-5	1.659E-2	A
A	16	-2.489E3	-9.385E1	-1.801E3	-7.072E-4	-6.212E-4	1.651E-2	A
A	17	0.000E0	2.305E2	4.358E3	-4.107E-4	-4.156E-4	1.662E-2	A
A	18	0.000E0	-1.580E2	2.591E2	-3.633E-4	2.525E-4	1.609E-2	A
A	19	0.000E0	-4.484E1	-5.306E1	-3.159E-4	-1.694E-5	1.472E-2	A
A	20	0.000E0	1.914E2	2.278E0	-2.685E-4	-5.390E-7	1.372E-2	A
A	21	0.000E0	-2.374E2	2.149E-1	-2.211E-4	1.691E-7	1.220E-2	A
A	22	0.000E0	1.482E2	-3.404E-2	-1.737E-4	-9.394E-9	1.045E-2	A
A	23	0.000E0	-5.570E1	1.098E-3	-1.263E-4	-5.152E-10	8.994E-3	A
A	24	0.000E0	5.244E1	1.667E-4	-7.886E-5	1.109E-10	7.285E-3	A
A	25	0.000E0	-9.548E1	-2.141E-5	-3.146E-5	-4.960E-12	5.342E-3	A
A	26	0.000E0	9.568E1	4.563E-7	1.595E-5	-4.336E-13	3.419E-3	A
A	27	0.000E0	-4.617E1	1.235E-7	6.335E-5	7.136E-14	1.516E-3	A
A	28	0.000E0	-4.617E1	-1.339E-8	1.108E-4	-2.078E-15	-6.612E-4	A
A	29	0.000E0	9.571E1	-8.561E-9	1.582E-4	1.360E-16	-2.564E-3	A
A	30	0.000E0	-9.563E1	1.186E-7	2.056E-4	-5.236E-14	-4.487E-3	A
A	31	0.000E0	4.935E1	-9.607E-8	2.530E-4	4.939E-13	-6.430E-3	A
A	32	0.000E0	-3.124E0	-1.487E-5	3.004E-4	1.773E-12	-8.120E-3	A
A	33	0.000E0	3.206E0	1.711E-4	3.478E-4	-8.509E-11	-9.829E-3	A
A	34	0.000E0	-4.617E1	1.734E-4	3.952E-4	6.677E-10	-1.156E-2	A
A	35	0.000E0	4.640E1	-2.480E-2	4.426E-4	4.306E-9	-1.305E-2	A
A	36	0.000E0	2.755E0	2.406E-1	4.900E-4	-1.354E-7	-1.432E-2	A
A	37	0.000E0	-9.965E1	7.652E-1	5.374E-4	8.629E-7	-1.564E-2	A
A	38	0.000E0	2.451E2	-4.041E1	5.848E-4	8.971E-6	-1.644E-2	A
A	39	0.000E0	-6.556E2	3.273E2	6.322E-4	-2.112E-4	-1.759E-2	A
A	40	0.000E0	-2.191E3	1.936E3	6.796E-4	1.044E-3	-1.665E-2	A
A	41	0.000E0	3.216E3	-1.921E3	5.904E-4	1.037E-3	-1.669E-2	A
A	42	0.000E0	-8.865E3	-3.658E2	2.368E-4	-1.432E-4	-2.382E-2	A

MEMBER LOADS OF COMBINED CASE 1

H.B. ROBINSON 30 CW-11 UNDERGROUND WATER PIPE
VERTICAL SEISMIC (1/2 SINE WAVE END TO END)

---LOCAL MEMBER END LOADS---

L	M	N	AXIAL	X2SHEAR	X3SHEAR	TORSN	X2MOM	X3MOM	L
L	1	1	-3.300E-1	-1.351E1	-2.860E0	-8.232E-4	4.394E-6	-2.081E-5	L
L	1	2	3.300E-1	1.351E1	2.860E0	8.232E-4	8.449E2	-3.992E3	L
L	2	2	-6.436E-1	3.650E1	4.354E0	-9.115E2	-4.737E2	3.949E3	L
L	2	3	6.436E-1	-3.650E1	-4.354E0	9.115E2	-7.490E1	6.500E2	L
L	3	3	-9.654E-1	-8.568E1	-1.021E1	-9.116E2	7.490E1	-6.500E2	L
L	3	4	9.654E-1	8.568E1	1.021E1	9.116E2	2.314E3	-1.940E4	L
L	4	4	-1.563E0	4.618E2	1.345E2	-1.422E4	-3.750E3	1.290E4	L
L	4	5	1.563E0	-4.618E2	-1.345E2	1.422E4	-1.195E4	4.100E4	L
L	5	5	-1.609E0	-9.326E1	3.983E0	-3.988E4	-8.893E2	-2.085E4	L
L	5	6	1.609E0	9.326E1	-3.983E0	3.988E4	-4.280E1	-9.723E2	L
L	6	6	-1.931E0	3.849E0	-1.519E-1	-3.988E4	4.280E1	9.723E2	L
L	6	7	1.931E0	-3.849E0	1.519E-1	3.988E4	-7.251E0	-7.163E1	L
L	7	7	-2.253E0	6.827E-1	2.236E-1	-3.988E4	7.251E0	7.163E1	L
L	7	8	2.253E0	-6.827E-1	-2.236E-1	3.988E4	-5.958E1	8.812E1	L

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L	M	N	AXIAL	X2SHEAR	X3SHEAR	TORSN	X2MOM	X3MOM	L
L	8	8	-2.575E0	-7.664E0	-5.327E0	-3.988E4	5.958E1	-8.812E1	L
L	8	9	2.575E0	7.664E0	5.327E0	3.988E4	1.187E3	-1.705E3	L
L	9	9	-2.896E0	4.202E1	2.456E1	-3.988E4	-1.187E3	1.705E3	L
L	9	10	2.896E0	-4.202E1	-2.456E1	3.988E4	-4.561E3	8.128E3	L
L	10	10	-3.218E0	5.726E2	4.533E2	-3.988E4	4.561E3	-8.128E3	L
L	10	11	3.218E0	-5.726E2	-4.533E2	3.988E4	-5.624E4	7.341E4	L
L	11	11	-1.001E3	-9.570E2	-4.202E2	3.914E3	6.387E4	-7.776E4	L
L	11	12	1.001E3	9.570E2	4.202E2	-3.914E3	9.141E2	-6.978E4	L
L	12	12	-3.713E1	3.143E2	3.466E1	-5.584E3	-6.700E3	6.935E4	L
L	12	13	3.713E1	-3.143E2	-3.466E1	5.584E3	-1.436E3	4.439E3	L
L	13	13	8.374E2	-1.803E1	-1.128E1	-5.584E3	1.436E3	-4.439E3	L
L	13	14	-8.374E2	1.803E1	1.128E1	5.584E3	1.196E3	2.309E2	L
L	14	14	1.985E3	6.542E0	-2.591E1	-5.584E3	-1.196E3	-2.309E2	L
L	14	15	-1.985E3	-6.542E0	2.591E1	5.584E3	7.280E3	1.767E3	L
L	15	15	3.783E3	-1.286E2	-1.318E1	-5.584E3	-7.280E3	-1.767E3	L
L	15	16	-3.783E3	1.286E2	1.318E1	5.584E3	1.035E4	-2.825E4	L
L	16	16	6.816E3	3.579E2	8.067E1	-5.584E3	-1.035E4	2.825E4	L
L	16	17	-6.816E3	-3.579E2	-8.067E1	5.584E3	-4.477E3	3.756E4	L
L	17	17	5.073E3	-2.085E2	-1.499E2	-7.831E2	7.114E3	-3.756E4	L
L	17	18	-5.073E3	2.085E2	1.499E2	7.831E2	2.796E4	-1.123E4	L
L	18	18	5.073E3	5.060E1	8.126E0	-7.831E2	-2.796E4	1.123E4	L
L	18	19	-5.073E3	-5.060E1	-8.126E0	7.831E2	2.606E4	6.109E2	L
L	19	19	5.073E3	-2.460E0	5.297E1	-7.831E2	-2.605E4	-6.109E2	L
L	19	20	-5.073E3	2.460E0	-5.297E1	7.831E2	1.366E4	3.526E1	L
L	20	20	5.073E3	-1.821E-1	-1.385E2	-7.831E2	-1.366E4	-3.526E1	L
L	20	21	-5.073E3	1.821E-1	1.385E2	7.831E2	4.606E4	-7.353E0	L
L	21	21	5.073E3	3.279E-2	9.894E1	-7.831E2	-4.606E4	7.353E0	L
L	21	22	-5.073E3	-3.279E-2	-9.894E1	7.831E2	2.291E4	3.205E-1	L
L	22	22	5.073E3	-1.244E-3	-4.924E1	-7.831E2	-2.291E4	-3.205E-1	L
L	22	23	-5.073E3	1.244E-3	4.924E1	7.831E2	3.443E4	2.940E-2	L
L	23	23	5.073E3	-1.458E-4	6.463E0	-7.831E2	-3.443E4	-2.940E-2	L
L	23	24	-5.073E3	1.458E-4	-6.463E0	7.831E2	3.292E4	-4.723E-3	L
L	24	24	5.073E3	2.085E-5	-4.597E1	-7.831E2	-3.292E4	4.723E-3	L
L	24	25	-5.073E3	-2.085E-5	4.597E1	7.831E2	4.368E4	1.555E-4	L
L	25	25	5.073E3	-5.668E-7	4.951E1	-7.831E2	-4.368E4	-1.555E-4	L
L	25	26	-5.073E3	5.668E-7	-4.951E1	7.831E2	3.209E4	2.288E-5	L
L	26	26	5.073E3	-1.105E-7	-4.617E1	-7.831E2	-3.209E4	-2.288E-5	L
L	26	27	-5.073E3	1.105E-7	4.617E1	7.831E2	4.290E4	-2.976E-6	L
L	27	27	5.073E3	1.307E-8	1.038E-4	-7.831E2	-4.290E4	2.976E-6	L
L	27	28	-5.073E3	-1.307E-8	-1.038E-4	7.831E2	4.290E4	8.182E-8	L
L	28	28	5.073E3	-3.264E-10	4.617E1	-7.831E2	-4.290E4	-8.182E-8	L
L	28	29	-5.073E3	3.264E-10	-4.617E1	7.831E2	3.209E4	5.442E-9	L
L	29	29	5.073E3	-8.887E-9	-4.954E1	-7.831E2	-3.209E4	-5.442E-9	L
L	29	30	-5.073E3	8.887E-9	4.954E1	7.831E2	4.369E4	-2.074E-6	L
L	30	30	5.073E3	1.097E-7	4.609E1	-7.831E2	-4.369E4	2.074E-6	L
L	30	31	-5.073E3	-1.097E-7	-4.609E1	7.831E2	3.290E4	2.360E-5	L
L	31	31	5.073E3	1.365E-8	-3.258E0	-7.831E2	-3.290E4	-2.360E-5	L
L	31	32	-5.073E3	-1.365E-8	3.258E0	7.831E2	3.366E4	2.679E-5	L
L	32	32	5.073E3	-1.486E-5	-1.346E-1	-7.831E2	-3.366E4	-2.679E-5	L
L	32	33	-5.073E3	1.486E-5	1.346E-1	7.831E2	3.369E4	-3.450E-3	L
L	33	33	5.073E3	1.563E-4	-3.341E0	-7.831E2	-3.369E4	3.450E-3	L
L	33	34	-5.073E3	-1.563E-4	3.341E0	7.831E2	3.448E4	3.312E-2	L
L	34	34	5.073E3	3.297E-4	4.283E1	-7.831E2	-3.448E4	-3.312E-2	L
L	34	35	-5.073E3	-3.297E-4	-4.283E1	7.831E2	2.445E4	1.103E-1	L
L	35	35	5.073E3	-2.447E-2	-3.567E0	-7.831E2	-2.445E4	-1.103E-1	L
L	35	36	-5.073E3	2.447E-2	3.567E0	7.831E2	2.529E4	-5.615E0	L

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L	M	N	AXIAL	X2SHEAR	X3SHEAR	TORSN	X2MOM	X3MOM	L
L	36	36	5.073E3	2.161E-1	-6.322E0	-7.831E2	-2.529E4	5.615E0	L
L	36	37	-5.073E3	-2.161E-1	6.322E0	7.831E2	2.677E4	4.496E1	L
L	37	37	5.073E3	9.813E-1	9.333E1	-7.831E2	-2.677E4	-4.496E1	L
L	37	38	-5.073E3	-9.813E-1	-9.333E1	7.831E2	4.930E3	2.746E2	L
L	38	38	5.073E3	-3.942E1	-1.518E2	-7.831E2	-4.930E3	-2.746E2	L
L	38	39	-5.073E3	3.942E1	1.518E2	7.831E2	4.046E4	-8.951E3	L
L	39	39	5.073E3	2.879E2	5.038E2	-7.831E2	-4.046E4	8.951E3	L
L	39	40	-5.073E3	-2.879E2	-5.038E2	7.831E2	-7.743E4	5.842E4	L
L	40	40	5.880E3	-1.705E3	-6.749E2	1.116E3	3.355E4	-9.101E4	L
L	40	41	-5.880E3	1.705E3	6.749E2	-1.116E3	3.856E4	-9.115E4	L
L	41	41	5.073E3	3.167E2	-5.128E2	5.842E3	-8.114E4	5.638E4	L
L	41	42	-5.073E3	-3.167E2	5.128E2	-5.842E3	2.011E5	1.772E4	L
L	42	42	5.073E3	-2.964E2	8.338E3	5.842E3	-2.011E5	-1.772E4	L
L	42	43	-5.073E3	2.964E2	-8.338E3	-5.842E3	-1.750E6	-5.164E4	L
L									L

L==L

S==S

S=== MEMBER STRESSES OF COMBINED CASE 1 ===S

S==S

S H.B. ROBINSON 30 CW-11 UNDERGROUND WATER PIPE S

S VERTICAL SEISMIC (1/2 SINE WAVE END TO END) S

S ---LOCAL MEMBER END STRESSES--- S

S	M	N	AXIAL	X2SHEAR	X3SHEAR	TORSN	X2BEND	X3BEND	S
S	1	1	1.528E-2	-1.420E0	-3.005E-1	2.463E-6	-2.629E-8	-1.245E-7	S
S	1	2	1.528E-2	-1.420E0	-3.005E-1	2.463E-6	5.055E0	2.389E1	S
S	2	2	2.979E-2	3.836E0	4.576E-1	2.727E0	2.834E0	2.363E1	S
S	2	3	2.979E-2	3.836E0	4.576E-1	2.727E0	-4.481E-1	-3.889E0	S
S	3	3	4.469E-2	-9.005E0	-1.073E0	2.727E0	-4.481E-1	-3.889E0	S
S	3	4	4.469E-2	-9.005E0	-1.073E0	2.727E0	1.385E1	1.161E2	S
S	4	4	7.238E-2	4.854E1	1.414E1	4.253E1	2.244E1	7.717E1	S
S	4	5	7.238E-2	4.854E1	1.414E1	4.253E1	-7.150E1	-2.453E2	S
S	5	5	7.449E-2	-9.801E0	4.186E-1	1.193E2	5.321E0	-1.248E2	S
S	5	6	7.449E-2	-9.801E0	4.186E-1	1.193E2	-2.561E-1	5.818E0	S
S	6	6	8.939E-2	4.045E-1	-1.597E-2	1.193E2	-2.561E-1	5.818E0	S
S	6	7	8.939E-2	4.045E-1	-1.597E-2	1.193E2	-4.338E-2	4.286E-1	S
S	7	7	1.043E-1	7.175E-2	2.350E-2	1.193E2	-4.338E-2	4.286E-1	S
S	7	8	1.043E-1	7.175E-2	2.350E-2	1.193E2	-3.565E-1	-5.272E-1	S
S	8	8	1.192E-1	-8.054E-1	-5.598E-1	1.193E2	-3.565E-1	-5.272E-1	S
S	8	9	1.192E-1	-8.054E-1	-5.598E-1	1.193E2	7.101E0	1.020E1	S
S	9	9	1.341E-1	4.416E0	2.581E0	1.193E2	7.101E0	1.020E1	S
S	9	10	1.341E-1	4.416E0	2.581E0	1.193E2	-2.729E1	-4.863E1	S
S	10	10	1.490E-1	6.018E1	4.764E1	1.193E2	-2.729E1	-4.863E1	S
S	10	11	1.490E-1	6.018E1	4.764E1	1.193E2	-3.365E2	-4.392E2	S
S	11	11	4.634E1	-1.006E2	-4.416E1	-1.171E1	-3.822E2	-4.652E2	S
S	11	12	4.634E1	-1.006E2	-4.416E1	-1.171E1	5.469E0	4.175E2	S
S	12	12	1.719E0	3.303E1	3.642E0	1.671E1	4.009E1	4.149E2	S
S	12	13	1.719E0	3.303E1	3.642E0	1.671E1	-8.592E0	-2.656E1	S
S	13	13	-3.877E1	-1.895E0	-1.185E0	1.671E1	-8.592E0	-2.656E1	S
S	13	14	-3.877E1	-1.895E0	-1.185E0	1.671E1	7.157E0	-1.382E0	S
S	14	14	-9.191E1	6.875E-1	-2.723E0	1.671E1	7.157E0	-1.382E0	S
S	14	15	-9.191E1	6.875E-1	-2.723E0	1.671E1	4.356E1	-1.057E1	S
S	15	15	-1.752E2	-1.352E1	-1.385E0	1.671E1	4.356E1	-1.057E1	S
S	15	16	-1.752E2	-1.352E1	-1.385E0	1.671E1	6.195E1	1.690E2	S

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	M	N	AXIAL	X2SHEAR	X3SHEAR	TORSN	X2BEND	X3BEND	S
S	16	16	-3.156E2	3.761E1	8.478E0	1.671E1	6.195E1	1.690E2	S
S	16	17	-3.156E2	3.761E1	8.478E0	1.671E1	-2.679E1	-2.247E2	S
S	17	17	-2.349E2	-2.191E1	-1.575E1	2.343E0	-4.257E1	-2.247E2	S
S	17	18	-2.349E2	-2.191E1	-1.575E1	2.343E0	1.673E2	6.718E1	S
S	18	18	-2.349E2	5.317E0	8.540E-1	2.343E0	1.673E2	6.718E1	S
S	18	19	-2.349E2	5.317E0	8.540E-1	2.343E0	1.559E2	-3.655E0	S
S	19	19	-2.349E2	-2.585E-1	5.566E0	2.343E0	1.559E2	-3.655E0	S
S	19	20	-2.349E2	-2.585E-1	5.566E0	2.343E0	8.174E1	-2.110E-1	S
S	20	20	-2.349E2	-1.914E-2	-1.455E1	2.343E0	8.174E1	-2.110E-1	S
S	20	21	-2.349E2	-1.914E-2	-1.455E1	2.343E0	2.756E2	4.399E-2	S
S	21	21	-2.349E2	3.446E-3	1.040E1	2.343E0	2.756E2	4.399E-2	S
S	21	22	-2.349E2	3.446E-3	1.040E1	2.343E0	1.371E2	-1.918E-3	S
S	22	22	-2.349E2	-1.307E-4	-5.175E0	2.343E0	1.371E2	-1.918E-3	S
S	22	23	-2.349E2	-1.307E-4	-5.175E0	2.343E0	2.060E2	-1.759E-4	S
S	23	23	-2.349E2	-1.532E-5	6.792E-1	2.343E0	2.060E2	-1.759E-4	S
S	23	24	-2.349E2	-1.532E-5	6.792E-1	2.343E0	1.970E2	2.826E-5	S
S	24	24	-2.349E2	2.191E-6	-4.832E0	2.343E0	1.970E2	2.826E-5	S
S	24	25	-2.349E2	2.191E-6	-4.832E0	2.343E0	2.613E2	-9.304E-7	S
S	25	25	-2.349E2	-5.957E-8	5.203E0	2.343E0	2.613E2	-9.304E-7	S
S	25	26	-2.349E2	-5.957E-8	5.203E0	2.343E0	1.920E2	-1.369E-7	S
S	26	26	-2.349E2	-1.161E-8	-4.852E0	2.343E0	1.920E2	-1.369E-7	S
S	26	27	-2.349E2	-1.161E-8	-4.852E0	2.343E0	2.567E2	1.781E-8	S
S	27	27	-2.349E2	1.373E-9	1.091E-5	2.343E0	2.567E2	1.781E-8	S
S	27	28	-2.349E2	1.373E-9	1.091E-5	2.343E0	2.567E2	-4.895E-10	S
S	28	28	-2.349E2	-3.430E-11	4.852E0	2.343E0	2.567E2	-4.895E-10	S
S	28	29	-2.349E2	-3.430E-11	4.852E0	2.343E0	1.920E2	-3.256E-11	S
S	29	29	-2.349E2	-9.340E-10	-5.206E0	2.343E0	1.920E2	-3.256E-11	S
S	29	30	-2.349E2	-9.340E-10	-5.206E0	2.343E0	2.614E2	1.241E-8	S
S	30	30	-2.349E2	1.153E-8	4.844E0	2.343E0	2.614E2	1.241E-8	S
S	30	31	-2.349E2	1.153E-8	4.844E0	2.343E0	1.969E2	-1.412E-7	S
S	31	31	-2.349E2	1.434E-9	-3.424E-1	2.343E0	1.969E2	-1.412E-7	S
S	31	32	-2.349E2	1.434E-9	-3.424E-1	2.343E0	2.014E2	-1.603E-7	S
S	32	32	-2.349E2	-1.561E-6	-1.415E-2	2.343E0	2.014E2	-1.603E-7	S
S	32	33	-2.349E2	-1.561E-6	-1.415E-2	2.343E0	2.016E2	2.064E-5	S
S	33	33	-2.349E2	1.642E-5	-3.511E-1	2.343E0	2.016E2	2.064E-5	S
S	33	34	-2.349E2	1.642E-5	-3.511E-1	2.343E0	2.063E2	-1.982E-4	S
S	34	34	-2.349E2	3.465E-5	4.501E0	2.343E0	2.063E2	-1.982E-4	S
S	34	35	-2.349E2	3.465E-5	4.501E0	2.343E0	1.463E2	-6.598E-4	S
S	35	35	-2.349E2	-2.571E-3	-3.748E-1	2.343E0	1.463E2	-6.598E-4	S
S	35	36	-2.349E2	-2.571E-3	-3.748E-1	2.343E0	1.513E2	3.359E-2	S
S	36	36	-2.349E2	2.271E-2	-6.644E-1	2.343E0	1.513E2	3.359E-2	S
S	36	37	-2.349E2	2.271E-2	-6.644E-1	2.343E0	1.602E2	-2.690E-1	S
S	37	37	-2.349E2	1.031E-1	9.808E0	2.343E0	1.602E2	-2.690E-1	S
S	37	38	-2.349E2	1.031E-1	9.808E0	2.343E0	2.950E1	-1.643E0	S
S	38	38	-2.349E2	-4.143E0	-1.596E1	2.343E0	2.950E1	-1.643E0	S
S	38	39	-2.349E2	-4.143E0	-1.596E1	2.343E0	2.421E2	5.355E1	S
S	39	39	-2.349E2	3.026E1	5.295E1	2.343E0	2.421E2	5.355E1	S
S	39	40	-2.349E2	3.026E1	5.295E1	2.343E0	-4.633E2	-3.495E2	S
S	40	40	-2.722E2	-1.792E2	-7.092E1	-3.337E0	-2.007E2	-5.445E2	S
S	40	41	-2.722E2	-1.792E2	-7.092E1	-3.337E0	2.307E2	5.454E2	S
S	41	41	-2.349E2	3.328E1	-5.389E1	-1.748E1	4.855E2	3.373E2	S
S	41	42	-2.349E2	3.328E1	-5.389E1	-1.748E1	1.203E3	-1.060E2	S
S	42	42	-2.349E2	-3.115E1	8.763E2	-1.748E1	1.203E3	-1.060E2	S
S	42	43	-2.349E2	-3.115E1	8.763E2	-1.748E1	-1.047E4	3.090E2	S
S									S

S===S

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FRACTION OF SYSTEM NODE ALLOWABLES: COMBINED CASE 1

H.B. ROBINSON 30 CW-11 UNDERGROUND WATER PIPE
VERTICAL SEISMIC (1/2 SINE WAVE END TO END)

---SUMMARY OF FRACTION OF ALLOWABLE FOR EACH NODE---

N	DISPLACEMENT X	Y	Z	BASEPLATE COEFFICIENT
1	2.423E-18	1.281E-20	3.218E-15	0.000E0
2	8.872E-18	8.236E-21	3.218E-15	0.000E0
3	2.159E-17	1.710E-20	3.218E-15	0.000E0
4	9.953E-17	1.484E-19	3.218E-15	0.000E0
5	1.008E-16	1.493E-19	3.218E-15	0.000E0
6	1.705E-17	9.947E-21	3.218E-15	0.000E0
7	5.578E-19	4.252E-20	3.219E-15	0.000E0
8	1.422E-18	1.034E-18	3.219E-15	0.000E0
9	8.489E-18	5.605E-18	3.219E-15	0.000E0
10	8.985E-17	7.905E-17	3.219E-15	0.000E0
11	3.256E-16	1.942E-16	3.219E-15	0.000E0
12	2.630E-16	1.988E-14	4.298E-17	0.000E0
13	6.726E-17	5.001E-14	1.497E-16	0.000E0
14	1.454E-16	8.000E-14	1.393E-16	0.000E0
15	2.063E-16	1.100E-13	2.398E-16	0.000E0
16	4.366E-16	1.390E-13	3.159E-16	0.000E0
17	1.993E-15	1.610E-13	7.646E-16	0.000E0
18	2.284E-15	2.000E-13	4.545E-17	0.000E0
19	2.575E-15	2.360E-13	9.308E-18	0.000E0
20	2.866E-15	2.690E-13	3.996E-19	0.000E0
21	3.157E-15	3.000E-13	3.770E-20	0.000E0
22	3.448E-15	3.260E-13	5.971E-21	0.000E0
23	3.739E-15	3.490E-13	1.927E-22	0.000E0
24	4.030E-15	3.680E-13	2.924E-23	0.000E0
25	4.321E-15	3.830E-13	3.757E-24	0.000E0
26	4.612E-15	3.930E-13	8.005E-26	0.000E0
27	4.902E-15	3.990E-13	2.168E-26	0.000E0
28	5.193E-15	4.000E-13	2.350E-27	0.000E0
29	5.484E-15	3.960E-13	1.502E-27	0.000E0
30	5.775E-15	3.880E-13	2.081E-26	0.000E0
31	6.066E-15	3.750E-13	1.686E-26	0.000E0
32	6.357E-15	3.580E-13	2.609E-24	0.000E0
33	6.648E-15	3.370E-13	3.002E-23	0.000E0
34	6.939E-15	3.120E-13	3.043E-23	0.000E0
35	7.230E-15	2.830E-13	4.350E-21	0.000E0
36	7.521E-15	2.510E-13	4.221E-20	0.000E0
37	7.812E-15	2.160E-13	1.342E-19	0.000E0
38	8.103E-15	1.780E-13	7.089E-18	0.000E0
39	8.394E-15	1.389E-13	5.743E-17	0.000E0
40	8.685E-15	9.662E-14	3.396E-16	0.000E0
41	4.805E-16	8.656E-14	3.371E-16	0.000E0
42	1.895E-16	4.144E-14	6.417E-17	0.000E0
43	0.000E0	0.000E0	0.000E0	0.000E0
44	0.000E0	0.000E0	0.000E0	0.000E0

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FRACTION OF SYSTEM MEMBER ALLOWABLES: COMBINED CASE 1

H.B. ROBINSON 30 CW-11 UNDERGROUND WATER PIPE
VERTICAL SEISMIC (1/2 SINE WAVE END TO END)

---SUMMARY OF FRACTION OF ALLOWABLE FOR EACH MEMBER---

M	STRESS START	STRESS END	BUCKLING START	BUCKLING END	JOINT COEF. START	JOINT COEF. END
1	8.064E-17	1.073E-15	0.000E0	0.000E0	1.381E-12	4.081E-6
2	9.813E-16	3.661E-16	0.000E0	0.000E0	3.978E-6	6.543E-7
3	6.553E-16	4.814E-15	0.000E0	0.000E0	6.543E-7	1.954E-5
4	5.172E-15	1.174E-14	0.000E0	0.000E0	1.343E-5	4.270E-5
5	7.172E-15	7.172E-15	0.000E0	0.000E0	2.087E-5	9.733E-7
6	6.650E-15	6.650E-15	0.000E0	0.000E0	9.733E-7	7.200E-8
7	6.632E-15	6.632E-15	0.000E0	0.000E0	7.200E-8	1.064E-7
8	6.682E-15	6.682E-15	0.000E0	0.000E0	1.064E-7	2.078E-6
9	6.912E-15	6.912E-15	0.000E0	0.000E0	2.078E-6	9.320E-6
10	1.089E-14	2.873E-14	0.000E0	0.000E0	9.320E-6	9.247E-5
11	3.310E-14	1.738E-14	0.000E0	0.000E0	1.006E-4	6.979E-5
12	1.692E-14	2.774E-15	0.000E0	0.000E0	6.967E-5	4.665E-6
13	2.738E-15	1.752E-15	0.000E0	0.000E0	4.665E-6	1.218E-6
14	3.720E-15	5.409E-15	0.000E0	0.000E0	1.218E-6	7.491E-6
15	8.492E-15	1.504E-14	0.000E0	0.000E0	7.491E-6	3.008E-5
16	2.024E-14	2.100E-14	0.000E0	0.000E0	3.008E-5	3.782E-5
17	1.860E-14	1.738E-14	0.000E0	0.000E0	3.822E-5	3.013E-5
18	1.738E-14	1.461E-14	0.000E0	0.000E0	3.013E-5	2.606E-5
19	1.461E-14	1.173E-14	0.000E0	0.000E0	2.606E-5	1.366E-5
20	1.173E-14	1.891E-14	0.000E0	0.000E0	1.366E-5	4.606E-5
21	1.891E-14	1.378E-14	0.000E0	0.000E0	4.606E-5	2.291E-5
22	1.378E-14	1.633E-14	0.000E0	0.000E0	2.291E-5	3.443E-5
23	1.633E-14	1.599E-14	0.000E0	0.000E0	3.443E-5	3.292E-5
24	1.599E-14	1.838E-14	0.000E0	0.000E0	3.292E-5	4.368E-5
25	1.838E-14	1.581E-14	0.000E0	0.000E0	4.368E-5	3.209E-5
26	1.581E-14	1.820E-14	0.000E0	0.000E0	3.209E-5	4.290E-5
27	1.820E-14	1.820E-14	0.000E0	0.000E0	4.290E-5	4.290E-5
28	1.820E-14	1.581E-14	0.000E0	0.000E0	4.290E-5	3.209E-5
29	1.581E-14	1.838E-14	0.000E0	0.000E0	3.209E-5	4.369E-5
30	1.838E-14	1.599E-14	0.000E0	0.000E0	4.369E-5	3.290E-5
31	1.599E-14	1.616E-14	0.000E0	0.000E0	3.290E-5	3.366E-5
32	1.616E-14	1.617E-14	0.000E0	0.000E0	3.366E-5	3.369E-5
33	1.617E-14	1.634E-14	0.000E0	0.000E0	3.369E-5	3.448E-5
34	1.634E-14	1.412E-14	0.000E0	0.000E0	3.448E-5	2.445E-5
35	1.412E-14	1.430E-14	0.000E0	0.000E0	2.445E-5	2.529E-5
36	1.430E-14	1.464E-14	0.000E0	0.000E0	2.529E-5	2.677E-5
37	1.464E-14	9.852E-15	0.000E0	0.000E0	2.677E-5	4.937E-6
38	9.852E-15	1.965E-14	0.000E0	0.000E0	4.937E-6	4.143E-5
39	1.965E-14	3.880E-14	0.000E0	0.000E0	4.143E-5	9.700E-5
40	3.768E-14	3.883E-14	0.000E0	0.000E0	9.699E-5	9.897E-5
41	3.917E-14	5.719E-14	0.000E0	0.000E0	9.880E-5	2.019E-4
42	5.719E-14	4.080E-13	0.000E0	0.000E0	0.000E0	0.000E0

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QUALIFICATION SUMMARY REPORT

H.B. ROBINSON 30 CW-11 UNDERGROUND WATER PIPE

---PLANT IDENTIFICATION---

UTILITY: CPL
PLANT: H.B.ROBINSON
PWR______
NSSS:
A/E:
BWR______

---EQUIPMENT IDENTIFICATION---

SYSTEM:
DRAWING NO.:
BUILDING:
ELEVATION:
ADDITIONAL IDENTIFICATION:

---APPLIED LOADS---

DEADWEIGHT:_____
THERMAL:_____
RELATIVE DISP.:_____
SEISMIC:_____
HYDRODYNAMIC:_____

---LOAD COMBINATION---

VERTICAL 4 INCH MIDSPAN DISPLACEMENT OF PIPE RUN

---SUMMARY OF RESULTS---

---MAXIMUM FRACTION OF ALLOWABLE---

COMPONENT	FAILURE MODE	ALLOWABLE	MAX. FRACTION	PASS/FAIL
SYSTEM	JOINT	1.000E0	2.019E-4	PASS

COMMENTS:
JOINT MAX. FRACTION = REALATIVE JOINT ROTATION (RAD.)
JOINT KAXIAL=1E7 LB/IN JOINT KTORS,KROT2,KROT3=1E9 IN-LB.
....GROUND SPRING PER 19.5 FT. PIPE SEGMENT SET AT 5.7E5 LB/IN.
....DISPLACEMENTS ARE IMPOSED ON GROUNDED END OF NODAL GROUND SPRINGS.

PREPARED BY: D Lindley CO: CCL DATE: 12-4-90

VERIFIED BY: [signature] CO: CCL DATE: 12-7-90

Job Number: 90-2271
Sheet: - of: -
Calculated By: DWL Date: 12-4-90
Checked By: [illegible] Date: 12-7-90
Calculation Number: CCL-CA-352

ATTACHMENT A3

All piping segments begin and end with axial spring constants of 1.5E+08 lb_f/in, and torsional and bending spring constants of 2.0E+10 in-lb_f/rad.

CCL-CA-352

```
*****************************************************************************
*                                                                           *
* ***********  ***********  **     **    *******     *      **    ********  *
* ***********  ***********  **     **   *********    **     **   ********** *
* **                  ***   **     **   **      **   ***    **   **         *
* **                 ***    **     **   **      **   ****   **   **         *
* ***********       ***     *********   *********    *****  **   **  *****  *
* ***********      ***      *********   *********    ** *** **   **  ****** *
* **              ***       **     **   **      **   **  *****   **      ** *
* **             ***        **     **   **      **   **   ****   **      ** *
* **            ***         **     **   **      **   **    ***   **      ** *
* ***********  ***********  **     **   **      **   **     **   ********** *
* ***********  ***********  **     **   **      **   **      *    ********  *
*                                                                           *
*****************************************************************************
```

```
*********************************************************
*                                                       *
*              *** EZHANG RELEASE 8.1 ***               *
*                    COPYRIGHT 1990                     *
* USER:        1                        WA: 3012244     *
*-------------------------------------------------------*
*   CORPORATE CONSULTING AND DEVELOPMENT COMPANY, LTD.  *
*                P. O. BOX 12728                        *
*                RESEARCH TRIANGLE PARK,                *
*                N. C. 27709-9998                       *
*********************************************************
```

```
**********************************************
* PROJECT: 90-2271                           *
*                                            *
* TITLE:                                     *
*                                            *
*                                            *
* ANALYSIS BY: D. Lindley    DATE: 12-4-90   *
*                                            *
* CHECKED BY: [signature]    DATE: 12-7-90   *
**********************************************
```

CCL-CA-352

INPUT ECHO

```
SYSTEM 2000000
I 386.4 1 1.33 10E12 10E12 10E12
IDF .9 .6 1 1
N  1     0  15    0  0  0  0  0  0  0 -2 123 -1
N  2     0  81  288  0  0  0  0  0  0 -2 123 -1
N  3     0  81  414  0  0  0  0  0  0 -2 123 -1
N  4     0  81  648  0  0  0  0  0  0 -2 123 -1
N  5     0   0  732  0  0  0  0  0  0 -2 123 -1
N  6     0   0  966  0  0  0  0  0  0 -2 123 -1
N  7     0   0 1200  0  0  0  0  0  0 -2 123 -1
N  8     0   0 1434  0  0  0  0  0  0 -2 123 -1
N  9     0   0 1668  0  0  0  0  0  0 -2 123 -1
N 10     0   0 1902  0  0  0  0  0  0 -2 123 -1
N 11     0   0 2016  0  0  0  0  0  0 -2 123 -1
N 12   108  21 2124  0  0  0  0  0  0 -3 123 -1
N 13   274  21 2290  0  0  0  0  0  0 -3 123 -1
N 14   439  21 2455  0  0  0  0  0  0 -3 123 -1
N 15   605  21 2621  0  0  0  0  0  0 -3 123 -1
N 16   770  21 2786  0  0  0  0  0  0 -3 123 -1
N 17   900  21 2916  0  0  0  0  0  0 -4 123 -1
N 18  1134  21 2916  0  0  0  0  0  0 -4 123 -1
N 19  1368  21 2916  0  0  0  0  0  0 -4 123 -1
N 20  1602  21 2916  0  0  0  0  0  0 -4 123 -1
N 21  1836  21 2916  0  0  0  0  0  0 -4 123 -1
N 22  2070  21 2916  0  0  0  0  0  0 -4 123 -1
N 23  2304  21 2916  0  0  0  0  0  0 -4 123 -1
N 24  2538  21 2916  0  0  0  0  0  0 -4 123 -1
N 25  2772  21 2916  0  0  0  0  0  0 -4 123 -1
N 26  3006  21 2916  0  0  0  0  0  0 -4 123 -1
N 27  3240  21 2916  0  0  0  0  0  0 -4 123 -1
N 28  3474  21 2916  0  0  0  0  0  0 -4 123 -1
N 29  3708  21 2916  0  0  0  0  0  0 -4 123 -1
N 30  3942  21 2916  0  0  0  0  0  0 -4 123 -1
N 31  4176  21 2916  0  0  0  0  0  0 -4 123 -1
N 32  4410  21 2916  0  0  0  0  0  0 -4 123 -1
N 33  4644  21 2916  0  0  0  0  0  0 -4 123 -1
N 34  4878  21 2916  0  0  0  0  0  0 -4 123 -1
N 35  5112  21 2916  0  0  0  0  0  0 -4 123 -1
N 36  5346  21 2916  0  0  0  0  0  0 -4 123 -1
N 37  5580  21 2916  0  0  0  0  0  0 -4 123 -1
N 38  5814  21 2916  0  0  0  0  0  0 -4 123 -1
N 39  6048  21 2916  0  0  0  0  0  0 -4 123 -1
N 40  6282  21 2916  0  0  0  0  0  0 -4 123 -1
N 41  6348  87 2864  0  0  0  0  0  0 -4 123 -1
N 42  6582  87 2864  0  0  0  0  0  0 -4 123 -1
N 43  6816  87 2864 -1 -1 -1 -1 -1 -1
N 44   500  21  500 -1 -1 -1 -1 -1 -1
M  1     1   2    1 44
M  2     2   3    1 44
M  3     3   4    1 44
M  4     4   5    1 44
M  5     5   6    1 44
M  6     6   7    1 44
M  7     7   8    1 44
```

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```
M   8   8   9  1  44
M   9   9  10  1  44
M  10  10  11  1  44
M  11  11  12  1  44
M  12  12  13  1  44
M  13  13  14  1  44
M  14  14  15  1  44
M  15  15  16  1  44
M  16  16  17  1  44
M  17  17  18  1  44
M  18  18  19  1  44
M  19  19  20  1  44
M  20  20  21  1  44
M  21  21  22  1  44
M  22  22  23  1  44
M  23  23  24  1  44
M  24  24  25  1  44
M  25  25  26  1  44
M  26  26  27  1  44
M  27  27  28  1  44
M  28  28  29  1  44
M  29  29  30  1  44
M  30  30  31  1  44
M  31  31  32  1  44
M  32  32  33  1  44
M  33  33  34  1  44
M  34  34  35  1  44
M  35  35  36  1  44
M  36  36  37  1  44
M  37  37  38  1  44
M  38  38  39  1  44
M  39  39  40  1  44
M  40  40  41  1  44
M  41  41  42  1  44
M  42  42  43  2  44
P 1 21.6 1.61 5248 2624 2624 15.7 31.4 31.4 29E6
Q 1 -5 11E6 6E-6 .44 .44 2.27 2.27 30E15
P 2 21.6 1.61 5248 2624 2624 15.7 31.4 31.4 29E6
Q 2  0 11E6 6E-6 .44 .44 2.27 2.27 30E15
X -2 0 5.7E5 5.7E5 10 10 10 10
Y -2 0 10 10 10 10 10 10 0
X -3 0 5.7E5 5.7E5 5.7E5 10 10 10
Y -3 0 10 10 10 10 10 10 0
X -4 0 0 5.7E5 5.7E5 10 10 10
Y -4 0 10 10 10 10 10 10 0
X -5 0 1.5E8 -1 -1 2E10 2E10 2E10
Y -5 2 10E18 10E12 10E12 10E18 2E10 2E10 10
T H.B. ROBINSON 30 CW-11 UNDERGROUND WATER PIPE
E END GEOM
STATIC
T VERTICAL 4 INCH RELATIVE GROND DISPLACEMENT MIDSPAN
D   1     .00     .00     .00
D   2     .00     .00     .00
D   3     .00     .00     .00
D   4     .00     .00     .00
D   5     .00     .00     .00
```

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```
D   6     .00     .00     .00
D   7     .00     .00     .00
D   8     .00     .00     .00
D   9     .00     .00     .00
D  10     .00     .00     .00
D  11     .00     .00     .00
D  12     .00     .20     .00
D  13     .00     .50     .00
D  14     .00     .80     .00
D  15     .00    1.10     .00
D  16     .00    1.39     .00
D  17     .00    1.61     .00
D  18     .00    2.00     .00
D  19     .00    2.36     .00
D  20     .00    2.69     .00
D  21     .00    3.00     .00
D  22     .00    3.26     .00
D  23     .00    3.49     .00
D  24     .00    3.68     .00
D  25     .00    3.83     .00
D  26     .00    3.93     .00
D  27     .00    3.99     .00
D  28     .00    4.00     .00
D  29     .00    3.96     .00
D  30     .00    3.88     .00
D  31     .00    3.75     .00
D  32     .00    3.58     .00
D  33     .00    3.37     .00
D  34     .00    3.12     .00
D  35     .00    2.83     .00
D  36     .00    2.51     .00
D  37     .00    2.16     .00
D  38     .00    1.78     .00
D  39     .00    1.39     .00
D  40     .00     .97     .00
D  41     .00     .86     .00
D  42     .00     .43     .00
E END CASE
E END STATIC
COMBINE
T VERTICAL SEISMIC (1/2 SINE WAVE END TO END)
O OUTPUT
C CASE 1 1 1 0
E END OUTPUT
REPORT 1
A CPL
B H.B.ROBINSON
J VERTICAL 4 INCH MIDSPAN DISPLACEMENT OF PIPE RUN
K JOINT MAX. FRACTION = REALATIVE JOINT ROTATION (RAD.)
L JOINT KTRANS=1.5E8 LB/IN  JOINT KTORS,KROT2,KROT3=2E10 IN-LB.
M....GROUND SPRING PER 19.5 FT. PIPE SEGMENT SET AT 5.7E5 LB/IN.
M....DISPLACEMENTS ARE IMPOSED ON GROUNDED END OF NODAL GROUND SPRINGS.
E END REPORT
ENDRUN
```

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NODAL DATA TABLE

H.B. ROBINSON 30 CW-11 UNDERGROUND WATER PIPE

NODE	X	Y	Z	XWT	YWT	ZWT
	--- NODAL COORDINATES ---			--- NODAL WEIGHTS ---		
1	0.0000E0	1.5000E1	0.0000E0	5.138E3	5.138E3	5.138E3
2	0.0000E0	8.1000E1	2.8800E2	7.328E3	7.328E3	7.328E3
3	0.0000E0	8.1000E1	4.1400E2	6.260E3	6.260E3	6.260E3
4	0.0000E0	8.1000E1	6.4800E2	6.098E3	6.098E3	6.098E3
5	0.0000E0	0.0000E0	7.3200E2	6.098E3	6.098E3	6.098E3
6	0.0000E0	0.0000E0	9.6600E2	8.138E3	8.138E3	8.138E3
7	0.0000E0	0.0000E0	1.2000E3	8.138E3	8.138E3	8.138E3
8	0.0000E0	0.0000E0	1.4340E3	8.138E3	8.138E3	8.138E3
9	0.0000E0	0.0000E0	1.6680E3	8.138E3	8.138E3	8.138E3
10	0.0000E0	0.0000E0	1.9020E3	6.051E3	6.051E3	6.051E3
11	0.0000E0	0.0000E0	2.0160E3	4.663E3	4.663E3	4.663E3
12	1.0800E2	2.1000E1	2.1240E3	6.763E3	6.763E3	6.763E3
13	2.7400E2	2.1000E1	2.2900E3	8.139E3	8.139E3	8.139E3
14	4.3900E2	2.1000E1	2.4550E3	8.139E3	8.139E3	8.139E3
15	6.0500E2	2.1000E1	2.6210E3	8.139E3	8.139E3	8.139E3
16	7.7000E2	2.1000E1	2.7860E3	7.254E3	7.254E3	7.254E3
17	9.0000E2	2.1000E1	2.9160E3	7.266E3	7.266E3	7.266E3
18	1.1340E3	2.1000E1	2.9160E3	8.138E3	8.138E3	8.138E3
19	1.3680E3	2.1000E1	2.9160E3	8.138E3	8.138E3	8.138E3
20	1.6020E3	2.1000E1	2.9160E3	8.138E3	8.138E3	8.138E3
21	1.8360E3	2.1000E1	2.9160E3	8.138E3	8.138E3	8.138E3
22	2.0700E3	2.1000E1	2.9160E3	8.138E3	8.138E3	8.138E3
23	2.3040E3	2.1000E1	2.9160E3	8.138E3	8.138E3	8.138E3
24	2.5380E3	2.1000E1	2.9160E3	8.138E3	8.138E3	8.138E3
25	2.7720E3	2.1000E1	2.9160E3	8.138E3	8.138E3	8.138E3
26	3.0060E3	2.1000E1	2.9160E3	8.138E3	8.138E3	8.138E3
27	3.2400E3	2.1000E1	2.9160E3	8.138E3	8.138E3	8.138E3
28	3.4740E3	2.1000E1	2.9160E3	8.138E3	8.138E3	8.138E3
29	3.7080E3	2.1000E1	2.9160E3	8.138E3	8.138E3	8.138E3
30	3.9420E3	2.1000E1	2.9160E3	8.138E3	8.138E3	8.138E3
31	4.1760E3	2.1000E1	2.9160E3	8.138E3	8.138E3	8.138E3
32	4.4100E3	2.1000E1	2.9160E3	8.138E3	8.138E3	8.138E3
33	4.6440E3	2.1000E1	2.9160E3	8.138E3	8.138E3	8.138E3
34	4.8780E3	2.1000E1	2.9160E3	8.138E3	8.138E3	8.138E3
35	5.1120E3	2.1000E1	2.9160E3	8.138E3	8.138E3	8.138E3
36	5.3460E3	2.1000E1	2.9160E3	8.138E3	8.138E3	8.138E3
37	5.5800E3	2.1000E1	2.9160E3	8.138E3	8.138E3	8.138E3
38	5.8140E3	2.1000E1	2.9160E3	8.138E3	8.138E3	8.138E3
39	6.0480E3	2.1000E1	2.9160E3	8.138E3	8.138E3	8.138E3
40	6.2820E3	2.1000E1	2.9160E3	5.927E3	5.927E3	5.927E3
41	6.3480E3	8.7000E1	2.8640E3	5.927E3	5.927E3	5.927E3
42	6.5820E3	8.7000E1	2.8640E3	8.138E3	8.138E3	8.138E3
43	6.8160E3	8.7000E1	2.8640E3	4.069E3	4.069E3	4.069E3
44	5.0000E2	2.1000E1	5.0000E2	0.000E0	0.000E0	0.000E0
				3.230E5	3.230E5	3.230E5

--NODAL CONSTRAINTS-- BASEPLATE DATA

NODE XT YT ZT XR YR ZR JTYPE BXYZ CALC BANDWIDTH: 12

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BANDWIDTH: 12

N	NODE	XT	YT	ZT	XR	YR	ZR	JTYPE	BXYZ	CALC	N
N	1	0	0	0	0	0	0	-2	B123	0	N
N	2	0	0	0	0	0	0	-2	B123	0	N
N	3	0	0	0	0	0	0	-2	B123	0	N
N	4	0	0	0	0	0	0	-2	B123	0	N
N	5	0	0	0	0	0	0	-2	B123	0	N
N	6	0	0	0	0	0	0	-2	B123	0	N
N	7	0	0	0	0	0	0	-2	B123	0	N
N	8	0	0	0	0	0	0	-2	B123	0	N
N	9	0	0	0	0	0	0	-2	B123	0	N
N	10	0	0	0	0	0	0	-2	B123	0	N
N	11	0	0	0	0	0	0	-2	B123	0	N
N	12	0	0	0	0	0	0	-3	B123	0	N
N	13	0	0	0	0	0	0	-3	B123	0	N
N	14	0	0	0	0	0	0	-3	B123	0	N
N	15	0	0	0	0	0	0	-3	B123	0	N
N	16	0	0	0	0	0	0	-3	B123	0	N
N	17	0	0	0	0	0	0	-4	B123	0	N
N	18	0	0	0	0	0	0	-4	B123	0	N
N	19	0	0	0	0	0	0	-4	B123	0	N
N	20	0	0	0	0	0	0	-4	B123	0	N
N	21	0	0	0	0	0	0	-4	B123	0	N
N	22	0	0	0	0	0	0	-4	B123	0	N
N	23	0	0	0	0	0	0	-4	B123	0	N
N	24	0	0	0	0	0	0	-4	B123	0	N
N	25	0	0	0	0	0	0	-4	B123	0	N
N	26	0	0	0	0	0	0	-4	B123	0	N
N	27	0	0	0	0	0	0	-4	B123	0	N
N	28	0	0	0	0	0	0	-4	B123	0	N
N	29	0	0	0	0	0	0	-4	B123	0	N
N	30	0	0	0	0	0	0	-4	B123	0	N
N	31	0	0	0	0	0	0	-4	B123	0	N
N	32	0	0	0	0	0	0	-4	B123	0	N
N	33	0	0	0	0	0	0	-4	B123	0	N
N	34	0	0	0	0	0	0	-4	B123	0	N
N	35	0	0	0	0	0	0	-4	B123	0	N
N	36	0	0	0	0	0	0	-4	B123	0	N
N	37	0	0	0	0	0	0	-4	B123	0	N
N	38	0	0	0	0	0	0	-4	B123	0	N
N	39	0	0	0	0	0	0	-4	B123	0	N
N	40	0	0	0	0	0	0	-4	B123	0	N
N	41	0	0	0	0	0	0	-4	B123	0	N
N	42	0	0	0	0	0	0	-4	B123	0	N
N	43	-1	-1	-1	-1	-1	-1	0	B 0	0	N
N	44	-1	-1	-1	-1	-1	-1	0	B 0	0	N

JOINT AND SPRING DATA TABLE

H.B. ROBINSON 30 CW-11 UNDERGROUND WATER PIPE

--- JOINT SPRING RATES ---

JTYPE	K1	K2	K3	K4	K5	K6
-5	1.500E8	-1.000E0	-1.000E0	2.000E10	2.000E10	2.000E10

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J	JTYPE	K1	K2	K3	K4	K5	K6	J
J	-4	0.000E0	5.700E5	5.700E5	1.000E1	1.000E1	1.000E1	J
J	-3	5.700E5	5.700E5	5.700E5	1.000E1	1.000E1	1.000E1	J
J	-2	5.700E5	5.700E5	1.000E1	1.000E1	1.000E1	1.000E1	J

--- JOINT ALLOWABLE LOADS ---

J	JTYPE	A1	A2	A3	A4	A5	A6	J
J	-5	1.000E19	1.000E13	1.000E13	1.000E19	2.000E10	2.000E10	J
J	-4	1.000E1	1.000E1	1.000E1	1.000E1	1.000E1	1.000E1	J
J	-3	1.000E1	1.000E1	1.000E1	1.000E1	1.000E1	1.000E1	J
J	-2	1.000E1	1.000E1	1.000E1	1.000E1	1.000E1	1.000E1	J

---- JOINT WEIGHT AND CALC X VALUE ----

J	JTYPE	JOINT WT.	X VALUE	J
J	-5	0.000E0	2.000E0	J
J	-4	0.000E0	0.000E0	J
J	-3	0.000E0	0.000E0	J
J	-2	0.000E0	0.000E0	J

J==J

M==M

M=== MEMBER DATA TABLE ===M

M==M

M H.B. ROBINSON 30 CW-11 UNDERGROUND WATER PIPE M

--- PRIMARY MEMBER DATA ---

M	MEM	FROM	TO	PTYPE	RNODE	BANK	KFAC	QFAC	LENGTH	M
M	1	1	2	1	44	0.00E0	0.00E0	1.00E0	2.955E2	M
M	2	2	3	1	44	0.00E0	0.00E0	1.00E0	1.260E2	M
M	3	3	4	1	44	0.00E0	0.00E0	1.00E0	2.340E2	M
M	4	4	5	1	44	0.00E0	0.00E0	1.00E0	1.167E2	M
M	5	5	6	1	44	0.00E0	0.00E0	1.00E0	2.340E2	M
M	6	6	7	1	44	0.00E0	0.00E0	1.00E0	2.340E2	M
M	7	7	8	1	44	0.00E0	0.00E0	1.00E0	2.340E2	M
M	8	8	9	1	44	0.00E0	0.00E0	1.00E0	2.340E2	M
M	9	9	10	1	44	0.00E0	0.00E0	1.00E0	2.340E2	M
M	10	10	11	1	44	0.00E0	0.00E0	1.00E0	1.140E2	M
M	11	11	12	1	44	0.00E0	0.00E0	1.00E0	1.542E2	M
M	12	12	13	1	44	0.00E0	0.00E0	1.00E0	2.348E2	M
M	13	13	14	1	44	0.00E0	0.00E0	1.00E0	2.333E2	M
M	14	14	15	1	44	0.00E0	0.00E0	1.00E0	2.348E2	M
M	15	15	16	1	44	0.00E0	0.00E0	1.00E0	2.333E2	M
M	16	16	17	1	44	0.00E0	0.00E0	1.00E0	1.838E2	M
M	17	17	18	1	44	0.00E0	0.00E0	1.00E0	2.340E2	M
M	18	18	19	1	44	0.00E0	0.00E0	1.00E0	2.340E2	M
M	19	19	20	1	44	0.00E0	0.00E0	1.00E0	2.340E2	M
M	20	20	21	1	44	0.00E0	0.00E0	1.00E0	2.340E2	M
M	21	21	22	1	44	0.00E0	0.00E0	1.00E0	2.340E2	M
M	22	22	23	1	44	0.00E0	0.00E0	1.00E0	2.340E2	M
M	23	23	24	1	44	0.00E0	0.00E0	1.00E0	2.340E2	M
M	24	24	25	1	44	0.00E0	0.00E0	1.00E0	2.340E2	M
M	25	25	26	1	44	0.00E0	0.00E0	1.00E0	2.340E2	M
M	26	26	27	1	44	0.00E0	0.00E0	1.00E0	2.340E2	M
M	27	27	28	1	44	0.00E0	0.00E0	1.00E0	2.340E2	M
M	28	28	29	1	44	0.00E0	0.00E0	1.00E0	2.340E2	M

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M	MEM	FROM	TO	PTYPE	RNODE	BANK	KFAC	QFAC	LENGTH	M
M	29	29	30	1	44	0.00E0	0.00E0	1.00E0	2.340E2	M
M	30	30	31	1	44	0.00E0	0.00E0	1.00E0	2.340E2	M
M	31	31	32	1	44	0.00E0	0.00E0	1.00E0	2.340E2	M
M	32	32	33	1	44	0.00E0	0.00E0	1.00E0	2.340E2	M
M	33	33	34	1	44	0.00E0	0.00E0	1.00E0	2.340E2	M
M	34	34	35	1	44	0.00E0	0.00E0	1.00E0	2.340E2	M
M	35	35	36	1	44	0.00E0	0.00E0	1.00E0	2.340E2	M
M	36	36	37	1	44	0.00E0	0.00E0	1.00E0	2.340E2	M
M	37	37	38	1	44	0.00E0	0.00E0	1.00E0	2.340E2	M
M	38	38	39	1	44	0.00E0	0.00E0	1.00E0	2.340E2	M
M	39	39	40	1	44	0.00E0	0.00E0	1.00E0	2.340E2	M
M	40	40	41	1	44	0.00E0	0.00E0	1.00E0	1.068E2	M
M	41	41	42	1	44	0.00E0	0.00E0	1.00E0	2.340E2	M
M	42	42	43	2	44	0.00E0	0.00E0	1.00E0	2.340E2	M
M										M

M		--- FROM JOINT DATA ---			--- TO JOINT DATA ---			M
M	MEM	TYPE	HINGE	CALC	TYPE	HINGE	CALC	M
M	1	-5	111111	10	-5	111111	10	M
M	2	-5	111111	10	-5	111111	10	M
M	3	-5	111111	10	-5	111111	10	M
M	4	-5	111111	10	-5	111111	10	M
M	5	-5	111111	10	-5	111111	10	M
M	6	-5	111111	10	-5	111111	10	M
M	7	-5	111111	10	-5	111111	10	M
M	8	-5	111111	10	-5	111111	10	M
M	9	-5	111111	10	-5	111111	10	M
M	10	-5	111111	10	-5	111111	10	M
M	11	-5	111111	10	-5	111111	10	M
M	12	-5	111111	10	-5	111111	10	M
M	13	-5	111111	10	-5	111111	10	M
M	14	-5	111111	10	-5	111111	10	M
M	15	-5	111111	10	-5	111111	10	M
M	16	-5	111111	10	-5	111111	10	M
M	17	-5	111111	10	-5	111111	10	M
M	18	-5	111111	10	-5	111111	10	M
M	19	-5	111111	10	-5	111111	10	M
M	20	-5	111111	10	-5	111111	10	M
M	21	-5	111111	10	-5	111111	10	M
M	22	-5	111111	10	-5	111111	10	M
M	23	-5	111111	10	-5	111111	10	M
M	24	-5	111111	10	-5	111111	10	M
M	25	-5	111111	10	-5	111111	10	M
M	26	-5	111111	10	-5	111111	10	M
M	27	-5	111111	10	-5	111111	10	M
M	28	-5	111111	10	-5	111111	10	M
M	29	-5	111111	10	-5	111111	10	M
M	30	-5	111111	10	-5	111111	10	M
M	31	-5	111111	10	-5	111111	10	M
M	32	-5	111111	10	-5	111111	10	M
M	33	-5	111111	10	-5	111111	10	M
M	34	-5	111111	10	-5	111111	10	M
M	35	-5	111111	10	-5	111111	10	M
M	36	-5	111111	10	-5	111111	10	M
M	37	-5	111111	10	-5	111111	10	M
M	38	-5	111111	10	-5	111111	10	M
M	39	-5	111111	10	-5	111111	10	M

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MEM	TYPE	HINGE	CALC	TYPE	HINGE	CALC
40	-5	111111	10	-5	111111	10
41	-5	111111	10	-5	111111	10

--- MEMBER PROPERTY DATA ---

PTYPE	AREA	J	I2	I3	H2	H3
1	2.160E1	5.248E3	2.624E3	2.624E3	3.140E1	3.140E1
2	2.160E1	5.248E3	2.624E3	2.624E3	3.140E1	3.140E1

--- MEMBER PROPERTY DATA ---

PTYPE	JRADIUS	SHAPE2	SHAPE3	STRESSF2	STRESSF3	DJPROP
1	1.570E1	4.400E-1	4.400E-1	2.270E0	2.270E0	-5
2	1.570E1	4.400E-1	4.400E-1	2.270E0	2.270E0	0

--- MEMBER PROPERTY DATA ---

PTYPE	EMOD	SMOD	YIELD	DENSITY	ALPHA
1	2.900E7	1.100E7	3.000E16	1.610E0	6.000E-6
2	2.900E7	1.100E7	3.000E16	1.610E0	6.000E-6

DESIGN PARAMETERS

H.B. ROBINSON 30 CW-11 UNDERGROUND WATER PIPE

MEMBER DESIGN FACTOR:9.000E-1 ALLOWABLE X DISPLACEMENT:1.0000E13

BPLATE DESIGN FACTOR:1.000E0 ALLOWABLE Y DISPLACEMENT:1.0000E13

JOINT DESIGN FACTOR:1.000E0 ALLOWABLE Z DISPLACEMENT:1.0000E13

SHEAR DESIGN FACTOR:6.000E-1 BUCKLING FACTOR:1.3300E0

GRAVITATIONAL CONSTANT:3.864E2 DIR. PENDULUM PIVOT:

APPLIED LOADS FOR STAT CASE 1

H.B. ROBINSON 30 CW-11 UNDERGROUND WATER PIPE
VERTICAL 4 INCH RELATIVE GROND DISPLACEMENT MIDSPAN

---GENERIC LOADS---

GX= 0.00E0 GY= 0.00E0 GZ= 0.00E0 GRAV=3.86E2 TDEL= 0.00E0

---IMPOSED GROUND DISPLACEMENTS---

NODE	XT	YT	ZT	XR	YR	ZR
1	0E0	0E0	0E0	0E0	0E0	0E0
2	0E0	0E0	0E0	0E0	0E0	0E0
3	0E0	0E0	0E0	0E0	0E0	0E0
4	0E0	0E0	0E0	0E0	0E0	0E0
5	0E0	0E0	0E0	0E0	0E0	0E0
6	0E0	0E0	0E0	0E0	0E0	0E0

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NODE	XT	YT	ZT	XR	YR	ZR
7	0E0	0E0	0E0	0E0	0E0	0E0
8	0E0	0E0	0E0	0E0	0E0	0E0
9	0E0	0E0	0E0	0E0	0E0	0E0
10	0E0	0E0	0E0	0E0	0E0	0E0
11	0E0	0E0	0E0	0E0	0E0	0E0
12	0E0	2E-1	0E0	0E0	0E0	0E0
13	0E0	5E-1	0E0	0E0	0E0	0E0
14	0E0	8E-1	0E0	0E0	0E0	0E0
15	0E0	1E0	0E0	0E0	0E0	0E0
16	0E0	1E0	0E0	0E0	0E0	0E0
17	0E0	2E0	0E0	0E0	0E0	0E0
18	0E0	2E0	0E0	0E0	0E0	0E0
19	0E0	2E0	0E0	0E0	0E0	0E0
20	0E0	3E0	0E0	0E0	0E0	0E0
21	0E0	3E0	0E0	0E0	0E0	0E0
22	0E0	3E0	0E0	0E0	0E0	0E0
23	0E0	3E0	0E0	0E0	0E0	0E0
24	0E0	4E0	0E0	0E0	0E0	0E0
25	0E0	4E0	0E0	0E0	0E0	0E0
26	0E0	4E0	0E0	0E0	0E0	0E0
27	0E0	4E0	0E0	0E0	0E0	0E0
28	0E0	4E0	0E0	0E0	0E0	0E0
29	0E0	4E0	0E0	0E0	0E0	0E0
30	0E0	4E0	0E0	0E0	0E0	0E0
31	0E0	4E0	0E0	0E0	0E0	0E0
32	0E0	4E0	0E0	0E0	0E0	0E0
33	0E0	3E0	0E0	0E0	0E0	0E0
34	0E0	3E0	0E0	0E0	0E0	0E0
35	0E0	3E0	0E0	0E0	0E0	0E0
36	0E0	3E0	0E0	0E0	0E0	0E0
37	0E0	2E0	0E0	0E0	0E0	0E0
38	0E0	2E0	0E0	0E0	0E0	0E0
39	0E0	1E0	0E0	0E0	0E0	0E0
40	0E0	1E0	0E0	0E0	0E0	0E0
41	0E0	9E-1	0E0	0E0	0E0	0E0
42	0E0	4E-1	0E0	0E0	0E0	0E0

ANCHOR ANALYSIS OF COMBINED CASE 1

H.B. ROBINSON 30 CW-11 UNDERGROUND WATER PIPE
VERTICAL SEISMIC (1/2 SINE WAVE END TO END)

---NODAL DEFLECTIONS---

NODE	XT	YT	ZT	XR	YR	ZR
1	3.674E-5	1.115E-7	2.769E-2	5.941E-10	1.964E-5	7.142E-5
2	-1.454E-4	-3.459E-8	2.769E-2	6.593E-10	7.625E-6	7.417E-5
3	3.449E-4	-2.606E-7	2.769E-2	5.568E-9	3.888E-6	7.732E-5
4	-1.564E-3	-9.251E-7	2.769E-2	-1.567E-8	-4.050E-5	8.306E-5
5	1.603E-3	9.846E-7	2.769E-2	-1.668E-8	-4.449E-5	1.430E-4
6	-2.968E-4	1.396E-7	2.769E-2	1.323E-8	4.594E-6	4.033E-4
7	1.600E-5	-3.609E-6	2.769E-2	2.014E-8	-7.646E-8	6.636E-4
8	6.389E-5	4.338E-5	2.770E-2	-7.305E-7	9.557E-7	9.239E-4

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A	NODE	XT	YT	ZT	XR	YR	ZR	A
A	9	-3.162E-4	-1.945E-4	2.770E-2	6.183E-6	-9.224E-6	1.184E-3	A
A	10	-1.319E-3	-1.158E-3	2.770E-2	-1.124E-5	2.281E-5	1.444E-3	A
A	11	5.702E-3	3.175E-3	2.770E-2	-1.047E-4	1.483E-4	1.574E-3	A
A	12	-4.702E-3	1.980E-1	8.766E-4	-2.021E-4	1.536E-4	1.634E-3	A
A	13	-1.071E-3	5.001E-1	-2.687E-3	-1.691E-4	-2.114E-5	1.646E-3	A
A	14	-2.382E-3	8.001E-1	-2.136E-3	-1.474E-4	3.984E-7	1.670E-3	A
A	15	-2.685E-3	1.100E0	-3.596E-3	-1.097E-4	1.198E-5	1.677E-3	A
A	16	-6.230E-3	1.390E0	-3.186E-3	-5.365E-5	-8.571E-5	1.666E-3	A
A	17	-2.331E-2	1.611E0	9.756E-3	-2.532E-5	-5.362E-5	1.673E-3	A
A	18	-2.617E-2	2.000E0	1.251E-3	-2.123E-5	4.307E-5	1.613E-3	A
A	19	-2.902E-2	2.360E0	-3.101E-4	-1.713E-5	-5.423E-6	1.469E-3	A
A	20	-3.188E-2	2.691E0	2.737E-5	-1.303E-5	1.927E-7	1.375E-3	A
A	21	-3.473E-2	2.999E0	2.782E-7	-8.936E-6	4.566E-8	1.221E-3	A
A	22	-3.759E-2	3.261E0	-4.089E-7	-4.839E-6	-9.113E-9	1.043E-3	A
A	23	-4.044E-2	3.490E0	5.459E-8	-7.423E-7	6.844E-10	9.011E-4	A
A	24	-4.330E-2	3.680E0	-2.273E-9	3.354E-6	2.528E-11	7.300E-4	A
A	25	-4.615E-2	3.830E0	-4.120E-10	7.451E-6	-1.284E-11	5.339E-4	A
A	26	-4.900E-2	3.930E0	8.945E-11	1.155E-5	1.491E-12	3.417E-4	A
A	27	-5.186E-2	3.990E0	-7.214E-12	1.564E-5	-3.946E-14	1.535E-4	A
A	28	-5.471E-2	4.000E0	-8.284E-14	1.974E-5	-1.622E-14	-6.800E-5	A
A	29	-5.757E-2	3.960E0	-2.103E-13	2.384E-5	1.547E-14	-2.562E-4	A
A	30	-6.042E-2	3.880E0	-3.595E-12	2.793E-5	-6.448E-15	-4.485E-4	A
A	31	-6.328E-2	3.750E0	6.255E-11	3.203E-5	-8.878E-13	-6.447E-4	A
A	32	-6.613E-2	3.580E0	-3.962E-10	3.613E-5	9.855E-12	-8.117E-4	A
A	33	-6.899E-2	3.370E0	-4.462E-10	4.023E-5	-3.843E-11	-9.826E-4	A
A	34	-7.184E-2	3.120E0	3.409E-8	4.432E-5	-3.241E-10	-1.157E-3	A
A	35	-7.470E-2	2.830E0	-3.275E-7	4.842E-5	6.277E-9	-1.307E-3	A
A	36	-7.755E-2	2.510E0	9.370E-7	5.252E-5	-4.237E-8	-1.431E-3	A
A	37	-8.041E-2	2.160E0	1.437E-5	5.661E-5	-1.720E-8	-1.567E-3	A
A	38	-8.326E-2	1.781E0	-2.215E-4	6.071E-5	3.323E-6	-1.640E-3	A
A	39	-8.612E-2	1.387E0	1.277E-3	6.481E-5	-3.387E-5	-1.778E-3	A
A	40	-8.897E-2	9.671E-1	2.908E-3	6.890E-5	1.119E-4	-1.655E-3	A
A	41	5.611E-3	8.658E-1	-2.901E-3	6.220E-5	1.107E-4	-1.640E-3	A
A	42	2.756E-3	4.136E-1	-1.332E-3	3.072E-5	-3.146E-5	-2.311E-3	A
A	43	0.000E0	0.000E0	0.000E0	0.000E0	0.000E0	0.000E0	A
A	44	0.000E0	0.000E0	0.000E0	0.000E0	0.000E0	0.000E0	A

A A

A ---REACTION LOADS AT FIXED DEGREES OF FREEDOM--- A

A	NODE	XF	YF	ZF	XM	YM	ZM	A
A	43	-7.379E3	-8.800E3	-1.444E2	-7.579E3	-6.665E3	1.781E6	A
A	44	0.000E0	0.000E0	0.000E0	0.000E0	0.000E0	0.000E0	A

A A

A ---BASEPLATE LOADS--- A

A	NODE	XF	YF	ZF	XM	YM	ZM	A
A	1	2.094E1	6.357E-2	2.769E-1	5.941E-9	1.964E-4	7.142E-4	A
A	2	-8.289E1	-1.972E-2	2.769E-1	6.593E-9	7.625E-5	7.417E-4	A
A	3	1.966E2	-1.485E-1	2.769E-1	5.568E-8	3.888E-5	7.732E-4	A
A	4	-8.913E2	-5.273E-1	2.769E-1	-1.567E-7	-4.050E-4	8.306E-4	A
A	5	9.136E2	5.612E-1	2.769E-1	-1.668E-7	-4.449E-4	1.430E-3	A
A	6	-1.692E2	7.960E-2	2.769E-1	1.323E-7	4.594E-5	4.033E-3	A
A	7	9.118E0	-2.057E0	2.769E-1	2.014E-7	-7.646E-7	6.636E-3	A
A	8	3.642E1	2.473E1	2.770E-1	-7.305E-6	9.557E-6	9.239E-3	A
A	9	-1.802E2	-1.109E2	2.770E-1	6.183E-5	-9.224E-5	1.184E-2	A
A	10	-7.517E2	-6.603E2	2.770E-1	-1.124E-4	2.281E-4	1.444E-2	A
A	11	3.250E3	1.810E3	2.770E-1	-1.047E-3	1.483E-3	1.574E-2	A
A	12	-2.680E3	-1.118E3	4.997E2	-2.021E-3	1.536E-3	1.634E-2	A

A	NODE	XF	YF	ZF	XM	YM	ZM	A
A	13	-6.107E2	7.142E1	-1.532E3	-1.691E-3	-2.114E-4	1.646E-2	A
A	14	-1.357E3	3.022E1	-1.218E3	-1.474E-3	3.984E-6	1.670E-2	A
A	15	-1.531E3	-1.851E1	-2.050E3	-1.097E-3	1.198E-4	1.677E-2	A
A	16	-3.551E3	-1.590E2	-1.816E3	-5.365E-4	-8.571E-4	1.666E-2	A
A	17	0.000E0	3.786E2	5.561E3	-2.532E-4	-5.362E-4	1.673E-2	A
A	18	0.000E0	-2.670E2	7.133E2	-2.123E-4	4.307E-4	1.613E-2	A
A	19	0.000E0	-9.018E1	-1.768E2	-1.713E-4	-5.423E-5	1.469E-2	A
A	20	0.000E0	3.804E2	1.560E1	-1.303E-4	1.927E-6	1.375E-2	A
A	21	0.000E0	-4.708E2	1.586E-1	-8.936E-5	4.566E-7	1.221E-2	A
A	22	0.000E0	3.040E2	-2.331E-1	-4.839E-5	-9.113E-8	1.043E-2	A
A	23	0.000E0	-1.258E2	3.112E-2	-7.423E-6	6.844E-9	9.011E-3	A
A	24	0.000E0	1.137E2	-1.296E-3	3.354E-5	2.528E-10	7.300E-3	A
A	25	0.000E0	-1.909E2	-2.349E-4	7.451E-5	-1.284E-10	5.339E-3	A
A	26	0.000E0	1.901E2	5.099E-5	1.155E-4	1.491E-11	3.417E-3	A
A	27	0.000E0	-8.957E1	-4.112E-6	1.564E-4	-3.946E-13	1.535E-3	A
A	28	0.000E0	-8.960E1	-4.722E-8	1.974E-4	-1.622E-13	-6.800E-4	A
A	29	0.000E0	1.902E2	-1.198E-7	2.384E-4	1.547E-13	-2.562E-3	A
A	30	0.000E0	-1.907E2	-2.049E-6	2.793E-4	-6.448E-14	-4.485E-3	A
A	31	0.000E0	1.014E2	3.565E-5	3.203E-4	-8.878E-12	-6.447E-3	A
A	32	0.000E0	-1.236E1	-2.258E-4	3.613E-4	9.855E-11	-8.117E-3	A
A	33	0.000E0	1.193E1	-2.543E-4	4.023E-4	-3.843E-10	-9.826E-3	A
A	34	0.000E0	-8.964E1	1.943E-2	4.432E-4	-3.241E-9	-1.157E-2	A
A	35	0.000E0	8.908E1	-1.867E-1	4.842E-4	6.277E-8	-1.307E-2	A
A	36	0.000E0	1.145E1	5.341E-1	5.252E-4	-4.237E-7	-1.431E-2	A
A	37	0.000E0	-2.133E2	8.191E0	5.661E-4	-1.720E-7	-1.567E-2	A
A	38	0.000E0	5.556E2	-1.262E2	6.071E-4	3.323E-5	-1.640E-2	A
A	39	0.000E0	-1.428E3	7.280E2	6.481E-4	-3.387E-4	-1.778E-2	A
A	40	0.000E0	-1.650E3	1.658E3	6.890E-4	1.119E-3	-1.655E-2	A
A	41	0.000E0	3.284E3	-1.653E3	6.220E-4	1.107E-3	-1.640E-2	A
A	42	0.000E0	-9.370E3	-7.590E2	3.072E-4	-3.146E-4	-2.311E-2	A
A								A

A===A

L===L

L=== MEMBER LOADS OF COMBINED CASE 1 ===L

L===L

L H.B. ROBINSON 30 CW-11 UNDERGROUND WATER PIPE L
L VERTICAL SEISMIC (1/2 SINE WAVE END TO END) L

---LOCAL MEMBER END LOADS---

L	M	N	AXIAL	X2SHEAR	X3SHEAR	TORSN	X2MOM	X3MOM	L
L	1	1	-2.841E-1	-2.049E1	-4.337E0	-7.400E-4	6.595E-6	-3.119E-5	L
L	1	2	2.841E-1	2.049E1	4.337E0	7.400E-4	1.281E3	-6.054E3	L
L	2	2	-5.538E-1	6.151E1	7.338E0	-1.382E3	-7.187E2	5.989E3	L
L	2	3	5.538E-1	-6.151E1	-7.338E0	1.382E3	-2.059E2	1.762E3	L
L	3	3	-8.307E-1	-1.337E2	-1.594E1	-1.382E3	2.059E2	-1.762E3	L
L	3	4	8.307E-1	1.337E2	1.594E1	1.382E3	3.524E3	-2.952E4	L
L	4	4	-1.236E0	7.264E2	2.117E2	-2.163E4	-5.710E3	1.963E4	L
L	4	5	1.236E0	-7.264E2	-2.117E2	2.163E4	-1.899E4	6.513E4	L
L	5	5	-1.385E0	-1.568E2	6.656E0	-6.267E4	-1.437E3	-3.379E4	L
L	5	6	1.385E0	1.568E2	-6.656E0	6.267E4	-1.207E2	-2.900E3	L
L	6	6	-1.662E0	1.222E1	-5.223E-1	-6.267E4	1.207E2	2.900E3	L
L	6	7	1.662E0	-1.222E1	5.223E-1	6.267E4	1.545E0	-3.971E1	L
L	7	7	-1.938E0	3.200E0	1.916E0	-6.267E4	-1.545E0	3.971E1	L
L	7	8	1.938E0	-3.200E0	-1.916E0	6.267E4	-4.467E2	7.092E2	L

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L	M	N	AXIAL	X2SHEAR	X3SHEAR	TORSN	X2MOM	X3MOM	L
L	8	8	-2.215E0	-3.422E1	-2.126E1	-6.267E4	4.467E2	-7.092E2	L
L	8	9	2.215E0	3.422E1	2.126E1	6.267E4	4.528E3	-7.299E3	L
L	9	9	-2.492E0	1.505E2	8.194E1	-6.267E4	-4.528E3	7.299E3	L
L	9	10	2.492E0	-1.505E2	-8.194E1	6.267E4	-1.465E4	2.792E4	L
L	10	10	-2.769E0	9.293E2	7.101E2	-6.267E4	1.465E4	-2.792E4	L
L	10	11	2.769E0	-9.293E2	-7.101E2	6.267E4	-9.560E4	1.339E5	L
L	11	11	-1.794E3	-1.723E3	-6.839E2	9.276E3	1.045E5	-1.414E5	L
L	11	12	1.794E3	1.723E3	6.839E2	-9.276E3	9.756E2	-1.243E5	L
L	12	12	-1.229E2	5.881E2	5.674E1	-7.673E3	-1.128E4	1.239E5	L
L	12	13	1.229E2	-5.881E2	-5.674E1	7.673E3	-2.035E3	1.416E4	L
L	13	13	1.392E3	-6.307E1	-1.469E1	-7.673E3	2.035E3	-1.416E4	L
L	13	14	-1.392E3	6.307E1	1.469E1	7.673E3	1.392E3	-5.568E2	L
L	14	14	3.213E3	3.573E1	-4.490E1	-7.673E3	-1.392E3	5.568E2	L
L	14	15	-3.213E3	-3.573E1	4.490E1	7.673E3	1.193E4	7.832E3	L
L	15	15	5.745E3	-3.316E2	-2.640E1	-7.673E3	-1.193E4	-7.832E3	L
L	15	16	-5.745E3	3.316E2	2.640E1	7.673E3	1.809E4	-6.954E4	L
L	16	16	9.540E3	8.952E2	1.326E2	-7.673E3	-1.809E4	6.954E4	L
L	16	17	-9.540E3	-8.952E2	-1.326E2	7.673E3	-6.278E3	9.504E4	L
L	17	17	7.379E3	-5.521E2	-2.461E2	-9.863E2	9.864E3	-9.504E4	L
L	17	18	-7.379E3	5.521E2	2.461E2	9.863E2	4.772E4	-3.414E4	L
L	18	18	7.379E3	1.612E2	2.093E1	-9.863E2	-4.772E4	3.414E4	L
L	18	19	-7.379E3	-1.612E2	-2.093E1	9.863E2	4.282E4	3.589E3	L
L	19	19	7.379E3	-1.556E1	1.111E2	-9.863E2	-4.282E4	-3.589E3	L
L	19	20	-7.379E3	1.556E1	-1.111E2	9.863E2	1.682E4	-5.155E1	L
L	20	20	7.379E3	4.485E-2	-2.693E2	-9.863E2	-1.682E4	5.155E1	L
L	20	21	-7.379E3	-4.485E-2	2.693E2	9.863E2	7.982E4	-4.105E1	L
L	21	21	7.379E3	2.034E-1	2.016E2	-9.863E2	-7.982E4	4.105E1	L
L	21	22	-7.379E3	-2.034E-1	-2.016E2	9.863E2	3.266E4	6.553E0	L
L	22	22	7.379E3	-2.963E-2	-1.025E2	-9.863E2	-3.266E4	-6.553E0	L
L	22	23	-7.379E3	2.963E-2	1.025E2	9.863E2	5.663E4	-3.812E-1	L
L	23	23	7.379E3	1.484E-3	2.333E1	-9.863E2	-5.663E4	3.812E-1	L
L	23	24	-7.379E3	-1.484E-3	-2.333E1	9.863E2	5.117E4	-3.400E-2	L
L	24	24	7.379E3	1.880E-4	-9.035E1	-9.863E2	-5.117E4	3.400E-2	L
L	24	25	-7.379E3	-1.880E-4	9.035E1	9.863E2	7.231E4	9.994E-3	L
L	25	25	7.379E3	-4.684E-5	1.005E2	-9.863E2	-7.231E4	-9.994E-3	L
L	25	26	-7.379E3	4.684E-5	-1.005E2	9.863E2	4.879E4	-9.672E-4	L
L	26	26	7.379E3	4.147E-6	-8.957E1	-9.863E2	-4.879E4	9.672E-4	L
L	26	27	-7.379E3	-4.147E-6	8.957E1	9.863E2	6.975E4	3.224E-6	L
L	27	27	7.379E3	3.499E-8	-1.418E-3	-9.863E2	-6.975E4	-3.224E-6	L
L	27	28	-7.379E3	-3.499E-8	1.418E-3	9.863E2	6.975E4	1.141E-5	L
L	28	28	7.379E3	-1.223E-8	8.960E1	-9.863E2	-6.975E4	-1.141E-5	L
L	28	29	-7.379E3	1.223E-8	-8.960E1	9.863E2	4.879E4	8.550E-6	L
L	29	29	7.379E3	-1.321E-7	-1.006E2	-9.863E2	-4.879E4	-8.550E-6	L
L	29	30	-7.379E3	1.321E-7	1.006E2	9.863E2	7.234E4	-2.235E-5	L
L	30	30	7.379E3	-2.181E-6	9.002E1	-9.863E2	-7.234E4	2.235E-5	L
L	30	31	-7.379E3	2.181E-6	-9.002E1	9.863E2	5.127E4	-5.328E-4	L
L	31	31	7.379E3	3.347E-5	-1.141E1	-9.863E2	-5.127E4	5.328E-4	L
L	31	32	-7.379E3	-3.347E-5	1.141E1	9.863E2	5.394E4	7.300E-3	L
L	32	32	7.379E3	-1.924E-4	9.451E-1	-9.863E2	-5.394E4	-7.300E-3	L
L	32	33	-7.379E3	1.924E-4	-9.451E-1	9.863E2	5.372E4	-3.771E-2	L
L	33	33	7.379E3	-4.467E-4	-1.099E1	-9.863E2	-5.372E4	3.771E-2	L
L	33	34	-7.379E3	4.467E-4	1.099E1	9.863E2	5.629E4	-1.422E-1	L
L	34	34	7.379E3	1.899E-2	7.865E1	-9.863E2	-5.629E4	1.422E-1	L
L	34	35	-7.379E3	-1.899E-2	-7.865E1	9.863E2	3.789E4	4.300E0	L
L	35	35	7.379E3	-1.677E-1	-1.043E1	-9.863E2	-3.789E4	-4.300E0	L
L	35	36	-7.379E3	1.677E-1	1.043E1	9.863E2	4.033E4	-3.494E1	L

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L	M	N	AXIAL	X2SHEAR	X3SHEAR	TORSN	X2MOM	X3MOM	L
L	36	36	7.379E3	3.664E-1	-2.188E1	-9.863E2	-4.033E4	3.494E1	L
L	36	37	-7.379E3	-3.664E-1	2.188E1	9.863E2	4.545E4	5.080E1	L
L	37	37	7.379E3	8.557E0	1.915E2	-9.863E2	-4.545E4	-5.080E1	L
L	37	38	-7.379E3	-8.557E0	-1.915E2	9.863E2	6.471E2	2.053E3	L
L	38	38	7.379E3	-1.177E2	-3.642E2	-9.863E2	-6.471E2	-2.053E3	L
L	38	39	-7.379E3	1.177E2	3.642E2	9.863E2	8.586E4	-2.548E4	L
L	39	39	7.379E3	6.103E2	1.064E3	-9.863E2	-8.586E4	2.548E4	L
L	39	40	-7.379E3	-6.103E2	-1.064E3	9.863E2	-1.631E5	1.173E5	L
L	40	40	7.338E3	-3.386E3	-1.282E3	6.305E3	7.166E4	-1.876E5	L
L	40	41	-7.338E3	3.386E3	1.282E3	-6.305E3	6.536E4	-1.741E5	L
L	41	41	7.379E3	6.302E2	-5.523E2	7.579E3	-1.480E5	1.126E5	L
L	41	42	-7.379E3	-6.302E2	5.523E2	-7.579E3	2.772E5	3.488E4	L
L	42	42	7.379E3	-3.899E2	8.792E3	7.579E3	-2.772E5	-3.488E4	L
L	42	43	-7.379E3	3.899E2	-8.792E3	-7.579E3	-1.780E6	-5.637E4	L
L									L

L===L

S===S

S=== MEMBER STRESSES OF COMBINED CASE 1 ===S

S===S

S H.B. ROBINSON 30 CW-11 UNDERGROUND WATER PIPE S
S VERTICAL SEISMIC (1/2 SINE WAVE END TO END) S

S ---LOCAL MEMBER END STRESSES--- S

S	M	N	AXIAL	X2SHEAR	X3SHEAR	TORSN	X2BEND	X3BEND	S
S	1	1	1.315E-2	-2.153E0	-4.558E-1	2.214E-6	-3.946E-8	-1.866E-7	S
S	1	2	1.315E-2	-2.153E0	-4.558E-1	2.214E-6	7.667E0	3.622E1	S
S	2	2	2.564E-2	6.465E0	7.711E-1	4.135E0	4.300E0	3.583E1	S
S	2	3	2.564E-2	6.465E0	7.711E-1	4.135E0	-1.232E0	-1.054E1	S
S	3	3	3.846E-2	-1.405E1	-1.675E0	4.135E0	-1.232E0	-1.054E1	S
S	3	4	3.846E-2	-1.405E1	-1.675E0	4.135E0	2.108E1	1.767E2	S
S	4	4	5.722E-2	7.634E1	2.225E1	6.472E1	3.416E1	1.175E2	S
S	4	5	5.722E-2	7.634E1	2.225E1	6.472E1	-1.136E2	-3.897E2	S
S	5	5	6.410E-2	-1.648E1	6.995E-1	1.875E2	8.597E0	-2.022E2	S
S	5	6	6.410E-2	-1.648E1	6.995E-1	1.875E2	-7.220E-1	1.735E1	S
S	6	6	7.692E-2	1.285E0	-5.489E-2	1.875E2	-7.220E-1	1.735E1	S
S	6	7	7.692E-2	1.285E0	-5.489E-2	1.875E2	9.243E-3	2.376E-1	S
S	7	7	8.974E-2	3.363E-1	2.013E-1	1.875E2	9.243E-3	2.376E-1	S
S	7	8	8.974E-2	3.363E-1	2.013E-1	1.875E2	-2.673E0	-4.243E0	S
S	8	8	1.026E-1	-3.596E0	-2.234E0	1.875E2	-2.673E0	-4.243E0	S
S	8	9	1.026E-1	-3.596E0	-2.234E0	1.875E2	2.709E1	4.367E1	S
S	9	9	1.154E-1	1.582E1	8.611E0	1.875E2	2.709E1	4.367E1	S
S	9	10	1.154E-1	1.582E1	8.611E0	1.875E2	-8.762E1	-1.670E2	S
S	10	10	1.282E-1	9.766E1	7.463E1	1.875E2	-8.762E1	-1.670E2	S
S	10	11	1.282E-1	9.766E1	7.463E1	1.875E2	-5.720E2	-8.009E2	S
S	11	11	8.305E1	-1.811E2	-7.187E1	-2.775E1	-6.250E2	-8.459E2	S
S	11	12	8.305E1	-1.811E2	-7.187E1	-2.775E1	5.837E0	7.437E2	S
S	12	12	5.688E0	6.181E1	5.962E0	2.295E1	6.751E1	7.413E2	S
S	12	13	5.688E0	6.181E1	5.962E0	2.295E1	-1.218E1	-8.473E1	S
S	13	13	-6.444E1	-6.629E0	-1.543E0	2.295E1	-1.218E1	-8.473E1	S
S	13	14	-6.444E1	-6.629E0	-1.543E0	2.295E1	8.327E0	3.332E0	S
S	14	14	-1.487E2	3.755E0	-4.719E0	2.295E1	8.326E0	3.332E0	S
S	14	15	-1.487E2	3.755E0	-4.719E0	2.295E1	7.140E1	-4.686E1	S
S	15	15	-2.660E2	-3.484E1	-2.774E0	2.295E1	7.140E1	-4.686E1	S
S	15	16	-2.660E2	-3.484E1	-2.774E0	2.295E1	1.083E2	4.161E2	S

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S	M	N	AXIAL	X2SHEAR	X3SHEAR	TORSN	X2BEND	X3BEND	S
S	16	16	-4.417E2	9.408E1	1.393E1	2.295E1	1.083E2	4.161E2	S
S	16	17	-4.417E2	9.408E1	1.393E1	2.295E1	-3.756E1	-5.687E2	S
S	17	17	-3.416E2	-5.802E1	-2.586E1	2.951E0	-5.902E1	-5.687E2	S
S	17	18	-3.416E2	-5.802E1	-2.586E1	2.951E0	2.855E2	2.043E2	S
S	18	18	-3.416E2	1.694E1	2.200E0	2.951E0	2.855E2	2.043E2	S
S	18	19	-3.416E2	1.694E1	2.200E0	2.951E0	2.562E2	-2.147E1	S
S	19	19	-3.416E2	-1.635E0	1.168E1	2.951E0	2.562E2	-2.147E1	S
S	19	20	-3.416E2	-1.635E0	1.168E1	2.951E0	1.006E2	3.084E-1	S
S	20	20	-3.416E2	4.714E-3	-2.830E1	2.951E0	1.006E2	3.084E-1	S
S	20	21	-3.416E2	4.714E-3	-2.830E1	2.951E0	4.776E2	2.456E-1	S
S	21	21	-3.416E2	2.138E-2	2.118E1	2.951E0	4.776E2	2.456E-1	S
S	21	22	-3.416E2	2.138E-2	2.118E1	2.951E0	1.954E2	-3.921E-2	S
S	22	22	-3.416E2	-3.114E-3	-1.077E1	2.951E0	1.954E2	-3.921E-2	S
S	22	23	-3.416E2	-3.114E-3	-1.077E1	2.951E0	3.388E2	2.281E-3	S
S	23	23	-3.416E2	1.559E-4	2.451E0	2.951E0	3.388E2	2.281E-3	S
S	23	24	-3.416E2	1.559E-4	2.451E0	2.951E0	3.062E2	2.035E-4	S
S	24	24	-3.416E2	1.976E-5	-9.495E0	2.951E0	3.062E2	2.035E-4	S
S	24	25	-3.416E2	1.976E-5	-9.495E0	2.951E0	4.327E2	-5.979E-5	S
S	25	25	-3.416E2	-4.923E-6	1.056E1	2.951E0	4.327E2	-5.979E-5	S
S	25	26	-3.416E2	-4.923E-6	1.056E1	2.951E0	2.919E2	5.787E-6	S
S	26	26	-3.416E2	4.358E-7	-9.414E0	2.951E0	2.919E2	5.787E-6	S
S	26	27	-3.416E2	4.358E-7	-9.414E0	2.951E0	4.173E2	-1.929E-8	S
S	27	27	-3.416E2	3.677E-9	-1.490E-4	2.951E0	4.173E2	-1.929E-8	S
S	27	28	-3.416E2	3.677E-9	-1.490E-4	2.951E0	4.173E2	-6.828E-8	S
S	28	28	-3.416E2	-1.285E-9	9.416E0	2.951E0	4.173E2	-6.828E-8	S
S	28	29	-3.416E2	-1.285E-9	9.416E0	2.951E0	2.919E2	-5.116E-8	S
S	29	29	-3.416E2	-1.388E-8	-1.058E1	2.951E0	2.919E2	-5.116E-8	S
S	29	30	-3.416E2	-1.388E-8	-1.058E1	2.951E0	4.328E2	1.338E-7	S
S	30	30	-3.416E2	-2.292E-7	9.461E0	2.951E0	4.328E2	1.338E-7	S
S	30	31	-3.416E2	-2.292E-7	9.461E0	2.951E0	3.068E2	3.188E-6	S
S	31	31	-3.416E2	3.518E-6	-1.200E0	2.951E0	3.068E2	3.188E-6	S
S	31	32	-3.416E2	3.518E-6	-1.200E0	2.951E0	3.227E2	-4.368E-5	S
S	32	32	-3.416E2	-2.022E-5	9.932E-2	2.951E0	3.227E2	-4.368E-5	S
S	32	33	-3.416E2	-2.022E-5	9.932E-2	2.951E0	3.214E2	2.257E-4	S
S	33	33	-3.416E2	-4.694E-5	-1.155E0	2.951E0	3.214E2	2.257E-4	S
S	33	34	-3.416E2	-4.694E-5	-1.155E0	2.951E0	3.368E2	8.511E-4	S
S	34	34	-3.416E2	1.995E-3	8.266E0	2.951E0	3.368E2	8.511E-4	S
S	34	35	-3.416E2	1.995E-3	8.266E0	2.951E0	2.267E2	-2.573E-2	S
S	35	35	-3.416E2	-1.762E-2	-1.096E0	2.951E0	2.267E2	-2.573E-2	S
S	35	36	-3.416E2	-1.762E-2	-1.096E0	2.951E0	2.413E2	2.091E-1	S
S	36	36	-3.416E2	3.851E-2	-2.299E0	2.951E0	2.413E2	2.091E-1	S
S	36	37	-3.416E2	3.851E-2	-2.299E0	2.951E0	2.719E2	-3.039E-1	S
S	37	37	-3.416E2	8.993E-1	2.012E1	2.951E0	2.719E2	-3.039E-1	S
S	37	38	-3.416E2	8.993E-1	2.012E1	2.951E0	3.872E0	-1.228E1	S
S	38	38	-3.416E2	-1.237E1	-3.827E1	2.951E0	3.872E0	-1.228E1	S
S	38	39	-3.416E2	-1.237E1	-3.827E1	2.951E0	5.137E2	1.525E2	S
S	39	39	-3.416E2	6.414E1	1.118E2	2.951E0	5.137E2	1.525E2	S
S	39	40	-3.416E2	6.414E1	1.118E2	2.951E0	-9.760E2	-7.020E2	S
S	40	40	-3.397E2	-3.558E2	-1.348E2	-1.886E1	-4.287E2	-1.123E3	S
S	40	41	-3.397E2	-3.558E2	-1.348E2	-1.886E1	3.910E2	1.042E3	S
S	41	41	-3.416E2	6.623E1	-5.804E1	-2.267E1	8.852E2	6.737E2	S
S	41	42	-3.416E2	6.623E1	-5.804E1	-2.267E1	1.658E3	-2.087E2	S
S	42	42	-3.416E2	-4.098E1	9.240E2	-2.267E1	1.658E3	-2.087E2	S
S	42	43	-3.416E2	-4.098E1	9.240E2	-2.267E1	-1.065E4	3.373E2	S
S									S

S===S

CCL-CA-352

FRACTION OF SYSTEM NODE ALLOWABLES: COMBINED CASE 1

H.B. ROBINSON 30 CW-11 UNDERGROUND WATER PIPE
VERTICAL SEISMIC (1/2 SINE WAVE END TO END)

---SUMMARY OF FRACTION OF ALLOWABLE FOR EACH NODE---

	DISPLACEMENT			BASEPLATE
N	X	Y	Z	COEFFICIENT
1	3.674E-18	1.115E-20	2.769E-15	0.000E0
2	1.454E-17	3.459E-21	2.769E-15	0.000E0
3	3.449E-17	2.606E-20	2.769E-15	0.000E0
4	1.564E-16	9.251E-20	2.769E-15	0.000E0
5	1.603E-16	9.846E-20	2.769E-15	0.000E0
6	2.968E-17	1.396E-20	2.769E-15	0.000E0
7	1.600E-18	3.609E-19	2.769E-15	0.000E0
8	6.389E-18	4.338E-18	2.770E-15	0.000E0
9	3.162E-17	1.945E-17	2.770E-15	0.000E0
10	1.319E-16	1.158E-16	2.770E-15	0.000E0
11	5.702E-16	3.175E-16	2.770E-15	0.000E0
12	4.702E-16	1.980E-14	8.766E-17	0.000E0
13	1.071E-16	5.001E-14	2.687E-16	0.000E0
14	2.382E-16	8.001E-14	2.136E-16	0.000E0
15	2.685E-16	1.100E-13	3.596E-16	0.000E0
16	6.230E-16	1.390E-13	3.186E-16	0.000E0
17	2.331E-15	1.611E-13	9.756E-16	0.000E0
18	2.617E-15	2.000E-13	1.251E-16	0.000E0
19	2.902E-15	2.360E-13	3.101E-17	0.000E0
20	3.188E-15	2.691E-13	2.737E-18	0.000E0
21	3.473E-15	2.999E-13	2.782E-20	0.000E0
22	3.759E-15	3.261E-13	4.089E-20	0.000E0
23	4.044E-15	3.490E-13	5.459E-21	0.000E0
24	4.330E-15	3.680E-13	2.273E-22	0.000E0
25	4.615E-15	3.830E-13	4.120E-23	0.000E0
26	4.900E-15	3.930E-13	8.945E-24	0.000E0
27	5.186E-15	3.990E-13	7.214E-25	0.000E0
28	5.471E-15	4.000E-13	8.284E-27	0.000E0
29	5.757E-15	3.960E-13	2.103E-26	0.000E0
30	6.042E-15	3.880E-13	3.595E-25	0.000E0
31	6.328E-15	3.750E-13	6.255E-24	0.000E0
32	6.613E-15	3.580E-13	3.962E-23	0.000E0
33	6.899E-15	3.370E-13	4.462E-23	0.000E0
34	7.184E-15	3.120E-13	3.409E-21	0.000E0
35	7.470E-15	2.830E-13	3.275E-20	0.000E0
36	7.755E-15	2.510E-13	9.370E-20	0.000E0
37	8.041E-15	2.160E-13	1.437E-18	0.000E0
38	8.326E-15	1.781E-13	2.215E-17	0.000E0
39	8.612E-15	1.387E-13	1.277E-16	0.000E0
40	8.897E-15	9.671E-14	2.908E-16	0.000E0
41	5.611E-16	8.658E-14	2.901E-16	0.000E0
42	2.756E-16	4.136E-14	1.332E-16	0.000E0
43	0.000E0	0.000E0	0.000E0	0.000E0
44	0.000E0	0.000E0	0.000E0	0.000E0

FRACTION OF SYSTEM MEMBER ALLOWABLES: COMBINED CASE 1

H.B. ROBINSON 30 CW-11 UNDERGROUND WATER PIPE
VERTICAL SEISMIC (1/2 SINE WAVE END TO END)

---SUMMARY OF FRACTION OF ALLOWABLE FOR EACH MEMBER---

	STRESS		BUCKLING		JOINT COEF.	
M	START	END	START	END	START	END
1	1.223E-16	1.626E-15	0.000E0	0.000E0	2.094E-12	3.094E-7
2	1.487E-15	5.914E-16	0.000E0	0.000E0	3.016E-7	8.871E-8
3	1.016E-15	7.325E-15	0.000E0	0.000E0	8.871E-8	1.487E-6
4	8.013E-15	1.864E-14	0.000E0	0.000E0	1.022E-6	3.392E-6
5	1.133E-14	1.133E-14	0.000E0	0.000E0	1.691E-6	1.451E-7
6	1.049E-14	1.049E-14	0.000E0	0.000E0	1.451E-7	1.987E-9
7	1.044E-14	1.044E-14	0.000E0	0.000E0	1.987E-9	4.191E-8
8	1.065E-14	1.065E-14	0.000E0	0.000E0	4.191E-8	4.295E-7
9	1.142E-14	1.142E-14	0.000E0	0.000E0	4.295E-7	1.576E-6
10	1.724E-14	5.085E-14	0.000E0	0.000E0	1.576E-6	8.224E-6
11	5.755E-14	3.084E-14	0.000E0	0.000E0	8.789E-6	6.215E-6
12	3.017E-14	4.725E-15	0.000E0	0.000E0	6.221E-6	7.153E-7
13	5.976E-15	2.819E-15	0.000E0	0.000E0	7.153E-7	7.495E-8
14	5.941E-15	9.889E-15	0.000E0	0.000E0	7.495E-8	7.137E-7
15	1.423E-14	2.927E-14	0.000E0	0.000E0	7.137E-7	3.593E-6
16	3.578E-14	3.881E-14	0.000E0	0.000E0	3.593E-6	4.763E-6
17	3.590E-14	3.079E-14	0.000E0	0.000E0	4.778E-6	2.934E-6
18	3.079E-14	2.294E-14	0.000E0	0.000E0	2.934E-6	2.149E-6
19	2.294E-14	1.639E-14	0.000E0	0.000E0	2.149E-6	8.410E-7
20	1.639E-14	3.035E-14	0.000E0	0.000E0	8.410E-7	3.991E-6
21	3.035E-14	1.989E-14	0.000E0	0.000E0	3.991E-6	1.633E-6
22	1.989E-14	2.520E-14	0.000E0	0.000E0	1.633E-6	2.832E-6
23	2.520E-14	2.399E-14	0.000E0	0.000E0	2.832E-6	2.559E-6
24	2.399E-14	2.868E-14	0.000E0	0.000E0	2.559E-6	3.616E-6
25	2.868E-14	2.346E-14	0.000E0	0.000E0	3.616E-6	2.440E-6
26	2.346E-14	2.811E-14	0.000E0	0.000E0	2.440E-6	3.488E-6
27	2.811E-14	2.811E-14	0.000E0	0.000E0	3.488E-6	3.488E-6
28	2.811E-14	2.346E-14	0.000E0	0.000E0	3.488E-6	2.439E-6
29	2.346E-14	2.868E-14	0.000E0	0.000E0	2.439E-6	3.617E-6
30	2.868E-14	2.401E-14	0.000E0	0.000E0	3.617E-6	2.564E-6
31	2.401E-14	2.461E-14	0.000E0	0.000E0	2.564E-6	2.697E-6
32	2.461E-14	2.456E-14	0.000E0	0.000E0	2.697E-6	2.686E-6
33	2.456E-14	2.513E-14	0.000E0	0.000E0	2.686E-6	2.815E-6
34	2.513E-14	2.105E-14	0.000E0	0.000E0	2.815E-6	1.894E-6
35	2.105E-14	2.160E-14	0.000E0	0.000E0	1.894E-6	2.016E-6
36	2.160E-14	2.273E-14	0.000E0	0.000E0	2.016E-6	2.272E-6
37	2.273E-14	1.325E-14	0.000E0	0.000E0	2.272E-6	1.076E-7
38	1.325E-14	3.733E-14	0.000E0	0.000E0	1.076E-7	4.478E-6
39	3.733E-14	7.480E-14	0.000E0	0.000E0	4.478E-6	1.005E-5
40	7.004E-14	6.565E-14	0.000E0	0.000E0	1.004E-5	9.298E-6
41	7.039E-14	8.181E-14	0.000E0	0.000E0	9.296E-6	1.397E-5
42	8.181E-14	4.196E-13	0.000E0	0.000E0	0.000E0	0.000E0

QUALIFICATION SUMMARY REPORT

H.B. ROBINSON 30 CW-11 UNDERGROUND WATER PIPE

---PLANT IDENTIFICATION---

UTILITY: CPL
PLANT: H.B.ROBINSON
PWR_____
NSSS:
A/E:
BWR_____

---EQUIPMENT IDENTIFICATION---

SYSTEM:
DRAWING NO.:
BUILDING:
ELEVATION:
ADDITIONAL IDENTIFICATION:

---APPLIED LOADS---

DEADWEIGHT:____
THERMAL:____
RELATIVE DISP.:____
SEISMIC:____
HYDRODYNAMIC:____

---LOAD COMBINATION---

VERTICAL 4 INCH MIDSPAN DISPLACEMENT OF PIPE RUN

---SUMMARY OF RESULTS---

---MAXIMUM FRACTION OF ALLOWABLE---

COMPONENT	FAILURE MODE	ALLOWABLE	MAX. FRACTION	PASS/FAIL
SYSTEM	JOINT	1.000E0	1.397E-5	PASS

COMMENTS:
JOINT MAX. FRACTION = REALATIVE JOINT ROTATION (RAD.)
JOINT KTRANS=1.5E8 LB/IN JOINT KTORS,KROT2,KROT3=2E10 IN-LB.
....GROUND SPRING PER 19.5 FT. PIPE SEGMENT SET AT 5.7E5 LB/IN.
....DISPLACEMENTS ARE IMPOSED ON GROUNDED END OF NODAL GROUND SPRINGS.

PREPARED BY: D Lindley CO: CCL DATE: 12-4-90

VERIFIED BY: [signature] CO: CCL DATE: 12-7-90

Job Number: 90-2271
Sheet: - of: -
Calculated By: DWL Date: 12-4-90
Checked By: JP Date: 12-7-90
Calculation Number: CCL-CA-352

ATTACHMENT A4

All piping segments begin and end with axial spring constants of 3.0E+08 lb_f/in, and torsional and bending spring constants of 4.0E+10 in-lb_f/rad.

CCL-CA-352

```
****************************************************************************
*                                                                          *
* ***********  ***********  **      **     *******     *      **    ********  *
* ***********  ***********  **      **    *********    **     **   *********** *
* **                  ***   **      **    **      **   ***    **   **          *
* **                 ***    **      **    **      **   ****   **   **          *
* ***********       ***     *********     *********    *****  **   **   *****  *
* ***********      ***      *********     *********    ** *** **   **   ****** *
* **              ***       **      **    **      **   **  *****   **       ** *
* **             ***        **      **    **      **   **   ****   **       ** *
* **            ***         **      **    **      **   **    ***   **       ** *
* ***********  ***********  **      **    **      **   **     **   *********** *
* ***********  ***********  **      **    **      **   **      *    ********   *
*                                                                          *
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********************************************************
*                                                      *
*               *** EZHANG RELEASE 8.1 ***             *
*                     COPYRIGHT 1990                   *
* USER:        1                        WA: 3012244    *
*------------------------------------------------------*
*   CORPORATE CONSULTING AND DEVELOPMENT COMPANY, LTD. *
*                P. O. BOX 12728                       *
*                RESEARCH TRIANGLE PARK,               *
*                N. C. 27709-9998                      *
********************************************************
```

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**********************************************
* PROJECT:  90-2271                          *
*                                            *
* TITLE:                                     *
*                                            *
*                                            *
* ANALYSIS BY: D Lindley      DATE: 12-4-90  *
*                                            *
* CHECKED BY: [signature]     DATE: 12-7-90  *
**********************************************
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CCL-CA-352

INPUT ECHO

```
SYSTEM 2000000
I 386.4 1 1.33 10E12 10E12 10E12
IDF .9 .6 1 1
N   1     0   15     0  0  0  0  0  0  0  -2 123 -1
N   2     0   81   288  0  0  0  0  0  0  -2 123 -1
N   3     0   81   414  0  0  0  0  0  0  -2 123 -1
N   4     0   81   648  0  0  0  0  0  0  -2 123 -1
N   5     0    0   732  0  0  0  0  0  0  -2 123 -1
N   6     0    0   966  0  0  0  0  0  0  -2 123 -1
N   7     0    0  1200  0  0  0  0  0  0  -2 123 -1
N   8     0    0  1434  0  0  0  0  0  0  -2 123 -1
N   9     0    0  1668  0  0  0  0  0  0  -2 123 -1
N  10     0    0  1902  0  0  0  0  0  0  -2 123 -1
N  11     0    0  2016  0  0  0  0  0  0  -2 123 -1
N  12   108   21  2124  0  0  0  0  0  0  -3 123 -1
N  13   274   21  2290  0  0  0  0  0  0  -3 123 -1
N  14   439   21  2455  0  0  0  0  0  0  -3 123 -1
N  15   605   21  2621  0  0  0  0  0  0  -3 123 -1
N  16   770   21  2786  0  0  0  0  0  0  -3 123 -1
N  17   900   21  2916  0  0  0  0  0  0  -4 123 -1
N  18  1134   21  2916  0  0  0  0  0  0  -4 123 -1
N  19  1368   21  2916  0  0  0  0  0  0  -4 123 -1
N  20  1602   21  2916  0  0  0  0  0  0  -4 123 -1
N  21  1836   21  2916  0  0  0  0  0  0  -4 123 -1
N  22  2070   21  2916  0  0  0  0  0  0  -4 123 -1
N  23  2304   21  2916  0  0  0  0  0  0  -4 123 -1
N  24  2538   21  2916  0  0  0  0  0  0  -4 123 -1
N  25  2772   21  2916  0  0  0  0  0  0  -4 123 -1
N  26  3006   21  2916  0  0  0  0  0  0  -4 123 -1
N  27  3240   21  2916  0  0  0  0  0  0  -4 123 -1
N  28  3474   21  2916  0  0  0  0  0  0  -4 123 -1
N  29  3708   21  2916  0  0  0  0  0  0  -4 123 -1
N  30  3942   21  2916  0  0  0  0  0  0  -4 123 -1
N  31  4176   21  2916  0  0  0  0  0  0  -4 123 -1
N  32  4410   21  2916  0  0  0  0  0  0  -4 123 -1
N  33  4644   21  2916  0  0  0  0  0  0  -4 123 -1
N  34  4878   21  2916  0  0  0  0  0  0  -4 123 -1
N  35  5112   21  2916  0  0  0  0  0  0  -4 123 -1
N  36  5346   21  2916  0  0  0  0  0  0  -4 123 -1
N  37  5580   21  2916  0  0  0  0  0  0  -4 123 -1
N  38  5814   21  2916  0  0  0  0  0  0  -4 123 -1
N  39  6048   21  2916  0  0  0  0  0  0  -4 123 -1
N  40  6282   21  2916  0  0  0  0  0  0  -4 123 -1
N  41  6348   87  2864  0  0  0  0  0  0  -4 123 -1
N  42  6582   87  2864  0  0  0  0  0  0  -4 123 -1
N  43  6816   87  2864 -1 -1 -1 -1 -1 -1
N  44   500   21   500 -1 -1 -1 -1 -1 -1
M   1     1    2     1   44
M   2     2    3     1   44
M   3     3    4     1   44
M   4     4    5     1   44
M   5     5    6     1   44
M   6     6    7     1   44
M   7     7    8     1   44
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M    8    8    9    1   44
M    9    9   10    1   44
M   10   10   11    1   44
M   11   11   12    1   44
M   12   12   13    1   44
M   13   13   14    1   44
M   14   14   15    1   44
M   15   15   16    1   44
M   16   16   17    1   44
M   17   17   18    1   44
M   18   18   19    1   44
M   19   19   20    1   44
M   20   20   21    1   44
M   21   21   22    1   44
M   22   22   23    1   44
M   23   23   24    1   44
M   24   24   25    1   44
M   25   25   26    1   44
M   26   26   27    1   44
M   27   27   28    1   44
M   28   28   29    1   44
M   29   29   30    1   44
M   30   30   31    1   44
M   31   31   32    1   44
M   32   32   33    1   44
M   33   33   34    1   44
M   34   34   35    1   44
M   35   35   36    1   44
M   36   36   37    1   44
M   37   37   38    1   44
M   38   38   39    1   44
M   39   39   40    1   44
M   40   40   41    1   44
M   41   41   42    1   44
M   42   42   43    2   44
P 1 21.6 1.61 5248 2624 2624 15.7 31.4 31.4 29E6
Q 1 -5 11E6 6E-6 .44 .44 2.27 2.27 30E15
P 2 21.6 1.61 5248 2624 2624 15.7 31.4 31.4 29E6
Q 2  0 11E6 6E-6 .44 .44 2.27 2.27 30E15
X -2 0 5.7E5 5.7E5 10 10 10 10
Y -2 0 10 10 10 10 10 10 0
X -3 0 5.7E5 5.7E5 5.7E5 10 10 10
Y -3 0 10 10 10 10 10 10 0
X -4 0 0 5.7E5 5.7E5 10 10 10
Y -4 0 10 10 10 10 10 10 0
X -5 0 3E8 -1 -1 4E10 4E10 4E10
Y -5 2 10E18 10E12 10E12 10E18 4E10 4E10 10
T H.B. ROBINSON 30 CW-11 UNDERGROUND WATER PIPE
E END GEOM
STATIC
T VERTICAL 4 INCH RELATIVE GROND DISPLACEMENT MIDSPAN
D   1       .00       .00       .00
D   2       .00       .00       .00
D   3       .00       .00       .00
D   4       .00       .00       .00
D   5       .00       .00       .00
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D   6      .00      .00      .00
D   7      .00      .00      .00
D   8      .00      .00      .00
D   9      .00      .00      .00
D  10      .00      .00      .00
D  11      .00      .00      .00
D  12      .00      .20      .00
D  13      .00      .50      .00
D  14      .00      .80      .00
D  15      .00     1.10      .00
D  16      .00     1.39      .00
D  17      .00     1.61      .00
D  18      .00     2.00      .00
D  19      .00     2.36      .00
D  20      .00     2.69      .00
D  21      .00     3.00      .00
D  22      .00     3.26      .00
D  23      .00     3.49      .00
D  24      .00     3.68      .00
D  25      .00     3.83      .00
D  26      .00     3.93      .00
D  27      .00     3.99      .00
D  28      .00     4.00      .00
D  29      .00     3.96      .00
D  30      .00     3.88      .00
D  31      .00     3.75      .00
D  32      .00     3.58      .00
D  33      .00     3.37      .00
D  34      .00     3.12      .00
D  35      .00     2.83      .00
D  36      .00     2.51      .00
D  37      .00     2.16      .00
D  38      .00     1.78      .00
D  39      .00     1.39      .00
D  40      .00      .97      .00
D  41      .00      .86      .00
D  42      .00      .43      .00
E END CASE
E END STATIC
COMBINE
T VERTICAL SEISMIC (1/2 SINE WAVE END TO END)
O OUTPUT
C CASE 1 1 1 0
E END OUTPUT
REPORT 1
A CPL
B H.B.ROBINSON
J VERTICAL 4 INCH MIDSPAN DISPLACEMENT OF PIPE RUN
K JOINT MAX. FRACTION = REALATIVE JOINT ROTATION (RAD.)
L JOINT KTRANS=3E8 LB/IN  JOINT KTORS,KROT2,KROT3=4E10 IN-LB.
M....GROUND SPRING PER 19.5 FT. PIPE SEGMENT SET AT 5.7E5 LB/IN.
M....DISPLACEMENTS ARE IMPOSED ON GROUNDED END OF NODAL GROUND SPRINGS.
E END REPORT
ENDRUN
```

N===N
N=== NODAL DATA TABLE ===N
N===N

H.B. ROBINSON 30 CW-11 UNDERGROUND WATER PIPE

	--- NODAL COORDINATES ---			--- NODAL WEIGHTS ---		
NODE	X	Y	Z	XWT	YWT	ZWT
1	0.0000E0	1.5000E1	0.0000E0	5.138E3	5.138E3	5.138E3
2	0.0000E0	8.1000E1	2.8800E2	7.328E3	7.328E3	7.328E3
3	0.0000E0	8.1000E1	4.1400E2	6.260E3	6.260E3	6.260E3
4	0.0000E0	8.1000E1	6.4800E2	6.098E3	6.098E3	6.098E3
5	0.0000E0	0.0000E0	7.3200E2	6.098E3	6.098E3	6.098E3
6	0.0000E0	0.0000E0	9.6600E2	8.138E3	8.138E3	8.138E3
7	0.0000E0	0.0000E0	1.2000E3	8.138E3	8.138E3	8.138E3
8	0.0000E0	0.0000E0	1.4340E3	8.138E3	8.138E3	8.138E3
9	0.0000E0	0.0000E0	1.6680E3	8.138E3	8.138E3	8.138E3
10	0.0000E0	0.0000E0	1.9020E3	6.051E3	6.051E3	6.051E3
11	0.0000E0	0.0000E0	2.0160E3	4.663E3	4.663E3	4.663E3
12	1.0800E2	2.1000E1	2.1240E3	6.763E3	6.763E3	6.763E3
13	2.7400E2	2.1000E1	2.2900E3	8.139E3	8.139E3	8.139E3
14	4.3900E2	2.1000E1	2.4550E3	8.139E3	8.139E3	8.139E3
15	6.0500E2	2.1000E1	2.6210E3	8.139E3	8.139E3	8.139E3
16	7.7000E2	2.1000E1	2.7860E3	7.254E3	7.254E3	7.254E3
17	9.0000E2	2.1000E1	2.9160E3	7.266E3	7.266E3	7.266E3
18	1.1340E3	2.1000E1	2.9160E3	8.138E3	8.138E3	8.138E3
19	1.3680E3	2.1000E1	2.9160E3	8.138E3	8.138E3	8.138E3
20	1.6020E3	2.1000E1	2.9160E3	8.138E3	8.138E3	8.138E3
21	1.8360E3	2.1000E1	2.9160E3	8.138E3	8.138E3	8.138E3
22	2.0700E3	2.1000E1	2.9160E3	8.138E3	8.138E3	8.138E3
23	2.3040E3	2.1000E1	2.9160E3	8.138E3	8.138E3	8.138E3
24	2.5380E3	2.1000E1	2.9160E3	8.138E3	8.138E3	8.138E3
25	2.7720E3	2.1000E1	2.9160E3	8.138E3	8.138E3	8.138E3
26	3.0060E3	2.1000E1	2.9160E3	8.138E3	8.138E3	8.138E3
27	3.2400E3	2.1000E1	2.9160E3	8.138E3	8.138E3	8.138E3
28	3.4740E3	2.1000E1	2.9160E3	8.138E3	8.138E3	8.138E3
29	3.7080E3	2.1000E1	2.9160E3	8.138E3	8.138E3	8.138E3
30	3.9420E3	2.1000E1	2.9160E3	8.138E3	8.138E3	8.138E3
31	4.1760E3	2.1000E1	2.9160E3	8.138E3	8.138E3	8.138E3
32	4.4100E3	2.1000E1	2.9160E3	8.138E3	8.138E3	8.138E3
33	4.6440E3	2.1000E1	2.9160E3	8.138E3	8.138E3	8.138E3
34	4.8780E3	2.1000E1	2.9160E3	8.138E3	8.138E3	8.138E3
35	5.1120E3	2.1000E1	2.9160E3	8.138E3	8.138E3	8.138E3
36	5.3460E3	2.1000E1	2.9160E3	8.138E3	8.138E3	8.138E3
37	5.5800E3	2.1000E1	2.9160E3	8.138E3	8.138E3	8.138E3
38	5.8140E3	2.1000E1	2.9160E3	8.138E3	8.138E3	8.138E3
39	6.0480E3	2.1000E1	2.9160E3	8.138E3	8.138E3	8.138E3
40	6.2820E3	2.1000E1	2.9160E3	5.927E3	5.927E3	5.927E3
41	6.3480E3	8.7000E1	2.8640E3	5.927E3	5.927E3	5.927E3
42	6.5820E3	8.7000E1	2.8640E3	8.138E3	8.138E3	8.138E3
43	6.8160E3	8.7000E1	2.8640E3	4.069E3	4.069E3	4.069E3
44	5.0000E2	2.1000E1	5.0000E2	0.000E0	0.000E0	0.000E0
				3.230E5	3.230E5	3.230E5

--NODAL CONSTRAINTS-- BASEPLATE DATA

NODE XT YT ZT XR YR ZR JTYPE BXYZ CALC BANDWIDTH: 12

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BANDWIDTH: 12

I	NODE	XT	YT	ZT	XR	YR	ZR	JTYPE	BXYZ	CALC	N
N	1	0	0	0	0	0	0	-2	B123	0	N
N	2	0	0	0	0	0	0	-2	B123	0	N
N	3	0	0	0	0	0	0	-2	B123	0	N
N	4	0	0	0	0	0	0	-2	B123	0	N
N	5	0	0	0	0	0	0	-2	B123	0	N
N	6	0	0	0	0	0	0	-2	B123	0	N
N	7	0	0	0	0	0	0	-2	B123	0	N
N	8	0	0	0	0	0	0	-2	B123	0	N
N	9	0	0	0	0	0	0	-2	B123	0	N
N	10	0	0	0	0	0	0	-2	B123	0	N
N	11	0	0	0	0	0	0	-2	B123	0	N
N	12	0	0	0	0	0	0	-3	B123	0	N
N	13	0	0	0	0	0	0	-3	B123	0	N
N	14	0	0	0	0	0	0	-3	B123	0	N
N	15	0	0	0	0	0	0	-3	B123	0	N
N	16	0	0	0	0	0	0	-3	B123	0	N
N	17	0	0	0	0	0	0	-4	B123	0	N
N	18	0	0	0	0	0	0	-4	B123	0	N
N	19	0	0	0	0	0	0	-4	B123	0	N
N	20	0	0	0	0	0	0	-4	B123	0	N
N	21	0	0	0	0	0	0	-4	B123	0	N
N	22	0	0	0	0	0	0	-4	B123	0	N
N	23	0	0	0	0	0	0	-4	B123	0	N
N	24	0	0	0	0	0	0	-4	B123	0	N
N	25	0	0	0	0	0	0	-4	B123	0	N
N	26	0	0	0	0	0	0	-4	B123	0	N
N	27	0	0	0	0	0	0	-4	B123	0	N
N	28	0	0	0	0	0	0	-4	B123	0	N
N	29	0	0	0	0	0	0	-4	B123	0	N
N	30	0	0	0	0	0	0	-4	B123	0	N
N	31	0	0	0	0	0	0	-4	B123	0	N
N	32	0	0	0	0	0	0	-4	B123	0	N
N	33	0	0	0	0	0	0	-4	B123	0	N
N	34	0	0	0	0	0	0	-4	B123	0	N
N	35	0	0	0	0	0	0	-4	B123	0	N
N	36	0	0	0	0	0	0	-4	B123	0	N
N	37	0	0	0	0	0	0	-4	B123	0	N
N	38	0	0	0	0	0	0	-4	B123	0	N
N	39	0	0	0	0	0	0	-4	B123	0	N
N	40	0	0	0	0	0	0	-4	B123	0	N
N	41	0	0	0	0	0	0	-4	B123	0	N
N	42	0	0	0	0	0	0	-4	B123	0	N
N	43	-1	-1	-1	-1	-1	-1	0	B 0	0	N
N	44	-1	-1	-1	-1	-1	-1	0	B 0	0	N

JOINT AND SPRING DATA TABLE

H.B. ROBINSON 30 CW-11 UNDERGROUND WATER PIPE

--- JOINT SPRING RATES ---

JTYPE	K1	K2	K3	K4	K5	K6
-5	3.000E8	-1.000E0	-1.000E0	4.000E10	4.000E10	4.000E10

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	JTYPE	K1	K2	K3	K4	K5	K6	
J	-4	0.000E0	5.700E5	5.700E5	1.000E1	1.000E1	1.000E1	J
J	-3	5.700E5	5.700E5	5.700E5	1.000E1	1.000E1	1.000E1	J
J	-2	5.700E5	5.700E5	1.000E1	1.000E1	1.000E1	1.000E1	J

--- JOINT ALLOWABLE LOADS ---

	JTYPE	A1	A2	A3	A4	A5	A6	
J	-5	1.000E19	1.000E13	1.000E13	1.000E19	4.000E10	4.000E10	J
J	-4	1.000E1	1.000E1	1.000E1	1.000E1	1.000E1	1.000E1	J
J	-3	1.000E1	1.000E1	1.000E1	1.000E1	1.000E1	1.000E1	J
J	-2	1.000E1	1.000E1	1.000E1	1.000E1	1.000E1	1.000E1	J

---- JOINT WEIGHT AND CALC X VALUE ----

JTYPE	JOINT WT.	X VALUE
-5	0.000E0	2.000E0
-4	0.000E0	0.000E0
-3	0.000E0	0.000E0
-2	0.000E0	0.000E0

MEMBER DATA TABLE

H.B. ROBINSON 30 CW-11 UNDERGROUND WATER PIPE

--- PRIMARY MEMBER DATA ---

	MEM	FROM	TO	PTYPE	RNODE	BANK	KFAC	QFAC	LENGTH	
M	1	1	2	1	44	0.00E0	0.00E0	1.00E0	2.955E2	M
M	2	2	3	1	44	0.00E0	0.00E0	1.00E0	1.260E2	M
M	3	3	4	1	44	0.00E0	0.00E0	1.00E0	2.340E2	M
M	4	4	5	1	44	0.00E0	0.00E0	1.00E0	1.167E2	M
M	5	5	6	1	44	0.00E0	0.00E0	1.00E0	2.340E2	M
M	6	6	7	1	44	0.00E0	0.00E0	1.00E0	2.340E2	M
M	7	7	8	1	44	0.00E0	0.00E0	1.00E0	2.340E2	M
M	8	8	9	1	44	0.00E0	0.00E0	1.00E0	2.340E2	M
M	9	9	10	1	44	0.00E0	0.00E0	1.00E0	2.340E2	M
M	10	10	11	1	44	0.00E0	0.00E0	1.00E0	1.140E2	M
M	11	11	12	1	44	0.00E0	0.00E0	1.00E0	1.542E2	M
M	12	12	13	1	44	0.00E0	0.00E0	1.00E0	2.348E2	M
M	13	13	14	1	44	0.00E0	0.00E0	1.00E0	2.333E2	M
M	14	14	15	1	44	0.00E0	0.00E0	1.00E0	2.348E2	M
M	15	15	16	1	44	0.00E0	0.00E0	1.00E0	2.333E2	M
M	16	16	17	1	44	0.00E0	0.00E0	1.00E0	1.838E2	M
M	17	17	18	1	44	0.00E0	0.00E0	1.00E0	2.340E2	M
M	18	18	19	1	44	0.00E0	0.00E0	1.00E0	2.340E2	M
M	19	19	20	1	44	0.00E0	0.00E0	1.00E0	2.340E2	M
M	20	20	21	1	44	0.00E0	0.00E0	1.00E0	2.340E2	M
M	21	21	22	1	44	0.00E0	0.00E0	1.00E0	2.340E2	M
M	22	22	23	1	44	0.00E0	0.00E0	1.00E0	2.340E2	M
M	23	23	24	1	44	0.00E0	0.00E0	1.00E0	2.340E2	M
M	24	24	25	1	44	0.00E0	0.00E0	1.00E0	2.340E2	M
M	25	25	26	1	44	0.00E0	0.00E0	1.00E0	2.340E2	M
M	26	26	27	1	44	0.00E0	0.00E0	1.00E0	2.340E2	M
M	27	27	28	1	44	0.00E0	0.00E0	1.00E0	2.340E2	M
M	28	28	29	1	44	0.00E0	0.00E0	1.00E0	2.340E2	M

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M	MEM	FROM	TO	PTYPE	RNODE	BANK	KFAC	QFAC	LENGTH	M
M	29	29	30	1	44	0.00E0	0.00E0	1.00E0	2.340E2	M
M	30	30	31	1	44	0.00E0	0.00E0	1.00E0	2.340E2	M
M	31	31	32	1	44	0.00E0	0.00E0	1.00E0	2.340E2	M
M	32	32	33	1	44	0.00E0	0.00E0	1.00E0	2.340E2	M
M	33	33	34	1	44	0.00E0	0.00E0	1.00E0	2.340E2	M
M	34	34	35	1	44	0.00E0	0.00E0	1.00E0	2.340E2	M
M	35	35	36	1	44	0.00E0	0.00E0	1.00E0	2.340E2	M
M	36	36	37	1	44	0.00E0	0.00E0	1.00E0	2.340E2	M
M	37	37	38	1	44	0.00E0	0.00E0	1.00E0	2.340E2	M
M	38	38	39	1	44	0.00E0	0.00E0	1.00E0	2.340E2	M
M	39	39	40	1	44	0.00E0	0.00E0	1.00E0	2.340E2	M
M	40	40	41	1	44	0.00E0	0.00E0	1.00E0	1.068E2	M
M	41	41	42	1	44	0.00E0	0.00E0	1.00E0	2.340E2	M
M	42	42	43	2	44	0.00E0	0.00E0	1.00E0	2.340E2	M

M		--- FROM JOINT DATA ---			--- TO JOINT DATA ---			M
M	MEM	TYPE	HINGE	CALC	TYPE	HINGE	CALC	M
M	1	-5	111111	10	-5	111111	10	M
M	2	-5	111111	10	-5	111111	10	M
M	3	-5	111111	10	-5	111111	10	M
M	4	-5	111111	10	-5	111111	10	M
M	5	-5	111111	10	-5	111111	10	M
M	6	-5	111111	10	-5	111111	10	M
M	7	-5	111111	10	-5	111111	10	M
M	8	-5	111111	10	-5	111111	10	M
M	9	-5	111111	10	-5	111111	10	M
M	10	-5	111111	10	-5	111111	10	M
M	11	-5	111111	10	-5	111111	10	M
M	12	-5	111111	10	-5	111111	10	M
M	13	-5	111111	10	-5	111111	10	M
M	14	-5	111111	10	-5	111111	10	M
M	15	-5	111111	10	-5	111111	10	M
M	16	-5	111111	10	-5	111111	10	M
M	17	-5	111111	10	-5	111111	10	M
M	18	-5	111111	10	-5	111111	10	M
M	19	-5	111111	10	-5	111111	10	M
M	20	-5	111111	10	-5	111111	10	M
M	21	-5	111111	10	-5	111111	10	M
M	22	-5	111111	10	-5	111111	10	M
M	23	-5	111111	10	-5	111111	10	M
M	24	-5	111111	10	-5	111111	10	M
M	25	-5	111111	10	-5	111111	10	M
M	26	-5	111111	10	-5	111111	10	M
M	27	-5	111111	10	-5	111111	10	M
M	28	-5	111111	10	-5	111111	10	M
M	29	-5	111111	10	-5	111111	10	M
M	30	-5	111111	10	-5	111111	10	M
M	31	-5	111111	10	-5	111111	10	M
M	32	-5	111111	10	-5	111111	10	M
M	33	-5	111111	10	-5	111111	10	M
M	34	-5	111111	10	-5	111111	10	M
M	35	-5	111111	10	-5	111111	10	M
M	36	-5	111111	10	-5	111111	10	M
M	37	-5	111111	10	-5	111111	10	M
M	38	-5	111111	10	-5	111111	10	M
M	39	-5	111111	10	-5	111111	10	M

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I	MEM	TYPE	HINGE	CALC	TYPE	HINGE	CALC
M	40	-5	111111	10	-5	111111	10
M	41	-5	111111	10	-5	111111	10

--- MEMBER PROPERTY DATA ---

PTYPE	AREA	J	I2	I3	H2	H3
1	2.160E1	5.248E3	2.624E3	2.624E3	3.140E1	3.140E1
2	2.160E1	5.248E3	2.624E3	2.624E3	3.140E1	3.140E1

--- MEMBER PROPERTY DATA ---

PTYPE	JRADIUS	SHAPE2	SHAPE3	STRESSF2	STRESSF3	DJPROP
1	1.570E1	4.400E-1	4.400E-1	2.270E0	2.270E0	-5
2	1.570E1	4.400E-1	4.400E-1	2.270E0	2.270E0	0

--- MEMBER PROPERTY DATA ---

PTYPE	EMOD	SMOD	YIELD	DENSITY	ALPHA
1	2.900E7	1.100E7	3.000E16	1.610E0	6.000E-6
2	2.900E7	1.100E7	3.000E16	1.610E0	6.000E-6

DESIGN PARAMETERS

H.B. ROBINSON 30 CW-11 UNDERGROUND WATER PIPE

MEMBER DESIGN FACTOR:9.000E-1 ALLOWABLE X DISPLACEMENT:1.0000E13

BPLATE DESIGN FACTOR:1.000E0 ALLOWABLE Y DISPLACEMENT:1.0000E13

JOINT DESIGN FACTOR:1.000E0 ALLOWABLE Z DISPLACEMENT:1.0000E13

SHEAR DESIGN FACTOR:6.000E-1 BUCKLING FACTOR:1.3300E0

GRAVITATIONAL CONSTANT:3.864E2 DIR. PENDULUM PIVOT:

APPLIED LOADS FOR STAT CASE 1

H.B. ROBINSON 30 CW-11 UNDERGROUND WATER PIPE
VERTICAL 4 INCH RELATIVE GROND DISPLACEMENT MIDSPAN

---GENERIC LOADS---

GX= 0.00E0 GY= 0.00E0 GZ= 0.00E0 GRAV=3.86E2 TDEL= 0.00E0

---IMPOSED GROUND DISPLACEMENTS---

NODE	XT	YT	ZT	XR	YR	ZR
1	0E0	0E0	0E0	0E0	0E0	0E0
2	0E0	0E0	0E0	0E0	0E0	0E0
3	0E0	0E0	0E0	0E0	0E0	0E0
4	0E0	0E0	0E0	0E0	0E0	0E0
5	0E0	0E0	0E0	0E0	0E0	0E0
6	0E0	0E0	0E0	0E0	0E0	0E0

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C	NODE	XT	YT	ZT	XR	YR	ZR	C
C	7	0E0	0E0	0E0	0E0	0E0	0E0	C
C	8	0E0	0E0	0E0	0E0	0E0	0E0	C
C	9	0E0	0E0	0E0	0E0	0E0	0E0	C
C	10	0E0	0E0	0E0	0E0	0E0	0E0	C
C	11	0E0	0E0	0E0	0E0	0E0	0E0	C
C	12	0E0	2E-1	0E0	0E0	0E0	0E0	C
C	13	0E0	5E-1	0E0	0E0	0E0	0E0	C
C	14	0E0	8E-1	0E0	0E0	0E0	0E0	C
C	15	0E0	1E0	0E0	0E0	0E0	0E0	C
C	16	0E0	1E0	0E0	0E0	0E0	0E0	C
C	17	0E0	2E0	0E0	0E0	0E0	0E0	C
C	18	0E0	2E0	0E0	0E0	0E0	0E0	C
C	19	0E0	2E0	0E0	0E0	0E0	0E0	C
C	20	0E0	3E0	0E0	0E0	0E0	0E0	C
C	21	0E0	3E0	0E0	0E0	0E0	0E0	C
C	22	0E0	3E0	0E0	0E0	0E0	0E0	C
C	23	0E0	3E0	0E0	0E0	0E0	0E0	C
C	24	0E0	4E0	0E0	0E0	0E0	0E0	C
C	25	0E0	4E0	0E0	0E0	0E0	0E0	C
C	26	0E0	4E0	0E0	0E0	0E0	0E0	C
C	27	0E0	4E0	0E0	0E0	0E0	0E0	C
C	28	0E0	4E0	0E0	0E0	0E0	0E0	C
C	29	0E0	4E0	0E0	0E0	0E0	0E0	C
C	30	0E0	4E0	0E0	0E0	0E0	0E0	C
C	31	0E0	4E0	0E0	0E0	0E0	0E0	C
C	32	0E0	4E0	0E0	0E0	0E0	0E0	C
C	33	0E0	3E0	0E0	0E0	0E0	0E0	C
C	34	0E0	3E0	0E0	0E0	0E0	0E0	C
C	35	0E0	3E0	0E0	0E0	0E0	0E0	C
C	36	0E0	3E0	0E0	0E0	0E0	0E0	C
C	37	0E0	2E0	0E0	0E0	0E0	0E0	C
C	38	0E0	2E0	0E0	0E0	0E0	0E0	C
C	39	0E0	1E0	0E0	0E0	0E0	0E0	C
C	40	0E0	1E0	0E0	0E0	0E0	0E0	C
C	41	0E0	9E-1	0E0	0E0	0E0	0E0	C
C	42	0E0	4E-1	0E0	0E0	0E0	0E0	C

C==C

A==A
A=== ANCHOR ANALYSIS OF COMBINED CASE 1 ===A
A==A

A H.B. ROBINSON 30 CW-11 UNDERGROUND WATER PIPE A
A VERTICAL SEISMIC (1/2 SINE WAVE END TO END) A

A ---NODAL DEFLECTIONS--- A

A	NODE	XT	YT	ZT	XR	YR	ZR	A
A	1	3.724E-5	1.108E-7	2.748E-2	5.704E-10	1.960E-5	7.107E-5	A
A	2	-1.479E-4	-3.244E-8	2.748E-2	6.711E-10	7.579E-6	7.383E-5	A
A	3	3.504E-4	-2.643E-7	2.748E-2	5.557E-9	3.930E-6	7.695E-5	A
A	4	-1.588E-3	-9.030E-7	2.748E-2	-1.546E-8	-4.029E-5	8.270E-5	A
A	5	1.628E-3	9.664E-7	2.748E-2	-1.655E-8	-4.435E-5	1.419E-4	A
A	6	-3.029E-4	1.515E-7	2.748E-2	1.339E-8	4.675E-6	4.030E-4	A
A	7	1.653E-5	-3.918E-6	2.748E-2	2.377E-8	-9.611E-8	6.641E-4	A
A	8	6.775E-5	4.584E-5	2.748E-2	-7.703E-7	1.017E-6	9.252E-4	A

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A	NODE	XT	YT	ZT	XR	YR	ZR	A
A	9	-3.323E-4	-2.037E-4	2.748E-2	6.369E-6	-9.549E-6	1.186E-3	A
A	10	-1.331E-3	-1.171E-3	2.748E-2	-1.147E-5	2.335E-5	1.447E-3	A
A	11	5.818E-3	3.229E-3	2.748E-2	-1.040E-4	1.481E-4	1.576E-3	A
A	12	-4.807E-3	1.980E-1	8.971E-4	-2.012E-4	1.536E-4	1.635E-3	A
A	13	-1.092E-3	5.001E-1	-2.750E-3	-1.682E-4	-2.157E-5	1.647E-3	A
A	14	-2.432E-3	8.001E-1	-2.173E-3	-1.466E-4	4.256E-7	1.670E-3	A
A	15	-2.713E-3	1.100E0	-3.662E-3	-1.090E-4	1.241E-5	1.678E-3	A
A	16	-6.335E-3	1.390E0	-3.176E-3	-5.292E-5	-8.700E-5	1.667E-3	A
A	17	-2.347E-2	1.611E0	9.852E-3	-2.464E-5	-5.425E-5	1.674E-3	A
A	18	-2.633E-2	2.000E0	1.304E-3	-2.057E-5	4.410E-5	1.613E-3	A
A	19	-2.918E-2	2.360E0	-3.259E-4	-1.650E-5	-5.681E-6	1.469E-3	A
A	20	-3.203E-2	2.691E0	2.953E-5	-1.243E-5	2.202E-7	1.375E-3	A
A	21	-3.488E-2	2.999E0	1.879E-7	-8.364E-6	4.622E-8	1.221E-3	A
A	22	-3.774E-2	3.261E0	-4.345E-7	-4.295E-6	-9.773E-9	1.043E-3	A
A	23	-4.059E-2	3.490E0	6.074E-8	-2.250E-7	7.874E-10	9.012E-4	A
A	24	-4.344E-2	3.680E0	-2.865E-9	3.845E-6	1.994E-11	7.300E-4	A
A	25	-4.630E-2	3.830E0	-4.197E-10	7.914E-6	-1.376E-11	5.339E-4	A
A	26	-4.915E-2	3.930E0	1.007E-10	1.198E-5	1.731E-12	3.416E-4	A
A	27	-5.200E-2	3.990E0	-8.901E-12	1.605E-5	-6.253E-14	1.536E-4	A
A	28	-5.485E-2	4.000E0	1.654E-14	2.012E-5	-1.681E-14	-6.810E-5	A
A	29	-5.771E-2	3.960E0	-1.696E-13	2.419E-5	1.665E-14	-2.562E-4	A
A	30	-6.056E-2	3.880E0	-4.657E-12	2.826E-5	5.944E-15	-4.484E-4	A
A	31	-6.341E-2	3.750E0	7.121E-11	3.233E-5	-1.055E-12	-6.448E-4	A
A	32	-6.627E-2	3.580E0	-4.166E-10	3.640E-5	1.071E-11	-8.117E-4	A
A	33	-6.912E-2	3.370E0	-7.609E-10	4.047E-5	-3.669E-11	-9.826E-4	A
A	34	-7.197E-2	3.120E0	3.826E-8	4.454E-5	-3.886E-10	-1.157E-3	A
A	35	-7.482E-2	2.830E0	-3.494E-7	4.861E-5	6.771E-9	-1.307E-3	A
A	36	-7.768E-2	2.510E0	9.191E-7	5.268E-5	-4.340E-8	-1.431E-3	A
A	37	-8.053E-2	2.160E0	1.563E-5	5.675E-5	-3.218E-8	-1.567E-3	A
A	38	-8.338E-2	1.781E0	-2.319E-4	6.082E-5	3.489E-6	-1.640E-3	A
A	39	-8.624E-2	1.387E0	1.319E-3	6.489E-5	-3.456E-5	-1.779E-3	A
A	40	-8.909E-2	9.672E-1	2.878E-3	6.896E-5	1.123E-4	-1.654E-3	A
A	41	5.656E-3	8.658E-1	-2.873E-3	6.230E-5	1.111E-4	-1.639E-3	A
A	42	2.803E-3	4.135E-1	-1.369E-3	3.096E-5	-3.242E-5	-2.309E-3	A
A	43	0.000E0	0.000E0	0.000E0	0.000E0	0.000E0	0.000E0	A
A	44	0.000E0	0.000E0	0.000E0	0.000E0	0.000E0	0.000E0	A

A A

A ---REACTION LOADS AT FIXED DEGREES OF FREEDOM--- A

A	NODE	XF	YF	ZF	XM	YM	ZM	A
A	43	-7.503E3	-8.816E3	-1.490E2	-7.637E3	-6.887E3	1.782E6	A
A	44	0.000E0	0.000E0	0.000E0	0.000E0	0.000E0	0.000E0	A

A A

A ---BASEPLATE LOADS--- A

A	NODE	XF	YF	ZF	XM	YM	ZM	A
A	1	2.123E1	6.314E-2	2.748E-1	5.704E-9	1.960E-4	7.107E-4	A
A	2	-8.431E1	-1.849E-2	2.748E-1	6.711E-9	7.579E-5	7.383E-4	A
A	3	1.997E2	-1.507E-1	2.748E-1	5.557E-8	3.930E-5	7.695E-4	A
A	4	-9.049E2	-5.147E-1	2.748E-1	-1.546E-7	-4.029E-4	8.270E-4	A
A	5	9.281E2	5.508E-1	2.748E-1	-1.655E-7	-4.435E-4	1.419E-3	A
A	6	-1.726E2	8.633E-2	2.748E-1	1.339E-7	4.675E-5	4.030E-3	A
A	7	9.422E0	-2.233E0	2.748E-1	2.377E-7	-9.611E-7	6.641E-3	A
A	8	3.862E1	2.613E1	2.748E-1	-7.703E-6	1.017E-5	9.252E-3	A
A	9	-1.894E2	-1.161E2	2.748E-1	6.369E-5	-9.549E-5	1.186E-2	A
A	10	-7.589E2	-6.673E2	2.748E-1	-1.147E-4	2.335E-4	1.447E-2	A
A	11	3.316E3	1.840E3	2.748E-1	-1.040E-3	1.481E-3	1.576E-2	A
A	12	-2.740E3	-1.139E3	5.114E2	-2.012E-3	1.536E-3	1.635E-2	A

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A	NODE	XF	YF	ZF	XM	YM	ZM	A
A	13	-6.226E2	7.241E1	-1.567E3	-1.682E-3	-2.157E-4	1.647E-2	A
A	14	-1.386E3	3.106E1	-1.239E3	-1.466E-3	4.256E-6	1.670E-2	A
A	15	-1.546E3	-1.870E1	-2.087E3	-1.090E-3	1.241E-4	1.678E-2	A
A	16	-3.611E3	-1.620E2	-1.810E3	-5.292E-4	-8.700E-4	1.667E-2	A
A	17	0.000E0	3.852E2	5.615E3	-2.464E-4	-5.425E-4	1.674E-2	A
A	18	0.000E0	-2.719E2	7.432E2	-2.057E-4	4.410E-4	1.613E-2	A
A	19	0.000E0	-9.276E1	-1.857E2	-1.650E-4	-5.681E-5	1.469E-2	A
A	20	0.000E0	3.905E2	1.683E1	-1.243E-4	2.202E-6	1.375E-2	A
A	21	0.000E0	-4.834E2	1.071E-1	-8.364E-5	4.622E-7	1.221E-2	A
A	22	0.000E0	3.127E2	-2.476E-1	-4.295E-5	-9.773E-8	1.043E-2	A
A	23	0.000E0	-1.300E2	3.462E-2	-2.250E-6	7.874E-9	9.012E-3	A
A	24	0.000E0	1.172E2	-1.633E-3	3.845E-5	1.994E-10	7.300E-3	A
A	25	0.000E0	-1.961E2	-2.392E-4	7.914E-5	-1.376E-10	5.339E-3	A
A	26	0.000E0	1.952E2	5.738E-5	1.198E-4	1.731E-11	3.416E-3	A
A	27	0.000E0	-9.186E1	-5.074E-6	1.605E-4	-6.253E-13	1.536E-3	A
A	28	0.000E0	-9.189E1	9.429E-9	2.012E-4	-1.681E-13	-6.810E-4	A
A	29	0.000E0	1.953E2	-9.667E-8	2.419E-4	1.665E-13	-2.562E-3	A
A	30	0.000E0	-1.958E2	-2.654E-6	2.826E-4	5.944E-14	-4.484E-3	A
A	31	0.000E0	1.043E2	4.059E-5	3.233E-4	-1.055E-11	-6.448E-3	A
A	32	0.000E0	-1.303E1	-2.374E-4	3.640E-4	1.071E-10	-8.117E-3	A
A	33	0.000E0	1.255E1	-4.337E-4	4.047E-4	-3.669E-10	-9.826E-3	A
A	34	0.000E0	-9.194E1	2.181E-2	4.454E-4	-3.886E-9	-1.157E-2	A
A	35	0.000E0	9.128E1	-1.992E-1	4.861E-4	6.771E-8	-1.307E-2	A
A	36	0.000E0	1.212E1	5.239E-1	5.268E-4	-4.340E-7	-1.431E-2	A
A	37	0.000E0	-2.201E2	8.908E0	5.675E-4	-3.218E-7	-1.567E-2	A
A	38	0.000E0	5.744E2	-1.322E2	6.082E-4	3.489E-5	-1.640E-2	A
A	39	0.000E0	-1.473E3	7.517E2	6.489E-4	-3.456E-4	-1.779E-2	A
A	40	0.000E0	-1.619E3	1.641E3	6.896E-4	1.123E-3	-1.654E-2	A
A	41	0.000E0	3.281E3	-1.638E3	6.230E-4	1.111E-3	-1.639E-2	A
A	42	0.000E0	-9.382E3	-7.805E2	3.096E-4	-3.242E-4	-2.309E-2	A
A								A

A===A

L===L
L=== MEMBER LOADS OF COMBINED CASE 1 ===L
L==L
L L
L H.B. ROBINSON 30 CW-11 UNDERGROUND WATER PIPE L
L VERTICAL SEISMIC (1/2 SINE WAVE END TO END) L
L L
L ---LOCAL MEMBER END LOADS--- L

L	M	N	AXIAL	X2SHEAR	X3SHEAR	TORSN	X2MOM	X3MOM	L
L	1	1	-2.819E-1	-2.077E1	-4.396E0	-7.365E-4	6.681E-6	-3.159E-5	L
L	1	2	2.819E-1	2.077E1	4.396E0	7.365E-4	1.299E3	-6.136E3	L
L	2	2	-5.495E-1	6.264E1	7.472E0	-1.401E3	-7.284E2	6.070E3	L
L	2	3	5.495E-1	-6.264E1	-7.472E0	1.401E3	-2.130E2	1.823E3	L
L	3	3	-8.243E-1	-1.357E2	-1.617E1	-1.401E3	2.130E2	-1.823E3	L
L	3	4	8.243E-1	1.357E2	1.617E1	1.401E3	3.572E3	-2.993E4	L
L	4	4	-1.222E0	7.376E2	2.149E2	-2.193E4	-5.787E3	1.990E4	L
L	4	5	1.222E0	-7.376E2	-2.149E2	2.193E4	-1.929E4	6.617E4	L
L	5	5	-1.374E0	-1.597E2	6.779E0	-6.363E4	-1.461E3	-3.436E4	L
L	5	6	1.374E0	1.597E2	-6.779E0	6.363E4	-1.253E2	-3.017E3	L
L	6	6	-1.649E0	1.275E1	-5.518E-1	-6.363E4	1.253E2	- 3.017E3	L
L	6	7	1.649E0	-1.275E1	5.518E-1	6.363E4	3.815E0	-3.422E1	L
L	7	7	-1.923E0	3.426E0	2.075E0	-6.363E4	-3.815E0	3.422E1	L
L	7	8	1.923E0	-3.426E0	-2.075E0	6.363E4	-4.816E2	7.675E2	L

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L	M	N	AXIAL	X2SHEAR	X3SHEAR	TORSN	X2MOM	X3MOM	L
L	8	8	-2.198E0	-3.625E1	-2.241E1	-6.363E4	4.816E2	-7.675E2	L
L	8	9	2.198E0	3.625E1	2.241E1	6.363E4	4.763E3	-7.716E3	L
L	9	9	-2.473E0	1.579E2	8.567E1	-6.363E4	-4.763E3	7.716E3	L
L	9	10	2.473E0	-1.579E2	-8.567E1	6.363E4	-1.528E4	2.923E4	L
L	10	10	-2.748E0	9.442E2	7.205E2	-6.363E4	1.528E4	-2.923E4	L
L	10	11	2.748E0	-9.442E2	-7.205E2	6.363E4	-9.742E4	1.369E5	L
L	11	11	-1.833E3	-1.761E3	-6.955E2	9.567E3	1.063E5	-1.445E5	L
L	11	12	1.833E3	1.761E3	6.955E2	-9.567E3	9.637E2	-1.269E5	L
L	12	12	-1.254E2	6.020E2	5.768E1	-7.743E3	-1.149E4	1.266E5	L
L	12	13	1.254E2	-6.020E2	-5.768E1	7.743E3	-2.051E3	1.477E4	L
L	13	13	1.423E3	-6.612E1	-1.473E1	-7.743E3	2.051E3	-1.477E4	L
L	13	14	-1.423E3	6.612E1	1.473E1	7.743E3	1.386E3	-6.544E2	L
L	14	14	3.279E3	3.814E1	-4.579E1	-7.743E3	-1.386E3	6.544E2	L
L	14	15	-3.279E3	-3.814E1	4.579E1	7.743E3	1.214E4	8.299E3	L
L	15	15	5.849E3	-3.445E2	-2.709E1	-7.743E3	-1.214E4	-8.299E3	L
L	15	16	-5.849E3	3.445E2	2.709E1	7.743E3	1.846E4	-7.209E4	L
L	16	16	9.682E3	9.287E2	1.349E2	-7.743E3	-1.846E4	7.209E4	L
L	16	17	-9.682E3	-9.287E2	-1.349E2	7.743E3	-6.340E3	9.865E4	L
L	17	17	7.503E3	-5.742E2	-2.503E2	-9.918E2	9.958E3	-9.865E4	L
L	17	18	-7.503E3	5.742E2	2.503E2	9.918E2	4.862E4	-3.571E4	L
L	18	18	7.503E3	1.690E2	2.158E1	-9.918E2	-4.862E4	3.571E4	L
L	18	19	-7.503E3	-1.690E2	-2.158E1	9.918E2	4.357E4	3.845E3	L
L	19	19	7.503E3	-1.672E1	1.143E2	-9.918E2	-4.357E4	-3.845E3	L
L	19	20	-7.503E3	1.672E1	-1.143E2	9.918E2	1.681E4	-6.827E1	L
L	20	20	7.503E3	1.077E-1	-2.762E2	-9.918E2	-1.681E4	6.827E1	L
L	20	21	-7.503E3	-1.077E-1	2.762E2	9.918E2	8.144E4	-4.305E1	L
L	21	21	7.503E3	2.148E-1	2.072E2	-9.918E2	-8.144E4	4.305E1	L
L	21	22	-7.503E3	-2.148E-1	-2.072E2	9.918E2	3.295E4	7.217E0	L
L	22	22	7.503E3	-3.280E-2	-1.055E2	-9.918E2	-3.295E4	-7.217E0	L
L	22	23	-7.503E3	3.280E-2	1.055E2	9.918E2	5.763E4	-4.585E-1	L
L	23	23	7.503E3	1.820E-3	2.449E1	-9.918E2	-5.763E4	4.585E-1	L
L	23	24	-7.503E3	-1.820E-3	-2.449E1	9.918E2	5.190E4	-3.265E-2	L
L	24	24	7.503E3	1.869E-4	-9.275E1	-9.918E2	-5.190E4	3.265E-2	L
L	24	25	-7.503E3	-1.869E-4	9.275E1	9.918E2	7.361E4	1.108E-2	L
L	25	25	7.503E3	-5.233E-5	1.033E2	-9.918E2	-7.361E4	-1.108E-2	L
L	25	26	-7.503E3	5.233E-5	-1.033E2	9.918E2	4.943E4	-1.165E-3	L
L	26	26	7.503E3	5.052E-6	-9.186E1	-9.918E2	-4.943E4	1.165E-3	L
L	26	27	-7.503E3	-5.052E-6	9.186E1	9.918E2	7.093E4	1.714E-5	L
L	27	27	7.503E3	-2.149E-8	-1.646E-3	-9.918E2	-7.093E4	-1.714E-5	L
L	27	28	-7.503E3	2.149E-8	1.646E-3	9.918E2	7.093E4	1.212E-5	L
L	28	28	7.503E3	-1.206E-8	9.188E1	-9.918E2	-7.093E4	-1.212E-5	L
L	28	29	-7.503E3	1.206E-8	-9.188E1	9.918E2	4.943E4	9.296E-6	L
L	29	29	7.503E3	-1.087E-7	-1.034E2	-9.918E2	-4.943E4	-9.296E-6	L
L	29	30	-7.503E3	1.087E-7	1.034E2	9.918E2	7.363E4	-1.615E-5	L
L	30	30	7.503E3	-2.763E-6	9.237E1	-9.918E2	-7.363E4	1.615E-5	L
L	30	31	-7.503E3	2.763E-6	-9.237E1	9.918E2	5.202E4	-6.627E-4	L
L	31	31	7.503E3	3.783E-5	-1.197E1	-9.918E2	-5.202E4	6.627E-4	L
L	31	32	-7.503E3	-3.783E-5	1.197E1	9.918E2	5.482E4	8.189E-3	L
L	32	32	7.503E3	-1.996E-4	1.061E0	-9.918E2	-5.482E4	-8.189E-3	L
L	32	33	-7.503E3	1.996E-4	-1.061E0	9.918E2	5.457E4	-3.852E-2	L
L	33	33	7.503E3	-6.333E-4	-1.149E1	-9.918E2	-5.457E4	3.852E-2	L
L	33	34	-7.503E3	6.333E-4	1.149E1	9.918E2	5.726E4	-1.867E-1	L
L	34	34	7.503E3	2.118E-2	8.045E1	-9.918E2	-5.726E4	1.867E-1	L
L	34	35	-7.503E3	-2.118E-2	-8.045E1	9.918E2	3.843E4	4.769E0	L
L	35	35	7.503E3	-1.780E-1	-1.082E1	-9.918E2	-3.843E4	-4.769E0	L
L	35	36	-7.503E3	1.780E-1	1.082E1	9.918E2	4.096E4	-3.688E1	L

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L	M	N	AXIAL	X2SHEAR	X3SHEAR	TORSN	X2MOM	X3MOM	L
L	36	36	7.503E3	3.459E-1	-2.295E1	-9.918E2	-4.096E4	3.688E1	L
L	36	37	-7.503E3	-3.459E-1	2.295E1	9.918E2	4.633E4	4.406E1	L
L	37	37	7.503E3	9.253E0	1.971E2	-9.918E2	-4.633E4	-4.406E1	L
L	37	38	-7.503E3	-9.253E0	-1.971E2	9.918E2	2.095E2	2.209E3	L
L	38	38	7.503E3	-1.229E2	-3.772E2	-9.918E2	-2.095E2	-2.209E3	L
L	38	39	-7.503E3	1.229E2	3.772E2	9.918E2	8.848E4	-2.656E4	L
L	39	39	7.503E3	6.288E2	1.096E3	-9.918E2	-8.848E4	2.656E4	L
L	39	40	-7.503E3	-6.288E2	-1.096E3	9.918E2	-1.679E5	1.206E5	L
L	40	40	7.416E3	-3.477E3	-1.315E3	6.644E3	7.381E4	-1.930E5	L
L	40	41	-7.416E3	3.477E3	1.315E3	-6.644E3	6.667E4	-1.785E5	L
L	41	41	7.503E3	6.471E2	-5.488E2	7.637E3	-1.514E5	1.156E5	L
L	41	42	-7.503E3	-6.471E2	5.488E2	-7.637E3	2.798E5	3.579E4	L
L	42	42	7.503E3	-3.949E2	8.808E3	7.637E3	-2.798E5	-3.579E4	L
L	42	43	-7.503E3	3.949E2	-8.808E3	-7.637E3	-1.781E6	-5.662E4	L
L									L

L===L

S===S
S=== MEMBER STRESSES OF COMBINED CASE 1 ===S
S===S
S S
S H.B. ROBINSON 30 CW-11 UNDERGROUND WATER PIPE S
S VERTICAL SEISMIC (1/2 SINE WAVE END TO END) S
S S
S ---LOCAL MEMBER END STRESSES--- S

S	M	N	AXIAL	X2SHEAR	X3SHEAR	TORSN	X2BEND	X3BEND	S
S	1	1	1.305E-2	-2.182E0	-4.620E-1	2.203E-6	-3.997E-8	-1.890E-7	S
S	1	2	1.305E-2	-2.182E0	-4.620E-1	2.203E-6	7.771E0	3.671E1	S
S	2	2	2.544E-2	6.583E0	7.852E-1	4.191E0	4.358E0	3.632E1	S
S	2	3	2.544E-2	6.583E0	7.852E-1	4.191E0	-1.275E0	-1.091E1	S
S	3	3	3.816E-2	-1.426E1	-1.700E0	4.191E0	-1.275E0	-1.091E1	S
S	3	4	3.816E-2	-1.426E1	-1.700E0	4.191E0	2.137E1	1.791E2	S
S	4	4	5.657E-2	7.751E1	2.259E1	6.560E1	3.463E1	1.191E2	S
S	4	5	5.657E-2	7.751E1	2.259E1	6.560E1	-1.154E2	-3.959E2	S
S	5	5	6.360E-2	-1.679E1	7.124E-1	1.904E2	8.742E0	-2.056E2	S
S	5	6	6.360E-2	-1.679E1	7.124E-1	1.904E2	-7.497E-1	1.805E1	S
S	6	6	7.633E-2	1.339E0	-5.799E-2	1.904E2	-7.497E-1	1.805E1	S
S	6	7	7.633E-2	1.339E0	-5.799E-2	1.904E2	2.283E-2	2.047E-1	S
S	7	7	8.905E-2	3.601E-1	2.180E-1	1.904E2	2.283E-2	2.047E-1	S
S	7	8	8.905E-2	3.601E-1	2.180E-1	1.904E2	-2.882E0	-4.592E0	S
S	8	8	1.018E-1	-3.810E0	-2.355E0	1.904E2	-2.882E0	-4.592E0	S
S	8	9	1.018E-1	-3.810E0	-2.355E0	1.904E2	2.850E1	4.617E1	S
S	9	9	1.145E-1	1.659E1	9.004E0	1.904E2	2.850E1	4.617E1	S
S	9	10	1.145E-1	1.659E1	9.004E0	1.904E2	-9.145E1	-1.749E2	S
S	10	10	1.272E-1	9.922E1	7.572E1	1.904E2	-9.145E1	-1.749E2	S
S	10	11	1.272E-1	9.922E1	7.572E1	1.904E2	-5.829E2	-8.189E2	S
S	11	11	8.485E1	-1.851E2	-7.309E1	-2.862E1	-6.358E2	-8.648E2	S
S	11	12	8.485E1	-1.851E2	-7.309E1	-2.862E1	5.766E0	7.595E2	S
S	12	12	5.808E0	6.327E1	6.062E0	2.316E1	6.875E1	7.572E2	S
S	12	13	5.808E0	6.327E1	6.062E0	2.316E1	-1.227E1	-8.839E1	S
S	13	13	-6.589E1	-6.948E0	-1.548E0	2.316E1	-1.227E1	-8.839E1	S
S	13	14	-6.589E1	-6.948E0	-1.548E0	2.316E1	8.293E0	3.916E0	S
S	14	14	-1.518E2	4.008E0	-4.812E0	2.316E1	8.293E0	3.916E0	S
S	14	15	-1.518E2	4.008E0	-4.812E0	2.316E1	7.261E1	-4.966E1	S
S	15	15	-2.708E2	-3.621E1	-2.847E0	2.316E1	7.261E1	-4.966E1	S
S	15	16	-2.708E2	-3.621E1	-2.847E0	2.316E1	1.104E2	4.314E2	S

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S	M	N	AXIAL	X2SHEAR	X3SHEAR	TORSN	X2BEND	X3BEND	S
S	16	16	-4.482E2	9.760E1	1.418E1	2.316E1	1.104E2	4.314E2	S
S	16	17	-4.482E2	9.760E1	1.418E1	2.316E1	-3.793E1	-5.903E2	S
S	17	17	-3.474E2	-6.034E1	-2.631E1	2.967E0	-5.958E1	-5.903E2	S
S	17	18	-3.474E2	-6.034E1	-2.631E1	2.967E0	2.909E2	2.136E2	S
S	18	18	-3.474E2	1.776E1	2.268E0	2.967E0	2.909E2	2.136E2	S
S	18	19	-3.474E2	1.776E1	2.268E0	2.967E0	2.607E2	-2.301E1	S
S	19	19	-3.474E2	-1.758E0	1.202E1	2.967E0	2.607E2	-2.301E1	S
S	19	20	-3.474E2	-1.758E0	1.202E1	2.967E0	1.006E2	4.085E-1	S
S	20	20	-3.474E2	1.132E-2	-2.902E1	2.967E0	1.006E2	4.085E-1	S
S	20	21	-3.474E2	1.132E-2	-2.902E1	2.967E0	4.873E2	2.576E-1	S
S	21	21	-3.474E2	2.258E-2	2.177E1	2.967E0	4.873E2	2.576E-1	S
S	21	22	-3.474E2	2.258E-2	2.177E1	2.967E0	1.972E2	-4.318E-2	S
S	22	22	-3.474E2	-3.447E-3	-1.108E1	2.967E0	1.972E2	-4.318E-2	S
S	22	23	-3.474E2	-3.447E-3	-1.108E1	2.967E0	3.448E2	2.744E-3	S
S	23	23	-3.474E2	1.913E-4	2.573E0	2.967E0	3.448E2	2.744E-3	S
S	23	24	-3.474E2	1.913E-4	2.573E0	2.967E0	3.106E2	1.954E-4	S
S	24	24	-3.474E2	1.964E-5	-9.748E0	2.967E0	3.106E2	1.954E-4	S
S	24	25	-3.474E2	1.964E-5	-9.748E0	2.967E0	4.404E2	-6.630E-5	S
S	25	25	-3.474E2	-5.500E-6	1.086E1	2.967E0	4.404E2	-6.630E-5	S
S	25	26	-3.474E2	-5.500E-6	1.086E1	2.967E0	2.958E2	6.971E-6	S
S	26	26	-3.474E2	5.310E-7	-9.654E0	2.967E0	2.958E2	6.971E-6	S
S	26	27	-3.474E2	5.310E-7	-9.654E0	2.967E0	4.244E2	-1.026E-7	S
S	27	27	-3.474E2	-2.258E-9	-1.730E-4	2.967E0	4.244E2	-1.026E-7	S
S	27	28	-3.474E2	-2.258E-9	-1.730E-4	2.967E0	4.244E2	-7.250E-8	S
S	28	28	-3.474E2	-1.267E-9	9.656E0	2.967E0	4.244E2	-7.250E-8	S
S	28	29	-3.474E2	-1.267E-9	9.656E0	2.967E0	2.957E2	-5.562E-8	S
S	29	29	-3.474E2	-1.143E-8	-1.087E1	2.967E0	2.957E2	-5.562E-8	S
S	29	30	-3.474E2	-1.143E-8	-1.087E1	2.967E0	4.405E2	9.661E-8	S
S	30	30	-3.474E2	-2.904E-7	9.707E0	2.967E0	4.405E2	9.661E-8	S
S	30	31	-3.474E2	-2.904E-7	9.707E0	2.967E0	3.112E2	3.965E-6	S
S	31	31	-3.474E2	3.975E-6	-1.258E0	2.967E0	3.112E2	3.965E-6	S
S	31	32	-3.474E2	3.975E-6	-1.258E0	2.967E0	3.280E2	-4.900E-5	S
S	32	32	-3.474E2	-2.098E-5	1.115E-1	2.967E0	3.280E2	-4.900E-5	S
S	32	33	-3.474E2	-2.098E-5	1.115E-1	2.967E0	3.265E2	2.305E-4	S
S	33	33	-3.474E2	-6.656E-5	-1.207E0	2.967E0	3.265E2	2.305E-4	S
S	33	34	-3.474E2	-6.656E-5	-1.207E0	2.967E0	3.426E2	1.117E-3	S
S	34	34	-3.474E2	2.226E-3	8.455E0	2.967E0	3.426E2	1.117E-3	S
S	34	35	-3.474E2	2.226E-3	8.455E0	2.967E0	2.299E2	-2.853E-2	S
S	35	35	-3.474E2	-1.871E-2	-1.138E0	2.967E0	2.299E2	-2.853E-2	S
S	35	36	-3.474E2	-1.871E-2	-1.138E0	2.967E0	2.451E2	2.207E-1	S
S	36	36	-3.474E2	3.635E-2	-2.411E0	2.967E0	2.451E2	2.207E-1	S
S	36	37	-3.474E2	3.635E-2	-2.411E0	2.967E0	2.772E2	-2.636E-1	S
S	37	37	-3.474E2	9.725E-1	2.071E1	2.967E0	2.772E2	-2.636E-1	S
S	37	38	-3.474E2	9.725E-1	2.071E1	2.967E0	1.253E0	-1.322E1	S
S	38	38	-3.474E2	-1.292E1	-3.965E1	2.967E0	1.253E0	-1.322E1	S
S	38	39	-3.474E2	-1.292E1	-3.965E1	2.967E0	5.294E2	1.589E2	S
S	39	39	-3.474E2	6.608E1	1.152E2	2.967E0	5.294E2	1.589E2	S
S	39	40	-3.474E2	6.608E1	1.152E2	2.967E0	-1.005E3	-7.214E2	S
S	40	40	-3.433E2	-3.654E2	-1.382E2	-1.988E1	-4.416E2	-1.155E3	S
S	40	41	-3.433E2	-3.654E2	-1.382E2	-1.988E1	3.989E2	1.068E3	S
S	41	41	-3.474E2	6.800E1	-5.768E1	-2.285E1	9.058E2	6.918E2	S
S	41	42	-3.474E2	6.800E1	-5.768E1	-2.285E1	1.674E3	-2.142E2	S
S	42	42	-3.474E2	-4.150E1	9.257E2	-2.285E1	1.674E3	-2.142E2	S
S	42	43	-3.474E2	-4.150E1	9.257E2	-2.285E1	-1.066E4	3.388E2	S
S									S

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FRACTION OF SYSTEM NODE ALLOWABLES: COMBINED CASE 1

H.B. ROBINSON 30 CW-11 UNDERGROUND WATER PIPE
VERTICAL SEISMIC (1/2 SINE WAVE END TO END)

---SUMMARY OF FRACTION OF ALLOWABLE FOR EACH NODE---

N	DISPLACEMENT X	DISPLACEMENT Y	DISPLACEMENT Z	BASEPLATE COEFFICIENT
1	3.724E-18	1.108E-20	2.748E-15	0.000E0
2	1.479E-17	3.244E-21	2.748E-15	0.000E0
3	3.504E-17	2.643E-20	2.748E-15	0.000E0
4	1.588E-16	9.030E-20	2.748E-15	0.000E0
5	1.628E-16	9.664E-20	2.748E-15	0.000E0
6	3.029E-17	1.515E-20	2.748E-15	0.000E0
7	1.653E-18	3.918E-19	2.748E-15	0.000E0
8	6.775E-18	4.584E-18	2.748E-15	0.000E0
9	3.323E-17	2.037E-17	2.748E-15	0.000E0
10	1.331E-16	1.171E-16	2.748E-15	0.000E0
11	5.818E-16	3.229E-16	2.748E-15	0.000E0
12	4.807E-16	1.980E-14	8.971E-17	0.000E0
13	1.092E-16	5.001E-14	2.750E-16	0.000E0
14	2.432E-16	8.001E-14	2.173E-16	0.000E0
15	2.713E-16	1.100E-13	3.662E-16	0.000E0
16	6.335E-16	1.390E-13	3.176E-16	0.000E0
17	2.347E-15	1.611E-13	9.852E-16	0.000E0
18	2.633E-15	2.000E-13	1.304E-16	0.000E0
19	2.918E-15	2.360E-13	3.259E-17	0.000E0
20	3.203E-15	2.691E-13	2.953E-18	0.000E0
21	3.488E-15	2.999E-13	1.879E-20	0.000E0
22	3.774E-15	3.261E-13	4.345E-20	0.000E0
23	4.059E-15	3.490E-13	6.074E-21	0.000E0
24	4.344E-15	3.680E-13	2.865E-22	0.000E0
25	4.630E-15	3.830E-13	4.197E-23	0.000E0
26	4.915E-15	3.930E-13	1.007E-23	0.000E0
27	5.200E-15	3.990E-13	8.901E-25	0.000E0
28	5.485E-15	4.000E-13	1.654E-27	0.000E0
29	5.771E-15	3.960E-13	1.696E-26	0.000E0
30	6.056E-15	3.880E-13	4.657E-25	0.000E0
31	6.341E-15	3.750E-13	7.121E-24	0.000E0
32	6.627E-15	3.580E-13	4.166E-23	0.000E0
33	6.912E-15	3.370E-13	7.609E-23	0.000E0
34	7.197E-15	3.120E-13	3.826E-21	0.000E0
35	7.482E-15	2.830E-13	3.494E-20	0.000E0
36	7.768E-15	2.510E-13	9.191E-20	0.000E0
37	8.053E-15	2.160E-13	1.563E-18	0.000E0
38	8.338E-15	1.781E-13	2.319E-17	0.000E0
39	8.624E-15	1.387E-13	1.319E-16	0.000E0
40	8.909E-15	9.672E-14	2.878E-16	0.000E0
41	5.656E-16	8.658E-14	2.873E-16	0.000E0
42	2.803E-16	4.135E-14	1.369E-16	0.000E0
43	0.000E0	0.000E0	0.000E0	0.000E0
44	0.000E0	0.000E0	0.000E0	0.000E0

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FRACTION OF SYSTEM MEMBER ALLOWABLES: COMBINED CASE 1

H.B. ROBINSON 30 CW-11 UNDERGROUND WATER PIPE
VERTICAL SEISMIC (1/2 SINE WAVE END TO END)

---SUMMARY OF FRACTION OF ALLOWABLE FOR EACH MEMBER---

	STRESS		BUCKLING		JOINT COEF.	
M	START	END	START	END	START	END
1	1.239E-16	1.648E-15	0.000E0	0.000E0	2.123E-12	1.568E-7
2	1.507E-15	6.012E-16	0.000E0	0.000E0	1.528E-7	4.589E-8
3	1.031E-15	7.424E-15	0.000E0	0.000E0	4.589E-8	7.534E-7
4	8.130E-15	1.894E-14	0.000E0	0.000E0	5.181E-7	1.723E-6
5	1.151E-14	1.151E-14	0.000E0	0.000E0	8.599E-7	7.548E-8
6	1.065E-14	1.065E-14	0.000E0	0.000E0	7.548E-8	8.608E-10
7	1.060E-14	1.060E-14	0.000E0	0.000E0	8.608E-10	2.265E-8
8	1.082E-14	1.082E-14	0.000E0	0.000E0	2.265E-8	2.267E-7
9	1.162E-14	1.162E-14	0.000E0	0.000E0	2.267E-7	8.246E-7
10	1.751E-14	5.192E-14	0.000E0	0.000E0	8.246E-7	4.200E-6
11	5.872E-14	3.149E-14	0.000E0	0.000E0	4.485E-6	3.174E-6
12	3.081E-14	4.818E-15	0.000E0	0.000E0	3.177E-6	3.729E-7
13	6.169E-15	2.892E-15	0.000E0	0.000E0	3.729E-7	3.832E-8
14	6.075E-15	1.015E-14	0.000E0	0.000E0	3.832E-8	3.676E-7
15	1.456E-14	3.010E-14	0.000E0	0.000E0	3.676E-7	1.860E-6
16	3.667E-14	3.987E-14	0.000E0	0.000E0	1.860E-6	2.471E-6
17	3.693E-14	3.155E-14	0.000E0	0.000E0	2.479E-6	1.508E-6
18	3.155E-14	2.337E-14	0.000E0	0.000E0	1.508E-6	1.094E-6
19	2.337E-14	1.661E-14	0.000E0	0.000E0	1.094E-6	4.204E-7
20	1.661E-14	3.092E-14	0.000E0	0.000E0	4.204E-7	2.036E-6
21	3.092E-14	2.017E-14	0.000E0	0.000E0	2.036E-6	8.239E-7
22	2.017E-14	2.564E-14	0.000E0	0.000E0	8.239E-7	1.441E-6
23	2.564E-14	2.437E-14	0.000E0	0.000E0	1.441E-6	1.298E-6
24	2.437E-14	2.918E-14	0.000E0	0.000E0	1.298E-6	1.840E-6
25	2.918E-14	2.382E-14	0.000E0	0.000E0	1.840E-6	1.236E-6
26	2.382E-14	2.858E-14	0.000E0	0.000E0	1.236E-6	1.773E-6
27	2.858E-14	2.858E-14	0.000E0	0.000E0	1.773E-6	1.773E-6
28	2.858E-14	2.382E-14	0.000E0	0.000E0	1.773E-6	1.236E-6
29	2.382E-14	2.918E-14	0.000E0	0.000E0	1.236E-6	1.841E-6
30	2.918E-14	2.439E-14	0.000E0	0.000E0	1.841E-6	1.300E-6
31	2.439E-14	2.501E-14	0.000E0	0.000E0	1.300E-6	1.370E-6
32	2.501E-14	2.496E-14	0.000E0	0.000E0	1.370E-6	1.364E-6
33	2.496E-14	2.555E-14	0.000E0	0.000E0	1.364E-6	1.431E-6
34	2.555E-14	2.138E-14	0.000E0	0.000E0	1.431E-6	9.608E-7
35	2.138E-14	2.195E-14	0.000E0	0.000E0	9.608E-7	1.024E-6
36	2.195E-14	2.314E-14	0.000E0	0.000E0	1.024E-6	1.158E-6
37	2.314E-14	1.340E-14	0.000E0	0.000E0	1.158E-6	5.548E-8
38	1.340E-14	3.836E-14	0.000E0	0.000E0	5.548E-8	2.310E-6
39	3.836E-14	7.680E-14	0.000E0	0.000E0	2.310E-6	5.169E-6
40	7.184E-14	6.704E-14	0.000E0	0.000E0	5.166E-6	4.763E-6
41	7.203E-14	8.280E-14	0.000E0	0.000E0	4.762E-6	7.052E-6
42	8.280E-14	4.202E-13	0.000E0	0.000E0	0.000E0	0.000E0

QUALIFICATION SUMMARY REPORT

H.B. ROBINSON 30 CW-11 UNDERGROUND WATER PIPE

---PLANT IDENTIFICATION---

UTILITY: CPL
PLANT: H.B.ROBINSON
PWR_____
NSSS:
A/E:
BWR_____

---EQUIPMENT IDENTIFICATION---

SYSTEM:
DRAWING NO.:
BUILDING:
ELEVATION:
ADDITIONAL IDENTIFICATION:

---APPLIED LOADS---

DEADWEIGHT:_____
THERMAL:_____
RELATIVE DISP.:_____
SEISMIC:_____
HYDRODYNAMIC:_____

---LOAD COMBINATION---

VERTICAL 4 INCH MIDSPAN DISPLACEMENT OF PIPE RUN

---SUMMARY OF RESULTS---

---MAXIMUM FRACTION OF ALLOWABLE---

COMPONENT	FAILURE MODE	ALLOWABLE	MAX. FRACTION	PASS/FAIL
SYSTEM	JOINT	1.000E0	7.052E-6	PASS

COMMENTS:
JOINT MAX. FRACTION = REALATIVE JOINT ROTATION (RAD.)
JOINT KTRANS=3E8 LB/IN JOINT KTORS,KROT2,KROT3=4E10 IN-LB.
....GROUND SPRING PER 19.5 FT. PIPE SEGMENT SET AT 5.7E5 LB/IN.
....DISPLACEMENTS ARE IMPOSED ON GROUNDED END OF NODAL GROUND SPRINGS.

PREPARED BY: D Lindley CO: CCL DATE: 12-4-90

VERIFIED BY: [signature] CO: CCL DATE: 12-7-90

N	NODE	XT	YT	ZT	XR	YR	ZR	JTYPE	BXYZ	CALC	BANDWIDTH: 12	N
N	1	0	0	0	0	0	0	-2	B123	0		N
N	2	0	0	0	0	0	0	-2	B123	0		N
N	3	0	0	0	0	0	0	-2	B123	0		N
N	4	0	0	0	0	0	0	-2	B123	0		N
N	5	0	0	0	0	0	0	-2	B123	0		N
N	6	0	0	0	0	0	0	-2	B123	0		N
N	7	0	0	0	0	0	0	-2	B123	0		N
N	8	0	0	0	0	0	0	-2	B123	0		N
N	9	0	0	0	0	0	0	-2	B123	0		N
N	10	0	0	0	0	0	0	-2	B123	0		N
N	11	0	0	0	0	0	0	-2	B123	0		N
N	12	0	0	0	0	0	0	-3	B123	0		N
N	13	0	0	0	0	0	0	-3	B123	0		N
N	14	0	0	0	0	0	0	-3	B123	0		N
N	15	0	0	0	0	0	0	-3	B123	0		N
N	16	0	0	0	0	0	0	-3	B123	0		N
N	17	0	0	0	0	0	0	-4	B123	0		N
N	18	0	0	0	0	0	0	-4	B123	0		N
N	19	0	0	0	0	0	0	-4	B123	0		N
N	20	0	0	0	0	0	0	-4	B123	0		N
N	21	0	0	0	0	0	0	-4	B123	0		N
N	22	0	0	0	0	0	0	-4	B123	0		N
N	23	0	0	0	0	0	0	-4	B123	0		N
N	24	0	0	0	0	0	0	-4	B123	0		N
N	25	0	0	0	0	0	0	-4	B123	0		N
N	26	0	0	0	0	0	0	-4	B123	0		N
N	27	0	0	0	0	0	0	-4	B123	0		N
N	28	0	0	0	0	0	0	-4	B123	0		N
N	29	0	0	0	0	0	0	-4	B123	0		N
N	30	0	0	0	0	0	0	-4	B123	0		N
N	31	0	0	0	0	0	0	-4	B123	0		N
N	32	0	0	0	0	0	0	-4	B123	0		N
N	33	0	0	0	0	0	0	-4	B123	0		N
N	34	0	0	0	0	0	0	-4	B123	0		N
N	35	0	0	0	0	0	0	-4	B123	0		N
N	36	0	0	0	0	0	0	-4	B123	0		N
N	37	0	0	0	0	0	0	-4	B123	0		N
N	38	0	0	0	0	0	0	-4	B123	0		N
N	39	0	0	0	0	0	0	-4	B123	0		N
N	40	0	0	0	0	0	0	-4	B123	0		N
N	41	0	0	0	0	0	0	-4	B123	0		N
N	42	0	0	0	0	0	0	-4	B123	0		N
N	43	-1	-1	-1	-1	-1	-1	0	B 0	0		N
N	44	-1	-1	-1	-1	-1	-1	0	B 0	0		N

JOINT AND SPRING DATA TABLE

H.B. ROBINSON 30 CW-11 UNDERGROUND WATER PIPE

--- JOINT SPRING RATES ---

JTYPE	K1	K2	K3	K4	K5	K6
-5	6.300E8	-1.000E0	-1.000E0	7.600E10	7.600E10	7.600E10

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J	JTYPE	K1	K2	K3	K4	K5	K6	J
J	-4	0.000E0	5.700E5	5.700E5	1.000E1	1.000E1	1.000E1	J
J	-3	5.700E5	5.700E5	5.700E5	1.000E1	1.000E1	1.000E1	J
J	-2	5.700E5	5.700E5	1.000E1	1.000E1	1.000E1	1.000E1	J

--- JOINT ALLOWABLE LOADS ---

J	JTYPE	A1	A2	A3	A4	A5	A6	J
J	-5	1.000E19	1.000E13	1.000E13	1.000E19	7.600E10	7.600E10	J
J	-4	1.000E1	1.000E1	1.000E1	1.000E1	1.000E1	1.000E1	J
J	-3	1.000E1	1.000E1	1.000E1	1.000E1	1.000E1	1.000E1	J
J	-2	1.000E1	1.000E1	1.000E1	1.000E1	1.000E1	1.000E1	J

---- JOINT WEIGHT AND CALC X VALUE ----

JTYPE	JOINT WT.	X VALUE
-5	0.000E0	2.000E0
-4	0.000E0	0.000E0
-3	0.000E0	0.000E0
-2	0.000E0	0.000E0

J===J

M===M

M=== MEMBER DATA TABLE ===M

M===M

H.B. ROBINSON 30 CW-11 UNDERGROUND WATER PIPE

--- PRIMARY MEMBER DATA ---

M	MEM	FROM	TO	PTYPE	RNODE	BANK	KFAC	QFAC	LENGTH	M
M	1	1	2	1	44	0.00E0	0.00E0	1.00E0	2.955E2	M
M	2	2	3	1	44	0.00E0	0.00E0	1.00E0	1.260E2	M
M	3	3	4	1	44	0.00E0	0.00E0	1.00E0	2.340E2	M
M	4	4	5	1	44	0.00E0	0.00E0	1.00E0	1.167E2	M
M	5	5	6	1	44	0.00E0	0.00E0	1.00E0	2.340E2	M
M	6	6	7	1	44	0.00E0	0.00E0	1.00E0	2.340E2	M
M	7	7	8	1	44	0.00E0	0.00E0	1.00E0	2.340E2	M
M	8	8	9	1	44	0.00E0	0.00E0	1.00E0	2.340E2	M
M	9	9	10	1	44	0.00E0	0.00E0	1.00E0	2.340E2	M
M	10	10	11	1	44	0.00E0	0.00E0	1.00E0	1.140E2	M
M	11	11	12	1	44	0.00E0	0.00E0	1.00E0	1.542E2	M
M	12	12	13	1	44	0.00E0	0.00E0	1.00E0	2.348E2	M
M	13	13	14	1	44	0.00E0	0.00E0	1.00E0	2.333E2	M
M	14	14	15	1	44	0.00E0	0.00E0	1.00E0	2.348E2	M
M	15	15	16	1	44	0.00E0	0.00E0	1.00E0	2.333E2	M
M	16	16	17	1	44	0.00E0	0.00E0	1.00E0	1.838E2	M
M	17	17	18	1	44	0.00E0	0.00E0	1.00E0	2.340E2	M
M	18	18	19	1	44	0.00E0	0.00E0	1.00E0	2.340E2	M
M	19	19	20	1	44	0.00E0	0.00E0	1.00E0	2.340E2	M
M	20	20	21	1	44	0.00E0	0.00E0	1.00E0	2.340E2	M
M	21	21	22	1	44	0.00E0	0.00E0	1.00E0	2.340E2	M
M	22	22	23	1	44	0.00E0	0.00E0	1.00E0	2.340E2	M
M	23	23	24	1	44	0.00E0	0.00E0	1.00E0	2.340E2	M
M	24	24	25	1	44	0.00E0	0.00E0	1.00E0	2.340E2	M
M	25	25	26	1	44	0.00E0	0.00E0	1.00E0	2.340E2	M
M	26	26	27	1	44	0.00E0	0.00E0	1.00E0	2.340E2	M
M	27	27	28	1	44	0.00E0	0.00E0	1.00E0	2.340E2	M
M	28	28	29	1	44	0.00E0	0.00E0	1.00E0	2.340E2	M

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M	MEM	FROM	TO	PTYPE	RNODE	BANK	KFAC	QFAC	LENGTH	M
M	29	29	30	1	44	0.00E0	0.00E0	1.00E0	2.340E2	M
M	30	30	31	1	44	0.00E0	0.00E0	1.00E0	2.340E2	M
M	31	31	32	1	44	0.00E0	0.00E0	1.00E0	2.340E2	M
M	32	32	33	1	44	0.00E0	0.00E0	1.00E0	2.340E2	M
M	33	33	34	1	44	0.00E0	0.00E0	1.00E0	2.340E2	M
M	34	34	35	1	44	0.00E0	0.00E0	1.00E0	2.340E2	M
M	35	35	36	1	44	0.00E0	0.00E0	1.00E0	2.340E2	M
M	36	36	37	1	44	0.00E0	0.00E0	1.00E0	2.340E2	M
M	37	37	38	1	44	0.00E0	0.00E0	1.00E0	2.340E2	M
M	38	38	39	1	44	0.00E0	0.00E0	1.00E0	2.340E2	M
M	39	39	40	1	44	0.00E0	0.00E0	1.00E0	2.340E2	M
M	40	40	41	1	44	0.00E0	0.00E0	1.00E0	1.068E2	M
M	41	41	42	1	44	0.00E0	0.00E0	1.00E0	2.340E2	M
M	42	42	43	2	44	0.00E0	0.00E0	1.00E0	2.340E2	M

M		--- FROM JOINT DATA ---			--- TO JOINT DATA ---			M
M	MEM	TYPE	HINGE	CALC	TYPE	HINGE	CALC	M
M	1	-5	111111	10	-5	111111	10	M
M	2	-5	111111	10	-5	111111	10	M
M	3	-5	111111	10	-5	111111	10	M
M	4	-5	111111	10	-5	111111	10	M
M	5	-5	111111	10	-5	111111	10	M
M	6	-5	111111	10	-5	111111	10	M
M	7	-5	111111	10	-5	111111	10	M
M	8	-5	111111	10	-5	111111	10	M
M	9	-5	111111	10	-5	111111	10	M
M	10	-5	111111	10	-5	111111	10	M
M	11	-5	111111	10	-5	111111	10	M
M	12	-5	111111	10	-5	111111	10	M
M	13	-5	111111	10	-5	111111	10	M
M	14	-5	111111	10	-5	111111	10	M
M	15	-5	111111	10	-5	111111	10	M
M	16	-5	111111	10	-5	111111	10	M
M	17	-5	111111	10	-5	111111	10	M
M	18	-5	111111	10	-5	111111	10	M
M	19	-5	111111	10	-5	111111	10	M
M	20	-5	111111	10	-5	111111	10	M
M	21	-5	111111	10	-5	111111	10	M
M	22	-5	111111	10	-5	111111	10	M
M	23	-5	111111	10	-5	111111	10	M
M	24	-5	111111	10	-5	111111	10	M
M	25	-5	111111	10	-5	111111	10	M
M	26	-5	111111	10	-5	111111	10	M
M	27	-5	111111	10	-5	111111	10	M
M	28	-5	111111	10	-5	111111	10	M
M	29	-5	111111	10	-5	111111	10	M
M	30	-5	111111	10	-5	111111	10	M
M	31	-5	111111	10	-5	111111	10	M
M	32	-5	111111	10	-5	111111	10	M
M	33	-5	111111	10	-5	111111	10	M
M	34	-5	111111	10	-5	111111	10	M
M	35	-5	111111	10	-5	111111	10	M
M	36	-5	111111	10	-5	111111	10	M
M	37	-5	111111	10	-5	111111	10	M
M	38	-5	111111	10	-5	111111	10	M
M	39	-5	111111	10	-5	111111	10	M

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M  MEM        TYPE    HINGE    CALC                  TYPE    HINGE    CALC         M
M   40          -5   111111     10                     -5   111111     10          M
M   41          -5   111111     10                     -5   111111     10          M
M                                                                                  M
M                        --- MEMBER PROPERTY DATA ---                              M
M PTYPE   AREA        J          I2          I3          H2          H3            M
M   1   2.160E1    5.248E3    2.624E3    2.624E3     3.140E1     3.140E1           M
M   2   2.160E1    5.248E3    2.624E3    2.624E3     3.140E1     3.140E1           M
M                                                                                  M
M                        --- MEMBER PROPERTY DATA ---                              M
M PTYPE  JRADIUS     SHAPE2     SHAPE3     STRESSF2    STRESSF3     DJPROP         M
M   1    1.570E1   4.400E-1   4.400E-1    2.270E0     2.270E0        -5            M
M   2    1.570E1   4.400E-1   4.400E-1    2.270E0     2.270E0         0            M
M                                                                                  M
M                        --- MEMBER PROPERTY DATA ---                              M
M PTYPE   EMOD       SMOD       YIELD      DENSITY      ALPHA                      M
M   1   2.900E7    1.100E7    3.000E16   1.610E0     6.000E-6                      M
M   2   2.900E7    1.100E7    3.000E16   1.610E0     6.000E-6                      M
M                                                                                  M
M==================================================================================M

  D==============================================================================D
 D===                            DESIGN PARAMETERS                             ===D
D=================================================================================D
D                                                                                 D
D H.B. ROBINSON 30 CW-11 UNDERGROUND WATER PIPE                                   D
D                                                                                 D
D   MEMBER DESIGN FACTOR:9.000E-1   ALLOWABLE X DISPLACEMENT:1.0000E13            D
D                                                                                 D
D   BPLATE DESIGN FACTOR:1.000E0    ALLOWABLE Y DISPLACEMENT:1.0000E13            D
D                                                                                 D
D    JOINT DESIGN FACTOR:1.000E0    ALLOWABLE Z DISPLACEMENT:1.0000E13            D
D                                                                                 D
D    SHEAR DESIGN FACTOR:6.000E-1            BUCKLING FACTOR:1.3300E0             D
D                                                                                 D
D GRAVITATIONAL CONSTANT:3.864E2        DIR. PENDULUM PIVOT:                      D
D                                                                                 D
D=================================================================================D

  C==============================================================================C
 C===                     APPLIED LOADS FOR STAT CASE  1                       ===C
C=================================================================================C
C                                                                                 C
C H.B. ROBINSON 30 CW-11 UNDERGROUND WATER PIPE                                   C
C VERTICAL 4 INCH RELATIVE GROND DISPLACEMENT MIDSPAN                             C
C                                                                                 C
C                                 ---GENERIC LOADS---                             C
C GX= 0.00E0    GY= 0.00E0    GZ= 0.00E0    GRAV=3.86E2    TDEL= 0.00E0           C
C                                                                                 C
C                       ---IMPOSED GROUND DISPLACEMENTS---                        C
C NODE      XT         YT         ZT         XR         YR          ZR              C
C   1      0E0        0E0        0E0        0E0        0E0         0E0             C
C   2      0E0        0E0        0E0        0E0        0E0         0E0             C
C   3      0E0        0E0        0E0        0E0        0E0         0E0             C
C   4      0E0        0E0        0E0        0E0        0E0         0E0             C
C   5      0E0        0E0        0E0        0E0        0E0         0E0             C
C   6      0E0        0E0        0E0        0E0        0E0         0E0             C
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NODE	XT	YT	ZT	XR	YR	ZR
7	0E0	0E0	0E0	0E0	0E0	0E0
8	0E0	0E0	0E0	0E0	0E0	0E0
9	0E0	0E0	0E0	0E0	0E0	0E0
10	0E0	0E0	0E0	0E0	0E0	0E0
11	0E0	0E0	0E0	0E0	0E0	0E0
12	0E0	2E-1	0E0	0E0	0E0	0E0
13	0E0	5E-1	0E0	0E0	0E0	0E0
14	0E0	8E-1	0E0	0E0	0E0	0E0
15	0E0	1E0	0E0	0E0	0E0	0E0
16	0E0	1E0	0E0	0E0	0E0	0E0
17	0E0	2E0	0E0	0E0	0E0	0E0
18	0E0	2E0	0E0	0E0	0E0	0E0
19	0E0	2E0	0E0	0E0	0E0	0E0
20	0E0	3E0	0E0	0E0	0E0	0E0
21	0E0	3E0	0E0	0E0	0E0	0E0
22	0E0	3E0	0E0	0E0	0E0	0E0
23	0E0	3E0	0E0	0E0	0E0	0E0
24	0E0	4E0	0E0	0E0	0E0	0E0
25	0E0	4E0	0E0	0E0	0E0	0E0
26	0E0	4E0	0E0	0E0	0E0	0E0
27	0E0	4E0	0E0	0E0	0E0	0E0
28	0E0	4E0	0E0	0E0	0E0	0E0
29	0E0	4E0	0E0	0E0	0E0	0E0
30	0E0	4E0	0E0	0E0	0E0	0E0
31	0E0	4E0	0E0	0E0	0E0	0E0
32	0E0	4E0	0E0	0E0	0E0	0E0
33	0E0	3E0	0E0	0E0	0E0	0E0
34	0E0	3E0	0E0	0E0	0E0	0E0
35	0E0	3E0	0E0	0E0	0E0	0E0
36	0E0	3E0	0E0	0E0	0E0	0E0
37	0E0	2E0	0E0	0E0	0E0	0E0
38	0E0	2E0	0E0	0E0	0E0	0E0
39	0E0	1E0	0E0	0E0	0E0	0E0
40	0E0	1E0	0E0	0E0	0E0	0E0
41	0E0	9E-1	0E0	0E0	0E0	0E0
42	0E0	4E-1	0E0	0E0	0E0	0E0

ANCHOR ANALYSIS OF COMBINED CASE 1

H.B. ROBINSON 30 CW-11 UNDERGROUND WATER PIPE
VERTICAL SEISMIC (1/2 SINE WAVE END TO END)

---NODAL DEFLECTIONS---

NODE	XT	YT	ZT	XR	YR	ZR
1	3.748E-5	1.104E-7	2.737E-2	5.586E-10	1.958E-5	7.090E-5
2	-1.491E-4	-3.139E-8	2.737E-2	6.768E-10	7.556E-6	7.366E-5
3	3.530E-4	-2.661E-7	2.737E-2	5.552E-9	3.950E-6	7.677E-5
4	-1.599E-3	-8.923E-7	2.737E-2	-1.536E-8	-4.019E-5	8.253E-5
5	1.641E-3	9.576E-7	2.737E-2	-1.649E-8	-4.428E-5	1.414E-4
6	-3.059E-4	1.580E-7	2.737E-2	1.345E-8	4.714E-6	4.029E-4
7	1.679E-5	-4.076E-6	2.737E-2	2.566E-8	-1.061E-7	6.644E-4
8	6.970E-5	4.708E-5	2.738E-2	-7.902E-7	1.048E-6	9.258E-4

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A	NODE	XT	YT	ZT	XR	YR	ZR	A
A	9	-3.404E-4	-2.084E-4	2.738E-2	6.461E-6	-9.710E-6	1.187E-3	A
A	10	-1.337E-3	-1.176E-3	2.738E-2	-1.158E-5	2.361E-5	1.449E-3	A
A	11	5.874E-3	3.255E-3	2.738E-2	-1.037E-4	1.481E-4	1.577E-3	A
A	12	-4.859E-3	1.980E-1	9.060E-4	-2.008E-4	1.536E-4	1.636E-3	A
A	13	-1.104E-3	5.001E-1	-2.782E-3	-1.678E-4	-2.179E-5	1.648E-3	A
A	14	-2.458E-3	8.001E-1	-2.193E-3	-1.462E-4	4.386E-7	1.671E-3	A
A	15	-2.727E-3	1.100E0	-3.696E-3	-1.087E-4	1.262E-5	1.678E-3	A
A	16	-6.389E-3	1.390E0	-3.171E-3	-5.256E-5	-8.767E-5	1.667E-3	A
A	17	-2.356E-2	1.611E0	9.904E-3	-2.431E-5	-5.458E-5	1.674E-3	A
A	18	-2.641E-2	2.000E0	1.331E-3	-2.026E-5	4.464E-5	1.613E-3	A
A	19	-2.926E-2	2.360E0	-3.340E-4	-1.620E-5	-5.814E-6	1.469E-3	A
A	20	-3.211E-2	2.691E0	3.065E-5	-1.214E-5	2.345E-7	1.375E-3	A
A	21	-3.496E-2	2.999E0	1.381E-7	-8.087E-6	4.645E-8	1.221E-3	A
A	22	-3.781E-2	3.261E0	-4.473E-7	-4.030E-6	-1.011E-8	1.043E-3	A
A	23	-4.067E-2	3.490E0	6.395E-8	2.651E-8	8.417E-10	9.012E-4	A
A	24	-4.352E-2	3.680E0	-3.189E-9	4.083E-6	1.685E-11	7.300E-4	A
A	25	-4.637E-2	3.830E0	-4.213E-10	8.140E-6	-1.421E-11	5.339E-4	A
A	26	-4.922E-2	3.930E0	1.065E-10	1.220E-5	1.858E-12	3.416E-4	A
A	27	-5.207E-2	3.990E0	-9.825E-12	1.625E-5	-7.556E-14	1.536E-4	A
A	28	-5.492E-2	4.000E0	7.685E-14	2.031E-5	-1.697E-14	-6.814E-5	A
A	29	-5.777E-2	3.960E0	-1.432E-13	2.437E-5	1.718E-14	-2.562E-4	A
A	30	-6.062E-2	3.880E0	-5.244E-12	2.842E-5	1.315E-14	-4.484E-4	A
A	31	-6.348E-2	3.750E0	7.573E-11	3.248E-5	-1.143E-12	-6.448E-4	A
A	32	-6.633E-2	3.580E0	-4.256E-10	3.654E-5	1.113E-11	-8.117E-4	A
A	33	-6.918E-2	3.370E0	-9.360E-10	4.059E-5	-3.555E-11	-9.826E-4	A
A	34	-7.203E-2	3.120E0	4.045E-8	4.465E-5	-4.228E-10	-1.157E-3	A
A	35	-7.488E-2	2.830E0	-3.605E-7	4.871E-5	7.022E-9	-1.307E-3	A
A	36	-7.773E-2	2.510E0	9.076E-7	5.276E-5	-4.389E-8	-1.431E-3	A
A	37	-8.058E-2	2.160E0	1.628E-5	5.682E-5	-4.001E-8	-1.567E-3	A
A	38	-8.344E-2	1.781E0	-2.373E-4	6.088E-5	3.574E-6	-1.640E-3	A
A	39	-8.629E-2	1.387E0	1.340E-3	6.493E-5	-3.491E-5	-1.779E-3	A
A	40	-8.914E-2	9.672E-1	2.866E-3	6.899E-5	1.126E-4	-1.654E-3	A
A	41	5.679E-3	8.658E-1	-2.862E-3	6.234E-5	1.113E-4	-1.638E-3	A
A	42	2.827E-3	4.135E-1	-1.388E-3	3.107E-5	-3.291E-5	-2.307E-3	A
A	43	0.000E0	0.000E0	0.000E0	0.000E0	0.000E0	0.000E0	A
A	44	0.000E0	0.000E0	0.000E0	0.000E0	0.000E0	0.000E0	A

---REACTION LOADS AT FIXED DEGREES OF FREEDOM---

A	NODE	XF	YF	ZF	XM	YM	ZM	A
A	43	-7.568E3	-8.823E3	-1.513E2	-7.665E3	-7.000E3	1.783E6	A
A	44	0.000E0	0.000E0	0.000E0	0.000E0	0.000E0	0.000E0	A

---BASEPLATE LOADS---

A	NODE	XF	YF	ZF	XM	YM	ZM	A
A	1	2.136E1	6.293E-2	2.737E-1	5.586E-9	1.958E-4	7.090E-4	A
A	2	-8.500E1	-1.789E-2	2.737E-1	6.768E-9	7.556E-5	7.366E-4	A
A	3	2.012E2	-1.517E-1	2.737E-1	5.552E-8	3.950E-5	7.677E-4	A
A	4	-9.115E2	-5.086E-1	2.737E-1	-1.536E-7	-4.019E-4	8.253E-4	A
A	5	9.352E2	5.458E-1	2.737E-1	-1.649E-7	-4.428E-4	1.414E-3	A
A	6	-1.743E2	9.003E-2	2.737E-1	1.345E-7	4.714E-5	4.029E-3	A
A	7	9.569E0	-2.323E0	2.737E-1	2.566E-7	-1.061E-6	6.644E-3	A
A	8	3.973E1	2.684E1	2.738E-1	-7.902E-6	1.048E-5	9.258E-3	A
A	9	-1.940E2	-1.188E2	2.738E-1	6.461E-5	-9.710E-5	1.187E-2	A
A	10	-7.623E2	-6.706E2	2.738E-1	-1.158E-4	2.361E-4	1.449E-2	A
A	11	3.348E3	1.855E3	2.738E-1	-1.037E-3	1.481E-3	1.577E-2	A
A	12	-2.770E3	-1.149E3	5.164E2	-2.008E-3	1.536E-3	1.636E-2	A

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NODE	XF	YF	ZF	XM	YM	ZM
13	-6.292E2	7.289E1	-1.586E3	-1.678E-3	-2.179E-4	1.648E-2
14	-1.401E3	3.148E1	-1.250E3	-1.462E-3	4.386E-6	1.671E-2
15	-1.555E3	-1.879E1	-2.107E3	-1.087E-3	1.262E-4	1.678E-2
16	-3.642E3	-1.634E2	-1.808E3	-5.256E-4	-8.767E-4	1.667E-2
17	0.000E0	3.884E2	5.645E3	-2.431E-4	-5.458E-4	1.674E-2
18	0.000E0	-2.743E2	7.585E2	-2.026E-4	4.464E-4	1.613E-2
19	0.000E0	-9.404E1	-1.904E2	-1.620E-4	-5.814E-5	1.469E-2
20	0.000E0	3.955E2	1.747E1	-1.214E-4	2.345E-6	1.375E-2
21	0.000E0	-4.895E2	7.870E-2	-8.087E-5	4.645E-7	1.221E-2
22	0.000E0	3.169E2	-2.550E-1	-4.030E-5	-1.011E-7	1.043E-2
23	0.000E0	-1.320E2	3.645E-2	2.651E-7	8.417E-9	9.012E-3
24	0.000E0	1.190E2	-1.817E-3	4.083E-5	1.685E-10	7.300E-3
25	0.000E0	-1.986E2	-2.401E-4	8.140E-5	-1.421E-10	5.339E-3
26	0.000E0	1.977E2	6.069E-5	1.220E-4	1.858E-11	3.416E-3
27	0.000E0	-9.299E1	-5.600E-6	1.625E-4	-7.556E-13	1.536E-3
28	0.000E0	-9.301E1	4.380E-8	2.031E-4	-1.697E-13	-6.814E-4
29	0.000E0	1.978E2	-8.162E-8	2.437E-4	1.718E-13	-2.562E-3
30	0.000E0	-1.983E2	-2.989E-6	2.842E-4	1.315E-13	-4.484E-3
31	0.000E0	1.058E2	4.316E-5	3.248E-4	-1.143E-11	-6.448E-3
32	0.000E0	-1.336E1	-2.426E-4	3.654E-4	1.113E-10	-8.117E-3
33	0.000E0	1.285E1	-5.335E-4	4.059E-4	-3.555E-10	-9.826E-3
34	0.000E0	-9.306E1	2.306E-2	4.465E-4	-4.228E-9	-1.157E-2
35	0.000E0	9.235E1	-2.055E-1	4.871E-4	7.022E-8	-1.307E-2
36	0.000E0	1.246E1	5.173E-1	5.276E-4	-4.389E-7	-1.431E-2
37	0.000E0	-2.234E2	9.280E0	5.682E-4	-4.001E-7	-1.567E-2
38	0.000E0	5.838E2	-1.353E2	6.088E-4	3.574E-5	-1.640E-2
39	0.000E0	-1.496E3	7.638E2	6.493E-4	-3.491E-4	-1.779E-2
40	0.000E0	-1.605E3	1.634E3	6.899E-4	1.126E-3	-1.654E-2
41	0.000E0	3.282E3	-1.632E3	6.234E-4	1.113E-3	-1.638E-2
42	0.000E0	-9.388E3	-7.914E2	3.107E-4	-3.291E-4	-2.307E-2

MEMBER LOADS OF COMBINED CASE 1

H.B. ROBINSON 30 CW-11 UNDERGROUND WATER PIPE
VERTICAL SEISMIC (1/2 SINE WAVE END TO END)

---LOCAL MEMBER END LOADS---

M	N	AXIAL	X2SHEAR	X3SHEAR	TORSN	X2MOM	X3MOM
1	1	-2.808E-1	-2.090E1	-4.424E0	-7.349E-4	6.723E-6	-3.179E-5
1	2	2.808E-1	2.090E1	4.424E0	7.349E-4	1.307E3	-6.175E3
2	2	-5.474E-1	6.319E1	7.537E0	-1.410E3	-7.331E2	6.109E3
2	3	5.474E-1	-6.319E1	-7.537E0	1.410E3	-2.166E2	1.853E3
3	3	-8.211E-1	-1.366E2	-1.629E1	-1.410E3	2.166E2	-1.853E3
3	4	8.211E-1	1.366E2	1.629E1	1.410E3	3.595E3	-3.012E4
4	4	-1.215E0	7.430E2	2.165E2	-2.207E4	-5.825E3	2.003E4
4	5	1.215E0	-7.430E2	-2.165E2	2.207E4	-1.944E4	6.667E4
5	5	-1.369E0	-1.612E2	6.839E0	-6.409E4	-1.473E3	-3.464E4
5	6	1.369E0	1.612E2	-6.839E0	6.409E4	-1.276E2	-3.075E3
6	6	-1.642E0	1.300E1	-5.668E-1	-6.409E4	1.276E2	3.075E3
6	7	1.642E0	-1.300E1	5.668E-1	6.409E4	5.034E0	-3.142E1
7	7	-1.916E0	3.542E0	2.156E0	-6.409E4	-5.034E0	3.142E1
7	8	1.916E0	-3.542E0	-2.156E0	6.409E4	-4.995E2	7.973E2

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L	M	N	AXIAL	X2SHEAR	X3SHEAR	TORSN	X2MOM	X3MOM	L
L	8	8	-2.190E0	-3.728E1	-2.299E1	-6.409E4	4.995E2	-7.973E2	L
L	8	9	2.190E0	3.728E1	2.299E1	6.409E4	4.880E3	-7.925E3	L
L	9	9	-2.464E0	1.616E2	8.753E1	-6.409E4	-4.880E3	7.925E3	L
L	9	10	2.464E0	-1.616E2	-8.753E1	6.409E4	-1.560E4	2.988E4	L
L	10	10	-2.737E0	9.514E2	7.255E2	-6.409E4	1.560E4	-2.988E4	L
L	10	11	2.737E0	-9.514E2	-7.255E2	6.409E4	-9.831E4	1.383E5	L
L	11	11	-1.852E3	-1.779E3	-7.011E2	9.710E3	1.071E5	-1.461E5	L
L	11	12	1.852E3	1.779E3	7.011E2	-9.710E3	9.579E2	-1.282E5	L
L	12	12	-1.258E2	6.088E2	5.814E1	-7.776E3	-1.159E4	1.278E5	L
L	12	13	1.258E2	-6.088E2	-5.814E1	7.776E3	-2.058E3	1.508E4	L
L	13	13	1.440E3	-6.763E1	-1.474E1	-7.776E3	2.058E3	-1.508E4	L
L	13	14	-1.440E3	6.763E1	1.474E1	7.776E3	1.383E3	-7.050E2	L
L	14	14	3.315E3	3.937E1	-4.622E1	-7.776E3	-1.383E3	7.050E2	L
L	14	15	-3.315E3	-3.937E1	4.622E1	7.776E3	1.223E4	8.538E3	L
L	15	15	5.904E3	-3.511E2	-2.744E1	-7.776E3	-1.223E4	-8.538E3	L
L	15	16	-5.904E3	3.511E2	2.744E1	7.776E3	1.864E4	-7.340E4	L
L	16	16	9.757E3	9.458E2	1.360E2	-7.776E3	-1.864E4	7.340E4	L
L	16	17	-9.757E3	-9.458E2	-1.360E2	7.776E3	-6.370E3	1.005E5	L
L	17	17	7.568E3	-5.855E2	-2.524E2	-9.943E2	1.000E4	-1.005E5	L
L	17	18	-7.568E3	5.855E2	2.524E2	9.943E2	4.906E4	-3.651E4	L
L	18	18	7.568E3	1.730E2	2.190E1	-9.943E2	-4.906E4	3.651E4	L
L	18	19	-7.568E3	-1.730E2	-2.190E1	9.943E2	4.394E4	3.978E3	L
L	19	19	7.568E3	-1.733E1	1.159E2	-9.943E2	-4.394E4	-3.978E3	L
L	19	20	-7.568E3	1.733E1	-1.159E2	9.943E2	1.681E4	-7.722E1	L
L	20	20	7.568E3	1.418E-1	-2.796E2	-9.943E2	-1.681E4	7.722E1	L
L	20	21	-7.568E3	-1.418E-1	2.796E2	9.943E2	8.223E4	-4.404E1	L
L	21	21	7.568E3	2.205E-1	2.100E2	-9.943E2	-8.223E4	4.404E1	L
L	21	22	-7.568E3	-2.205E-1	-2.100E2	9.943E2	3.310E4	7.561E0	L
L	22	22	7.568E3	-3.445E-2	-1.070E2	-9.943E2	-3.310E4	-7.561E0	L
L	22	23	-7.568E3	3.445E-2	1.070E2	9.943E2	5.812E4	-5.002E-1	L
L	23	23	7.568E3	2.002E-3	2.507E1	-9.943E2	-5.812E4	5.002E-1	L
L	23	24	-7.568E3	-2.002E-3	-2.507E1	9.943E2	5.226E4	-3.166E-2	L
L	24	24	7.568E3	1.850E-4	-9.394E1	-9.943E2	-5.226E4	3.166E-2	L
L	24	25	-7.568E3	-1.850E-4	9.394E1	9.943E2	7.424E4	1.163E-2	L
L	25	25	7.568E3	-5.514E-5	1.047E2	-9.943E2	-7.424E4	-1.163E-2	L
L	25	26	-7.568E3	5.514E-5	-1.047E2	9.943E2	4.974E4	-1.272E-3	L
L	26	26	7.568E3	5.545E-6	-9.299E1	-9.943E2	-4.974E4	1.272E-3	L
L	26	27	-7.568E3	-5.545E-6	9.299E1	9.943E2	7.150E4	2.540E-5	L
L	27	27	7.568E3	-5.559E-8	-1.766E-3	-9.943E2	-7.150E4	-2.540E-5	L
L	27	28	-7.568E3	5.559E-8	1.766E-3	9.943E2	7.150E4	1.239E-5	L
L	28	28	7.568E3	-1.179E-8	9.301E1	-9.943E2	-7.150E4	-1.239E-5	L
L	28	29	-7.568E3	1.179E-8	-9.301E1	9.943E2	4.974E4	9.630E-6	L
L	29	29	7.568E3	-9.341E-8	-1.048E2	-9.943E2	-4.974E4	-9.630E-6	L
L	29	30	-7.568E3	9.341E-8	1.048E2	9.943E2	7.426E4	-1.223E-5	L
L	30	30	7.568E3	-3.083E-6	9.352E1	-9.943E2	-7.426E4	1.223E-5	L
L	30	31	-7.568E3	3.083E-6	-9.352E1	9.943E2	5.238E4	-7.336E-4	L
L	31	31	7.568E3	4.008E-5	-1.224E1	-9.943E2	-5.238E4	7.336E-4	L
L	31	32	-7.568E3	-4.008E-5	1.224E1	9.943E2	5.524E4	8.645E-3	L
L	32	32	7.568E3	-2.025E-4	1.120E0	-9.943E2	-5.524E4	-8.645E-3	L
L	32	33	-7.568E3	2.025E-4	-1.120E0	9.943E2	5.498E4	-3.874E-2	L
L	33	33	7.568E3	-7.360E-4	-1.173E1	-9.943E2	-5.498E4	3.874E-2	L
L	33	34	-7.568E3	7.360E-4	1.173E1	9.943E2	5.772E4	-2.110E-1	L
L	34	34	7.568E3	2.232E-2	8.133E1	-9.943E2	-5.772E4	2.110E-1	L
L	34	35	-7.568E3	-2.232E-2	-8.133E1	9.943E2	3.869E4	5.012E0	L
L	35	35	7.568E3	-1.831E-1	-1.102E1	-9.943E2	-3.869E4	-5.012E0	L
L	35	36	-7.568E3	1.831E-1	1.102E1	9.943E2	4.127E4	-3.785E1	L

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L	M	N	AXIAL	X2SHEAR	X3SHEAR	TORSN	X2MOM	X3MOM	L
L	36	36	7.568E3	3.342E-1	-2.348E1	-9.943E2	-4.127E4	3.785E1	L
L	36	37	-7.568E3	-3.342E-1	2.348E1	9.943E2	4.677E4	4.035E1	L
L	37	37	7.568E3	9.615E0	1.999E2	-9.943E2	-4.677E4	-4.035E1	L
L	37	38	-7.568E3	-9.615E0	-1.999E2	9.943E2	-1.505E1	2.290E3	L
L	38	38	7.568E3	-1.256E2	-3.838E2	-9.943E2	1.503E1	-2.290E3	L
L	38	39	-7.568E3	1.256E2	3.838E2	9.943E2	8.980E4	-2.711E4	L
L	39	39	7.568E3	6.382E2	1.112E3	-9.943E2	-8.980E4	2.711E4	L
L	39	40	-7.568E3	-6.382E2	-1.112E3	9.943E2	-1.704E5	1.222E5	L
L	40	40	7.459E3	-3.523E3	-1.331E3	6.813E3	7.491E4	-1.957E5	L
L	40	41	-7.459E3	3.523E3	1.331E3	-6.813E3	6.734E4	-1.807E5	L
L	41	41	7.568E3	6.557E2	-5.466E2	7.665E3	-1.531E5	1.172E5	L
L	41	42	-7.568E3	-6.557E2	5.466E2	-7.665E3	2.810E5	3.626E4	L
L	42	42	7.568E3	-3.975E2	8.816E3	7.665E3	-2.810E5	-3.626E4	L
L	42	43	-7.568E3	3.975E2	-8.816E3	-7.665E3	-1.782E6	-5.675E4	L
L									L

L===L

S==S
S=== MEMBER STRESSES OF COMBINED CASE 1 ===S
S==S

S H.B. ROBINSON 30 CW-11 UNDERGROUND WATER PIPE S
S VERTICAL SEISMIC (1/2 SINE WAVE END TO END) S

S ---LOCAL MEMBER END STRESSES--- S

S	M	N	AXIAL	X2SHEAR	X3SHEAR	TORSN	X2BEND	X3BEND	S
S	1	1	1.300E-2	-2.196E0	-4.650E-1	2.198E-6	-4.022E-8	-1.902E-7	S
S	1	2	1.300E-2	-2.196E0	-4.650E-1	2.198E-6	7.821E0	3.695E1	S
S	2	2	2.534E-2	6.641E0	7.921E-1	4.218E0	4.386E0	3.655E1	S
S	2	3	2.534E-2	6.641E0	7.921E-1	4.218E0	-1.296E0	-1.109E1	S
S	3	3	3.801E-2	-1.436E1	-1.712E0	4.218E0	-1.296E0	-1.109E1	S
S	3	4	3.801E-2	-1.436E1	-1.712E0	4.218E0	2.151E1	1.802E2	S
S	4	4	5.626E-2	7.808E1	2.275E1	6.602E1	3.485E1	1.198E2	S
S	4	5	5.626E-2	7.808E1	2.275E1	6.602E1	-1.163E2	-3.989E2	S
S	5	5	6.336E-2	-1.694E1	7.187E-1	1.917E2	8.812E0	-2.073E2	S
S	5	6	6.336E-2	-1.694E1	7.187E-1	1.917E2	-7.635E-1	1.840E1	S
S	6	6	7.603E-2	1.367E0	-5.957E-2	1.917E2	-7.635E-1	1.840E1	S
S	6	7	7.603E-2	1.367E0	-5.957E-2	1.917E2	3.012E-2	1.880E-1	S
S	7	7	8.871E-2	3.722E-1	2.266E-1	1.917E2	3.012E-2	1.880E-1	S
S	7	8	8.871E-2	3.722E-1	2.266E-1	1.917E2	-2.988E0	-4.771E0	S
S	8	8	1.014E-1	-3.918E0	-2.416E0	1.917E2	-2.988E0	-4.771E0	S
S	8	9	1.014E-1	-3.918E0	-2.416E0	1.917E2	2.920E1	4.742E1	S
S	9	9	1.141E-1	1.698E1	9.199E0	1.917E2	2.920E1	4.742E1	S
S	9	10	1.141E-1	1.698E1	9.199E0	1.917E2	-9.336E1	-1.788E2	S
S	10	10	1.267E-1	9.998E1	7.625E1	1.917E2	-9.336E1	-1.788E2	S
S	10	11	1.267E-1	9.998E1	7.625E1	1.917E2	-5.882E2	-8.277E2	S
S	11	11	8.573E1	-1.870E2	-7.368E1	-2.905E1	-6.410E2	-8.740E2	S
S	11	12	8.573E1	-1.870E2	-7.368E1	-2.905E1	5.731E0	7.672E2	S
S	12	12	5.825E0	6.398E1	6.110E0	2.326E1	6.936E1	7.649E2	S
S	12	13	5.825E0	6.398E1	6.110E0	2.326E1	-1.231E1	-9.021E1	S
S	13	13	-6.669E1	-7.108E0	-1.550E0	2.326E1	-1.231E1	-9.021E1	S
S	13	14	-6.669E1	-7.108E0	-1.550E0	2.326E1	8.273E0	4.218E0	S
S	14	14	-1.535E2	4.138E0	-4.858E0	2.326E1	8.273E0	4.218E0	S
S	14	15	-1.535E2	4.138E0	-4.858E0	2.326E1	7.320E1	-5.109E1	S
S	15	15	-2.733E2	-3.690E1	-2.883E0	2.326E1	7.320E1	-5.109E1	S
S	15	16	-2.733E2	-3.690E1	-2.883E0	2.326E1	1.115E2	4.391E2	S

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S	M	N	AXIAL	X2SHEAR	X3SHEAR	TORSN	X2BEND	X3BEND	S
S	16	16	-4.517E2	9.940E1	1.429E1	2.326E1	1.115E2	4.391E2	S
S	16	17	-4.517E2	9.940E1	1.429E1	2.326E1	-3.811E1	-6.013E2	S
S	17	17	-3.504E2	-6.153E1	-2.653E1	2.975E0	-5.985E1	-6.013E2	S
S	17	18	-3.504E2	-6.153E1	-2.653E1	2.975E0	2.935E2	2.185E2	S
S	18	18	-3.504E2	1.818E1	2.302E0	2.975E0	2.935E2	2.185E2	S
S	18	19	-3.504E2	1.818E1	2.302E0	2.975E0	2.629E2	-2.380E1	S
S	19	19	-3.504E2	-1.821E0	1.218E1	2.975E0	2.629E2	-2.380E1	S
S	19	20	-3.504E2	-1.821E0	1.218E1	2.975E0	1.006E2	4.620E-1	S
S	20	20	-3.504E2	1.490E-2	-2.938E1	2.975E0	1.006E2	4.620E-1	S
S	20	21	-3.504E2	1.490E-2	-2.938E1	2.975E0	4.920E2	2.635E-1	S
S	21	21	-3.504E2	2.317E-2	2.207E1	2.975E0	4.920E2	2.635E-1	S
S	21	22	-3.504E2	2.317E-2	2.207E1	2.975E0	1.980E2	-4.524E-2	S
S	22	22	-3.504E2	-3.621E-3	-1.124E1	2.975E0	1.980E2	-4.524E-2	S
S	22	23	-3.504E2	-3.621E-3	-1.124E1	2.975E0	3.478E2	2.993E-3	S
S	23	23	-3.504E2	2.104E-4	2.635E0	2.975E0	3.478E2	2.993E-3	S
S	23	24	-3.504E2	2.104E-4	2.635E0	2.975E0	3.127E2	1.894E-4	S
S	24	24	-3.504E2	1.944E-5	-9.872E0	2.975E0	3.127E2	1.894E-4	S
S	24	25	-3.504E2	1.944E-5	-9.872E0	2.975E0	4.442E2	-6.959E-5	S
S	25	25	-3.504E2	-5.795E-6	1.100E1	2.975E0	4.442E2	-6.959E-5	S
S	25	26	-3.504E2	-5.795E-6	1.100E1	2.975E0	2.976E2	7.611E-6	S
S	26	26	-3.504E2	5.827E-7	-9.772E0	2.975E0	2.976E2	7.611E-6	S
S	26	27	-3.504E2	5.827E-7	-9.772E0	2.975E0	4.278E2	-1.520E-7	S
S	27	27	-3.504E2	-5.842E-9	-1.856E-4	2.975E0	4.278E2	-1.520E-7	S
S	27	28	-3.504E2	-5.842E-9	-1.856E-4	2.975E0	4.278E2	-7.412E-8	S
S	28	28	-3.504E2	-1.239E-9	9.775E0	2.975E0	4.278E2	-7.412E-8	S
S	28	29	-3.504E2	-1.239E-9	9.775E0	2.975E0	2.976E2	-5.762E-8	S
S	29	29	-3.504E2	-9.817E-9	-1.101E1	2.975E0	2.976E2	-5.762E-8	S
S	29	30	-3.504E2	-9.817E-9	-1.101E1	2.975E0	4.443E2	7.316E-8	S
S	30	30	-3.504E2	-3.240E-7	9.829E0	2.975E0	4.443E2	7.316E-8	S
S	30	31	-3.504E2	-3.240E-7	9.829E0	2.975E0	3.134E2	4.389E-6	S
S	31	31	-3.504E2	4.212E-6	-1.287E0	2.975E0	3.134E2	4.389E-6	S
S	31	32	-3.504E2	4.212E-6	-1.287E0	2.975E0	3.305E2	-5.173E-5	S
S	32	32	-3.504E2	-2.128E-5	1.177E-1	2.975E0	3.305E2	-5.173E-5	S
S	32	33	-3.504E2	-2.128E-5	1.177E-1	2.975E0	3.290E2	2.318E-4	S
S	33	33	-3.504E2	-7.735E-5	-1.233E0	2.975E0	3.290E2	2.318E-4	S
S	33	34	-3.504E2	-7.735E-5	-1.233E0	2.975E0	3.454E2	1.262E-3	S
S	34	34	-3.504E2	2.346E-3	8.547E0	2.975E0	3.454E2	1.262E-3	S
S	34	35	-3.504E2	2.346E-3	8.547E0	2.975E0	2.315E2	-2.999E-2	S
S	35	35	-3.504E2	-1.925E-2	-1.158E0	2.975E0	2.315E2	-2.999E-2	S
S	35	36	-3.504E2	-1.925E-2	-1.158E0	2.975E0	2.469E2	2.264E-1	S
S	36	36	-3.504E2	3.512E-2	-2.468E0	2.975E0	2.469E2	2.264E-1	S
S	36	37	-3.504E2	3.512E-2	-2.468E0	2.975E0	2.798E2	-2.414E-1	S
S	37	37	-3.504E2	1.010E0	2.101E1	2.975E0	2.798E2	-2.414E-1	S
S	37	38	-3.504E2	1.010E0	2.101E1	2.975E0	-9.004E-2	-1.370E1	S
S	38	38	-3.504E2	-1.320E1	-4.034E1	2.975E0	-8.994E-2	-1.370E1	S
S	38	39	-3.504E2	-1.320E1	-4.034E1	2.975E0	5.373E2	1.622E2	S
S	39	39	-3.504E2	6.707E1	1.169E2	2.975E0	5.373E2	1.622E2	S
S	39	40	-3.504E2	6.707E1	1.169E2	2.975E0	-1.020E3	-7.313E2	S
S	40	40	-3.453E2	-3.703E2	-1.399E2	-2.038E1	-4.482E2	-1.171E3	S
S	40	41	-3.453E2	-3.703E2	-1.399E2	-2.038E1	4.029E2	1.081E3	S
S	41	41	-3.504E2	6.891E1	-5.745E1	-2.293E1	9.162E2	7.010E2	S
S	41	42	-3.504E2	6.891E1	-5.745E1	-2.293E1	1.682E3	-2.169E2	S
S	42	42	-3.504E2	-4.177E1	9.265E2	-2.293E1	1.682E3	-2.169E2	S
S	42	43	-3.504E2	-4.177E1	9.265E2	-2.293E1	-1.066E4	3.395E2	S
S									S

S===S

N===N
N=== FRACTION OF SYSTEM NODE ALLOWABLES: COMBINED CASE 1 ===N
N===N

H.B. ROBINSON 30 CW-11 UNDERGROUND WATER PIPE
VERTICAL SEISMIC (1/2 SINE WAVE END TO END)

---SUMMARY OF FRACTION OF ALLOWABLE FOR EACH NODE---

N	DISPLACEMENT X	DISPLACEMENT Y	DISPLACEMENT Z	BASEPLATE COEFFICIENT
1	3.748E-18	1.104E-20	2.737E-15	0.000E0
2	1.491E-17	3.139E-21	2.737E-15	0.000E0
3	3.530E-17	2.661E-20	2.737E-15	0.000E0
4	1.599E-16	8.923E-20	2.737E-15	0.000E0
5	1.641E-16	9.576E-20	2.737E-15	0.000E0
6	3.059E-17	1.580E-20	2.737E-15	0.000E0
7	1.679E-18	4.076E-19	2.737E-15	0.000E0
8	6.970E-18	4.708E-18	2.738E-15	0.000E0
9	3.404E-17	2.084E-17	2.738E-15	0.000E0
10	1.337E-16	1.176E-16	2.738E-15	0.000E0
11	5.874E-16	3.255E-16	2.738E-15	0.000E0
12	4.859E-16	1.980E-14	9.060E-17	0.000E0
13	1.104E-16	5.001E-14	2.782E-16	0.000E0
14	2.458E-16	8.001E-14	2.193E-16	0.000E0
15	2.727E-16	1.100E-13	3.696E-16	0.000E0
16	6.389E-16	1.390E-13	3.171E-16	0.000E0
17	2.356E-15	1.611E-13	9.904E-16	0.000E0
18	2.641E-15	2.000E-13	1.331E-16	0.000E0
19	2.926E-15	2.360E-13	3.340E-17	0.000E0
20	3.211E-15	2.691E-13	3.065E-18	0.000E0
21	3.496E-15	2.999E-13	1.381E-20	0.000E0
22	3.781E-15	3.261E-13	4.473E-20	0.000E0
23	4.067E-15	3.490E-13	6.395E-21	0.000E0
24	4.352E-15	3.680E-13	3.189E-22	0.000E0
25	4.637E-15	3.830E-13	4.213E-23	0.000E0
26	4.922E-15	3.930E-13	1.065E-23	0.000E0
27	5.207E-15	3.990E-13	9.825E-25	0.000E0
28	5.492E-15	4.000E-13	7.685E-27	0.000E0
29	5.777E-15	3.960E-13	1.432E-26	0.000E0
30	6.062E-15	3.880E-13	5.244E-25	0.000E0
31	6.348E-15	3.750E-13	7.573E-24	0.000E0
32	6.633E-15	3.580E-13	4.256E-23	0.000E0
33	6.918E-15	3.370E-13	9.360E-23	0.000E0
34	7.203E-15	3.120E-13	4.045E-21	0.000E0
35	7.488E-15	2.830E-13	3.605E-20	0.000E0
36	7.773E-15	2.510E-13	9.076E-20	0.000E0
37	8.058E-15	2.160E-13	1.628E-18	0.000E0
38	8.344E-15	1.781E-13	2.373E-17	0.000E0
39	8.629E-15	1.387E-13	1.340E-16	0.000E0
40	8.914E-15	9.672E-14	2.866E-16	0.000E0
41	5.679E-16	8.658E-14	2.862E-16	0.000E0
42	2.827E-16	4.135E-14	1.388E-16	0.000E0
43	0.000E0	0.000E0	0.000E0	0.000E0
44	0.000E0	0.000E0	0.000E0	0.000E0

N===N

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FRACTION OF SYSTEM MEMBER ALLOWABLES: COMBINED CASE 1

H.B. ROBINSON 30 CW-11 UNDERGROUND WATER PIPE
VERTICAL SEISMIC (1/2 SINE WAVE END TO END)

---SUMMARY OF FRACTION OF ALLOWABLE FOR EACH MEMBER---

	STRESS		BUCKLING		JOINT COEF.	
M	START	END	START	END	START	END
1	1.247E-16	1.659E-15	0.000E0	0.000E0	2.136E-12	8.305E-8
2	1.517E-15	6.059E-16	0.000E0	0.000E0	8.096E-8	2.455E-8
3	1.038E-15	7.472E-15	0.000E0	0.000E0	2.455E-8	3.991E-7
4	8.186E-15	1.908E-14	0.000E0	0.000E0	2.744E-7	9.138E-7
5	1.159E-14	1.159E-14	0.000E0	0.000E0	4.562E-7	4.049E-8
6	1.073E-14	1.073E-14	0.000E0	0.000E0	4.049E-8	4.187E-10
7	1.068E-14	1.068E-14	0.000E0	0.000E0	4.187E-10	1.238E-8
8	1.091E-14	1.091E-14	0.000E0	0.000E0	1.238E-8	1.225E-7
9	1.173E-14	1.173E-14	0.000E0	0.000E0	1.225E-7	4.436E-7
10	1.764E-14	5.245E-14	0.000E0	0.000E0	4.436E-7	2.233E-6
11	5.929E-14	3.180E-14	0.000E0	0.000E0	2.384E-6	1.687E-6
12	3.111E-14	4.863E-15	0.000E0	0.000E0	1.689E-6	2.002E-7
13	6.267E-15	2.933E-15	0.000E0	0.000E0	2.002E-7	2.042E-8
14	6.147E-15	1.029E-14	0.000E0	0.000E0	2.042E-8	1.963E-7
15	1.473E-14	3.052E-14	0.000E0	0.000E0	1.963E-7	9.964E-7
16	3.712E-14	4.041E-14	0.000E0	0.000E0	9.964E-7	1.325E-6
17	3.746E-14	3.194E-14	0.000E0	0.000E0	1.329E-6	8.047E-7
18	3.194E-14	2.360E-14	0.000E0	0.000E0	8.047E-7	5.805E-7
19	2.360E-14	1.672E-14	0.000E0	0.000E0	5.805E-7	2.212E-7
20	1.672E-14	3.121E-14	0.000E0	0.000E0	2.212E-7	1.082E-6
21	3.121E-14	2.031E-14	0.000E0	0.000E0	1.082E-6	4.355E-7
22	2.031E-14	2.586E-14	0.000E0	0.000E0	4.355E-7	7.648E-7
23	2.586E-14	2.456E-14	0.000E0	0.000E0	7.648E-7	6.876E-7
24	2.456E-14	2.943E-14	0.000E0	0.000E0	6.876E-7	9.768E-7
25	2.943E-14	2.400E-14	0.000E0	0.000E0	9.768E-7	6.545E-7
26	2.400E-14	2.882E-14	0.000E0	0.000E0	6.545E-7	9.408E-7
27	2.882E-14	2.882E-14	0.000E0	0.000E0	9.408E-7	9.408E-7
28	2.882E-14	2.400E-14	0.000E0	0.000E0	9.408E-7	6.545E-7
29	2.400E-14	2.943E-14	0.000E0	0.000E0	6.545E-7	9.771E-7
30	2.943E-14	2.458E-14	0.000E0	0.000E0	9.771E-7	6.892E-7
31	2.458E-14	2.522E-14	0.000E0	0.000E0	6.892E-7	7.269E-7
32	2.522E-14	2.516E-14	0.000E0	0.000E0	7.269E-7	7.234E-7
33	2.516E-14	2.577E-14	0.000E0	0.000E0	7.234E-7	7.595E-7
34	2.577E-14	2.155E-14	0.000E0	0.000E0	7.595E-7	5.091E-7
35	2.155E-14	2.213E-14	0.000E0	0.000E0	5.091E-7	5.430E-7
36	2.213E-14	2.335E-14	0.000E0	0.000E0	5.430E-7	6.153E-7
37	2.335E-14	1.349E-14	0.000E0	0.000E0	6.153E-7	3.013E-8
38	1.349E-14	3.889E-14	0.000E0	0.000E0	3.013E-8	1.234E-6
39	3.889E-14	7.782E-14	0.000E0	0.000E0	1.234E-6	2.759E-6
40	7.277E-14	6.776E-14	0.000E0	0.000E0	2.758E-6	2.537E-6
41	7.288E-14	8.329E-14	0.000E0	0.000E0	2.537E-6	3.729E-6
42	8.329E-14	4.204E-13	0.000E0	0.000E0	0.000E0	0.000E0

CCL-CA-362

QUALIFICATION SUMMARY REPORT

H.B. ROBINSON 30 CW-11 UNDERGROUND WATER PIPE

---PLANT IDENTIFICATION---

UTILITY: CPL PLANT: H.B.ROBINSON PWR_____
NSSS: A/E: BWR_____

---EQUIPMENT IDENTIFICATION---

SYSTEM: DRAWING NO.:
BUILDING: ELEVATION:
ADDITIONAL IDENTIFICATION:

---APPLIED LOADS---

DEADWEIGHT:____ THERMAL:____ RELATIVE DISP.:____
SEISMIC:____ HYDRODYNAMIC:____

---LOAD COMBINATION---

VERTICAL 4 INCH MIDSPAN DISPLACEMENT OF PIPE RUN

---SUMMARY OF RESULTS---

---MAXIMUM FRACTION OF ALLOWABLE---

COMPONENT	FAILURE MODE	ALLOWABLE	MAX. FRACTION	PASS/FAIL
SYSTEM	JOINT	1.000E0	3.729E-6	PASS

COMMENTS:
JOINT MAX. FRACTION = REALATIVE JOINT ROTATION (RAD.)
JOINT KTRANS=6.3E8 LB/IN JOINT KTORS,KROT2,KROT3=7.6E10 IN-LB.
....GROUND SPRING PER 19.5 FT. PIPE SEGMENT SET AT 5.7E5 LB/IN.
....DISPLACEMENTS ARE IMPOSED ON GROUNDED END OF NODAL GROUND SPRINGS.

PREPARED BY: D Lindley CO: CCL DATE: 12-4-90

VERIFIED BY: CO: DATE:

Job Number: 90-2271
Sheet: - of: -
Calculated By: DWL Date: 12-4-90
Checked By: H. Bird Date: 12-1-90
Calculation Number: CCL-CA-352

ATTACHMENT B

DESIGN VERIFICATION RECORD

DESIGN VERIFICATION RECORD

I. Instructions to Verification Personnel

Project No.: 90-2271 Calculation No.: CCL-CA-352

Revision No.: 0

Design in verification should be done in accordance with ANSI N45.2.11, Section 6, as amended by Reg. Guide 1.64, Rev. 2.

Special Instructions: NONE

II. Verification Documentation

Method Used:

✓ Design Review (Attach any documentation and check sheet)
____ Alternate or Simplified Calculations (Attach calculations)
____ Qualification Testing

Design Document Acceptable: Yes ✓ No ____

If not acceptable, give reasons or provide comments on attached sheet to this form: ____

Verification check completed by:

[signature] (Signature) 12-7-90 (Date)

III. Resolution of Comments N/A

Comments resolved (See attached page):

____ (Responsible Engineer) ____ (Date)

Action taken makes design document acceptable

____ Project Engineer ____ Date ____ Verifier ____ Date

Design Review Check Sheet

Project No.: 90-2271 Calculation No.: CCL-CA-352

Revision: 0

Description:

Mark each item yes, no, or not applicable (N/A) and initial each item checked by you.

1. YES Were the inputs correctly selected and incorporated into design?

2. YES Are assumptions necessary to perform the design activity adequately described and reasonable? Where necessary, are the assumptions identified for subsequent re-verifications when the detailed design activities are completed?

3. YES Are the appropriate quality and quality assurance requirements specified?

4. YES Are the applicable codes, standards and regulatory requirements including issue and addenda properly identified and are their requirements for design met?

5. YES Have applicable construction and operating experience been considered?

6. YES Have the design interface requirements been satisfied?

7. YES Was an appropriate design method used?

8. YES Is the output reasonable compared to inputs?

9. YES Are the specified parts, equipment, and processes suitable for the required application?

10. YES Are the specified materials compatible with each other and the design environmental conditions to which the material will be exposed?

11. N/A Have adequate maintenance features and requirements been specified?

12. YES Are accessibility and other design provisions adequate for performance of needed maintenance and repair?

13. YES Has adequate accessibility been provided to perform the in-service inspection expected to be required during the plant life?

14. N/A Has the design properly considered radiation exposure to the public and plant personnel?

15. YES Are the acceptance criteria incorporated in the design documents sufficient to allow verification that design requirements have been satisfactorily accomplished?

16. N/A Have adequate pre-operational and subsequent periodic test requirements been appropriately specified?

17. N/A Are adequate handling, storage, cleaning, and shipping requirements specified?

18. YES Are adequate identification requirements specified?

19. YES Are requirements for record preparation review, approval, retention, etc., adequately specified?

For each question on the checksheet not answered yes, explain, sign, and date at the bottom of each explanation.

11. MAINTENANCE AND REQUIREMENTS ARE NOT PART OF CCL'S SCOPE OF WORK.
14. ALARA IS CP&L'S RESPONSIBILITY.
16. CP&L WI[illegible] D[illegible]INE PRE-OPERATIONAL TESTING.
17. HANDLIN[illegible] ST[illegible]GE, CLEANING, AND SHIPPING OF COMPONENTS ARE CP&L'S RESPONSIBILITY.

[signature] 12-7-90

[signature] 12-7-90
Signature (Design Verifier/Checker) — Date

TF-133
1/12/89

ATTACHMENT "K"
65 SHEETS

SYSTEM# 4060
TYPE CO

CAROLINA POWER & LIGHT COMPANY
P. O. BOX 1551
RALEIGH, NORTH CAROLINA 27602

RNP-C/STRS-1114
(ANALYSIS/CALCULATION #)

FOR

CORROSION EVALUATION FOR BURIED SERVICE WATER PIPE LINES 30CW11 & 30CW12.
(TITLE)

FOR

H.B. ROBINSON - UNIT 2
(PROJECT AND/OR PLANT NAME & APPLICABLE UNIT)
(STRUCTURE/SYSTEM/COMPONENT)

SAFETY CLASSIFICATION: Q
SEISMIC CLASSIFICATION: I

APPROVAL

REV. NO.	PREPARED BY DATE	VERIFIED BY DATE	PROJECT ENGINEER DATE	PRINCIPAL ENGINEER DATE
0	A.M Wolfe 12-4-90 : 12-7-90	John C. Hopkins WPC 12-7-90 12-4-90	[illegible] 12.17.90	[illegible] 12/17/90
1	John C. Hopkins 12-18-90	James B. Wheeler 12-18-90	[illegible] 12.18.90	[illegible] 12/18/90

REASON FOR CHANGE: INCLUDE REFERENCE TO CCL CALCULATION NO: CCL-CA-352; "GEOMETRIC DISPLACEMENTS ANALYSES OF H.B. ROBINSON STM. ELEC PLANT S.W. PIPING, LINE NO. CW-11."

REV. NO.	PREPARED BY DATE	VERIFIED BY DATE	PROJECT ENGINEER DATE	PRINCIPAL ENGINEER DATE

REASON FOR CHANGE:

REV. NO.	PREPARED BY DATE	VERIFIED BY DATE	PROJECT ENGINEER DATE	PRINCIPAL ENGINEER DATE

REASON FOR CHANGE:

FORM NO. 0019M
2/89
REV. 6/89

CAROLINA POWER & LIGHT COMPANY

PLANT	UNIT	CALCULATION NUMBER
H. B. ROBINSON	2	RNP-C/STRS-1114

PCN/PID NUMBER	FILE	PAGE	REVISION
		1	0

SUBJECT: CORROSION EVALUATION FOR BURIED SERVICE WATER PIPE LINES 30CW11 & 30CW12

ORIGINATOR'S INITIALS/DATE: A.M. Wolfe ~~12-7-90~~ 12/21/90

CHECKER'S INITIALS/DATE: JCHopkins ~~12-7-90~~ 12/21/90

REV. △1 By: JCH 12-18-90 CKD: JBW 12-18-90

ALL PAGES REV. 0 UNLESS OTHERWISE NOTED

LIST OF EFFECTIVE PAGES

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ATT. B 2 SHT'S		
ATT. C 39 SHT'S		
ATT. D 2 SHT		
ATT. E 2 SHTS		

PAGE	REVISION

PAGE	REVISION

FORM NO. 78055 REV. 10/85

Computed by: A.M. Waft Date: 12-7-90	CAROLINA POWER & LIGHT COMPANY	Calculation ID: RNP-C/STRS-1114	
Checked by: DCH Date: 12-7-90	H.B. ROBINSON - UNIT 2	Pg. 2 of	Rev. 0
Tar / PID No.:	CALCULATION SHEET	File:	
Project Title:			
Calculation Title: CORROSION EVALUATION OF BURIED SERVICE WATER PIPE 30CW11 & 12			
Status: Prelim. ☐ Final ☐ Void ☐			

Rev. 1 BY: DCH 12-18-90 CKD: JBW 12-18-90

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△1

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Computed by: A.M. Wafte Date: 11-27-90	CAROLINA POWER & LIGHT COMPANY	Calculation ID: RNP-C/STRS-1114	
Checked by: JCH Date: 12-3-90	H.B. ROBINSON - UNIT 2	Pg. 3 of	Rev. 0
Tar / PID No.:	CALCULATION SHEET	File:	

Project Title:

Calculation Title: CORROSION EVALUATION OF BURIED SERVICE WATER PIPE 30CW11 & 30CW12

Status: Prelim. ☐ Final ☐ Void ☐

PURPOSE:

EVALUATE THE BURIED PORTIONS OF SERVICE WATER LINES 30CW11 & 30CW12 DUE TO MINIMUM WALL VIOLATIONS FOUND DURING THE INSERVICE INSPECTION UNDERTAKEN DURING THE 1990 REFUELING OUTAGE. THESE LINES ARE BURIED IN THE YARD BETWEEN THE INTAKE STRUCTURE and REACTOR AUXILIARY BUILDING.

MINIMUM WALL VIOLATIONS HAVE OCCURRED AT THE UNCEMENTED BELL & SPIGOT JOINTS DUE TO CORROSION. THE EVALUATION IS BASED ON A POPULATION OF WORST CASE JOINTS DETERMINED BY VISUAL INSPECTION OF NED and TECH SUPPORT PERSONNEL.

FORM NO. 78055 REV. 10/85

Computed by: A.M. Wolfe Date: 12-3-90	CAROLINA POWER & LIGHT COMPANY H. B. ROBINSON - UNIT 2	Calculation ID: RNP-C/STRS-1114	
Checked by: DCH Date: 12-3-90	CALCULATION SHEET	Pg. 4 of	Rev. 0
Tar / PID No.:		File:	
Project Title:			
Calculation Title: CORROSION EVALUATION OF BURIED SERVICE WATER PIPE 30CW11 & 30CW12			
Status: Prelim. ☐ Final ☐ Void ☐			

REV. △1 BY: DCH 12-18-90
CKD: JBW 12-18-90

REFERENCES

1. DWG. B-190174 SHT. 13 REV. 11 LINE LIST
2. DWG. G-190199 SHT. 1 REV. 32; SHT. 2 REV. 31; SHT. 9 REV. 31; SHT. 10 REV. 28 — FLOW DIAGRAMS
3. DWG. G-190778 REV. 11 — YARD PIPING LAYOUT
4. DWG. G-190779 REV. 4 — YARD PIPING LAYOUT
5. P.O. # NY-434315 TO SUPPLEMENT #3 ARMCO STEEL CORP.
6. CALC. RRC-1608.00-00-0001 REV. 0 FOUNDATION ANALYSIS FOR VOLUME REDUCTION / SOLIDIFICATION MODIFICATION STRUCTURE
7. CALC. RRC-1633.00-00-0003 REV. 3 ANALYSIS & DESIGN OF SW SUPPLY RELOCATED AROUND RADWASTE FACILITY
8. FILE WELC-5379, CAR-5680 BOOK # 17 - MISC. CALCULATIONS (THRUST BLOCKS)
9. SPEC. AWWA-C-202-64 PIPE
10. SPEC. AWWA-C-205-62T CEMENT LINING
11. SPEC. AWWA-C-203-66 COAL TAR COATING
12. ASA B31.1-1955
13. USAS B31.1-1967
14. USAS B31.7-1969
15. ASME CODE CASE N-480
16. AISC STEEL MANUAL 8th EDITION
17. DWG # SK-RET-R-90-167-001 REV. 0 "BUTT-STRAP" FIX
18. CCL CALCULATION NO: CCL-CA-352, REV. 0; "GEOMETRIC DISPLACEMENTS ANALYSES OF H.B. ROBINSON STEAM ELECTRIC PLANT SERVICE WATER PIPING, LINE NUMBER CW-11" △1

FORM NO. 78055 REV. 10/85

Computed by: A.M. Wolfe Date: 11-23-90	CAROLINA POWER & LIGHT COMPANY	Calculation ID: RNP-C/STRS-1114	
Checked by: JCH Date: 12-3-90	H. B. ROBINSON - UNIT 2	Pg. 5 of	Rev. 0
Tar / PID No.:	CALCULATION SHEET	File:	
Project Title:			
Calculation Title: CORROSION EVALUATION OF BURIED SERVICE WATER PIPE 30CW11 & 30CW12			
Status: Prelim. ☐ Final ☐ Void ☐			

PIPE PROPERTIES & OPERATING CONDITIONS

31-3/8" Ø O.D. x 0.188" WALL — AWWA C202 GRADE B
SPIRAL WELDED — (A-139 GRADE B)

INTERIOR IS LINED WITH 3/8" CEMENT MORTAR - AWWA C205-62T
EXTERIOR IS COAL TAR COATED - AWWA C203-66

	t = .188"	t = .150"	t = .130"
A (in^2)	18.362	14.71	12.754
I (in^4)	2240.10	1793.83	1557.63
Z (in^3)	142.79	114.35	99.29

WHERE: A = METAL AREA = $0.785(D^2 - d^2)$
I = MOMENT OF INERTIA = $0.0491(D^4 - d^4)$
Z = SECTION MODULUS = $0.0982(D^4 - d^4)/D$

T_{DESIGN} = 125°F
T_{OPER} = 95°F - 35°F
P_{DESIGN} = 100 psig
P_{OPER} = 50 psig

α_T = 6.13×10^{-6} in/in/°F @ 95°F
E_c = 27.9×10^6 psi

S_{ULT} = 60 ksi
S_Y = 35 ksi
* S_M = 20 ksi

** $S_c = S_h$ = 12 ksi
S_A = 18 ksi

* BASED ON SMALLER VALUE OF $\frac{1}{3} S_{ULT}$ OR $\frac{2}{3} S_Y$ — B31.7-1969

** INCLUDES WELD JOINT EFFICIENCY FACTOR = 0.8 (USAS B31.1-1967). THIS IS EQUIVALENT TO $S_c = S_h$ = 12 ksi (ASA B31.1-1955) WHICH DOESN'T ADDRESS WELD JOINT EFFICIENCY FACTORS.

FORM NO. 78055 REV. 10/85

Computed by: A.M. Wolfe Date: 11-23-90	CAROLINA POWER & LIGHT COMPANY	Calculation ID: RNP-C/STRS-1114
Checked by: JCK Date: 12-3-90	H.B. ROBINSON - UNIT 2	Pg. 6 of Rev. 0
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Project Title:		
Calculation Title: CORROSION EVALUATION OF BURIED SERVICE WATER PIPE 30CW11 & 30CW12		
Status: Prelim. ☐ Final ☐ Void ☐		

CALCULATE MINIMUM WALL REQUIRED FOR PRESSURE DESIGN

EQUATION (1) SECTION 122 PG. 13 ASA B31.1 - 1955

$$t_m = \frac{PD}{2S + 2yP} + C = \frac{100\,(31.375)}{2\,(12000 + 100 \times .4)} + 0 = \boxed{0.130''}$$

THIS CALCULATION ASSUMES NO CORROSION ALLOWANCE SINCE PIPING IS COAL TAR LINED ON EXTERIOR and CEMENT LINED ON INTERIOR.

NOTE: $t_{min} = 0.130''$ AS CALCULATED TO THE REQUIREMENTS OF USAS B31.1 - 1967 - SECTION 104.1

MINIMUM WALL CALCULATION IS BASED ON INTERNAL DESIGN PRESSURE = 100 psig WHICH EXCEEDS EXTERNAL PRESSURE.

FORM NO. 78055 REV. 10/85

Computed by: A.M. WOLFE	Date: 11-27-90	CAROLINA POWER & LIGHT COMPANY	Calculation ID: RNP-C/STRS-1114	
Checked by: JCH	Date: 12-3-90	H.B. ROBINSON - UNIT 2	Pg. 7 of	Rev. 0
Tar / PID No.:		CALCULATION SHEET	File:	
Project Title:				
Calculation Title: CORROSION EVALUATION OF BURIED SERVICE WATER PIPE 30CW11 & 30CW12				
Status: Prelim. ☐ Final ☐ Void ☐				

REV. 1 BY: JCH 12-18-90 CKD: JBW 12-18-90

SEISMIC QUALIFICATION

THE BURIED PORTIONS OF SERVICE WATER LINES 30CW11 and 30CW12 ARE CONSIDERED SEISMICALLY QUALIFIED AS STATED IN THE ANSWER TO AEC QUESTION III B10C dated 9-17-69, "THE BURIED CLASS I PIPE IS DESIGNED TO MOVE WITH THE GROUND and ASSUME A SINUSOIDAL SHAPE CORRESPONDING TO THE GROUND WAVE WITHOUT EXCEEDING ALLOWABLE STRESSES OR OPENING OF JOINTS. THE DESIGN CRITERIA FOR THE PLANT DOES NOT INCLUDE PROVISIONS FOR GROUND FISSURES OR OTHER GROSS PERMANENT GROUND DISPLACEMENTS." BASICALLY, THE ORIGINAL LICENSING BASED ASSUMPTION IS THAT THE PIPE WOULD FLEX DURING AN EARTHQUAKE WITH NO LOSS OF FUNCTION.

THE DRESSER STYLE 38 COUPLING LOCATED IN THE VAULT ROOM ADJACENT TO THE INTAKE STRUCTURE (ONE PER LINE) IS INSTALLED TO REDUCE LOADS ON THE INTAKE STRUCTURE and STRAINERS DUE TO SEISMIC and THERMAL CONDITIONS. BASICALLY THESE COUPLINGS ACT AS TIED EXPANSION JOINTS.

THE BELL and SPIGOT STAB-IN JOINTS PROVIDE STRAIN RELIEF FOR EACH OF THE ADJACENT PIPE SEGMENTS. ALTHOUGH THE BUTT STRAP FIX WILL PROVIDE A CONTINUOUSLY WELDED JOINT AT A FEW OF THE JOINTS, THE OVERALL BURIED PIPING SYSTEM WILL MAINTAIN IT'S INTENDED FLEXIBILITY. ~~REFERENCE 6 INCLUDES AN ANALYSIS THAT DEMONSTRATES THAT NO LIQUEFACTION WILL OCCUR.~~ CCL CALCULATION NO. CCL-CA-352, REFERENCE 18, SHOWS THAT FOR THE PREDICTED GROUND DISPLACEMENTS AT THE ROBINSON SITE, NO FUNCTION LOSS OF THE BURIED SERVICE WATER PIPING WILL BE EXPERIENCED DUE TO JOINT SEPARATION. IN ADDITION, IT IS ALSO SEEN THAT THE JOINT ROTATIONS ARE OF SUCH A SMALL MAGNITUDE SO THAT NO BENDING OF THE BELL AND SPIGOTS WILL OCCUR. THEREFORE, BASICALLY NO SEISMIC STRESSES WILL BE GENERATED IN THE PIPING. (Rev. 1)

FORM NO. 78055 REV. 10/85

Computed by: A.M. Wolfe Date: 11-27-90	CAROLINA POWER & LIGHT COMPANY	Calculation ID: RNP-C/STRS-1114	
Checked by: [signature] Date: 11-27-90	H.B. ROBINSON - UNIT 2	Pg. 8 of	Rev. 0
Tar / PID No.:	CALCULATION SHEET	File:	

Project Title:

Calculation Title: CORROSION EVALUATION OF BURIED SERVICE WATER PIPE 30CW11 & 30CW12

Status: Prelim. ☐ Final ☐ Void ☐

WELD SIZE - "BUTT STRAP" TO PIPE

AISC STEEL MANUAL 8th EDITION

PIPE t = .188" I.D. = 31.0"

"BUTT-STRAP" t = .188"

ASSUMPTIONS:

1) BUTT STRAP MATERIAL PROPERTIES ARE NOT LESS THAN THAT OF THE PIPE.
2) E70XX ELECTRODES ARE USED
3) WELD IS SIZED DUE TO AXIAL LOAD IN PIPE DUE TO PRESSURE

$F = PA = (100 psig)(.785)(31 in)^2 = 75.5^k$

CIRCUMFERENCE = $\pi D = \pi(31") = 97.39"$ ✓

FORCE / LENGTH = F / CIRCUMFERENCE = 75500#/97.39" = 775#/IN

ALLOWABLE FILLET WELD SIZE = .707(.0625")(.3 × 70,000) = 928#/IN / 1/16"

MINIMUM SIZE FILLET WELD (SEC. 1.17.2) = 1/8" f_{all} = 1856#/IN

MAXIMUM SIZE FILLET WELD (SEC. 1.17.3) = 3/16" f_{all} = 2784#/IN

∴ USE 1/8" FILLET WELD WELD AROUND CIRCUMFERENCE

WELD DETAIL IS SHOWN ON DWG # SK-RET-R-90-167-001 REV. A

FORM NO. 78055 REV. 10/85

Computed by: A.M. WOLFE Date: 11-23-90	CAROLINA POWER & LIGHT COMPANY H. B. ROBINSON - UNIT 2 CALCULATION SHEET	Calculation ID: RNP-C/STRS - 1114	
Checked by: JCK Date: 12-3-90		Pg. 9 of	Rev. 0
Tar / PID No.:		File:	
Project Title:			
Calculation Title: CORROSION EVALUATION OF BURIED SERVICE WATER PIPE 30CW11 & 30CW12			
Status: Prelim. ☐ Final ☐ Void ☐			

MINIMUM WALL VIOLATIONS

MINIMUM WALL VIOLATION EVALUATIONS WILL BE PERFORMED TO THE REQUIREMENTS OF ASME CODE CASE N-480 APPROVED 5-10-90.

$R = 31.375'' / 2 = 15.6875''$

$t_{nom} = 0.188''$

$t_{min} = 0.130''$

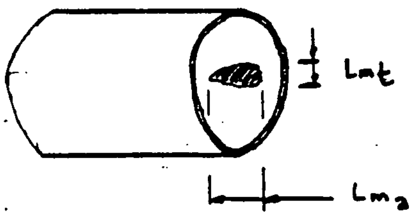
t_p = MINIMUM PREDICTED WALL THICKNESS PROJECTED TO NEXT INSERVICE INSPECTION. THIS VALUE IS ASSUMED = t_{actual} SINCE PIPING WILL BE RECEMENTED (INTERIOR) SUCH THAT EROSION / CORROSION WILL NOT CONTINUE.

FROM SECTION 3410, PIPING SHALL BE REPAIRED OR REPLACED IF $t_p < .3 t_{nom}$ OR $0.0564''$.

THEREFORE THIS EVALUATION WILL ADDRESS MIN. WALL VIOLATIONS FOR LOCALIZED WALL THICKNESSES BETWEEN $0.06''$ and $t_{min} = 0.130''$.

FOR LOCAL THINNING (CASE 1 SECTION 3622.1)

$L_{m(t)} < \sqrt{R t_{min}} < \sqrt{(31.375/2)(.130'')} < 1.43''$



A) USE CURVE ① OF FIGURE -3622-1

B) IF CASE 1 FAILS, GO TO CASE 2

FORM NO. 78055 REV. 10/85

Computed by: A.M. WOLFE Date: 11-23-90	CAROLINA POWER & LIGHT COMPANY	Calculation ID: RNP-C/STRS-1114
Checked by: [signature] Date: 12-3-90	H.B. ROBINSON - UNIT 2	Pg. 10 of Rev. 0
Tar / PID No.:	CALCULATION SHEET	File:
Project Title:		
Calculation Title: CORROSION EVALUATION OF BURIED SERVICE WATER PIPE 30CW11 & 30CW12		
Status: Prelim. ☐ Final ☐ Void ☐		

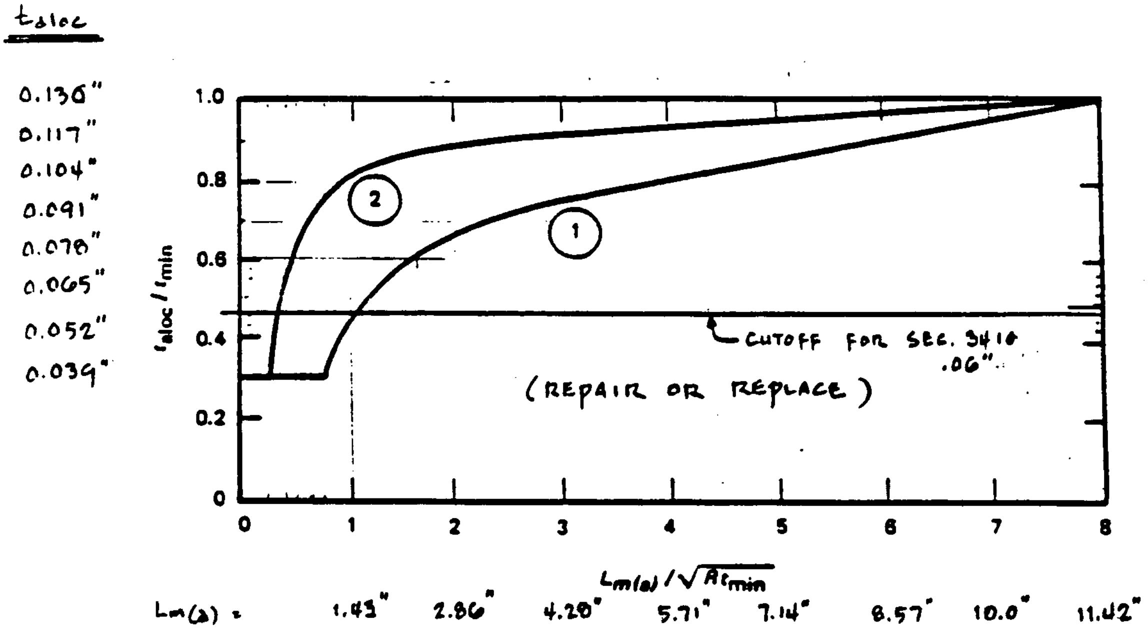


FIG. -3622-1 ALLOWABLE DEPTH AND LENGTH OF LOCALLY THINNED AREA

FORM NO. 78055 REV. 10/85

Computed by: A.M. WOLFE	Date: 11-23-90	CAROLINA POWER & LIGHT COMPANY H.B. ROBINSON - UNIT 2 CALCULATION SHEET	Calculation ID: RNP-C/STRS-1114	
Checked by: JCH	Date: 12-3-90		Pg. 11 of	Rev. 0
Tar / PID No.:			File:	

Project Title:

Calculation Title: CORROSION EVALUATION OF BURIED SERVICE WATER PIPE 30CW11 & 30CW12

Status: Prelim. ☐ Final ☐ Void ☐

FOR LOCAL THINNING (CASE 2 SECTION 3622.2)

$$t_m < 2.65\sqrt{R\,t_{min}} < 2.65\sqrt{(31.375/2)(.130)} < 3.784''$$

(LONGEST PITTED LENGTH)

$$t_{nom} > 1.13\,t_{min} > 1.13(.130'') > 0.147''$$

MUST SATISFY THE FOLLOWING TWO EQUATIONS:

EQ.(1) $$\frac{t_{aloc}}{t_{min}} \geq \frac{1.5\sqrt{R\,t_{min}}}{L}\left[1 - \frac{t_{nom}}{t_{min}}\right] + 1.0$$

$$\frac{t_{aloc}}{t_{min}} \geq \frac{1.5\sqrt{(31.375/2)(.130)}}{L}\left[1 - \frac{.188}{.130}\right] + 1.0$$

$$\frac{t_{aloc}}{t_{min}} \geq 1.0 - \frac{0.9557}{L}$$

WHERE L = LONGEST LENGTH OVER PITTED AREA BACK TO t_{nom}.

EQ.(2) $$\frac{t_{aloc}}{t_{min}} \geq \frac{0.353\,L_m}{\sqrt{R\,t_{min}}} \geq \frac{0.353\,L_m}{\sqrt{(31.375/2)(.130)}} \geq 0.2472\,L_m$$

IF CASE 2 FAILS, GO TO CASE 3.

FORM NO. 78055 REV. 10/85

Computed by: A.M. Wolfe Date: 11-28-90 Checked by: JCH Date: 12-3-90	CAROLINA POWER & LIGHT COMPANY H.B. ROBINSON - UNIT 2	Calculation ID: RNP-C/STRS-1114	
Tar / PID No.:	CALCULATION SHEET	Pg. 12 of	Rev. 0
		File:	
Project Title:			
Calculation Title: CORROSION EVALUATION FOR BURIED SERVICE WATER PIPE 30CW11 & 30CW12			
Status: Prelim. ☐ Final ☐ Void ☐			

FOR LOCAL THINNING (CASE 3 SECTION 3622.3)

TWO REQUIREMENTS MUST BE MET:

A) USE CURVE (2) OF FIGURE 3622-1 FOR $\frac{t_{aloc}}{t_{min}}$

B) $\frac{t_{aloc}}{t_{min}} \geq \frac{1}{1.2}\left[0.5 + \left(\frac{t_{nom}}{t_{min}}\right)\left(\frac{P_b}{S_h}\right)\right]$

WHERE P_b = PIPE LONGITUDINAL BENDING STRESS RESULTING FROM ALL PRIMARY PIPE LOADINGS.

NOTE: ONLY DEADWEIGHT & SEISMIC INERTIA PRODUCE PRIMARY BENDING STRESS. PRESSURE STRESS IS A MEMBRANE STRESS P_L. SINCE THE BELL & SPIGOT JOINTS ARE NOT RIGID CONNECTIONS, THEY PROVIDE STRESS RELIEF FOR THE ADJACENT PIPING SEGMENTS AND THEREFORE PRIMARY BENDING STRESS IS NEGLIGIBLE @ THE BELL & SPIGOT JOINTS.

THEREFORE REQUIREMENT B IS CONSIDERED MET AT ANY BELL & SPIGOT JOINT.

FORM NO. 78055 REV. 10/85

Computed by: A.M. Wolfe	Date: 11-27-90	CAROLINA POWER & LIGHT COMPANY H.B. ROBINSON - UNIT 2 CALCULATION SHEET	Calculation ID: RNP-C/STRS-1114	
Checked by: JCH	Date: 12-3-90		Pg. 13 of	Rev. 0
Tar / PID No.:			File:	

Project Title:

Calculation Title: CORROSION EVALUATION FOR BURIED SERVICE WATER PIPE 30CW11 & 12

Status: Prelim. ☐ Final ☐ Void ☐

SOUTH HEADER 30-CW-12 - INTERNAL CONTOURS

JOINT #	MINIMUM ACTUAL t	ACTUAL $L_{m(1)}$	ACTUAL $L_{m(2)}$	L_m *	L *	CASE #	MINIMUM ALLOWED t_{aloc} **	
#6 75°	.07	.75"	.4"			1	.06	
90°	.07	.7"	.7"			1	.06	
#7 90°	.10	1.0	<.5"			1	.06	
270°	.11	.75	.6"			1	.06	
#9 90°	.10	.5	.8			1	.06	
#10	.04	—	—	—	—	—	—	REPAIR
#11 10°	.10	.3	1.1			1	.06	
90°	.10	.4	1.3			1	.06	
270°	.19	—	—	—	—	—	t_{min} = .13	OK
#12 95°	.19	—	—	—	—	—	t_{min} = .13	OK
250°	.12	.4	.5			1	.06	
290°	.12	.5	.3			1	.06	
#22 170°	.12	.2	.2			1	.06	
200°	.11	.5	.4			1	.06	
#39 10°	.12	.3	.5			1	.06	
95°	.11	.65	.4			1	.06	
#42	.03	—	—	—	—	—	—	REPAIR
#43 0°	.06	.5	1.0			1	.06	
90°	.07	.7	.5			1	.06	

* L_m & L NOT NEEDED FOR CASE 1

NOTE: ** FOR $L_{m1} < 1.43"$ and $L_{m2} < 1.43"$, $t_{aloc} = .06"$ FOR CASE 1. ACTUAL VALUES OF t, L_{m1} and L_{m2} ARE SCALED FROM CONTOUR SKETCHES IN ATTACHMENT C and RECORDED MEASUREMENTS ARE CONSERVATIVE.

FORM NO. 78055 REV. 10/85

Computed by: A.M. Wolfe Date: 11-28-90	CAROLINA POWER & LIGHT COMPANY H.B. ROBINSON - UNIT 2	Calculation ID: RNP-C/STRS-1114
Checked by: JCH Date: 12-3-90	CALCULATION SHEET	Pg. 14 of	Rev. 0
Tar / PID No.:		File:

Project Title:

Calculation Title: CORROSION EVALUATION FOR BURIED SERVICE WATER PIPE 30CW11 & 30CW12

Status: Prelim. ☐ Final ☐ Void ☐

REV 1 By: JCH 12-18-90 CKD: JBW 12-18-90

SOUTH HEADER 30 CW-12 EXTERNAL UT'S

JOINT #	MINIMUM ACTUAL t

#6 - .07" @ -20/E AREA IS < 1□" THEREFORE CASE 1 OF SECTION 3622.1 IS SATISFIED (t=.06) OK

#7 - .1" @ D/-5 TO -8 (WORST CASE) MAX. AREA = L_{mt} < 3.5", L_{ma} < 1.5"

CASE 1 IS NOT MET L_{mt} > 1.43"
CASE 2 IS NOT MET L - UNDETERMINED
USE CASE 3, FOR L_{ma} < 1.5" $t_{req'd}$ = 0.1" ∴ OK

#32 - .12" @ 77F, 80F, 90F, 94F - AREA IS < 1□" THEREFORE CASE 1 IS SATISFIED (t=.06") OK

- .10" @ 68-71/F MAX AREA = L_{mt} < 4.5", L_{ma} < 1.5" OK (← BOUNDING CASE, REV 1)

FROM JOINT 7 ABOVE (CASE 3) $t_{req'd}$ = 0.1"

- .09" @ 56-57/F MAX AREA = L_{mt} < 1.5" L_{ma} < 1" OK
- .09" @ 59-60/F MAX AREA = L_{mt} < 2.5" L_{ma} < 1" OK
- FROM CASE 3 $t_{req'd}$ = .09"

- .09" @ 66D THIS "SCAN" IS CONSIDERED ISOLATED FROM 68-71/F SINCE INTERPOLATION FROM 66E TO 67D and 66D TO 67E YIELDS WALL t = .14" MINIMUM, THEREFORE AREA IS < 1□" and $t_{req'd}$ = .06" OK

FORM NO. 78055 REV. 10/85

Computed by: A.M. Watt Date: 11-28-90	CAROLINA POWER & LIGHT COMPANY	Calculation ID: RNP-C/STRS-1114	
Checked by: JCK Date: 12-3-90	H.B. ROBINSON - UNIT 2	Pg. 15 of	Rev. 0
Tar / PID No.:	CALCULATION SHEET	File:	
Project Title:			
Calculation Title: CORROSION EVALUATION FOR BURIED SERVICE WATER PIPE 30CW11 & 30CW12			
Status: Prelim. ☐ Final ☐ Void ☐			

SOUTH HEADER 30CW12 · EXTERNAL UT'S

JOINT *

* BUTT-WELD JOINT BETWEEN #32 & #33

THE BUTT-WELD JOINT IS TO BE REPAIRED SUCH THAT THE UT READINGS @ +A & -A ARE NOT VALID. THEREFORE MIN. WALL IS EVALUATED FOR THE CONTOURS AS FOLLOWS:

t = .11" @ +43/-E
t = .06" @ -44/+B TO +C

} BOTH AREAS ARE LOCALIZED < 1" SUCH THAT CASE 1 IS MET ($t_{req'd}$ = .06")

FORM NO. 78055 REV. 10/85

Computed by: A.M. Wolfe Date: 12-3-90	CAROLINA POWER & LIGHT COMPANY	Calculation ID: RNP-C/STRS-1114	
Checked by: JCH Date: 12-4-90	H.B. ROBINSON - UNIT 2	Pg. 10 of	Rev. 0
Tar / PID No.:	CALCULATION SHEET	File: RET-R-90-167	

Project Title:

Calculation Title: CORROSION EVALUATION OF BURIED SERVICE WATER PIPE 30CW11 & 30CW12

Status: Prelim. ☐ Final ☐ Void ☐

OPERABILITY EVALUATION PRIOR TO BACKFILL

IT IS ACCEPTABLE FOR EITHER 30CW11 OR 30CW12 TO BE DECLARED OPERABLE WITH THE FOLLOWING JOINTS EXPOSED PRIOR TO BACKFILLING ?

NORTH HEADER JOINTS 3, 4

SOUTH HEADER JOINTS 6, 7 (2/3 ENCASED IN CONCRETE).
31 (• THRUST BLOCK)
32 & BUTT-WELD JOINT ≈ 5' DOWNSTREAM

SEISMIC QUALIFICATION WILL NOT CHANGE DUE TO THE SMALL AMOUNT OF PIPING EXPOSED.

SINCE THE SMALL AMOUNT OF EXPOSED PIPING IS LOCATED WITHIN A TRENCH and SOME OF THE EXPOSED PIPING ON THE SOUTH HEADER IS ENCASED IN CONCRETE OR LOCATED AT A THRUST BLOCK, ADEQUATE MISSILE PROTECTION IS CONSIDERED PROVIDED DUE TO HORIZONTAL TORNADO PROJECTILES INCLUDING WIND LOADING.

THE EXPOSED JOINTS SHOULD BE RECOVERED BEFORE REACTOR CRITICALITY.

FORM NO. 78055 REV. 10/85

Computed by: A.M. Hoff	Date: 12-7-90	CAROLINA POWER & LIGHT COMPANY	Calculation ID: RNP-C/STRS - 1114	
Checked by: VCH	Date: 12-7-90	H.B. ROBINSON - UNIT 2	Pg. 17 of	Rev. 0
Tar / PID No.:		CALCULATION SHEET	File:	

Project Title:

Calculation Title: CORROSION EVALUATION OF BURIED SERVICE WATER PIPE 30CW11 & 12

Status: Prelim. ☐ Final ☐ Void ☐

CONCLUSION :

MINIMUM WALL VIOLATIONS HAVE BEEN FOUND TO BE ACCEPTABLE WITH THE EXCEPTION OF JOINTS 10 & 42 ON THE SOUTH HEADER. THESE JOINTS WILL BE FIXED WITH A BUTT-STRAP WELDED ALONG THE INTERIOR OF THE JOINT. ALSO JOINTS 1,2,3 & 4 REQUIRE FIXES ON THE NORTH HEADER.

JOINT # 31 ON THE SOUTH HEADER WILL BE REPAIRED WITH A BUTT-STRAP FIX (SEE LETTER IN ATTACHMENT D), THIS REPAIR DOES NOT CHANGE THE CONCLUSIONS FOR THE SEISMIC QUALIFICATION OF THIS PIPING and IS CONSIDERED ACCEPTABLE.

ALTHOUGH JOINT # 6 ON THE SOUTH HEADER WAS FOUND TO BE ACCEPTABLE, THE PLANT HAS DECIDED TO PERFORM A BASE METAL REPAIR TO THE CORRODED MANUFACTURERS SPIRAL WELD ≃ 3" IN LENGTH. (SEE LETTER IN ATTACHMENT D)

ATTACHMENT A
RNP-C/STRS-1114 R/0

DESIGN VERIFICATION RECORD

I. Instructions to Verification Personnel

Plant: RNP 2 Project No.: RET-R-90-167 File No. RET-R-90-167

Document Number	Revision	Document Title
RNP-C/STRS-1114	0	CORROSION EVALUATION FOR BURIED SERVICE
		WATER PIPE LINES 30CW11 & 30CW12

Design in verification should be done in accordance with ANSI N45.2.11, Section 6, as amended by Regulatory Guide 1.64, Rev. 2

Verification Methods to be used:

X Design Review
___ Alternate or Simplified Calculations
___ Qualification Testing

Document(s) "Q" Level:

X Q (Class A)
___ Seismic (Class B)
___ FP-Q (Class D)
___ Other

Special Instructions:

Discipline Project Engineer [signature] Date 12-7-90

II. Verification Documentation

Method Used:

X Design Review (Attach any documentation)
___ Alternate or Simplified Calculations (Attach Calculations)
___ Qualification Testing

Design Document Acceptable: Yes X No ___

If not acceptable, give reasons or provide comments on the reverse side of this form:

Verification Check Completed by (Signature): John C. Hopkins DATE 12-7-90
Acknowledgement of Verification: (DPE): [signature] DATE 12-17-90

III. Resolution of Comments:

Comments Resolved (See Reverse Side):

(RE)__________ DATE __________

Action taken makes Design Documents Acceptable

(DPE)__________ DATE __________ VERIFIER __________ DATE __________

ATTACHMENT A
RNP-C/STRS-1114 R/1
SHEET 2

DESIGN VERIFICATION RECORD

I. Instructions to Verification Personnel

Plant: RNP 2 Project No.: RET-R-90-167 File No. RET-R-90-167

Document Number	Revision	Document Title
RNP-C/STRS-1114	1	CORROSION EVALUATION FOR BURIED SERVICE
		WATER PIPE LINES 3DCW11 & 3DCW12.

Design in verification should be done in accordance with ANSI N45.2.11, Section 6, as amended by Regulatory Guide 1.64, Rev. 2

Verification Methods to be used:

X Design Review
___ Alternate or Simplified Calculations
___ Qualification Testing

Document(s) "Q" Level:

X Q (Class A)
___ Seismic (Class B)
___ FP-Q (Class D)
___ Other

Special Instructions:

Discipline Project Engineer VKS Date 12-18-90

II. Verification Documentation

Method Used:

___ Design Review (Attach any documentation)
___ Alternate or Simplified Calculations (Attach Calculations)
___ Qualification Testing

Design Document Acceptable: Yes X No ___

If not acceptable, give reasons or provide comments on the reverse side of this form:

Verification Check Completed by (Signature): JAMES B WHEELER DATE 12-18-90
Acknowledgement of Verification: (DPE): [signature] DATE 12-18-90

III. Resolution of Comments:

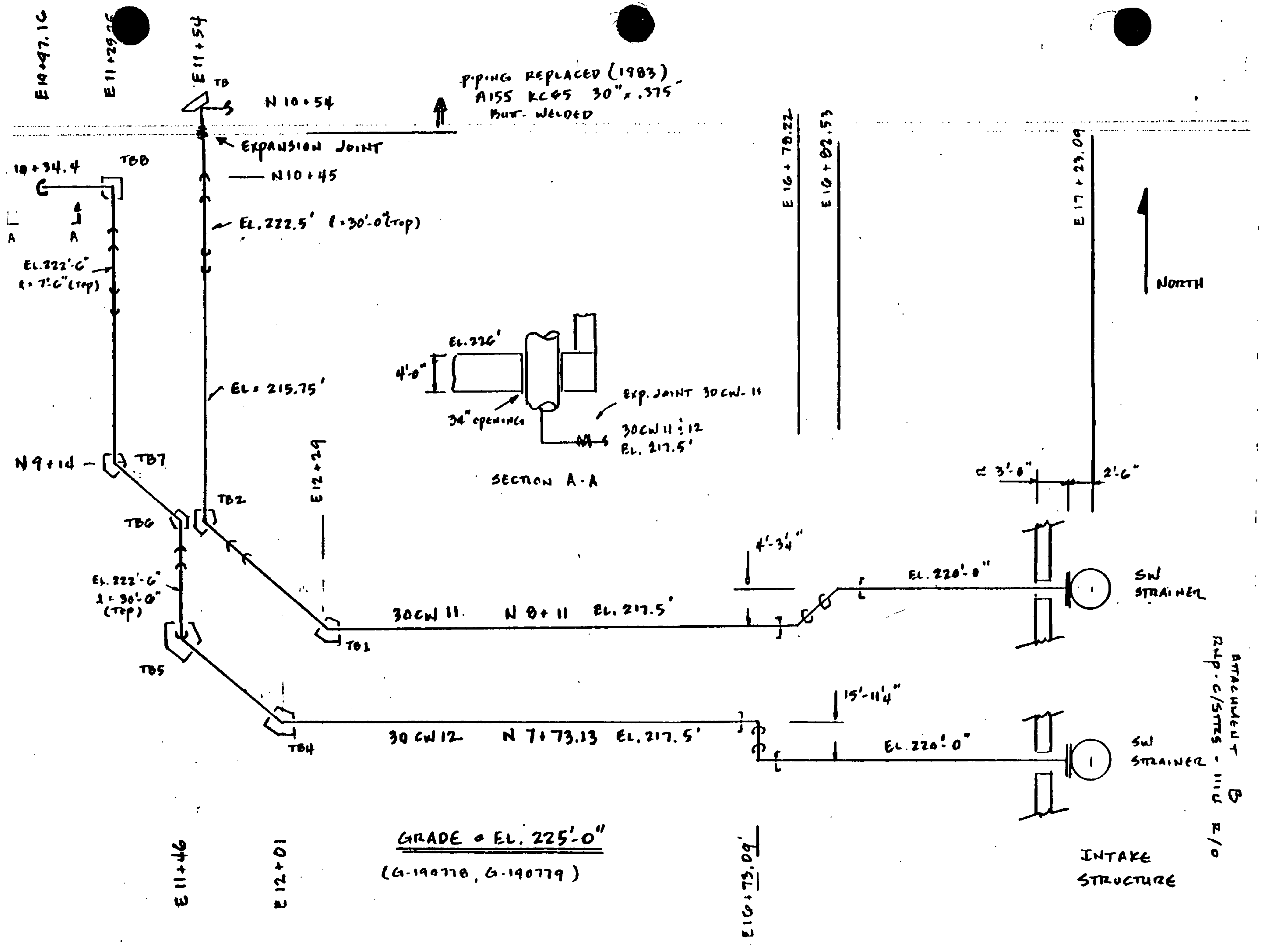
Comments Resolved (See Reverse Side):

(RE)___ DATE ___

Action taken makes Design Documents Acceptable

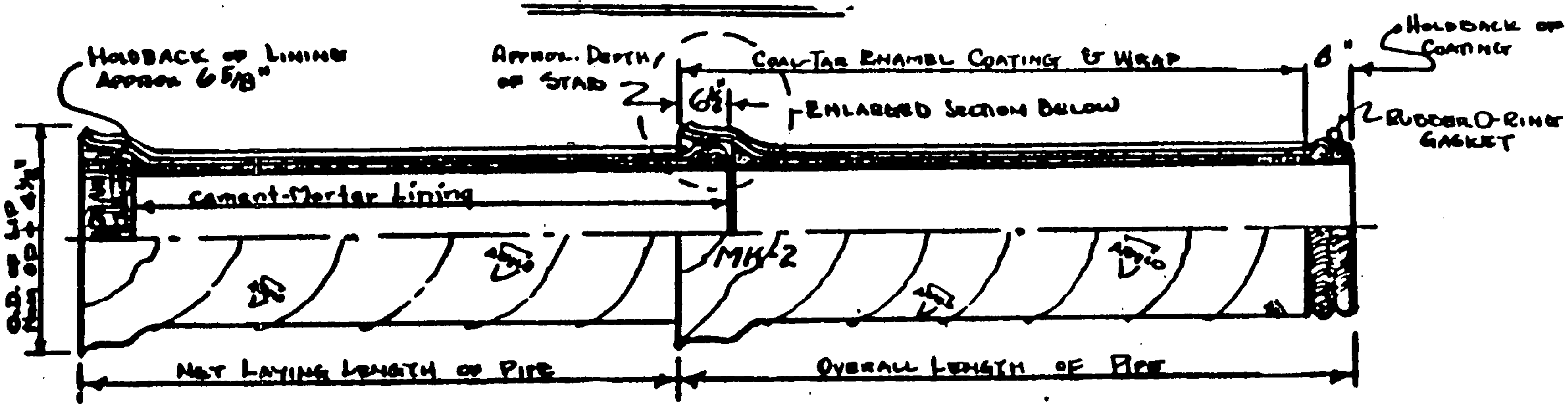
(DPE)___ DATE ___ VERIFIER ___ DATE ___

3.3/REV. 29
(PR59/cn)

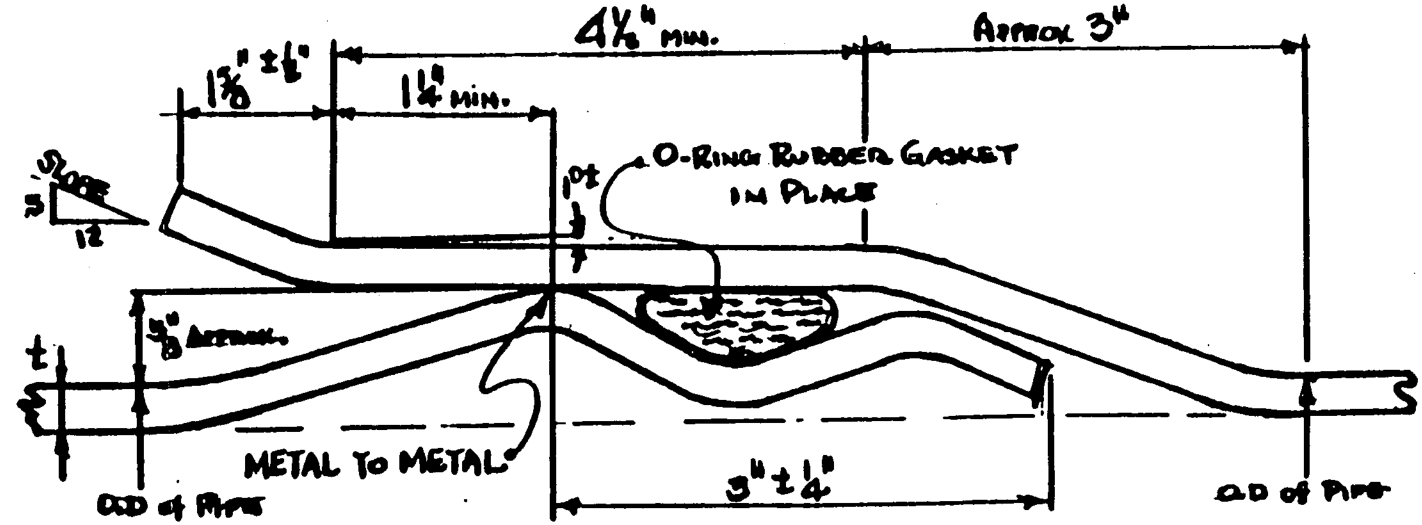


PIPING REPLACED (1983)
A155 KC65 30" x .375"
BUTT-WELDED
N 10+54
EXPANSION JOINT
N10+45
EL. 222.5' (1=30'-0" TOP)
EL. 222'-6"
1=7'-6" (TOP)
EL = 215.75'
E11+54
E11+25.25
E14+97.16
10+34.4
TB
TB8
TB7
TB6
TB2
TB5
TB1
TB4
A
N 9+14
E12+29
EL. 226'
4'-0"
34" OPENING
EXP. JOINT 30CW-11
30CW11 & 12
EL. 217.5'
SECTION A-A
E16+78.22
E16+82.53
E17+29.09
NORTH
3'-0"
2'-6"
4'-3¼"
EL. 220'-0"
SW STRAINER
30CW11
N 8+11
EL. 217.5'
EL. 222'-6"
1=30'-0" (TOP)
15'-11¼"
30CW12
N 7+73.13
EL. 217.5'
EL. 220'-0"
SW STRAINER
GRADE @ EL. 225'-0"
(G-190778, G-190779)
E11+46
E12+01
E16+73.09
INTAKE STRUCTURE
ATTACHMENT B
RLP-C/STES-1114 R/0

FIGURE



~ SCHEMATIC DRAWING OF PIPE ~



DETAILS OF BELL-AND-SPIGOT JOINT
~ COATINGS NOT SHOWN ~

DOCUMENTATION SUPPORTING QA RECORD Int. date

ATTACHMENT B
RNP-C/STRS-1114 12/0

ATTACHMENT C
RMP-C/STRS-1114 R/0

CP&L
Carolina Power & Light Company

NDE DRAWING ATTACHMENT

PAGE __ OF __

PROJECT HBR JOB NO. N/A UNIT 1☐ 2☒ 3☐ 4☐ DATE 11/20/90

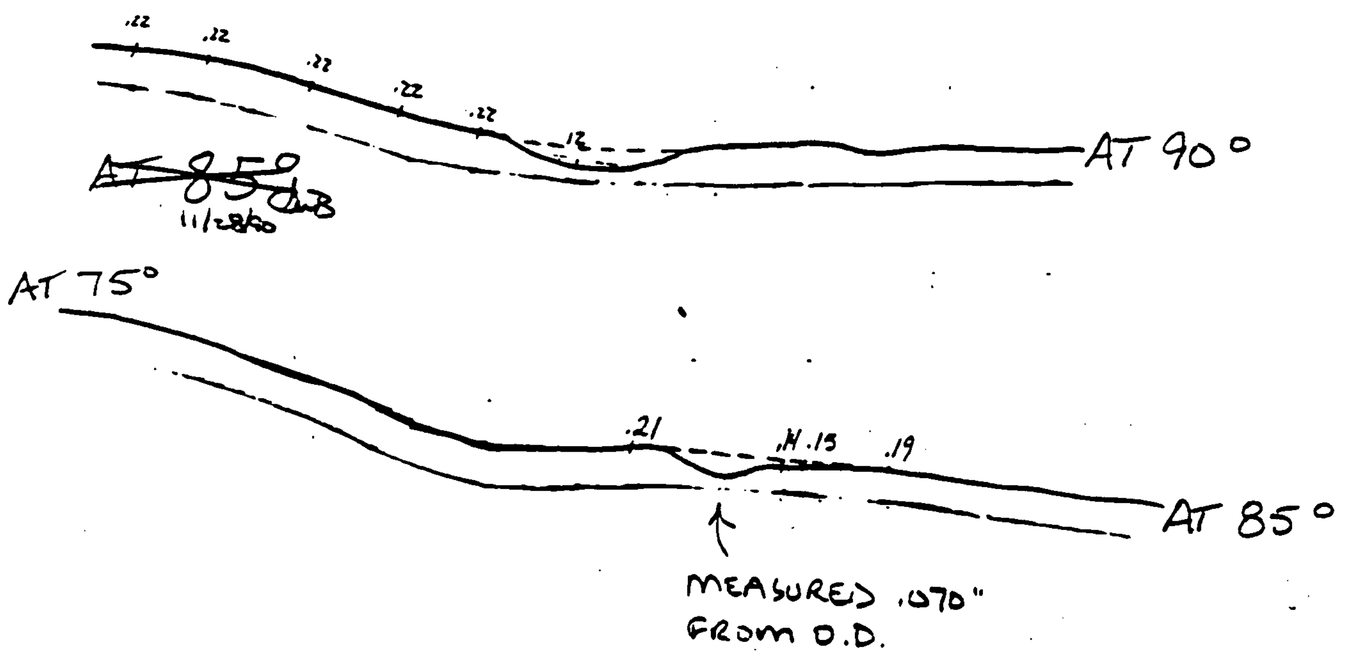
DRAWING	SYSTEM	LINE	WELD/ITEM NUMBER
3D-CW-12 ISO	Service Water	SOUTH HEADER	JOINT S-6

Joint 6

X AXIS (LONGITUDINAL)

90°

Flow ←



DOCUMENTATION SUPPORTING A
QA RECORD Int [initials] date 12/31/90
39 sheets

[signature] LEV II

CA NDE US 1 Rev. 0 6/83

ATTACHMENT C
RNP-C/STRS-1114 R/0

Carolina Power & Light Company

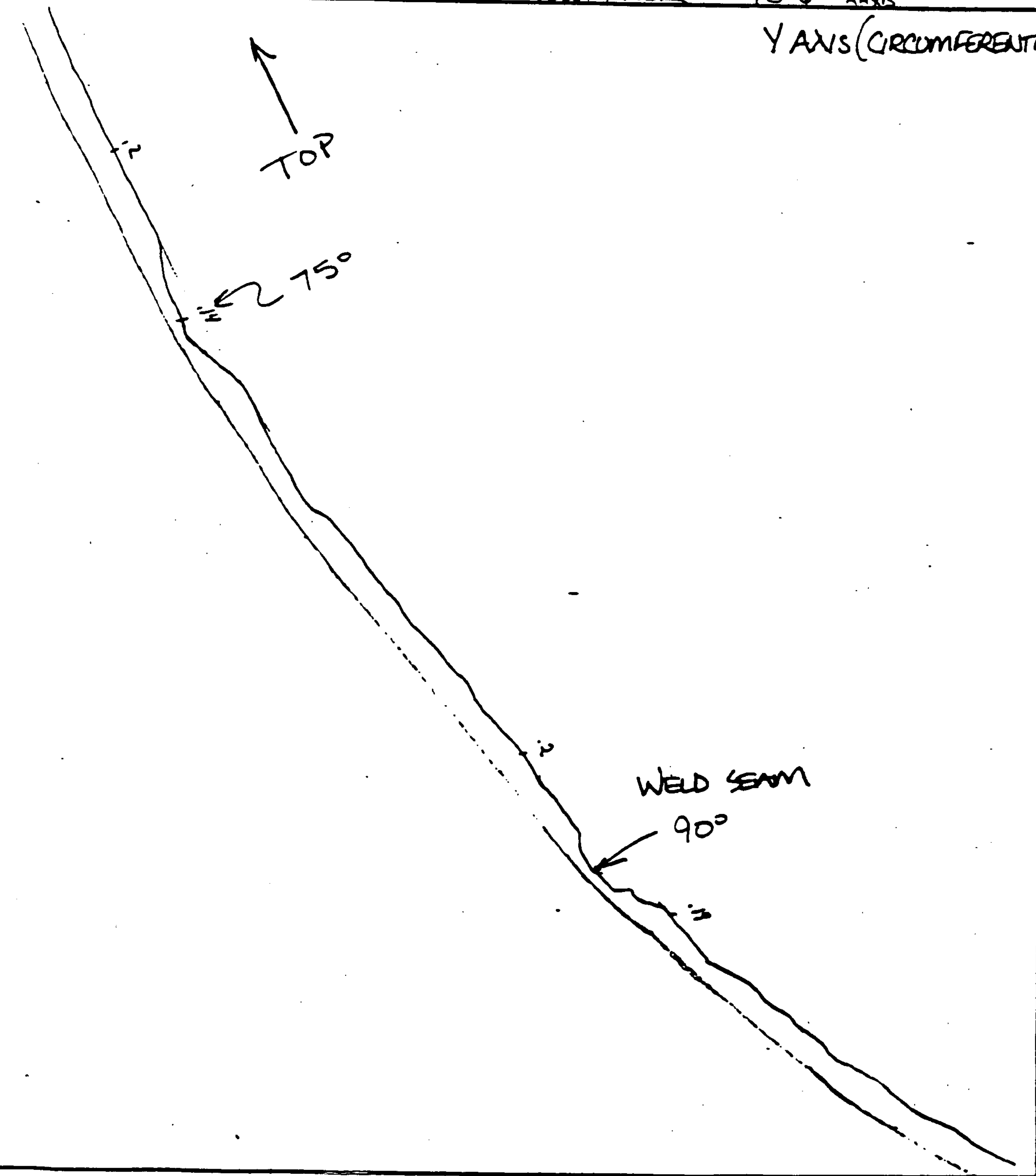
NDE DRAWING ATTACHMENT

PAGE __ OF __

PROJECT HBR JOB NO. UNIT 1☐ 2☑ 3☐ 4☐ DATE 11/27/90

DRAWING	SYSTEM	LINE	WELD/ITEM NUMBER
30-CW-12 ISO	SERVICE WATER	SOUTH HDR	S-6 Y AXIS

Y AXIS (CIRCUMFERENTIAL)



[signature] LEVEL II

APPENDIX A

WALL THICKNESS MEASUREMENT RECORD SHEET

PLANT: H.B. ROBINSON UNIT: 2

COMPONENT: S-6 NOM. SIZE O.D.: 30" NOM. WALL: ______ MIN. WALL: ______ ZONE: ______

LINEAR SPACING: 1" RADIAL SPACING: 1" STARTING AT: 1" FROM EDGE OF BELL - UPSTREAM ENDING AT: 12" DOWNSTREAM

FLOW ↓ ← CLOCKWISE

LINEAR INCREMENT	RADIAL INCREMENT -1"	0"	1"	2"	3"	4"	5"	6"	7"	8"	9"	10"	11"	12"	13"
A	.20	.22	.21	.21	.21	.21	.21	.22	.22	.22	.21	.21	.21	.22	.21
B	.21	.20	.21	.21	.20	.20	.20	.20	.20	.20	.20	.20	.20	.21	.21
C	.20	.20	.20	.20	.20	.20	.20	.20	.20	.20	.20	.20	.20	.20	.21
D	.16	.15	.19	.20	.20	.19	.20	.20	.20	.20	.20	.19	.19	.20	.20
E	.20	.19	.18	.20	.20	.20	.18	.18	.18	.17	.18	.18	.19	.20	.20
F	.18	.19	.20	.20	.15	.18	.20	.20	.18	.20	.17	.17	.16	.19	.20
G	.20	.21	.20	.20	.20	.20	.20	.20	.19	.20	.20	.19	.18	.20	.19
H	.21	.22	.22	.22	.20	.21	.21	.21	.21	.21	.22	.21	.21	.23	.21
I	.21	.21	.21	.21	.21	.21	.21	.22	.21	.21	.21	.21	.21	.21	.21
J	.21	.21	.21	.21	.21	.21	.21	.21	.21	.21	.21	.21	.23	.21	.21
K	.21	.21	.21	.21	.21	.21	.21	.21	.22	.21	.21	.21	.21	.22	.22
L	.22	.22	.23	.23	24	23	23	.23	.23	.22	.22	.23	.22	.22	.23

N/A

LOWEST MEASUREMENT: .15 AT LOCATION: (LIN. ~~F~~ D RAD. ~~3~~ 0) COMMENTS: ① 0" IS TOP DEAD CENTER

PERFORMED BY: James Phillips DATE: 11/15/90

② MEASUREMENTS MADE FROM O.D. SURFACE

③ SEE PAGE 3 FOR GRID SCHEME

ATTACHMENT C
RNP-C/STRS-1114
R/0

APPENDIX A

WALL THICKNESS MEASUREMENT RECORD SHEET

PLANT: H. B. ROBINSON UNIT: 2

COMPONENT: S-6 NOM. SIZE O.D.: 30" NOM. WALL: ______ MIN. WALL: ______ ZONE: ______

LINEAR SPACING: 1" RADIAL SPACING: 1" STARTING AT: 1" FROM EDGE OF BELL - UPSTREAM ENDING AT: 12" DOWNSTREAM

← CLOCKWISE

FLOW ↓

LINEAR INCREMENT \ RADIAL INCREMENT	-21"	-20"	-19"	-18"	-17"	-16"	-15"	-14"	-13"	-12"	-11"	-10"	-9"	-8"	-7"	-6"	-5"	-4"	-3"	-2"
A	.22	.21	.20	.20	.20	.20	.21	.21	.21	.21	.21	.19	.21	.21	.21	.21	.21	.20	.21	.21
B	.20	.19	.19	.20	.20	.20	.21	.20	.20	.20	.20	.20	.20	.19	.19	.21	.20	.20	.20	.20
C	.19	.19	.20	.20	.19	.20	.20	.19	.19	.20	.19	.19	.20	.19	.19	.20	.19	.19	.19	.19
D	.17	.19	.18	.19	.13	.18	.19	.18	.19	.18	.18	.18	.20	.16	.16	.18	.19	.17	.17	.17
E	.19	.07	.20	.21	.20	.21	.19	.19	.20	.19	.18	.20	.20	.13	.13	.16	.19	.19	.19	.19
F	.14	.14	.14	.15	.14	.16	.18	.18	.17	.17	.18	.19	.20	.16	.16	.17	.17	.16	.18	.15
G	.23	.22	.22	.21	.20	.21	.21	.21	.20	.20	.20	.20	.19	.19	.19	.19	.20	.19	.20	.20
H	NA	.23	.22	.23	.22	.22	.22	.22	.21	.21	.21	.21	.20	.20	.20	.21	.21	.21	.21	.21
I	NA	.24	.24	.23	.22	.22	.21	.22	.21	.21	.21	.21	.22	.19	.19	.20	.21	.21	.21	.21
J	NA	NA	.22	.22	.22	.21	.22	.21	.22	.21	.21	.21	.21	.20	.20	.20	.21	.21	.21	.21
K	NA	NA	NA	.21	.22	.21	.22	.22	.22	.22	.22	.21	.21	.21	.21	.21	.21	.21	.21	.21
L	NA	NA	NA	.22	.21	.23	.23	.23	.21	.22	.21	.21	.21	.21	.21	.20	.22	.21	.21	.21

LOWEST MEASUREMENT: .13 AT LOCATION: (LIN. E / D RAD. -8, -7 / -17) COMMENTS: ______

PERFORMED BY: [signature] DATE: 11/15/90

ATTACHMENT C

RNP-C/STES-1114 R/0

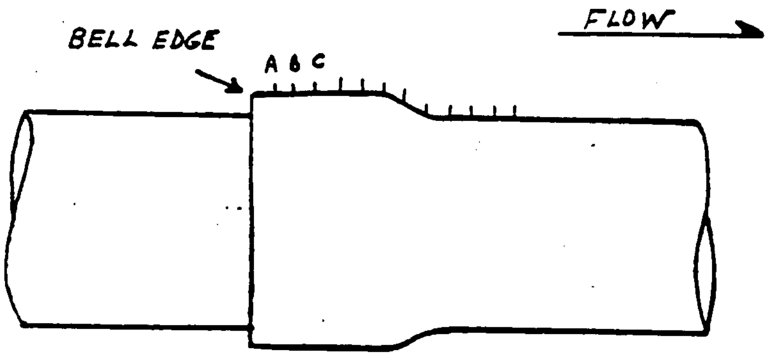
ATTACHMENT C
RNP-C/STRS-1114 R/0

CP&L
Carolina Power & Light Company

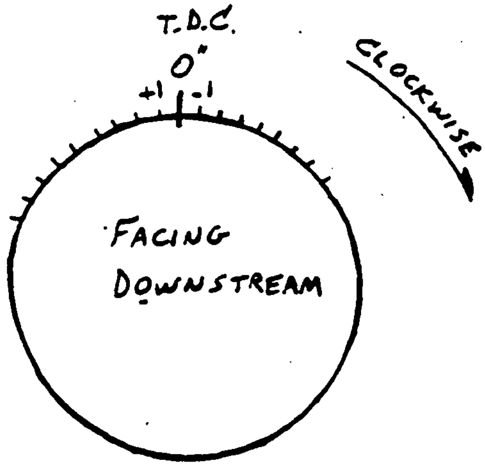
NDE DRAWING ATTACHMENT

PROJECT HBR JOB NO. UNIT 1☐ 2☒ 3☐ 4☐ DATE 11-15-90

DRAWING	SYSTEM	LINE	WELD/ITEM NUMBER
	SERVICE WATER		S-6



LINEAR INCREMENTS ARE SPACED 1" APART



CIRCUMFERENTIAL INCREMENTS ARE SPACED 1" APART.

II-T
11-15-90

APPENDIX A

THICKNESS CALIBRATION SHEET

PLANT/UNIT: HBR-2 COMPONENT: SERVICE WATER

PROCEDURE #: NDEP-408 REV. 6

CALIBRATION BLOCK #1 NDE 89-03 BLOCK THICKNESS .05" TO .25"

#2 NA BLOCK THICKNESS NA

INSTRUMENT: USK-7

CAL. DUE DATE: 12-12-90

SERIAL NUMBER: 27276-4182

SWEEP: 0.50

DELAY: 7.21

RANGE: .5"

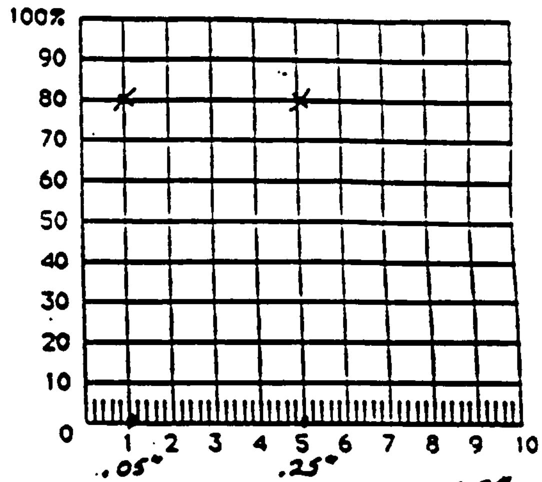
TRANSDUCER FREQUENCY: 5 MHz

TRANSDUCER SERIAL NO.: G 31043

TRANSDUCER BRAND: KB AEROTECH

TRANSDUCER SIZE: .25"

TRANSDUCER ELEMENT: SINGLE OR (DUAL)



EACH MAJOR SCREEN DIVISION: .05"

CALIBRATION VER. / CHECK	
INITIAL	TIME
JP	08:15
JP	11:00
JP	13:30
JP	16:45
N/A	

COMMENTS:

REF. GAIN = 80%

S-6

HORIZONTAL LINEARITY VERIFIED

EXAMINERS 1 [signature] DATE 11-15-90 LEVEL II-T

2 ________ DATE ________ LEVEL ________

REVIEWERS 1 ________ DATE ________

2 ________ DATE ________

3 ________ DATE ________

ADDITIONAL SHEETS: YES NO

ATTACHMENT C
RNP-C/STRS - 1114 R/0

CP&L
Carolina Power & Light Company

NDE DRAWING ATTACHMENT

PAGE __ OF __

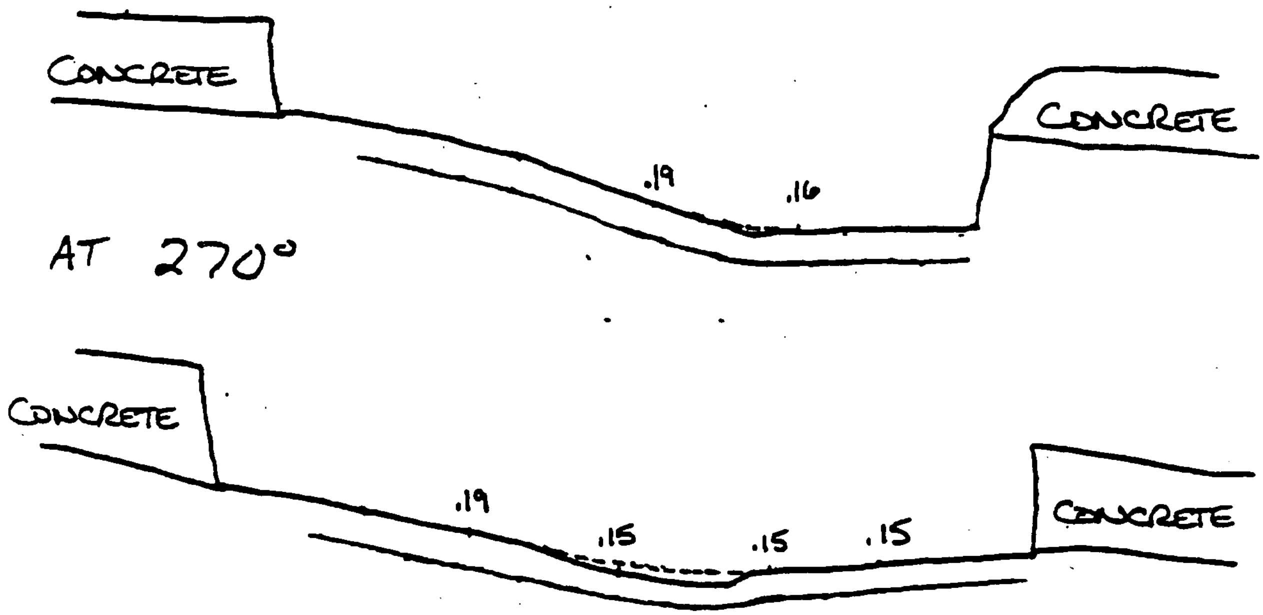
PROJECT HBR JOB NO. UNIT 1☐ 2☑ 3☐ 4☐ DATE 11/20/90

DRAWING	SYSTEM	LINE	WELD/ITEM NUMBER
30-CW-12 ISO	SERVICE WATER	SOUTH HEADER	JOINT HS-7

X AXIS (LONGITUDINAL)

Joint 7 Elbow FLOW ←

AT 90°



QA NDE CS 1 Rev. 0 6/83

[signature] LEV II

ATTACHMENT C
RNP-C/STRS-1114 R/0

FORM NO. ...
REV. 9/86

Carolina Power & Light Company

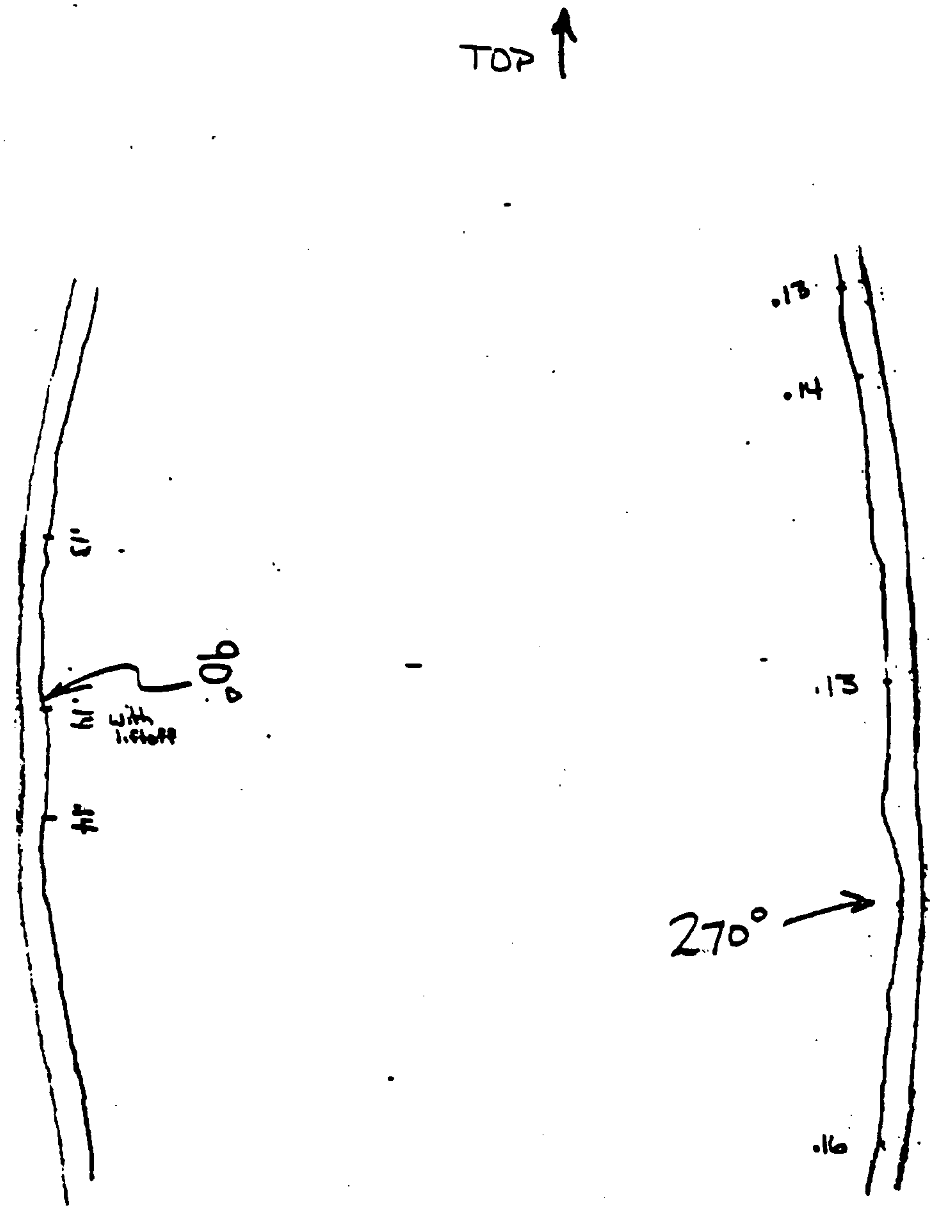
NDE DRAWING ATTACHMENT

PAGE__ OF__

PROJECT HBR JOB NO. UNIT 1☐ 2☒ 3☐ 4☐ DATE 11/27/90

DRAWING	SYSTEM	LINE	WELD/ITEM NUMBER
30-CW-12 ISO	SERVICE WATER	SOUTH HDR	S-7 Y AXIS

Y AXIS (CIRCUMFERENTIAL



J.R. Black CII

QA NDE ... 0 6/83

APPENDIX A

WALL THICKNESS MEASUREMENT RECORD SHEET

PLANT: *HB ROBINSON* UNIT: *2*

Page *1* of *3*

COMPONENT: *S-7* NOM. SIZE O.D.: ______ NOM. WALL: ______ MIN. WALL: ______ ZONE: ______

LINEAR SPACING: *1"* RADIAL SPACING: *1"* STARTING AT: *0" @ TDC 3" DOWNSTREAM OF BELL EDGE* ENDING AT: *-10" + +11" CIRCUM. AND 11" DOWNSTREAM OF BELL EDGE*

← CLOCKWISE

FLOW ↓

LINEAR INCREMENT	RADIAL INCREMENT -10"	-9"	-8"	-7"	-6"	-5"	-4"	-3"	-2"	-1"	0"	1"	2"	3"	4"	5"	6"	7"	8"	9"	10"	11"
A	.16	.17	.18	.18	.18	.18	.18	.18	.18	.17	.18	.18	.17	.18	.18	.17	.17	.17	.18	.18	.18	.18
B	.17	.17	.16	.17	.17	.17	.16	.17	.16	.17	.17	.18	.17	.17	.17	.17	.17	.17	.16	.17	.17	.17
C	.14	.12	.13	.11	.15	.15	.16	.15	.14	.14	.12	.15	.15	.13	.12	.15	.15	.15	.15	.14	.15	.14
D	.12	.14	.10	.11	.12	.12	.13	.15	.11	.15	.15	.15	.12	.10	.11	.15	.14	.15	.13	.11	.11	.15
E	.17	.17	.16	.17	.18	.18	.18	.17	.18	.18	.18	.18	.18	.18	.18	.17	.18	.17	.18	.16	.15	.19
F	.20	.20	.20	.20	.20	.20	.20	.20	.20	.20	.20	.19	.19	.20	.19	.19	.19	.19	.19	.19	.18	.18
G	.19	.20	.19	.19	.19	.19	.19	.19	.19	.19	.19	.19	.19	.19	.19	.19	.19	.19	.19	.19	.20	.19
H	.19	.19	.19	.19	.19	.19	.19	.19	.19	.19	.19	.19	.19	.19	.19	.19	.19	.19	.19	.19	.19	.19
I	.19	.19	.19	.19	.19	.19	.19	.19	.19	.19	.19	.19	.19	.19	.19	.19	.19	.19	.19	.19	.19	.18
-A	RANGE FROM .18 TO .20 →																					
-B	↓																					
-C	↓																					
-D	↓																					
-E	↓																					
NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA		
↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓		
NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA		

FLOW ↑

LOWEST MEASUREMENT: ~~.11~~ .10 AT LOCATION: (LIN. ~~C~~ D RAD. 8,3)

DATE: *11 / 14 / 90*

PERFORMED BY: *[illegible signature]*

COMMENTS: ① *0" IS TOP DEAD CENTER*
② *Measurements made from OD Surface*
③ *See pg 2 for Grid scheme*

ATTACHMENT C
RNP-C/STS-1114 R/0

ATTACHMENT C
RNP-C/STRS-1114 R/0

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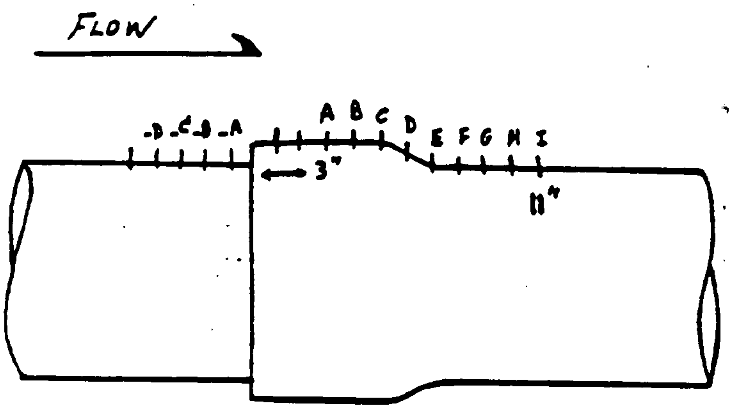
Carolina Power & Light Company

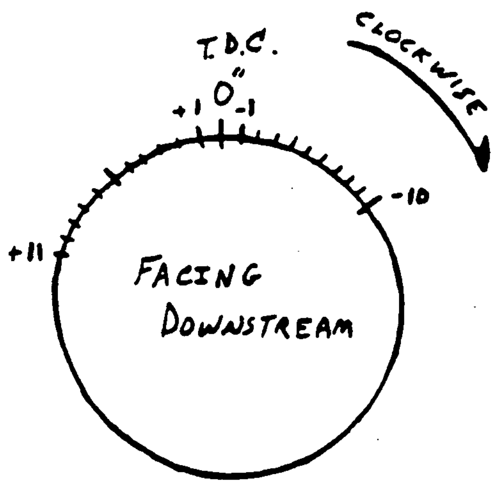
NDE DRAWING ATTACHMENT

PAGE 2 OF 3

PROJECT HBR	JOB NO.	UNIT 1☐ 2☒ 3☐ 4☐	DATE 11-14-90
DRAWING	SYSTEM SERVICE WATER	LINE	WELD/ITEM NUMBER S-7



LINEAR INCREMENTS ARE SPACED 1" APART



CIRCUMFERENTIAL INCREMENTS ARE SPACED 1" APART

[signature] II-T
11-14-90

APPENDIX A

THICKNESS CALIBRATION SHEET

PLANT/UNIT: H.B. ROBINSON COMPONENT: SERVICE WATER

PROCEDURE #: NDEP - 408 REV. 6

CALIBRATION BLOCK #1 NDE 89-03 BLOCK THICKNESS .05" TO .25"

#2 NA BLOCK THICKNESS NA

INSTRUMENT: USK - 7

CAL. DUE DATE: 12-12-90

SERIAL NUMBER: 27276 - 4182

SWEEP: 0.50

DELAY: 7.21

RANGE: .5"

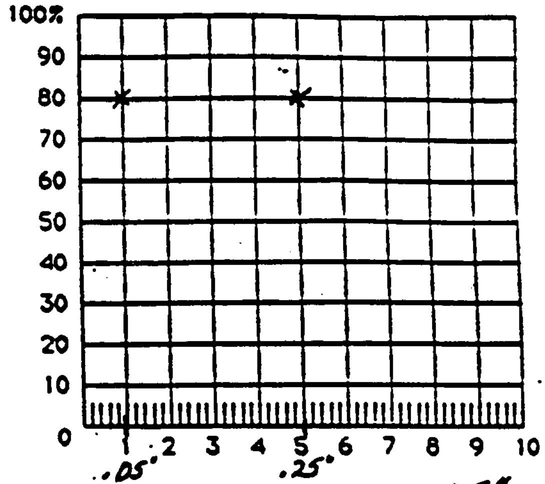
TRANSDUCER FREQUENCY: 5.0 MHz

TRANSDUCER SERIAL NO.: G 31043

TRANSDUCER BRAND: KB AEROTECH

TRANSDUCER SIZE: .25"

TRANSDUCER ELEMENT: SINGLE OR (DUAL)



EACH MAJOR SCREEN DIVISION: .05"

CALIBRATION VER. / CHECK	
INITIAL	TIME
JP	08:15
JP	11:00
JP	13:00
JP	16:15

COMMENTS: S-7

HORIZONTAL LINEARITY VERIFIED

EXAMINERS 1 [signature] DATE 11-14-90 LEVEL II-T

2 ______ DATE ______ LEVEL ______

REVIEWERS 1 ______ DATE ______

2 ______ DATE ______

3 ______ DATE ______

ADDITIONAL SHEETS: YES NO

ATTACHMENT C
RHP-C/STRS-1114 R/0

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NDE DRAWING ATTACHMENT

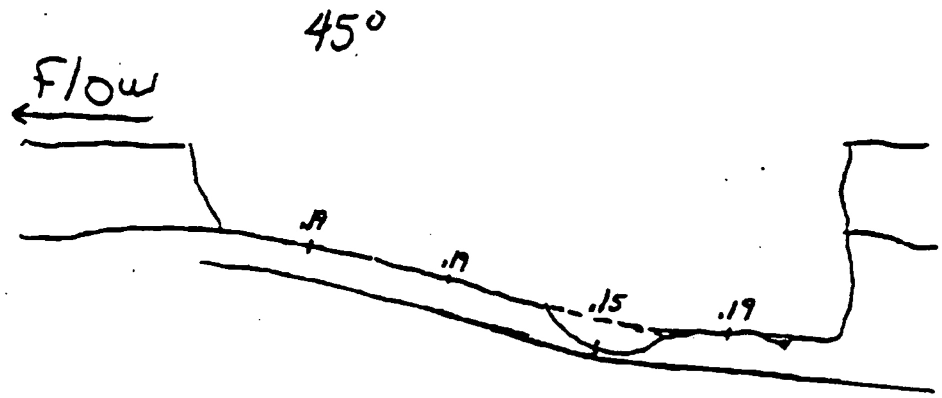
PAGE__OF__

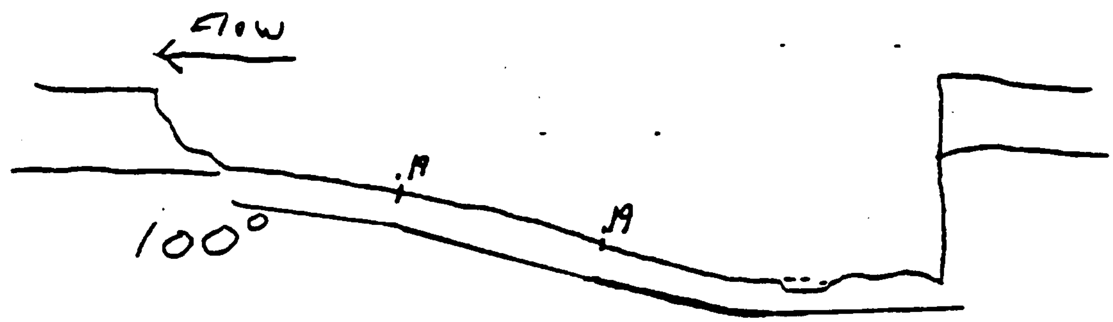
PROJECT HBR | JOB NO. N/A | UNIT 1☐ 2☒ 3☐ 4☐ | DATE 11/22/90

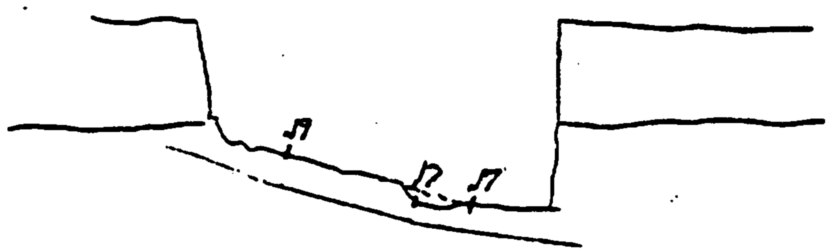
DRAWING	SYSTEM	LINE	WELD/ITEM NUMBER
30-CW-12 ISD	Service Water	South Header	JT. S-10

X AXIS (LONGITUDINAL)

JT #10







[signature] CB/II

QA NDE CS 1 Rev. 0 6/83

ATTACHMENT C
RNP-C/STRS-1114 R/0

FORM NO. [illegible]
REV. 9/86

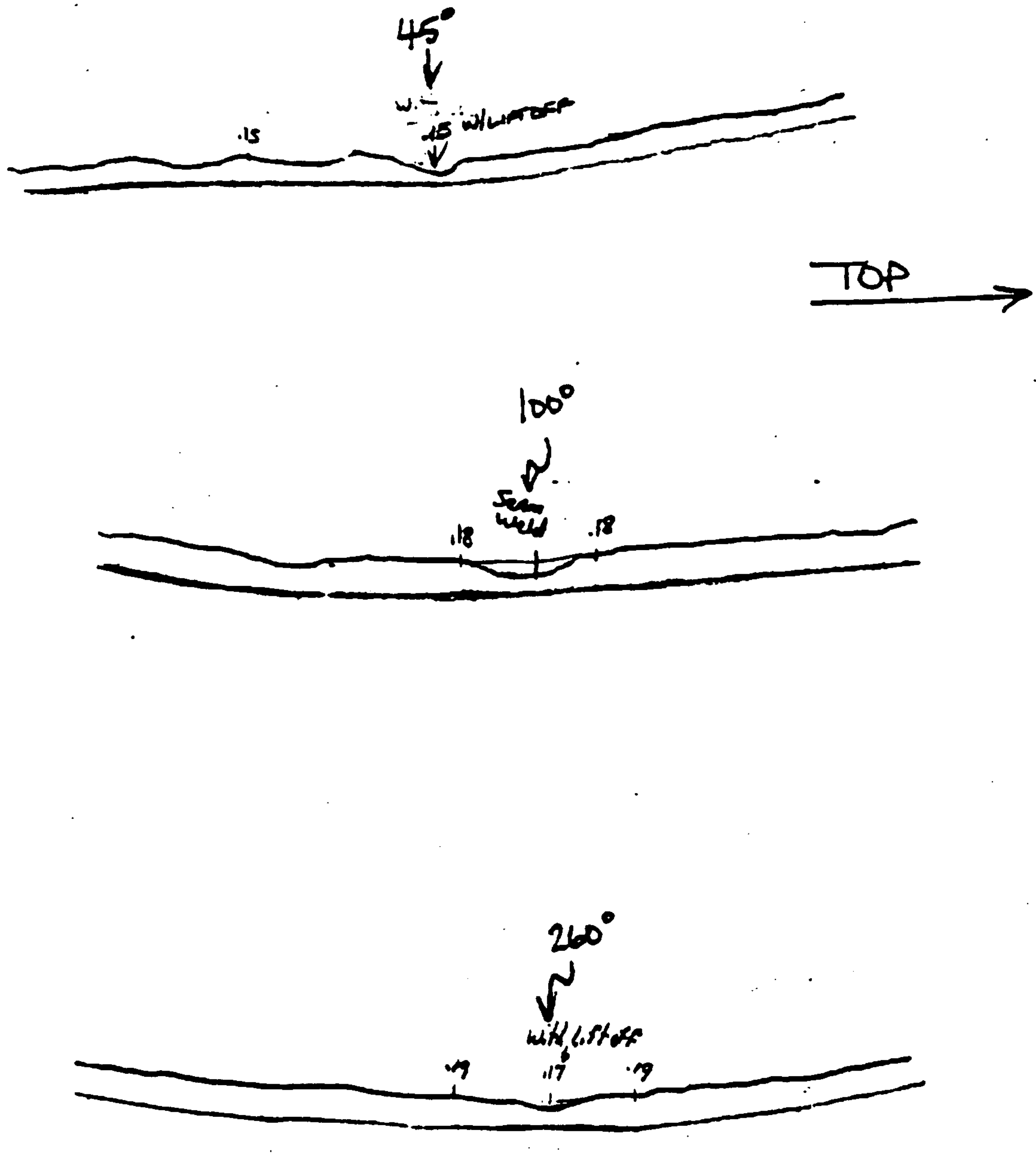
Carolina Power & Light Company

NDE DRAWING ATTACHMENT

PAGE__OF__

PROJECT HBR	JOB NO. N/A	UNIT 1☐ 2☒ 3☐ 4☐	DATE 11/27/90
DRAWING 30-CW-12 ISO	SYSTEM SERVICE WATER	LINE SOUTH HEADER	WELD/ITEM NUMBER S-10 Y AXIS

Y AXIS (CIRCUMFERENTIAL)



J M Black LEV II

ATTACHMENT C
RNP-C/STRS-1114 R/5

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Carolina Power & Light Company
NDE DRAWING ATTACHMENT

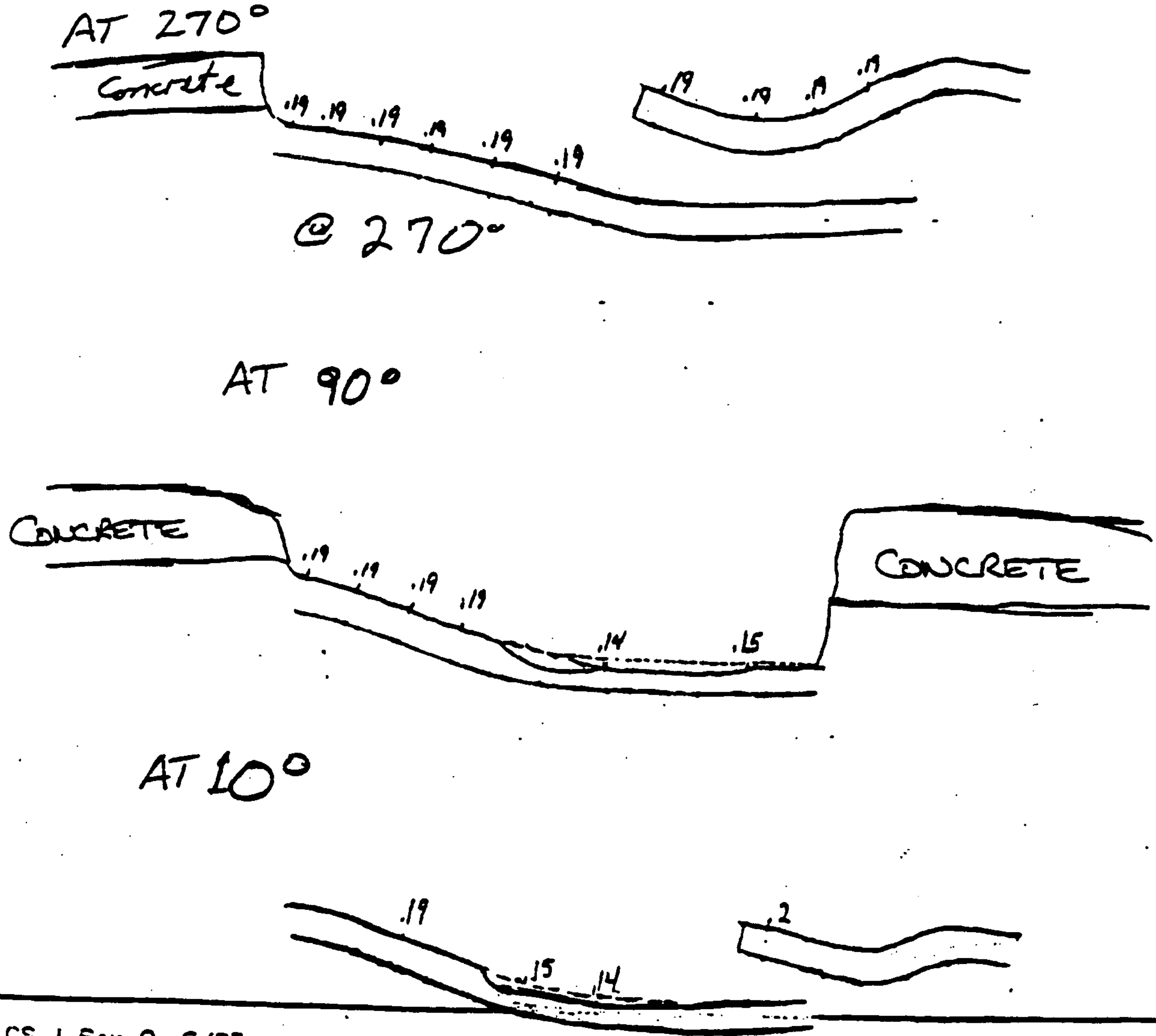
PAGE __ OF __

PROJECT HBR	JOB NO. N/A	UNIT 1☐ 2☒ 3☐ 4☐	DATE 11/20/90
DRAWING 30-CW-12 ISD	SYSTEM Service Water	LINE SOUTH HEADER	WELD/ITEM NUMBER S-11

X AXIS (LONGITUDINAL)

Joint 11

Flow ←



UT II

ATTACHMENT C
RNP-C/STRS-1114 R/0

Carolina Power & Light Company

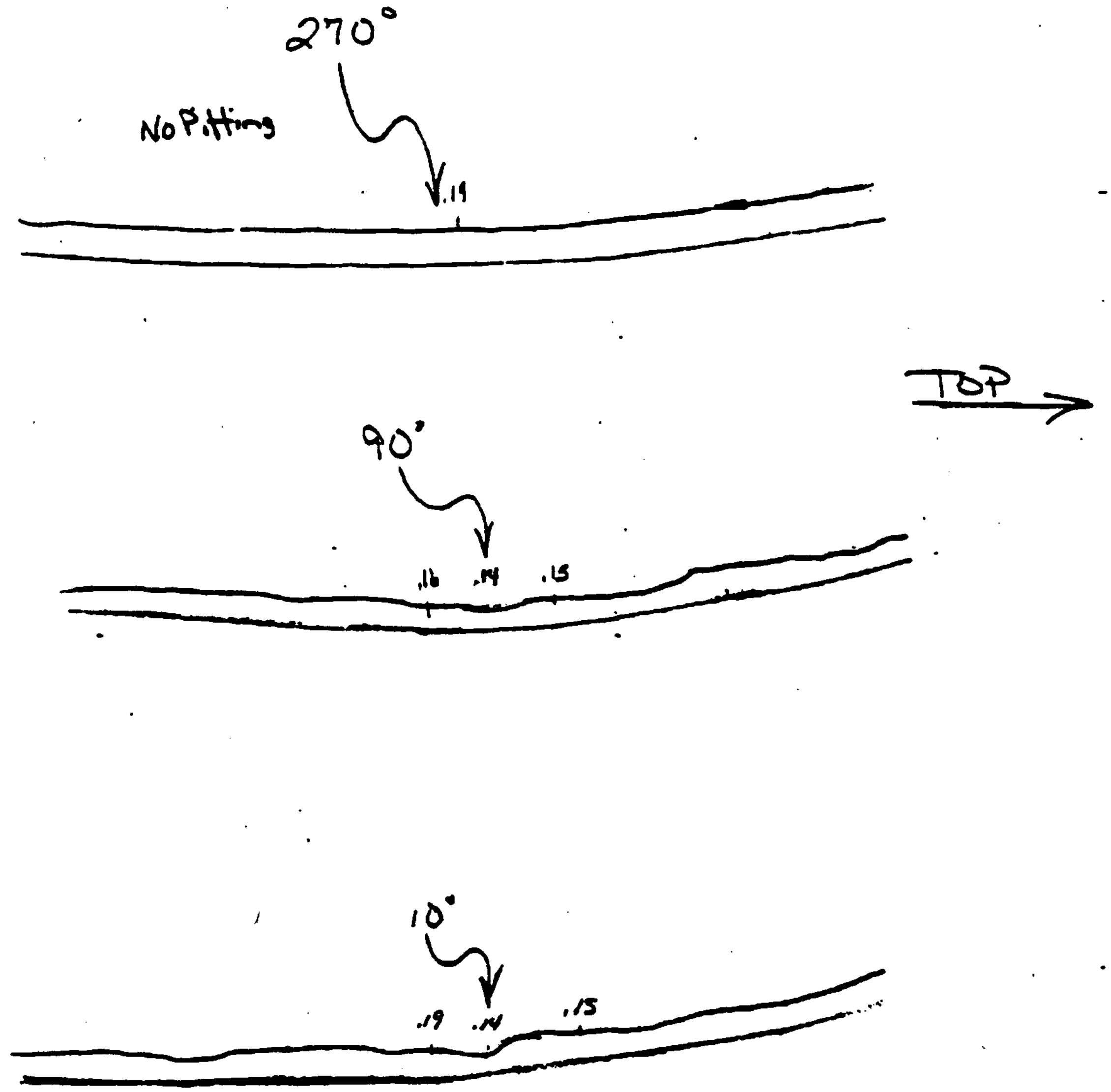
NDE DRAWING ATTACHMENT

PAGE__ OF__

PROJECT HBR JOB NO. UNIT 1☐ 2☒ 3☐ 4☐ DATE 11/27/90

DRAWING	SYSTEM	LINE	WELD/ITEM NUMBER
30-CW-12 ISO	SERVICE WATER	SOUTH HDR	S-11 Y AXIS

Y AXIS (CIRCUMFERENTIAL)



J. A. Black LII

ATTACHMENT C
RNP-C/STRS-1114 R/0

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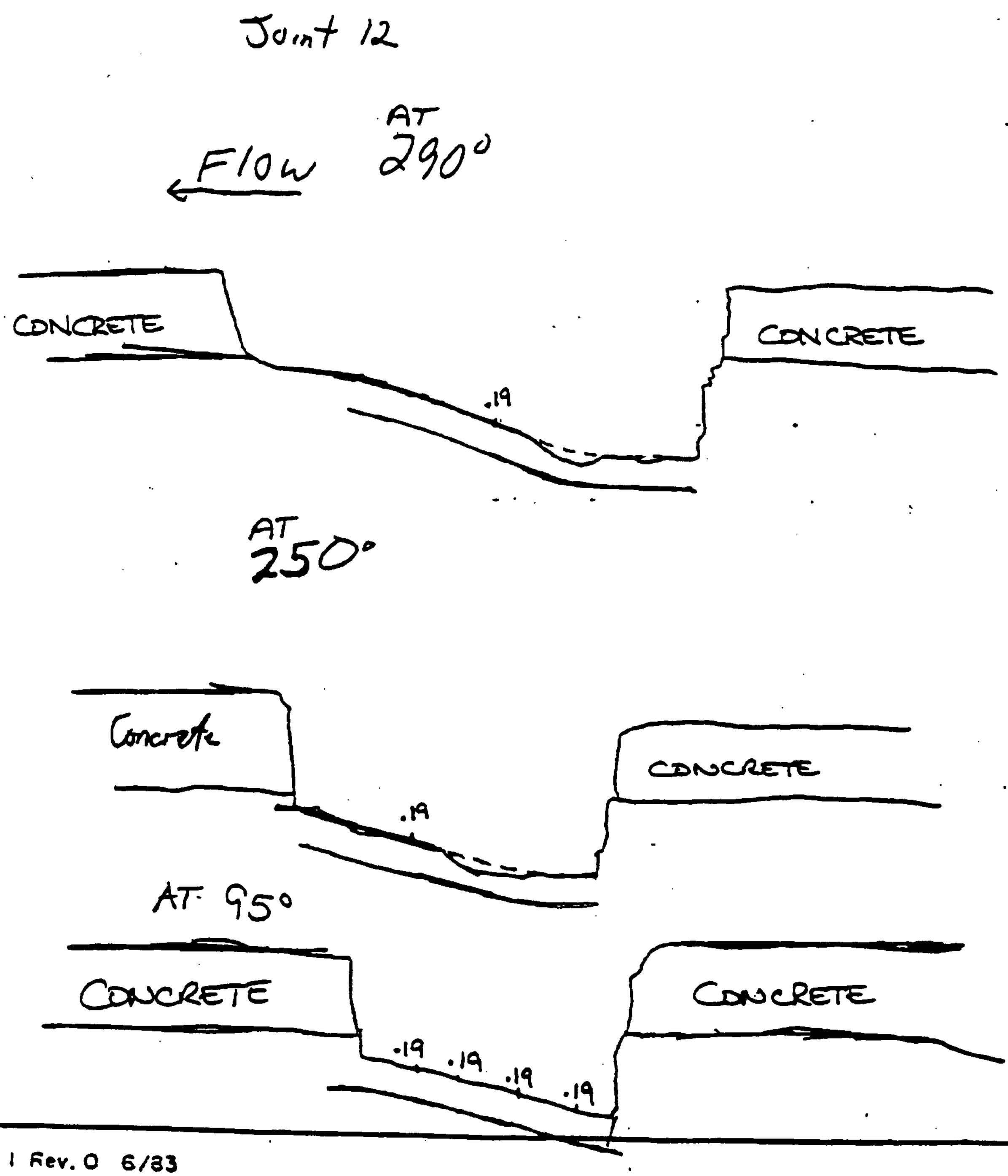
Carolina Power & Light Company
NDE DRAWING ATTACHMENT

PAGE _ OF __

PROJECT H.B. ROBINSON JOB NO.
UNIT 1☐ 2☑ 3☐ 4☐ DATE 11/20/90

DRAWING	SYSTEM	LINE	WELD/ITEM NUMBER
30-CW-12 ISO	SERVICE WATER	SOUTH HDR U/G PIPE	JOINTS-12

X AXIS (LONGITUDINAL)



QA NDE CS 1 Rev. 0 6/83

LEV II

ATTACHMENT C
RNP-C/STRS-1114 R/0

FORM N.D. ...
REV. 8/86

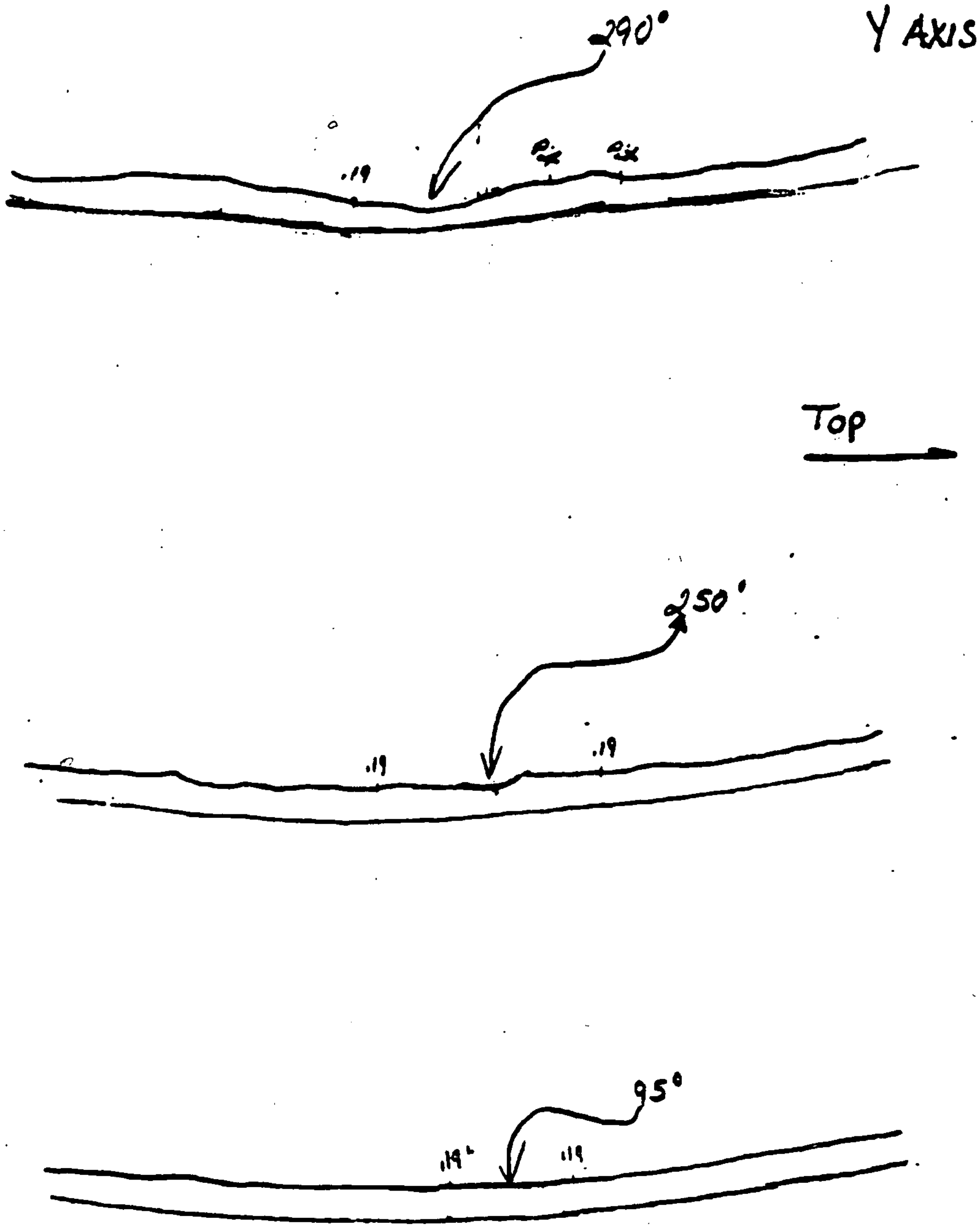
Carolina Power & Light Company

NDE DRAWING ATTACHMENT

PAGE__ OF__

PROJECT HBR	JOB NO.	UNIT 1☐ 2☑ 3☐ 4☐	DATE 1/27/90
DRAWING 30-CW-12 ISO	SYSTEM SERVICE WATER	LINE SOUTH HDR	WELD/ITEM NUMBER S-12 Y AXIS

Y AXIS (CIRCUMFEREN



J. Rybeck LEVEL II

ATTACHMENT C
RNP-C/STRS-1114 R/0

Carolina Power & Light Company

NDE DRAWING ATTACHMENT

PAGE__ OF__

PROJECT HBR JOB NO. N/A UNIT 1☐ 2☒ 3☐ 4☐ DATE 11/20/90

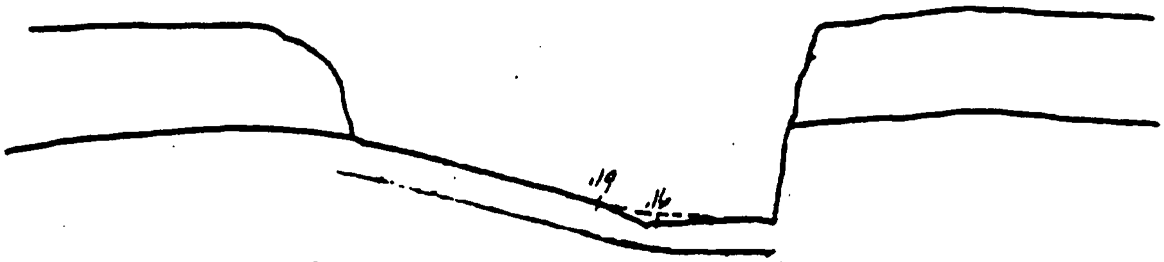
DRAWING	SYSTEM	LINE	WELD/ITEM NUMBER
30-CW-12 ISO	SERVICE WATER	SOUTH HEADER	JOINT S-22

Joint 22

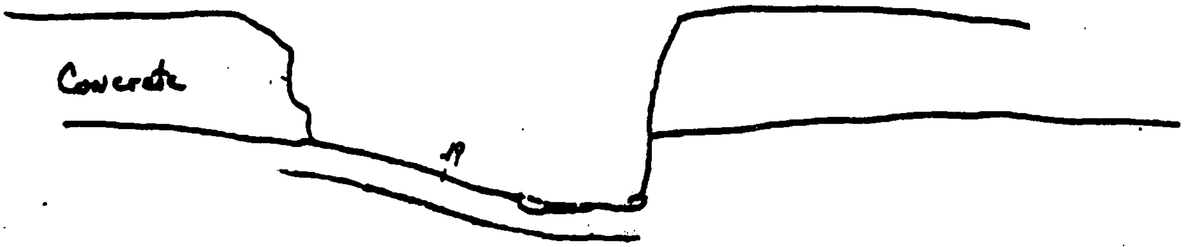
X AXIS (LONGITUDINAL)

170°

← Flow



@ 200°



J.M. Black LEV II

QA NDE CS 1 Rev. 0 6/83

ATTACHMENT E
RNP-C/STRS-1114 R/0

FORM NO. 7 515
REV. 5/86

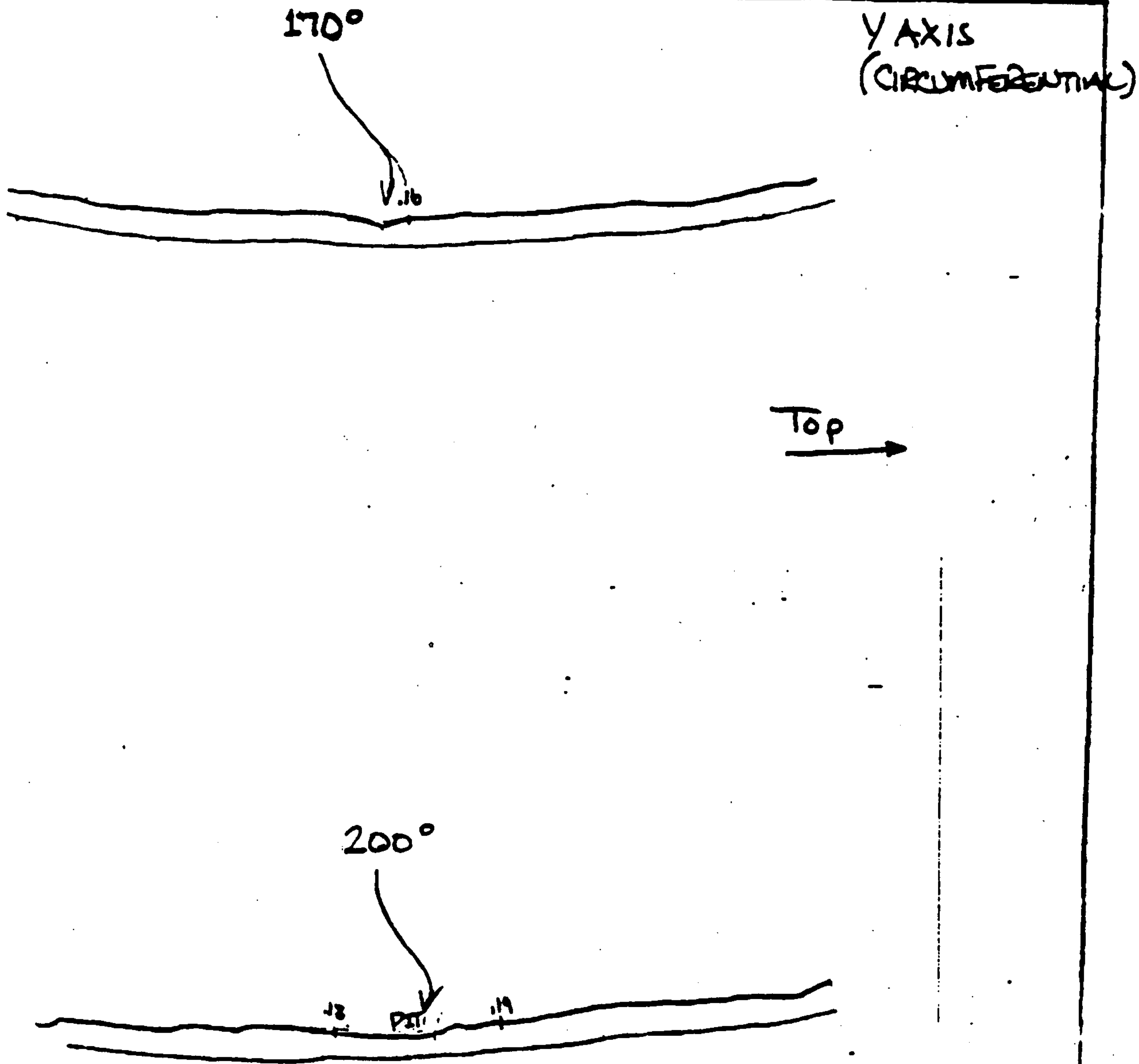
Carolina Power & Light Company

NDE DRAWING ATTACHMENT

PAGE__ OF__

PROJECT HBR JOB NO. N/A UNIT 1☐ 2☒ 3☐ 4☐ DATE 11/27/90

DRAWING	SYSTEM	LINE	WELD/ITEM NUMBER
30-CW-12 ISO	SERVICE WATER	SOUTH HDR	S22 Y axis



LBII

ATTACHMENT - C
RNP-C/STRS-1114 R/0

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Carolina Power & Light Company

NDE DRAWING ATTACHMENT

PAGE __ OF __

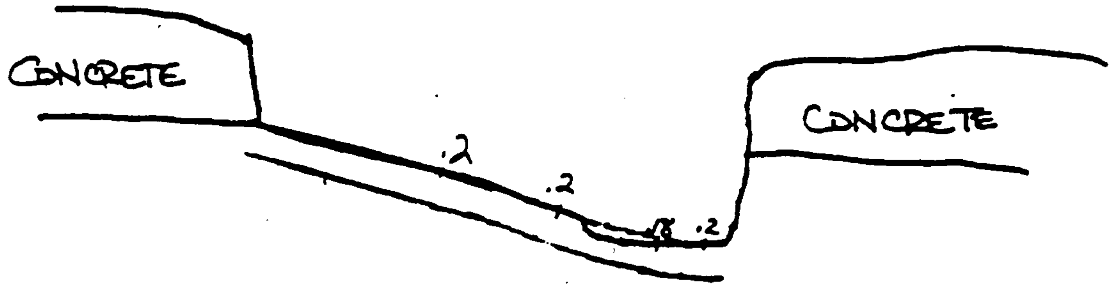
PROJECT HBR	JOB NO. N/A	UNIT 1☐ 2☒ 3☐ 4☐	DATE 11/20/90
DRAWING 5D-CW-12 TSD	SYSTEM Service Water	LINE SOUTH HEADER	WELD/ITEM NUMBER Joint S-39

Joint 39

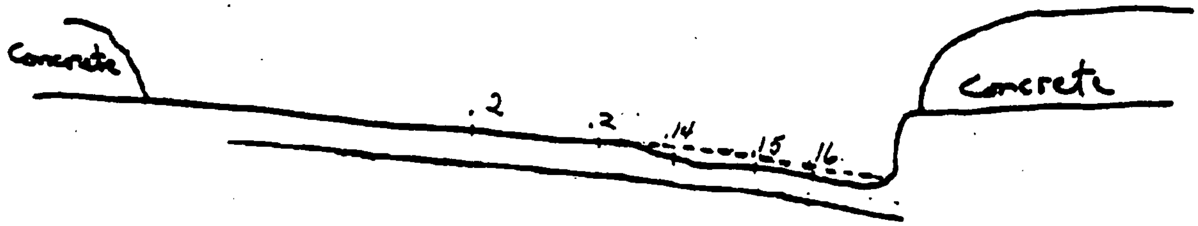
X AXIS
(LONGITUDINAL)

AT 95°

← Flow



AT 10°



J.M. Black LEV II

QA NDE CS 1 Rev. 0 6/83

ATTACHMENT C
RNP-C/STRS-1114 R/0

Carolina Power & Light Company

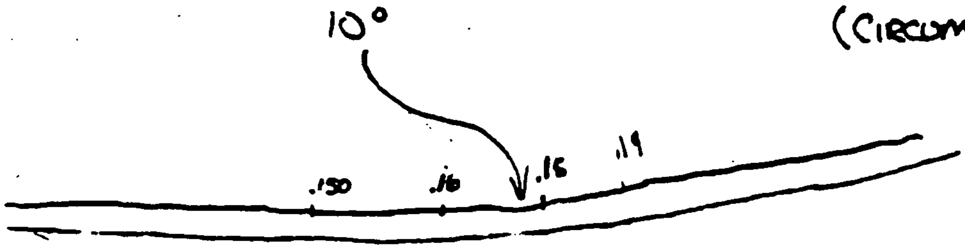
NDE DRAWING ATTACHMENT

PAGE__ OF__

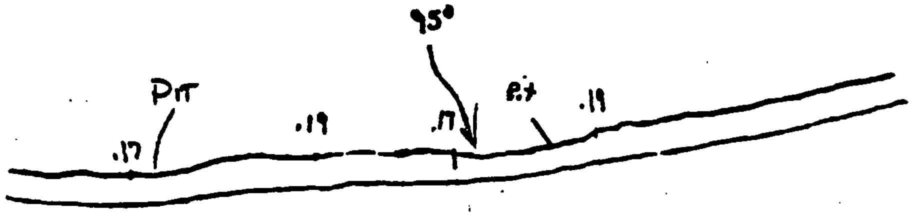
PROJECT HBR JOB NO. N/A UNIT 1☐ 2☒ 3☐ 4☐ DATE 11/27/90

DRAWING	SYSTEM	LINE	WELD/ITEM NUMBER
30-CW-12 ISO	SERVICE WATER	SOUTH HEADER	S-39 Y AXIS

Y AXIS
(CIRCUMFERENTIAL)



TOP →



J.M. Black LEV II

QA NDE CS I Rev. 0 6/83

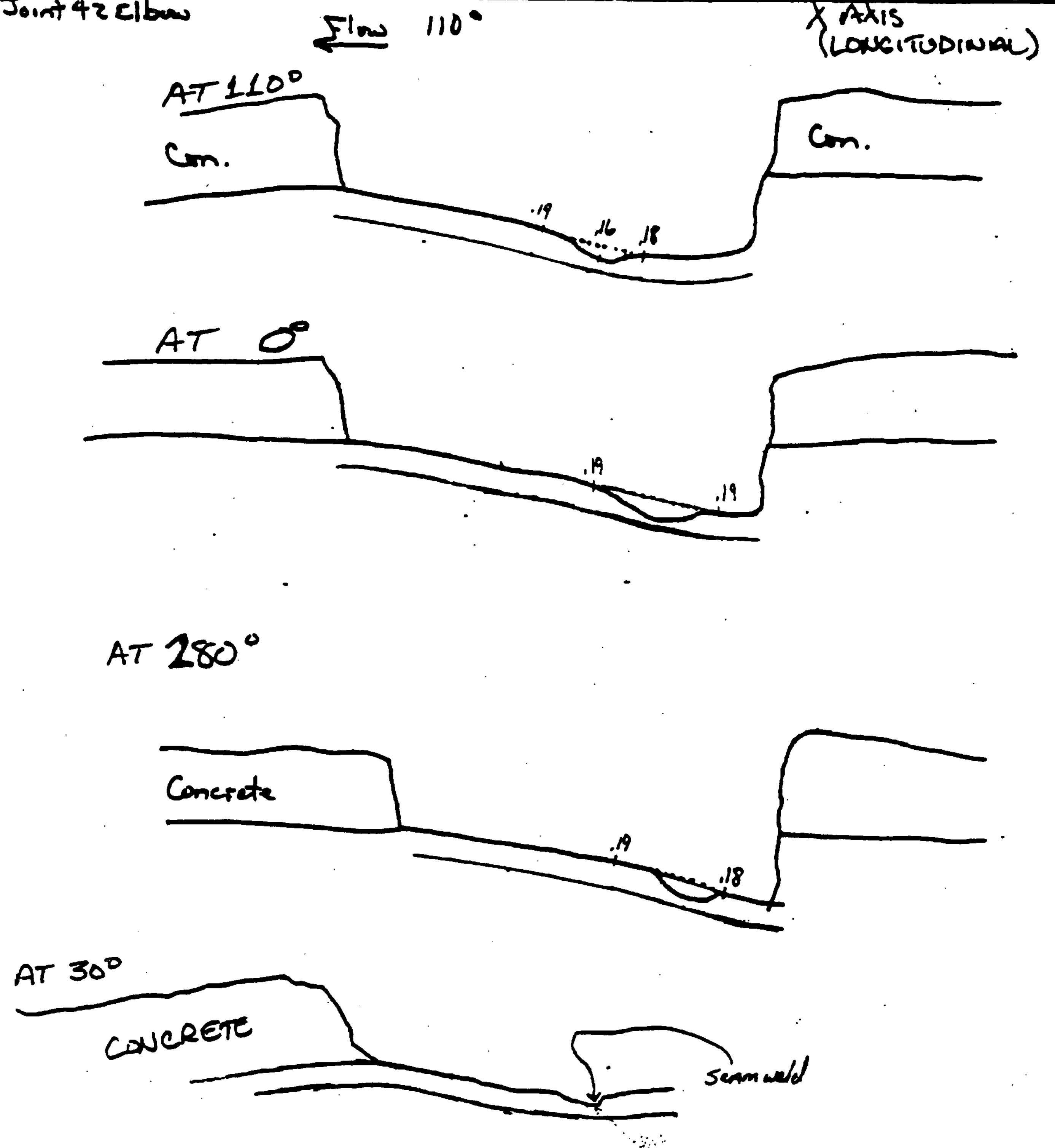
ATTACHMENT C
RNP-C/STRS - 1114 R/0

NDE DRAWING ATTACHMENT

PAGE__ OF__

PROJECT HBR	JOB NO. N/A	UNIT 1☐ 2☒ 3☐ 4☐	DATE 11/20/90
DRAWING 30-CW-12-ISO	SYSTEM Service Water	LINE SOUTH HEADER	WELD/ITEM NUMBER Joint S-42

Joint 42 Elbow



QA NDE CS 1 Rev. 0 6/83

[signature] LEV II

ATTACHMENT. 2
RNP- C/STRS-1114 R/0

FORM NO. ...
REV. 9/76

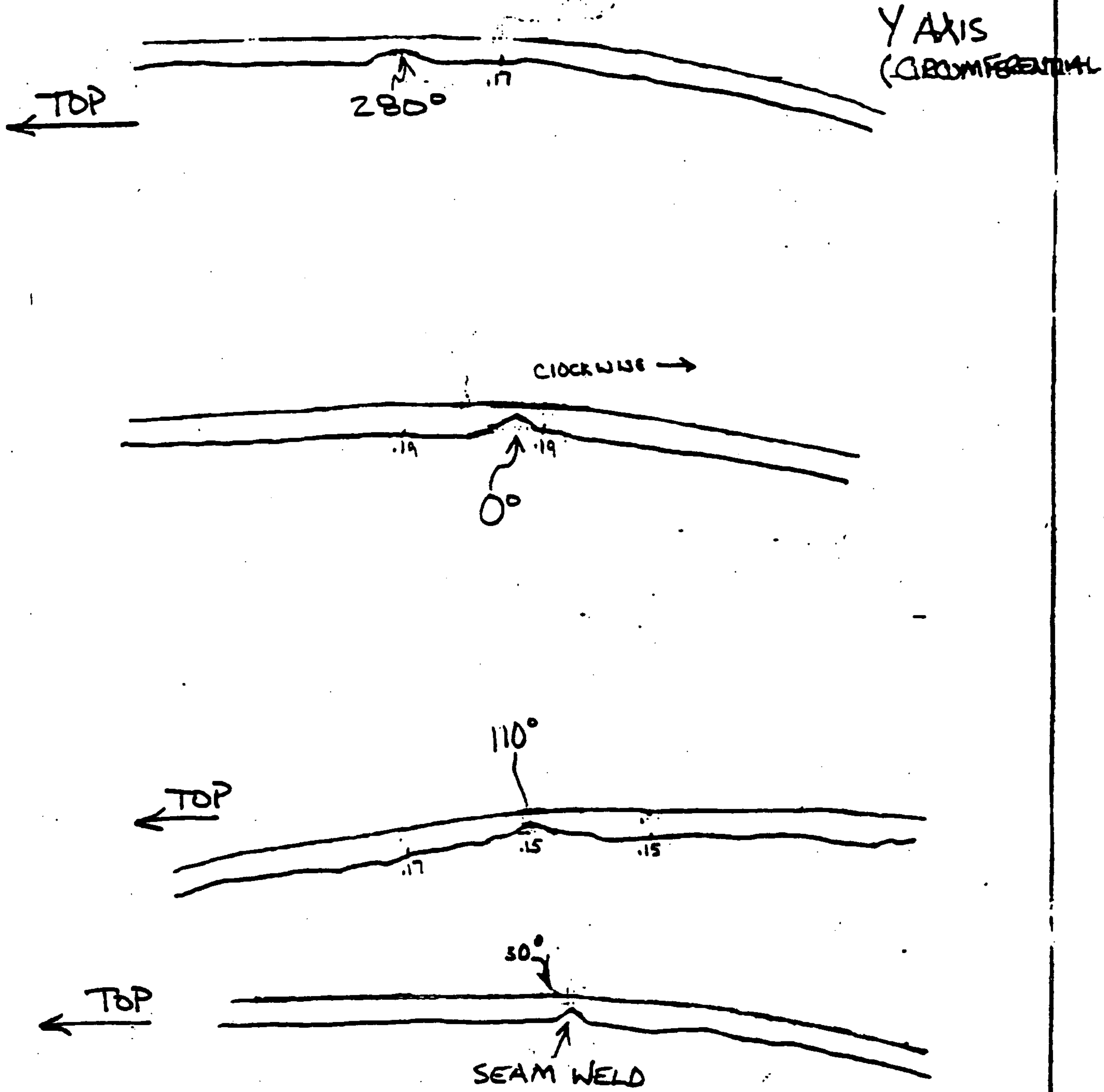
Carolina Power & Light Company

NDE DRAWING ATTACHMENT

PAGE __ OF __

PROJECT HBR | JOB NO. | UNIT 1☐ 2☑ 3☐ 4☐ | DATE 11/27/90

DRAWING	SYSTEM	LINE	WELD/ITEM NUMBER
30-CW-12 ISO	SERVICE WATER	SOUTH HDR	542 Y AXIS



QA NDE CS I Rev. 0 6/83

[signature] LEV II

ATTACHMENT C
RNP. C/STRS-1114 R/0

FORM NO. ...
REV. 3/86

Carolina Power & Light Company

NDE DRAWING ATTACHMENT

PAGE __ OF __

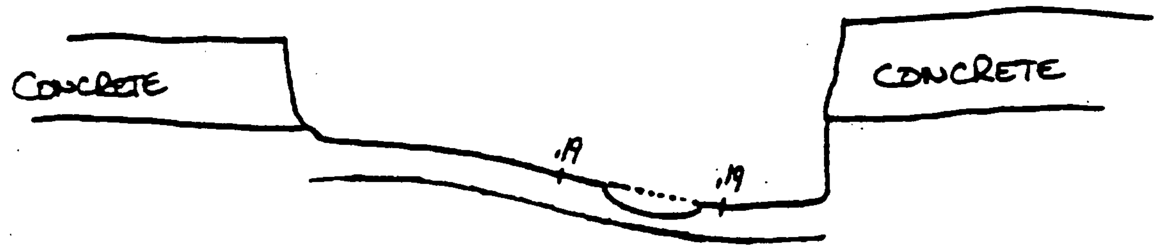
PROJECT HBR | JOB NO. N/A | UNIT 1☐ 2☒ 3☐ 4☐ | DATE 11/20/90

DRAWING	SYSTEM	LINE	WELD/ITEM NUMBER
30-CW-12 ISO	Service Water	SOUTH HEADER	JOINT S-43

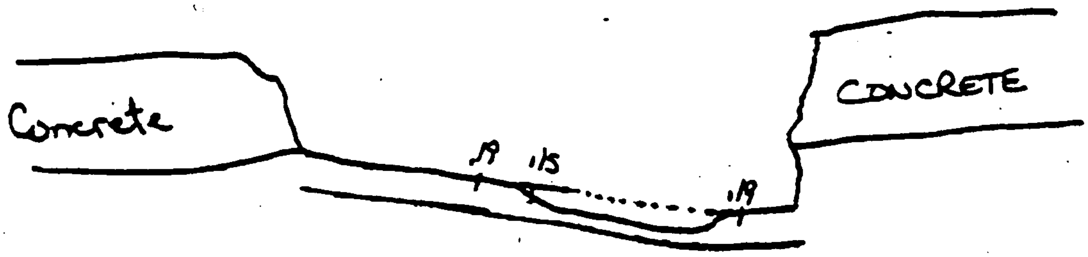
Joint 43 Elbow

X AXIS (LONGITUDINAL)

AT 90°



AT 0°



[signature] LEV II

QA NDE CS I Rev. 0 6/83

ATTACHMENT C
RNP-C/STRS-1114 R/0

Carolina Power & Light Company

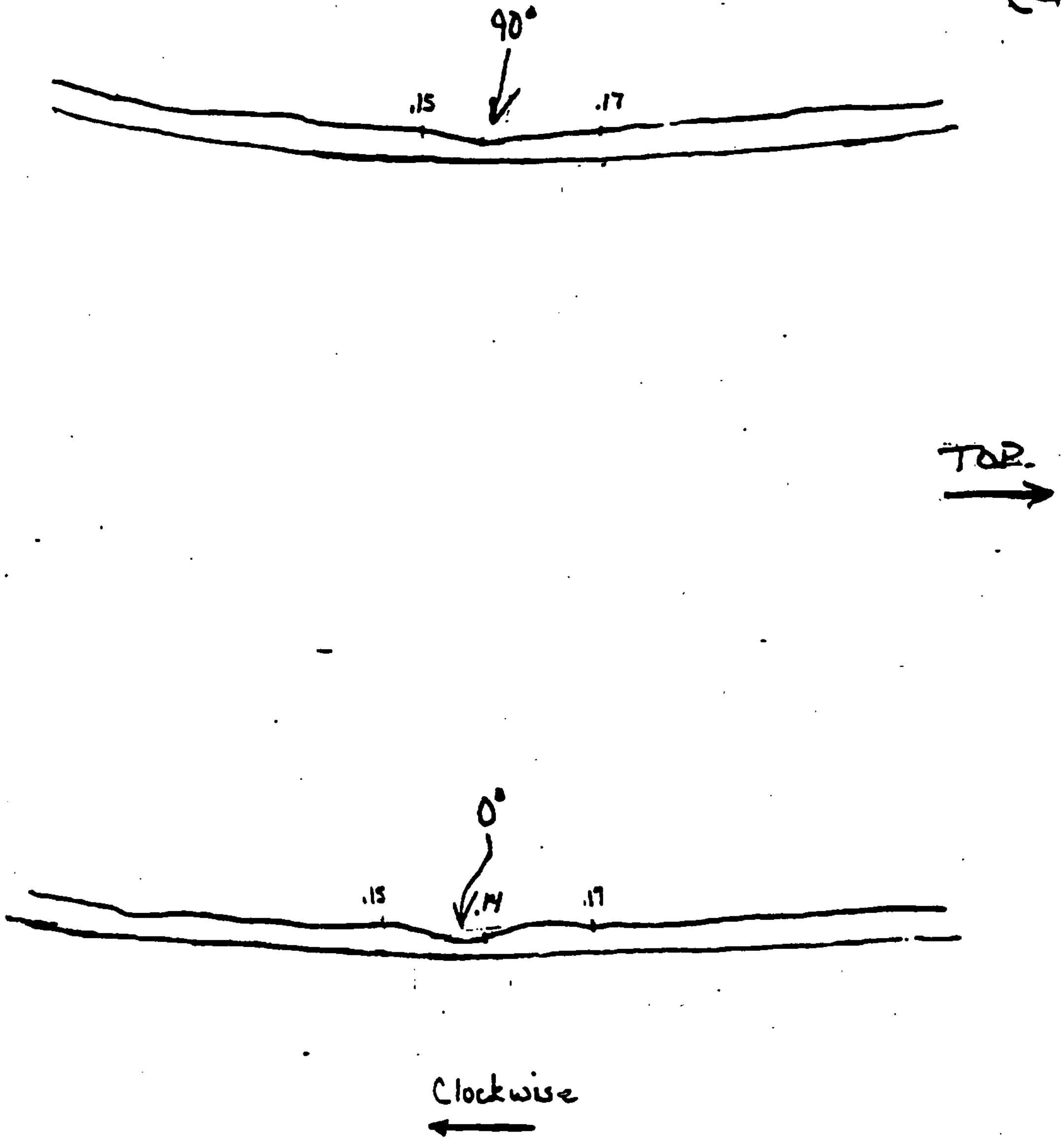
NDE DRAWING ATTACHMENT

PAGE__ OF__

PROJECT HBR JOB NO. N/A UNIT 1☐ 2☒ 3☐ 4☐ DATE 11/27/90

DRAWING	SYSTEM	LINE	WELD/ITEM NUMBER
30-CW-12 ISO	SERVICE WATER	SOUTH HDR	543 Y AXIS

YAXIS
(CIRCUMFERENTIAL)



[illegible signature] [illegible]

APPENDIX A

WALL THICKNESS MEASUREMENT RECORD SHEET

PLANT: H.B. ROBINSON UNIT: 2

COMPONENT: SOUTH HEADER S-32 NOM. SIZE O.D.: 30" NOM. WALL: ______ MIN. WALL: ______ ZONE: ______

LINEAR SPACING: 1" RADIAL SPACING: 1" STARTING AT: 3" DOWNSTREAM OF BELL EDGE. ENDING AT: 12" DOWNSTREAM OF BELL EDGE.

LINEAR INCREMENT / RADIAL INCREMENT — CLOCKWISE →

FLOW ↓

LINEAR INCREMENT	1"	2"	3"	4"	5"	6"	7"	8"	9"	10"	11"	12"	13"	14"	15"	16"	17"	18"	19"	20"
A																				
B																				
C	.19	←																	→	.19
D	.19	TO	.20	←																→
E	.19	←		→	.19	.18	.19	.19	.18	.19	←							→	.19	.18
F	.17	.17	.18	.18	.18	.17	.18	.17	.17	.19	.19	.17	.17	.18	.19	.17	.19	.16	.16	.17
G	.18	.17	.18	.19	.19	.19	.19	.19	.19	.19	.19	←							→	.19
H	.20	.20	.20	.20	.20	.20	.20	.20	.20	.20	.20	.20	.20	.20	.20	.20	.20	.20	.20	.20
I	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓
J	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓
K	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓
L	.20	.20	.20	.20	.20	.20	.20	.20	.20	.20	.20	.20	.20	.20	.20	.20	.20	.20	.20	.20

FLOW ↑

LINEAR INCREMENT	1"	2"	3"	4"	5"	6"	7"	8"	9"	10"	11"	12"	13"	14"	15"	16"	17"	18"	19"	20"
-A	(.20 TO .21)			→																→
-B	↓																			
-C	↓																			
-D	↓																			
-E	↓																			
-F	↓																			→

LOWEST MEASUREMENT: .16" AT LOCATION: (LIN. F RAD. 18,19) COMMENTS: ① 1" IS DEAD TOP CENTER

② MEASUREMENTS MADE FROM O.D. SURFACE

③ SEE PAGE 6 FOR GRID SCHEME

PERFORMED BY: James Phillips DATE: 11/15/90

ATTACHMENT C
RNP-C/STRS-1114 R/0

APPENDIX A

WALL THICKNESS MEASUREMENT RECORD SHEET

PLANT: H.B. ROBINSON UNIT: 2

Page 2 of 7

COMPONENT: SOUTH HEADER S-32 NOM. SIZE O.D.: 30" NOM. WALL: ______ MIN. WALL: ______ ZONE: ______

LINEAR SPACING: 1" RADIAL SPACING: 1" STARTING AT: 3" DOWNSTREAM OF BELL EDGE. ENDING AT: 12" DOWNSTREAM OF BELL EDGE

RADIAL INCREMENT: CLOCKWISE →

FLOW ↓

LINEAR INCREMENT	21"	22"	23"	24"	25"	26"	27"	28"	29"	30"	31"	32"	33"	34"	35"	36"	37"	38"	39"	40"
A																				
B																				
C	.18	.18	.19	.18	.19	.19	.19	.19	.19	.18	.18	.18	.18	.18	.18	.18	.18	.18	.18	.18
D	.19	.19	.19	.19	.19	.19	.19	.19	.19	.18	.18	.18	.18	.18	.19	.18	.19	.18	.18	.19
E	.18	.18	.18	.18	.18	.19	.19	.18	.18	.18	.17	.18	.18	.18	.18	.18	.17	.18	.19	.18
F	.18	.17	.15	.17	.17	.17	.17	.17	.17	.17	.16	.17	.17	.17	.17	.17	.15	.18	.16	.16
G	.19	.19	.18	.19	.18	.19	.19	.18	.19	.18	.18	.18	.18	.18	.18	.18	.18	.18	.18	.19
H	.20	.20	.20	.20	.20	.20	.20	.20	.20	.19	.19	.19	.19	.19	.19	.19	.19	.20	.20	.20
I	.19	→																	→	.19
J	↓																			↓
K	↓																			↓
L	.19	→																	→	.19

LOWEST MEASUREMENT: .15 AT LOCATION: (LIN. F RAD. 23,37) COMMENTS: ______

PERFORMED BY: [signature] DATE: 11/15/90

ATTACHMENT C
RNP-C/STRS-1114 R/0

APPENDIX A

WALL THICKNESS MEASUREMENT RECORD SHEET

PLANT: H.B. ROBINSON UNIT: 2

COMPONENT: SOUTH HEADER S-32 NOM. SIZE O.D.: 30" NOM. WALL: ____ MIN. WALL: ____ ZONE: ____

LINEAR SPACING: 1" RADIAL SPACING: 1" STARTING AT: 3" DOWNSTREAM OF BELL EDGE. ENDING AT: 12" DOWNSTREAM OF BELL EDGE.

LINEAR INCREMENT / RADIAL INCREMENT CLOCKWISE →

FLOW ↓

LINEAR INCREMENT	41"	42"	43"	44"	45"	46"	47"	48"	49"	50"	51"	52"	53"	54"	55"	56"	57"	58"	59"	60"
A																				
B																				
C	.17	.17	.18	.18	.18	.17	.17	.17	.16	.18	.19	.18	.18	.18	.18	.18	.18	.18	.18	.18
D	.18	.18	.18	.19	.18	.18	.18	.18	.17	.18	.18	.18	.17	.18	.17	.18	.18	.17	.18	.18
E	.17	.18	.18	.17	.18	.18	.18	.17	.17	.17	.18	.18	.17	.18	.16	.17	.16	.16	.16	.16
F	.15	.17	.18	.15	.17	.17	.17	.18	.18	.18	.17	.17	.17	.18	.16	.11	.12	.15	.12	.09
G	.18	.18	.19	.19	.20	.18	.20	.20	.18	.19	.20	.19	.18	.19	.19	.19	.19	.16	.18	.19
H	.20	.20	.20	.20	.20	.20	.20	.19	.19	.19	.20	.19	.19	.19	.20	.20	.20	.20	.20	.20
I	(.19	TO	.20)																	
J																				
K																				
L																				

LOWEST MEASUREMENT: .09 AT LOCATION: (LIN. ~~G~~ F RAD. ~~59~~ 56) COMMENTS: ____

PERFORMED BY: [signature] DATE: 11/15/90

ATTACHMENT C
RNP-C/STRS-1114 R/0

APPENDIX A

WALL THICKNESS MEASUREMENT RECORD SHEET

PLANT: H. B. ROBINSON UNIT: 2

SOUTH HEADER

COMPONENT: S-32 NOM. SIZE O.D.: 30" NOM. WALL: ______ MIN. WALL: ______ ZONE: ______

LINEAR SPACING: 1" RADIAL SPACING: 1" STARTING AT: 3" DOWNSTREAM OF BELL EDGE. ENDING AT: 12" DOWNSTREAM OF BELL EDGE

FLOW ←

CLOCKWISE →

LINEAR INCREMENT / RADIAL INCREMENT	61"	62"	63"	64"	65"	66"	67"	68"	69"	70"	71"	72"	73"	74"	75"	76"	77"	78"	79"	80"
A	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
B	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
C	.18	.18	.18	.18	.18	.18	.18	.18	.18	.19	.18	.19	.20	.19	NA	.19	.18	.18	.18	.17
D	.18	.17	.18	.18	.17	.16 8	.17	.18	.18	.19	.18	.19	.19	.19	.19	.18	.19	.18	.19	.18
E	.16	.16	.18	.18	.16	.15	.12	.10	.17	.15	.12	.19	.18	.20	.18	NA	.17	.18	.19	.18
F	.12	.14	.14	.13	.14	.15	.13	.10	.10	.10	.10	.15	.14	.15	.14	.15	.12	.15	.14	.12
G	.14	.19	.14	.17	.18	.19	.19	.19	.18	.20	.20	.15	.14	.15	.19	NA	.20	.19	.19	.17
H	.20	.20	.20	.19	—	.19	.19	.19	—	.20	.20	.20	.21	.20	.20	.20	.20	.19	.20	.20
I	.19	.20	NA	.19	.19	.19	.19	.19	—	.20	.20	.20	.20	.20	.20	.20	.20	.19	.20	.19
J	.19	.19	.19	.19	.19	—	.19	.19	—	.20	.20	.20	.20	.20	.20	.20	.20	.20	—	.19
K	.19	.19	.19	.19	.19	—	.19	.19	—	.20	.20	—	.20	.20	.20	.20	.20	—	—	—
L	.19	.19	.19	.19	.19	—	.19	.19	—	.20	.20	—	.20	.20	.20	.20	.20	—	—	—

LOWEST MEASUREMENT: .09 AT LOCATION: (LIN. D RAD. 66) COMMENTS: ______

PERFORMED BY: [signature] DATE: 11/15/90

ATTACHMENT 6

RHP - E/STRS - 1114 E/O

APPENDIX A

WALL THICKNESS MEASUREMENT RECORD SHEET

SOUTH HEADER

PLANT: H.B. ROBINSON UNIT: 2

Page 5 of 7

COMPONENT: S-32 NOM. SIZE O.D.: 30" NOM. WALL: ______ MIN. WALL: ______ ZONE: ______

LINEAR SPACING: 1" RADIAL SPACING: 1" STARTING AT: 3" DOWNSTREAM OF BELL EDGE. ENDING AT: 12" DOWNSTREAM OF BELL EDGE.

CLOCKWISE →

FLOW ↓

LINEAR INCREMENT \ RADIAL INCREMENT	81"	82"	83"	84"	85"	86"	87"	88"	89"	90"	91"	92"	93"	94"	95"	96"	97"	98"	99"	100"
A	.19	.14	.14	.16	.16	.16	.16	.16	.15	.16	.19	.19	.20	.20	.20	.20	.20	.20	.20	.19
B	.19	.18	.18	.18	.18	.17	.17	.17	.18	.18	.19	.19	.19	.19	.19	.19	.19	.19	.19	.18
C	.18	.18	.18	.18	.18	.19	.17	.18	.17	.18	.18	.18	.19	.17	.18	.19	.19	.18	.18	.18
D	.19	.19	.18	.19	.19	.19	.18	.19	.19	.18	.19	.18	.19	.19	.19	.19	.19	.19	.18	.18
E	.18	.18	.18	.18	.18	.18	.20	.18	.18	.18	.18	.18	.18	.18	.18	.18	.19	.18	.17	.18
F	.13	.14	.16	.14	.17	.15	.13	.16	.15	.12	.16	.13	.17	.12	.16	.16	.18	.17	.16	.17
G	.18	.18	.19	.19	.19	.19	.19	.19	.19	.18	.18	.18	.19	.18	.20	.20	.16	.18	.18	.19
H	.20	.20	.20	.20	.20	.20	.20	.20	.20	.20	.20	.20	.20	.20	.20	.20	.18	.20	.19	.19
I	.20	.20	↓	↓	↓	↓	↓	↓	↓	.20	.19	.19	.20	.20	.20	.20	.20	.20	.20	.20
J	.20	.20	↓	↓	↓	↓	↓	↓	↓	.19	.19	.19	.19	.20	.19	.20	.18	.19	.19	.19
K	.20	.20	↓	↓	↓	↓	↓	↓	↓	.20	.20	.20	.20	.20	.20	.19	.19	.19	.19	.19
L	.20	.20	.20	.20	.20	.20	.20	.20	.20	.20	.20	.20	.20	.20	.20	.19	.19	.19	.19	.19

FLOW ↑

-A	(.2	TO	.21)	→																
-B	↓																			
-C	↓																			
-D	↓																			
-E	↓																			
-F	↓																			

LOWEST MEASUREMENT: .12 AT LOCATION: (LIN. F F RAD. 90 94) COMMENTS: ______

PERFORMED BY: [signature] DATE: 11/15/90

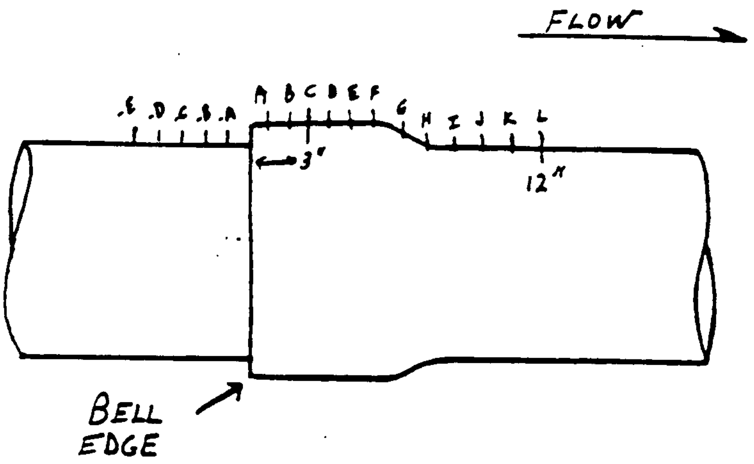
ATTACHMENT C
RNP-E/STE-114 E/0

ATTACHMENT C
RHP-C/STRS-1114 R/0

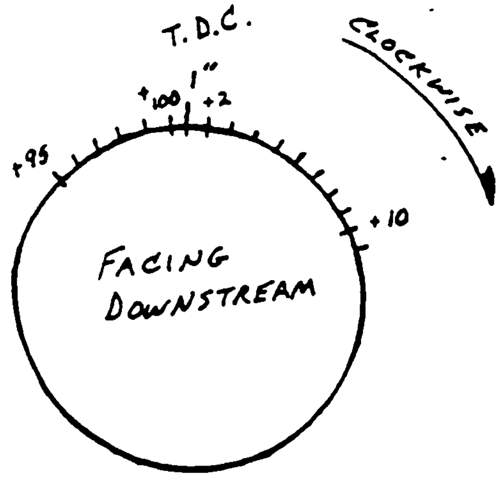
CP&L
Carolina Power & Light Company
NDE DRAWING ATTACHMENT

PROJECT HBR   JOB NO.   UNIT 1☐ 2☒ 3☐ 4☐   DATE 11-15-90

DRAWING	SYSTEM	LINE	WELD/ITEM NUMBER
30-CW-12 ISO	SERVICE WATER	SOUTH HEADER	S-32



LINEAR INCREMENTS ARE SPACED 1" APART



CIRCUMFERENTIAL INCREMENTS ARE SPACED 1" APART

[signature] II-T
11-15-90

APPENDIX A

THICKNESS CALIBRATION SHEET

PLANT/UNIT: HBR-2 COMPONENT: S-32 SERVICE WATER

PROCEDURE #: NDEP-408 REV. 6

CALIBRATION BLOCK #1 NDE 89-03 BLOCK THICKNESS .05" TO .25"

#2 NA BLOCK THICKNESS NA

INSTRUMENT: USK-7

CAL. DUE DATE: 12-12-90

SERIAL NUMBER: 27276-4182

SWEEP: 0.50

DELAY: 7.21

RANGE: .5"

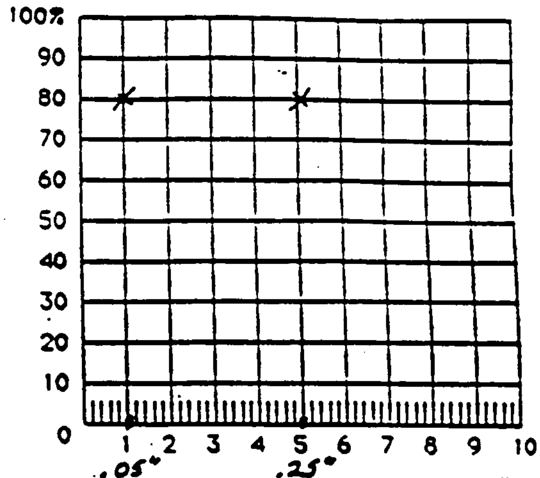
TRANSDUCER FREQUENCY: 5 MHz

TRANSDUCER SERIAL NO.: G31043

TRANSDUCER BRAND: KB AEROTECH

TRANSDUCER SIZE: .25"

TRANSDUCER ELEMENT: SINGLE OR (DUAL)



EACH MAJOR SCREEN DIVISION: .05"

CALIBRATION VER. / CHECK	
INITIAL	TIME
JP	08:15
JP	11:00
JP	13:30
JP	16:45
N/A	

COMMENTS:

REF. GAIN = 80%

HORIZONTAL LINEARITY VERIFIED

EXAMINERS 1 [signature] DATE 11-15-90 LEVEL II-T

2 ______ DATE ______ LEVEL ______

REVIEWERS 1 ______ DATE ______

2 ______ DATE ______

3 ______ DATE ______

ADDITIONAL SHEETS: YES NO

JOINT EXCAVATED
BEHIND CANTEEN

APPENDIX A

WALL THICKNESS MEASUREMENT RECORD SHEET

PLANT: HBROBINSON UNIT: 2

COMPONENT: AT WELD D/S OF JOINT S-32 SOUTH SUPPLY HDR - SERVICE WATER NOM. SIZE O.D.: 30" NOM. WALL: ______ MIN. WALL: ______ Page 1 of 5 ZONE: ______

LINEAR SPACING: 1" RADIAL SPACING: 1" STARTING AT: 4" U/S OF WELD PREP ENDING AT: 3" D/S OF WELD PREP

LINEAR INCREMENT / RADIAL INCREMENT

LINEAR INCREMENT	-A	-B	-C	-D	-E	+A	+B	+C	+D		-A	-B	-C	-D	-E	+A	+B	+C	+D	
+0	.18	.20	.20	.20	.20	.18	.19	.20	.20											
+1	.18	.20	.20	.20	.30	.18	.19	.20	.20	+(20)	.19	.19	.20	.20	.20	.18	.20	.20	.20	
+2	.19	.20	.20	.20	.20	.19	.19	.20	.20	+(21)	.17	.19	.20	.20	.20	.18	.19	.20	.20	
+3	.19	.20	.20	.20	.20	.18	.20	.30	.20	+(22)	.16	.19	.20	.20	.20	.17	.20	.20	.20	
+4	.18	.19	.20	.20	.20	.18	.19	.20	.20	+(23)	.16	.19	.19	.20	.20	.17	.19	.20	.20	
+5	.17	.20	.20	.20	.20	.14	.17	.20	.20	+(24)	.14	.18	.18	.20	.20	.16	.18	.20	.20	
+6	.19	.19	.20	.20	.20	.12	.20	.20	.20	+(25)	.16	.18	.19	.20	.20	.15	.18	.20	.19	
+7	.17	.18	.19	.20	.20	.16	.19	.20	.20	+(26)	.16	.20	.20	.20	.20	.15	.20	.20	.18	
+8	.16	.19	.20	.20	.20	.18	.20	.20	.20	+(27)	.17	.20	.20	.20	.20	.18	.20	.20	.20	
+9	.17	.19	.20	.20	.20	.12	.19	.20	.20	+(28)	.17	.19	.20	.20	.20	.18	.18	.20	.20	
+10	.18	.19	.20	.20	.20	.18	~~.20~~ .19 [illegible]	.20	.20	+(29)	.20	.20	.20	.20	.20	.19	.20	.20	.20	
+11	.17	.19	.20	.20	.20	.17	.20	.20	.20	+(30)	.17	.19	.20	.28		.18	.20	.20	.20	
+12	.16	.19	.20	.20	.20	.18	.20	.20	.20	+(31)	.20	.19	.27	.20		.18	.20	.20	.20	
+13	.17	.20	.20	.20	.20	.18	.20	.20	.20	+(32)	.19	.20	.20	.19		.19	.18	.20	.20	
+14	.17	.20	.20	.20	.20	.17	.20	.20	.20	+(33)	.18	.30	.20	.20		.21	.20	.21	.20	
+15	.17	.19	.19	.20	.20	.18	.20	.20	.20	+(34)	.24	.20	.20	.20		.18	.20	.20	.20	
+16	.16	.19	.20	.20	.20	.18	.20	.20	.20	+(35)	.20	.20	.20	.20		.18	.19	.20	.20	
+17	.16	.19	.20	.20	.20	.17	.20	.20	.20	+(36)	.18	.20	.20	.20		.15	.18	.18	.18	
+18	.16	.19	.20	.20	.20	.18	.19	.20	.20	+(37)	N/C	N/C	N/C	N/C		.18	.20	.17	.18	
+19	.18	.19	.20	.20	.20	.19	.20	.20	.20	+(38)	N/C	N/C	N/C	N/C		N/C	N/C	N/C	N/S	

LOWEST MEASUREMENT: [illegible]" AT LOCATION: (LIN. +A RAD. +[illegible]) COMMENTS: ______

PERFORMED BY: [signature] DATE: 11 /20 /90

ATTACHMENT C
RNP-C/STS - 1114 R/0

JOINT EXCAVATED BEHIND CANTEEN

APPENDIX A

WALL THICKNESS MEASUREMENT RECORD SHEET

PLANT: H.B. ROBINSON UNIT: 2

COMPONENT: AT WELD D/S OF JOINT S-32 SOUTH SUPPLY HDR - SERVICE WATER NOM. SIZE O.D.: 30" NOM. WALL: ______ MIN. WALL: ______ ZONE: ______ Page 2 of 5

LINEAR SPACING: 1" RADIAL SPACING: 1" STARTING AT: 4" U/S OF WELD PREP ENDING AT: 3" D/S OF WELD PREP

LINEAR INCREMENT	RADIAL INCREMENT -A	-B	-C	-D	-E	+A	+B	+C	+D		-A	-B	-C	-D	-E	+A	+B	+C	+D	
+39	—	—	—	—	—	—	—	—	—	(-8)	.16	.19	.19	.19	—	.23	.19	.19	.19	—
+40	THIS AREA EXHIBITS GROSS							—	—	(-9)	.16	.19	.20	.20	—	.19	.19	.19	.19	—
+41	PITTING ON O.D. -			—	—	—	—	—	—	(-10)	.18	.19	.19	.19	—	.17	.19	.19	.19	—
+42	UNABLE TO MEASURE WITH							—	—	(-11)	.17	.19	.20	.19	—	.17	.19	.19	.19	—
+43	UT FROM O.D.			—	—	—	—	—	—	(-12)	.16	.19	.19	.19	—	.18	.18	.19	.19	—
+44	SEE MEASUREMENTS FROM I.D.								—	(-13)	.18	.19	.19	.19	—	.18	.19	.19	.19	—
+45	—	—	—	—	—	—	—	—	—	(-14)	.16	.19	.19	.19	—	.18	.19	.19	.19	—
+46	—	—	—	—	—	—	—	—	—	(-15)	.18	.19	.19	.19	—	.17	.19	.19	.19	—
+47	—	—	—	—	—	—	—	—	—	(-16)	.17	.19	.19	.19	—	.16	.19	.19	19	—
+48	—	—	—	—	—	—	—	—	—	(-17)	.16	.19	.19	.20	—	.17	.18	.19	.20	—
+49	—	—	—	—	—	—	—	—	—	(-18)	.18	.18	.19	.20	—	.18	.18	.19	.20	—
+50	—	—	—	—	—	—	—	—	—	(-19)	.19	.19	.17	.18	—	.18	.17	.19	.20	—
-1	.18	.19	.19	.19	.19	~~.18~~ Pit depth: .16	.18	.19	~~.20~~ Pit depth: .19	(-20)	.17	.19	.17	.19	—	.18	.18	.19	.20	—
-2	.18	.19	.19	.19	.20	.17	.18	.19	.19	(-21)	.18	.19	.18	.18	—	.19	.19	.19	.19	—
-3	.18	.20	.20	.20	.20	.17	.18	.18	.30	(-22)	.17	.19	.17	.18	—	.18	.18	.19	.19	—
-4	.18	.19	.19	.19	.20	.18	.19	.20	.19	(-23)	.17	.20	.18	.18	—	.17	.18	.20	.19	—
-5	.18	.19	.19	.20	.20	.17	.18	.29	.19	(-24)	NC	.19	.19	.19	—	.18	.19	.19	.19	—
-6	.19	.20	.20	.20	—	.17	.18	.18	.19	(-25)	.15	.19	.19	.19	—	.16	.20	.18	.20	—
-7	.17	.19	.19	.19	—	.17	.26	.19	.19	(-26)	.15	.18	.19	.18	—	.19	NC	.17	.17	—

LOWEST MEASUREMENT: .150" AT LOCATION: (LIN. -25 RAD. -A) COMMENTS: (1) N/C = NOT CLEAN

PERFORMED BY: [signature] DATE: 11/20/90 (2) MEASUREMENTS TAKEN FROM O.D. SURFACE

ATTACHMENT C RNP-C/STRS-1114 R/0

APPENDIX A

WALL THICKNESS MEASUREMENT RECORD SHEET

PLANT: H.B. ROBINSON UNIT: 2

SOUTH SUPPLY HDR - SERVICE WATER

COMPONENT: AT WELD D/S OF JOINT S-32 NOM. SIZE O.D.: 30" NOM. WALL: ____ MIN. WALL: ____ Page 3 of 5

ZONE: ____

LINEAR SPACING: 1" RADIAL SPACING: 1" STARTING AT: 4" U/S OF WELD PREP ENDING AT: 3" D/S OF WELD PREP

LINEAR INCREMENT / RADIAL INCREMENT

Columns -A -B -C -D -E +A +B +C +D: no readings recorded for -27 through -44. Handwritten note across these columns:

THIS AREA EXHIBITS GROSS PITTING ON O.D. - UNABLE TO MEASURE WITH UT FROM O.D. SEE MEASUREMENTS TAKEN FROM I.D. →

Linear		-A	-B	+A	+B		-A	-B	+A	+B
-27	(-27)	.15	.18	.15	.17	(+38)	.19	.19	.13	.19
-28	(-28)	N/A	.18	.16	.19	(+39)	.18	.18	.17	.19
-29	(-29)	.10	.16	.15	.18	(+40)	.16	.18	.17	.19
-30	(-30)	.09	.17	.16	.18	(+41)	.18	.18	.18	.19
-31	(-31)	.10	.18	.17	.17	(+42)	.15	.16	.16	.18
-32	(-32)	<.1	.16	.15	.18	(+43)	.12	.17	.15	.17
-33	(-33)	.14	.17	.15	.19	(+44)	.13	.15	.15	.17
-34	(-34)	.15	.17	.16	.18	(+45)	.14	.15	.15	.15
-35	(-35)	.14	.16	.17	.16	(+46)	.12	.13	<.10	.15
-36	(-36)	.15	.18	.13	.17	(+47)	.12	.12	.15	.15
-37	(-37)	.14	.17	.17	.18	(+48)	.15	.13	.15	.14
-38	(-38)	.15	.17	.19	.16	(+49)	<.10	.13	.13	.15
-39	(-39)	.17	.17	.16	.17	(+50)	.12	.14	.12	.14
-40	(-40)	.13	.17	.14	.18					
-41	(-41)	.15	.16	.14	.16					
-42	(-42)	N/A	.15	.16	.16					
-43	(-43)	.15	.16	.15	.17					
-44	(-44)	.10	.14	.12	.13					

DUE TO PITTING THESE MEASUREMENTS TAKEN FROM I.D. OF PIPE

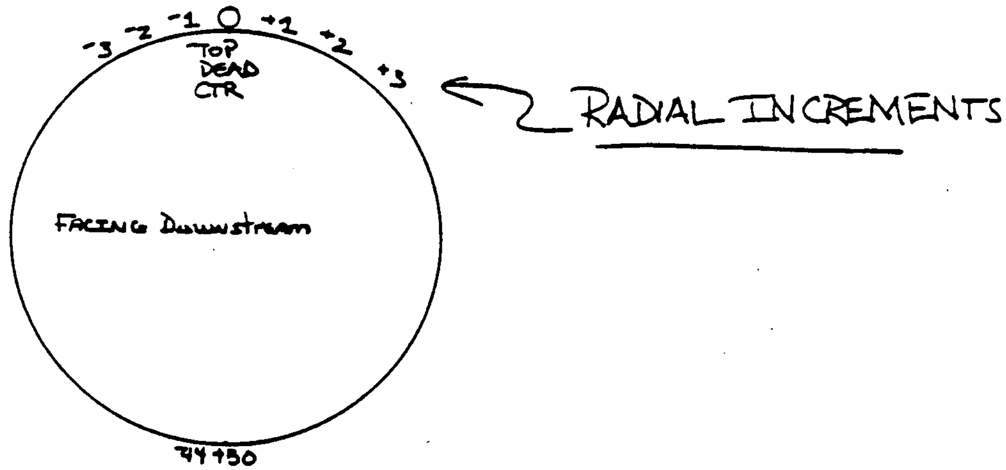
LOWEST MEASUREMENT: <.100 AT LOCATION: (LIN. -32 (+46) RAD. -A (+A)) COMMENTS: ① PROFILE TAKEN AT +43-E SEE PAGE 4 ② PROFILE TAKEN AT -44 +C SEE PAGE 4

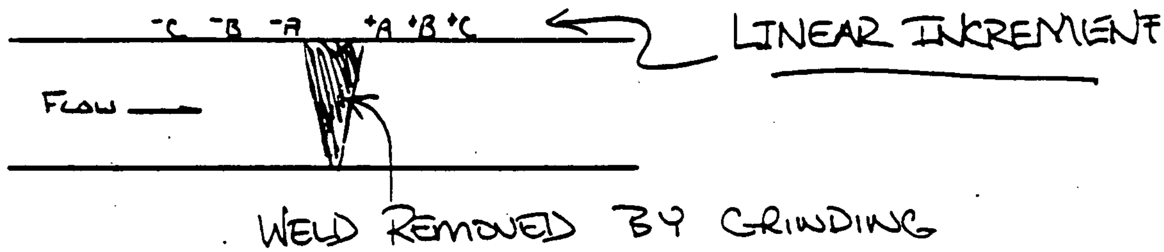
PERFORMED BY: [signature] DATE: 11/20/90

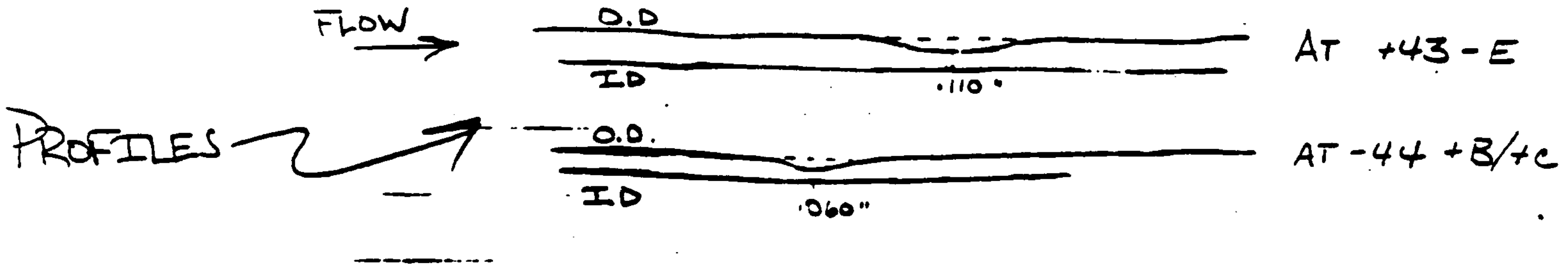
ATTACHMENT C
RNP-C/STRS-1114 R/0

H.B. ROBINSON UNIT 2

AT WELD DOWNSTREAM OF JOINT S-32
SOUTH SUPPLY HEADER -- SERVICE WATER







[signature] 11/20/90

ATTACHMENT C
RNP-C/STRS-1114 R/0

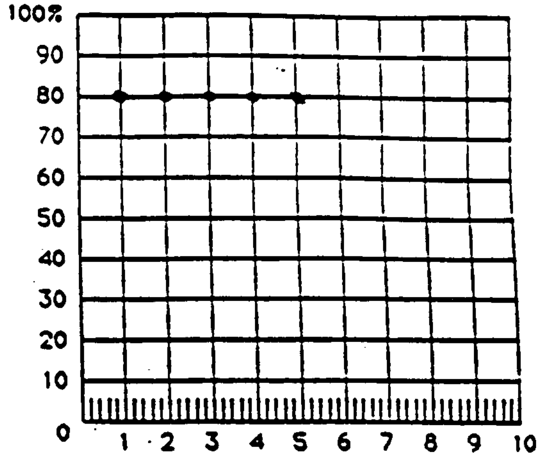
APPENDIX A

THICKNESS CALIBRATION SHEET

PLANT/UNIT: HBR u/2 COMPONENT: Service Water
PROCEDURE #: 408 REV. 6
CALIBRATION BLOCK #1 8903 BLOCK THICKNESS .250 (.050" Incr.)
#2 ________ BLOCK THICKNESS ________

INSTRUMENT: K-B USK7
CAL. DUE DATE: 12-12-90
SERIAL NUMBER: 27276-4182
SWEEP: 0.94
DELAY: 7.22
RANGE: 0.5

TRANSDUCER FREQUENCY: 5.0
TRANSDUCER SERIAL NO.: G31043
TRANSDUCER BRAND: KBA
TRANSDUCER SIZE: 1/4"
TRANSDUCER ELEMENT: SINGLE OR (DUAL)



EACH MAJOR SCREEN DIVISION: .050"

CALIBRATION VER. / CHECK	
INITIAL	TIME
JWB	0930
JWB	1200
JWB	1245
JWB	1600

COMMENTS: Ref Gain = 80% FSH

EXAMINERS 1 [signature] DATE 11/20/90 LEVEL II
2 ________ DATE ________ LEVEL ________
REVIEWERS 1 ________ DATE ________
2 ________ DATE ________
3 ________ DATE ________

ADDITIONAL SHEETS: YES NO

ATTACHMENT D
RNP-C/STRS-1114 R/0

12/4/90

To: Lee Williams
From: Mark Gerber

Subject: Installation of a Butt Strap to South Header Joint #31

The examination of joint #31 revealed localized corrosion (~3") in the manufactures spiral weld at the bell and spigot joint. The balance of the joint was in good condition and did not require any attention.

The initial repair method was to perform localized base metal repair at the weld. While performing the repair, the welder "blew" through the wall of the pipe and then proceeded to complete the repair. This resulted in a contaminated weld which was rejected. Joint #31 is located in a concrete thrust block and therefore is inaccessible from the exterior.

As a result of the above, the current repair method is to install a butt strap to enclose the contaminated repair. This butt strap is necessary due to the contaminated weld and is not related to any other pipe issues.

Mark Gerber

ATTACHMENT D
RNP-C/STRS-1114 R/0

12/6/90

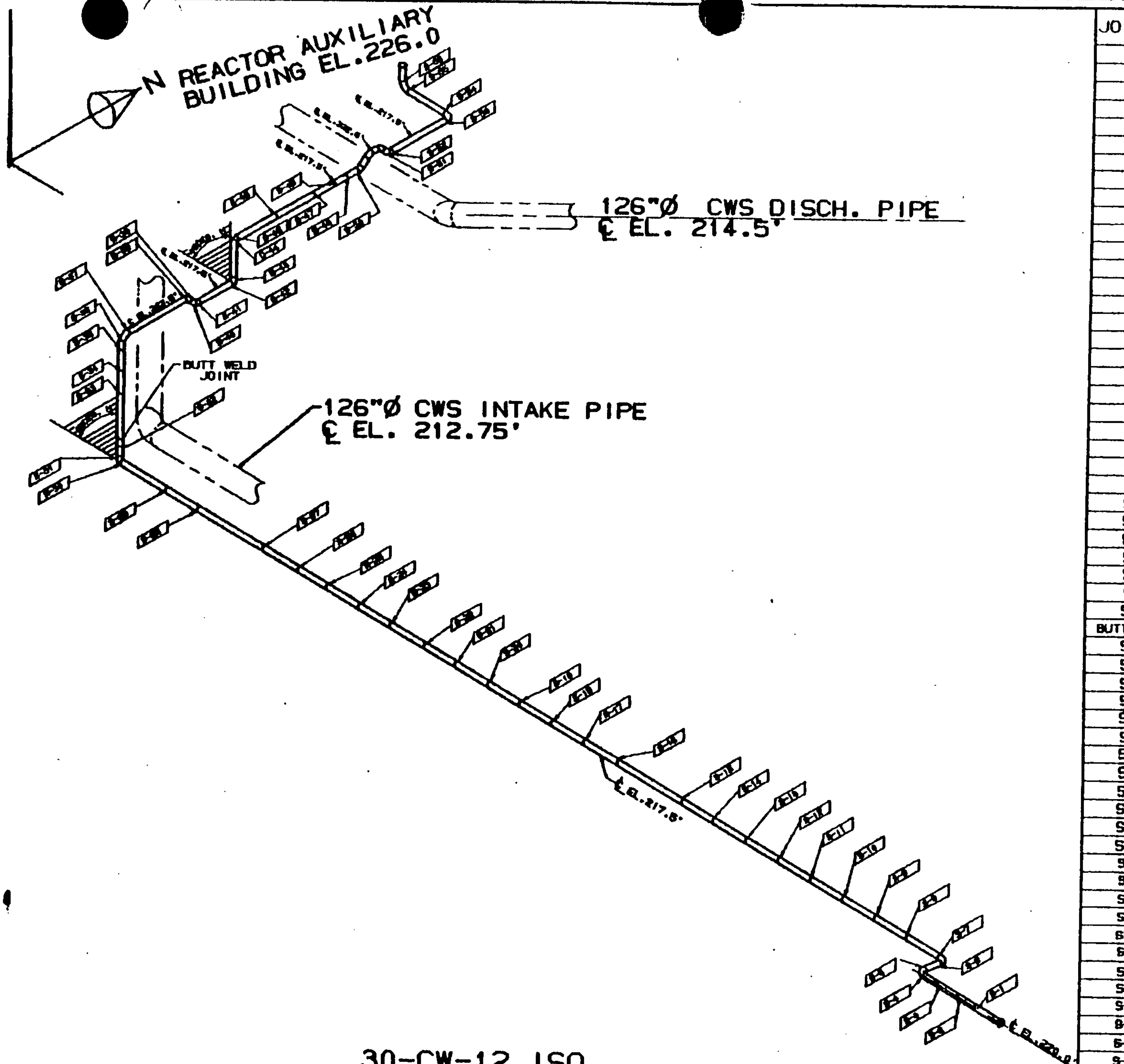
To: Vann K. Stephenson
From: Mark Gerber
Subject: Service Water South Header Joint S-6

Localized corrosion, in the manufactures spiral weld at joint #6, was noted during the inspection of the South Service Water Header. This corrosion is limited to a small portion of weld (~3") in the vicinity of the "Bell" portion of the joint. This minor repair will consist of grinding out the corroded portion of the weld and performing base metal repair form both the inside and outside. The majority of the exposed metal at this joint is in good condition and does not require repair.

I can be reached at 383-1518 if you have any questions concerning the Service Water piping inspection.

Mark Gerber

Mark Gerber



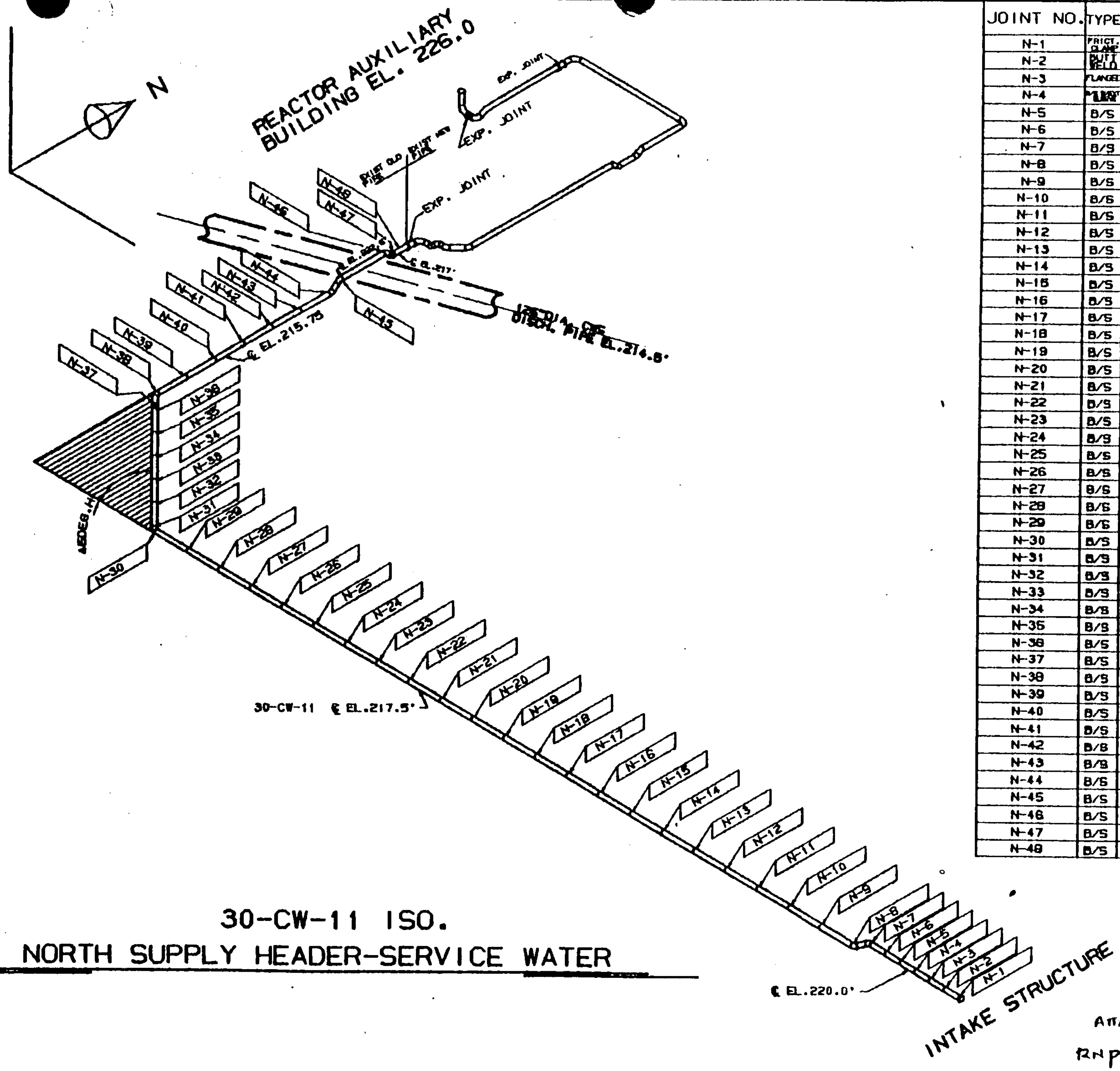
JOINT NO.	TYPE	FIX	EXT	[illegible]	CONTOUR MEASUREMENT
S-1	FRICT. CLAMP	GROUT	NO	NO	NO
S-2	B/S	GROUT	NO	NO	NO
S-3	B/S	GROUT	NO	NO	NO
S-4	B/S	GROUT	NO	NO	NO
S-5	B/S	GROUT	NO	NO	NO
S-6	B/S	WELD/ GROUT	YES	YES	YES
S-7	B/S	GROUT	YES	YES	YES
S-8	B/S	GROUT	NO	NO	NO
S-9	B/S	GROUT	NO	YES	YES
S-10	B/S	BUTT STRAP	NO	YES	YES (<.05)
S-11	B/S	GROUT	NO	YES	YES
S-12	B/S	GROUT	NO	YES	YES
S-13	B/S	GROUT	NO	NO	NO
S-14	B/S	GROUT	NO	NO	NO
S-15	B/S	GROUT	NO	NO	NO
S-16	B/S	GROUT	NO	NO	NO
S-17	B/S	GROUT	NO	NO	NO
S-18	B/S	GROUT	NO	NO	NO
S-19	B/S	GROUT	NO	NO	NO
S-20	B/S	GROUT	NO	NO	NO
S-21	B/S	GROUT	NO	NO	NO
S-22	B/S	GROUT	NO	YES	YES
S-23	B/S	GROUT	NO	NO	NO
S-24	B/S	GROUT	NO	NO	NO
S-25	B/S	GROUT	NO	NO	NO
S-26	B/S	GROUT	NO	NO	NO
S-27	B/S	GROUT	NO	NO	NO
S-28	B/S	GROUT	NO	NO	NO
S-29	B/S	GROUT	NO	NO	NO
S-30	B/S	GROUT	NO	NO	NO
S-31	B/S	BUTT STRAP	NO	NO	NO
S-32	B/S	GROUT	YES	NO	NO
BUTT WELD JOINT		WELD REPAIR	YES	NO	NO
S-33	B/S	GROUT	NO	NO	NO
S-34	B/S	GROUT	NO	NO	NO
S-35	B/S	GROUT	NO	NO	NO
S-36	B/S	GROUT	NO	NO	NO
S-37	B/S	GROUT	NO	NO	NO
S-38	B/S	GROUT	NO	NO	NO
S-39	B/S	GROUT	NO	YES	YES
S-40	B/S	GROUT	NO	NO	NO
S-41	B/S	GROUT	NO	NO	NO
S-42	B/S	BUTT STRAP	NO	YES	YES (<.05)
S-43	B/S	GROUT	NO	YES	YES
S-44	B/S	GROUT	NO	NO	NO
S-45	B/S	GROUT	NO	NO	NO
S-46	B/S	GROUT	NO	NO	NO
S-47	B/S	GROUT	NO	NO	NO
S-48	B/S	GROUT	NO	NO	NO
S-49	B/S	GROUT	NO	NO	NO
S-50	B/S	GROUT	NO	NO	NO
S-51	B/S	GROUT	NO	NO	NO
S-52	B/S	GROUT	NO	NO	NO
S-53	B/S	GROUT	NO	NO	NO
S-54	B/S	GROUT	NO	NO	NO
S-55	B/S	GROUT	NO	NO	NO
S-56	B/S	GROUT	NO	NO	NO

30-CW-12 ISO.

SOUTH SUPPLY HEADER-SERVICE WATER

INTAKE STRUCTURE

ATTACHMENT E
RNP-C/STRS-1114 R/0



JOINT NO.	TYPE	FIX	EXT.	[illegible]	CONTOUR MEASUREMENT
N-1	FRICT. CLAMP	REPAIR REPLACE	YES	YES	YES
N-2	BUTT WELD	BUTT STRAP	NO	NO	NO
N-3	FLANGED	REPLACE	YES	NO	NO
N-4	[illegible]	REPLACE	YES	NO	NO
N-5	B/S	GROUT	NO	NO	NO
N-6	B/S	GROUT	NO	NO	NO
N-7	B/S	GROUT	NO	NO	NO
N-8	B/S	GROUT	NO	NO	NO
N-9	B/S	GROUT	NO	NO	NO
N-10	B/S	GROUT	NO	NO	NO
N-11	B/S	GROUT	NO	NO	NO
N-12	B/S	GROUT	NO	NO	NO
N-13	B/S	GROUT	NO	NO	NO
N-14	B/S	GROUT	NO	NO	NO
N-15	B/S	GROUT	NO	NO	NO
N-16	B/S	GROUT	NO	NO	NO
N-17	B/S	GROUT	NO	NO	NO
N-18	B/S	GROUT	NO	NO	NO
N-19	B/S	GROUT	NO	NO	NO
N-20	B/S	GROUT	NO	NO	NO
N-21	B/S	GROUT	NO	NO	NO
N-22	B/S	GROUT	NO	NO	NO
N-23	B/S	GROUT	NO	NO	NO
N-24	B/S	GROUT	NO	NO	NO
N-25	B/S	GROUT	NO	NO	NO
N-26	B/S	GROUT	NO	NO	NO
N-27	B/S	GROUT	NO	NO	NO
N-28	B/S	GROUT	NO	NO	NO
N-29	B/S	GROUT	NO	NO	NO
N-30	B/S	GROUT	NO	NO	NO
N-31	B/S	GROUT	NO	NO	NO
N-32	B/S	GROUT	NO	NO	NO
N-33	B/S	GROUT	NO	NO	NO
N-34	B/S	GROUT	NO	NO	NO
N-35	B/S	GROUT	NO	NO	NO
N-36	B/S	GROUT	NO	NO	NO
N-37	B/S	GROUT	NO	NO	NO
N-38	B/S	GROUT	NO	NO	NO
N-39	B/S	GROUT	NO	NO	NO
N-40	B/S	GROUT	NO	NO	NO
N-41	B/S	GROUT	NO	NO	NO
N-42	B/S	GROUT	NO	NO	NO
N-43	B/S	GROUT	NO	NO	NO
N-44	B/S	GROUT	NO	NO	NO
N-45	B/S	GROUT	NO	NO	NO
N-46	B/S	GROUT	NO	NO	NO
N-47	B/S	GROUT	NO	NO	NO
N-48	B/S	GROUT	NO	NO	NO

30-CW-11 ISO.

NORTH SUPPLY HEADER-SERVICE WATER

ATTACHMENT E

RNP-C/STRS-1114 R/0

ATTACHMENT "L"
20 SHEETS

CERTIFICATION OF ENGINEERING CALCULATION

Station and Unit Number CP&L — H. B. Robinson Plant - Unit 2

Title of Calculation Foundation Analysis for the Volume Reduction / Solidification Modification Structure (RADWASTE FACILITY)

Calculation Number RRC-1608.00-00-0001 Originally consisting of Pages 1 through 94.

These Engineering Calculations cover QA CONDITION 2 items. In accordance with established procedures, the quality has been assured and I certify that the above calculation has been performed, checked or approved as noted below:

Performed by Bobbie Shields Date March 15, 1982

Checked by Mark McGary Date 5/18/82

Approved by D G Marcelli C. Q. Reeves Date 3-7-83

Issued to General Services Division Kenneth Holuberg Date 4/18/83

Received by General Services Division Rose T. Loquedio Date 4-18-83

Revision/Addenda Log:

No.	Pages Revised	Pages Deleted	Pages Added	Performed By / Date	Checked By / Date	Approved By / Date	Issue Date / Rec Date

SOUTH CAROLINA REGISTERED No. 9456 PROFESSIONAL ENGINEER G. MARCELLI

D G Marcelli 5/22/86

5659715

Form 101.1/Revision

DUKE POWER COMPANY

Dev. Station CP&L - H.B. Robinson Unit 2 File No. RRC-1608.00-00-0001

Subject VR/SMS

Foundation Analysis By J. Shields Date March 1982

Sheet No. 1 of ___ Problem No. ___ Checked By ___ Date ___

1. The purpose of this calculation is to determine an appropriate foundation for the Volume Reduction/Solidification Modification Structure (VR/SMS) and to determine appropriate foundation parameters for input into a structural model using the substructuring technique.

2. The VR/SMS is QA Condition 2 structure since it houses systems which process liquid radwaste.

3. Design method used are those commonly used by engineers who are familiar with static and dynamic soil mechanics and geotechnical engineering.

4. There are no codes or standards applicable to this calculation.

5. <u>Other Design Criteria.</u>

   a) Regulatory Guide 1.143, "Design Guidance for Radioactive Waste Management Systems, Structures, and Components Installed in Light-Water-Cooled Nuclear Power Plants," Oct. 1979.

   b) Regulatory Guide 1.132, Site Investigation of Foundations of Nuclear Power Plants, March, 1979.

1 5 6 0 9 0 1 0 0

6. FSAR Criteria

a) Section 2.9.7 of the H.B. Robinson Unit 2 FSAR lists the aseismic design criteria.

b) Section 2.8 of the H.B. Robinson Unit 2 FSAR describes the geological condition at the site.

7. Assumptions are stated in the body of the calculation when used.

8. Sources of Information (References)

Because of the impracticality of listing all sources of information used, only the major sources will be listed. Most of these major sources will list additional sources of information, some of which were used.

a) Dames and Moore, "Report, Site Environmental Studies, Proposed H.B. Robinson Nuclear Power Plant, Hartsville, South Carolina, CP&L.

b) Raymond Concrete Pile Company, "Report on Foundation Test Piles at the H.B. Robinson Steam Electric Plant, CP&L

c) Soil & Material Engineers, Inc., "Geotechnical Investigation Report, Radwaste Building, H.B. Robinson Steam Electric Plant, Hartsville, South Carolina. Feb 82

d) ASCE, Earthquake Engineering and Soil Dynamics, (3 Volumes) [illegible] 1978

e) ASCE, "In-situ Measurement of soil properties," (2 Volumes) June 1975

f) Desai and Christian, "Numerical Methods in Geotechnical Engineering", McGraw-Hill, 1977.

g) Ronald F. Scott, "Foundation Analysis", Prentice Hall, 1981.

h) EPRI, "Seismic Design of Nuclear Power Plants- An Assessment", June 1975.

i) NAVFAC DM-7, "Design Manual, Soil Mechanics, Foundations and Earth Structures", March, 1971.

j) Means, "Building Construction Cost Data", 1982.

k) H. Bolton Seed & I.M. Idriss, "Soil Moduli and Damping Factors For Dynamic Response Analyses," Earthquake Engineering Research Center, Dec. 1970.

l) ASCE, "Insitu Testing To Evaluate Liquefaction Susceptibility", Oct. 1981.

m) J. H. Schmertmann, "Static Cone to Compute Static Settlement Over Sand", ASCE, SM3, Vol 96, May 1970.

RRC.1608.00-88-0001

LIQUEFACTION ANALYSIS

Dev./Station: CP&L H.B. Robinson — Unit: 2 — File No. RRC-160800-00-CEO1
Subject: VR/SMS Foundation Analysis
By: B. Shiells — Date: March, '82
Sheet No. 28 of ___ — Problem No. ___ — Checked By: [illegible] — Date: [illegible]

Liquefaction analysis is performed following the procedure outlined by Seed & Idriss (See paper following sheet no. 31.)

$$\frac{\tau}{\sigma_v'} = 0.65 \frac{a_{max}}{g} \cdot \frac{\sigma_o}{\sigma_o'} \cdot r_d$$

* Ref.: "Soil Dynamics" [illegible], Fig. 3.15, [illegible]

where $\frac{a_{max}}{g} = 0.1$ for OBE

$\sigma_o = 130$ pcf

$\sigma_o' = (130 - 62.4) = 67.6$ pcf

r_d = stress reduction factor which varies from 1 at the ground surface to 0.9 at 30 feet.

$\therefore \frac{\tau}{\sigma_v'} = (0.65)(0.1)(1.923)\, r_d = 0.125\, r_d$

h, ft	r_d	τ/σ_v'	N_1
0	~~0~~ 1.0 *	0	0
10	~~0.3~~ .99	~~0.037~~ .123	2.4 7.9
20	~~0.6~~ .96	~~0.075~~ .120	4.8 7.6
30	~~0.9~~ .93	~~0.112~~ .116	7.1 7.3
40	0.9	0.112	7.1
50	0.9	0.112	7.1
60	0.9	0.112	7.1

N_1 was scaled from Fig. 14 of Seed & Idriss's paper for $M \approx 5\frac{1}{4}$. This is still on the conservative side since a magnitude, $M \approx 4.5$, corresponds to the OBE selected [illegible]

N_1 → taken from ref. 2

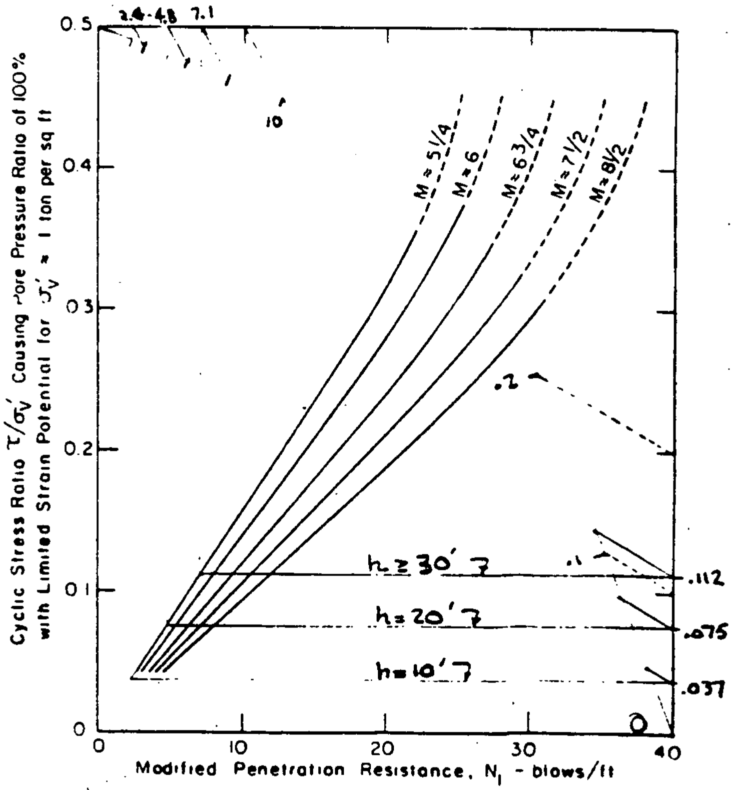


FIG. 14 CHART FOR EVALUATION OF LIQUEFACTION POTENTIAL FOR

Calculation of N_1

$N_1 = C_N \times N_{measured}$

The following relationship between h and C_N is scaled from Fig. 4 of Seed & Idriss's paper for $D_r = 40$-60%

σ_o', ksf	h, ft	C_N
0	0	1.600
0.75	11.1	1.600
1.00	14.8	1.365
1.50	22.2	1.135
2.00	29.6	0.990
2.50	37.0	0.885
3.00	44.4	0.805
3.50	51.8	0.740
4.00	59.2	0.690

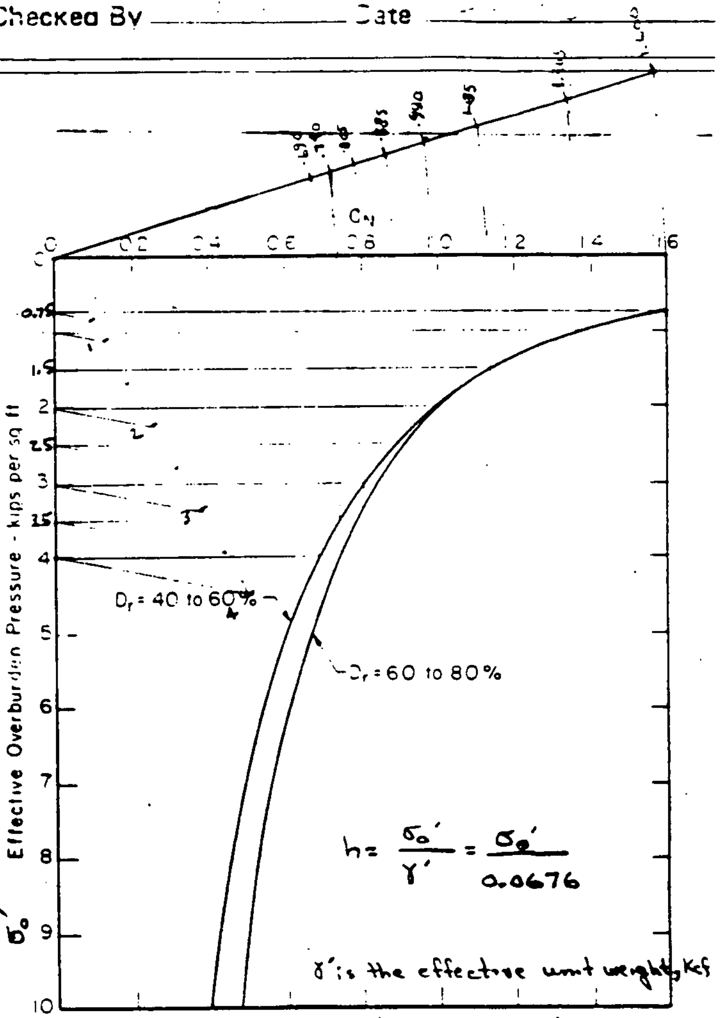
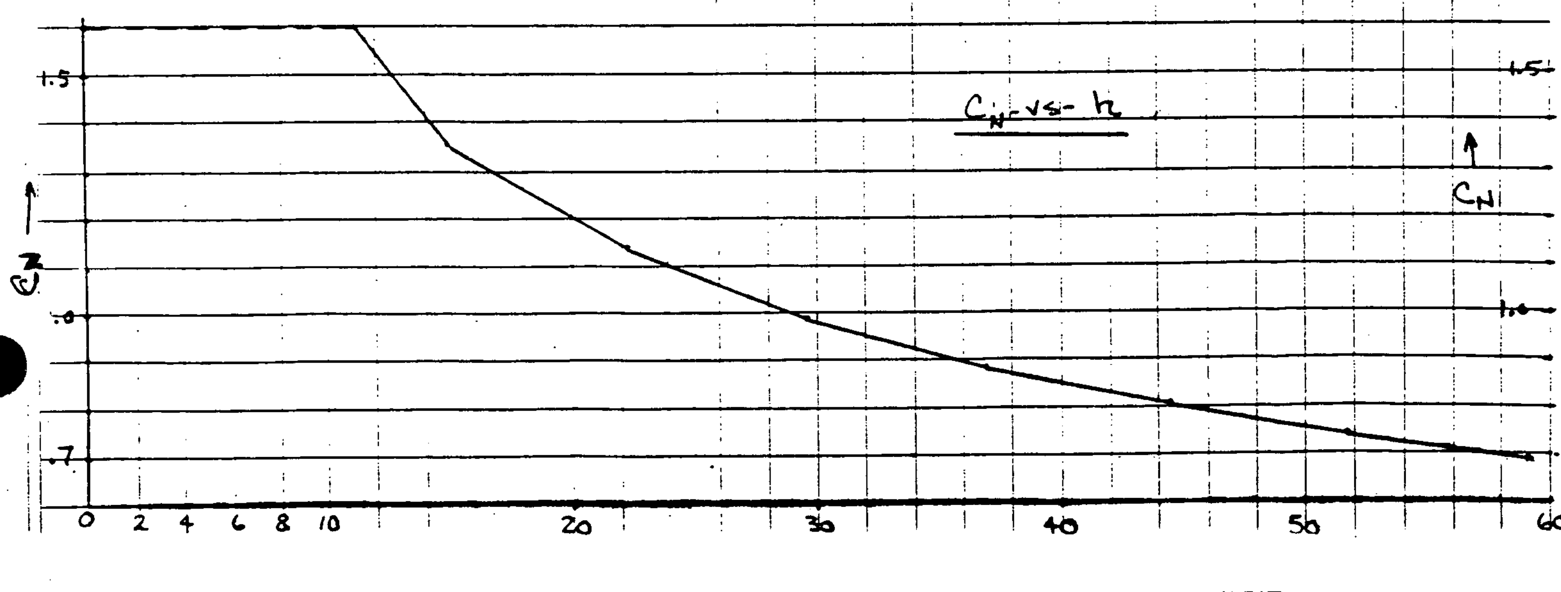


FIG. 4 RECOMMENDED CURVES FOR DETERMINATION OF C_N BASED ON AVERAGES FOR W.E.S. TESTS



00106093

Duke Power Company
Dev./Station CP&L H.B. Robinson Unit 2 File No. -0001
Subject VR/SMS Foundation Analysis
Sheet No. 30 of Problem No.
By B. Smith Date March '82
Checked By Date

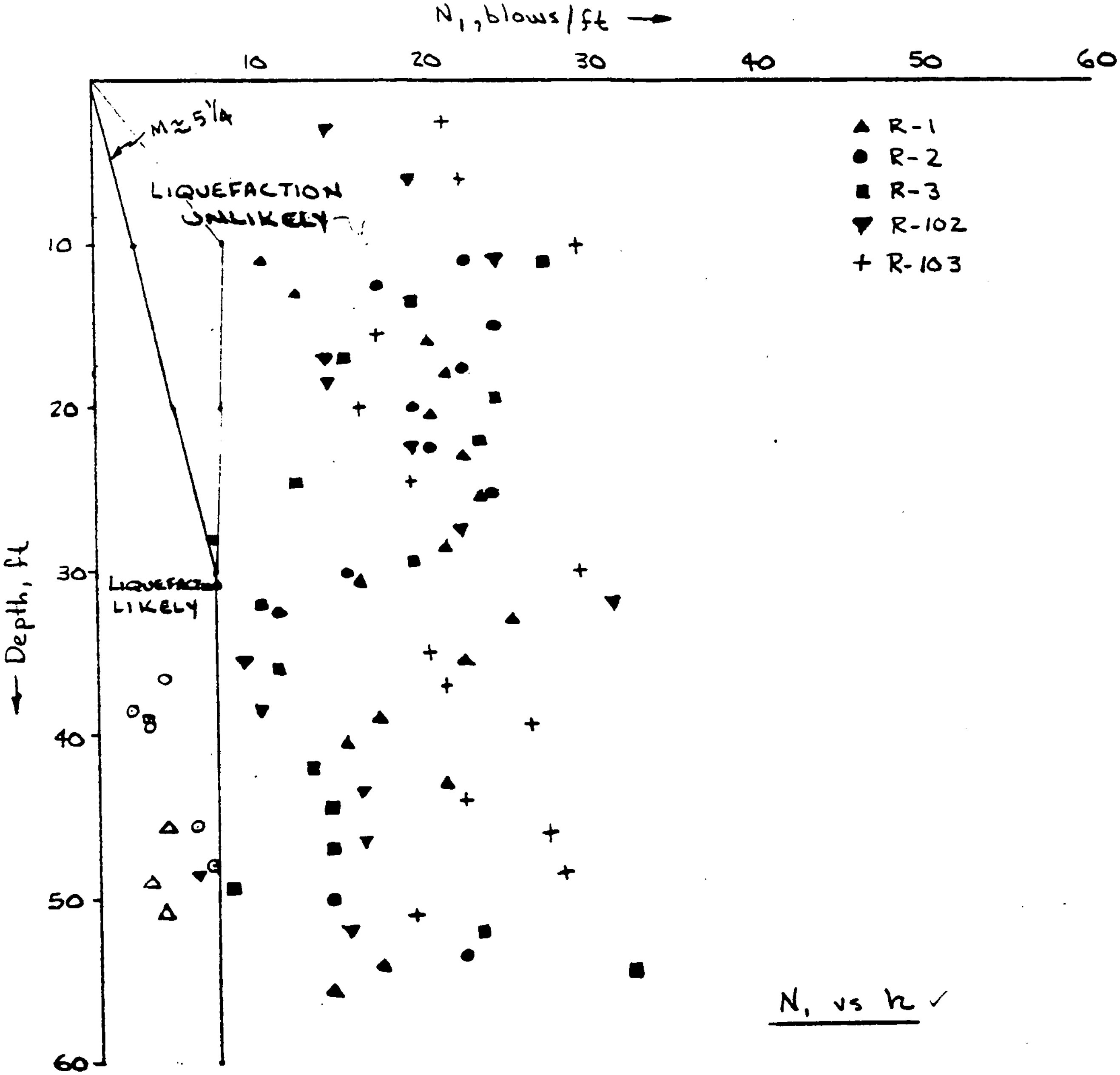
Calculation of N_1 (Continued)

Boring R-2				Boring R-3				Boring R-102				Boring R-103			
h, ft	N	C_N	N_1	h, ft	N	C_N	N_1	h, ft	N	C_N	N_1	h, ft	N	C_N	N_1
11.0	14	1.60	22	11.0	17	1.60	27	3.0	9	1.60	14	2.5	13	1.60	21
12.5	11	1.52	17	13.5	13	1.43	19	6.0	12	1.60	19	6.0	14	1.60	22
15.0	18	1.35	24	17.0	12	1.29	15	11.0	15	1.60	24	10.0	18	1.60	29
17.5	17	1.28	22	19.5	20	1.22	24	17.0	11	1.29	14	15.5	13	1.33	17
20.0	16	1.20	19	22.0	20	1.14	23	18.5	11	1.26	14	20.0	13	1.20	16
22.5	18	1.13	20	24.5	11	1.08	12	22.5	17	1.13	19	24.5	18	1.08	19
25.5	22	1.06	23	28.0	7	1.02	7	27.5	22	1.00	22	30.0	30	0.98	29
30.0	15	0.98	15	29.5	19	0.98	19	32.0	33	0.95	31	35.0	22	0.91	20
32.5	12	0.94	11	32.0	10	0.95	10	35.5	10	0.90	9	37.0	24	0.88	21
36.5	4	0.88	4	36.0	12	0.89	11	38.5	12	0.86	10	39.5	30	0.85	26
38.5	2	0.86	2	39.5	3	0.85	3	43.5	20	0.82	16	44.0	27	0.81	22
39.5	4	0.85	3	42.0	16	0.83	13	46.5	21	0.78	16	46.0	34	0.79	27
45.5	7	0.79	6	44.5	17	0.80	14	48.5	8	0.77	6	48.5	36	0.77	28
48.0	9	0.77	7	47.0	18	0.77	14	52.0	21	0.73	15	51.0	25	0.74	19
50.0	18	0.75	14	49.5	11	0.76	8								
53.5	31	0.72	22	52.0	32	0.73	23								
				54.5	45	0.72	32								

CP&L H. B. Robinson Unit 2
VR/SHS Foundation Analysis
By: B. Shields March '82

RRL-1608.00-00-0001

Sheet no. 31



N1 vs h ✓

Conclusion: As seen from the above plot, the points lying in the region where liquefaction is likely are statistically insignificant and therefore liquefaction at the site of the building is unlikely during an OBE. ✓ conservative

0010640981

EVALUATION OF LIQUEFACTION POTENTIAL OF SAND DEPOSITS BASED ON OBSERVATIONS OF PERFORMANCE IN PREVIOUS EARTHQUAKES

by

H. Bolton Seed,[1] F. ASCE and I. M. Idriss,[2] M. ASCE

Taken from Ref. 2

RAC-1608.00-00-0001 Sheet no. 31a

General Procedures for Evaluation of Liquefaction Potential

There are basically two methods available for evaluating the cyclic liquefaction potential of a deposit of saturated sand subjected to earthquake shaking:

1. Using methods based on field observations of the performance of sand deposits in previous earthquakes and involving the use of some in-situ characteristic of the deposits to determine probable similarities or dis-similarities between those sites and a proposed new site with regard to their potential behavior.

and 2. Using methods based on an evaluation of the cyclic stress or strain conditions likely to be developed in the field by a proposed design earthquake and a comparison of these stresses or strains with those observed to cause liquefaction of representative samples of the deposit in some appropriate laboratory test which provides an adequate simulation of field conditions or which can provide results permitting an assessment of the soil behavior under field conditions.

These are usually considered to be quite different approaches, since the first method is based on empirical correlations of some in-situ characteristic and observed performance, while the second method is based entirely on an analysis of stress or strain conditions and the use of laboratory testing procedures.

In fact, however, because of the manner in which field performance data are often expressed, the two methods involve the same basic approach and differ only on the manner in which the field liquefaction characteristics of a deposit are determined.

Thus, for example, it has been found that a convenient parameter for expressing the cyclic liquefaction characteristics of a sand under level ground conditions is the cyclic stress ratio; that is, the ratio of the average cyclic shear stress τ_h developed on horizontal surfaces of the sand as a result of the cyclic or earthquake loading to the initial vertical effective stress σ_o' acting on the sand layer before the cyclic stresses were applied. This parameter has the advantage of taking into account the depth of the soil layer involved, the depth of the water table and the intensity of earthquake shaking or other cyclic loading phenomena.

The cyclic stress ratio developed in the field due to earthquake shaking can readily be computed from an equation of the form:

---

[1]Professor of Civil Engineering, University of California, Berkeley, CA.

[2]Principal, Woodward-Clyde Consultants, San Francisco, CA.

$$\frac{(\tau_h)_{av}}{\sigma_o'} = 0.65 \frac{a_{max}}{g} \cdot \frac{\sigma_o}{\sigma_o'} \cdot r_d \qquad (1)$$

where a_{max} = maximum acceleration at the ground surface

σ_o = total overburden pressure on sand layer under consideration

σ_o' = initial effective overburden pressure on sand layer under consideration

r_d = a stress reduction factor varying from a value of 1 at the ground surface to a value of 0.9 at a depth of about 30 ft.

and values of this parameter have been correlated, for sites which have and have not liquefied during actual earthquakes, with parameters indicative of soil characteristics such as relative density based on penetration test data (24), some form of corrected penetration resistance (3, 23), or the electrical characteristics of soil deposits (1). Thus in evaluating the liquefaction resistance of a new site for a given level of shaking, the stress ratio induced by the earthquake can be determined by Eq. (1), or a procedure similar to that on which this equation is based, and compared with the stress ratio required to cause liquefaction of the soil determined either

(1) by use of the field correlations discussed above

or (2) by means of laboratory tests or representative samples of the soil deposit involved.

The latter procedure may be conducted in terms of stress ratio, stress, or strain. However no matter which of these parameters is used, the in-situ properties can only be evaluated reliably if appropriate tests are performed on undisturbed samples. Because of the great difficulty in obtaining undisturbed samples of sand deposits, many engineers have preferred to adopt the field performance correlation approach since it circumvents this aspect of the problem (18).

While in principle, soil liquefaction characteristics determined by field performance can be correlated with a variety of soil index parameters such as standard penetration resistance, cone penetration resistance, electrical properties, shear wave velocity and perhaps others, there is very little field data available to establish good correlations of field performance with any soil characteristic other than the standard penetration resistance. This situation will no doubt change with time as other index parameters are determined for soils whose liquefaction resistance has been established by actual earthquakes, and possibly improved correlations will be developed. Furthermore other parameters can potentially be measured more accurately, over a wider depth range and in more difficult environmental conditions than can the standard penetration resistance.

However because the SPT has been so widely used in the past, the great bulk of available field performance data are currently only correlated with this index of soil characteristics and it is the purpose of this report to summarize the available information concerning the correlations.

The Standard Penetration Test

Various studies in recent years have shown the potential variability in the conditions utilized in this supposedly standardized test procedure which was intended to measure the number of blows (of a 140 lb hammer falling freely through a height of 30 inches) required to drive a standard sampling tube (2" O.D. and 1-1/2" I.D.) 12 inches into the ground. For example, Kovacs, et al. (12, 13), e.g., made careful investigations of the energy in the hammer at its impact with the top of the sampling rod-anvil system, when using the conventional practice of lifting the hammer by means of a rope wrapped one to four times around a rotating drum, as compared with an ideal triggering device giving a truly free fall to the 140-lb drive weight. It was found that typically the energy in the hammer at impact when using the rope and drum procedure with two turns of the rope was only about 60% of that delivered by a free-falling weight. For three turns this was reduced to 40%; other minor variations were introduced by using old or new rope and changing the speed of the pulley. The authors concluded that an energy standard should be adopted as a criterion for the SPT test and in the meantime, all pertinent test conditions should be made a standard part of the boring log to aid in interpreting the results.

From recent comprehensive theoretical and field studies of the standard penetration test at the University of Florida (17, 19), Schmertmann (20) concludes that the results may be significantly influenced by such factors as: (1) The use of drilling mud versus casing for supporting the walls of the drill hole; (2) the use of a hollow stem auger versus casing and water; (3) the size of the drill [illegible] (4) [illegible] number of turns of the rope around the drum; (5) the use of a small or large anvil; (6) the length of the drive rods; (7) the use of nonstandard sampling tubes; and (8) the depth range (0 to 12 in. or 6 in. to 18 in.) over which the penetration resistance is measured.

Both Schmertmann and Kovacs, et al. conclude that a necessary prerequisite to the satisfactory use of the standard penetration test as a measure of any soil characteristic is an increased degree of standardization. Schmertmann (20) suggests that this is particularly true with respect to: (1) The amount of energy delivered into the drilling rods; and (2) the use of rotary drilling methods and a drill hole continuously filled with drilling mud.

If this approach is adopted, much of the variability can be eliminated by adopting standard test conditions and applying corrections for others. Thus in the present report, the loss of driving energy which results from using a short length of rods is corrected by reducing the measured N values in the depth range 0 to 10 ft by a factor of 0.75 and other aspects of the test are standardized by using data from tests performed under the following conditions:

(1) the use of a rope and drum system, with two turns of the rope around the drum, to lift the falling weight.

(2) drilling mud to support the sides of the hole

(3) a relatively small diameter hole, approximately 4 inches in diameter

and (4) penetration resistance measured over the range 6 inches to 18 inches penetration into the ground.

While it is recognized that these conditions do not represent the standard prescribed in the ideal test procedure, they represent conditions widely used for many years both in North America and in other countries throughout the world and they have been used in establishing much of the field data available for liquefaction correlations. Thus their adoption for the purposes of this report is justified for this reason alone. Where test conditions deviate from those listed above, appropriate corrections to the measured results should be made before using the correlation charts presented herein.

Correlations of SPT with the Performance of Sand Deposits in Previous Earthquakes

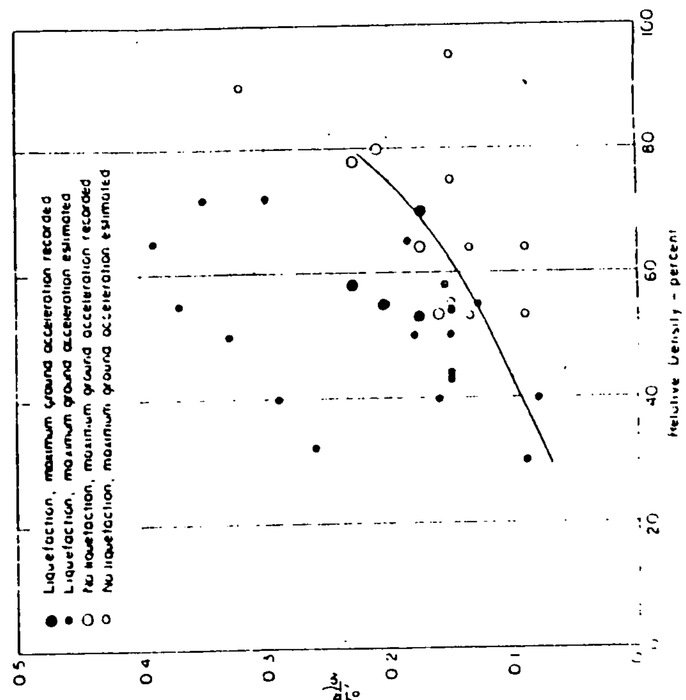
It was not until the Alaska and Niigata earthquakes of 1964 that geotechnical engineers took serious interest in the general phenomenon of earthquake-induced liquefaction or cyclic mobility or the conditions responsible for causing them to occur in the field. Following the Niigata earthquake, a number of Japanese engineers (10,11,16) studied the areas in Niigata where liquefaction had and had not occurred and developed criteria, based primarily on the Standard Penetration Resistance of the sand deposits, for differentiating between liquefiable and nonliquefiable conditions in that city. The results of these studies for Niigata are shown in Fig. 1. It should be recognized however that these results are not likely to be applicable to other areas where shaking intensities may be stronger or water tables may be at different depths than that in the Niigata area.

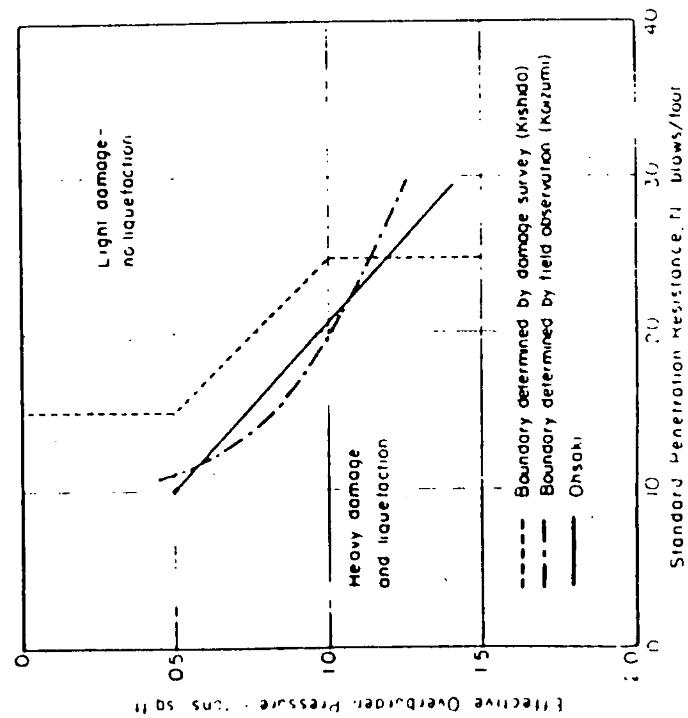
Subsequently, a more comprehensive collection of site conditions at various locations where some evidence of liquefaction or no liquefaction was known to have taken place was presented by Seed and Peacock (24) and used as a basis to determine the relationship between field values of cyclic stress ratio τ_h/σ_o' (in which τ_h = the average horizontal shear stress induced by an earthquake; and σ_o' = the initial effective overburden pressure on the soil layer involved) and the relative density of the sand, as determined from the Standard Penetration Resistance and its correlation with relative density proposed by Gibbs and Holtz (7). This collection of field cases shown in Fig. 2 has subsequently been used by others, often supplemented by a few additional site studies (e.g., Refs. (3) and (4)) to determine other correlations between liquefaction-producing parameters and penetration resistance. The most recently published form of this field data collection is shown in Fig. 3(a) (after Seed, Mori and Chan (23)). Values of stress ratio known to be associated with some evidence of liquefaction or no liquefaction in the field are plotted as a function of the normalized penetration resistance N_1 of the sand deposit involved. In this form of presentation N_1 is the measured penetration resistance corrected to an effective overburden pressure of 1 ton/sq ft and can be determined from the relationship:

$$N_1 = C_N \cdot N$$

where C_N is a function of the effective overburden pressure at the depth where the penetration test was conducted. In early studies values of C_N were read from the chart shown in Fig. 3(b) but more representative values are now determined from the chart shown in Fig. 4 which is based on recent studies conducted at the Waterways Experiment Station (2,15).

Thus for any given site and a given value of maximum ground surface acceleration, the possibility of cyclic mobility or [illegible]





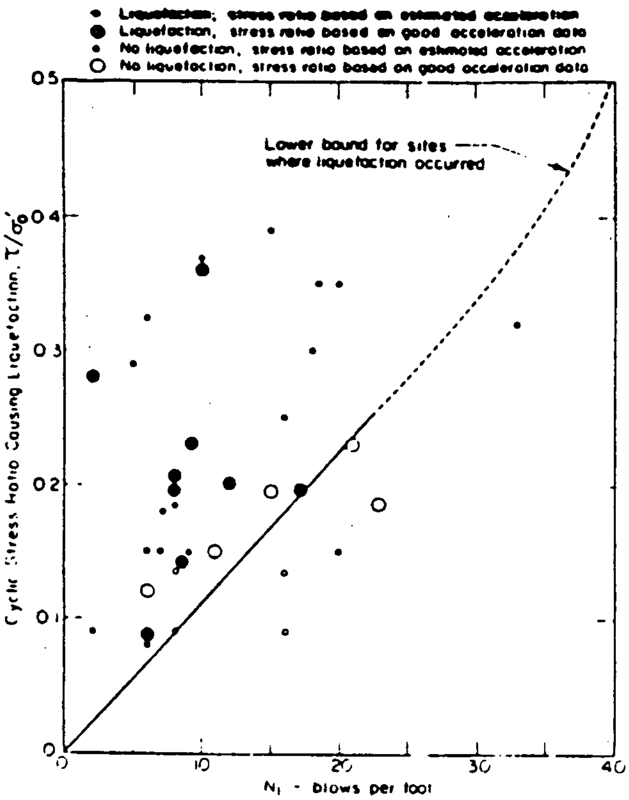


FIG. 3a CORRELATION BETWEEN STRESS RATIO CAUSING LIQUEFACTION IN THE FIELD AND PENETRATION RESISTANCE OF SAND

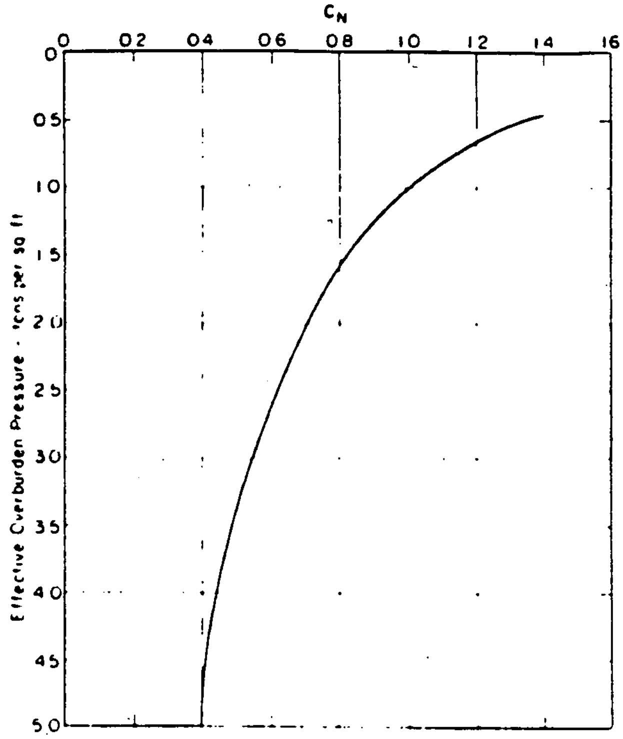


FIG. 3b RELATIONSHIP BETWEEN C_N AND EFFECTIVE OVERBURDEN PRESSURE

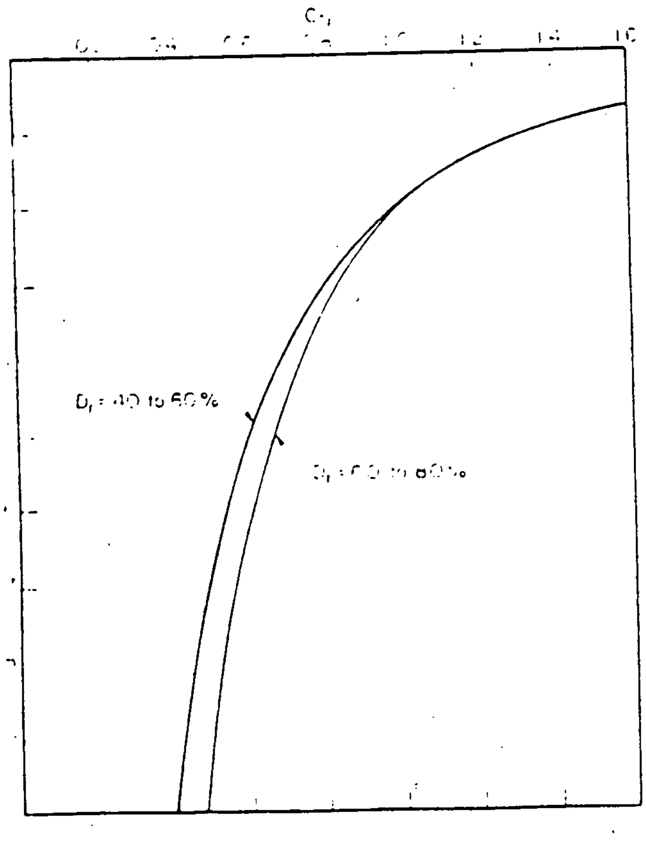
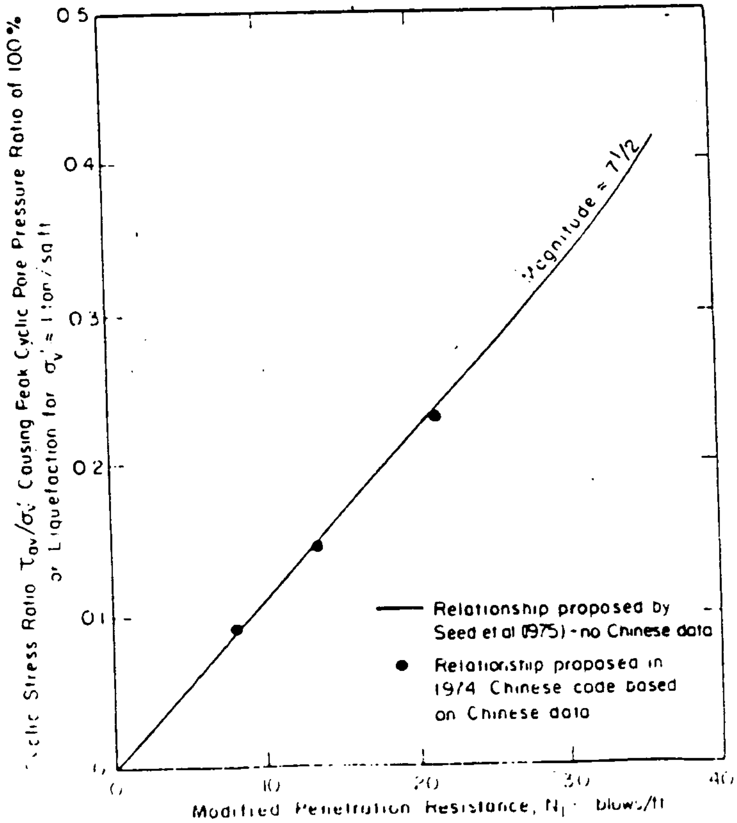


Fig 4 [illegible]



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can readily be evaluated on an empirical basis with the aid of this chart by determining the appropriate values of N_1 for the sand layers involved, reading off a lower bound value of τ_{av}/σ_o' for sites where some evidence of liquefaction is known to have occurred (such as the line shown in Fig. 3(a), and comparing this value with that induced by the design earthquake for the site under investigation (computed from Eq. 1). One of the greatest limitations of this plot at the time it was presented was the limited number of reliable data points available to define the boundary separating liquefiable from non-liquefiable sites. However in the past six years, supplementary data has been provided from a variety of sources to greatly increase the data base. Sources of this data include the following:

(1) Data from Chinese Building Code (1974)

Liquefaction studies in mainland China, apparently conducted independently but along similar lines to those developed in this country have also led to a correlation between earthquake shaking conditions causing cyclic mobility or liquefaction and the standard penetration resistance of sands (6). In this correlation, the critical value of the standard penetration resistance, N_{crit}, separating liquefiable from non-liquefiable conditions to a depth of approximately 50 ft is determined by

$$N_{crit} = \bar{N}[1 + 0.125\,(d_s - 3) - 0.05\,(d_w - 2)]$$

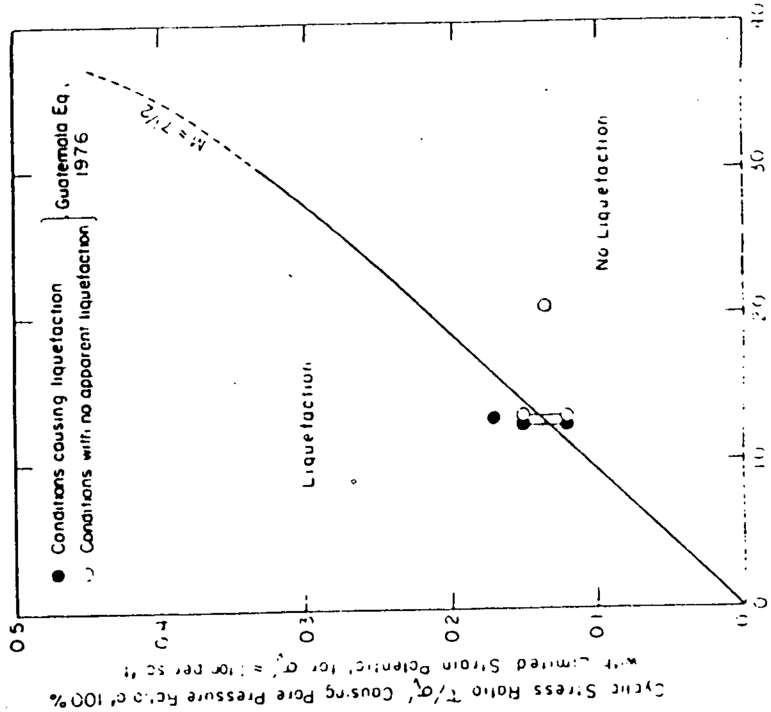
in which d_s = depth to sand layer under consideration in meters; d_w = depth of water below ground surface in meters; and $\bar{N}$ = a function of the shaking intensity as follows:

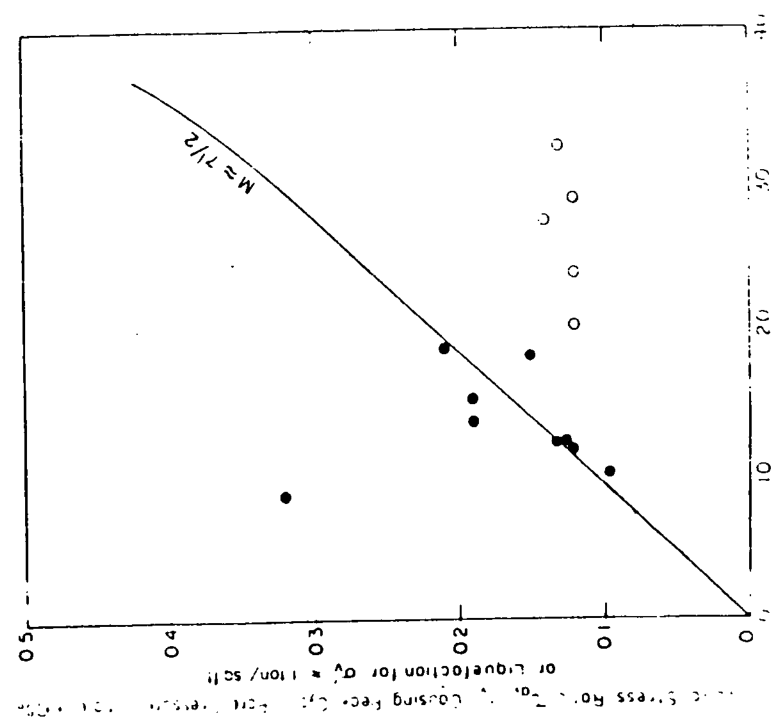
Modified Mercalli Intensity	$\bar{N}$, in blows per foot
≈VII	6
≈VIII	10
≈XI	16

This correlation, for a water table depth of 2 m, reduced to the same parameters as those used in Fig. 3, with the aid of the correlation between earthquake shaking intensity and maximum ground accelerations developed by Trifunac and Brady (26), is plotted in Fig. 5 where it is also compared with the lower bound line for sites showing evidence of some degree of cyclic mobility or liquefaction shown in Fig. 3(a). It may be seen that there is apparently a very high degree of agreement between the critical boundary determined in this way with that shown in Fig. 3(a). It is significant and remarkably that such a great similarity both in procedures and criteria should have evolved in countries with so little technical communication at the time the individual plots were developed.

(2) Data from the Haicheng and Tangshan Earthquakes in China

More recent data for 9 sites known to have liquefied and 5 for which there was no apparent liquefaction in the Haicheng (1974) and Tangshan (1976) earthquakes in China (Magnitudes 7.3 and 7.8 respectively) has been presented by Xie (28). These data, reduced to the form shown in Fig. 3 with the aid of the Trifunac and Brady correlation between intensity and peak ground acceleration are shown in Fig. 6, together with the boundary line from Fig. 3(a).





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(3) Data from the Guatemala Earthquake of 1976

During the Guatemala earthquake of 1976 (Magnitude 7.6) extensive liquefaction occurred in the area of La Playa on the edge of Lake Amatitlan. A detailed report of field and laboratory studies of the soil conditions in the area affected, in the adjacent area where no liquefaction occurred, and just beyond the boundary of the liquefied zone has been presented by Seed et al. (21). The correlation between induced stress ratio τ_{av}/σ_o' and the normalized SPT values for the different zones are shown in Fig. 7 where they are again compared with the boundary line separating sites known to have liquefied or not liquefied taken from Fig. 3(a).

(4) Data from the Argentina Earthquake of 1977

In November, 1977 a major earthquake with Magnitude 7.4 occurred in San Juan Province, Argentina and relationships between induced stress ratio determined from ground accelerations, and standard penetration test data for 11 sites where liquefaction occurred and 9 sites where liquefaction did not occur have been presented by Idriss et al. (8). Penetration data for the liquefied sites was taken in adjacent areas where liquefaction was not apparent. The results of these studies are presented in Fig. 8.

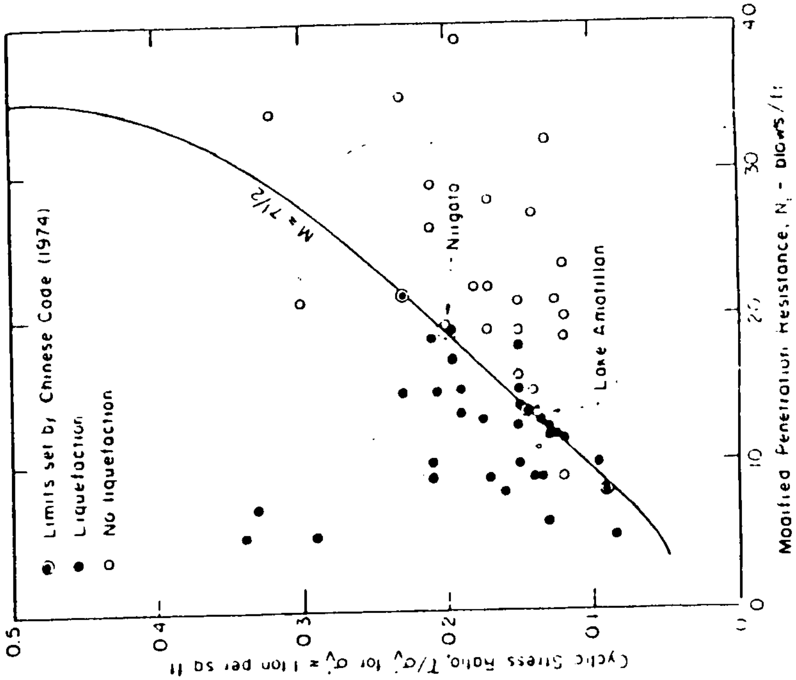
Compilation of Data

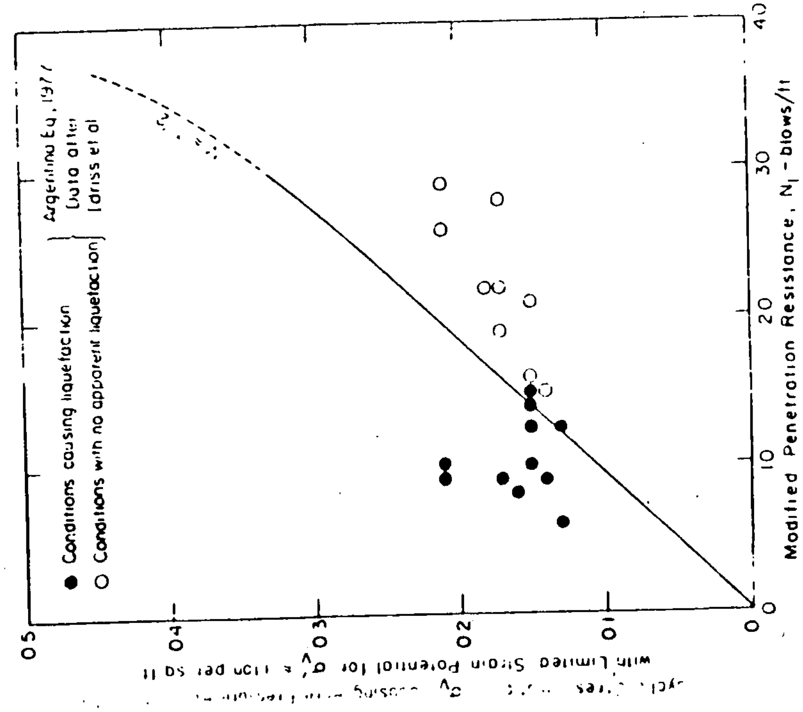
The reliable field data from Fig. 3(a), together with the supplementary results shown in Figs. 5 to 8, are plotted together in Fig. 9 where they provide a significantly greater data base from which to determine a boundary line separating sites known to have liquefied from sites which apparently have not liquefied in a series of earthquakes, all of which had magnitudes of about 7-1/2. The data for Niigata and Lake Amatitlan are known to be at the boundary for such a line and the Chinese code results are also intended to define limiting conditions. Thus a revised position for the separation boundary can be established. In fact this boundary is almost exactly the same as that originally proposed but it is supported by a significantly greater data base and thus can be drawn with much greater confidence than heretofore.

Analyses of New Data from Japan

After the plot shown in Fig. 9 had been developed, an abundant series of new data points, obtained primarily as a result of studies following the Miyagiken-Oki earthquake in Japan in June, 1978 (Magnitude 7.4), were presented by Tokimatsu and Yoshimi (25). The data are presented in a slightly different form than that used in the plots shown in Figs. 5 to 9, but they can readily be converted to the same form on the basis of the information provided in the report.

For sandy soils, having $D_{50} > 0.25$ mm, the corrected data from this study are shown in Fig. 10, where they are compared with the boundary line determined in Fig. 9. It may be seen that there is generally good agreement, although some sites where liquefaction apparently did not occur are found to plot above the boundary line. It is appropriate that this may occur since sites where liquefaction is not reported can not be considered with the same degrees of confidence as sites where evidence of liquefaction is clearly apparent. This is due to the fact that in the absence of surface evidence of liquefaction





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a site can only be classified as one with "no apparent liquefaction" since there is some possibility that liquefaction may have occurred at some depth below the ground surface but its effects were not evidenced at the ground surface. Viewed in this light the data points shown in Fig. 10 may be considered good confirmatory evidence of the position of the boundary line shown for sandy sites and Magnitude 7-1/2 earthquakes. A plot of all data from Figs. 9 and 10 is shown in Fig. 11, which thus represents a comprehensive summary of available results.

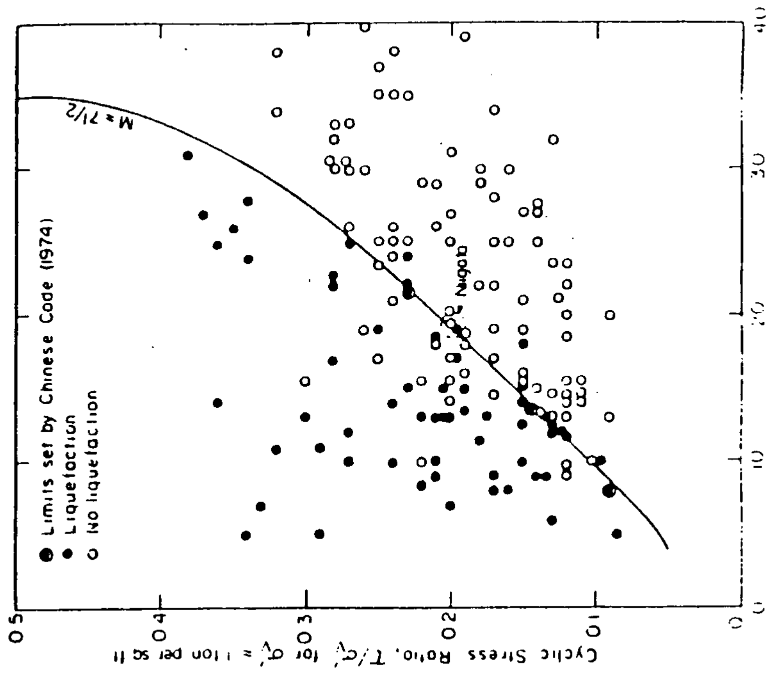
The study by Tokimatsu and Yoshimi also presented an extensive set of data points for silty sands (D_{50} < 0.15 mm). While it has been suspected for some time that silty sands are less vulnerable to liquefaction than sands with similar penetration resistance values, this is the first set of data to provide definitive field evidence that this is in fact the case. The data for silty sands, for sites which liquefied and sites with no apparent liquefaction are presented in the same form as the data in Figs. 5 to 11 in Fig. 12. Also shown in the figure are a reasonable boundary separating sites where liquefaction occurred and sites where no liquefaction occurred for these silty sand deposits, and the boundary line from Fig. 11. It may be seen that the boundary line for silty sands is significantly higher than the boundary for sandy soils, though the two boundaries are essentially parallel. In fact for any value of stress ratio, the normalized standard penetration resistance for sands with D_{50} > 0.25 mm is essentially equal to that for silty sands (D_{50} < 0.15 mm) plus 7.5. It may be concluded therefore that the boundary previously established for sands can be used for silty sands provided the N_1 value for the silty sand site is increased by 7.5 before entering the plots. This correction can have a very significant effect on liquefaction evaluations for silty sand deposits.

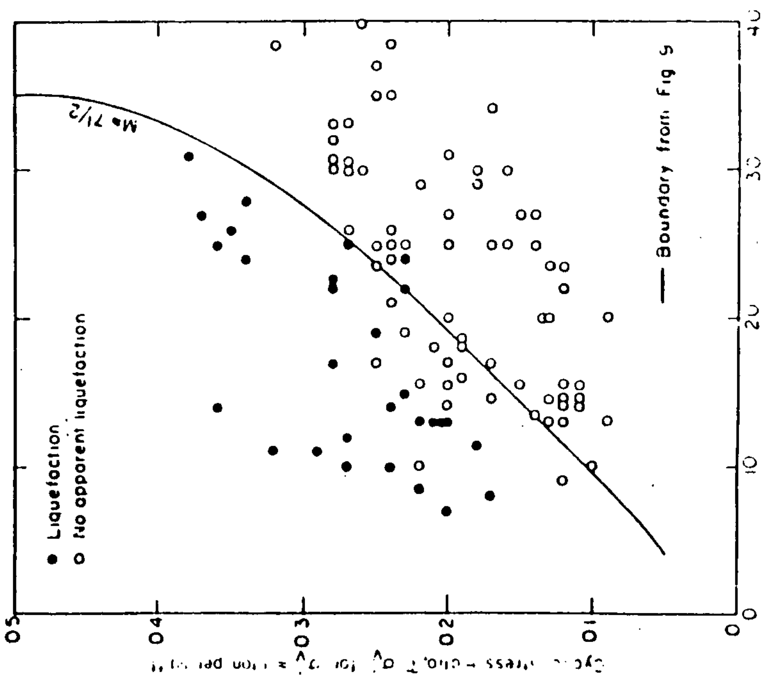
Correlations for Different Magnitude Earthquakes

The preceding results provide a realistic basis for developing correlations between standard penetration tests and the liquefaction characteristics of sands and silty sands for Magnitude 7-1/2 earthquakes. These results can be extended to other magnitude events by noting that from a liquefaction point of view, the main difference between different magnitude events is in the number of cycles of stress which they induce. Statistical studies (22) show that the number of cycles representative of different magnitude earthquakes is typically as shown in the following table:

Magnitude	No. of representative cycles at 0.65 τ_{max}
8-1/2	26
7-1/2	15
6-3/4	10
6	5-6
5-1/4	2-3

A representative shape for the relationship between cyclic stress ratio and number of cycles required to cause liquefaction is shown in Fig. 13. If the number of cycles, (15) for a magnitude 7-1/2 event is selected as a basis for comparison, then the relative values of stress ratio required to cause liquefaction for other numbers of cycles may b





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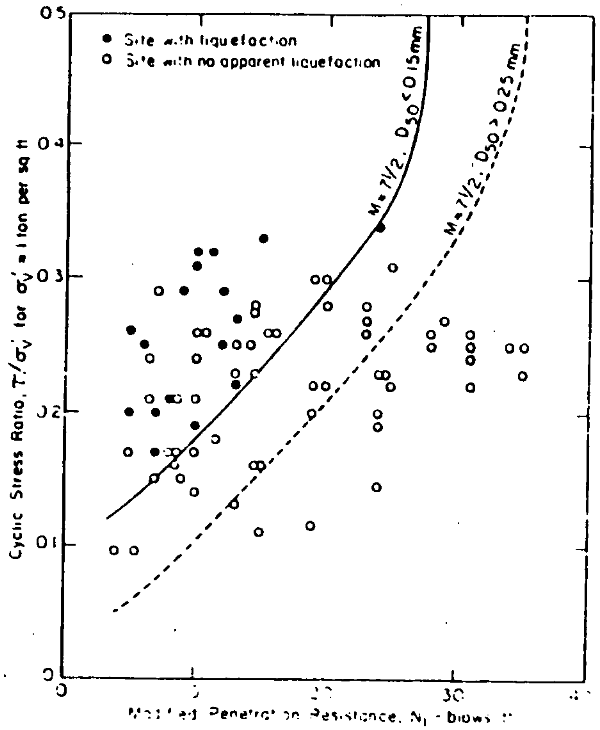
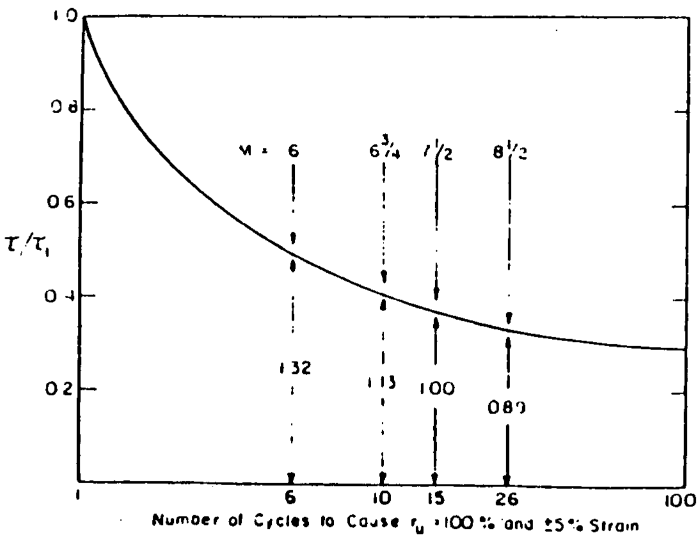


Fig. 12



expressed as ratios of the ordinates of the curve in Fig. 13, relative to the ordinate corresponding to 15 cycles. These ratios are shown directly on the plot and summarized below:

Earthquake Magnitude	No. of Representative Cycles at 0.65 τ_{max}	$\dfrac{(\tau_{av}/\sigma_o')_{M=M}}{(\tau_{av}/\sigma_o')_{M=7.5}}$
8-1/2	26	0.89
7-1/2	15	1.0
6-3/4	10	1.13
6	5	1.32
5-1/4	2-3	1.5

Thus by multiplying the boundary curves in Fig. 11 by the scaling factors shown in column (3) of the above table, boundary curves separating sites where liquefaction is likely to occur or unlikely to occur may be determined for earthquakes with different magnitudes. Such a family of curves for sands is shown in Fig. 14. The same curves may be used for silty sands provided the normalized SPT (N_1) for the silty sand is increased by 7-1/2 before entering the chart.

Liquefaction of Clayey Soils

Both laboratory tests and field performance data have shown that the great majority of clayey soils will not liquefy during earthquakes. However recent studies in China (27) have shown that certain types of clayey materials may be vulnerable to severe strength loss as a result of earthquake shaking. These soils appear to have the following characteristics:

- Percent finer than 0.005 mm < 15%
- Liquid Limit < 35
- Water Content > 0.9 x Liquid Limit

If soils with these characteristics plot above the A-line on the Plasticity chart, the best means of determining their cyclic loading characteristics is by test. Otherwise clayey soils may be considered non-vulnerable to liquefaction.

Determination of Pore Pressure Increase in Sandy or Silty Soils

In some cases it may be desirable to evaluate the potential pore pressure increase due to a given intensity of earthquake shaking in sandy soils. A simple approximate means for accomplishing this is to use the normalized form of pore pressure increase curves proposed by Lee et al. (14) and DeAlba et al. (5), shown in Fig. 15. Experience indicates that for many sands under level ground conditions, the relationship between induced pore pressure ratio (u_g/σ_o') and cycle ratio N_e/N_ℓ, where N_e is the number of equivalent cycles induced by the earthquake and N_ℓ is the

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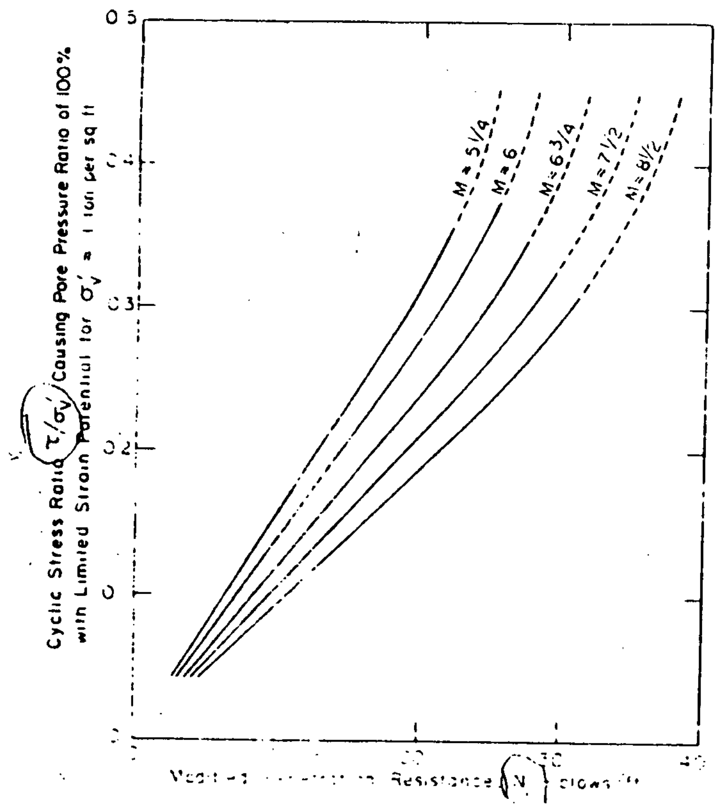
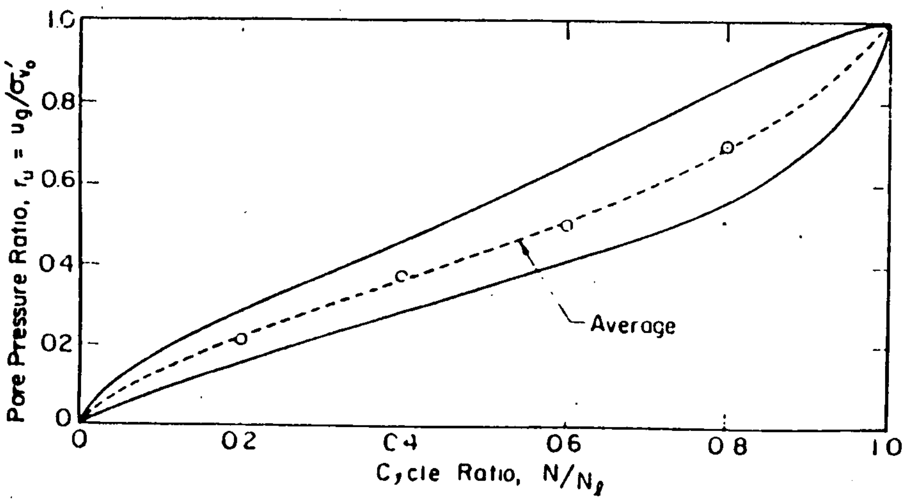


Fig 14



number of such cycles required to cause liquefaction, will lie between the boundaries shown in Fig. 15. Thus if for any given site and any given earthquake magnitude, the factor of safety against liquefaction is determined by the correlation charts to be greater than 1, then the induced pore pressure may be estimated as follows:

(1) Determine the average cyclic stress ratio induced by the earthquake and the factor of safety against liquefaction.

(2) Determine the number of effective stress cycles (at 0.65 τ_{max}) induced by the earthquake (N_e).

(3) Plot the induced effects (induced stress ratio expressed as the ordinate of the curve shown in Fig. 13 divided by the factor of safety versus the number of cycles is a point on Fig. 13).

(4) For the ordinate of the point determined in step (3) above, read off from the curve the number of cycles required to cause liquefaction (N_ℓ).

(5) Hence determine the Cycle Ratio = N_e/N_ℓ.

(6) For the determined value of Cycle Ratio, read off the induced pore pressure ratio, u_g/σ_o', from Fig. 15.

In a recent study, Ishihara (9) measured the pore pressure build-up in a sand deposit in Tokyo Bay resulting from a Magnitude 6 earthquake pro- ducing a maximum ground surface acceleration at the site of [illegible]. The normalized SPT value, N_1, for the silty sand in which pore pressures were measured was 10, and the pore pressure ratio induced by the earth- quake was about 0.15. The pore pressures induced in the deposit, com- puted by the procedure described above lie in the range 0.07 to 0.15, indicating that the method provides useful results for cases of partial pore pressure build-up.

Conclusion

The preceding pages have presented a review of the present status of the empirical method for evaluating the liquefaction resistance of sands and silty sands from measured values of the Standard Penetration Resistance. The method may be summarized in a series of steps as follows:

(1) For soils at depths shallower than 10 ft, multiply measured N values by 0.75 to allow for energy loss in the drive rods.

(2) Convert N values to N_1 values using the C_N correction curves shown in Fig. 4.

(3) For sands with D_{50} > 0.25 mm. use the standard correlation curves for sand shown in Figs. 11 and 14.

(4) For silty sands and silts plotting below the A-line and with D_{50} < 0.15 mm. use

$$N_1 = (N_1)_{measured} + 7.5$$

and use the standard correlation curves for sands.

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(5) If the confining pressure exceeds 1.5 tons/sq ft, reduce the stress ratio causing liquefaction to allow for the reduction due to increased confining pressure. Such reductions may be determined by laboratory tests or on the basis of experience.

(6) Consider some clay soils as potentially liquefiable. Based on the Chinese data these soils would appear to have the following characteristics:

Percent finer than 0.005 mm < 15%

Liquid Limit < 35

Water Content > 0.9 LL

The best way to handle these soils, if they plot above the A-line, would be to determine their liquefaction characteristics by tests.

(7) If the clay content (determined by 0.005 mm) > 20%, consider the soil non-liquefiable.

(8) If the water content of any clayey soil (clay, sandy clay, silty clay, clayey sand, etc.) < 0.9 LL, consider the soil non-liquefiable.

It should be noted that in using this approach with the charts presented, the SPT should be determined in the standard method using a rope and pulley system to lift the falling weight, as described previously. If a free-falling weight is used or if there are other deviations from the test procedure used in determining the N_1 values used in the charts shown, judgment must be exercised to evaluate an appropriate N_1 value for the soil before using the charts.

It may also be noted that the chart shown in Fig. 11 is based entirely on field performance of deposits during actual earthquakes and is thus based on a large number of field case studies. Its extension to silty sands is similarly well supported by field case data. Extension of the chart to earthquakes with magnitudes other than M = 7-1/2 is based on a statistical analysis of many earthquake records and the characteristic shape of a liquefaction curve determined by very large-scale cyclic simple shear tests. As such, it is not believed that the use of the scaling factors indicated by this curve will introduce any serious error in the positions of the family of curves shown in Fig. 14.

Because this empirical approach is founded on such a large body of field data, it is believed by the writer to provide the most useful empirical approach available at the present time. However it should be noted that the Standard Penetration Test cannot be performed conveniently at all depths (say deeper than 100 ft or through large depths of water) or in all soils (such as those containing a significant proportion of gravel particles). Thus, it is desirable that it be supplemented by other in-situ test methods which can also be correlated with soil liquefaction potential. In many cases the Static Cone test, which can be performed more rapidly and more continuously, may provide a good means for evaluating liquefaction potential provided it is correlated on a site dependent basis with SPT results. However this procedure also is limited to sands and silty sands. In dealing with soils containing large particles or in difficult environments, other in-situ characteristics such as the shear wave velocity or the electrical characteristics of the soil may provide a more suitable means for assessment of liquefaction potential. And in due course any or all of these in-situ test methods may have their own detailed correlation with field performance to validate their usefulness as meaningful indicators of liquefaction characteristics. It seems likely however that for onshore sites and with deposits of sand up to 100 ft deep or so, the correlation of liquefaction characteristics with Standard Penetration Test data will provide the most reliable empirical means of evaluating field liquefaction potential for some years to come. Other methods however have a significant role to play and should be developed to the fullest extent possible to provide information for different soil types and environments.

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Job Number: 90-2271
Sheet: - of: -
Calculated By: DWL Date: 12-4-90
Checked By: J Date: 12-7-90
Calculation Number: CCL-CA-352

ATTACHMENT A5

All piping segments begin and end with axial spring constants of 6.3E+08 lb_f/in, and torsional and bending spring constants of 7.6E+10 in-lb_f/rad.

CCL-CA-352

```
*****************************************************************************
*                                                                           *
* ***********  ***********  **      **   *******    *      **    ********   *
* ***********  ***********  **      **  *********   **     **   **********  *
* **                   ***  **      **  **     **   ***    **   **          *
* **                  ***   **      **  **     **   ****   **   **          *
* ***********        ***    *********   *********   *****  **   **  *****   *
* ***********       ***     *********   *********   ** *** **   **  ******  *
* **               ***      **      **  **     **   **  *****   **      **  *
* **              ***       **      **  **     **   **   ****   **      **  *
* **             ***        **      **  **     **   **    ***   **      **  *
* ***********  ***********  **      **  **     **   **     **   **********  *
* ***********  ***********  **      **  **     **   **      *    ********   *
*                                                                           *
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*******************************************************
*                                                     *
*             *** EZHANG RELEASE 8.1 ***              *
*                   COPYRIGHT 1990                    *
* USER:        1                         WA: 3012244  *
*-----------------------------------------------------*
*   CORPORATE CONSULTING AND DEVELOPMENT COMPANY, LTD. *
*                P. O. BOX 12728                      *
*                RESEARCH TRIANGLE PARK,              *
*                N. C. 27709-9998                     *
*******************************************************
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*********************************************
* PROJECT:  90-2271                         *
*                                           *
* TITLE:                                    *
*                                           *
*                                           *
* ANALYSIS BY: D Lindley      DATE: 12-4-90 *
*                                           *
* CHECKED BY:  [signature]    DATE: 12-7-90 *
*********************************************
```

CCL-CA-352

INPUT ECHO

```
SYSTEM 2000000
I 386.4 1 1.33 10E12 10E12 10E12
IDF .9 .6 1 1
N   1     0    15     0  0  0  0  0  0  0  -2 123 -1
N   2     0    81   288  0  0  0  0  0  0  -2 123 -1
N   3     0    81   414  0  0  0  0  0  0  -2 123 -1
N   4     0    81   648  0  0  0  0  0  0  -2 123 -1
N   5     0     0   732  0  0  0  0  0  0  -2 123 -1
N   6     0     0   966  0  0  0  0  0  0  -2 123 -1
N   7     0     0  1200  0  0  0  0  0  0  -2 123 -1
N   8     0     0  1434  0  0  0  0  0  0  -2 123 -1
N   9     0     0  1668  0  0  0  0  0  0  -2 123 -1
N  10     0     0  1902  0  0  0  0  0  0  -2 123 -1
N  11     0     0  2016  0  0  0  0  0  0  -2 123 -1
N  12   108    21  2124  0  0  0  0  0  0  -3 123 -1
N  13   274    21  2290  0  0  0  0  0  0  -3 123 -1
N  14   439    21  2455  0  0  0  0  0  0  -3 123 -1
N  15   605    21  2621  0  0  0  0  0  0  -3 123 -1
N  16   770    21  2786  0  0  0  0  0  0  -3 123 -1
N  17   900    21  2916  0  0  0  0  0  0  -4 123 -1
N  18  1134    21  2916  0  0  0  0  0  0  -4 123 -1
N  19  1368    21  2916  0  0  0  0  0  0  -4 123 -1
N  20  1602    21  2916  0  0  0  0  0  0  -4 123 -1
N  21  1836    21  2916  0  0  0  0  0  0  -4 123 -1
N  22  2070    21  2916  0  0  0  0  0  0  -4 123 -1
N  23  2304    21  2916  0  0  0  0  0  0  -4 123 -1
N  24  2538    21  2916  0  0  0  0  0  0  -4 123 -1
N  25  2772    21  2916  0  0  0  0  0  0  -4 123 -1
N  26  3006    21  2916  0  0  0  0  0  0  -4 123 -1
N  27  3240    21  2916  0  0  0  0  0  0  -4 123 -1
N  28  3474    21  2916  0  0  0  0  0  0  -4 123 -1
N  29  3708    21  2916  0  0  0  0  0  0  -4 123 -1
N  30  3942    21  2916  0  0  0  0  0  0  -4 123 -1
N  31  4176    21  2916  0  0  0  0  0  0  -4 123 -1
N  32  4410    21  2916  0  0  0  0  0  0  -4 123 -1
N  33  4644    21  2916  0  0  0  0  0  0  -4 123 -1
N  34  4878    21  2916  0  0  0  0  0  0  -4 123 -1
N  35  5112    21  2916  0  0  0  0  0  0  -4 123 -1
N  36  5346    21  2916  0  0  0  0  0  0  -4 123 -1
N  37  5580    21  2916  0  0  0  0  0  0  -4 123 -1
N  38  5814    21  2916  0  0  0  0  0  0  -4 123 -1
N  39  6048    21  2916  0  0  0  0  0  0  -4 123 -1
N  40  6282    21  2916  0  0  0  0  0  0  -4 123 -1
N  41  6348    87  2864  0  0  0  0  0  0  -4 123 -1
N  42  6582    87  2864  0  0  0  0  0  0  -4 123 -1
N  43  6816    87  2864 -1 -1 -1 -1 -1 -1
N  44   500    21   500 -1 -1 -1 -1 -1 -1
M   1     1   2     1  44
M   2     2   3     1  44
M   3     3   4     1  44
M   4     4   5     1  44
M   5     5   6     1  44
M   6     6   7     1  44
M   7     7   8     1  44
```

CCL-CA-352


```
M   8   8   9   1  44
M   9   9  10   1  44
M  10  10  11   1  44
M  11  11  12   1  44
M  12  12  13   1  44
M  13  13  14   1  44
M  14  14  15   1  44
M  15  15  16   1  44
M  16  16  17   1  44
M  17  17  18   1  44
M  18  18  19   1  44
M  19  19  20   1  44
M  20  20  21   1  44
M  21  21  22   1  44
M  22  22  23   1  44
M  23  23  24   1  44
M  24  24  25   1  44
M  25  25  26   1  44
M  26  26  27   1  44
M  27  27  28   1  44
M  28  28  29   1  44
M  29  29  30   1  44
M  30  30  31   1  44
M  31  31  32   1  44
M  32  32  33   1  44
M  33  33  34   1  44
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M  35  35  36   1  44
M  36  36  37   1  44
M  37  37  38   1  44
M  38  38  39   1  44
M  39  39  40   1  44
M  40  40  41   1  44
M  41  41  42   1  44
M  42  42  43   2  44
P 1 21.6 1.61 5248 2624 2624 15.7 31.4 31.4 29E6
Q 1 -5 11E6 6E-6 .44 .44 2.27 2.27 30E15
P 2 21.6 1.61 5248 2624 2624 15.7 31.4 31.4 29E6
Q 2  0 11E6 6E-6 .44 .44 2.27 2.27 30E15
X -2 0 5.7E5 5.7E5 10 10 10 10
Y -2 0 10 10 10 10 10 10 0
X -3 0 5.7E5 5.7E5 5.7E5 10 10 10
Y -3 0 10 10 10 10 10 10 0
X -4 0 0 5.7E5 5.7E5 10 10 10
Y -4 0 10 10 10 10 10 10 0
X -5 0 6.3E8 -1 -1 7.6E10 7.6E10 7.6E10
Y -5 2 10E18 10E12 10E12 10E18 7.6E10 7.6E10 10
T H.B. ROBINSON 30 CW-11 UNDERGROUND WATER PIPE
E END GEOM
STATIC
T VERTICAL 4 INCH RELATIVE GROND DISPLACEMENT MIDSPAN
D   1      .00      .00      .00
D   2      .00      .00      .00
D   3      .00      .00      .00
D   4      .00      .00      .00
D   5      .00      .00      .00
```

CCL-CA-352


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D   6     .00     .00     .00
D   7     .00     .00     .00
D   8     .00     .00     .00
D   9     .00     .00     .00
D  10     .00     .00     .00
D  11     .00     .00     .00
D  12     .00     .20     .00
D  13     .00     .50     .00
D  14     .00     .80     .00
D  15     .00    1.10     .00
D  16     .00    1.39     .00
D  17     .00    1.61     .00
D  18     .00    2.00     .00
D  19     .00    2.36     .00
D  20     .00    2.69     .00
D  21     .00    3.00     .00
D  22     .00    3.26     .00
D  23     .00    3.49     .00
D  24     .00    3.68     .00
D  25     .00    3.83     .00
D  26     .00    3.93     .00
D  27     .00    3.99     .00
D  28     .00    4.00     .00
D  29     .00    3.96     .00
D  30     .00    3.88     .00
D  31     .00    3.75     .00
D  32     .00    3.58     .00
D  33     .00    3.37     .00
D  34     .00    3.12     .00
D  35     .00    2.83     .00
D  36     .00    2.51     .00
D  37     .00    2.16     .00
D  38     .00    1.78     .00
D  39     .00    1.39     .00
D  40     .00     .97     .00
D  41     .00     .86     .00
D  42     .00     .43     .00
E END CASE
E END STATIC
COMBINE
T VERTICAL SEISMIC (1/2 SINE WAVE END TO END)
O OUTPUT
C CASE 1 1 1 0
E END OUTPUT
REPORT 1
A CPL
B H.B.ROBINSON
J VERTICAL 4 INCH MIDSPAN DISPLACEMENT OF PIPE RUN
K JOINT MAX. FRACTION = REALATIVE JOINT ROTATION (RAD.)
L JOINT KTRANS=6.3E8 LB/IN  JOINT KTORS,KROT2,KROT3=7.6E10 IN-LB.
M....GROUND SPRING PER 19.5 FT. PIPE SEGMENT SET AT 5.7E5 LB/IN.
M....DISPLACEMENTS ARE IMPOSED ON GROUNDED END OF NODAL GROUND SPRINGS.
E END REPORT
ENDRUN
```

CCL-CA-352

NODAL DATA TABLE

H.B. ROBINSON 30 CW-11 UNDERGROUND WATER PIPE

	--- NODAL COORDINATES ---			--- NODAL WEIGHTS ---		
NODE	X	Y	Z	XWT	YWT	ZWT
1	0.0000E0	1.5000E1	0.0000E0	5.138E3	5.138E3	5.138E3
2	0.0000E0	8.1000E1	2.8800E2	7.328E3	7.328E3	7.328E3
3	0.0000E0	8.1000E1	4.1400E2	6.260E3	6.260E3	6.260E3
4	0.0000E0	8.1000E1	6.4800E2	6.098E3	6.098E3	6.098E3
5	0.0000E0	0.0000E0	7.3200E2	6.098E3	6.098E3	6.098E3
6	0.0000E0	0.0000E0	9.6600E2	8.138E3	8.138E3	8.138E3
7	0.0000E0	0.0000E0	1.2000E3	8.138E3	8.138E3	8.138E3
8	0.0000E0	0.0000E0	1.4340E3	8.138E3	8.138E3	8.138E3
9	0.0000E0	0.0000E0	1.6680E3	8.138E3	8.138E3	8.138E3
10	0.0000E0	0.0000E0	1.9020E3	6.051E3	6.051E3	6.051E3
11	0.0000E0	0.0000E0	2.0160E3	4.663E3	4.663E3	4.663E3
12	1.0800E2	2.1000E1	2.1240E3	6.763E3	6.763E3	6.763E3
13	2.7400E2	2.1000E1	2.2900E3	8.139E3	8.139E3	8.139E3
14	4.3900E2	2.1000E1	2.4550E3	8.139E3	8.139E3	8.139E3
15	6.0500E2	2.1000E1	2.6210E3	8.139E3	8.139E3	8.139E3
16	7.7000E2	2.1000E1	2.7860E3	7.254E3	7.254E3	7.254E3
17	9.0000E2	2.1000E1	2.9160E3	7.266E3	7.266E3	7.266E3
18	1.1340E3	2.1000E1	2.9160E3	8.138E3	8.138E3	8.138E3
19	1.3680E3	2.1000E1	2.9160E3	8.138E3	8.138E3	8.138E3
20	1.6020E3	2.1000E1	2.9160E3	8.138E3	8.138E3	8.138E3
21	1.8360E3	2.1000E1	2.9160E3	8.138E3	8.138E3	8.138E3
22	2.0700E3	2.1000E1	2.9160E3	8.138E3	8.138E3	8.138E3
23	2.3040E3	2.1000E1	2.9160E3	8.138E3	8.138E3	8.138E3
24	2.5380E3	2.1000E1	2.9160E3	8.138E3	8.138E3	8.138E3
25	2.7720E3	2.1000E1	2.9160E3	8.138E3	8.138E3	8.138E3
26	3.0060E3	2.1000E1	2.9160E3	8.138E3	8.138E3	8.138E3
27	3.2400E3	2.1000E1	2.9160E3	8.138E3	8.138E3	8.138E3
28	3.4740E3	2.1000E1	2.9160E3	8.138E3	8.138E3	8.138E3
29	3.7080E3	2.1000E1	2.9160E3	8.138E3	8.138E3	8.138E3
30	3.9420E3	2.1000E1	2.9160E3	8.138E3	8.138E3	8.138E3
31	4.1760E3	2.1000E1	2.9160E3	8.138E3	8.138E3	8.138E3
32	4.4100E3	2.1000E1	2.9160E3	8.138E3	8.138E3	8.138E3
33	4.6440E3	2.1000E1	2.9160E3	8.138E3	8.138E3	8.138E3
34	4.8780E3	2.1000E1	2.9160E3	8.138E3	8.138E3	8.138E3
35	5.1120E3	2.1000E1	2.9160E3	8.138E3	8.138E3	8.138E3
36	5.3460E3	2.1000E1	2.9160E3	8.138E3	8.138E3	8.138E3
37	5.5800E3	2.1000E1	2.9160E3	8.138E3	8.138E3	8.138E3
38	5.8140E3	2.1000E1	2.9160E3	8.138E3	8.138E3	8.138E3
39	6.0480E3	2.1000E1	2.9160E3	8.138E3	8.138E3	8.138E3
40	6.2820E3	2.1000E1	2.9160E3	5.927E3	5.927E3	5.927E3
41	6.3480E3	8.7000E1	2.8640E3	5.927E3	5.927E3	5.927E3
42	6.5820E3	8.7000E1	2.8640E3	8.138E3	8.138E3	8.138E3
43	6.8160E3	8.7000E1	2.8640E3	4.069E3	4.069E3	4.069E3
44	5.0000E2	2.1000E1	5.0000E2	0.000E0	0.000E0	0.000E0
				3.230E5	3.230E5	3.230E5

--NODAL CONSTRAINTS-- BASEPLATE DATA

NODE XT YT ZT XR YR ZR JTYPE BXYZ CALC BANDWIDTH: 12