UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of	)	
	)	
TEXAS UTILITIES ELECTRIC COMPANY, *et al.*	)	Docket Nos. 50-445 and 50-446
	)	
(Comanche Peak Steam Electric Station, Units 1 and 2)	)	(Application for Operating Licenses)

APPLICANTS' STATEMENT OF MATERIAL FACTS AS TO WHICH THERE IS NO GENUINE ISSUE

1. A 1/16 inch gap was designed into each U-bolt restraint on a rigid frame. As a first support design effort, it was viewed that this gap would accommodate the thermal and seismic movement of piping. (The movement due to a seismic event was preliminarily calculated to be very small, *i.e.*, less than 1/32 inch, for almost all piping.) Accordingly, in the initial pipe support design (prior to as-built conditions), all such U-bolts had been considered as only one-way restraints (because the lateral gap was present). Affidavit at 3.

2. As the as-built design review and corresponding pipe support reanalyses were being conducted, Applicants determined that the thermal movement of piping associated with some U-bolt supports would exceed the 1/16 inch gap provided and some seismic movement may exceed 1/32 inch. *Id.*

3 As part of the as-built review program Gibbs & Hill reran the thermal piping analyses at all locations where U-bolts were initially considered as one-way restraints and where the piping thermal movement was equal to or exceeded 1/16 inch. Those reanalyses indicated that even assuming the U-bolt acted as a two-way restraint, the piping stresses would remain well within allowable values. Id. at 4.

4. Applicants decided to replace all U-bolts on rigid frames initially considered as one-way restraints where piping thermal movements were computed to equal or exceed 1/16 inch in the original analysis. Id.

5. There are currently seventy Unit 1 and common U-bolts on rigid frames which were originally modeled as one-way restraints. While the maximum thermal pipe movement associated with each of the seventy U-bolts would not exceed the 1/16 inch design gap, the maximum thermal plus seismic movement of eight would. Id. at 6.

6. To assess the impact on piping analyses of a U-bolt installed in the plant acting as a two-way restraint, Applicants conservatively reanalyzed stress problems associated with the two worst case U-bolts (i.e., those with the maximum combined thermal and seismic movement, CC-X-013-012-A43R and CC-1-007-040-A63R) and a representative sample of other U-bolts initially considered as providing one-way restraints. Id. at 6-7.

The reanalyses reflected that any effects of the U-bolts acting as two-way restraints on piping stresses and associated loads (e.g., nozzle and anchor loads) would be small or negligible and would not result in exceeding allowable stresses or manufacturers' allowable values. Further, the analyses reflected that the effects on other associated piping supports are generally decreases in the loads; where there are increases, they are well within allowables. Id. at 8-10.

7. If maximum thermal and seismic movement were assumed to occur simultaneously, there would be a lateral load (in addition to the load in the normal direction) acting on eight of the 70 U-bolts, noted above. Id. at 10. CASE acknowledges that this lateral load will be small when compared to the load in the normal direction (CASE Findings of Fact at II-3).

8. Applicants commissioned ITT Grinnell to carry out a series of tests on U-bolt capability to carry both normal and lateral loads. The tests reflected that even for lateral displacements exceeding the maximum that could occur, the lateral load would not impair the capability of the U-bolt to carry its load in the normal direction. For example, the tests reflect that even if the maximum seismic plus thermal lateral displacement were to induce a lateral load equal to fifty percent of the rated normal load, the U-bolt would still have more than a factor of 2.5 margin of safety in its normal direction. Id. at 10-11.

9. Using conservative assumptions, it was determined that all of the U-bolts at issue here were well within the manufacturer's interaction formula limits. Id. at 12-15.

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Table 1

Unit 1 and Common Building 1

ALL U-BOLTS ON RIGID FRAMES MODELED AS ONE-WAY RESTRAINTS

	MAXIMUM THERMAL MOVEMENT (IN)	MAXIMUM SEISMIC MOVEMENT (IN)	TOTAL MOVEMENT (IN)	LINE SIZE (IN)	DISTANCE TO NEAREST RIGID SUPPORT IN OPPOSITE DIRECTION
AF-1-038-004-S33R	.002	.0006	.0026	3	1' - 4 1/4"
AF-1-052-035-S62R	.005	.004	.009	4	2' - 9"
AF-1-059-001-S33R	.007	.005	.012	10	1' - 10 11/16"
AF-1-059-003-S33R	.020	.017	.037	8	5' - 2 5/8"
AF-1-067-001-S33R	0.000	.016	.016	3	1' - 9 1/4"
AF-1-098-022-S63R	.031	.004	.035	4	4' - 2 3/16"
AF-1-098-032-S33R	.006	.008	.014	4	3' - 1 1/2"
AF-1-098-700-S33R	.019	.037	.056	4	4' - 0"
AF-1-100-005-S43A	.003	.033	.036	4	1' - 4 1/2"
AF-1-100-007-S53R	0.000	.009	.009	4	0' - 6 1/4"
AF-1-100-009-S53R	.002	.017	.019	4	0' - 11 3/4"
AF-1-100-025-S53R	.003	.031	.034	4	0' - 5"
AF-1-101-003-S33R	.018	.029	.047	4	1' - 5 7/8"
AF-1-101-014-S53R	.001	.022	.023	4	0' - 6 3/4"
BR-X-056-713-A53R	.003	.003	.006	4	0' - 3"
BR-X-162-700-A53R	.029	.025	.054	3	5' - 3 1/4"
CC-1-003-001-A73R	.002	.016	.018	3	4' - 1"
CC-1-005-001-A73R	.019	.022	.041	3	4' - 1"
*CC-1-007-040-A63R	.028	.113	.141	6	5' - 7 1/2"
CC-1-011-023-A53R	.005	.0442	.0492	6	1' - 9"
*CC-1-011-029-A53R	.050	.0668	.1168	6	2' - 0 3/4"
CC-1-065-001-S33R	.013	.003	.016	18	2' - 2 7/16"
CC-1-137-709-E63R	.008	.001	.009	3	5' - 1"
CC-1-146-006-S43R	.004	.0374	.0414	6	4' - 0"
CC-1-146-007-S43R	.008	.0275	.0355	6	2' - 11"
CC-1-148-003-S43R	.013	.0032	.0162	4	1' - 5 7/8"
CC-1-166-005-S43R	.009	.004	.013	4	1' - 4"
CC-2-005-703-A73R	.003	.005	.008	3	3' - 3 1/8"
*CC-2-007-006-A53R	.034	.033	.067	6	6' - 11"
*CC-2-007-007-A53R	.006	.085	.091	6	6' - 11 1/4"
CC-2-020-007-A33R	.001	.0001	.0011	24	1' - 0 1/4"
CC-2-035-712-E33R	.010	.020	.030	6	3' - 8"
CC-2-126-005-F43R	.008	.0261	.0341	12	1' - 3 1/2"
CC-2-126-006-F43R	.006	.039	.045	12	2' - 3 5/8"
CC-2-126-011-F43R	0.000	0.000	0.000	12	0' - 7"
CC-2-164-401-A53R	.001	.001	.002	10	0' - 5 15/16"
*CC-X-013-012-A43R	.038	.1277	.1657	6	7' - 3"
CC-X-021-002-A43R	.014	.0252	.0392	6	3' - 3"
CC-X-023-014-A43R	.003	.0082	.0112	6	1' - 3"
CC-X-025-005-A43R	.014	.0257	.0397	6	11' - 6 1/8"
CC-X-027-008-A43R	.022	.0079	.0299	4	2' - 7"

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Table 1

Unit 1 and Common Building 1

ALL U-BOLTS ON RIGID FRAMES MODELED AS ONE-WAY RESTRAINTS

	MAXIMUM THERMAL MOVEMENT (IN)	MAXIMUM SEISMIC MOVEMENT (IN)	TOTAL MOVEMENT (IN)	LINE SIZE (IN)	DISTANCE TO NEAREST RIGID SUPPORT IN OPPOSITE DIRECTION
AF-1-038-004-S33R	.002	.0006	.0026	3	1' - 4 1/4"
AF-1-052-035-S62R	.005	.004	.009	4	2' - 9"
AF-1-059-001-S33R	.007	.005	.012	10	1' - 10 11/16"
AF-1-059-003-S33R	.020	.017	.037	8	5' - 2 5/8"
AF-1-067-001-S33R	0.000	.016	.016	3	1' - 9 1/4"
AF-1-098-022-S63R	.031	.004	.035	4	4' - 2 3/16"
AF-1-098-032-S33R	.006	.008	.014	4	3' - 1 1/2"
AF-1-098-700-S33R	.019	.037	.056	4	4' - 0"
AF-1-100-005-S43A	.003	.033	.036	4	1' - 4 1/2"
AF-1-100-007-S53R	0.000	.009	.009	4	0' - 6 1/4"
AF-1-100-009-S53R	.002	.017	.019	4	0' - 11 3/4"
AF-1-100-025-S53R	.003	.031	.034	4	0' - 5"
AF-1-101-003-S33R	.018	.029	.047	4	1' - 5 7/8"
AF-1-101-014-S53R	.001	.022	.023	4	0' - 6 3/4"
BR-X-056-713-A53R	.003	.003	.006	4	0' - 3"
BR-X-162-700-A53R	.029	.025	.054	3	5' - 3 1/4"
CC-1-003-001-A73R	.002	.016	.018	3	4' - 1"
CC-1-005-001-A73R	.019	.022	.041	3	4' - 1"
*CC-1-007-040-A63R	.028	.113	.141	6	5' - 7 1/2"
CC-1-011-023-A53R	.005	.0442	.0492	6	1' - 9"
*CC-1-011-029-A53R	.050	.0668	.1168	6	2' - 0 3/4"
CC-1-065-001-S33R	.013	.003	.016	18	2' - 2 7/16"
CC-1-137-709-E63R	.008	.001	.009	3	5' - 1"
CC-1-146-006-S43R	.004	.0374	.0414	6	4' - 0"
CC-1-146-007-S43R	.008	.0275	.0355	6	2' - 11"
CC-1-148-003-S43R	.013	.0032	.0162	4	1' - 5 7/8"
CC-1-166-005-S43R	.009	.004	.013	4	1' - 4"
CC-2-005-703-A73R	.003	.005	.008	3	3' - 3 1/8"
CC-2-007-006-A53R	.034	.033	.067	6	6' - 11"
*CC-2-007-007-A53R	.006	.085	.091	6	6' - 11 1/4"
CC-2-020-007-A33R	.001	.0001	.0011	24	1' - 0 1/4"
CC-2-035-712-E33R	.010	.020	.030	6	3' - 8"
CC-2-126-005-F43R	.008	.0261	.0341	12	1' - 3 1/2"
CC-2-126-006-F43R	.006	.039	.045	12	2' - 3 5/8"
CC-2-126-011-F43R	0.000	0.000	0.000	12	0' - 7"
CC-2-164-401-A53R	.001	.001	.002	10	0' - 5 15/16"
*CC-X-013-012-A43R	.038	.1277	.1657	6	7' - 3"
CC-X-021-002-A43R	.014	.0252	.0392	6	3' - 3"
CC-X-023-014-A43R	.003	.0082	0112	6	1' - 3"
CC-X-025-005-A43R	.014	.0257	.0397	6	11' - 6 1/8"
CC-X-027-008-A43R	.022	.0079	.0299	4	2' - 7"

	MAXIMUM THERMAL MOVEMENT (IN)	MAXIMUM SEISMIC MOVEMENT (IN)	TOTAL MOVEMENT (IN)	LINE SIZE (IN)	DISTANCE TO NEAREST RIGID SUPPORT IN OPPOSITE DIRECTION
CC-X-031-002-A43R	034	.0019	.0359	4	5' - 2"
*CC-X-034-005-A43R	.032	.0337	.0675	4	4' - 9 13/16"
CC-X-039-005-F43R	010	.0031	.0131	12	3' - 7"
CC-X-082-700-A33R	.003	.0159	.0189	24	11' - 8 1/4"
CH-1-240-717-A33R	.002	0.000	.002	3	1' - 3 1/2"
CH-1-249-005-S43R	.001	.018	.019	3	1' - 7"
CH-1-249-010-S33R	001	.018	.019	3	0' - 8 1/2"
CS-1-015-700-S42R	.017	.0086	.0256	3	1' - 5 1/4"
CS-1-076-005-A42R	.039	.002	.041	4	0' - 3"
*CS-1-155-019-S42R	.018	.051	.069	3	3' - 1/2"
CS-1-155-020-S42R	.020	.018	.038	3	3' - 5/8"
CS-1-251-022-S53R	.031	.0272	.0582	3	3' - 3"
CS-1-319-008-S53R	.005	.0099	.0149	3	1' - 1 1/4"
CS-1-454-008-S52R	.004	.0139	.0179	3	0' - 5 3/8"
RH-1-005-008-C42R	.001	.001	.002	3	0' - 5 1/2"
SF-X-005-031-F53R	0.000	.0046	.0046	10	3' - 10"
SF-X-006-010-F53R	0.000	.0039	.0039	10	3' - 10"
SF-X-024-702-A43R	.030	.0194	.0494	4	2' -.9 5/8"
SF-X-034-012-F53R	0.000	.0021	.0021	10	3' - 10"
SI-1-029-055-S32R	0.000	.0273	.0273	24	2' - 11 1/4"
SI-1-031-004-A32R	003	.0028	.0058	12	0' - 8 9/16"
SI-1-039-016-S22R	.002	.005	.007	4	0' - 4 7/8"
SI-1-039-017-S22R	0.000	.018	.018	4	1' - 2 5/8"
SI-1-039-022-S22R	0.000	.016	.016	4	0' - 5 7/8"
SW-2-010-004-A33R	.019	.010	.029	24	1' - 4 5/8"
*SW-2-102-018-A43R	.044	.0347	.0787	10	5' - 6"
SW-2-129-022-A43R	004	.014	.018	10	0' - 6"
SW-2-129-027-A43R	.007	.045	.052	10	1' - 9 1/8"
WP-1-049-700-S43R	.005	.002	.007	3	1' - 1"

* Indicates two-way action

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SUPPORT NUMBER		LOADS 8-16-82 FX	LOADS 8-16-82 FY	LOADS 8-16-82 FZ	LOADS 5-10-84 FX	LOADS 5-10-84 FY	LOADS 5-10-84 FZ	MAX %CHANGE
[illegible]	A		579			519		.2
	B		921			913		.3
	C		1017			1008		.3
CC-X-004-002-A43R	A		255			255		0
	B		353			353		0
	C		394			394		0
CC-X-004-003-A43R	A		357			357		0
	B		602			602		0
	C		639			639		0
CC-X-004-004-A43R	A		421			421		0
	B		807			807		0
	C		972			972		0
CC-X-004-005-A43R	A		340			340		0
	B		551			551		.2
	C		621			621		0
CC-X-004-006-A43R	A		435	25		435	25	0
	B		679	603		679	592	-2
	C		761	755		760	743	-1.6
CC-X-004-007-A43R	A		243			243		0
	B		413			413		0
	C		458			458		0
CC-X-004-008-A43R	A		166	85		166	85	0
	B		475	636		475	626	-1.6
	C		562	784		562	772	-1.6
CC-X-004-009-A43R	A	46			46			0
	B	813			811			-.2
	C	1127			1126			-.09

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SUPPORT NUMBER		LOADS 8-16-82 FX	FY	FZ	LOADS 5-10-84 FX	FY	FZ	MAX %CHANGE
CC-X-004-010-A43R	A			120			120	0
	B			635			613	-3.5
	C			752			727	-3.4
CC-X-004-011-A43R	A			238			238	0
	B			682			674	-1.1
	C			744			734	-.12
CC-X-004-012-A43R	A	390			390			0
	B	699			693			-.9
	C	786			779			-.9
CC-X-005-001-A43R	A		165			165		0
	B		203			203		0
	C		214			214		0
CC-X-005-002-A43S	A		119			119		0
	B							
	C							
CC-X-005-003-A43R	A							
	B			232			227	-2.2
	C			292			287	-1.7
CC-X-005-004-A43R	A	285			285			0
	B	461			459			-.4
	C	519			518			-.2
CC-X-006-001-A43S	A		199			199		0
	B							
	C							
CC-X-006-002-A43S	A		360			360		0
	B							
	C							

SUPPORT NUMBER		LOADS 8-16-82 FX	LOADS 8-16-82 FY	LOADS 8-16-82 FZ	LOADS 5-10-84 FX	LOADS 5-10-84 FY	LOADS 5-10-84 FZ	MAX %CHANGE
CC-X-006-003-A43R	A	87			87			0
	B	199			196			-1.5
	C	228			226			-0.9
CC-X-013-001-A43R	A		909			909		
	B		1660			1693		2.1
	C		1807			1858		2.8
CC-X-013-002-A43R	A		413			413		0
	B		905			896		-.9
	C		998			992		-.6
CC-X-013-003-A43R	A		507	99		507	99	0
	B		1006	196		997	190	-1.0
	C		1141	222		1131	216	-1.0
CC-X-013-004-A43R	A		413			413		0
	B		780			778		-.2
	C		882			883		+.1
CC-X-013-006-A43R	A		388			388		0
	B		614			615		+.16
	C		659			662		+.45
CC-X-013-009-A43S	A		545			545		0
	B							
	C							
CC-X-013-010-A43R	A	101			101			0
	B	365			384			+5.2
	C	443			485			+9.5
CC-X-013-011-A43R	A		221	186		221	186	0
	B		310	390		299	373	-4.0
	C		334	439		316	419	-4.8

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SUPPORT NUMBER		LOADS 8-16-82 FX	FY	FZ	LOADS 5-10-84 FX	FY	FZ	MAX %CHANGE
* CC-X-013-012-A43R	A		161			161	0	
	B		[illegible]			213	199	
	C		597			232	271	
CC-X-013-013-A43R	A	200	409		200	409		0
	B	432	741		401	738		-2.0
	C	433	320		432	317		-1.6
CC-X-013-014-A43R	A	57			57			0
	B	428			417			-2.6
	C	518			517			-.2
CC-X-013-015-A43R	A	306			306			0
	B	1143			1131			-1.0
	C	1355			1369			+1.0
CC-X-013-016-A43R	A		72	162		72	162	0
	B		321	720		309	693	-3.7
	C		379	850		366	821	-3.4
CC-X-013-017-A43R	A		14	32		14	32	0
	B		128	288		118	266	-7.6
	C		160	260		149	236	-6.7
CC-X-013-018-A43R	A		168	726		168	726	0
	B		351	1520		358	1526	+1.7
	C		388	1680		397	1718	+2.2
CC-X-014-759-A43S	A		272			272		0
	B							
	C							
CC-X-014-791-A43R	A	320			320			0
	B	893			744			-16.7
	C	1045			924			-11.6

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SUPPORT NUMBER		LOADS 8-16-82 FX	FY	FZ	LOADS 5-10-84 FX	FY	FZ	MAX %CHANGE
CC-X-023-001-A43R	A		598			598		0
	B		[illegible]			[illegible]		-.6
	C		2684			2557		-.6
CC-X-023-002-A43R	A		478			478		0
	B		952			855		-10.2
	C		1055			933		-11.6
CC-X-023-003-A43R	A		655			[illegible]		0
	B		1301			[illegible]		-2.1
	C		1413			1380		-2.3
CC-X-023-005-A43R	A		480			480		0
	B		989			931		-5.9
	C		1143			1066		-6.7
CC-X-023-006-A43R	A		402			402		0
	B		834			714		-14.4
	C		941			800		-15.0
CC-X-023-007-A43R	A	2758	452		2758	452		0
	B	5095	989		5105	920	5135	-.1
	C	5573	1122		5586	1040		-.05
CC-X-023-008-A43R	A		207	426		207	426	0
	B		776	1593		751	1542	-3.2
	C		875	1795		839	1722	-4.1
CC-X-023-009-A43R	A		56			56		0
	B		471			413		-12.3
	C		563			497		-11.7
CC-X-023-010-A43R	A		69	142		69	142	0
	B		332	632		[illegible]	656	-3.8
	C		387	793		369	753	-4.5

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		LOADS 8-16-82			LOADS 5-10-84			MAX
SUPPORT NUMBER		FX	FY	FZ	FX	FY	FZ	%CHANGE
	A		160	237		160	237	0
	B		1873	1925	[illegible]	1835	[illegible]	-1.2
CC-023-011-A43R	C		1542	2287	2758 / 2718	1520	[illegible]	-1.4
	A		155			155		0
CC-X-023-012-A43R	B		335			312		-6.9
Node Pt 19921	C		332			357		+7.5
	A	2578			2518			0
CC-X-023-012-A43R	B	4359			4341			-.4
Node Pt 792	C	4739			4717			-.5
	A							
CC-X-023-013-A43R	B			279			159	-43.
	C			350			211	-39.7
	A			326		—	326	
* CC-X-023-014-A43R	B			636		71	613	
	C			700		91	681	
	A			434		—	434	
* CC-X-023-015-A43R	B			835		88	834	
	C			907		107	907	
	A	44			44			0
CC-X-024-002-A43R	B	131			154			-14.9
	C	219			195			-10.9
	A		328			328		0
CC-X-024-003-A43S	B							
Node Pt 9956	C							
	A		548			548		0
CC-X-025-003-A42S	B							
Node Pt 9941	C							

AB-1-65

SUPPORT NUMBER		LOADS 8-16-82 FX	FY	FZ	LOADS 5-10-84 FX	FY	FZ	MAX %CHANGE
CC-X-025-004-A43R	A	56			56			0
	B	333			222			-33.3
	C	392			284			-27.5
* CC-X-025-005-A43R	A		456			456	—	
	B		568			540	203	
	C		596			568	243	
CC-1-106-001-A43R	A		2165			2165		0
	B		2546			2552		+.2
	C		2635			2644		+.3
CC-1-106-002-A43R	A	3251		236	3251		236	0
	B	3378		788	3378		792	~0
	C	3413		905	3413		913	~0
CC-1-120-001-A43R	A		4244			4244		0
	B		4984			4999		+.3
	C		5135			5158		+.4
CC-1-120-002-A43R	A			1119			1119	0
	B			1392			1369	-1.6
	C			1452			1427	-1.7
CC-1-123-001-A43R	A		1992			1992		0
	B		2773			2771		~0
	C		2938			2936		~0
CC-1-123-002-A43R	A			1164			1164	0
	B			2424			2418	-.2
	C			2689			2632	-.3
CC-X-024-004-A43R	A		198			198		0
	B		280			267		-4.6
	C		304			270		-11.2

Seismic Displacements

	ΔX	ΔY	ΔZ
CC-X-013-012-A43R Node Pt. 9850	+0.058 -0.057	0.0 0.0	+0.028 -0.030
CC-X-025-005-A43R Node Pt. 9932	+0.027 -0.026	0.0 -0.001	+0.019 -0.019
CC-X-023-014-A43R Node Pt. 6	+0.011 -0.012	+0.004 -0.010	+0.001 -0.001
CC-X-023-015-A43R Node Pt. 77	+0.014 -0.014	+0.006 -0.011	+0.001 -0.001

Gibbs & Hill, Inc. Job No. 11-2323-030 Client TUSI-CPSES

Subject As-Built Stress Verification-Analysis Results-Maximum Stress

Calculation Number Problem AB-1-065 Sheet No. 20

Revision	Orig. Issue	Date	Rev.	Date	Rev.	Date	Rev.	Date	Rev.	Date
Checking Method	1									
Preparer	I.J.P.	7/27/82								
Checker	W.B.W.	7/28/82								

AB-1-65 WITHOUT U-BOLT LATERAL STIFFNESS PER Q.A BOOK

MAXIMUM STRESS RESULTS

Plant Condition	Equation	Allowable Stress (1)	Calculated Stress	Node	S.I.F.	Description
Normal and Upset	8	S_h 15000	2457	937	3.26	Unreinforced Branch connex
Normal and Upset	9	$1.2\ S_h$ 18000	14698	989	1.699	Elbow
Emergency	9	$1.8\ S_h$ 27000	17582	989	1.699	Elbow
Faulted	9	$2.4\ S_h$ 36000	Faulted Equation 9 is bounded by Emergency Equation 9			
Normal and Upset	10 (2)	S_A 22500	15812	914	7.44	45° Lateral tee connex
Normal and Upset	11	$S_A + S_h$ 37500	17514	914	7.44	45° Lateral tee connex.

(1) Piping Material: SA-106 Gr. B

Design Temperature: 200°F

Note: A separate maximum stress sheet should be used for each piping material within a problem.

(2) Based upon reference 11, equation 10 may be exceeded if equation 11 is satisfied.

Checking Method # 1

1. Line-by-line checking
2. Alternative Calculation Results compared
3. Manual Calculation Results compared
4. Compare inputs and results of computer with corresponding inputs and results of similar codes

F-166, 4-81

Gibbs & Hill, Inc. Job No. 11-2323-030 Client TUSI-CPSES

Subject As-Built Stress Verification-Analysis Results-Maximum Stress

Calculation Number Problem AB-1-65 Sheet No. × TEST RJ

Revision	Orig. Issue	Date	# Rev.	Date	Rev.	Date	Rev.	Date	Rev.	Date
Sheets Affected			1							
Preparer			JSA	5/7/84						
Checker			[illegible]	5/7/84						

AB-1-65 WITH U-BOLT LATERAL STIFFNESS PER COMPUTER ANALYSIS J219 dtd. May 8, 1984 : OUTPUT TAPE 715176/021

MAXIMUM STRESS RESULTS

Plant Condition	Equation	Allowable Stress (1)	Calculated Stress	Node	S.I.F.	Description
Normal and Upset	8	S_h 15,000.0	2457.0	937	3.26	Unreinforced Branch connection
Normal and Upset	9	$1.2\ S_h$ 18,000.0	14686.0	989	1.699*	ELBOW
Emergency	9	$1.8\ S_h$ 27,000.0	17566.0	989	1.699*	ELBOW
Faulted	9	$2.4\ S_h$ 36000.0	FAULTED CONDITION EQUATION 9 IS BOUNDED BY EMERGENCY CONDITION EQUATION 9			
Normal and Upset	10 (2)	S_A 22500.0	15812.0	914	7.44	45° Lateral TEE CONNECTION
Normal and Upset	11	$S_A + S_h$ 37500.0	17515.0	914	7.44	45° Lateral TEE CONNECTION

(1) Piping Material: SA-106 Gr. B

Design Temperature: 200°F

Note: A separate maximum stress sheet should be used for each piping material within a problem.

(2) Based upon reference 11, equation 10 may be exceeded if equation 11 is satisfied.

* S.I.F. = 0.75i = (0.75)(2.266) = 1.699 FOR EQUATION 9

Checking Method #

1 [illegible]
2 [illegible]
3 [illegible]
4 [illegible]

Gibbs & Hill, Inc. Job No. 2323 Client TUSI-CPSES

Subject AS-BUILT STRESS VERIFICATION -ANALYSIS RESULTS-ANCHOR/NOZZLE/PENE.

Calculation Number PROBLEM AB-1-65 Sheet No. ORIGINAL RUN RESULTS

Revision	Original Issue	Date	Rev.	Date	Rev.	Date	Rev.	Date	Rev.	Date
			1							
Preparer			SA	3/17/84						
Checker			[illegible]	3/17/84						

BRP/OTHER CC-X-AB-012A NODE: 9945 (" NOZZLE) IDENT: EVAP. CONDENSER TBX-WPEVND-02

	NORMAL		UPSET		EMERGENCY		FAULTED	
	AS-BU.	ALL	AS-BU.	ALLO.	AS-BU	ALLO.	AS-BU.	ALLO.
F_x	42		133		133.		BOUNDED BY	
F_y AXIAL	480.		520.		529.			
F_z	151.		240.		264.		EMERG.	
FR/Shear	157.		274		305.			
M_x	225		317.		344.			
M_y TOR.	86		178.		209.			
M_z	320		428.		452			
MR/Bend	341		533		568.			

BRP/OTHER CC-X-AB-012B NODE: 9962 4" NOZZLE IDENT: DIST. COOLER TBX-WPEVND-02

	NORMAL		UPSET		EMERGENCY		FAULTED	
	AS-BU.	ALL	AS-BU.	ALLO.	AS-BU	ALLO.	AS-BU.	ALLO.
F_x	33		119		145.		BOUNDED BY	
F_y AXIAL	21.		78		97.			
F_z	65.		101		113.		EMERG.	
FR/Shear	73.		156.		184.			
M_x	303.		430.		468.			
M_y Torsion	154.		214		225.			
M_z	13		45.		56.			
MR/Bend	303		432.		471.			

Notes: 1) Forces are in lbs, moments in Ft-lbs
2) For allowable loads see ____ (3) For anchors, complimentary problem results must be tabulated

Checking Method # [illegible]

F-166, 4-81

AB-1-65 WITHOUT U-BOLT LATERAL STIFFNESS - PER Q.A. BOOK

Gibbs & Hill, Inc. Job No. 2323 Client TUSI-CPSES

Subject AS-BUILT STRESS VERIFICATION -ANALYSIS RESULTS-~~ANCHOR~~/NOZZLE/~~SPEC~~.

Calculation Number PROBLEM AB-1-065 Sheet No. ORIGINAL RUN RESULTS

Revision	Original Issue	Date	Rev.	Date	Rev.	Date	Rev.	Date	Rev.	Date
Checking Method	1	X	1	X		X		X		X
Preparer	BKG		JSA	5/17/84						
Checker			[illegible]	5/17/84						

BRP/OTHER CC-X-AB-008 NODE: 9864 (6" NOZZLE) IDENT: EVAP. CONDENSER TBX-WPEVND-01

	NORMAL		UPSET		EMERGENCY		FAULTED	
	AS-BU.	ALL	AS-BU.	ALLO.	AS-BU	ALLO.	AS-BU.	ALLO.
F_x	44	-----	132	-----	-159	-----	BOUNDED	
F_y	388	-----	691	-----	746	-----	BY	
F_z	34	-----	441	-----	516	-----	EMERGENCY	
FR/ Shear	56	-----	460	-----	540	-----	-----	-----
M_x	107	-----	638	-----	735	-----	-----	-----
M_y	143	-----	731	-----	838	-----	-----	-----
M_z	237	-----	576	-----	643	-----	-----	-----
MR/ Bend	260	-----	860	-----	977	-----	-----	-----

BRP/OTHER CC-X-AB-008 NODE: 9873 (4" NOZZLE) IDENT: DIST. COOLER TBX-WPEVND-01

	NORMAL		UPSET		EMERGENCY		FAULTED	
	AS-BU.	ALL.	AS-BU.	ALLO.	AS-BU	ALLO.	AS-BU.	ALLO.
F_x	78	-----	-279	-----	333	-----	-----	-----
F_y	99	-----	162	-----	176	-----	BOUNDED	
F_z	44	-----	106	-----	123	-----	BY	
FR/ Shear	90	-----	298	-----	355	-----	EMERGENCY	
M_x	161	-----	371	-----	429	-----	-----	-----
M_y	64	-----	104	-----	112	-----	-----	-----
M_z	37	-----	121	-----	144	-----	-----	-----
MR/ Bend	165	-----	390	-----	453	-----	-----	-----

Notes: 1) Forces are in lbs, moments in Ft-lbs
2) For allowable loads see ______ (3) For anchors, complimentary problem results must be tabulated

Checking Method #

F-186, 4-81

AB-1-65 WITHOUT U-BOLT LATERAL STIFFNESS PER QA BOOK

Gibbs & Hill, Inc. Job No. 2323 Client TUSI-CPSES

Subject AS-BUILT STRESS VERIFICATION -ANALYSIS RESULTS-ANCHOR/NOZZLE/PENE.

Calculation Number PROBLEM AB-1-65 Sheet No. ORIGINAL RUN RESULTS

Revision	Orig. Issue	Date	Rev. 1	Date	Rev.	Date	Rev.	Date	Rev.	Date
Sticky Seal		X		X		X		X		X
Preparer			[illegible]	5/11/84						
Checker			[illegible]	5/11/84						

BRP/OTHER CC-X-AB-004 NODE: 9804 (4" Nozzle) IDENT: DIST. COOLER TBX-BREVRE

	NORMAL		UPSET		EMERGENCY		FAULTED	
	AS-BU.	ALL	AS-BU.	ALLO.	AS-BU	ALLO.	AS-BU.	ALLO.
F_x	8	—	21.	—	24.	—	BOUNDED	BY
F_y	16.5	—	176.	—	179.	—	—	—
F_z	20	—	52.	—	60.	—	EMERGENCY	
FR/ shear	22	—	56.	—	65.	—	—	—
M_x	125.	—	228.	—	254.	—	—	—
M_y	16.	—	20.	—	21.	—	—	—
M_z	141.	—	188.	—	200.	—	—	—
MR/ Bend	188.	—	296.	—	323.	—	—	—

BRP/OTHER CC-X-AB-004 NODE: 9817 (6" NOZZLE) IDENT: EVAP. CONDENSER TBX-BREVRE-01

	NORMAL		UPSET		EMERGENCY		FAULTED	
	AS-BU.	ALL.	AS-BU	ALLO.	AS-BU	ALLO.	AS-BU.	ALLO.
F_x	60.	—	99.	—	109.	—	—	—
F_y	464.	—	623.	—	668.	—	BOUNDED	BY
F_z	78.	—	110.	—	119.	—	—	—
FR/ Shear	98	—	148.	—	161.	—	EMERGENCY	
M_x	230.	—	414.	—	467.	—	—	—
M_y	107.	—	126.	—	131	—	—	—
M_z	237.	—	363.	—	401	—	—	—
MR/ Bend	328	—	551.	—	616	—	—	—

Notes: 1) Forces are in lbs, moments in Ft-lbs
2) For allowable loads see ______ (3) For anchors, complimentary problem results must be tabulated

Checking Method # [illegible]

F-166, 4-81

AB-1-65 WITHOUT U-BOLT LATERAL STIFFNESS
AS PER QA BOOK

Gibbs & Hill, Inc. Job No. 2323 Client TUSI-CPSES

Subject AS-BUILT STRESS VERIFICATION -ANALYSIS RESULTS-ANCHOR/NOZZLE/PENE.

Calculation Number PROBLEM AB-1-65 Sheet No. *TEST RUN

Revision	Client Issue	Date	Rev.	Date	Rev.	Date	Rev.	Date	Rev.	Date
Project Leader			1							
Preparer			JSA	5/17/84						
Checker			[illegible]	5/17/84						

BRP/OTHER CC-X-AB-12A NODE: 9445 (6" NOZZLE) IDENT: EVAP CONDENSER TBX-WPEVWD-02

	NORMAL AS-BU.	NORMAL ALL	UPSET AS-BU.	UPSET ALLO.	EMERGENCY AS-BU	EMERGENCY ALLO.	FAULTED AS-BU.	FAULTED ALLO.
F_x	48.	----	106.	----	127.	----	BOUNDED BY	
F_y	453.	----	464.	----	468.	----	----	----
F_z	124.	----	200.	----	226.	----	EMERGENCY	
FR/ Shear	133.	----	286.4	----	259.2	----	----	----
M_x	145.	----	283.	----	313.	----	----	----
M_y TORS	69.	----	189.	----	297.	----	----	----
M_z	310.	----	392.	----	423.	----	----	----
MR/ Bend	366.2	----	483.5	----	526.2	----	----	----

BRP/OTHER CC-X-AB-12B NODE: 9412 (4" NOZZLE) IDENT: DIST. COOLER TBX-WPEVWD-02

	NORMAL AS-BU.	NORMAL ALL.	UPSET AS-BU	UPSET ALLO.	EMERGENCY AS-BU	EMERGENCY ALLO.	FAULTED AS-BU.	FAULTED ALLO.
F_x	32.	----	110.	----	138.	----	----	----
F_y AXIAL	19.	----	76.	----	95.	----	BOUNDED BY	
F_z	47.	----	76.	----	88.	----	----	----
FR/ Shear	56.4	----	133.7	----	163.7	----	EMERGENCY	
M_x	241.	----	348.	----	383.	----	----	----
M_y TORSION	120.	----	176.	----	190.	----	----	----
M_z	12.	----	43.	----	54.	----	----	----
MR/ Bend	241.3	----	345.7	----	386.8	----	----	----

Notes: 1) Forces are in lbs, moments in ft-lbs
2) For allowable loads see ______ (3) For anchors, complimentary problem results must be tabulated

Checking Method #

F-186, 4-81

AB-1-65 WITH U-BOLT LATERAL STIFFNESS
JOB# 219 dtd. 5/8/84 OUTPUT TAPE 715176/021

Gibbs & Hill, Inc. Job No. 2323 Client TUSI-CPSES

Subject AS-BUILT STRESS VERIFICATION -ANALYSIS RESULTS-ANCHOR/NOZZLE/PENE.

Calculation Number PROBLEM AB-1-65 Sheet No. # TEST RUN

Revision	Original Issue	Date	Rev. #	Date	Rev.	Date	Rev.	Date	Rev.	Date
Status			1							
Preparer			JSA	5/17/84						
Checker			[illegible]	5/17/84						

BRP/OTHER ~~CC-X-AB-008~~ NODE: ~~9761~~ -6" NOZZLE IDENT: EVAP - CONDENSER ~~TBX-VAFEVWD-01~~

	NORMAL		UPSET		EMERGENCY		FAULTED	
	AS-BU.	ALL.	AS-BU.	ALLO.	AS-BU	ALLO.	AS-BU.	ALLO.
F_x	-52.		147		180.		BOUNDED BY	
F_y	454		494		508.			
F_z	-57.		139.		168.		EMERGENCY	
FR/Shear	97.2		202.3		246.2			
M_x	293.		344.		387.			
M_y Torsion	52		237.		304.			
M_z	181		313.		442.			
MR/Bend	287.2		507.4		587.5			

BRP/OTHER CC-X-AB-008 NODE: 9873 4" NOZZLE IDENT: DIST COOLER TBX-NPEVWD-01

	NORMAL		UPSET		EMERGENCY		FAULTED	
	AS-BU.	ALL.	AS-BU	ALLO.	AS-BU	ALLO.	AS-BU.	ALLO.
F_x	88.		236.		300.			
F_y	102.		159.		174.		BOUNDED BY	
F_z	45.		114.		137.			
FR/Shear	98.8		262.1		329.8		EMERGENCY	
M_x	163.		398.		478.			
M_y Torsion	54.		65.		69.			
M_z	43.		105.		132.			
MR/Bend	168.6		411.6		495.9			

Notes: 1) Forces are in lbs, moments in Ft-lbs
2) For allowable loads see_____ (3) For anchors, complimentary problem results must be tabulated

Checking Method #

F-186, 4-81

AB-1-65 WITH U-BOLT LATERAL STIFFNESS
Job # 219 Dtd. 5/8/84 : OUTPUT TAPE T15176/021

Gibbs & Hill, Inc. Job No. 2323 Client TUSI-CPSES

Subject AS-BUILT STRESS VERIFICATION -ANALYSIS RESULTS-ANCHOR/NOZZLE/PENE.

Calculation Number PROBLEM AB-1-65 Sheet No. * TEST RUN

Revision	Orig. Issue	Date	Rev. *	Date	Rev.	Date	Rev.	Date	Rev.	Date
Checking Method #		X	1	X		X		X		X
Preparer			[illegible]	5/11/84						
Checker			[illegible]	[illegible]						

BRP/OTHER CC-X-AB-04 NODE: 9804 (4" NOZZLE) IDENT: DIST. COOLER TBX-BRBVRE-01

	NORMAL		UPSET		EMERGENCY		FAULTED	
	AS-BU.	ALL	AS-BU.	ALLO.	AS-BU	ALLO.	AS-BU.	ALLO.
F_x	8	—	-20	—	-23	—	BOUNDED	
F_y	165	—	176	—	179	—	BY	—
F_z	20	—	51	—	58	—	EMERGENCY	
FR/ Shear	21.5	—	54.8	—	62.4	—	—	—
M_x	125	—	222	—	247	—	—	—
M_y	16	—	20	—	21	—	—	—
M_z	-141	—	-185	—	-197	—	—	—
MR/ Bend	188.4	—	289.0	—	316.0	—	—	—

BRP/OTHER CC-X-AB-04 NODE: 9817 (6" NOZZLE) IDENT: EVAP. CONDENSER TBX-BRBVRE-01

	NORMAL		UPSET		EMERGENCY		FAULTED	
	AS-BU	ALL	AS-BU	ALLO.	AS-BU	ALLO.	AS-BU.	ALLO.
F_x	-60	—	-97		-108			
F_y	464		623		668	—	BOUNDED	
F_z	78		109		118	—	BY	
FR/ Shear	98.4		146.0		160.0	—	EMERGENCY	
M_x	230	—	414		467		—	—
M_y	107	—	125	—	130		—	—
M_z	-234	—	-362	—	-399	—	—	—
MR/ Bend	328.1	—	550.0	—	614.2	—	—	—

Notes: 1) Forces are in lbs, moments in Ft-lbs
2) For allowable loads see ______ (3) For anchors, complimentary problem results must be tabulated

Checking Method # 1. [illegible] 2. [illegible] 3. [illegible] 4. [illegible]

F-186, 7-81

AB-1-65 WITH U-BOLT LATERAL STIFFNESS
JOB# 219 dtd. 5/8/84 OUTPUT TAPE T15176/021

AB-1-62E Table 3

SUPPORT NUMBER		LOADS 5-21-82 FX	FY	FZ	LOADS 5-10-84 FX	FY	FZ	%CHANGE
CC-1-007-007-A43S	A		337			337		0
	B							
	C							
CC-1-007-013-A43R	A		450			450		0
	B		693			690		-.4
	C		731			728		-.4
CC-1-007-014-A43S	A		322			322		0
	B							
	C							
CC-1-007-015-A43K	A							
	B	1015			1013			-.1
	C	1254			1252			-.1
CC-1-007-016-A43R	A			78			78	0
	B			1370			1340	-2.1
	C			1667			1634	-1.9
CC-1-007-017-A43R	A		622			622		
	B		1601			1469		-8.2
	C		1795			1648		-8.1
CC-1-007-018-A43R	A			4			4	
	B			343			365	6
	C			416			444	6
CC-1-007-019-A43R	A		667			667		
	B		1736			1483		-17
	C		1882			1615		-16
CC-1-007-020-A43R	A			4			4	
	B			683			735	+8
	C			845			908	+8

AB-1-62E

SUPPORT NUMBER		LOADS 5-21-82 FX	LOADS 5-21-82 FY	LOADS 5-21-82 FZ	LOADS 5-10-84 FX	LOADS 5-10-84 FY	LOADS 5-10-84 FZ	%CHANGE
CC-1-007-021-A43R	A		558			558		
	B		1304			1284		-1
	C		1459			1458		-.07
CC-1-007-022-A43R	A		381			381		
	B		626			624		-.3
	C		677			680		+.4
CC-1-007-023-A43R	A			170			170	
	B			580			576	-1
	C			656			647	-2
CC-1-007-024-A43R	A		276			276		
	B		428			425		-.5
	C		458			455		-.4
CC-1-007-025-A43R	A	49			49			
	B	563			721			+29
	C	763			944			+25
CC-1-007-026-A43K	A							
	B			604			614	+2
	C			884			896	+1
CC-1-007-027-A43K	A							
	B	492			540			+10
	C	731			787			+8
CC-1-007-028-A43K	A							
	B		330			327		-.9
	C		441			438		-.7
CC-1-007-029-A43R	A			49			49	
	B			1068			1023	-4.2
	C			1236			1191	-3.6

AB-1-62E

SUPPORT NUMBER		LOADS FX	FY	FZ	LOADS FX	FY	FZ	%CHANGE
CC-1-007-030-A53R	A	159			159			
	B	789			652			-17
	C	941			790			-16
CC-1-007-031-A53S	A		1166			1166		
	B							
	C							
CC-1-007-032-A53R	A			61			61	
	B			969			979	+1
	C			1183			1207	+2
CC-1-007-033-A63R	A	92			92			
	B	878			730			-17
	C	1013			855			-15
CC-1-007-034-A63K	A							
	B			962			889	-8
	C			1158			1090	-6
* CC-1-007-035-A63R	A		526			526		
	B		3396		291	2828	291	
	C		3852		362	3258	362	
CC-1-007-036-A63R	A	50			50			
	B	729			577			-20
	C	835			701			-16
CC-1-007-037-A63R	A		630			630		
	B		1566			1481		-5
	C		1710			1636		-4
CC-1-007-038-A63R	A	11			11			
	B	813			690			-15
	C	988			858			-13

AB-1-62E

SUPPORT NUMBER		LOADS 5-21-82 FX	FY	FZ	LOADS 5-10-84 FX	FY	FZ	%CHANGE
CC-1-007-039-A63R	A		691			691		
	B		1652			2006		+21
	C		1741			2284		+31
* CC-1-007-040-A63R	A	7			7			
	B	1021			812	806		
	C	1228			998	957		
CC-1-007-041-A63R	A		704			704		
	B		1762			1691		-4
	C		1833			1854		+1
CC-1-007-042-A63R	A	20			20			
	B	715			526			-3
	C	848			642			-2
CC-1-007-043-A63R	A			68			68	
	B			2672			2230	-16
	C			2980			2551	-14
CC-1-007-044-A73R	A		1237			1237		
	B		2884			2620		-9
	C		2975			2714		-9
CC-1-007-045-A73R	A	30			30			
	B	1566			1284			-21
	C	1941			1583			-22
CC-1-007-048-A43R	A			50			50	
	B			948			934	-1
	C			1164			1149	-1
CC-1-948-700-A73R	A			44			44	
	B			1014			832	-18
	C			1145			962	-16

AB-1-62E

SUPPORT NUMBER		LOADS 5-21-82			LOADS 5-10-84			
		FX	FY	FZ	FX	FY	FZ	%CHANGE
CC-1-007-704-A43R	A	101			101			
	B	2222			2856			+28
	C	2941			3677			+25
	A							
	B							
	C							
	A							
	B							
	C							
	A							
	B							
	C							
	A							
	B							
	C							
	A							
	B							
	C							
	A							
	B							
	C							
	A							
	B							
	C							
	A							
	B							
	C							

	SEISMIC DISPLACEMENT		
	ΔX	ΔY	ΔZ
CC-1-007-035-A63R	+.06 -.06	+.002 -.002	+.038 -.038
CC-1-007-040-A63R	+.001 -.001	+.067 -.073	+.044 -.044

AB-1-62E WITHOUT U-BOLT LATERAL STIFFNESS PER Q.A. Book

Gibbs & Hill, Inc. Job No. 11-2323-030 Client TUSI-CPSES

Subject AS-BUILT STRESS VERIFICATION -ANALYSIS RESULTS-ANCHOR/NOZZLE/PENE.

Calculation Number PROBLEM AB-1-62E Sheet No. 23

Revision	Original Issue	Date	Rev.	Date	Rev.	Date	Rev.	Date	Rev.	Date
Checking Method #	1									
Preparer	[illegible]	3/27/82								
Checker	[illegible]	3/29/82								

BRP: CC-1-AB-046 NODE: 1359 IDENT: C01-CCATST-01

	NORMAL		UPSET		EMERGENCY		FAULTED	
	AS-BU.	ALL	AS-BU.	ALLO.	AS-BU	ALLO.	AS-BU.	ALLO.
F_x	26.0		522.0		645.0			
F_y (max)	159.0	975.0	749.0	1950.0	786.0	2930.0	-	
F_z	7.0		46.0		56.0			
FR/ Shear	27.0	975.0	524.0	1950.0	647.0	2930 -		
M_x	152.0		760.0		830.0			
M_y (MR)	66.0	2479.0	258.0	4958.0	273.0	7438.0		
M_z	106.0		2309.0		2518.0			
MR/ Bend	240.0	1240.0	2431.0	2479.0	2651.0	3719.0		

BRP: N/A NODE: N/A IDENT: N/A

	NORMAL		UPSET		EMERGENCY		FAULTED	
	AS-BU.	ALL	AS-BU.	ALLO.	AS-BU.	ALLO.	AS-BU.	ALLO.
F_x				SINCE THERE IS NO COMPLIMENTARY				
F_y				PROBLEM, TO F14 THIS PART OF THE				
F_z				TABLE IS NOT REQUIRED!				
FR/ Shear								
M_x								
M_y								
M_z								
MR/ Bend								

Notes: 1) Forces are in lbs, moments in Ft-lbs
2) For allowable loads see Attach. X (3) For anchors, complimentary problem results must be

AB-1-62E WITH U-BOLT LATERAL STIFFNESS PER COMPUTER ANALYSIS J525 dtd. May 7, 1984
OUTPUT TAPE 715176/020

Gibbs & Hill, Inc. Job No. 2323 Client TUSI-CPSES

Subject AS-BUILT STRESS VERIFICATION -ANALYSIS RESULTS-ANCHOR/NOZZLE/PENE.

Calculation Number PROBLEM AB-1-625 Sheet No. * TEST RUN

Revision	Original Issue	Date	Rev	Date	Rev	Date	Rev	Date	Rev	Date	
Checking Method #	X	X	1	X		X		X		X	
Preparer	X	X	JSA	5/17/84							
Checker	X	X	[illegible]	5/17/84							

BRP/~~OTHER~~ CC-1-AB-046 NODE: 1359 IDENT: CPI-CCATSF-01

	NORMAL		UPSET		EMERGENCY		FAULTED	
	AS-BU.	ALL	AS-BU.	ALLO.	AS-BU	ALLO.	AS-BU.	ALLO.
F_x	15 / -23.		457. / -465		554. / -561.		BOUNDED BY EMERGENCY	
F_y (Res)	154 / 67.	~~975~~	627. / -407.	1950.	661. / -441.	2930.		
F_z	8. / -2.		42. / -36.		49. / -48.			
~~FR/~~ shear	243	~~975~~	466.9	1950.	563.1	2930.		
M_x	155 / -103.		620. / -548.		675. / -623.			
M_y (Res)	34 / -63.	2479.	183. / -212.	4958.	195 / -224	7438.		
M_z	192 / 31.		141. / -1732.		2145. / -1915.			
~~MR/~~ Bend	246.7	1240	2056.7	2479.	2242.7	3719.		

BRP/~~OTHER~~ NODE: IDENT:

	NORMAL		UPSET		EMERGENCY		FAULTED	
	AS-BU.	ALL.	AS-BU.	ALLO.	AS-BU	ALLO.	AS-BU.	ALLO.
F_x								
F_y								
F_z								
FR/ Shear								
M_x								
M_y								
M_z								
MR/ Bend								

Notes: 1) Forces are in lbs, moments in Ft-lbs
2) For allowable loads see ______ (3) For anchors, complimentary problem results must be tabulated

Checking Method #

F-186, 4-81

Gibbs & Hill, Inc. Job No. 11-2323-030 Client TUSI-CPSES

Subject As-Built Stress Verification-Analysis Results-Maximum Stress

Calculation Number Problem AB-1-62E Sheet No. 22

Revision	Original Issue	Date	Rev.	Date	Rev.	Date	Rev.	Date	Rev.	Date
Checking Method #	1									
Preparer	[illegible]	03/17/88								
Checker	[illegible]	3/26/88								

AB-1-62E WITHOUT U-BOLT LATERAL STIFFNESS

MAXIMUM STRESS RESULTS

PER Q.A. BOOK

Plant Condition	Equation	Allowable Stress (1)	Calculated Stress	Node	S.I.F.	Description
Normal and Upset	8	S_h 15000	6094.0	325	1.0	CRUN
Normal and Upset	9	$1.2\ S_h$ 18000	8822.0	1349	1.9	CRUN
Emergency	9	$1.8\ S_h$ 27000.	10090.0	1349	1.9	CRUN
Faulted	9	$2.4\ S_h$	FAULTED EQUATION 9 IS BOUNDED BY EMERGENCY EQUATION 9			
Normal and Upset	10 (2)	S_A 22500	3724.0	1322	2.266	ELBOW
Normal and Upset	11	$S_A + S_h$ 37500	8026.0	325	1.0	CRUN

(1) Piping Material: SA-106 Gr. B

Design Temperature: 225°F

Note: A separate maximum stress sheet should be used for each piping material within a problem.

(2) Based upon reference 11, equation 10 may be exceeded if equation 11 is satisfied.

Checking Method # 1. Line-by-line checking 2. Alternate Calculation (results compared)

Gibbs & Hill, Inc. Job No. 11-2323-030 Client TUSI-CPSES

Subject As-built Stress Verification-Analysis Results-Maximum Stress

Calculation Number Problem AB-1-62E Sheet No. TEST RUN

Revision	Orig. Issue	Date	Rev.	Date	Rev.	Date	Rev.	Date	Rev.	Date
Drawing Issue #			1							
Preparer			[illegible]	5/17/84						
Checker			[illegible]	5/17/84						

AB-1-62E WITH U-BOLT LATERAL STIFFNESS PER COMPUTER ANALYSIS J525 dtd May 7, 1984

MAXIMUM STRESS RESULTS

OUTPUT TAPE T15176/020

Plant Condition	Equation	Allowable Stress (1)	Calculated Stress	Node	S.I.F	Description
Normal and Upset	8	S_h 15000.0	2413.0	2315 (END)	1.0	CRUN
Normal and Upset	9	$1.2\ S_h$ 18000.0	7641.0	1331 (BEG)	2.266	ELBOW
Emergency	9	$1.8\ S_h$ 27000.0	9424.0	309 (END)	1.0	CRUN
Faulted	9	$2.4\ S_h$ 36000.0	FAULTED CONDITION EQUATION 9 IS BOUNDED BY EMERGENCY CONDITION EQUATION 9			
Normal and Upset	10 (2)	S_A 22500.0	4782.0	1336 (END)	2.266	ELBOW
Normal and Upset	11	$S_A + S_h$ 37500.0	5922.0	1336 (END)	2.266	ELBOW

(1) Piping Material: SA-106 Gr. B

Design Temperature: 225°F

Note: A separate maximum stress sheet should be used for each piping material within a problem.

(2) Based upon reference 11, equation 10 may be exceeded if equation 11 is satisfied.

AB-2-63B Table 4

SUPPORT NUMBER		LOADS 1-17-83			LOADS 5-11-84			%CHANGE
		FX	FY	FZ	FX	FY	FZ	
	A	3570			3570			
CC2-133-401-A43R	B	11279			11406			+1
	C	12587			12845			+2
	A		3392			3392		
CC2-158-405-A43R	B		6512			6696		+3
	C		7165			7466		+4
	A			321			321	
CC2-158-410-A43R	B			3777			3592	-5
	C			4949			4671	-6
	A		4398			4398		
CC2-158-406-A43R	B		8846			9670		+9
	C		10090			11310		+11
	A			565			565	
CC2-158-411-A43R	B			4514			4631	+3
	C			5846			5932	+1
	A		5953			5953		
CC2-158-403-A43R	B		13028			13234		+2
	C		14267			14560		+2
	A			3022			3022	
CC2-158-409-A43R	B			6567			6642	+1
	C			7522			7558	+.5
	A							
CC2-158-407-A43K	B		4388			4786		+8
	C		5400			5847		+8
	A							
CC2-158-408-A43K	B	5508			5654			+3
	C	7044			7307			+4

AB-2-63B

SUPPORT NUMBER		LOADS 1-17-83 FX	FY	FZ	LOADS 5-11-84 FX	FY	FZ.	%CHANGE
CC2-126-401-A43R	A		2625			2625		
	B		5641			5981		+6
	C		6572			7074		+7
CC2-126-402-A43R	A	152			152			
	B	2844			2847			+.04
	C	3425			3443			+.5
CC2-126-403-A43R	A	116	59		116	59		
	B	1914	975		1835	935		-4.4
	C	2520	1284		2392	1219		-5.4
CC2-126-403-A43R	A		1986			1986		
	B		4250			4512		+6
	C		5212			5568		+6
CC2-126-404-A43R	A							
	B			4672			4993	+6
	C			6158			6706	+8
CC2-126-001-F43R	A	1225			1225			
	B	4157			4321			+4
	C	5008			5237			+4
CC2-126-002-F43R	A		2213			2213		
	B		4901			5333		+9
	C		5818			6396		+9
CC2-126-003-F43R	A		1231			1231		
	B		2856			2617		-8
	C		2969			3000		+1
CC2-126-009-F43R	A			239			239	
	B			1518			1579	+4
	C			1826			1902	+4

AB-2-63B

SUPPORT NUMBER		LOADS 1-17-83 FX	FY	FZ	LOADS 5-11-84 FX	FY	FZ	%CHANGE
* CC2-126-010-F43R	A	624			624			
	B	1998			2545			+21
	C	2353			3180			+26
* CC2-126-011-F43R	A		2242			2242		
	B		3388		61	3553		
	C		3683		73	3957		
CC2-126-004-F43K	A							
	B			2664			2685	+.8
	C			3675			3748	+2
CC2-126-007-F43R	A		2173			2173		
	B		3361			4741		+41
	C		3608			5804		+61
* CC2-126-005-F43R	A	615			615			
	B	2904			3434	952		
	C	3757			4542	1484		
* CC2-126-006-F43R	A	46			46			
	B	2235			2707	318		
	C	2521			3130	387		
CC2-126-008-F43R	A		2821			2821		
	B		5702			6085		+7
	C		6538			7082		+8
CC2-164-403-A53S	A		941			941		
	B							
	C							
CC-2-164-401-A53R	A	1034			1034			
	B	1974			1991			+.8
	C	2441			2455			+.6

*

AB-2-63B

SUPPORT NUMBER		LOADS 1-17-83 FX	FY	FZ	LOADS 5-11-84 FX	FY	FZ	%CHANGE
CC2-164-402-A53R	A			836			836	
	B			1704			1763	+3
	C			2148			2208	+3
CC2-164-404-A63R	A							
	B	464			575			+19
	C	643			772			+17
CC2-164-405-A63R	A			413			413	
	B			953			1047	+9
	C			1163			1246	+7
CC2-164-406-A63R	A		6073			6073		
	B		8920			9415		+5
	C		9871			10351		+5
CC2-164-407-A63R	A							
	B	2189			3014			+27
	C	2659			3508			+24
CC2-164-408-A63R	A			177			177	
	B			1064			1170	+9
	C			1444			1561	+7
CC2-164-409-A63R	A		1418			1418		
	B		2088			2239		+7
	C		2267			2420		+6
CC2-164-410-A63R	A			356			356	
	B			1637			1875	+13
	C			2064			2276	+10
CC2-164-411-A63R	A		1545			1545		
	B		2401			2465		+3
	C		2597			2695		+4

AB-2-63B

SUPPORT NUMBER		LOADS 1-17-83 FX	FY	FZ	LOADS 5-11-84 FX	FY	FZ	%CHANGE
CC2-164-412-A63R	A		924	833		924	833	
	B		1653	1491		1782	1606	+8
	C		1969	1775		2158	1946	+10
CC2-164-414-A63R	A		35	69		35	69	
	B		590	1151		660	1289	+12
	C		833	1635		944	1842	+13
CC2-164-415-A63R	A		1746			1746		
	B		3115			3102		-.4
	C		3718			3693		-.7
CC2-164-416-A63R	A			495			495	
	B			1495			1547	+3
	C			1779			1825	+3
CC2-164-417-A63R	A	5168			5168			
	B	7504			7825			+4
	C	8202			8508			+4
Node Point 1853	A		2284			2284		
	B		3144			3159		+.5
	C		3460			3483		+.7
	A							
	B							
	C							
	A							
	B							
	C							
	A							
	B							
	C							

SEISMIC DISPLACEMENT

SUPPORT NUMBER	ΔX	ΔY	ΔZ
~~CC-2-126-010-F43R N.P. 730~~	~~+.113 -.113~~	~~+.213 -.214~~	~~+.139 -.140~~
CC-2-126-011-F43R N.P. (x) 6	+.113 -.113	+.218 -.217	+.147 -.147
N.P. (Y) 4	+.123 -.122	+.212 -.212	+.139 -.139
CC-2-126-005-F43R N.P. (x) 14	+.113 -.113	+.027 -.028	+.173 -.174
N.P (Y) 10	+.118 -.118	+.212 -.212	+.166 -.166
CC-2-126-006-F43R N.P. (x) 22	+.113 -.113	+.235 -.235	+.166 -.165
N.P. (Y) 18	+.117 -.117	+.212 -.212	+.172 -.172

Gibbs & Hill, Inc. Job No. 11-2323-030 Client TUSI-CPSES

Subject As-Built Stress Verification-Analysis Results-Maximum Stress

Calculation Number Problem AB-2-63B Sheet No. 14

Revision	1	Date	Rev	Date	Rev	Date	Rev	Date	Rev	Date
Preparer	BG, 10	1/3/83								
Checker	BRG	1/5/83								

AB-2-63B WITHOUT U-BOLT LATERAL STIFFNESS

MAXIMUM STRESS RESULTS

PER Q.A BOOK OF AB-2-63B

Plant Condition	Equation	Allowable Stress (1)	Calculated Stress	Node	S.I.F.	Description
Normal and Upset	8	S_h 15000	4763	710 (BEG)	2.954	TEE
Normal and Upset	9	$1.2\ S_h$ 18000	13697	812 (END)	3.07	WELDOLET
Emergency	9	$1.8\ S_h$ 27000	15417	812 (END)	3.07	"
Faulted	9	$2.4\ S_h$ 36000	BOUNDED BY EMERGENCY CONDITION			
Normal and Upset	10 (2)	S_A 22500	14485	852 (BEG)	2.605	ELBOW
Normal and Upset	11	$S_A + S_h$ 37500	15796	"	"	"

(1) Piping Material: SA-106 GR. B

Design Temperature: 225 °F

Note: A separate maximum stress sheet should be used for each piping material within a problem.

(2) Based upon reference 11, equation 10 may be exceeded if equation 11 is satisfied.

Gibbs & Hill, Inc. Job No. 11-2323-030 Client TUSI-CPSES

Subject As-Built Stress Verification-Analysis Results-Maximum Stress

Calculation Number Problem AB-2-63B Sheet No.* TEST RUN

Revision	Orig. Rev.	Date	Rev.#	Date	Rev.	Date	Rev.	Date	Rev.	Date
Orig. Issue			1							
Preparer			[illegible]	5/17/84						
Checker			[illegible]	5/17/84						

AB-2-63B WITH U-BOLT LATERAL STIFFNESS PER COMPUTER ANALYSIS J 746 dtd May 9, 1984 OUTPUT TAPE T15176/022

MAXIMUM STRESS RESULTS

Plant Condition	Equation	Allowable Stress (1)	Calculated Stress	Node	S.I.F.	Description
Normal and Upset	8	S_h 15,000.0	4763.0	710 BEG	2.954	TEE
Normal and Upset	9	1.2 S_h 18,000.0	13,900.0	812 END	3.07	WELDOLET
Emergency	9	1.8 S_h 27,000.0	15670.0	812 END	3.07	WELDOLET
Faulted	9	2.4 S_h 36,000.0	FAULTED CONDITION EQUATION 9 IS BOUNDED BY EMERGENCY CONDITION EQUATION 9			
Normal and Upset	10 (2)	S_A 22500.0	14485.0	852 BEG	2.605	ELBOW
Normal and Upset	11	$S_A + S_h$ 37500.0	15796.0	852 BEG	2.605	ELBOW

(1) Piping Material: SA-106 Gr. B

Design Temperature: 225 °F

Note: A separate maximum stress sheet should be used for each piping material within a problem.

(2) Based upon reference 11, equation 10 may be exceeded if equation 11 is satisfied.

ANCHOR SUPPORTS

⑥

*

AB-2-63B

SUPPORT NUMBER		LOADS 1-17-83 A	LOADS 1-17-83 B	LOADS 1-17-83 C	LOADS 5-11-84 A	LOADS 5-11-84 B	LOADS 5-11-84 C	% CHAN
CC-2-133-700-A43A	FX	3062	8189	9000	3062	8217	9051	
	FY	14744	19822	20677	14744	20061	21022	
	FZ	1166	5428	6446	1166	5467	6500	
	MX	82092	286248	328596	82092	298380	343476	
	MY	106500	216540	234096	106500	220464	239688	
	MZ	102636	210108	230028	102636	212304	233676	
CC-2-159-700-A43A	FX	2713	6603	10230	2713	6620	10253	
	FY	4177	6963	8986	4177	7201	9214	
	FZ	3184	6060	7733	3184	6135	7820	
	MX	202584	327828	408624	202584	341988	422196	
	MY	283020	414732	531612	283020	415680	532920	
	MZ	46968	181884	307836	46968	183132	309144	
CC-X-022-001-F43A	FX	1330	3803	4252	1330	3760	4197	
	FY	3244	5074	5661	3244	5287	5965	
	FZ	2457	8330	9378	2457	8576	9759	
	MX	64380	391752	444900	64380	409200	471252	
	MY	27456	98100	111492	27456	98304	112680	
	MZ	13416	148560	169008	13416	154836	180780	
CC-X-070-700-A75A	FX	15835	18052	18629	15835	13116	18698	
	FY	5914	8313	8910	5914	8313	8910	
	FZ	166	6816	8634	166	6788	8567	
	MX	22488	324852	394044	22488	325284	394356	
	MY	48540	163260	198492	48540	162744	195852	
	MZ	53436	90912	103296	53436	90972	103332	

Gibbs & Hill, Inc. Job No. Client

Subject

Calculation Number Sheet No.

Revision	Original Issue	Date	Rev.	Date	Rev.	Date	Rev.	Date	Rev.	Date	
Checking Method #											
Preparer											
Checker											

AB-1-62E.

BRH	NODE	W/O U-BOLTS			W. U-BOLTS.		
		FX	FY	FZ	FX	FY	FZ
CC-1-007-035-A63R	335		29/-52		890/-500	37/-65	890/-500
CC-1-007-040-A63R	342	6/-4			20/-35	40/-72	

	BRH	NODE	THERMAL DISP W/O U-BOLT		
			DX	DY	DZ
*	CC-1-007-035-A63R	335	.001/-.002		.143/-.256
*	CC-1-007-040-A63R	342		.011/-.092	

STRESSES W/O		STRESSES W/O	
1322	3724	1336	4782
1303	3698	337	4432
1323	3627	337	4432
1421	3566	1323	4219

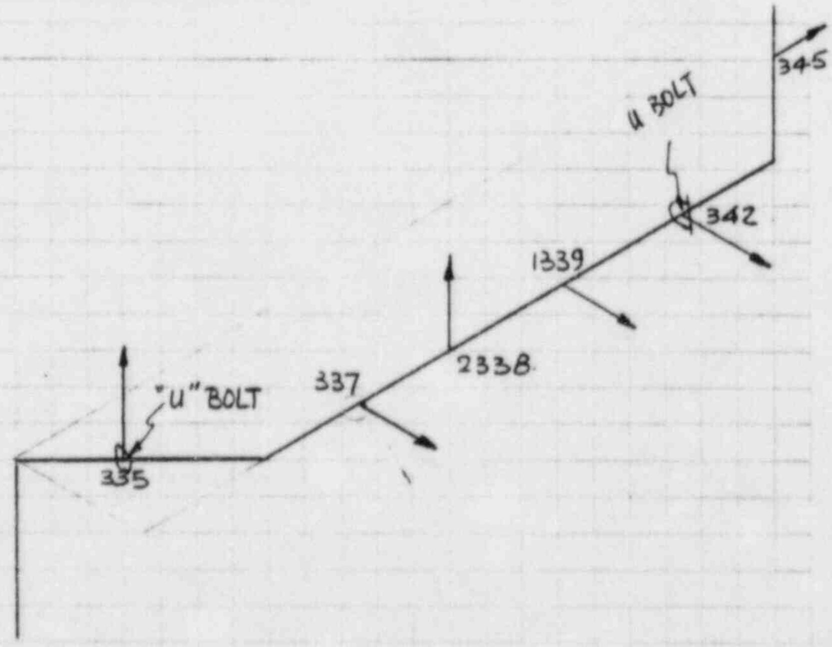

Table 5b
Rev. 3/28/84

Prob. 62E   6"-CC-1-07-152-3

"U" size = 5/8" × 6" , $K_u = 1.31 \times 10^4$, Generic $K = 1 \times 10^6$

"U"-bolt locations:

Node	Mark No.	Direction	Load Max. Pos		Load Max. Neg.		STRESS	COMMENTS
			x	z	x	z		
335	CC-1-007-035-A63R	skew horizontal	890	890	-500	-500	1023	
342	CC-1-007-040-A63R	Y	40		-72		423	

Eq. 10 (thermal stress), 4 highest values:

w/o 'U'-bolts

Node	stress
1322	3724 psi
1303	3698 ↓
1323	3627
1421	3566

with 'U'-bolts

Node	stress
1336	4782 psi
337	4432 ↓
337	4432
1323	4219

Anchor loads.

Node No.		Thermal max. positive Fx	Fy	Fz	Mx	My	Mz	Thermal max negative Fx	Fy	Fz	Mx	My	Mz
510	(with)	0	24	0	0	4	73	-130	-0	-167	-228	0	0
	(w/o)	0	24	0	0	4	72	-130	-0	-167	-228	0	0
1359	(with)	14	32	6	164	35	99	-24	-56	-3	-93	-62	-56
	(w/o)	15	33	6	159	37	104	-28	-58	-3	-90	-65	-59

Table 6

Gibbs & Hill, Inc. Job No. Client

Subject

Calculation Number Sheet No.

Revision	Original Issue	Date	Rev.	Date	Rev.	Date	Rev.	Date	Rev.	Date	
Checking Method #											
Preparer											
Checker											

AB-1-62F

BRH	NODE	W/O U-BOLT			W. U-BOLT			
		FX	FY	FZ	FX	FY	FZ	
CC-1-011-006-A63R	267		255/-453		267/-477	309/-549		
-029-	260			12/-21		408/-228	17/-30	
-026-	250	44/-22			45/-23	3/-		
-024-	245			5/-4		-/-9	6/-6	
-023-	2242			17/-40		-/-3	16/-40	
-021	1239			40/-18		27/-	40/18	

BRH	NODE	THERMAL DISP W/O U-BOLT		
		DX	DY	DZ
x CC-1-011-006-A63R	267	.054/-.03	-	
-029-	260		.021/-.037	
-026-	250		-.001	
-024-	245		.002/-	
-023-	2242		.001/-	
-021-	1239		-.005	

W/O NODE	W/O STRESSES	W. NODE	W. STRESSES
1271	6632	1270	6845
1270	6128	1271	6676
5272	6128	5272	5812
5273	5381	5273	5456
267	1664	267	1518
260	669	260	1198

Checking Method #
1. Line-by-line checking
2. Alternative Calculation Results compared
3. Identical Calculation Results compared
4. Compare inputs and results of computer with corresponding inputs and results of similar codes.

F-166, 7-82

Gibbs & Hill, Inc. Job No. Client

Subject

Calculation Number Sheet No.

Revision	Original Issue	Date	Rev.	Date	Rev.	Date	Rev.	Date	Rev.	Date
Checking Method #										
Preparer										
Checker										

AB-1-65

BRH	NODE	w/o U BOLT			w. U BOLT			
		Fx	Fy	Fz	Fx	Fy	Fz	
CC-X-013-012-A43R	9850		1/-5			65/-115	140/-80	
CC-X-023-015-A43R	77			246/-434		1/0	254/-449	
CC-X-023-014-A43R	6			321/-181		1/0	350/-197	
CC-X-025-005-A43R	9932	141/-251				114/-202	42/-75	

BRH	Th. DISP w/o U BOLT		
	Dx	Dy	Dz
CC-X-013-012-A43R	.019/-.032	–	.024/-.043
CC-X-023-015-A43R	.037/-.066	–	–
CC-X-023-014-A23R	.011/-.019	–	–
CC-X-025-005-A43R	.009/-.016	–	.018/-.01

w/o 'U' Bolt		w. U BOLT	
NODE	STRESS	NODE	STRESS
914	15812	914	15812
913	13702	913	13703
9917	12465	9917	12541
1414	10352	1414	10352
77	1884	77	1944
6	1191	6	1413

Checking Method #
1. Line-by-line checking
2. Alternative Calculation Results compared
3. Identical Calculation Results compared
4. Compare inputs and results of computer with corresponding inputs and results of similar codes.

. . ATT: J. FINNERAN / H. MENTEL

Table 8

Gibbs & Hill, Inc. Job No. 002323-030 Client TUSI

Subject. STUDY OF THE LOADS, MUTS AND STRESSES

Calculation Number PROB 1-62E Sheet No. 1&2 OF 6

Revision	Original Issue	Date	Rev.	Date	Rev.	Date	Rev.	Date	Rev.	Date
Checking Method #	1									
Preparer	PJ	5.10.84								
Checker	CSV	5.10.84								

~~(struck-out text)~~

SPG. HGR. SUMMARY ½ SSE + SAM / SSE + FSAM

NODE	Fx (lbs)	Fy	Fz	Dx (in.)	Dy	Dz	
335		2870 / 3326		0.071 / 0.088	0.003 / 0.003	0.055 / 0.063	w/o U-bolt
342	1014. / 1221.			0.001 / 0.001	0.099 / 0.113	0.052 / 0.059	w/o U-bolt
–							
335	291 / 362	2302 / 2732	291 / 362	0.049 / 0.060	0.002 / 0.003	0.032 / 0.033	w U-bolt
342	805 / 991	806 / 958		0.001 / 0.001	0.062 / 0.073	0.038 / 0.044	w U-bolt

ANCHOR LOAD REPORT ½ SSE + SAM / SSE + FSAM

NODE	Fx (lbs)	Fy	Fz	Mx (ft-lb)	My	Mz	Dx (in)	Dy	Dz	
510	451. / 673	207. / 299.	519 / 767.	1083 / 1572	823 / 1215	1031 / 1544	0.003 / 0.005	0.017 / 0.025	0.026 / 0.038	W/O U-bolt
1359	497. / 619	590. / 627.	39. / 48	607. / 677.	193. / 207.	2123. / 2332.	–	–	–	W/O U-bolt
510	486 / 713	208 / 300	531 / 781	1095 / 1589	840 / 1236	1101 / 1625	0.003 / 0.005	0.017 / 0.025	0.026 / 0.038	W U-bolt
1359	442 / 539	473 / 507	34 / 42	465 / 521	149 / 161	1769 / 1953	–	–	–	W U-bolt
-----										

Highest Stresses (psi)

NODE	σ (N.UPST)	σ (EMG)
1331	7641	8793
309	7502	9424.
1349	7228	8249.
1450	7129	7828.
335	3330	3755.
342	3205	3701.

(w/o U-bolt)

NODE	σ (N.UPST)	σ (EMG)
1349	8822	10090
1331	8679	9715
1450	8627	9419
1351	7526	7882
1324	7336	8784
342	4968	5741

(w. U-bolt)

Checking Method #
1. Line-by-line checking
2. Alternative Calculation Results compared
3. Identical Calculation Results compared
4. Compare inputs and results of computer with corresponding inputs and results of similar codes

F-166, 7-82

Gibbs & Hill, Inc. Job No. 002323-030 Client TUSI

Subject STUDY OF THE LOADS, MVTS AND STRESSES

Calculation Number PROB 1-62F Sheet No. 3 of 6

Revision	Original Issue	Date	Rev.	Date	Rev.	Date	Rev.	Date	Rev.	Date	
Checking Method #	1										
Preparer	RJ	5.10.84									
Checker	CSV	5.10.84									

W/o 'U' BOLT

SPG. HGR. SUMMARY ½ SSE + SAM / SSE + FSAM

NODE	Fx (lbs)	Fy	Fz	Dx (in.)	Dy	Dz
267		853. / 1964.		0.066 / 0.104	0.002 / 0.002	0.017 / 0.029
260			399. / 523.	0.115 / 0.134	0.053 / 0.067	0.0 / 0.001
250	1010. / 1443.			0.001 / 0.001	0.178 / 0.237	0.048 / 0.065
245			1808. / 2535.	0.033 / 0.045	0.112 / 0.144	0.002 / 0.003
2242			600. / 786.	0.032 / 0.044	0.036 / 0.044	0.001 / 0.001
1239			694. / 1068.	0.032 / 0.045	0.079 / 0.092	0.001 / 0.001

ANCHOR LOAD REPORT ½ SSE + SAM / SSE + FSAM

NODE	Fx (lbs)	Fy	Fz	Mx (ft-lb)	My	Mz	Dx (in)	Dy	Dz
541	1073. / 1525.	317. / 419.	575. / 862.	1179. / 1790.	711. / 1212.	2322. / 3335.	0.002 / 0.003	0.001 / 0.002	0.007 / 0.012
1296	95. / 160.	51. / 72.	98. / 128.	123. / 210.	112. / 143.	277. / 448.	–	–	–

HIGHEST STRESSES : (psi)

NODE	σ (N.UPSET)	σ (EMG)
1250	9063	10423
1265	8982	10624
1275	8716	10198
1251	8488	10033
250	5348	6640
2242	4605	5267

Checking Method #
1. Line-by-line checking
2. Alternative Calculation Results compared
3. Identical Calculation Results compared
4. Compare inputs and results of computer with corresponding inputs and results of similar codes.

Gibbs & Hill, Inc. Job No. 002323-030 Client TUSI

Subject STUDY OF THE LOADS, MVTS AND STRESSES

Calculation Number PROB 1-62F Sheet No. 4 OF 6

Revision	Original Issue	Date	Rev.	Date	Rev.	Date	Rev.	Date	Rev.	Date
Checking Method #	1									
Preparer	PJ	5.10.84								
Checker	CSV	5.10.84								

WITH 'U' BOLT

SPG. HGR. SUMMARY ½SSE+SAM / SSE+FSAM

NODE	Fx (lbs)	Fy	Fz	Dx (in.)	Dy	Dz
267	449. / 649.	1591. / 1949.	- / -	0.034 / 0.05	0.002 / 0.002	0.012 / 0.019
260		644. / 768.	391. / 507.	0.109 / 0.127	0.049 / 0.059	- / 0.001
250	720. / 1162.	1134. / 1348.		0.001 / 0.001	0.087 / 0.103	0.038 / 0.053
245		805. / 972.	1599. / 2196.	0.025 / 0.033	0.061 / 0.074	0.002 / 0.002
2242		472. / 579.	596. / 769.	.025 / 0.033	0.036 / 0.044	0.001 / 0.001
1239		767. / 922.	649. / 976.	0.025 / 0.033	0.059 / 0.07	0.001 / 0.001

ANCHOR LOAD REPORT ½SSE+SAM / SSE+FSAM

NODE	Fx (lbs)	Fy	Fz	Mx (ft-lb)	My	Mz	Dx (in)	Dy	Dz
541	1140. / 1585.	317. / 420.	581. / 828.	1191. / 1714.	717. / 1014.	2387. / 3397.	0.002 / 0.003	0.001 / 0.002	0.007 / 0.012
1293	88. / 143.	51. / 70.	87. / 115.	120. / 183.	111. / 141.	259. / 409.	-	-	-

HIGHEST STRESSES: (psi)

NODE	σ (N.UPST)	σ (EMG)
1248	9097	10639.
1265	8529	9840
1275	8503	9937
5284	8083	10608
250	5293	6332
1239	4196	5333.

Checking Method #
1. Line-by-line checking
2. Alternative Calculation Results compared
3. Identical Calculation Results compared
4. Compare inputs and results of computer with corresponding inputs and results of similar codes.

F-166, 7-82

Gibbs & Hill, Inc. Job No. 002323-030 Client TUSI

Subject: STUDY OF THE LOADS, MVTS AND STRESSES

Calculation Number: PROB 1-65 Sheet No. 5 OF 6

Revision	Original Issue	Date	Rev.	Date	Rev.	Date	Rev.	Date	Rev.	Date
Checking Method #	1									
Preparer	RV	5.10.84								
Checker	CSV	5.10.84								

W/o 'U' BOLT

SPG. HGR. SUMMARY 1/2 SSE + ~~SAM~~ / SSE + ~~ESAM~~

NODE	Fx (lbs)	Fy	Fz	Dx (in.)	Dy	Dz
9850		368. / 436.		0.064 / 0.077	0.0 / 0.0	0.108 / 0.128
77			401. / 473.	0.01 / 0.014	0.0 / 0.012	0.0 / 0.0
6			310. / 374.	0.01 / 0.012	0.007 / 0.008	0.0 / 0.0
9932		112. / 140.		0.027 / 0.034	0.0 / 0.0	0.021 / 0.026

ANCHOR LOAD REPORT 1/2 SSE + ~~SAM~~ / SSE + ~~ESAM~~

NODE	Fx (lbs)	Fy	Fz	Mx (ft-lb)	My	Mz	Dx (in)	Dy	Dz
708	858. / 1039.	851. / 1030.	669. / 806.	617. / 746.	3382. / 4067.	1873. / 2267.	—	—	—
937	1525. / 1846.	97. / 117.	431. / 520.	1123. / 1345.	3638. / 4377.	379. / 459.	—	—	—
9804	12. / 15.	11. / 14.	31. / 39.	99. / 125.	5. / 6.	46. / 57.	—	—	—
9817	38. / 48.	159. / 204.	32. / 41.	184. / 237.	19. / 24.	128. / 166.	—	—	—
9864	88. / 115.	303. / 358.	406. / 48?.	531. / 628.	588. / 694.	340. / 406.	—	—	—
9873	201. / 255.	53. / 76.	62. / 79.	210. / 268.	39. / 47.	84. / 107.	—	—	—
9745	91. / 111.	40. / 50.	89. / 112.	91. / 119.	91. / 123.	108. / 182.	—	—	—

HIGHEST STRESSES: (PSI)

NODE	σ (N.UPSET)	σ (EMG)
989	14698	17582
988	13620	16276
986	12748	15228
990	11644	13874
985	11622	13878
987	11503	13719
77	3402	3829

Checking Method #
1. Line-by-line checking
2. Alternative Calculation Results compared
3. Identical Calculation Results compared

Gibbs & Hill, Inc. Job No. 002323-030 Client TUSI

Subject STUDY OF THE LOADS, MNTS AND STRESSES

Calculation Number PROB 1-65 Sheet No. 6 OF 6

Revision	Original Issue	Date	Rev.	Date	Rev.	Date	Rev.	Date	Rev.	Date
Checking Method #	1									
Preparer	PJ	5.10.84								
Checker	CSV	5.10.84								

WITH 'U' BOLT

SPG. HGR. SUMMARY 1/2 SSE ~~FSAM~~ / SSE ~~FFSAM~~

NODE	Fx (lbs)	Fy	Fz	Dx (in.)	Dy	Dz
9850		52. / 70	199. / 271	0.042 / .057	0.0 / 0.0	0.015 / .021
77		88. / 107.	400. / 473.	0.011 / 0.014	0.007 / 0.008	0.0 / 0.0
6		72. / 91.	288. / 346.	0.009 / 0.011	0.005 / 0.007	0.0 / 0.0
9932		84. / 112.	144. / 189	0.02 / 0.026	0.0 / 0.0	0.011 / 0.014

ANCHOR LOAD REPORT 1/2 SSE ~~FSAM~~ / SSE ~~FFSAM~~

NODE	Fx (lbs)	Fy	Fz	Mx (ft-lb)	My	Mz	Dx (in)	Dy	Dz
708	858 / 1039	851 / 1030	668. / 807	619. / 753.	3376. / 4075	1873. / 2267.	-	-	-
937	1528. / 1852.	97. / 117.	432 / 522.	1127. / 1357.	3641 / 4396.	379. / 459.	-	-	-
9804	12. / 15	11. / 14.	31. / 39	97. / 122.	4. / 6	45. / 56.	-	-	-
9817	37 / 47	159. / 204	31. / 41	184 / 237	18. / 24	128. / 165	-	-	-
9864	94. / 128	41. / 54	81 / 111	120 / 163	185 / 252	193. / 261	-	-	-
9873	148 / 212	57. / 72	69 / 92	235. / 314	11 / 15	62. / 89	-	-	-
9945	57. / 79	11 / 15	76 / 101	88 / 117	119. / 157	82. / 113.	-	-	-

HIGHEST STRESSES : (psi)

NODE	σ (N.UPST)	σ (EMG)
989	14686.	17566.
988	13607.	16259
986	12724.	15196.
990	11635	13861
985	11596.	13842
987	11488.	13699.
77	3416.	3843.

Checking Method #
1. Line-by-line checking
2. Alternative Calculation Results compared
3. Identical Calculation Results compared
4. Compare inputs and results of computer with corresponding inputs and results of similar codes.

Attachment 1

TESTING OF FIGURE 137N U-BOLTS

FOR THE

COMANCHE PEAK STEAM ELECTRIC STATION

TEXAS UTILITIES SERVICES INCORPORATED

GLEN ROSE, TEXAS

ITT GRINNELL CORPORATION

PIPE HANGER DIVISION

PIPING/STRUCTURAL ANALYSIS SECTION

PROVIDENCE, RHODE ISLAND

APRIL 16,1984

Product Engineering Report No. 562

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TABLE OF CONTENTS

TEST OBJECTIVE

The purpose of the present tests is the evaluation of the behavior of the ITT Grinnell Figure 137N or equivalent U-bolts used on the Comanche Peak Project, under different loading conditions anticipated during the life of the support.

These loading conditions are summarized below:

Loading Condition 1 (See Figure 1)

The U-bolt is subjected to an initial normal load P_n per ITT Grinnell or NPSI Load Capacity Data Sheets (LCDS) and to a simultaneous uniformly increasing axial load P_a. The axial load will be increased in a controlled manner and the deflection of the U-bolt in the axial direction and change in normal load will be recorded. Failure of the U-bolt to perform it's function and sustain the applied loads in either direction, or the presence of excessive displacements will result in the termination of the test.

Loading Condition 2 (See Figure 2)

The U-bolt is subjected to an initial normal load P_n per ITT Grinnell or NPSI Load Capacity Data Sheets (LCDS) and to a simultaneous uniformly increasing side or lateral load P_s. The side load will be increased in a controlled manner, and the deflection of the U-bolt in the lateral direction and change in normal load will be recorded. Failure of the U-bolt to perform it's function and sustain the applied loads in either direction, or the presence of excessive displacements will result in the termination of the test.

Loading Condition 3 (See Figure 3)

The U-bolt is subjected to a normal load P_n. This normal load will be increased in a controlled manner until failure of the U-bolt occurs in the tensile mode. Elongation of the U-bolt will be recorded.

TEST SET-UP

The RHIELE testing machine located in the Research, Development and Engineering Department of ITT Grinnell in Providence, R.I. will be used for testing the Figure 137N 4" and 24" pipe U-bolts.

The test fixture consists of the lower test stand shown in sketch No. SA-4995-1 (see Appendix III) to support the U-bolt and pipe section. The lower test stand has two different designs, one for the 4" and the other for the 24" pipe U-bolt.

Sketch No. SA-4995-3 (see Appendix III) shows the upper test fixture which consists of a length of structural tubing attached to the upper fixed end of the machine.

The structural tubing supports the pipe and U-bolt under testing, through rods, eye-nuts, clevises and hex nuts (see Sketch No. SA-4995-4 & 5 of Appendix III). This upper test fixture is the same for both the 4" and 24" pipe U-bolts.

In order to generate axial and side loads at the centerline of the pipe, a lateral load base support is used shown in sketch No. SA-4995-2 (see Appendix III). This base support is used for holding the cylinder end of a hydraulic pump that in turn pushes axially or laterally on the pipe through load-inducing columns or rods. The location of this lateral load base support is shown in sketch No. SA-4995-4 & 5 (see Appendix III). It is secured on to the RHIELE testing machine.

In order to allow axial and lateral movements of the pipe, the introduction of pinned-joints was necessary in order to allow rotation (see Detail "A" on Sketch SA-4995-4, Appendix III).

In order to obtain conservative results, the pipe spools used were very stiff in comparison to actual pipes, in the case of the 24" being heavily stiffened with reinforcing circular plates. In utilizing this configuration, minimal energy is dissipated in deforming the pipe spool pieces, the major expension of energy taking place in the U-bolt deformation.

LOADING CONDITION 1

LCD NORMAL LOAD P_N AND AXIAL LOAD P_A

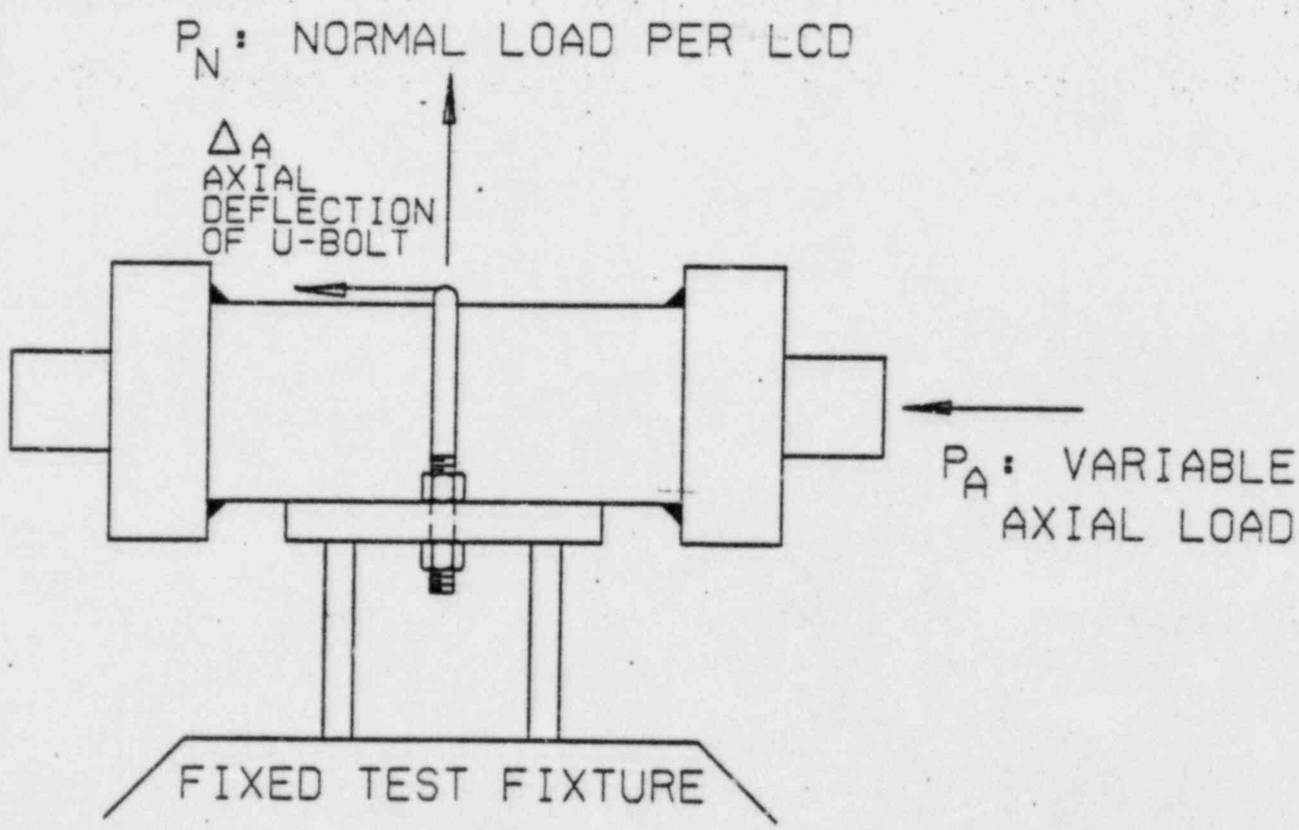


FIGURE 1

LOADING CONDITION 2

LCD NORMAL LOAD P_N AND SIDE LOAD P_S

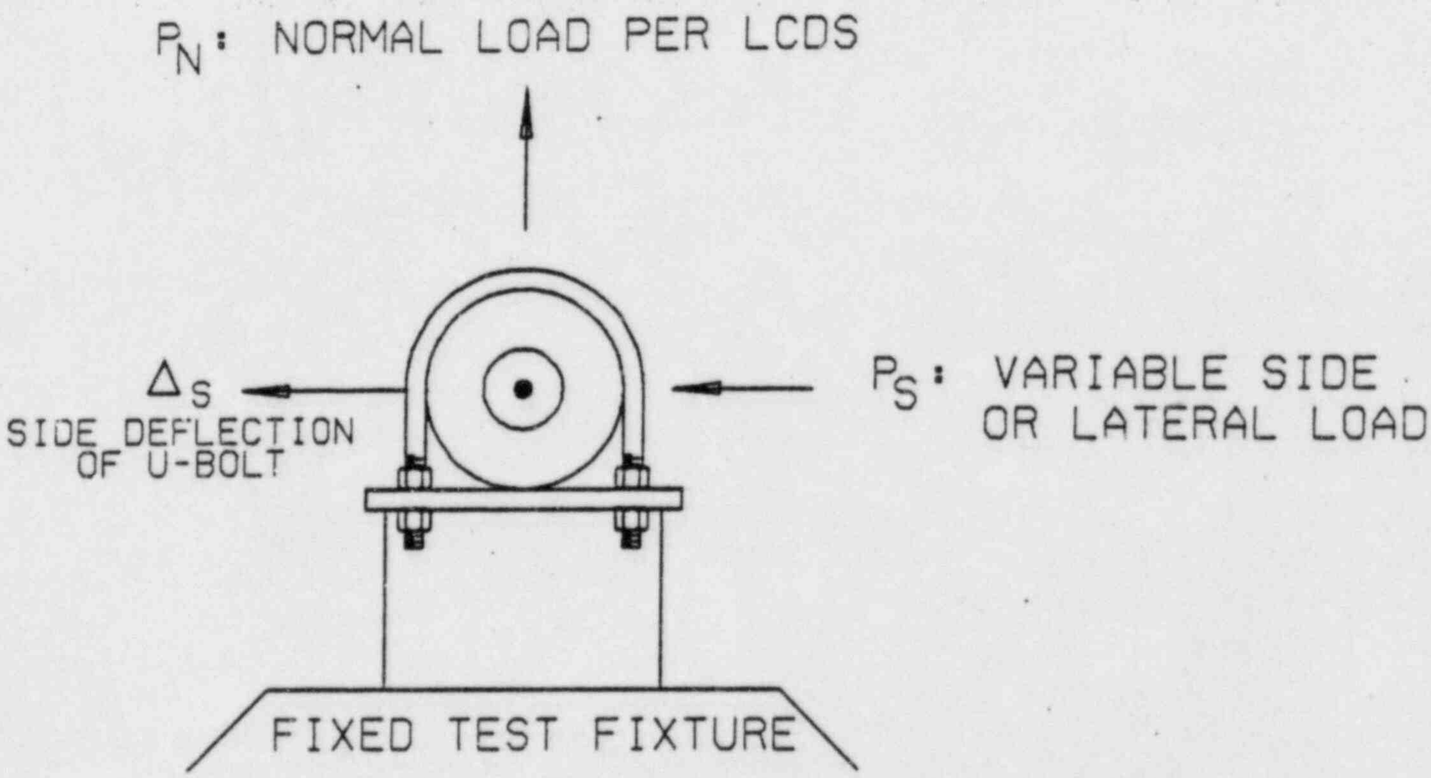


FIGURE 2

LOADING CONDITION 3

NORMAL LOAD P_N TO U-BOLT FAILURE

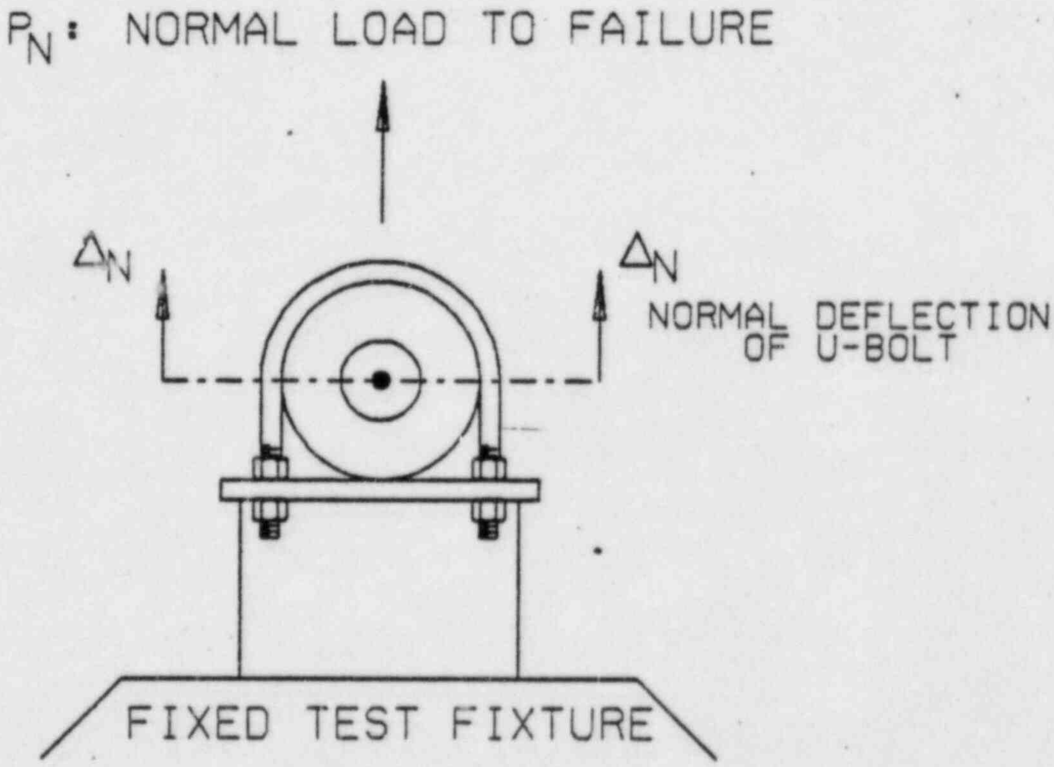


FIGURE 3

APPLICATION OF LOADS

Normal Loads

Normal loads will be applied through the testing machine. For the 4" pipe U-bolt this normal load will be 2260 lb and for the 24" pipe U-bolt the normal load will be 9920 lb (per ITTG DRS 137 Rev. 3; NPSI LCD PUS-040,240 Revision 1).

Axial Loads

Axial loads are the loads acting along the axis parallel to the length of the pipe. These loads will be applied through the 'ENERPAC S177' hydraulic pump and cylinder set. The cylinder will be suitably installed on the testing machine and its height adjusted to act along the center line of the pipe.

Side or Lateral Loads

Side or lateral loads are the loads acting perpendicular to the axis of the pipe in the plane of the U-bolt. The 'ENERPAC S177' hydraulic pump and cylinder set will be used to generate these loads. The cylinder will be installed in the same manner as for axial load and is height adjusted to act perpendicular to the center line of the pipe .

MEASUREMENTS

All normal loads (P_n) are measured on the Rhiele testing machine dial.

Side and axial loads are recorded through strain gages. These gages are installed on the load-inducing rods and connected to a strain measuring device (see appendix IV). At any time during testing and for any U-bolt axial or lateral deflection the strains may be recorded and printed out.

Strains obtained are then averaged and converted into pounds force (see Appendix V).

TESTING PROCEDURE

Three (3) tests will be performed for each of the loading conditions 1, 2 and 3 for each of two U-bolt sizes. The sizes involved are:

(a) 4" pipe, 1/2" rod size U-bolt Figure 137N, LCDS rated at 2260 lb normal load P_n, and 184 lb side load P_s.

(b) 24" pipe, 1" rod size U-bolt Figure 137N, LCDS rated at 9920 lb normal load P_n. No LCDS rating for side loading exists as of this time.

4" Pipe, 1/2" Rod U-Bolt Testing

Axial load plus rated normal load (Condition 1)

Test A
Test B
Test C

Side load plus rated normal load (Condition 2)

Test D
Test E
Test F

Normal load to failure (Condition 3)

Test G
Test H
Test I

LOADING CONDITION 1

Rated Normal Load Plus Variable Axial Load

U-bolt size : 4" pipe
1/2" rod.

Three tests A,B and C were performed. In each test, the U-bolt was loaded with the LCDS rated normal load of 2260 lb. Axial load was induced through the hydraulic pump. The magnitude of the axial load was determined through strain gages placed on the load-inducing columns and connected to the cylinder end of the pump.

As the hydraulic pump was activated, strains and deflections were recorded as well as any change in the original normal load.

Test 'A'

Test 'A' was performed as two separate parts. The test started using a pressure gage on the hydraulic pump. Halfway along the test it became evident that the pressure gage could not accommodate the axial load needed to produce significant axial deflections.

It was then decided that axial loads would be determined using strain gages mounted on the load-inducing columns. The gages were properly placed and the test continued.

TEST 'A'

Axial Deflection (IN)	Gage Pressure (PSIG)	Axial Load (LB)	Normal Load (LB)
.0	13.	0.	2260.
.002	46.	37.	2260.
.005	57.	61.	2260.
.010	67.	83.	2260.
.021	77.	104.	2260.
.027	85.	119.	2260.
.035	95.	139.	2260.
.044	102.	154.	2260.
.051	112.	175.	2260.
.058	120.	190.	2260.
.063	126.	202.	2260.
.069	135.	221.	2260.
.075	140.	232.	2260.
.080	146.	245.	2260.
.085	152.	258.	2260.
.094	162.	277.	2260.
.122	192.	338.	2270.
.151	212.	380	2305.
.176	227.	413.	2335.
.203	240.	440.	2375.
.251	260.	479.	2490.
.312	290.	542.	2650.

TEST 'A' (CONTINUED)

Axial Deflection (IN)	Axial Strains (in/in x 10^{-6}) Gage #1	Gage #4	Average	Axial Load (LB)	Normal Load (LB)
.312	53	-119	-33.0	554.	2825.
.325	53	-123	-35.0	587.	2860.
.340	53	-125	-36.0	604.	2920.
.355	54	-129	-37.5	629.	2990.
.400	55	-137	-41.0	688.	3180.
.450	58	-149	-45.5	763.	3410.
.500	61	-162	-50.5	847.	3620.
.550	65	-175	-55.0	923.	3830.
.600	66	-184	-59.0	990.	4030.
.650	68	-202	-67.0	1124.	4510.
.700	68	-218	-75.0	1259.	4990.
.750	71	-240	-84.5	1418.	5480.

TEST 'B'

Axial Deflection (IN)	Axial Strains (in/in x 10^{-6}) Gage #1	Gage #4	Average	Axial Load (LB)	Normal Load (LB)
.0	0	0	0	0.	2260.
.015	1	-10	-4.5	75.	2260.
.030	3	-16	-6.5	109.	2250.
.045	6	-23	-8.5	143.	2245.
.060	10	-30	-10.0	168.	2245.
.075	11	-36	-12.5	210.	2245.
.090	12	-41	-14.5	243	2245.
.110	14	-48	-17.0	285.	2260.
.125	15	-53	-19.0	319.	2275.
.150	16	-60	-22.0	369.	2320.
.175	16	-66	-25.0	420.	2365.
.200	14	-68	-27.0	453.	2415.
.225	14	-69	-27.5	461.	2475.
.250	11	-70	-29.5	495.	2540.
.275	10	-71	-30.5	512.	2600.
.300	9	-74	-32.5	545.	2685.
.325	8	-77	-34.5	579.	2770.
.350	9	-81	-36.0	604.	2860.
.375	7	-84	-38.5	646.	2965.
.400	7	-88	-40.5	680.	3080.
.425	6	-92	-43.0	722.	3200.
.450	6	-97	-45.5	763.	3330.
.475	7	-103	-48.0	805.	3460.
.500	8	-109	-50.5	847.	3600.
.550	11	-123	-56.0	940.	3850.
.600	12	-136	-62.0	1040.	4170.
.650	6	-151	-72.5	1217.	4770.
.700	2	-168	-83.0	1393.	5400.
.750	-1	-184	-92.5	1552.	5860.
.800	-6	-198	-102.0	1712.	6350.
.850	-13	-227	-120.0	2014.	6800.

TEST 'C'

Axial Deflection (IN)	Axial Strains (in/in x 10^{-6}) Gage #1	Gage #4	Average	Axial Load (LB)	Normal Load (LB)
.0	0	0	0	0	2280.
.015	2	-12	-5.0	84.	2280.
.030	3	-17	-7.0	117.	2280.
.045	3	-20	-8.5	143.	2290.
.060	3	-22	-9.5	159.	2310.
.075	2	-24	-11.0	185.	2330.
.090	2	-26	-12.0	201.	2345.
.110	1	-25	-12.0	201.	2365.
.125	4	-32	-14.0	235.	2400.
.150	4	-35	-15.5	260.	2440.
.175	5	-40	-17.5	294.	2495.
.200	6	-44	-19.0	319.	2545.
.225	7	-49	-21.0	352.	2585.
.250	9	-54	-22.5	378.	2630.
.275	10	-59	-24.5	411.	2685.
.300	11	-64	-26.5	445.	2750.
.325	12	-69	-28.5	478.	2805.
.350	13	-74	-30.5	512.	2865.
.375	15	-82	-33.5	562.	2930.
.400	17	-88	-35.5	595.	3015.
.425	21	-97	-38.0	638.	3090.
.450	23	-103	-40.0	671.	3175.
.475	25	-109	-42.0	705.	3275.
.500	24	-114	-45.0	755.	3375.
.550	24	-124	-50.0	839.	3620.
.600	25	-134	-54.5	915.	3835.
.650	25	-147	-61.0	1024.	4190.
.700	23	-163	-70.0	1175.	4640.
.750	22	-182	-80.0	1342.	5250.
.800	26	-210	-92.0	1544.	5860.
.850	33	-263	-115.0	1930.	6275.

LOADING CONDITION 2

Rated Normal Load Plus Variable Side Load

U-bolt size : 4" pipe
1/2" rod

Three tests D,E and F were performed. In each test the U-bolt was loaded with the LCDS rated normal load of 2260. lb. Side load was induced through the hydraulic pump. As in the case of the axial load, the magnitude of the side load was determined through strain gages placed on the load-inducing columns. The load inducing columns are inserted in the cylinder end of the pump and bear upon the pipe.

Deflections and strains were recorded as the hydraulic pump was activated. Also recorded was any change in the normal load.

TEST 'D'

Side Deflection (IN)	Strains (in/in x 10^{-6}) Gage #1	Gage #4	Average	Side Load (LB)	Normal Load (LB)
.0	0	0	0	0.	2270.
.015	4	-15	-5.5	92.	2225.
.030	9	-25	-8.0	134.	2180.
.045	13	-36	-11.5	193.	2125.
.060	22	-54	-16.0	268.	2125.
.075	30	-69	-19.5	327.	2125.
.090	37	-92	-27.5	461.	2160.
.110	42	-119	-38.5	646.	2185.
.125	42	-136	-47.0	789.	2200.
.150	34	-157	-61.5	1032.	2245.
.175	27	-173	-73.0	1225.	2300.
.200	21	-182	-80.5	1351.	2360.
.225	15	-190	-87.5	1468.	2436.
.250	10	-196	-93.0	1561.	2500.
.275	5	-201	-98.0	1644.	2585.
.300	0	-207	-103.5	1737.	2675.
.325	-8	-211	-109.5	1837.	2775.
.350	-16	-213	-114.5	1921.	2880.
.375	-24	-216	-120.0	2014.	2990.
.400	-33	-219	-126.0	2114.	3100.
.425	-42	-224	-133.0	2232.	3225.
.450	-48	-232	-140.0	2349.	3310.
.475	-52	-242	-147.0	2467.	3425.
.500	-61	-248	-154.5	2593.	3550.
.550	-81	-259	-170.0	2853.	3835.
.600	-101	-267	-184.0	3088.	4110.
.650	-129	-276	-202.5	3398.	4425.
.700	-156	-284	-220.0	3692.	4675.
.750	-183	-295	-239.0	4010.	4875.
.800	-221	-299	-260.0	4363.	5325.
.850	-261	-302	-281.5	4724.	5880.
.900	-311	-307	-309.0	5185.	6375.

TEST 'E'

Side Deflection (IN)	Strains (in/in x 10^{-6}) Gage #1	Gage #4	Average	Side Load (LB)	Normal Load (LB)
.0	0	0	0	0	2260.
.015	18	-35	-8.5	143.	2145.
.030	37	-68	-15.5	260.	2070.
.045	51	-100	-24.5	411.	2030.
.060	56	-122	-33.0	554.	2020.
.075	62	-144	-41.0	688.	2010.
.090	67	-167	-50.0	839.	2010.
.110	73	-194	-60.5	1015.	2075.
.125	76	-214	-69.0	1158.	2140.
.150	76	-236	-80.0	1342.	2235.
.175	75	-252	-88.5	1485.	2330.
.200	73	-263	-95.0	1594.	2430.
.225	71	-272	100.5	1686.	2540.
.250	68	-278	-105.0	1762.	2630.
.275	64	-283	109.5	1837.	2720.
.300	57	-288	-115.5	1938.	2830.
.325	50	-291	-120.5	2022.	2930.
.350	42	-294	-126.0	2114.	3020.
.375	34	-298	-132.0	2215.	3110.
.400	24	-302	-139.0	2332.	3220.
.425	17	-305	-144.0	2416.	3280.
.450	5	-307	-151.0	2534.	3420.
.475	-1	-310	-155.5	2609.	3510.
.500	-5	-320	-162.5	2727.	3590.
.550	-21	-331	-176.0	2953.	3810.
.600	-44	-336	-190.0	3188.	4030.
.650	-69	-341	-205.0	3440.	4270.
.700	-100	-346	-223.0	3742.	4540.
.750	-133	-349	-241.0	4044.	4790.
.800	-174	-346	-260.0	4363.	5190.
.850	-214	-348	-281.0	4715.	5590.

TEST 'F'

Side Deflection (IN)	Strains (in/in x 10^{-6}) Gage #1	Gage #4	Average	Side Load (LB)	Normal Load (LB)
.0	0	0	0	0	2260.
.015	-3	-10	-6.5	109.	2210.
.030	0	-19	-9.5	159.	2160.
.045	0	-28	-14.0	235.	2120.
.060	1	-37	-18.0	302.	2120.
.075	0	-45	-22.5	378.	2130.
.090	-2	-53	-27.5	461.	2150.
.110	-6	-64	-35.0	587.	2200.
.125	-11	-73	-42.0	705.	2240.
.150	-19	-87	-53.0	889.	2300.
.175	-29	-98	-63.5	1066.	2380.
.200	-38	-104	-71.0	1191.	2440.
.225	-48	-108	-78.0	1309.	2480.
.250	-54	-111	-82.5	1384	2500.
.275	-59	-116	-87.5	1468	2550.
.300	-65	-120	-92.5	1552.	2610.
.325	-70	-123	-96.5	1619.	2680.
.350	-75	-127	-101.0	1695.	2750.
.375	-81	-131	-106.0	1779.	2830.
.400	-87	-136	-111.5	1871.	2940.
.425	-96	-139	-117.5	1972.	3050.
.450	-105	-141	-123.0	2064.	3120.
.475	-116	-142	-129.0	2165.	3250.
.500	-127	-145	-136.0	2282.	3290.
.550	-150	-150	-150.0	2517.	3550.
.600	-171	-155	-163.0	2735.	3790.
.650	-196	-162	-179.0	3004.	4080.
.700	-221	-171	-196.0	3289.	4340.
.750	-242	-178	-210.0	3524.	4500.
.800	-269	-187	-228.0	3826.	4800.
.850	-299	-195	-247.0	4145.	5230.
.900	-332	-204	-268.0	4497.	5640.
.950	-366	-213	-289.5	4858.	6100.

LOADING CONDITION 3

Normal Load to Failure

U-Bolt size : 4" pipe
1/2" rod

Three tests G,H and I were performed. In each test the U-bolt was loaded normally by means of the tensile machine. The normal load was increased gradually until the U-bolt failed. The charting capability of the machine was utilized to plot the normal load against the normal deflection or elongation of the U-bolt. The location of failure for each U-bolt was observed.

24" Pipe, 1" Rod U-Bolt Testing

Axial load plus rated normal load (Condition 1)

Test K
Test L
Test M

Side load plus rated normal load (Condition 2)

Test N
Test O
Test P

Normal load to failure (Condition 3)

Test Q
Test R
Test S

LOADING CONDITION 1

Rated Normal Load Plus Variable Axial Load

U-bolt size : 24" pipe
1" rod

Three tests K,L and M were performed. In each test the U-bolt was loaded with the LCDS rated normal load of 9920 lb. Axial load was induced through the hydraulic pump.

The testing procedure is the same as for tests A,B and C.

TEST 'K'

Axial Deflection (IN)	Strains (in/in x 10^{-6}) Gage #1	Gage #4	Average	Axial Load (LB)	Normal Load (LB)
.0	0	0	0	0	9920.
.025	-18	-5	-11.5	193	9850.
.050	-31	-8	-19.5	327	9750.
.075	-52	-1	-26.5	445	9600.
.100	-63	-2	-32.5	545	9500.
.125	-70	-5	-37.5	629	9400.
.150	-76	-8	-42.0	705	9350.
.175	-84	-10	-47.0	789	9350.
.200	-117	16	-50.5	847	9300.
.225	-127	14	-56.5	948	9300.
.250	-135	15	-60.0	1007	9300.
.275	-144	17	-63.5	1066	9300.
.300	-151	18	-66.5	1116	9300.
.325	-160	18	-71.0	1191	9400.
.350	-168	20	-74.0	1242	9500.
.375	-177	22	-77.5	1300	9500.
.400	-185	23	-81.0	1359	9550.
.425	-194	23	-85.5	1435	9700.
.450	-201	22	-89.5	1502	9800.
.475	-207	21	-93.0	1561	9900.
.500	-211	19	-96.0	1611	9950.
.525	-217	19	-99.0	1661	10050.
.550	-222	18	-102.0	1712	10200.
.575	-227	16	-105.5	1770	10300.
.600	-232	13	-109.5	1837	10400.
.625	-233	11	-111.0	1863	10550.
.650	-237	11	-113.0	1896	10700.
.675	-241	9	-116.0	1946	10800.
.700	-245	7	-119.0	1997	11000.
.725	-251	8	-121.5	2039	11150.
.750	-256	8	-124.0	2081	11300.

TEST 'K'(CONTINUED)

Axial Deflection (IN)	Strains (in/in x 10^{-6})			Axial Load (LB)	Normal Load (LB)
	Gage #1	Gage #4	Average		
.775	-263	10	-126.5	2122	11500
.800	-266	8	-129.0	2165	11700
.825	-271	8	-131.5	2207	11900
.850	-278	7	-135.5	2274	12100
.875	-282	8	-137.0	2299	12350
.900	-288	7	-140.5	2358	12550
.925	-296	8	-144.0	2416	12800
.950	-301	7	-147.0	2467	13050
.975	-308	6	-151.0	2534	13350
1.000	-314	6	-154.0	2584	13600
1.025	-320	5	-157.5	2643	13850
1.050	-326	4	-161.0	2702	14150
1.075	-331	2	-164.5	2760	14450
1.100	-336	0	-168.0	2819	14700
1.125	-342	-1	-171.5	2878	15000
1.150	-345	-4	-174.5	2928	15250
1.175	-351	-7	-179.0	3004	15600
1.200	-354	-10	-182.0	3054	15950
1.225	-358	-14	-186.0	3121	16250
1.250	-364	-19	-191.5	3213	16600
1.275	-368	-22	-195.0	3272	16850
1.300	-374	-26	-200.0	3356	17200
1.325	-377	-30	-203.5	3415	17650
1.350	-383	-35	-209.0	3507	18000
1.375	-388	-39	-213.5	3583	18400
1.400	-393	-44	-218.5	3666	18700
1.425	-395	-50	-222.5	3734	19050
1.450	-400	-56	-228.0	3826	19500
1.475	-404	-64	-234.0	3927	19850
1.500	-405	-72	-238.5	4002	20200

TEST 'L'

Axial Deflection (IN)	Strains (in/in x 10^{-6}) Gage #1	Gage #4	Average	Axial Load (LB)	Normal Load (LB)
.0	0	0	0	0	9950
.025	-19	-3	-11.0	185	9900
.050	-25	-7	-16.0	268	9850
.075	-29	-10	-19.5	327	9850
.100	-32	-14	-23.0	386	9850
.125	-33	-20	-26.5	445	9800
.150	-38	-23	-30.5	512	9800
.175	-42	-27	-34.5	579	9800
.200	-47	-31	-39.0	654	9800
.225	-51	-35	-43.0	722	9850
.250	-56	-38	-47.0	789	9900
.275	-59	-43	-51.0	856	9950
.300	-64	-47	-55.5	931	10000
.325	-67	-52	-59.5	998	10050
.350	-70	-57	-63.5	1066	10150
.375	-72	-63	-67.5	1133	10250
.400	-74	-69	-71.5	1200	10350
.425	-75	-76	-75.5	1267	10450
.450	-78	-81	-79.5	1334	10500
.475	-81	-33	-57.0	956	10600
.500	-130	-44	-87.0	1460	10700
.525	-132	-51	-91.5	1535	10800
.550	-135	-57	-96.0	1611	10850
.575	-136	-63	-99.5	1670	10950
.600	-138	-68	-103.0	1728	11000
.625	-140	-74	-107.0	1795	11100
.650	-141	-80	-110.5	1854	11200
.675	-141	-87	-114.0	1913	11300
.700	-141	-92	-116.5	1955	11400
.725	-141	-100	-120.5	2022	11500
.750	-141	-107	-124.5	2081	11650

TEST 'L' (CONTINUED)

Axial Deflection (IN)	Strains (in/in x 10^{-6}) Gage #1	Gage #4	Average	Axial Load (LB)	Normal Load (LB)
.775	-141	-114	-127.5	2139	11800
.800	-142	-119	-130.5	2190	12000
.825	-142	-127	-134.5	2257	12150
.850	-142	-136	-139.0	2332	12400
.875	-142	-143	-142.5	2391	12650
.900	-142	-152	-147.0	2467	12900
.925	-140	-162	-151.0	2534	13100
.950	-140	-170	-155.0	2601	13400
.975	-140	-179	-159.5	2676	13700
1.000	-139	-186	-162.5	2727	13950
1.025	-138	-198	-168.0	2819	14250
1.050	-136	-209	-172.5	2895	14600
1.075	-135	-220	-177.5	2978	14900
1.100	-134	-230	-182.0	3054	15200
1.125	-131	-243	-187.0	3138	15500
1.150	-132	-250	-191.0	3205	15900
1.175	-129	-264	-196.5	3297	16250
1.200	-126	-277	-201.5	3381	16650
1.225	-125	-287	-206.0	3457	16950
1.250	-141	-303	-222.0	3725	17300

TEST 'M'

Axial Deflection (IN)	Strains (in/in x 10^{-6}) Gage #1	Gage #4	Average	Axial Load (LB)	Normal Load (LB)
.0	0	0	0	0	9950
.025	-30	2	-14.0	235	9950
.050	-44	4	-20.0	336	9950
.075	-42	0	-21.0	352	9700
.100	-49	-5	-27.0	453	9800
.125	-54	-11	-32.5	545	9850
.150	-58	-16	-37.0	621	9850
.175	-62	-21	-41.5	695	9900
.200	-66	-25	-45.5	763	9950
.225	-95	-4	-49.5	831	9950
.250	-94	-16	-55.0	923	10000
.275	-94	-25	-59.5	998	10050
.300	-97	-33	-65.0	1091	10150
.325	-99	-41	-70.0	1171	10200
.350	-106	-44	-75.0	1259	10250
.375	-115	-37	-76.0	1275	10350
.400	-118	-48	-83.0	1393	10450
.425	-130	-38	-84.0	1410	10550
.450	-132	-50	-91.0	1527	10700
.475	-141	-42	-91.5	1535	10750
.500	-143	-55	-99.0	1661	10900
.525	-154	-46	-100.0	1678	10900
.550	-157	-51	-104.0	1745	11100
.575	-161	-55	-108.0	1812	11200
.600	No readings available due to U-bolt "slip"				
.625	" "	"	" " "	"	
.650	-186	30	-78.0	1309	11100
.675	-211	32	-89.5	1502	11450
.700	-227	34	-96.5	1619	11700
.725	-238	32	-103.0	1728	12000
.750	-240	23	-108.5	1821	12250

TEST 'M' (CONTINUED)

Axial Deflection (IN)	Strains (in/in x 10^{-6}) Gage #1	Gage #4	Average	Axial Load (LB)	Normal Load (LB)
.775	-241	15	-113.0	1896	12500
.800	-244	7	-118.5	1988	12700
.825	-246	1	-122.5	2056	12950
.850	-247	-5	-126.0	2114	13200
.875	-249	-12	-130.5	2190	13350
.900	-252	-17	-134.5	2257	13600
.925	-250	-26	-138.0	2316	13850
.950	-254	-33	-143.5	2408	14100
.975	-256	-39	-147.5	2475	14350
1.000	-258	-44	-151.0	2534	14550
1.025	-259	-52	-155.5	2609	14800
1.050	-261	-58	-159.5	2676	15100
1.075	-263	-64	-163.5	2744	15300
1.100	-268	-66	-167.0	2802	15550
1.125	-268	-72	-170.0	2853	15800
1.150	-273	-77	-175.0	2937	16050
1.175	-275	-84	-179.5	3012	16350
1.200	-279	-90	-184.5	3096	16650
1.225	-281	-96	-188.5	3163	16950
1.250	-286	-104	-195.0	3272	17250
1.275	-286	-112	-199.0	3339	17550
1.300	-286	-123	-204.5	3432	17900
1.325	-290	-128	-209.0	3507	18250
1.350	-292	-136	-214.0	3591	18550
1.375	-294	-143	-218.5	3666	18850
1.400	-289	-154	-221.5	3717	19100
1.425	-295	-160	-227.5	3815	19500
1.450	-297	-169	-233.0	3910	19850
1.475	-299	-178	-238.5	4002	20200
1.500	-299	-191	-245.0	4111	20650

LOADING CONDITION 2

Rated Normal Load Plus Variable Side Load

U-bolt size : 24" pipe
1" rod

Three tests N,O and P were performed. In each test the U-bolt was loaded with the LCDS rated normal load of 9920 lb. Side load was induced through the hydraulic pump.

The testing procedure is the same as for tests D,E and F.

TEST 'N'

Side Deflection (IN)	Strains (in/in x 10^{-6}) Gage #1	Gage #4	Average	Side Load (LB)	Normal Load (LB)
.0	0	0	0	0	9920
.025	-38	24	-7.0	117	9900
.050	-76	49	-13.5	227	9900
.075	-107	68	-19.5	327	9950
.100	-130	80	-25.0	420	10050
.125	-158	97	-30.5	512	10250
.150	-187	114	-36.5	612	10400
.175	-222	134	-44.0	738	10550
.200	-256	155	-50.5	847	10700
.225	-295	178	-58.5	982	10850
.250	-330	199	-65.5	1099	11000
.275	-365	220	-72.5	1217	11200
.300	-398	239	-79.5	1334	11300
.325	-433	260	-86.5	1451	11550
.350	-468	279	-94.5	1586	11700
.375	-496	295	-100.5	1686	11950
.400	523	309	-107.0	1795	12150
.425	-555	326	-114.5	1921	12350
.450	-584	341	-121.5	2039	12550
.475	-612	355	-128.5	2156	12800
.500	634	365	-134.5	2257	13000
.525	-660	377	-141.5	2374	13300
.550	-683	387	-148.0	2483	13500
.575	-711	402	-154.5	2593	13750
.600	-737	416	-160.5	2693	14000
.625	-766	432	-167.0	2802	14250
.650	-790	446	-172.0	2886	14500
.675	-818	462	-178.0	2987	14750
.700	-843	477	-183.0	3071	15000
.725	-868	492	-188.0	3155	15250
.750	-891	507	-192.0	3222	15500

TEST 'N' (CONTINUED)

Side Deflection (IN)	Strains (in/in x 10^{-6}) Gage #1	Gage #4	Average	Side Load (LB)	Normal Load (LB)
.775	-908	519	-194.5	3264	15800
.800	-941	538	-201.5	3381	16050
.825	-962	553	-204.5	3432	16350
.850	-989	570	-209.5	3515	16650
.875	-101[illegible]	588	-215.0	3608	16950
.900	-1039	603	-218.0	3658	17250
.925	-1066	621	-222.5	3734	17550
.950	-1095	640	-227.5	3817	17850
.975	-1122	657	-232.5	3901	18150
1.000	-1146	674	-236.0	3960	18450
1.025	-1171	692	-239.5	4019	18800
1.050	-1202	711	-245.5	4119	19150
1.075	-1231	730	-250.5	4203	19500
1.100	-1260	750	-255.0	4279	20000
1.125	-1293	772	-260.5	4371	20150
1.150	-1325	793	-266.0	4463	20550
1.175	-1354	814	-270.0	4531	20900
1.200	-1391	838	-276.5	4640	21300
1.225	-1424	860	-282.0	4732	21600
1.250	-1458	885	-286.5	4807	22050
1.275	-1496	910	-293.0	4917	22400
1.300	-1538	938	-300.0	5034	22800
1.325	-1576	964	-306.0	5135	23250
1.350	-1616	993	-311.5	5227	23650
1.375	-1661	1022	-319.5	5361	24100
1.400	-1710	1053	-328.5	5512	24500
1.425	-1750	1081	-334.5	5613	24900
1.450	-1797	1113	-342.0	5739	25350
1.475	-1844	1143	-350.5	5881	25700
1.500	-1888	1172	-358.0	6007	26100

TEST '0'

Side Deflection (IN)	Strains (in/in x 10^{-6}) Gage #1	Gage #4	Average	Side Load (LB)	Normal Load (LB)
.0	-28	14	-7.0	117	9950
.025	-59	29	-15.0	252	9950
.050	-86	44	-21.0	352	9950
.075	-104	52	-26.0	436	9950
.100	-123	61	-31.0	520	9950
.125	-145	72	-36.5	612	9950
.150	-168	85	-41.5	696	9950
.175	-192	99	-46.5	780	9950
.200	-211	108	-51.5	864	10000
.225	-242	128	-57.0	956	10000
.250	-270	145	-62.5	1049	10100
.275	-295	160	-67.5	1133	10100
.300	-316	174	-71.0	1191	10100
.325	-342	189	-76.5	1284	10100
.350	-363	202	-80.5	1351	10100
.375	-385	215	-85.0	1426	10150
.400	-402	225	-88.5	1485	10200
.425	-421	238	-91.5	1535	10250
.450	-447	250	-98.5	1653	10300
.475	-466	261	-102.5	1720	10350
.500	-484	272	-106.0	1779	10450
.525	-503	282	-110.5	1854	10550
.550	-520	292	-114.0	1913	10700
.575	-542	303	-119.5	2005	10800
.600	565	316	-124.5	2089	11000
.625	590	328	-131.0	2198	11200
.650	-614	340	-137.0	2299	11350
.675	-636	353	-141.5	2374	11550
.700	-665	368	-148.5	2492	11700
.725	-691	382	-154.5	2593	11900
.750	-720	398	-161.0	2702	12100

TEST 'O'(CONTINUED)

Side Deflection (IN)	Strains (in/in x 10^{-6}) Gage #1	Gage #4	Average	Side Load (LB)	Normal Load (LB)
.775	-750	414	-168.0	2819	12300
.800	-774	430	-172.0	2886	12500
.825	-803	447	-178.0	2987	12750
.850	-833	464	-184.5	3096	12950
.875	-859	480	-189.5	3180	13150
.900	-887	497	-195.0	3272	13400
.925	-919	516	-201.5	3381	13650
.950	-942	533	-204.5	3432	13900
.975	-969	549	-210.0	3524	14150
1.000	-992	566	-213.0	3574	14400
1.025	-1026	587	-219.5	3683	14700
1.050	-1046	602	-222.0	3725	15000
1.075	-1069	618	-225.5	3784	15300
1.100	-1102	638	-232.0	3893	15600
1.125	-1123	654	-234.5	3935	15950
1.150	-1147	671	-238.0	3994	16300
1.175	-1171	687	-242.0	4061	16600
1.200	-1202	707	-247.5	4153	16950
1.225	-1231	725	-253.0	4245	17300
1.250	-1262	747	-257.5	4321	17650
1.275	-1286	764	-261.0	4380	18000
1.300	-1305	780	-262.5	4405	18200
1.325	-1347	806	-270.5	4539	18650
1.350	-1387	832	-277.5	4656	19050
1.375	-1415	853	-281.0	4715	19450
1.400	-1449	877	-286.0	4799	19800
1.425	-1486	901	-292.5	4908	20200
1.450	-1525	928	-298.5	5009	20600
1.475	-1557	952	-302.5	5076	21000
1.500	-1596	978	-309.0	5185	21350

TEST 'P

Side Deflection (IN)	Strains (in/in x 10^{-6}) Gage #1	Gage #4	Average	Side Load (LB)	Normal Load (LB)
.0	0	0	0	0	9920
.025	-58	35	-11.5	193	9920
.050	-96	57	-19.5	327	9850
.075	-132	80	-26.0	436	9850
.100	-176	108	-34.0	571	9800
.125	-215	134	-40.5	680	9750
.150	-253	160	-46.5	780	9700
.175	-287	182	-52.5	881	9700
.200	-322	206	-58.0	973	9650
.225	-353	227	-63.0	1057	9650
.250	-385	247	-69.0	1158	9650
.275	-412	265	-73.5	1233	9650
.300	-438	282	-78.0	1309	9650
.325	-460	294	-83.0	1393	9650
.350	-482	305	-88.5	1485	9750
.375	-501	314	-93.5	1569	9800
.400	-522	324	-99.0	1661	9850
.425	-541	333	-104.0	1745	9950
.450	-560	342	-109.0	1829	10000
.475	-581	352	-114.5	1921	10100
.500	-599	360	-119.5	2005	10250
.525	-620	369	-125.5	2106	10350
.550	-637	378	-129.5	2173	10450
.575	-656	389	-133.5	2240	10600
.600	-682	403	-139.5	2341	10800
.625	-699	414	-142.5	2391	10900
.650	-719	425	-147.0	2467	11100
.675	-742	438	-152.0	2551	11250
.700	-763	450	-156.5	2626	11400
.725	-789	465	-162.0	2718	11600
.750	-816	481	-167.5	2810	11750

TEST 'P (CONTINUED)

Side Deflection (IN)	Strains (in/in x 10^{-6}) Gage #1	Gage #4	Average	Side Load (LB)	Normal Load (LB)
.775	-841	496	-172.5	2895	12000
.800	-867	512	-177.5	2978	12200
.825	-893	528	-182.5	3062	12450
.850	-919	544	-187.5	3146	12700
.875	-944	560	-192.0	3222	12950
.900	-966	575	-195.5	3280	13250
.925	-991	591	-200.0	3356	13550
.950	-1011	606	-202.5	3398	13850
.975	-1035	622	-206.5	3465	14150
1.000	-1060	638	-211.0	3541	14450
1.025	-1085	655	-215.0	3608	14800
1.050	-1110	672	-219.0	3675	15150
1.075	-1133	688	-222.5	3734	15450
1.100	-1164	708	-228.0	3826	15850
1.125	-1200	730	-235.0	3943	16150
1.150	-1220	747	-236.5	3968	16550
1.175	-1254	769	-242.5	4069	17000
1.200	-1286	790	-248.0	4161	17400
1.225	-1322	813	-254.5	4271	17800
1.250	-1352	835	-258.5	4338	18200
1.275	-1386	857	-264.5	4438	18600
1.300	-1413	877	-268.0	4497	18950
1.325	-1452	903	-274.5	4606	19450
1.350	-1482	924	-279.0	4682	19800
1.375	-1519	949	-285.0	4782	20250
1.400	-1559	975	-292.0	4900	20650
1.425	-1600	1002	-299.0	5017	21100
1.450	-1632	1025	-303.5	5093	21500
1.475	-1671	1050	-310.5	5210	22000
1.500	-1709	1076	-316.5	5311	22400

LOADING CONDITION 3
Normal Load to Failure

U-bolt size : 24" pipe
1" rod

Three tests Q,R and S were performed. In each test the U-bolt was loaded normally by means of the tensile machine. The normal load was increased gradually until the U-bolt failed. The charting capability of the machine was utilized to plot the normal load against the normal deflection or elongation of the U-bolt. The location of failure for each U-bolt was observed.

LOAD RATING ACCORDING TO ASME NF-3260

SIZES	MATERIAL PROPERTIES - Stress in KSI Values from C.M.T.R.'s at 70° F S_u	S_y	$.5S_u$	$.6S_y$	F_{ALL}/S_u
4" PIPE 1/2" ROD	63.08	45.13	31.54	27.08	0.43
24" PIPE 1" ROD	73.4	51.6	36.7	30.96	0.42

SIZES	MATERIAL PROPERTIES - Stress in KSI Values from ASME Appx. 1 at 100° F S_u	S_y	$.5S_u$	$.6S_y$	F_{ALL}/S_u
4" PIPE 1/2" ROD	58	36	29	21.6	0.37
24" PIPE 1" ROD	58	36	29	21.6	0.37

SIZES	MATERIAL PROPERTIES - Stress in KSI Values from ASME Appx. 1 at 650° F S_u	S_y	$.5S_u$	$.6S_y$	F_{ALL}/S_u
4" PIPE 1/2" ROD	58	26.1	29	15.66	0.27
24" PIPE 1" ROD	58	26.1	29	15.66	0.27

F_{ALL} : Smallest of $.5S_u$ and $.6S_y$

Per NF-3262.3, Winter 1974 Addenda,

$$\text{LOAD RATING} = \text{T.L.} \times (F_{ALL}/S_u)$$

where T.L. = TEST LOAD

- the TEST LOAD for normal loading is the final load that produces failure of the U-bolt,

- for axial and lateral loading, the test load may be taken as the load at maximum observed axial or lateral deflection, since at this deflection the support was still sustaining the indicated loads.

LOADS AND DEFLECTIONS FOR USE IN LOAD RATING OF 4" & 24" PIPE U-BOLTS

TEST	LOAD	DEFLECTION	TEST	LOAD	DEFLECTION
A	1418	.75	K	4002	1.50
B	2014	.85	L	3725	1.25
C	1930	.85	M	4111	1.50
D	5185	.90	N	6007	1.50
E	4715	.85	O	5185	1.50
F	4858	.95	P	5311	1.50
G	19825	FAILURE	Q	89500	FAILURE
H	18675	FAILURE	R	90000	FAILURE
I	19850	FAILURE	S	90750	FAILURE

Based on the minimum values of the above table,

TEST LOAD for 4" Axial Load Test = 1418 LBS.
TEST LOAD for 4" Lateral Load Test = 4715 LBS.
TEST LOAD for 4" Normal Load Test = 18675 LBS.

TEST LOAD for 24" Axial Load Test = 3725 LBS.
TEST LOAD for 24" Lateral Load Test = 5185 LBS.
TEST LOAD for 24" Normal Load Test = 89500 LBS.

For material properties at 70° (per C.M.T.R.'s),

NF Load Rating for 4" Axial Load = 1418 (0.43) = 610 LBS.
NF Load Rating for 4" Lateral Load = 4715 (0.43) = 2027 LBS.
NF Load Rating for 4" Normal Load = 18675 (0.43) = 8030 LBS.
NF Load Rating for 24" Axial Load = 3725 (0.42) = 1565 LBS.
NF Load Rating for 24" Lateral Load = 5185 (0.42) = 2178 LBS.
NF Load Rating for 24" Normal Load = 89500 (0.42) = 37590 LBS.

For material properties at 100° (per ASME Appex. I),

NF Load Rating for 4" Axial Load = 1418 (0.37) = 525 LBS.
NF Load Rating for 4" Lateral Load = 4715 (0.37) = 1745 LBS.
NF Load Rating for 4" Normal Load = 18675 (0.37) = 6910 LBS.
NF Load Rating for 24" Axial Load = 3725 (0.37) = 1378 LBS.
NF Load Rating for 24" Lateral Load = 5185 (0.37) = 1918 LBS.
NF Load Rating for 24" Normal Load = 89500 (0.37) = 33115 LBS.

For material properties at 650° (per ASME Appex. I),

NF Load Rating for 4" Axial Load = 1418 (0.27) = 383 LBS.
NF Load Rating for 4" Lateral Load = 4715 (0.27) = 1273 LBS.
NF Load Rating for 4" Normal Load = 18675 (0.27) = 5042 LBS.
NF Load Rating for 24" Axial Load = 3725 (0.27) = 1006 LBS.
NF Load Rating for 24" Lateral Load = 5185 (0.27) = 1400 LBS.
NF Load Rating for 24" Normal Load = 89500 (0.27) = 24165 LBS.

TEST RESULTS

AXIAL LOADING OF U-BOLTS

4" PIPE

1/2" rod U-bolts
Tests A,B,C
Figures A-1 to A-6 of Appendix I

Axial loads of between 1342 and 1552 lbs were required to produce 0.75" of deflection in the axial direction for three different specimens. Load-deflection paths were comparatively similar for all U-bolts.

Normal load increased from the LCDS rated load of 2260. lbs at the beginning of the test, to a load of between 5250 and 5860 lbs at 0.75" of axial deflection.

Upon removal of the axial load, the axial deflection went down to approximately 0.51" and the normal load was reduced to 2500 lbs (test C data only). No measurements were taken upon removal of normal load.

24" PIPE

1" rod U-bolts
Tests K,L,M
Figures A-16 to A-21 of Appendix I

Axial loads of between 3213 and 3725 lbs were required to produce 1.25" of deflection in the axial direction for three different specimens. Load-deflection paths were comparatively similar except for test M when the U-bolt "slipped" on the pipe at about 0.6" of axial deflection.

Normal load increased from the LCDS rated load of 9920 lbs at the beginning of the test to a load of between 16600 and 17300 lbs at 1.25" of axial deflection.

Upon removal of the axial load, the axial deflection went down to between 0.602" and 0.742" and the normal load was reduced to between 7500 lbs and 9300 lbs. No measurements were taken upon removal of normal load.

TEST RESULTS (CONTINUED)

LATERAL LOADING OF U-BOLTS

4" PIPE

1/2" rod U-bolts
Tests D,E,F
Figures A-7 to A-12 of Appendix I

Lateral loads of between 3524 and 4044 lbs were required to produce 0.75" of deflection in the lateral direction, for three different specimens. Load-deflection paths were comparatively similar for all U-bolts.

Normal load increased from the LCDS rated load of 2260 lbs at the beginning of the test, to a load of between 4500 and 4875 lbs at 0.75" of lateral deflection.

Upon removal of the lateral load, the axial deflection was reduced to between 0.507" and 0.627" and the normal load was reduced to between 2450 lbs and 2570 lbs (tests E and F only). No measurements were taken upon removal of normal load.

24" PIPE

1" rod U-bolts
Tests N,O,P
Figures A-22 to A-27 of Appendix I

Lateral loads of between 4321 and 4807 lbs were required to produce 1.25" of deflection in the lateral direction for three different specimens. Load-deflection paths were comparatively similar for all U-bolts.

Normal load increased from the LCDS rated load of 9920 lbs at the beginning of the test, to a load of between 18200 and 22050 lbs at 1.25" of lateral deflection.

Upon removal of the lateral load, the axial deflection was reduced to between 0.638" and 0.683" and the normal load was reduced to between 7450 lbs and 8350 lbs. No measurements were taken upon removal of normal load.

TEST RESULTS (CONTINUED)

NORMAL LOADING OF U-BOLTS

4" PIPE

1/2" rod U-bolts
Tests G,H,I
Figures A-13 to A-15 of Appendix I

Normal loads of 19825, 18675 and 19850 lbs were required to break the three different U-bolts.

Based on theoretical calculations involving the tensile stress area of the threaded section of the U-bolts and the ultimate strength of the U-bolt material, failure should occur at 17890 lbs.

Failure occured, as expected, in the threaded section of the U-bolt, in the region between the two hex nuts securing the U-bolt on the base plate. Excessive necking is evident.

24" PIPE

1" rod U-bolts
Tests Q,R,S
Figures A-28 to A-30 of Appendix I

Normal loads of 89500, 90000 and 90750 lbs were required to break the three different U-bolts.

Based on theoretical calculations involving the tensile stress area of the threaded section of the U-bolts and the ultimate strength of the U-bolt material, failure should occur at 88475 lbs.

Failure occured, as expected, in the threaded section of the U-bolt, in the region between the two hex nuts securing the U-bolt on the base plate. Excessive necking is evident.

SUMMARY OF RESULTS

PIPE SIZE	LOAD DIRECTION	TEST	MAXIMUM TEST LOAD	NF-RATED* LOAD	LCD LOAD	REMARKS	
4"	AXIAL	A	1418			no failure	Δ=0.75"
		B	2014	383	N/A	no failure	Δ=0.85"
		C	1930			no failure	Δ=0.85"
4"	LATERAL	D	5185			no failure	Δ=0.90"
		E	4715	1273	184	no failure	Δ=0.85"
		F	4858			no failure	Δ=0.95"
4"	NORMAL	G	19825			failure	
		H	18675	5042	2260	failure	
		I	19850			failure	
24"	AXIAL	K	4002			no failure	Δ=1.50"
		L	3725	1006	N/A	no failure	Δ=1.25"
		M	4111			no failure	Δ=1.50"
24"	LATERAL	N	6007			no failure	Δ=1.50"
		O	5185	1400	N/A	no failure	Δ=1.50"
		P	5311			no failure	Δ=1.50"
24"	NORMAL	Q	89500			failure	
		R	90000	24165	9920	failure	
		S	90750			failure	

All loads in pounds

* These NF rated loads are those loads which have been extracted from the test results of the U-bolt specimens covered in this report. These loads are determined in accordance with the ASME Boiler and Pressure Vessel Code, Section III, Subsection NF, Article NF-3262.3, Winter 1974 Addenda. They reflect the maximum design load similar U-bolts installed at the plant may be qualified to. These values are presented to emphasize the fact that the items under investigation poses considerable reserve strength in comparison to their published design load.

CONCLUSIONS

During all tests, the U-bolt specimens sustained permanent deformation with no loss in the load-carrying capacity for either the axial or lateral loading direction. The load carrying capability only ceased at the actual U-bolt failure for the pullout test. For both the axial and lateral load tests, the U-bolts sustained the indicated loads.

Determination of the yield point of the U-bolt cannot be made from the plots of the tests included in the Appendix I. The nature of the applied normal load causes a stress stiffening effect where the state of stress in the member adds significantly to the overall stiffness. Hence with the U-bolts being loaded both normally and in bending, the transition between elastic and inelastic behavior is difficult to detect. It was observed during the course of testing that under the simultaneous loading, axial displacements in excess of one-eighth inch caused no noticeable permanent deformation upon removal of load.

The increase in normal load as axial or lateral deflection of the U-bolt increased may be attributed to the following. As the U-bolt is displaced, the bending resistance of the U-bolt predominates at smaller values of deflection. As yielding proceeds through the cross-section, this bending resistance diminishes. To account for this condition, the U-bolt resists load in the normal direction along the U-bolt axis. Throughout the course of each test, a space or "gap" existed between the pipe spool and base fixture as the pipe was forced upward against the U-bolt. This "gap" never closed. Stretching of the U-bolt caused the normal load to increase. This points out the fact that there is a tremendous amount of reserve strength available in the U-bolt to accommodate very large load increases. Also to be concluded is the fact that under the action of U-bolt tension and bending forces at low values of displacement (below one-eighth inch), no permanent deformation occurs in U-bolts which undergo such loading.

To summarize, it must be stated that failure of the specimens due to either axial or lateral load was not accomplished, even at the excessive maximum values of displacement for which the testing was done. It appears that after the elastic limit of the material was reached, yielding occured over a wide span of deflection due to the nature of the load. Even under cyclic loading with displacements in the order of one-eighth inch, failure of the bolt due to fatigue is nonexistent, since no yielding was evident within this range of deflections.

In light of these observations it may be concluded that the U-bolt assemblies will perform satisfactorily at postulated displcament values under operating conditions. Added to the safe performance of the U-bolts is the evidence contained herein of their substantial reserve strength.

APPENDIX I

The purpose of this appendix is to graphically represent the results obtained through testing the 4" and 24" pipe U-bolts. The graphs are self-explanatory, depicting deflection of the pipe and U-bolt (axial or lateral) and load (axial or lateral) required to produce that deflection.

Each test represents a separate U-bolt, and each curve represents a separate test. Three curves of the same test (axial load on 4" pipe U-bolt for instance) are also plotted together to show comparative behavior over the entire deflection range. A combined graph is also included to show behavior over the first one-eighth inch of deflection.

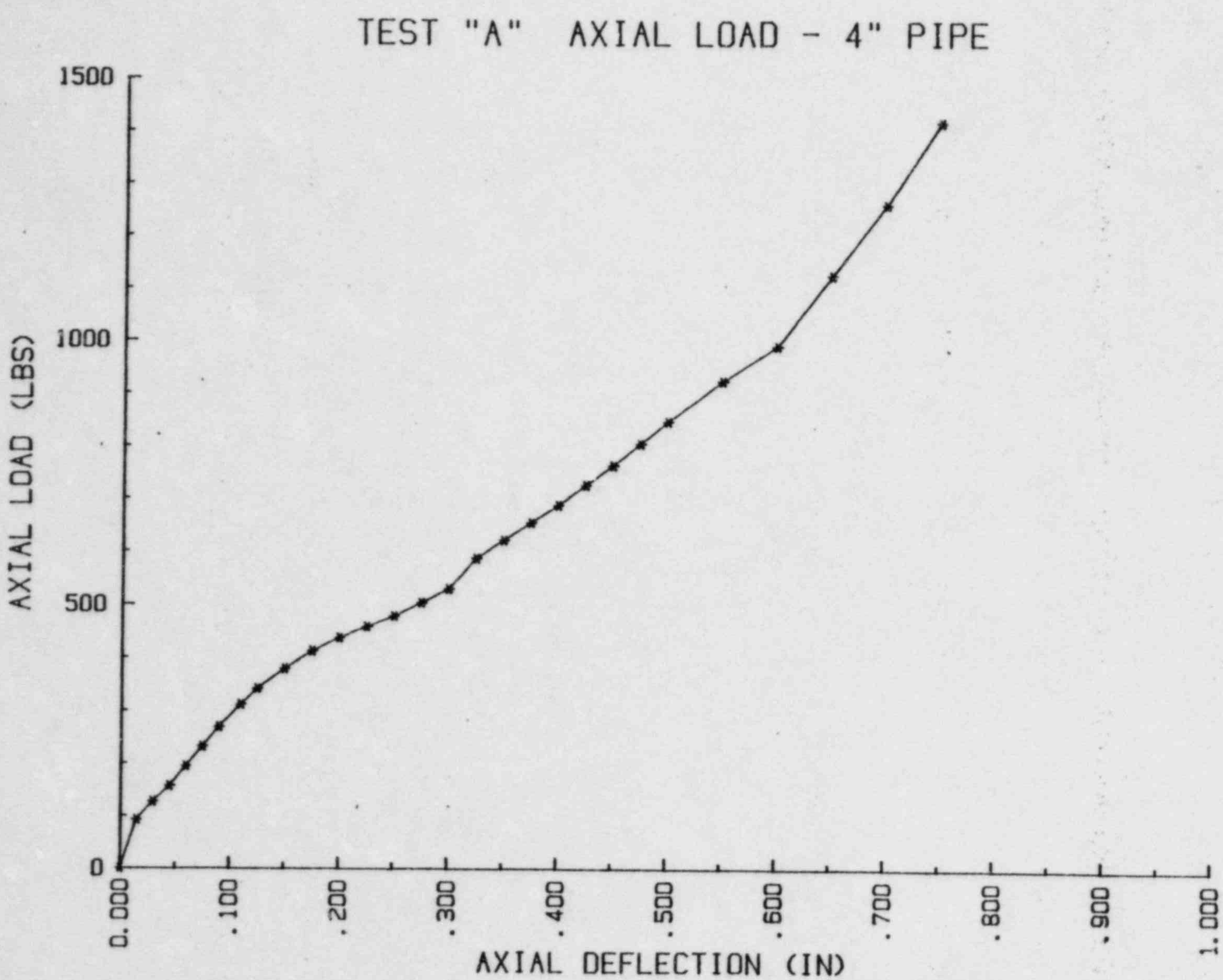


FIGURE A-1 TEST "A" : AXIAL DEFLECTION VS. AXIAL LOAD

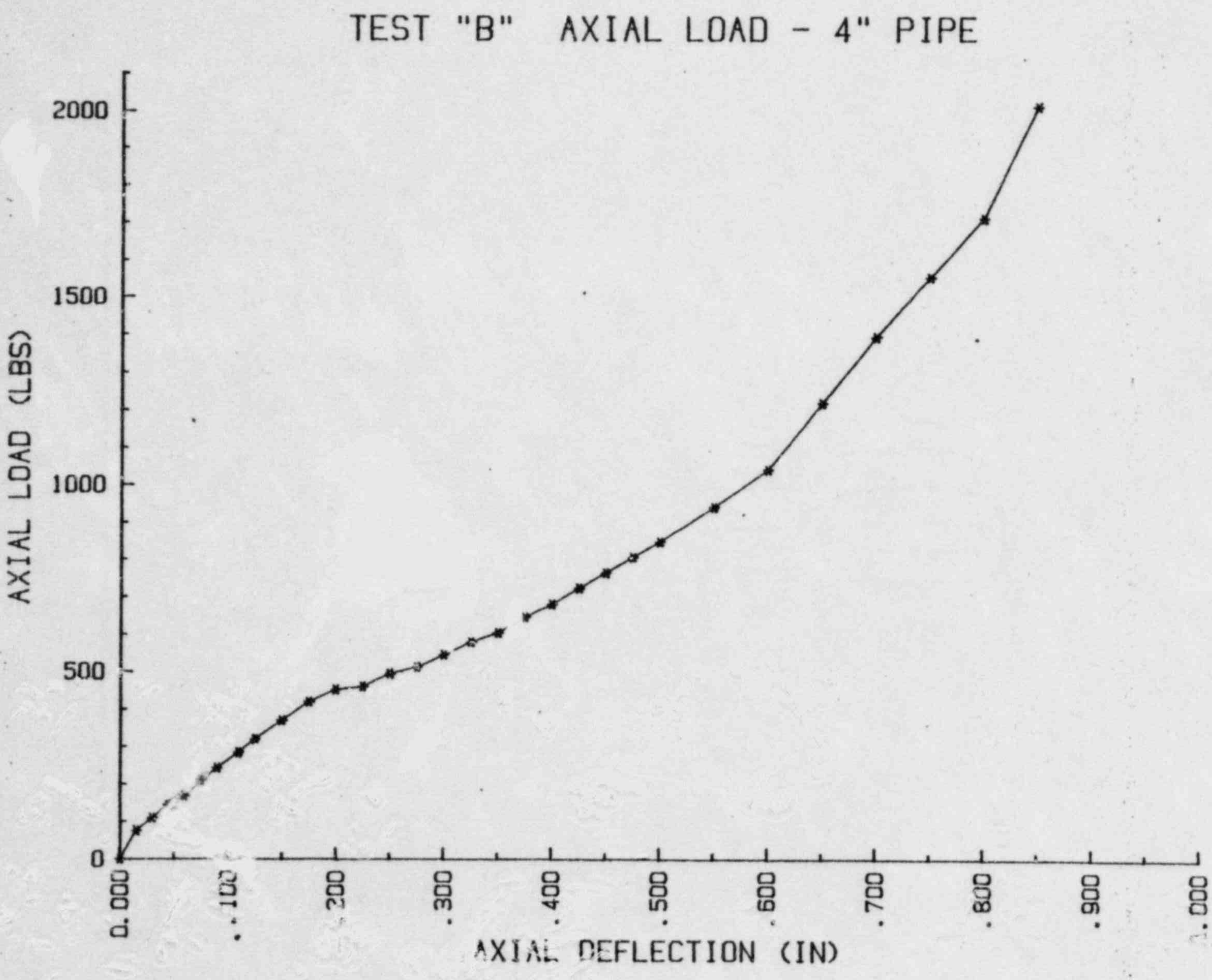


FIGURE A-2 TEST "B": AXIAL DEFLECTION VS. AXIAL LOAD

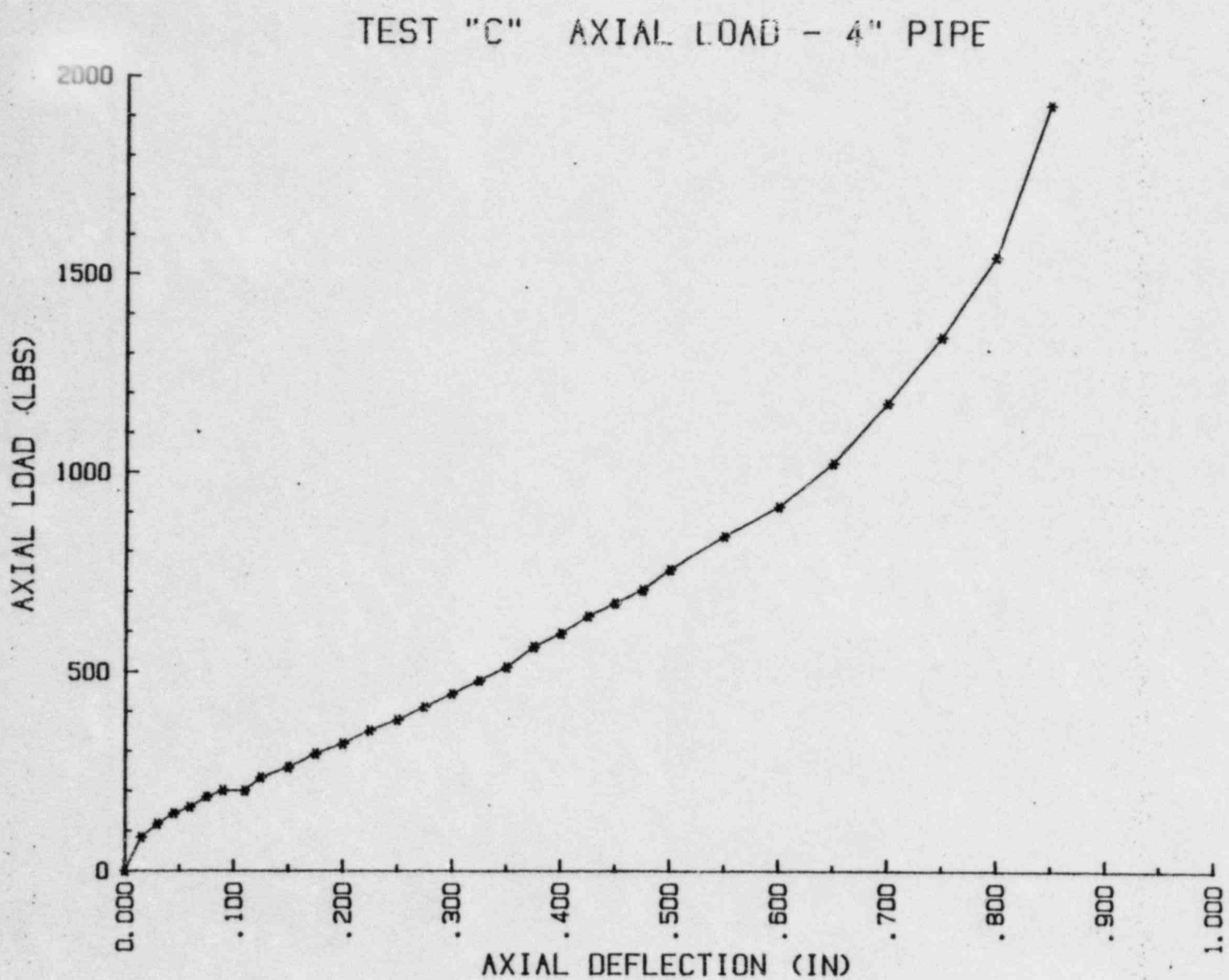


FIGURE A-3 TEST "C": AXIAL DEFLECTION VS. AXIAL LOAD

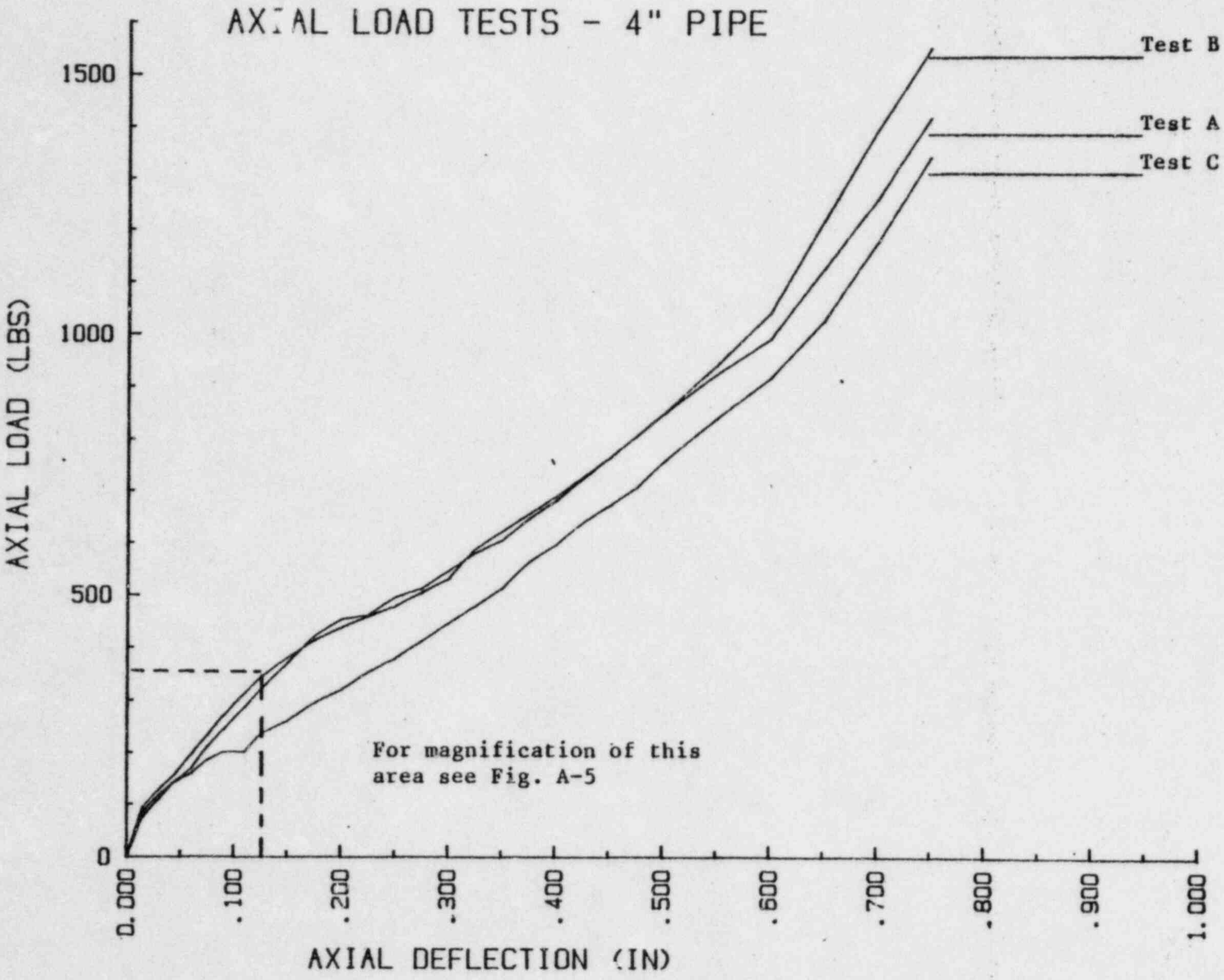
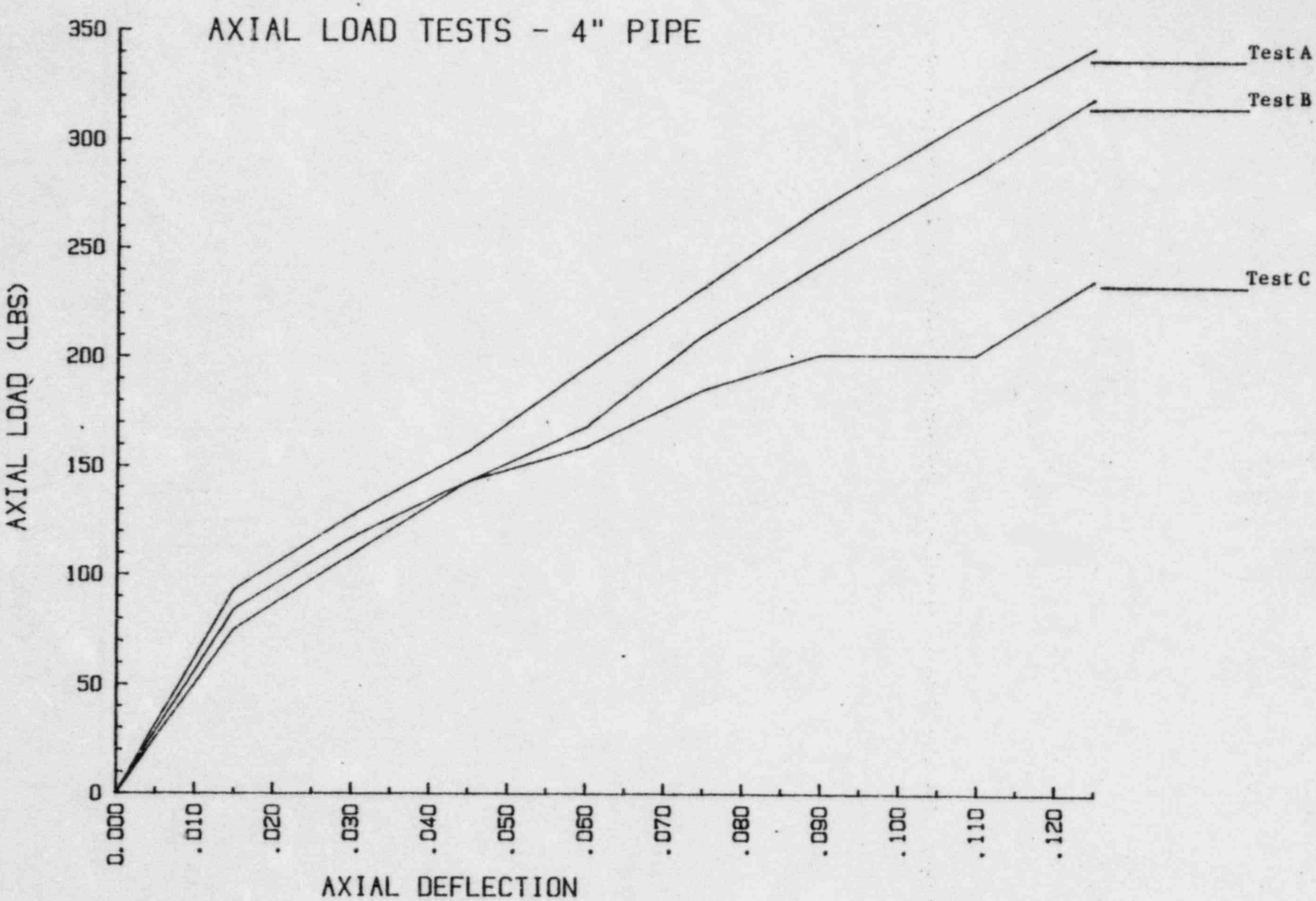
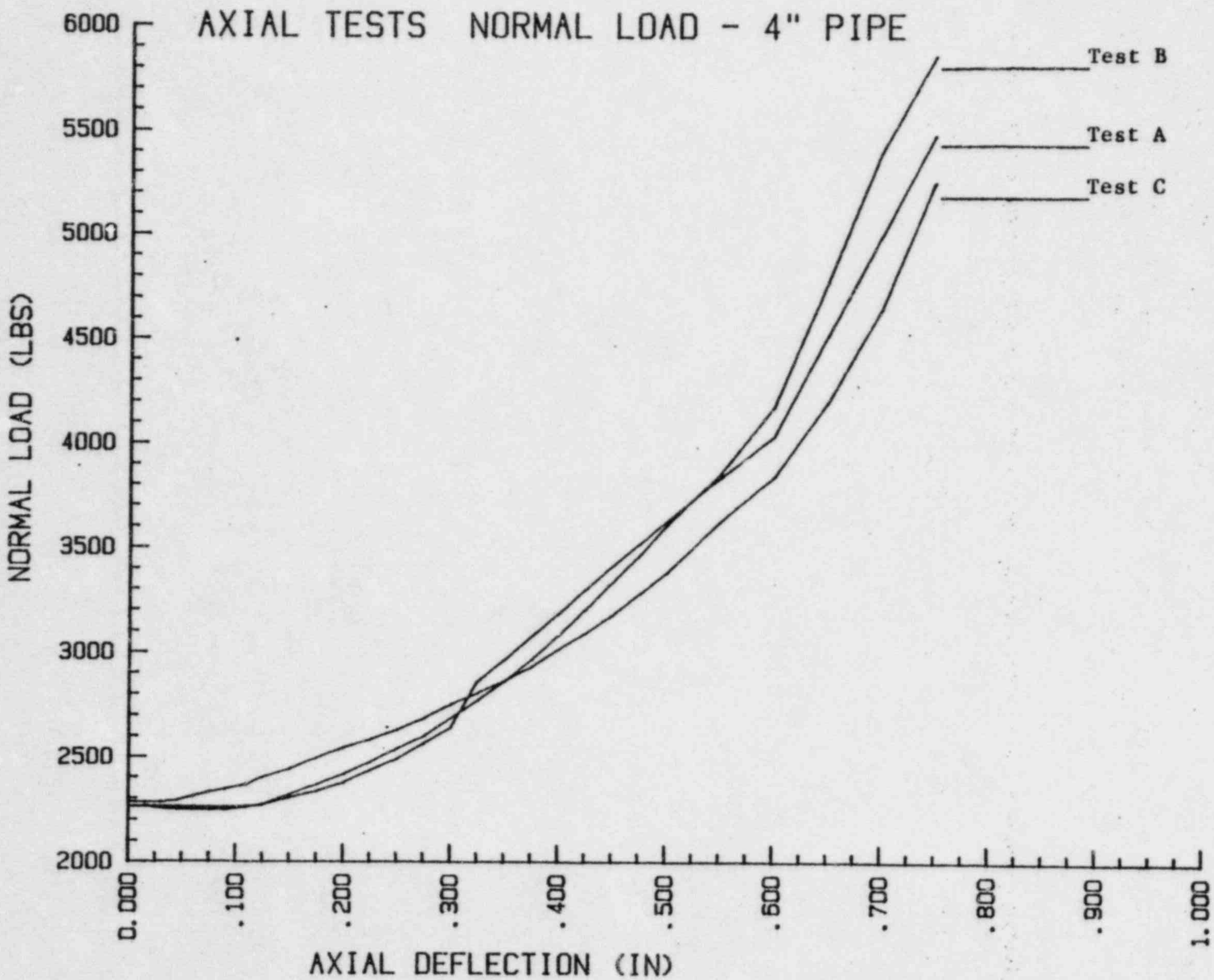


FIGURE A-4 TEST COMPARISONS: AXIAL DEFLECTION VS. AXIAL LOAD



<u>FIGURE A-5</u> TEST COMPARISONS: AXIAL DEFLECTION VS. AXIAL LOAD
SCALE MAGNIFICATION- 0 IN. TO .125 IN.



<u>FIGURE A-6</u> TEST COMPARISONS: AXIAL DEFLECTION VS. NORMAL LOAD

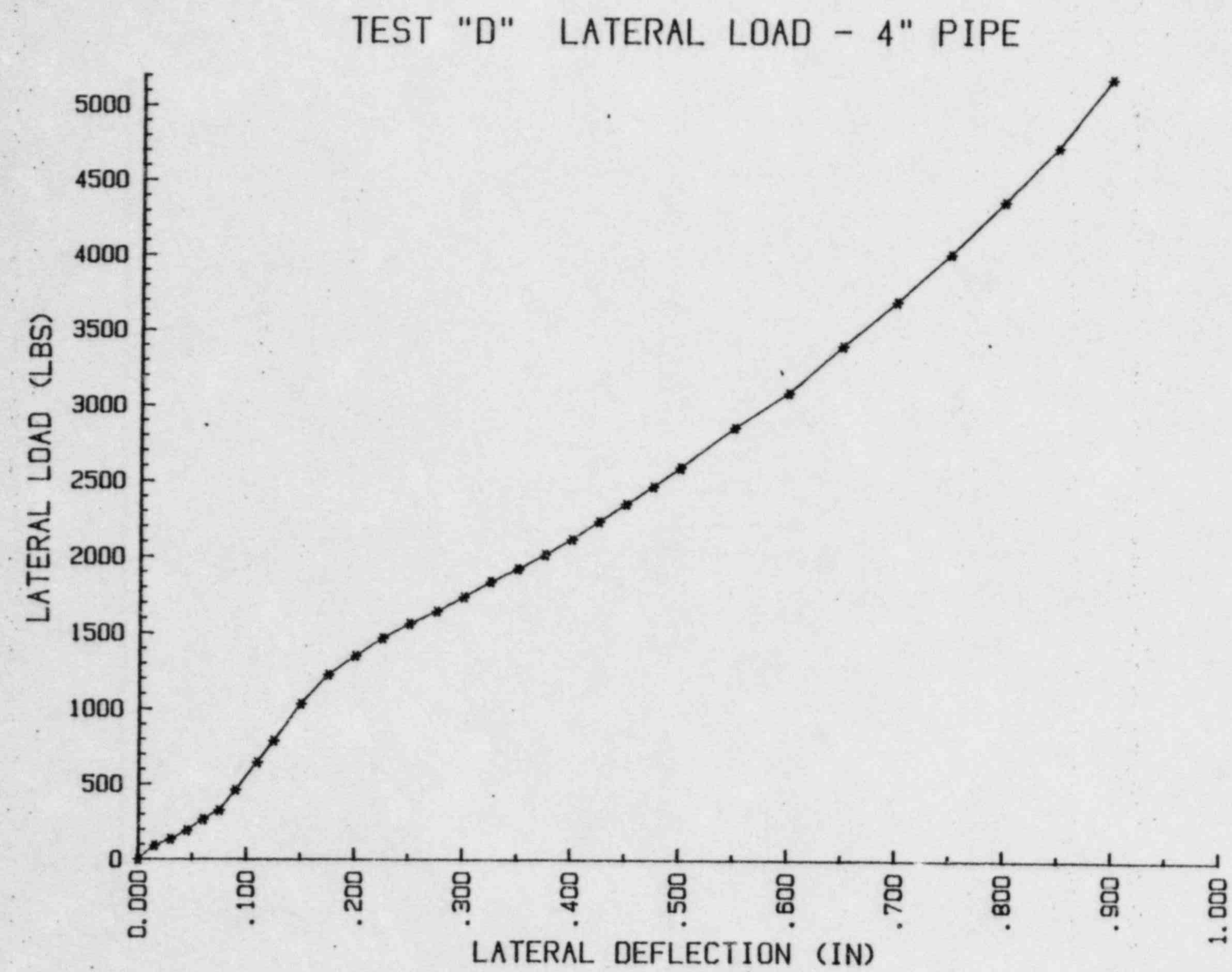
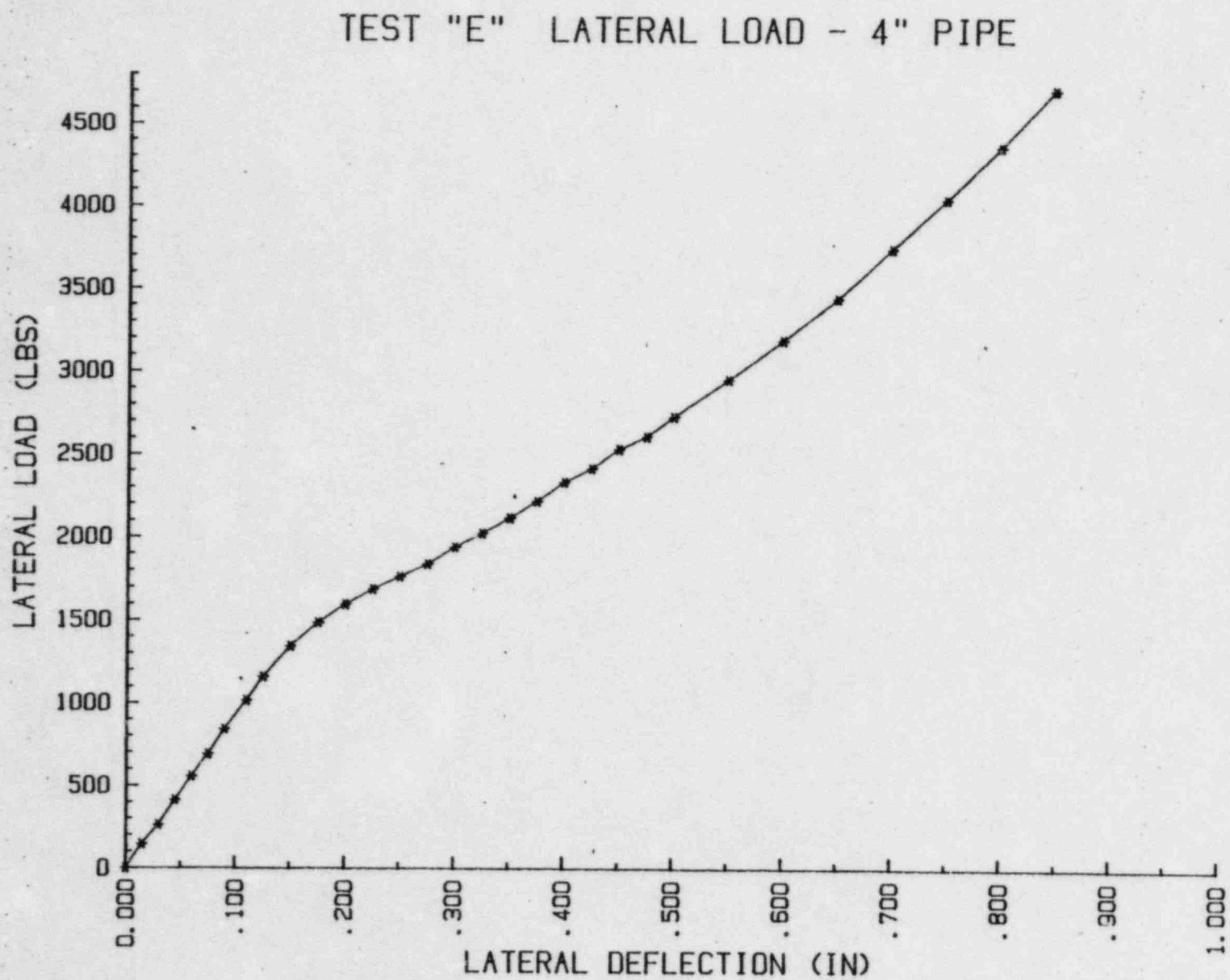


FIGURE A-7 TEST "D": LATERAL DEFLECTION VS. LATERAL LOAD



<u>FIGURE A-8</u> TEST "E": LATERAL DEFLECTION VS. LATERAL LOAD

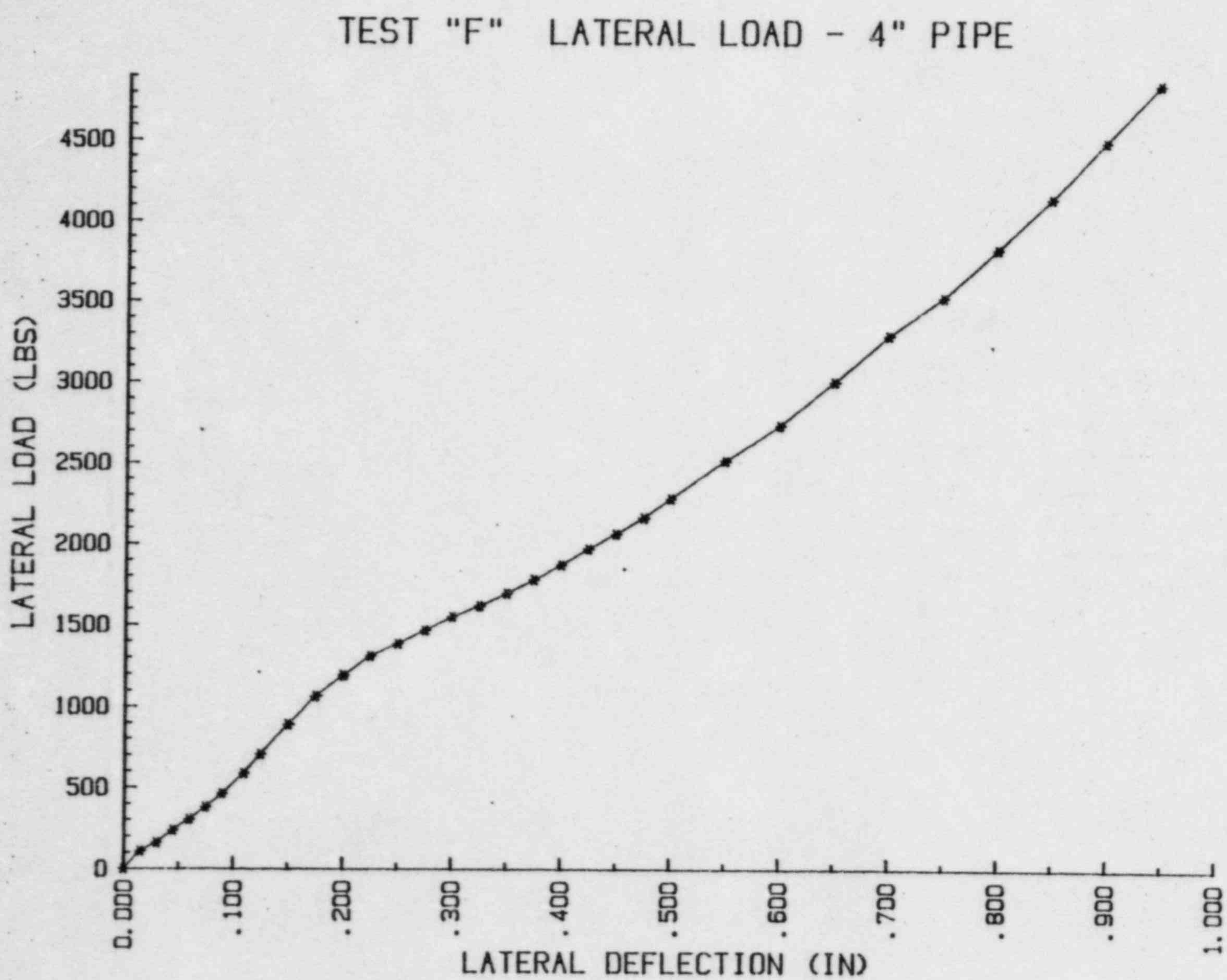
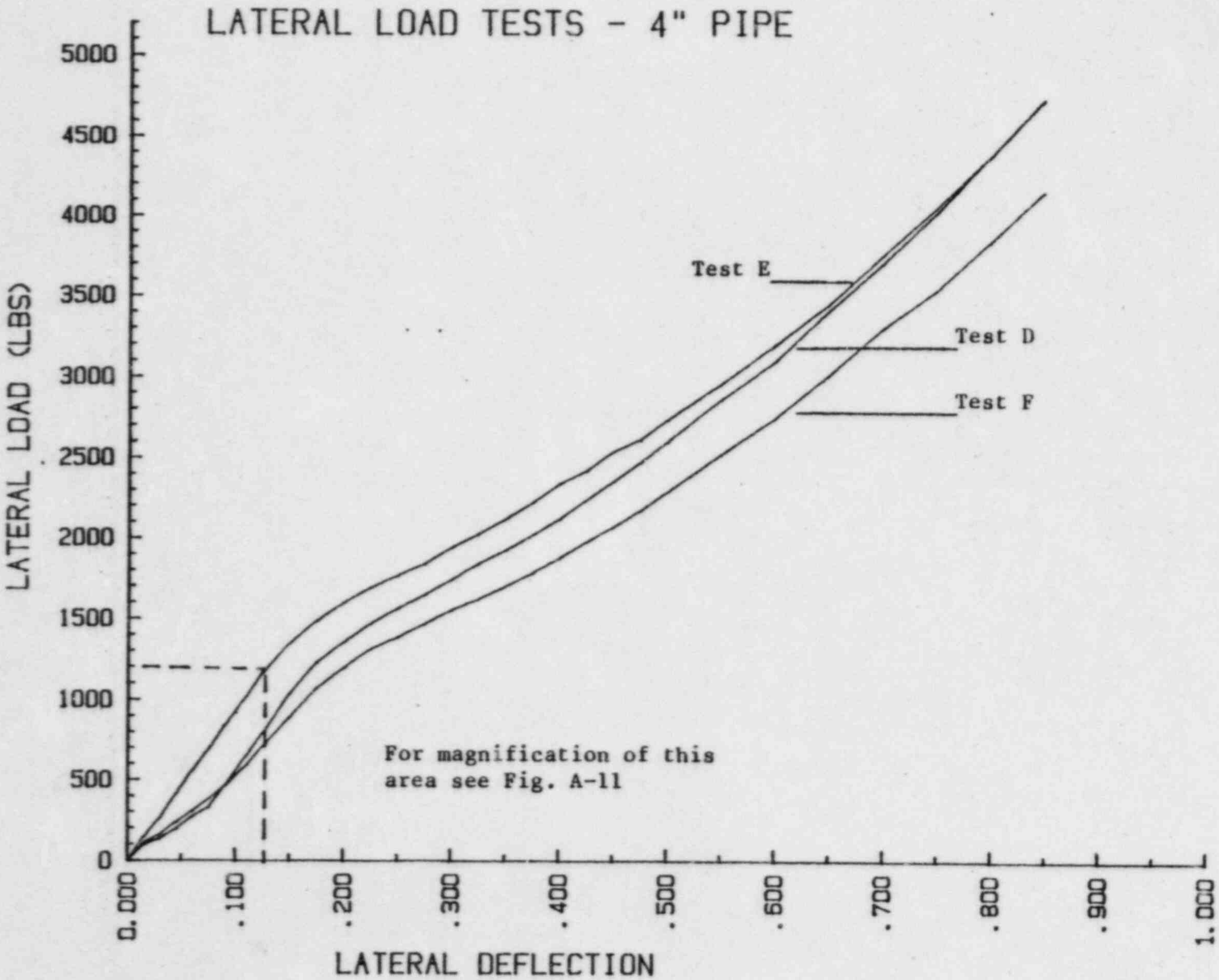


FIGURE A-9 TEST "F": LATERAL DEFLECTION VS. LATERAL LOAD



<u>FIGURE A-10</u> TEST COMPARISONS: LATERAL DEFLECTION VS. LATERAL LOAD

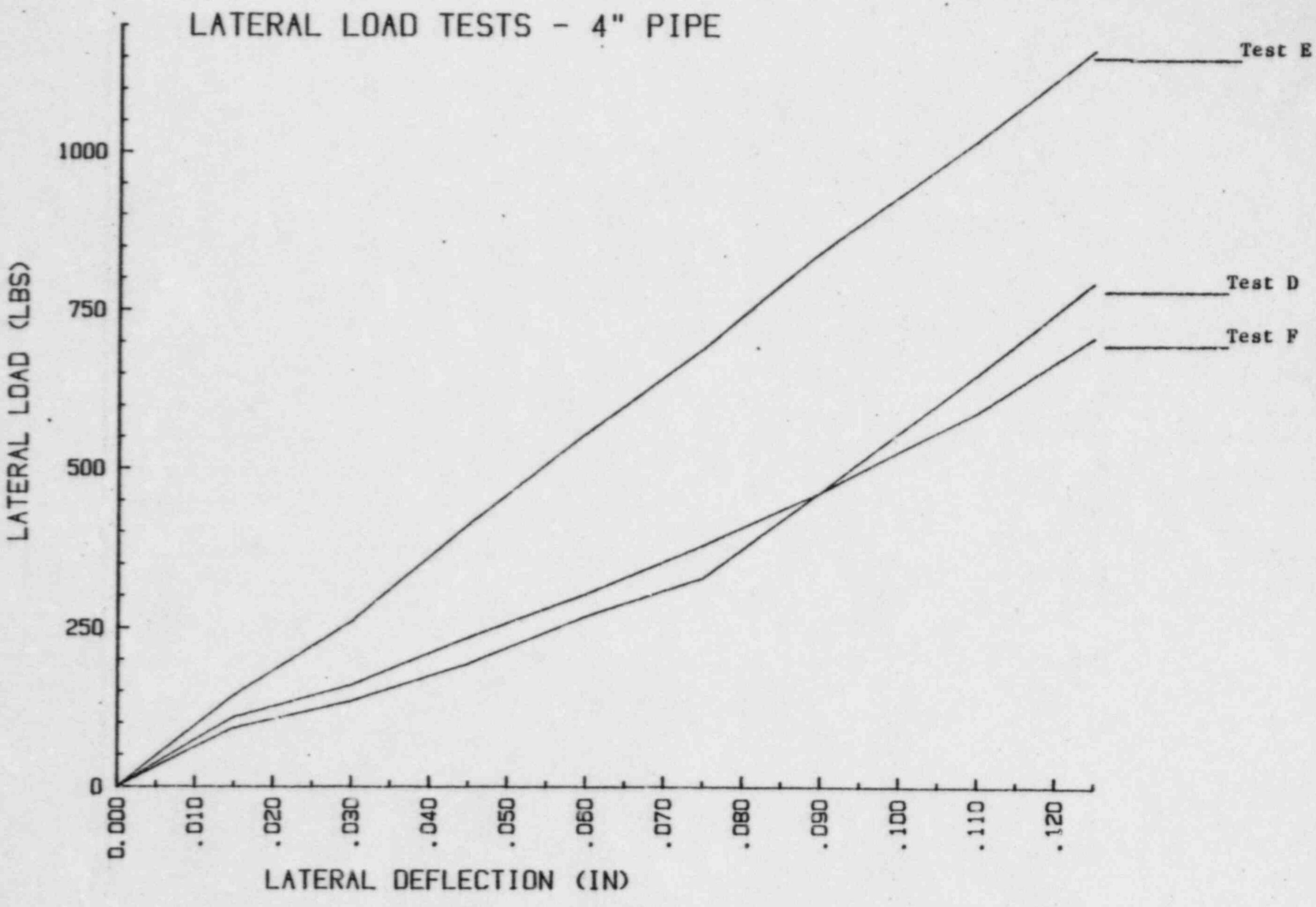


FIGURE A-11 TEST COMPARISONS: LATERAL DEFLECTION VS. LATERAL LOAD
SCALE MAGNIFICATION- 0 IN. TO .125 IN.

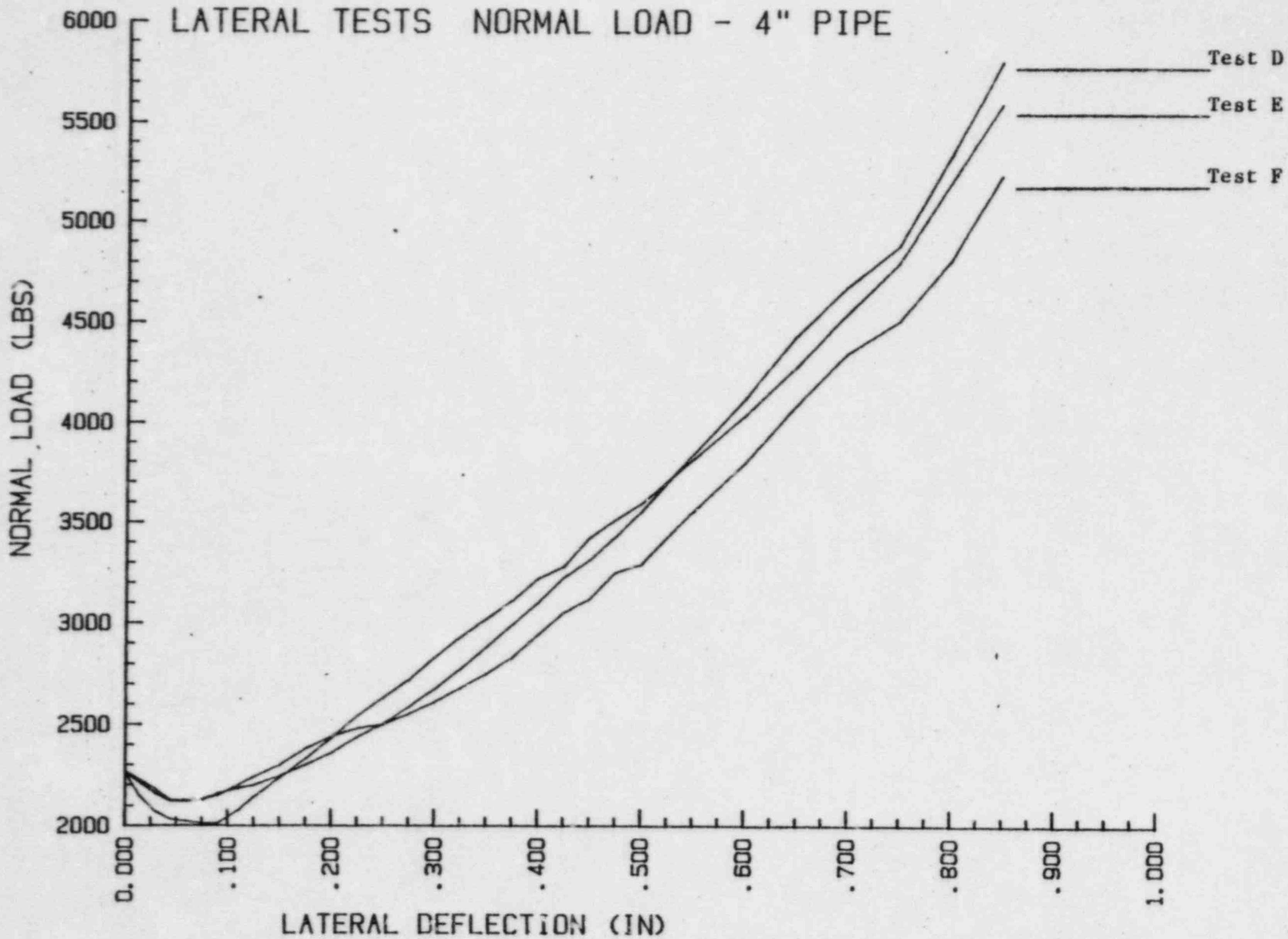


FIGURE A-12 TEST COMPARISONS: LATERAL DEFLECTION VS. NORMAL LOAD

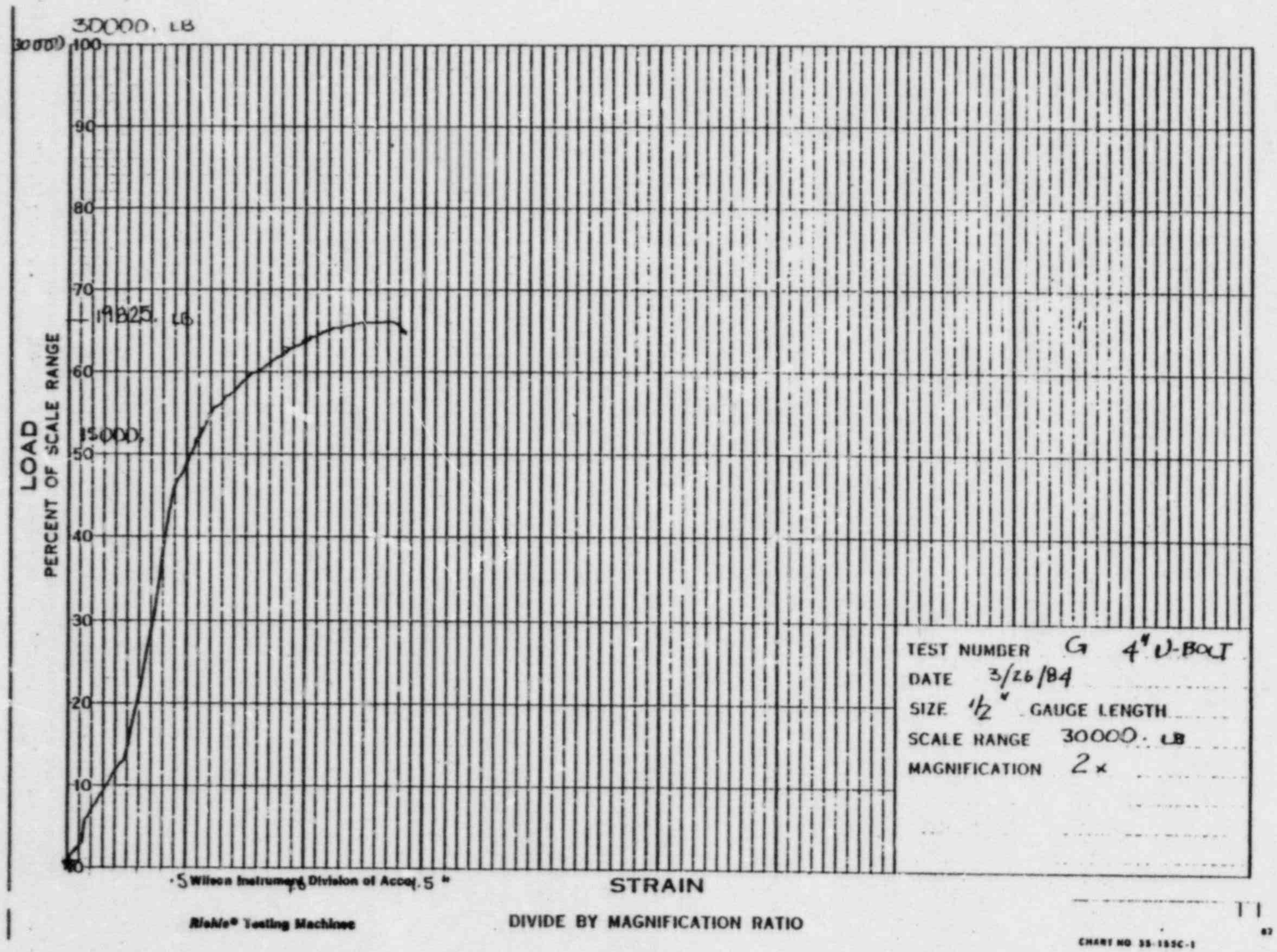


FIGURE A-13 TEST "G" : NORMAL LOAD VS. ELONGATION

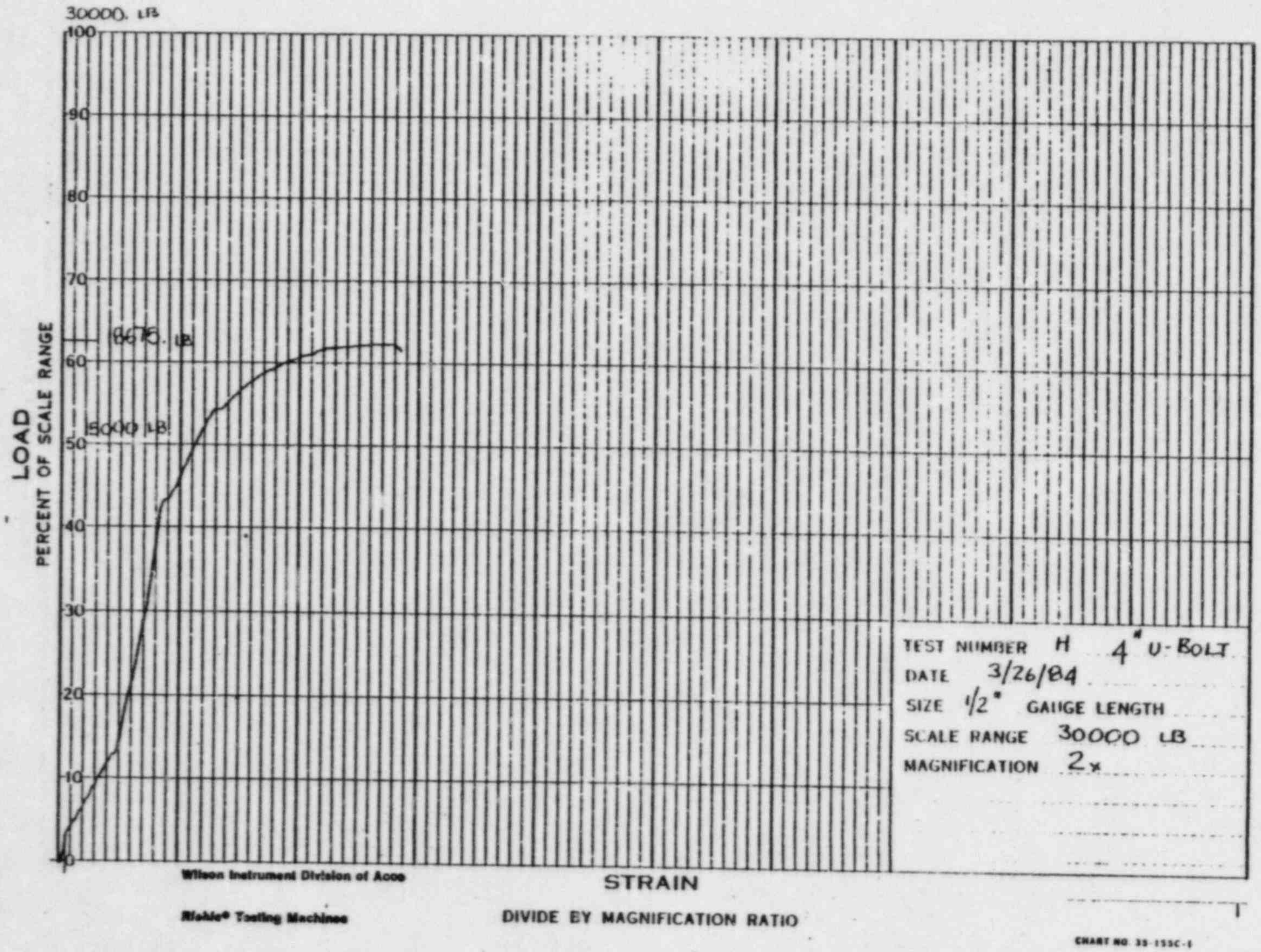


FIGURE A-14 TEST "H" : NORMAL LOAD VS. ELONGATION

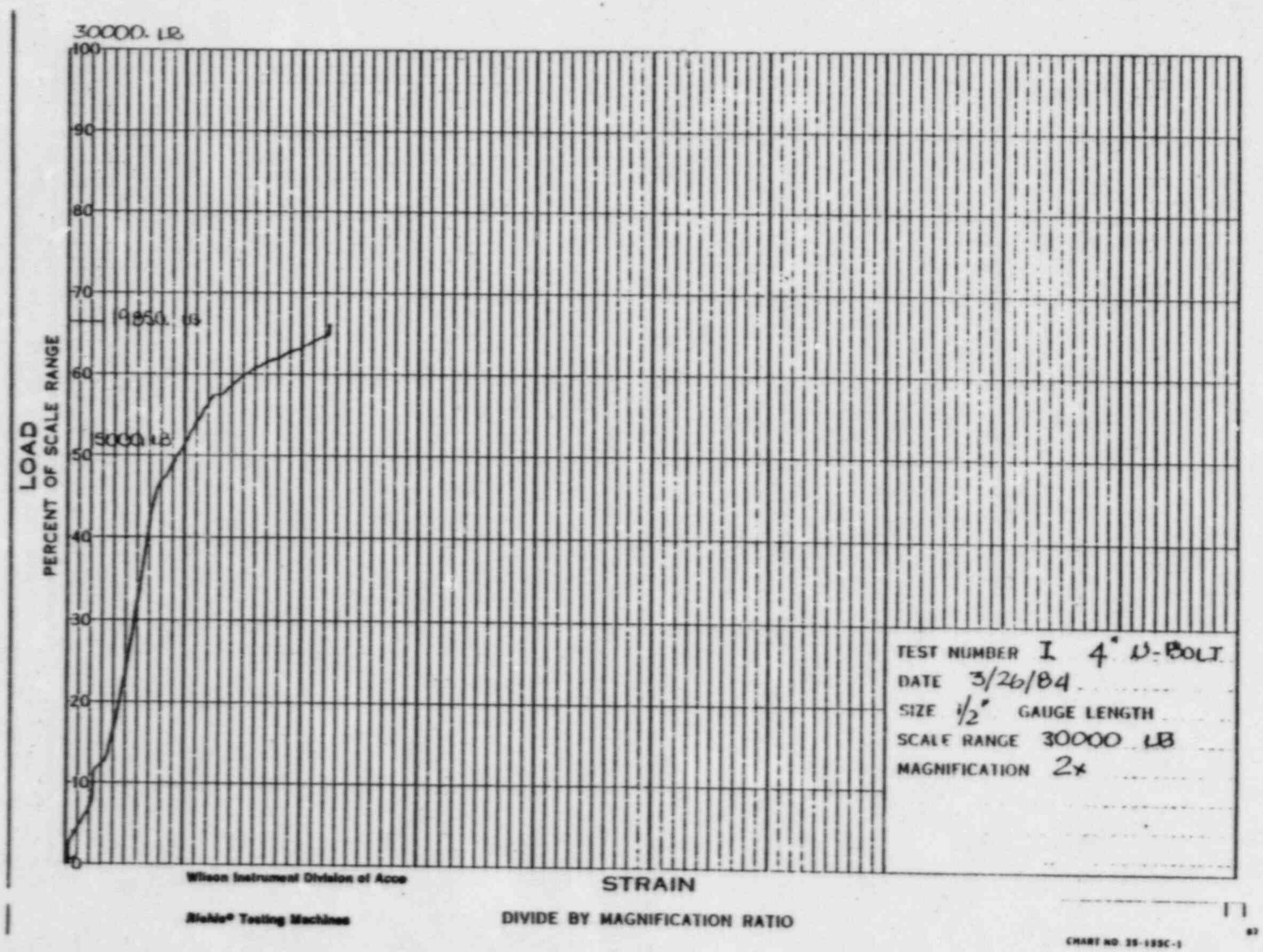


FIGURE A-15 TEST "I" : NORMAL LOAD VS. ELONGATION

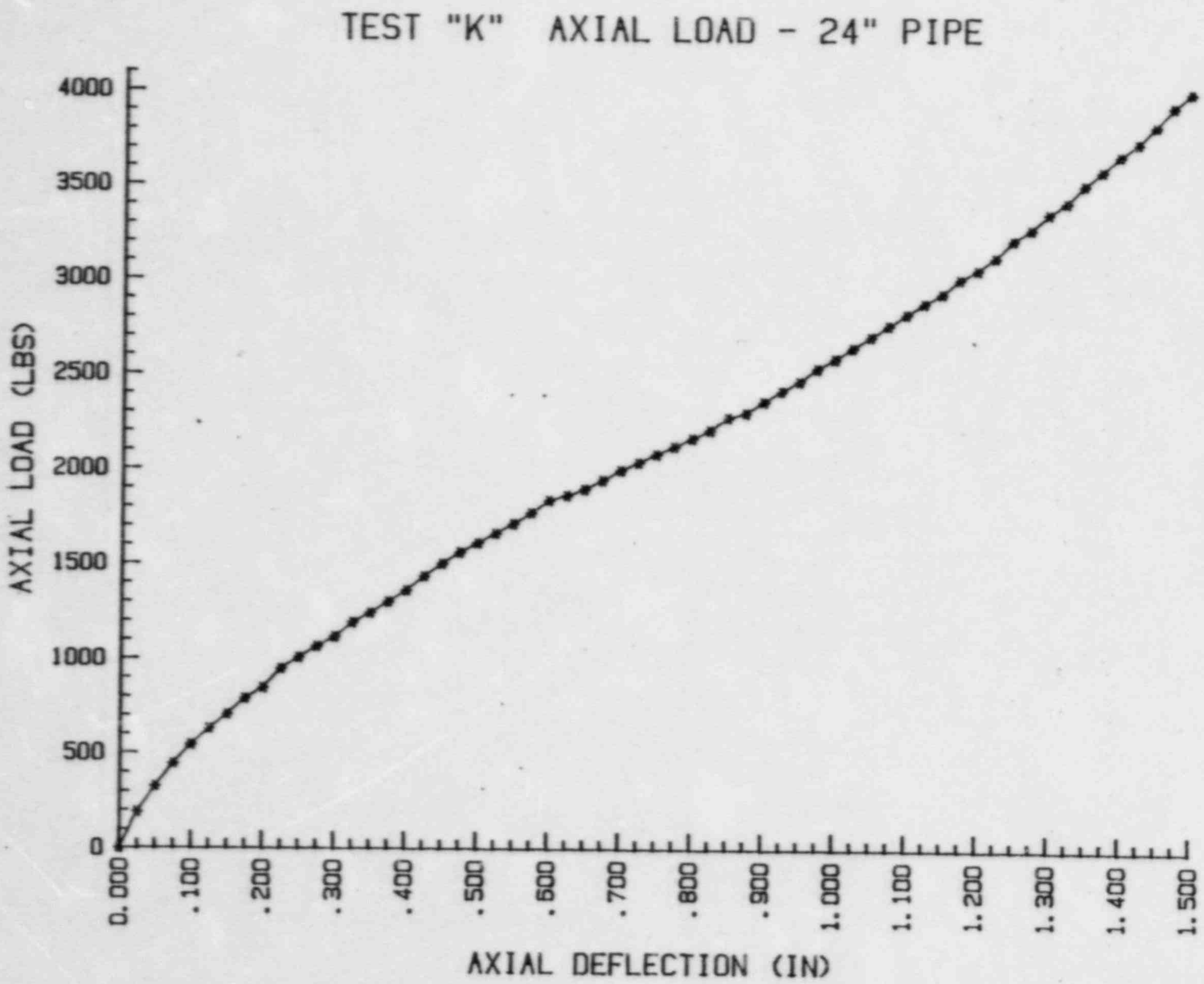


FIGURE A-16 TEST "K": AXIAL DEFLECTION VS. AXIAL LOAD

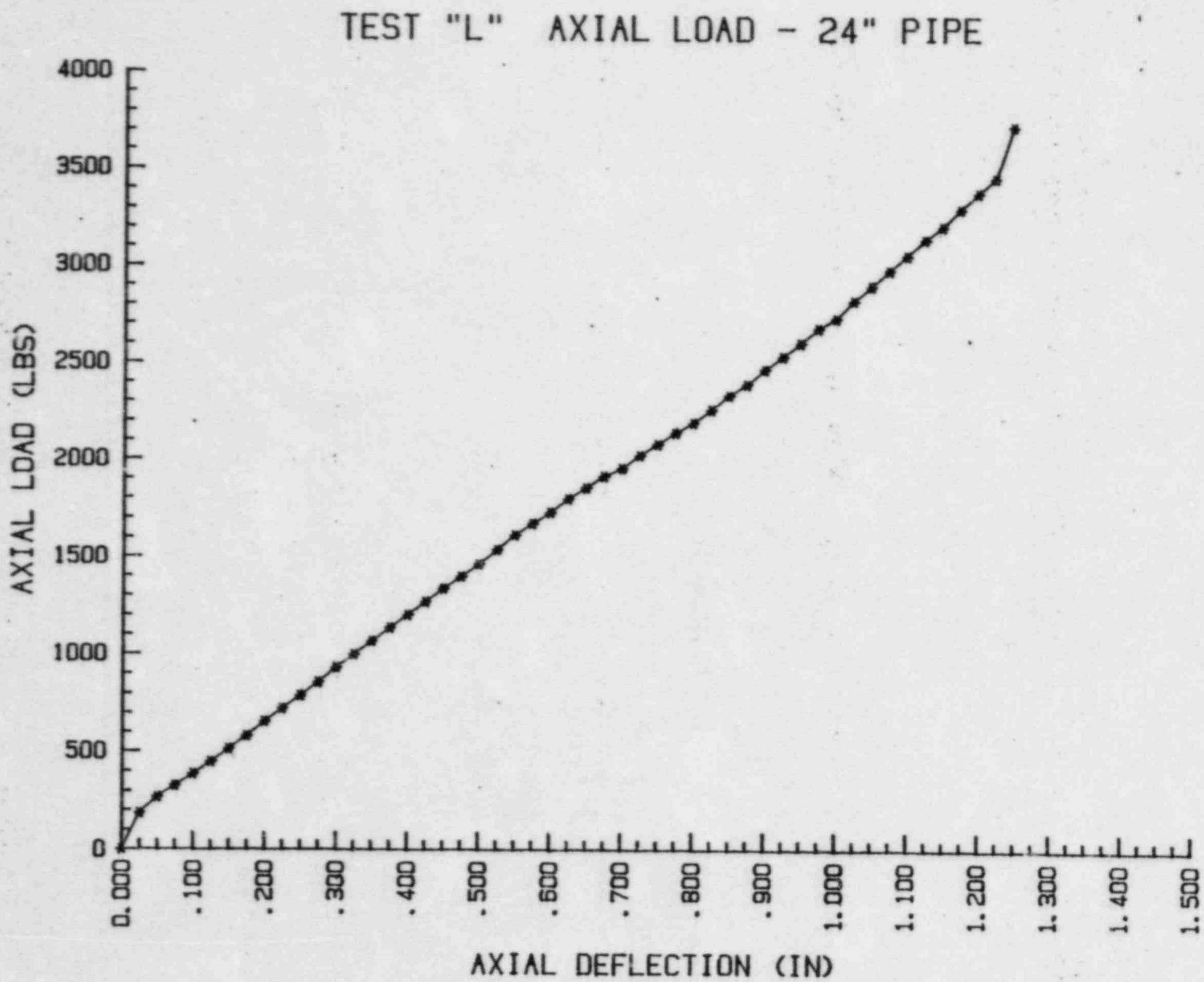


FIGURE A-17 TEST "L": AXIAL DEFLECTION VS. AXIAL LOAD

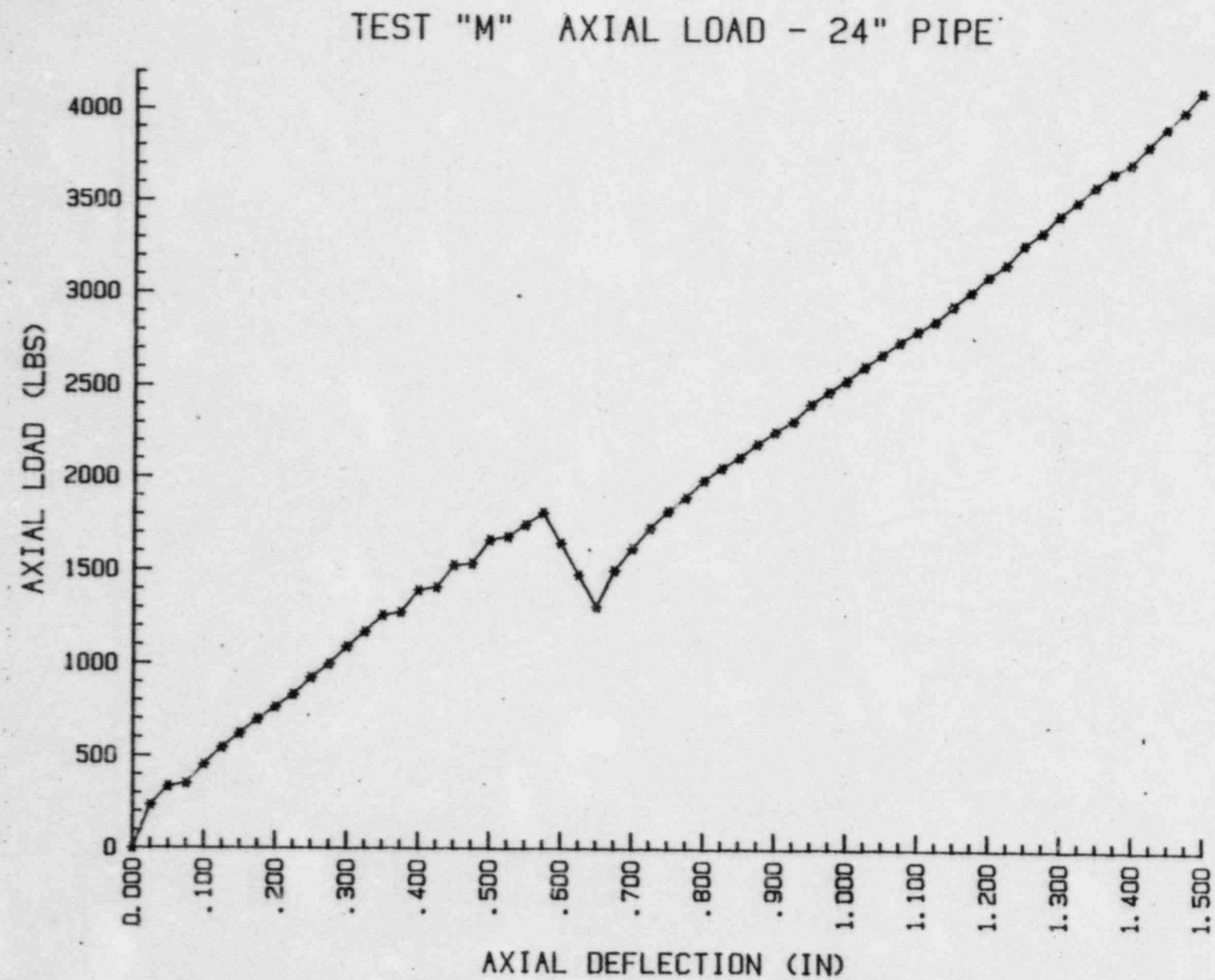


FIGURE A-18 TEST "M": AXIAL DEFLECTION VS. AXIAL LOAD

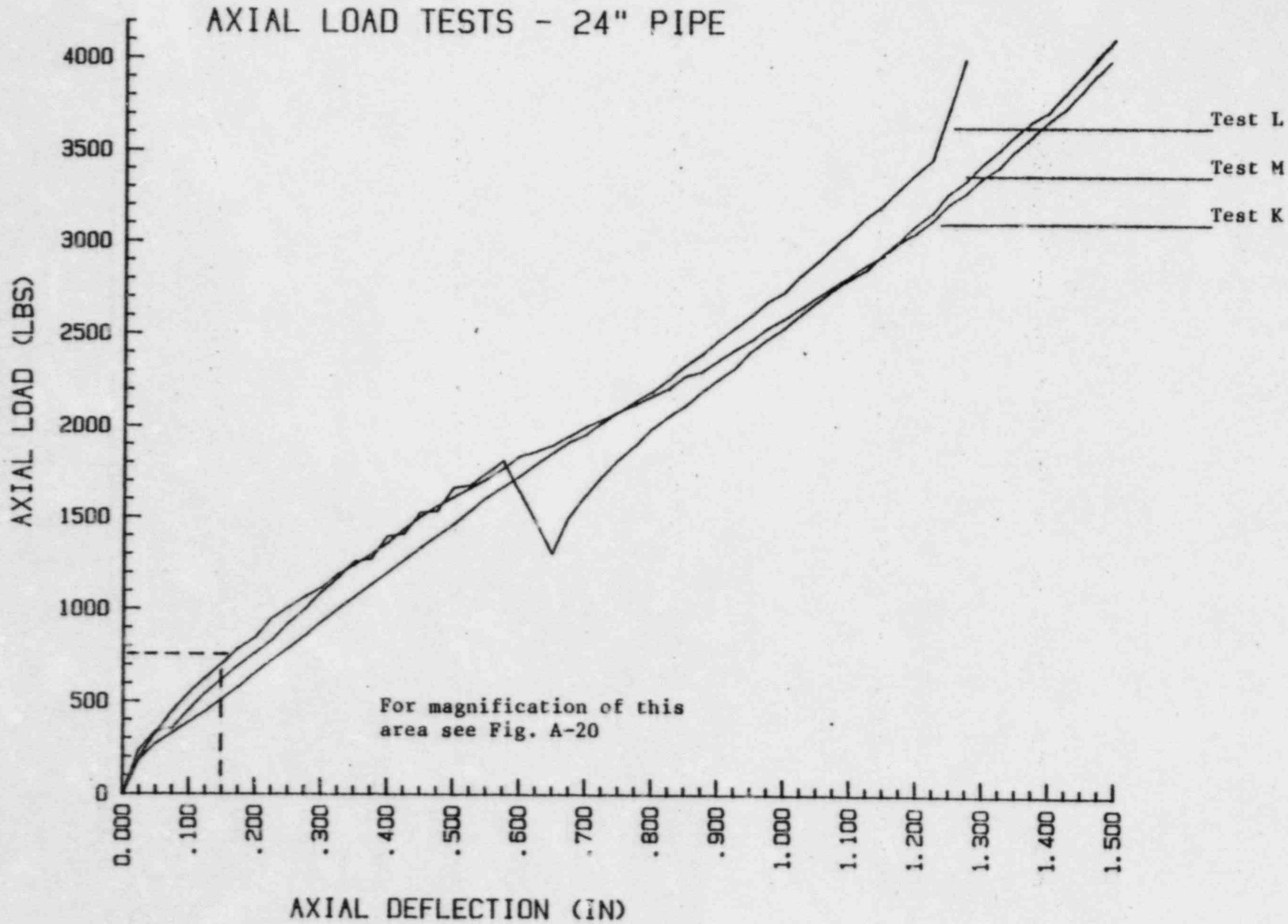


FIGURE A-19 TEST COMPARISONS: AXIAL DEFLECTION VS. AXIAL LOAD

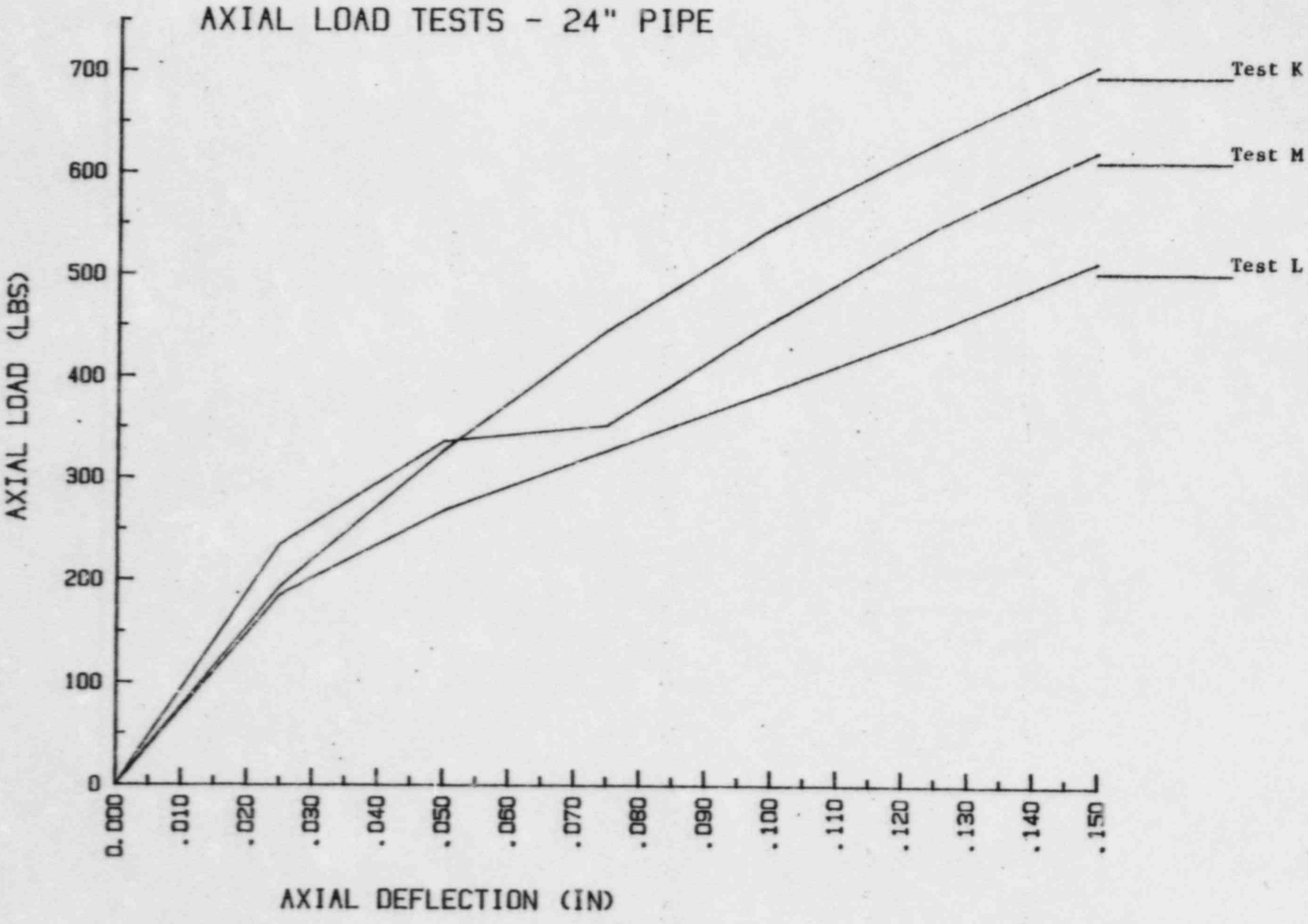
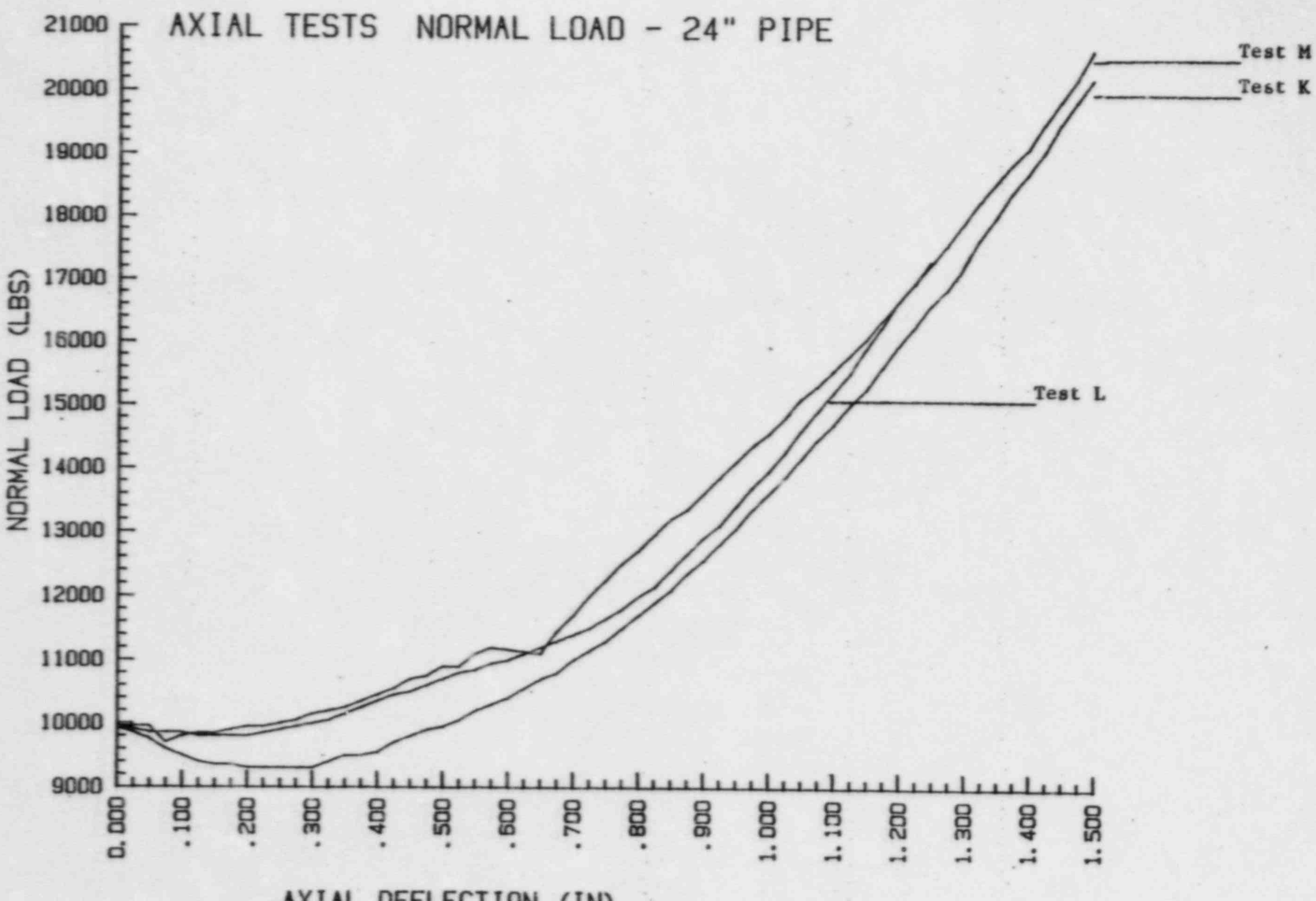
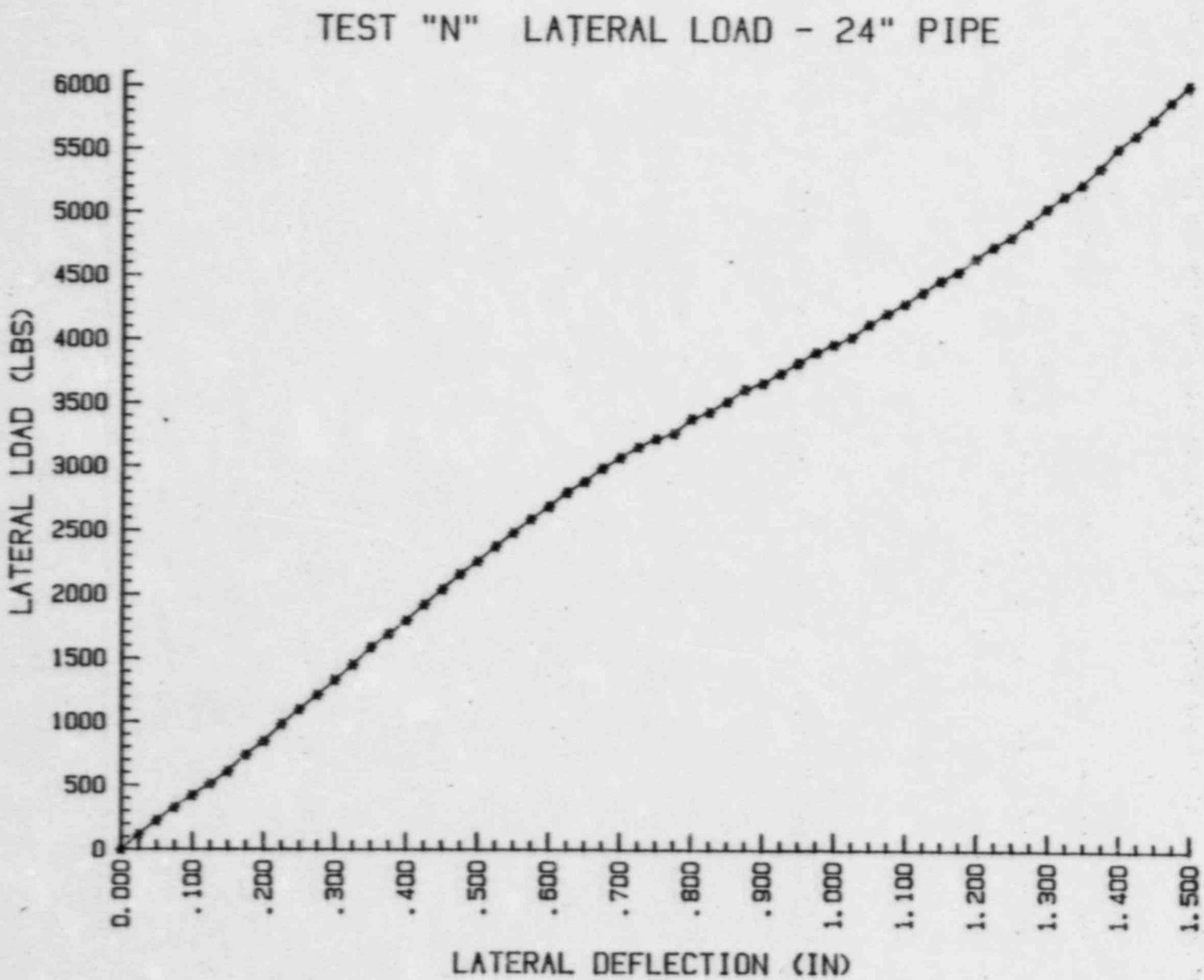


FIGURE A-20 TEST COMPARISONS: AXIAL DEFLECTIONS VS. AXIAL LOAD
SCALE MAGNIFICATION- 0 IN. TO .15 IN.



<u>FIGURE A-21</u> TEST COMPARISONS: AXIAL DEFLECTION VS. NORMAL LOAD



<u>FIGURE A-22</u> TEST "N": LATERAL DEFLECTION VS. LATERAL LOAD

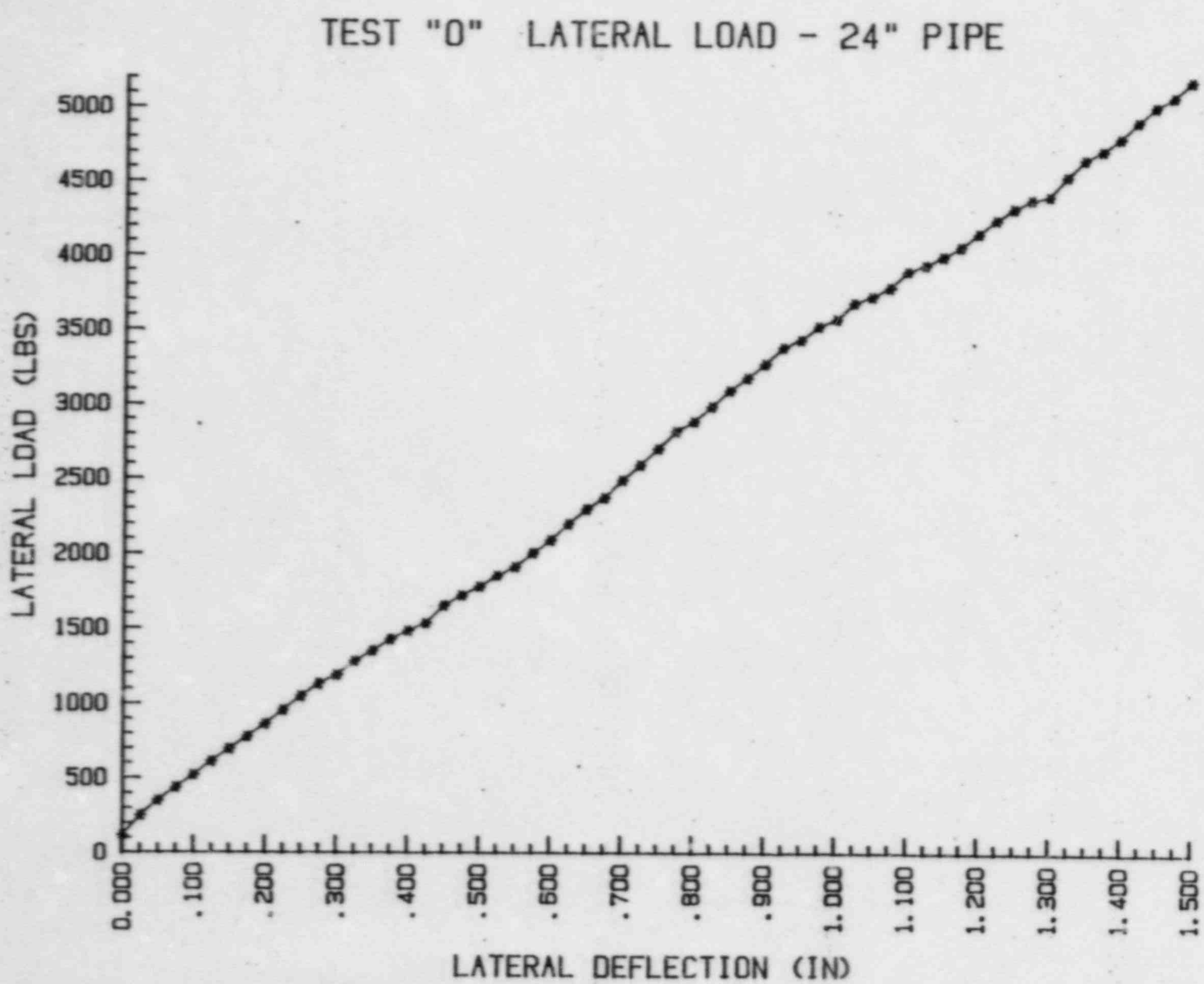


FIGURE A-23 TEST "O": LATERAL DEFLECTION VS. LATERAL LOAD

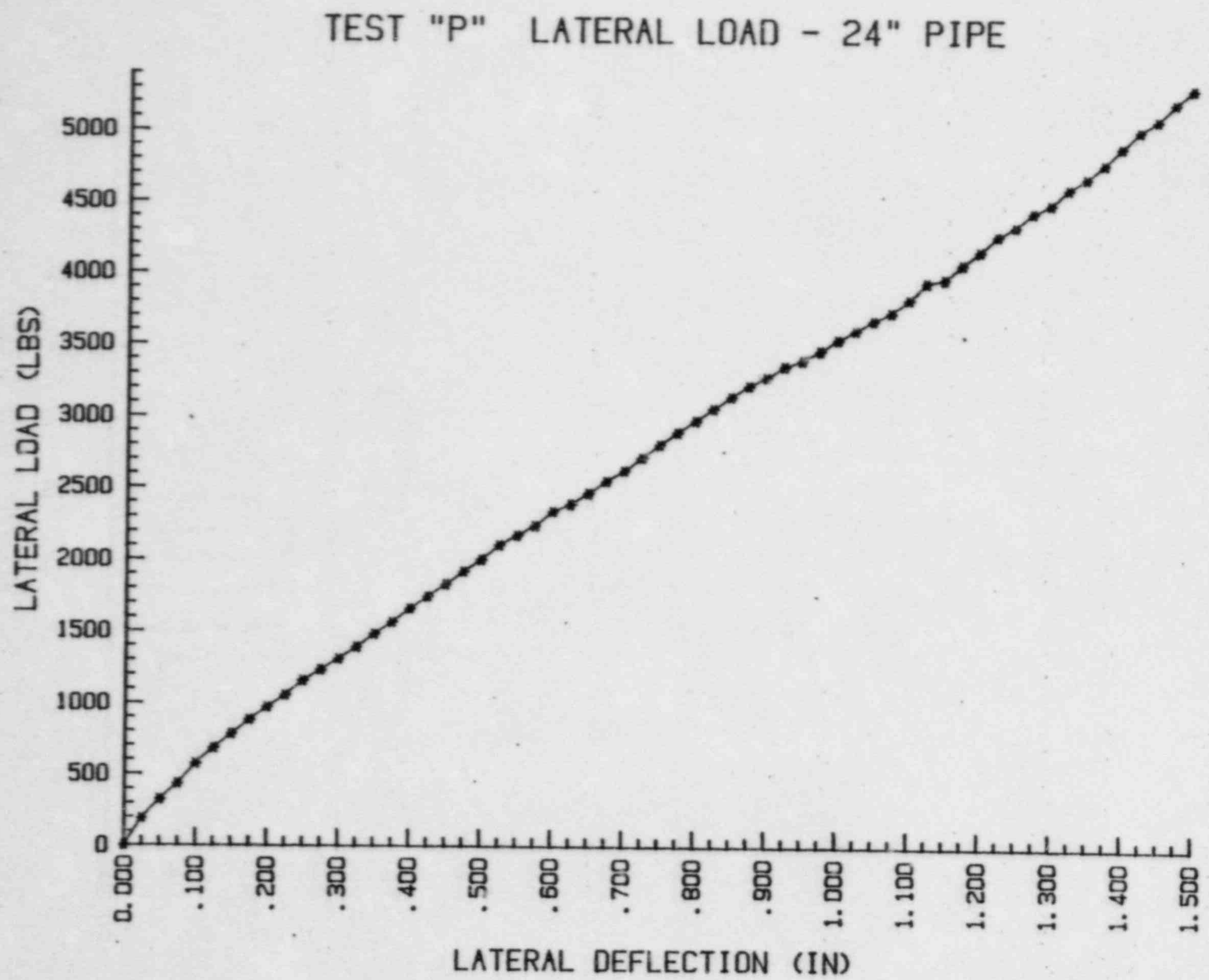


FIGURE A-24 TEST "P": LATERAL DEFLECTION VS. LATERAL LOAD

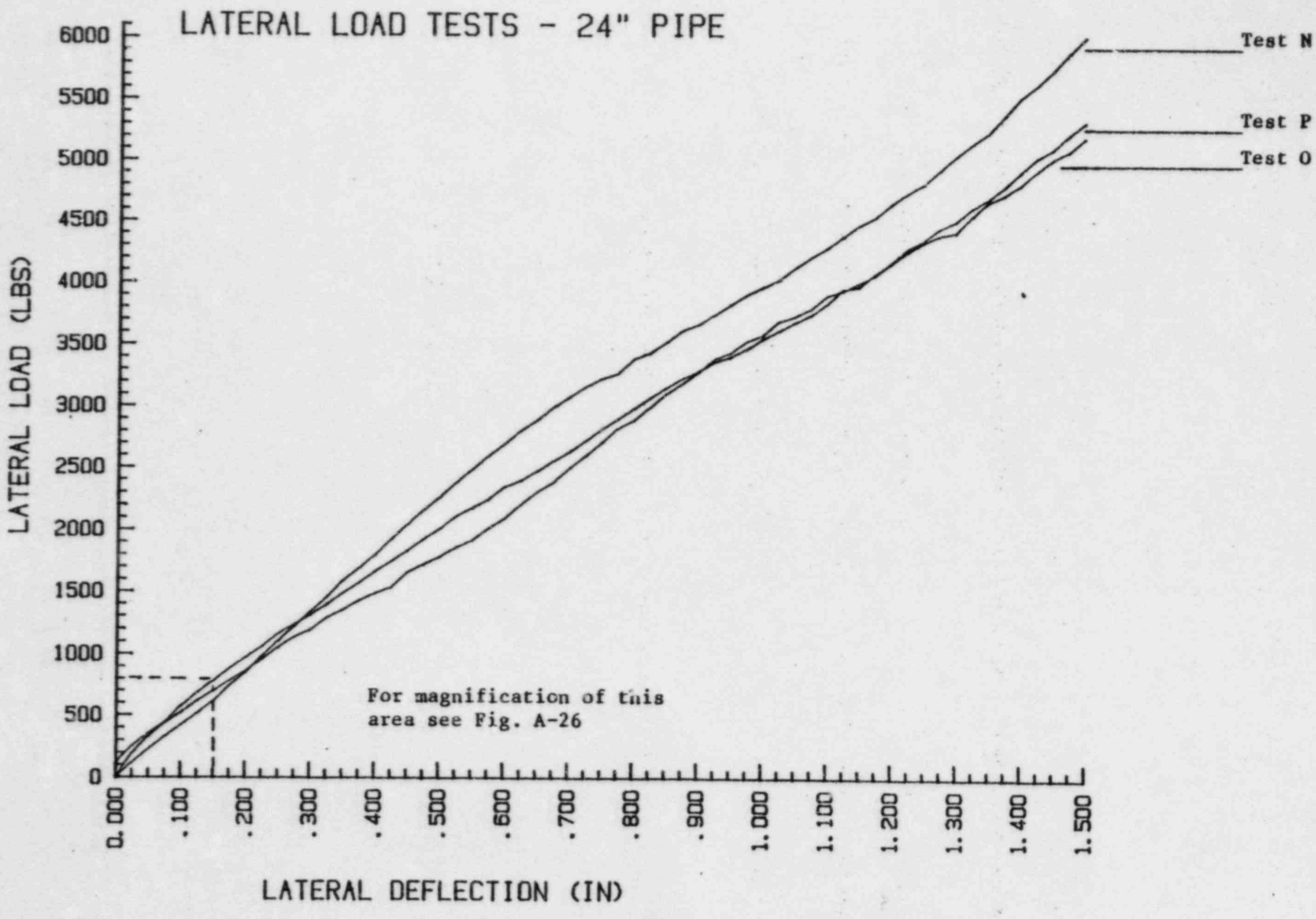
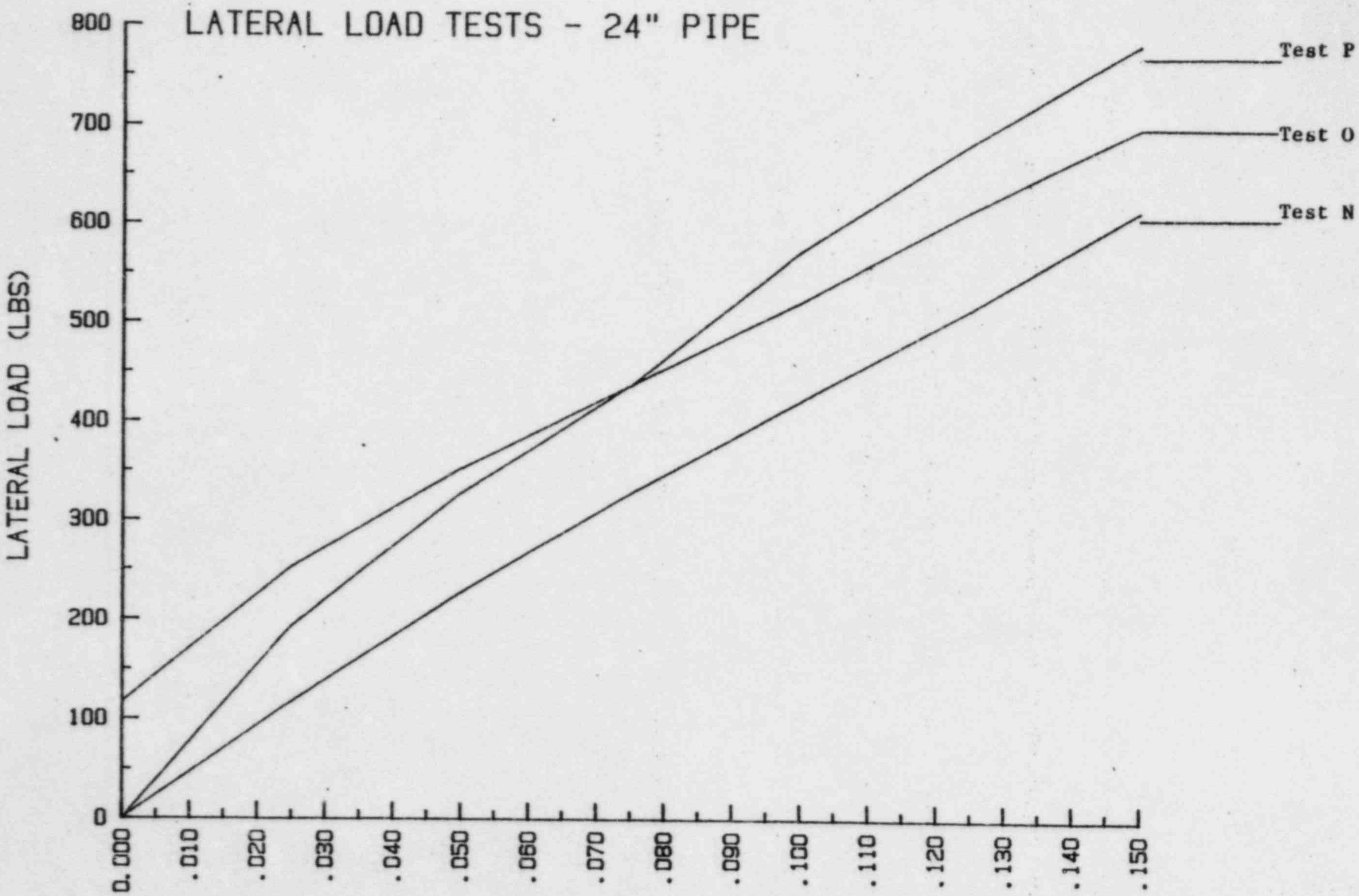


FIGURE A-25 TEST COMPARISONS: LATERAL DEFLECTION VS. LATERAL LOAD



<u>FIGURE A-26</u> TEST COMPARISONS: LATERAL DEFLECTION VS. LATERAL LOAD SCALE MAGNIFICATION- 0 IN. TO .15 IN.

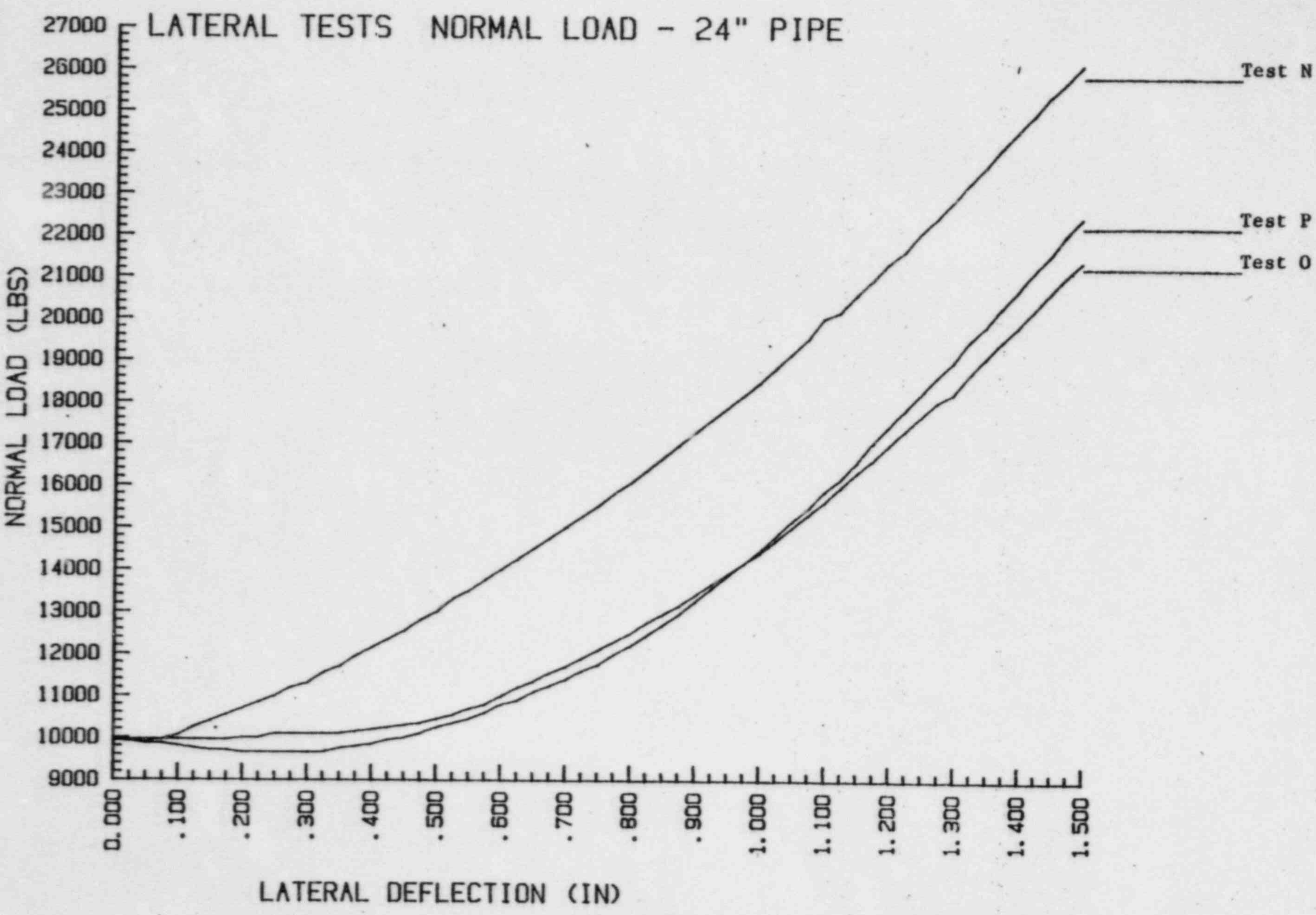


FIGURE A-27 TEST COMPARISONS: LATERAL DEFLECTION VS. NORMAL LOAD

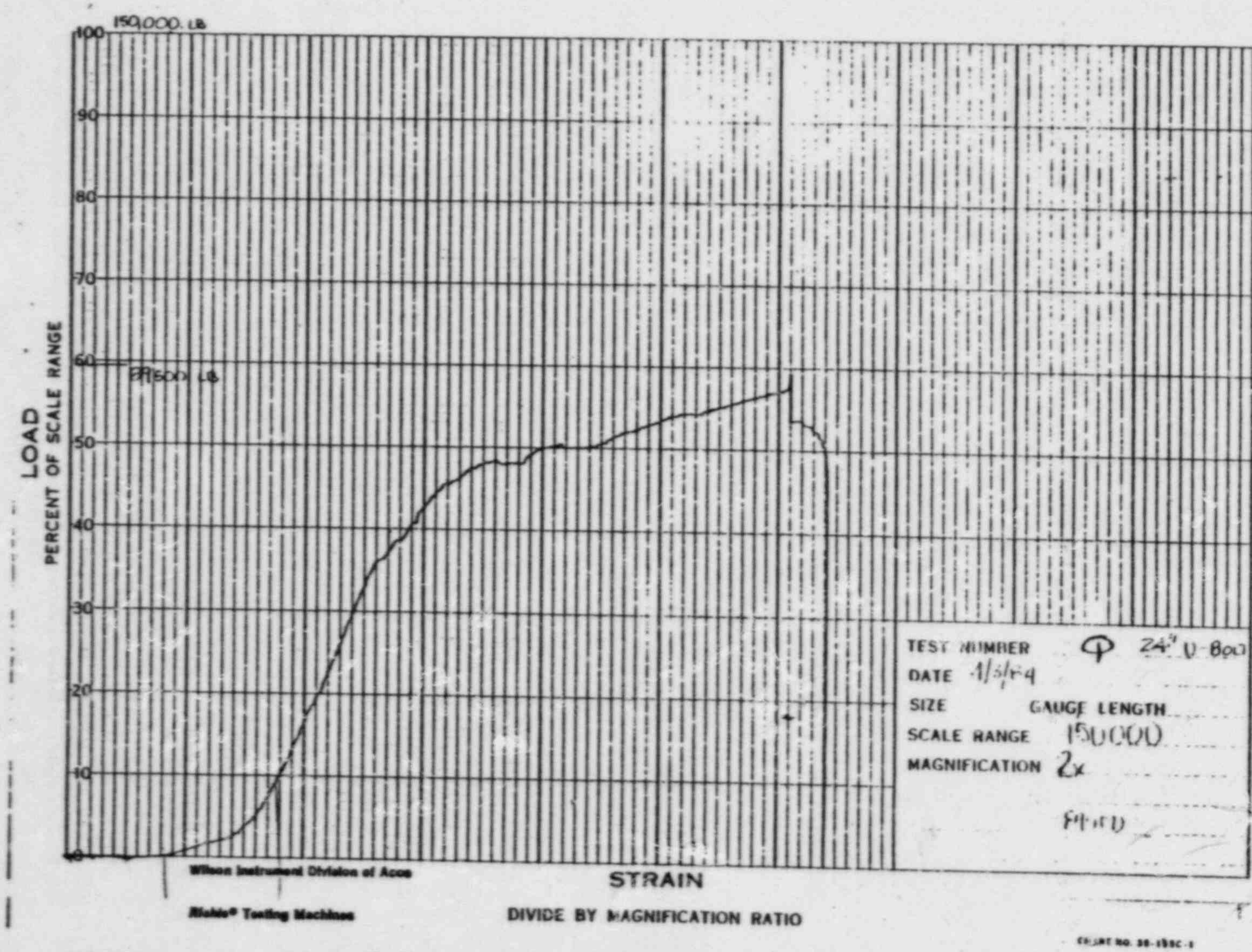


FIGURE A-28 TEST "Q" : NORMAL LOAD VS. ELONGATION

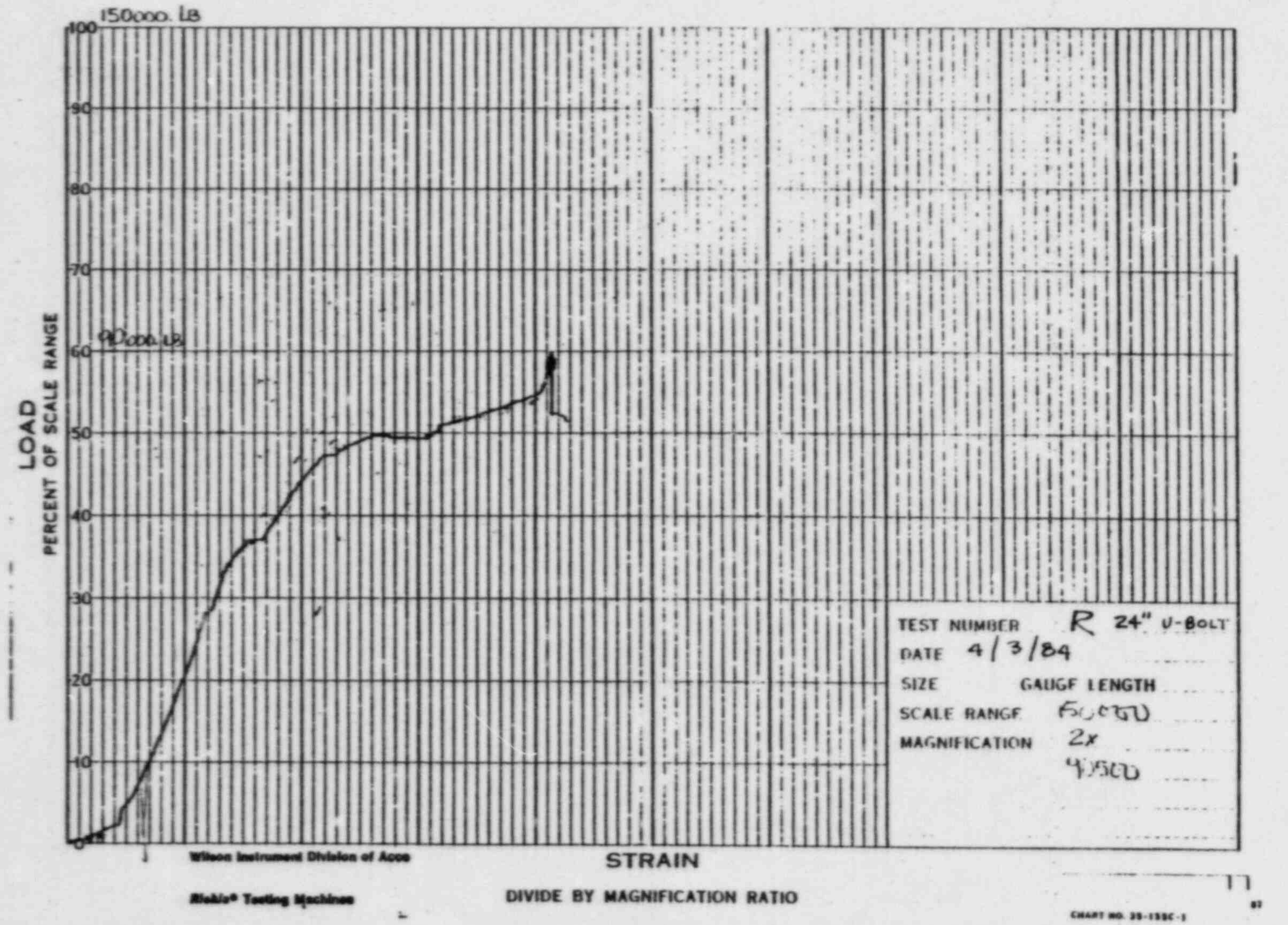


FIGURE A-29 TEST "R" : NORMAL LOAD VS. ELONGATION

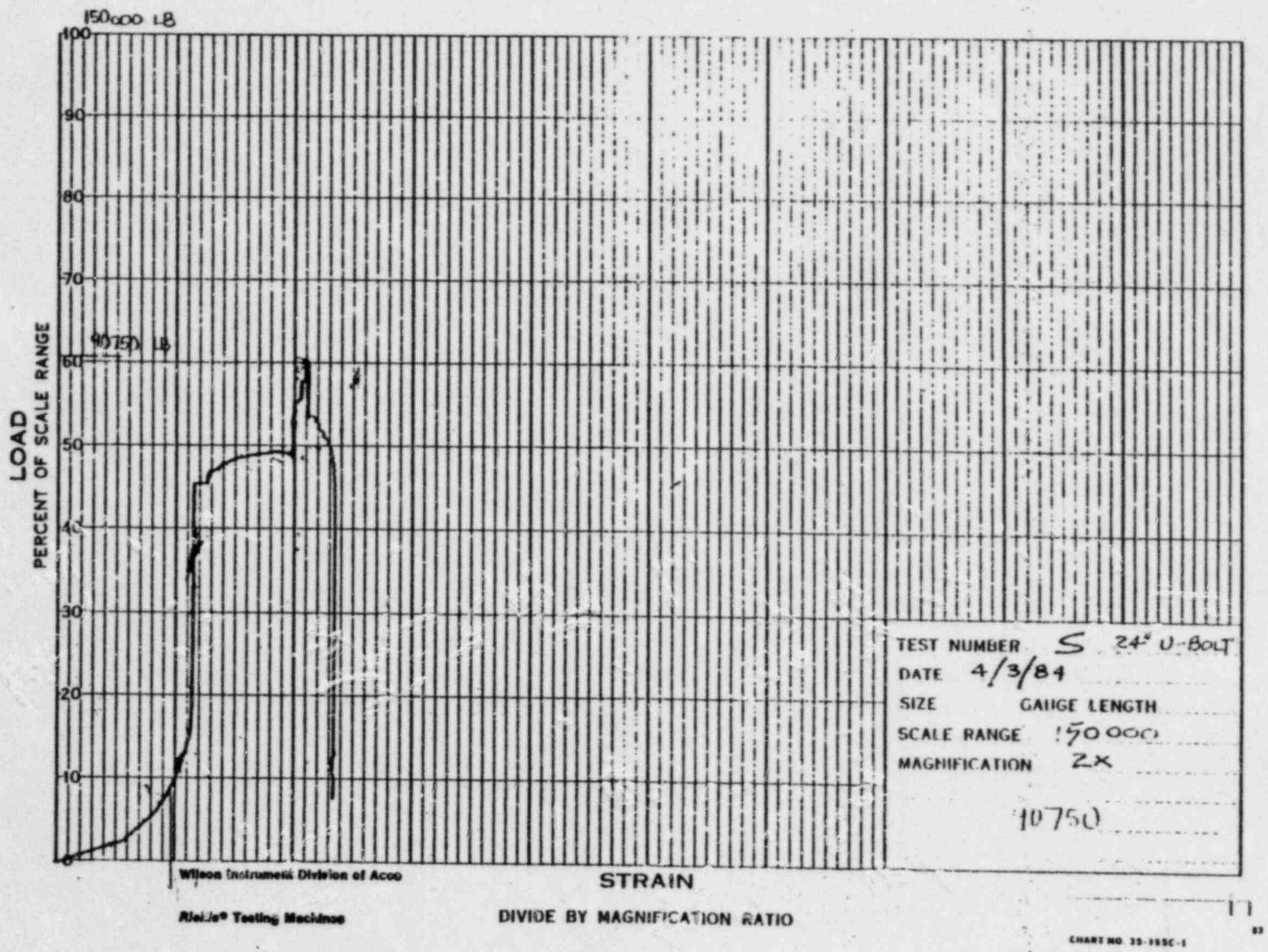
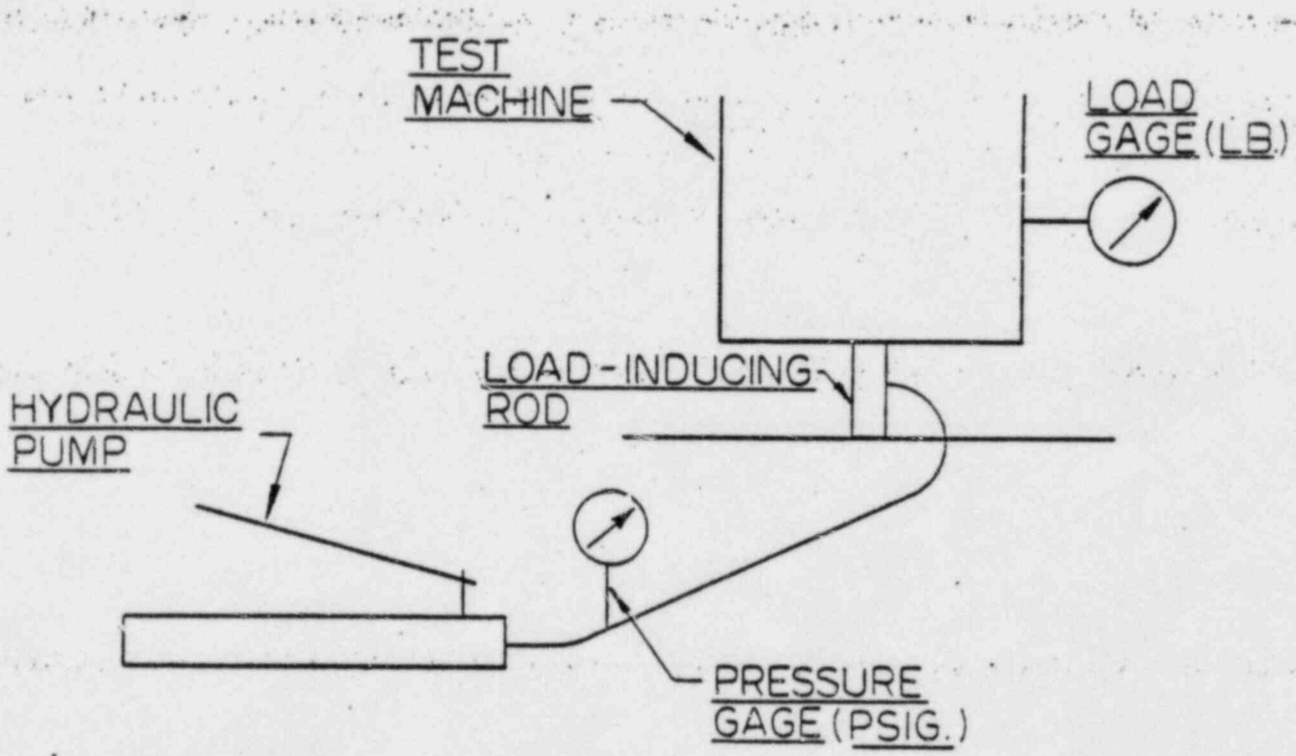


FIGURE A-30 TEST "S" : NORMAL LOAD VS. ELONGATION

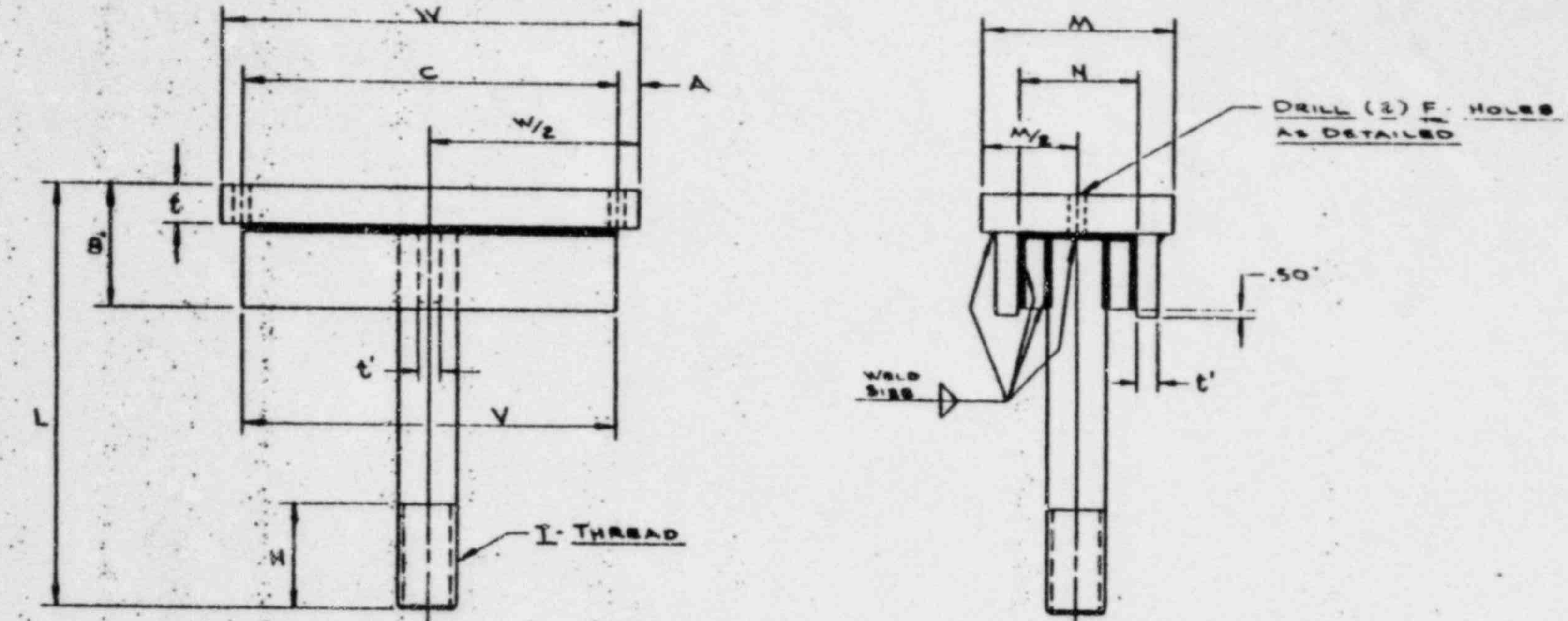
APPENDIX II

CALIBRATION OF 300 PSIG PRESSURE GAGE


TEST MACHINE
LOAD GAGE (LB.)
LOAD-INDUCING ROD
HYDRAULIC PUMP
PRESSURE GAGE (PSIG.)

<u>APPENDIX III</u>

TEST FIXTURE SKETCHES



PIPE SIZE	A	C	F-HOLE	H	L	M	N	t	t'	V	T-THREAD	WELD SIZE	W
4"	3.47"	5.06"	.56"	4.00"	24.00"	8.00"	4.50"	1.00"	.75"	8.00"	2"-8UN-2A	5/16	12.00"
24"	1.44"	25.12"	1.06"	7.00"	26.00"	18.00"	8.00"	2.00"	1.50"	25.00"	4"-8UN-2A	3/4	28.00"

REV.	DESCRIPTION	DCN	BY	APP'D	DATE

SCALE: NONE E.P.L. ~

MAT'L SPEC. ASTM A-36 OR EQUIVALENT
FAB. SPEC. N/A
WELD SPEC. N/A
NDE PROCEDURE N/A
FINISH, EXCEPT AS NOTED N/A
Q.A. REVIEW N/A

LIST OF PARTS ~
SUPERSEDES ~

TOLERANCE EXCEPT AS NOTED
FRAC.
DEC.
ANG.

DATE 3-13-84
DRAWN
CHK'D
APP'D

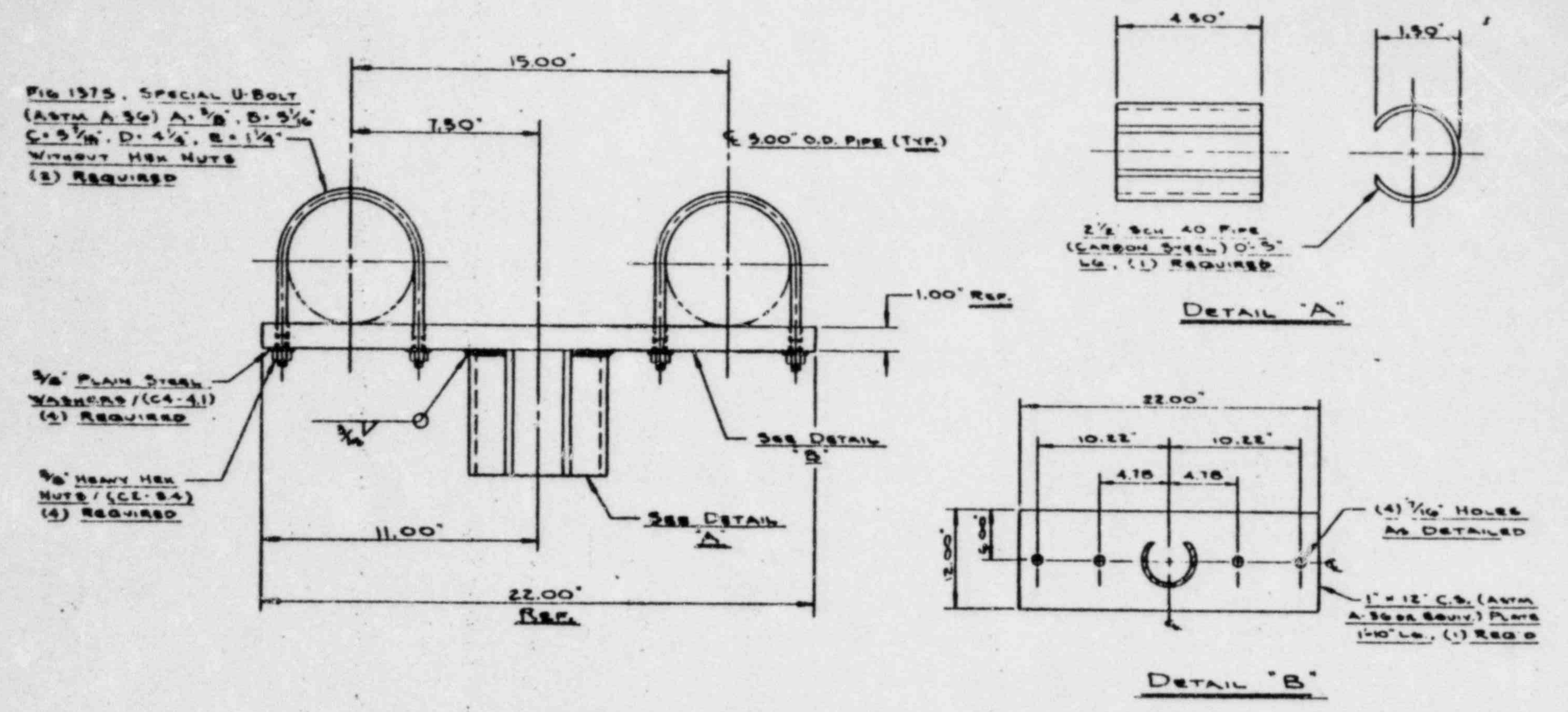
ITT Grinnell Corporation
PIPE HANGER DIVISION
RESEARCH, DEVELOPMENT & ENGINEERING
PROVIDENCE, R.I.

B FIG. 137 SIDE LOAD TEST STAND

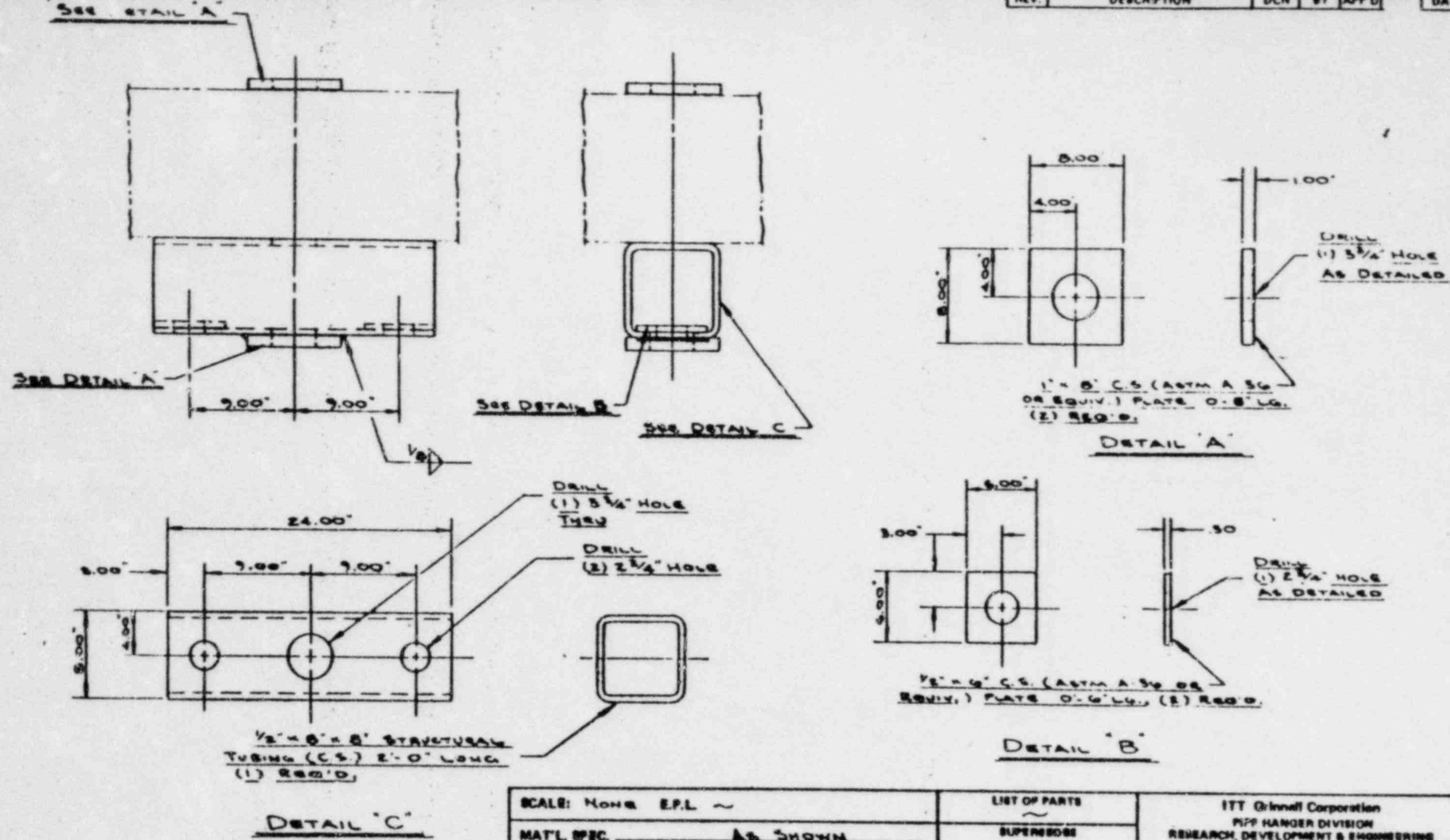
SA-4995-1

REV. —

REV.	DESCRIPTION	DCN	BY	APP'D	DATE

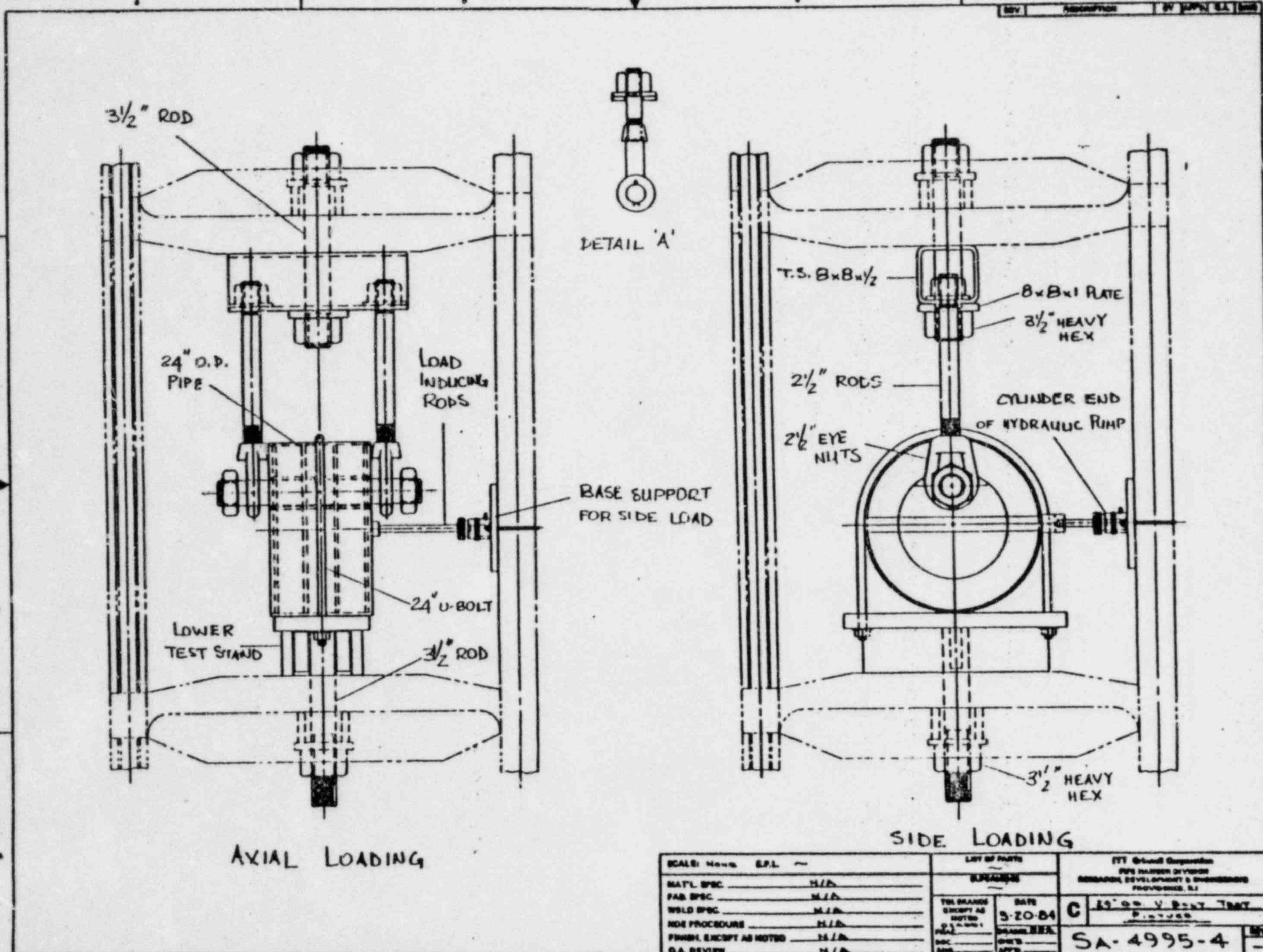


SCALE: NONE E.P.L. ~	LIST OF PARTS ~		ITT Grinnell Corporation PIPE HANGER DIVISION RESEARCH, DEVELOPMENT & ENGINEERING PROVIDENCE, R.I.	
MAT'L SPEC. AS SHOWN	SUPERSEDES ~			
FAB. SPEC. N/A	TOLERANCE EXCEPT AS NOTED 02A001	DATE 3-14-84	B	LATERAL LOAD BASE SUPPORT
WELD SPEC. N/A	FRAC.	DRAWN		
NDE PROCEDURE N/A	DEC.	CHK'D	SA-4995-2	REV. –
FINISH, EXCEPT AS NOTED N/A	ANG.	APP'D		
Q.A. REVIEW N/A				

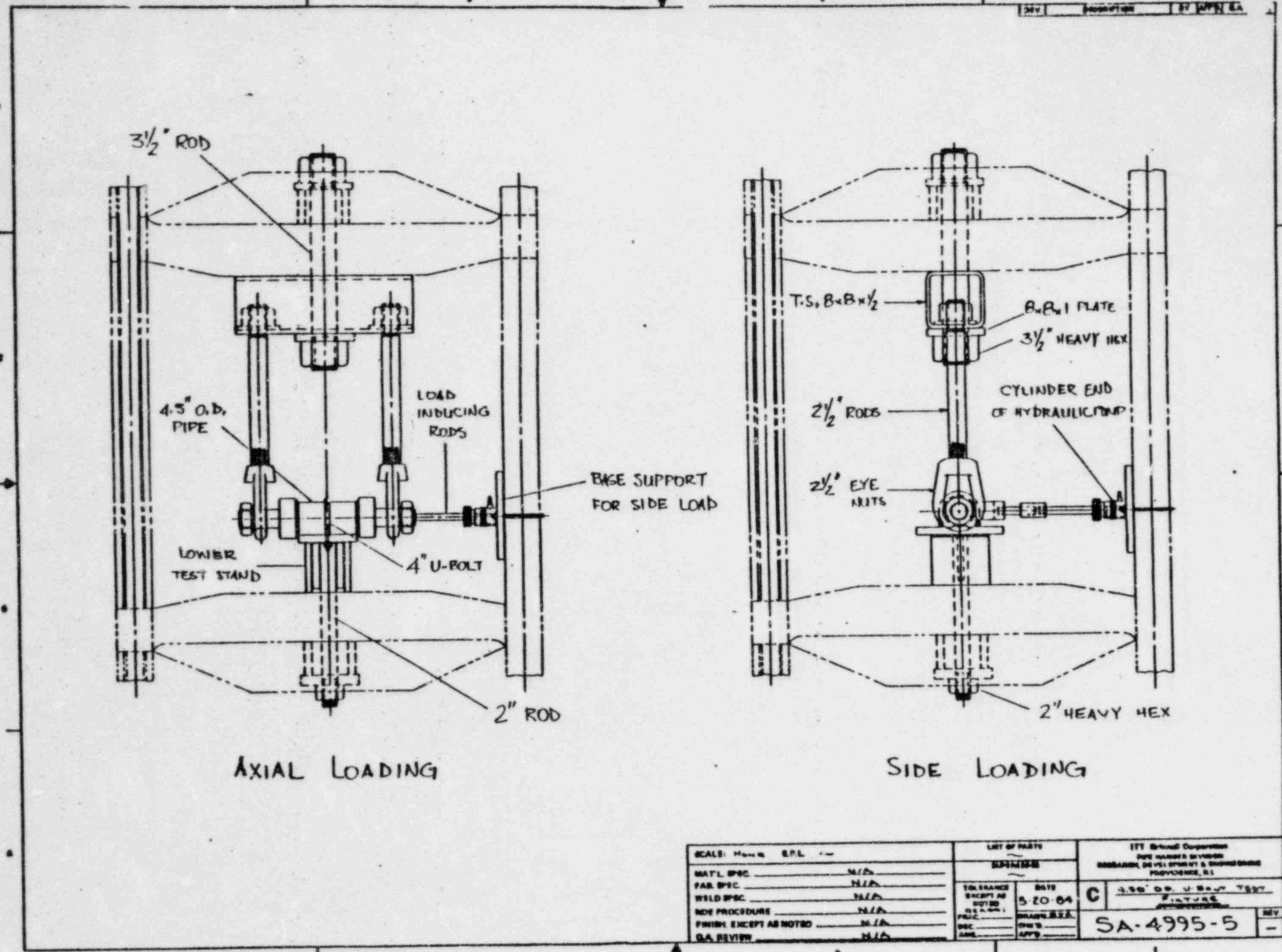


REV.	DESCRIPTION	DCN	BY	APP'D	DATE

SCALE: None E.P.L. ~	LIST OF PARTS ~	ITT Grinnell Corporation Pipe Hanger Division Research, Development & Engineering Providence, R.I.
MAT'L SPEC. As Shown FAB. SPEC. N/A WELD SPEC. N/A NDE PROCEDURE N/A FINISH, EXCEPT AS NOTED N/A Q.A. REVIEW N/A	SUPERSEDES ~ TOLERANCE EXCEPT AS NOTED 02A001 FRAC. ___ DEC. ___ ANG. ___ DATE 3-14-84 DRAWN E.T.S. CHK'D. ___ APP'D. ___	B Upper Test Fixture SA-4995-3 REV. —



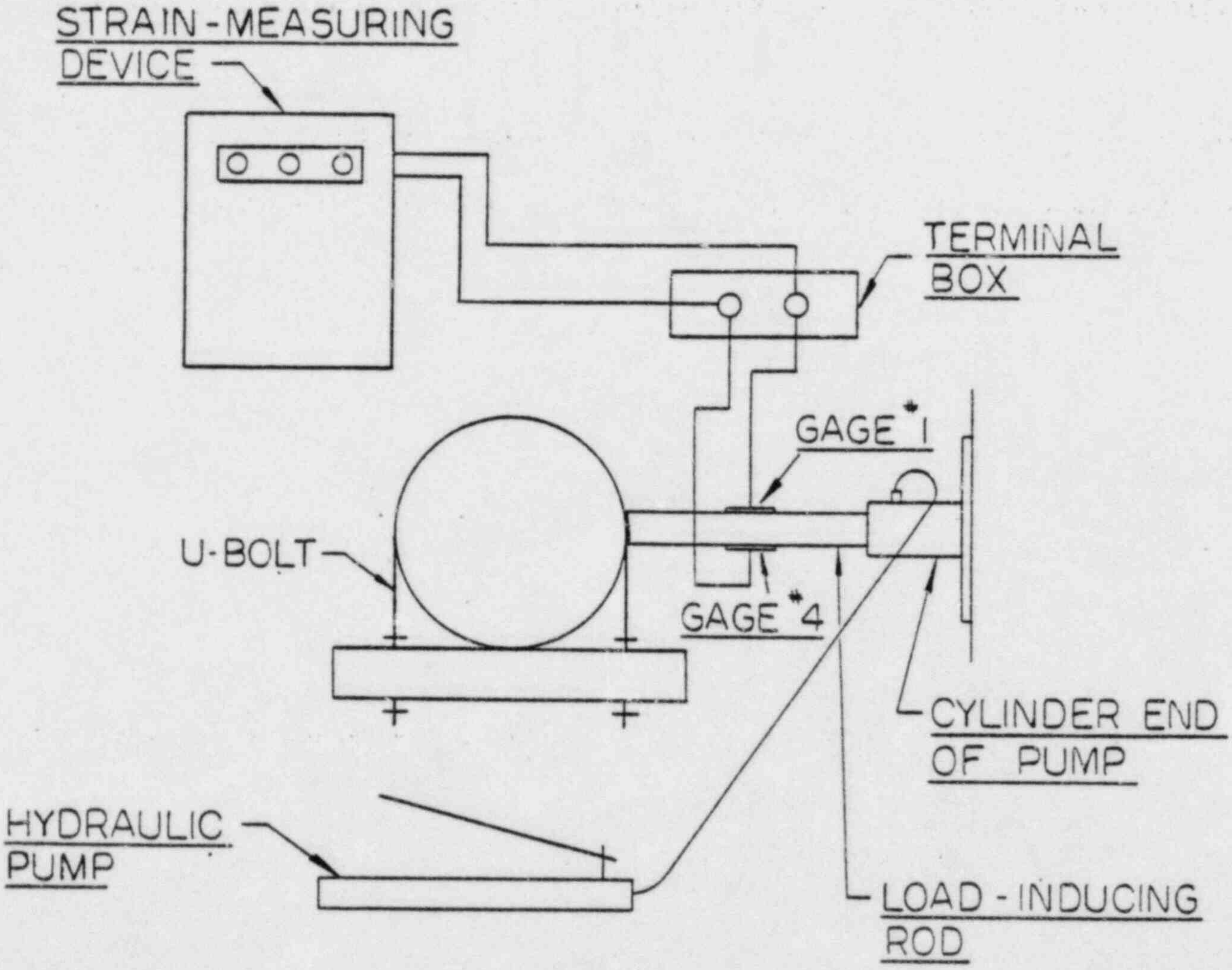
3½" ROD
DETAIL 'A'
24" O.D. PIPE
LOAD INDUCING RODS
BASE SUPPORT FOR SIDE LOAD
24" U-BOLT
LOWER TEST STAND
3½" ROD
AXIAL LOADING
T.S. 8×8×½
8×8×1 PLATE
3½" HEAVY HEX
2½" RODS
CYLINDER END OF HYDRAULIC PUMP
2½" EYE NUTS
3½" HEAVY HEX
SIDE LOADING
SCALE: None
MAT'L SPEC. N/A
FAB SPEC. N/A
WELD SPEC. N/A
NDE PROCEDURE N/A
FINISH, EXCEPT AS NOTED N/A
Q.A. REVIEW N/A
LIST OF PARTS
DATE 3-20-84
C
SA-4995-4



3½" ROD
4.5" O.D. PIPE
LOAD INDUCING RODS
BASE SUPPORT FOR SIDE LOAD
LOWER TEST STAND
4" U-BOLT
2" ROD
AXIAL LOADING
T.S. 8×8×½
8×8×1 PLATE
3½" HEAVY HEX
CYLINDER END OF HYDRAULIC PUMP
2½" RODS
2½" EYE NUTS
2" HEAVY HEX
SIDE LOADING
MAT'L SPEC. N/A
FAB. SPEC. N/A
WELD SPEC. N/A
NDE PROCEDURE N/A
FINISH, EXCEPT AS NOTED N/A
Q.A. REVIEW N/A
5-20-84
C
SA-4995-5
–

APPENDIX IV

MEASUREMENT OF STRAINS IN LOAD-INDUCING RODS


STRAIN-MEASURING DEVICE
TERMINAL BOX
GAGE #1
U-BOLT
GAGE #4
CYLINDER END OF PUMP
HYDRAULIC PUMP
LOAD-INDUCING ROD

APPENDIX V

STRAIN TO LOAD CONVERSION

The stress-strain relationship within a material's elastic range is given by;

$$\sigma = E \epsilon$$

where σ = stress in PSI

ϵ = strain in IN/IN

E = Young's Modulus in PSI

Since the gages are placed diametrically opposite on the 0.875 in. diameter rod whose material Young's modulus is 27900000 PSI, then,

$$\sigma = (27900000)\epsilon$$

but $$\sigma = \frac{P}{A}$$

therefore $$\frac{P}{A} = (27900000)\epsilon$$

or $$P = (27900000) A\epsilon$$

$$P = (27900000)\frac{\pi}{4}(.875)^2$$

$$P = (16780000)\epsilon$$

$$P = 16.78\epsilon' \text{ LBS}$$

where ϵ' = strain in IN/IN X 10^{-6}

APPENDIX VI

PHOTOGRAPHS OF TEST

LIST OF PHOTOGRAPHS

4" AXIAL LOAD

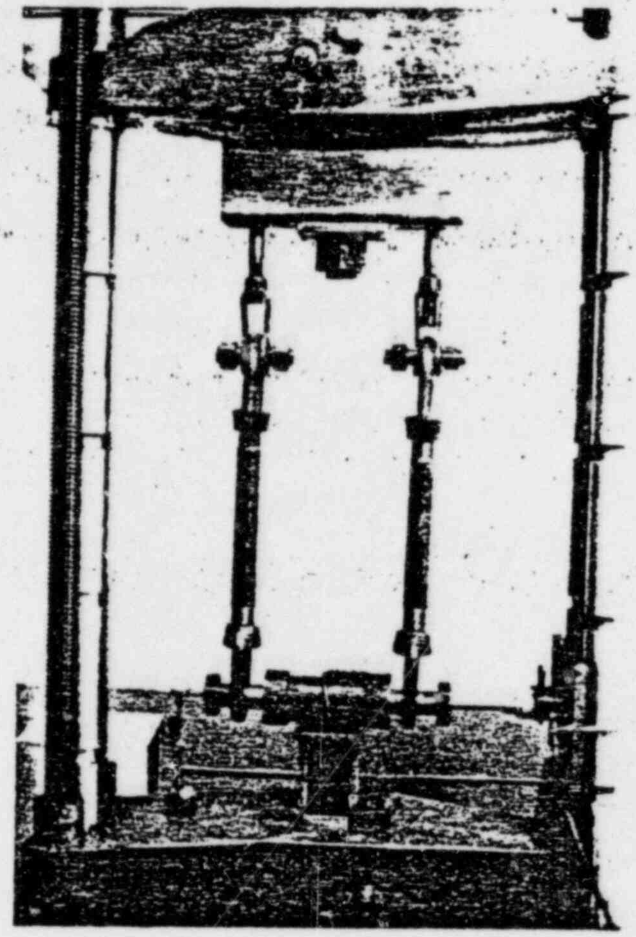


PHOTO 1
General Test Set-up for
Axial Load on 4" Pipe U-Bolt

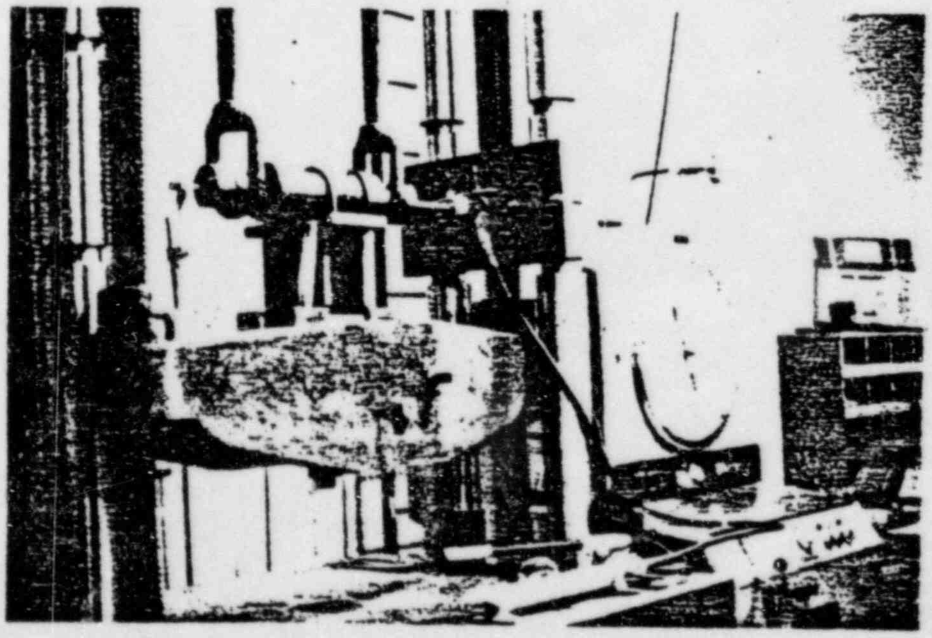


PHOTO 2
Hydraulic Pump
and Cylinder
Arrangement

4" AXIAL LOAD

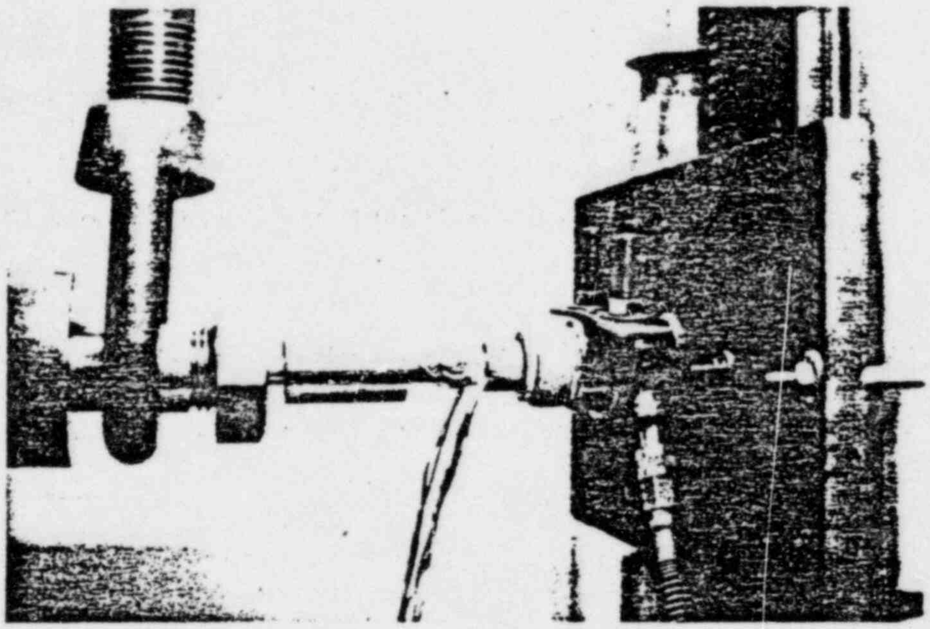


PHOTO 3 : Strain Gages on Load-Inducing Rods

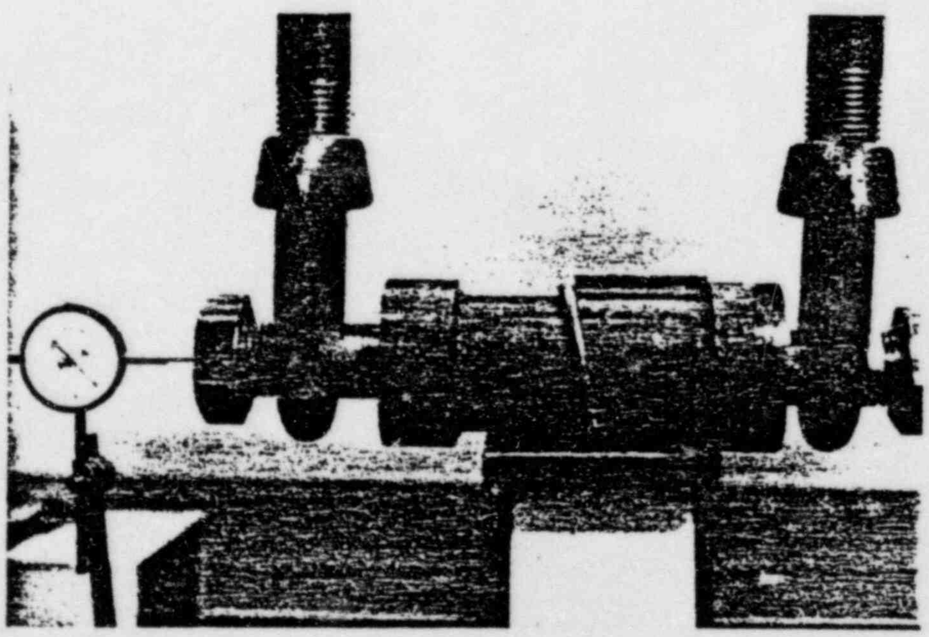


PHOTO 4 : Typical Axial Deflection and Dial Indicator

4" AXIAL LOAD

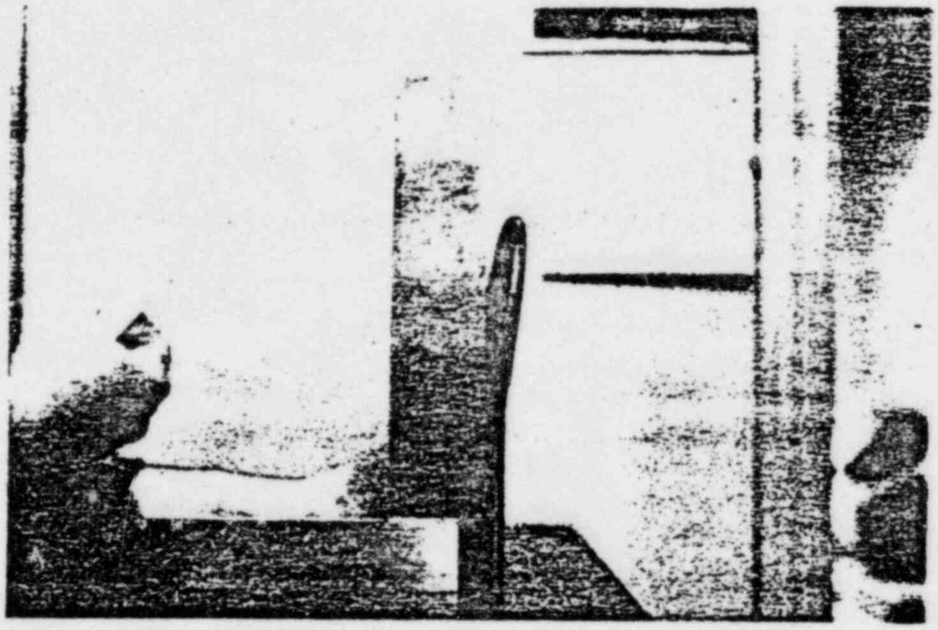


PHOTO 5 : Permanently Deflected Shape

4" LATERAL LOAD

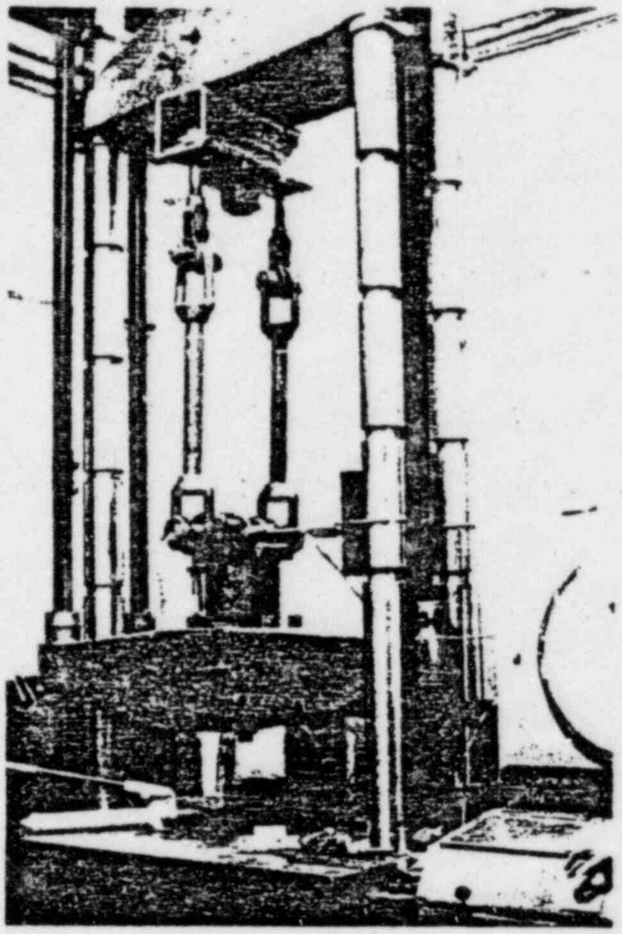
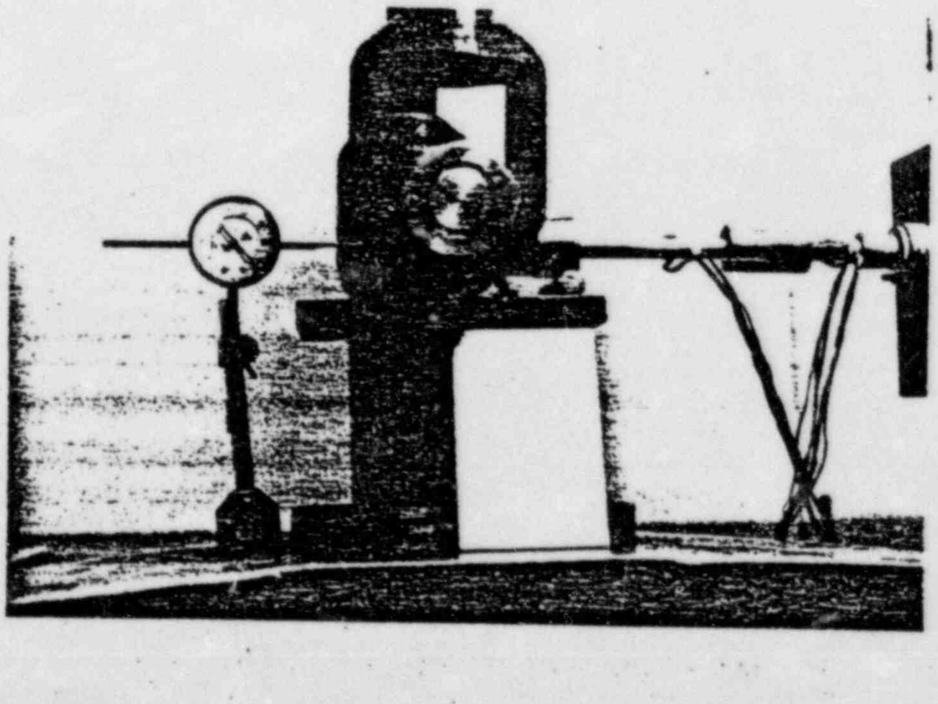


PHOTO 6 :
General Test Set-up for Side Load on 4" Pipe U-Bolt

PHOTO 7 :
Load-Inducing Rods and Dial Indicator



4" LATERAL LOAD

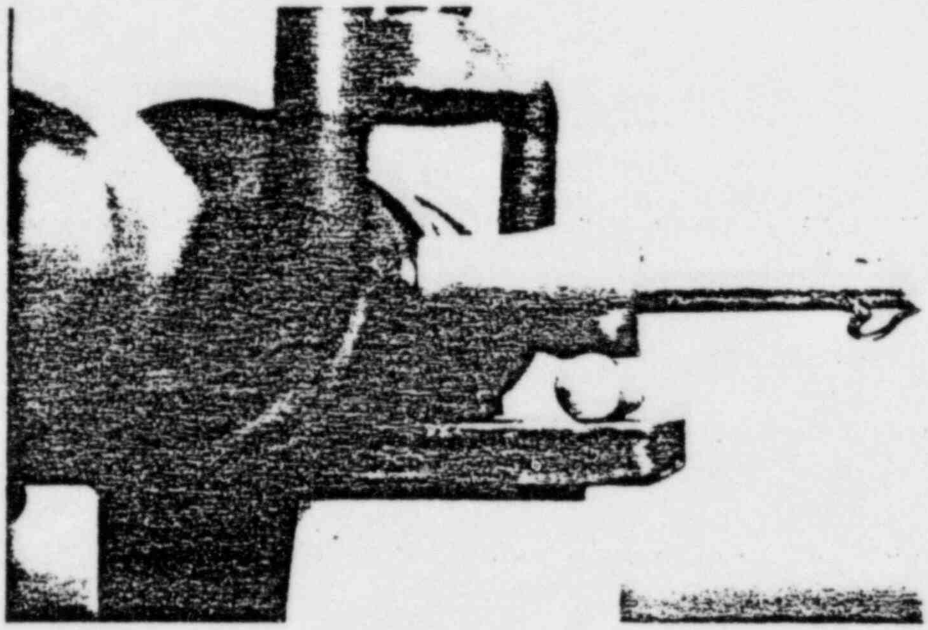


PHOTO 8 : Lift-up of Hex Nut due to Excessive Deformation

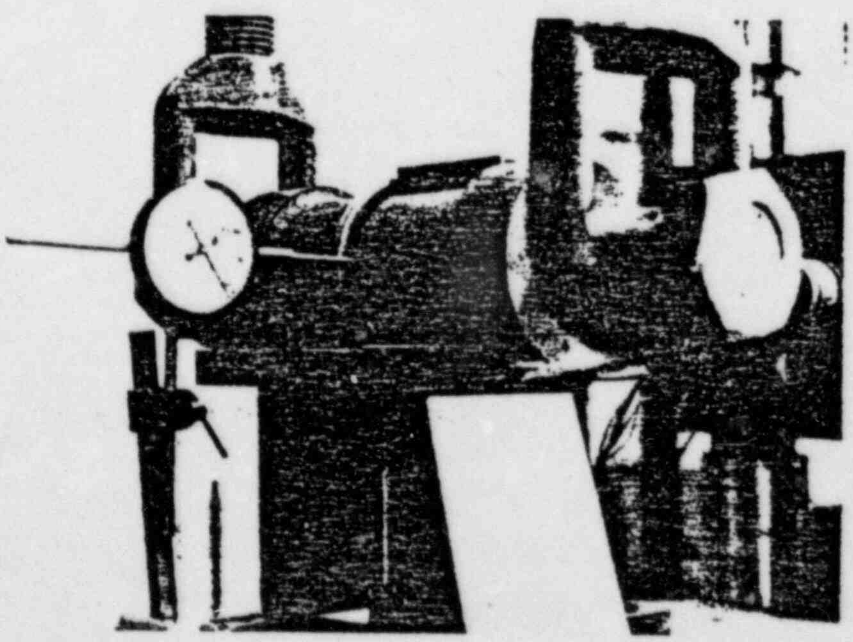


PHOTO 9 : Pronounced Deformation of U-Bolt

4" LATERAL LOAD

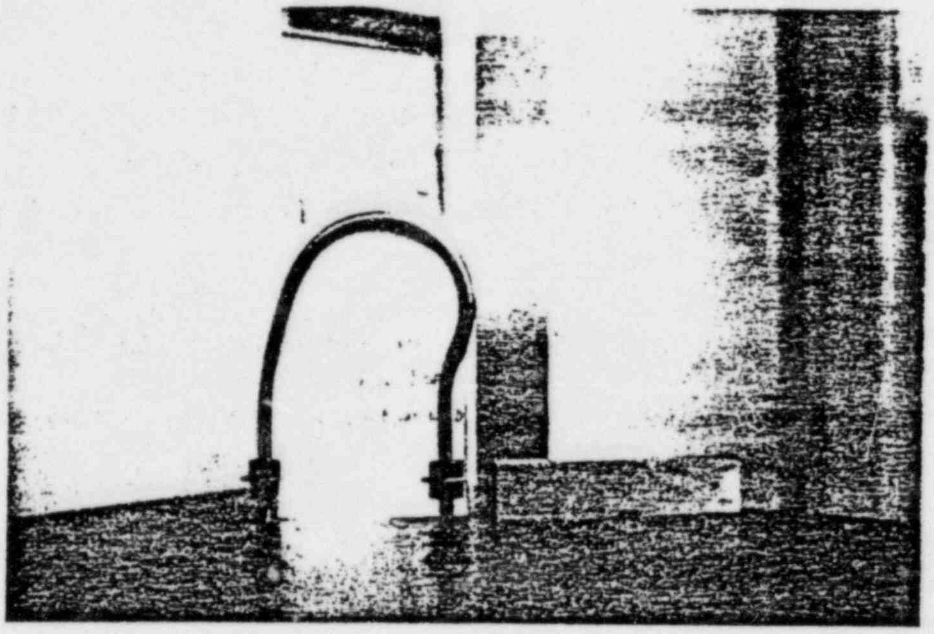


PHOTO 10 : Permanently Deflected Shape

4" NORMAL LOAD

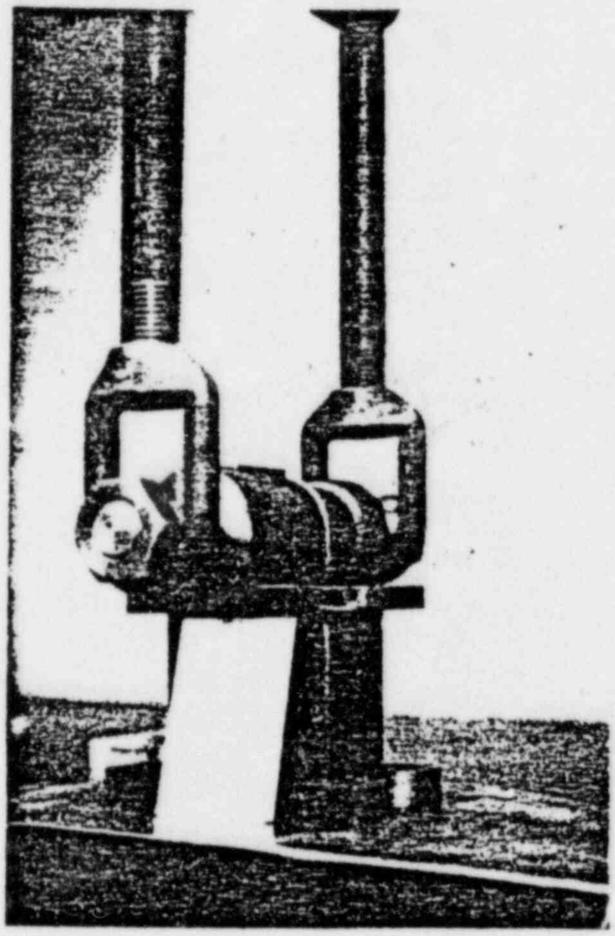


PHOTO 11 :
Normal Load Set-up for 4"
Pipe U-Bolt

PHOTO 12 :
Lift-up of Hex
Nut due to
Excessive
Deformation

4" NORMAL LOAD

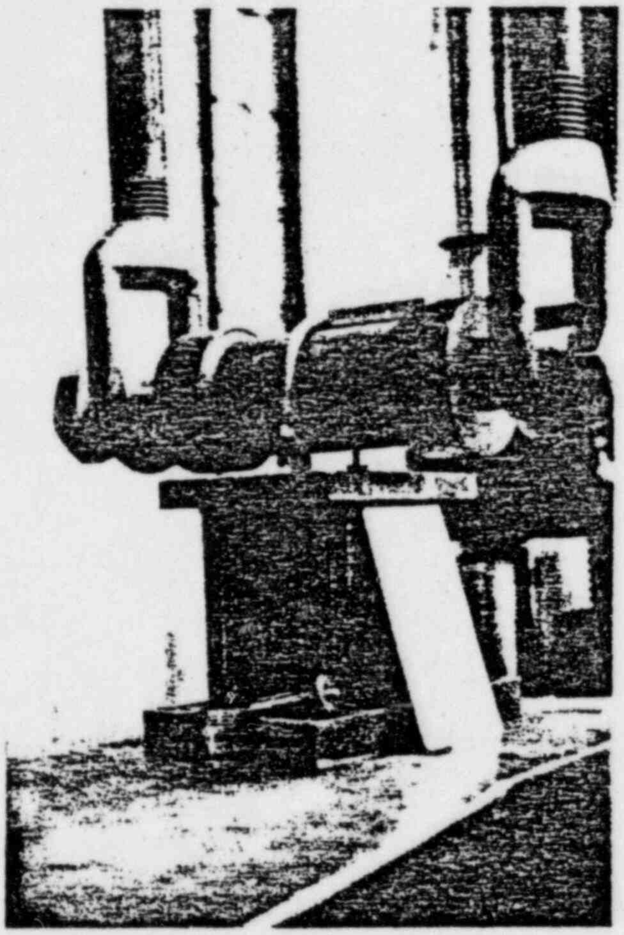


PHOTO 13 :
Failure of U-Bolt in the Tensile Mode

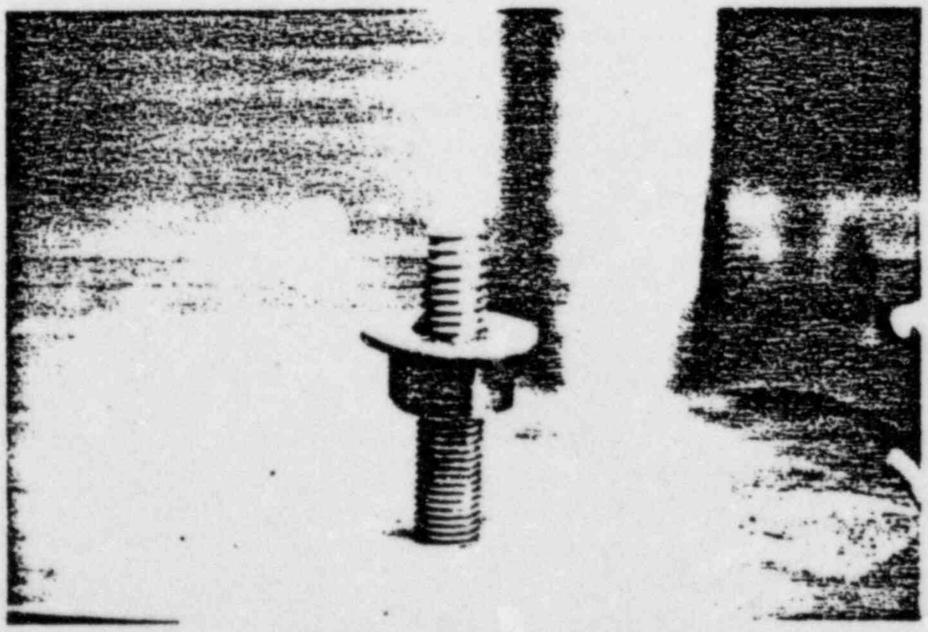


PHOTO 14 :
'Necking' of Threaded Section of U-Bolt

24" AXIAL LOAD

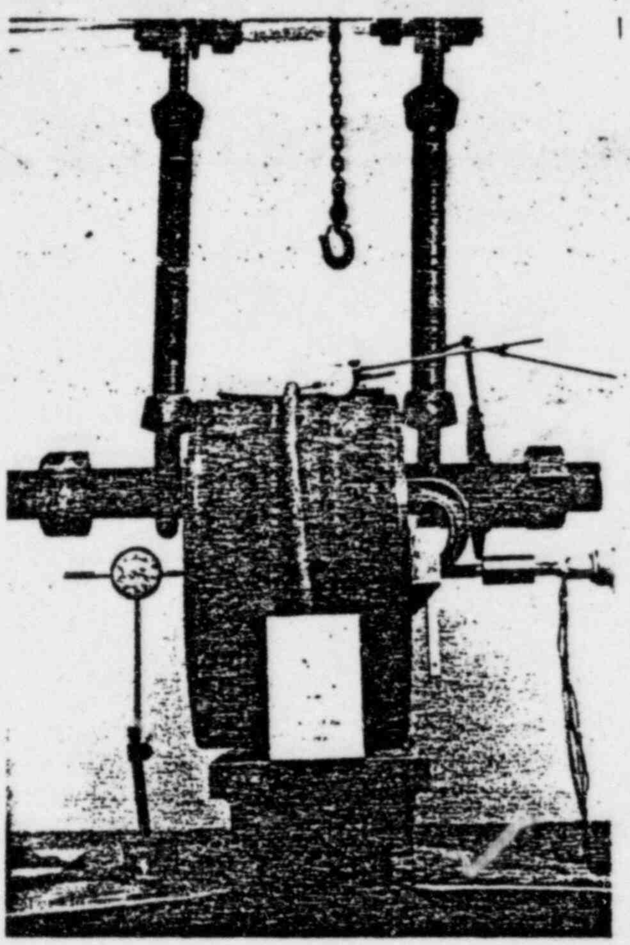


PHOTO 15 :
General Test Set-up for
Axial Load on 24" Pipe U-Bolt

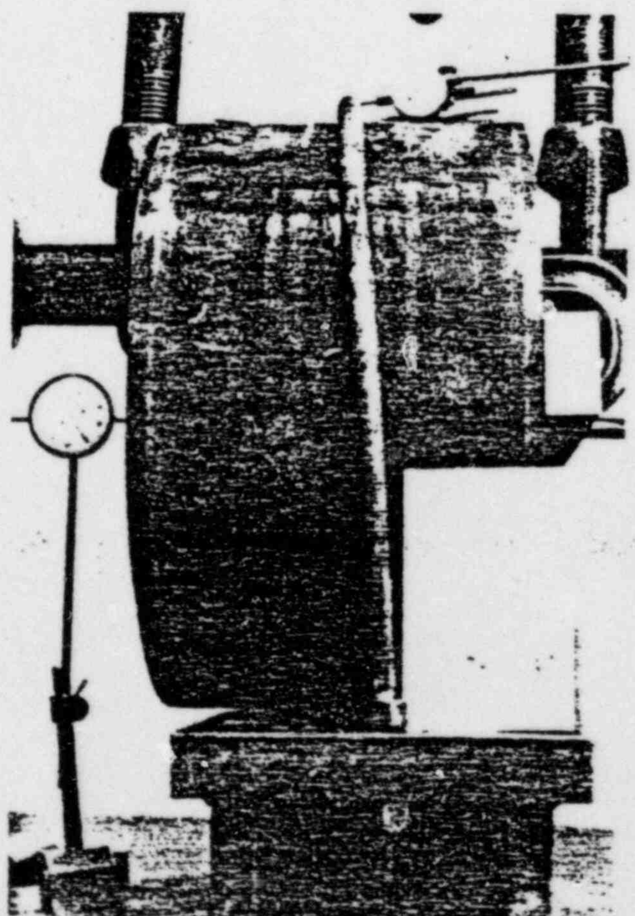


PHOTO 16 :
Axially Deflected
U-Bolt

<u>24" AXIAL LOAD</u>

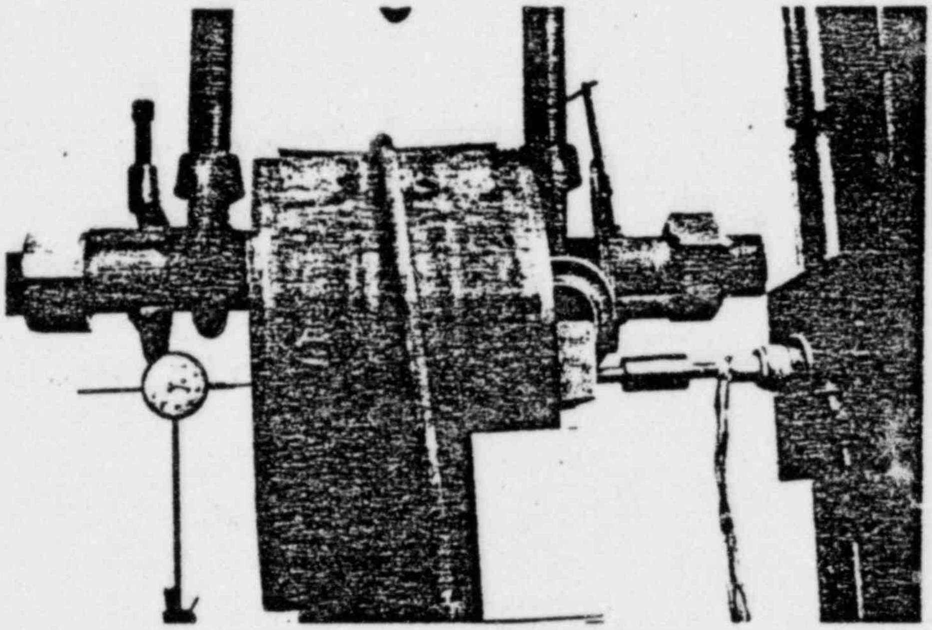


PHOTO 17 : Axially Deflected U-Bolt

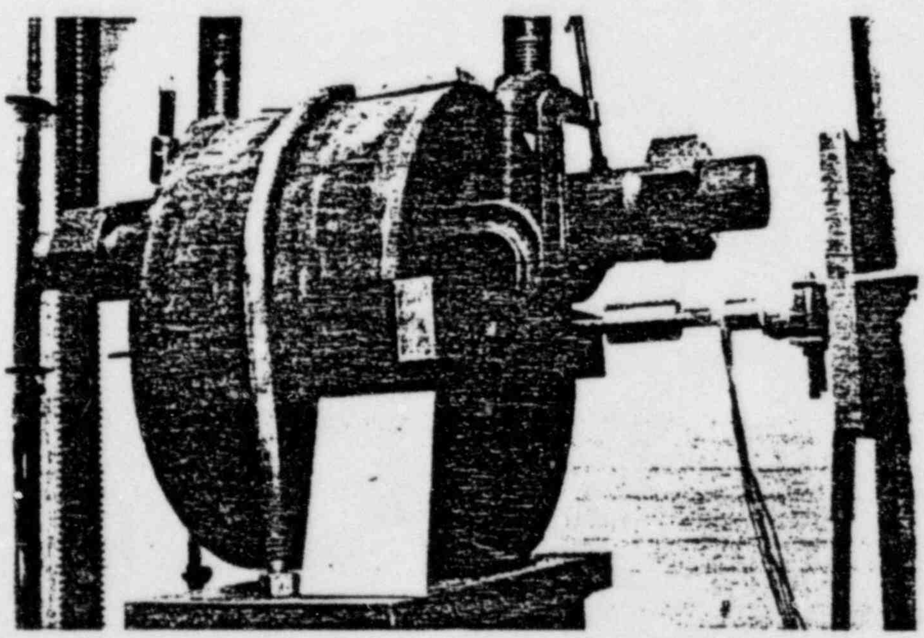


PHOTO 18 : Axially Deflected U-Bolt

24" LATERAL LOAD

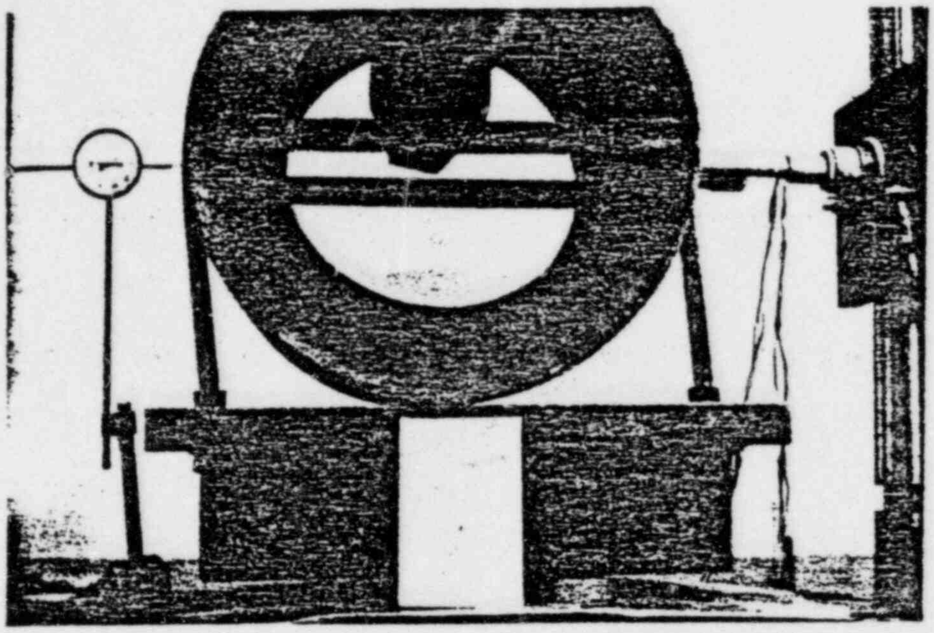


PHOTO 19 : Side Load on 24" Pipe U-Bolt General Deflected Shape

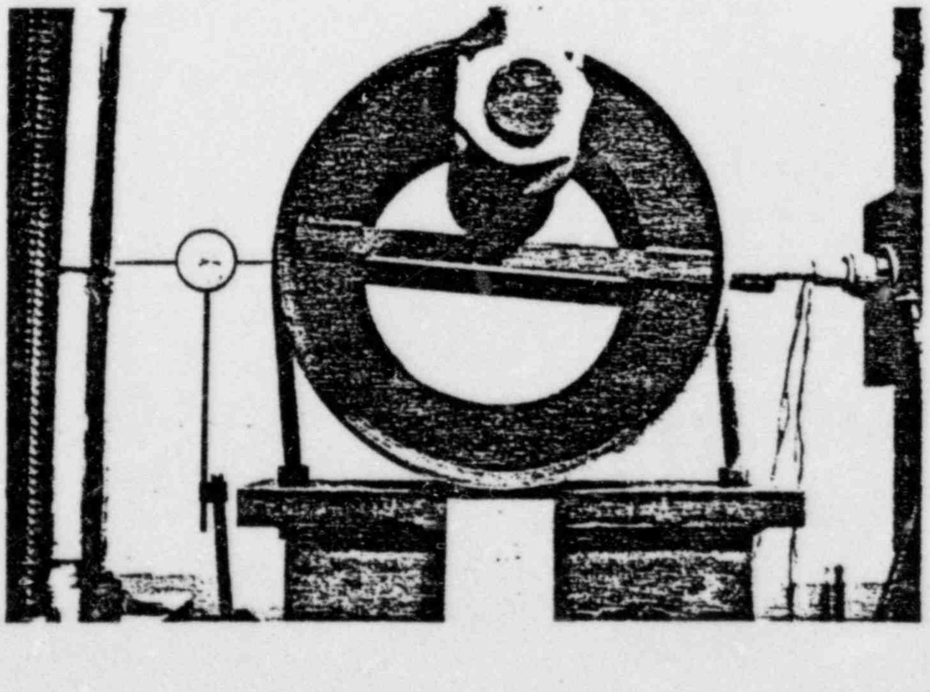


PHOTO 20 : Side Load on 24" Pipe U-Bolt General Deflected Shape

24" LATERAL LOAD

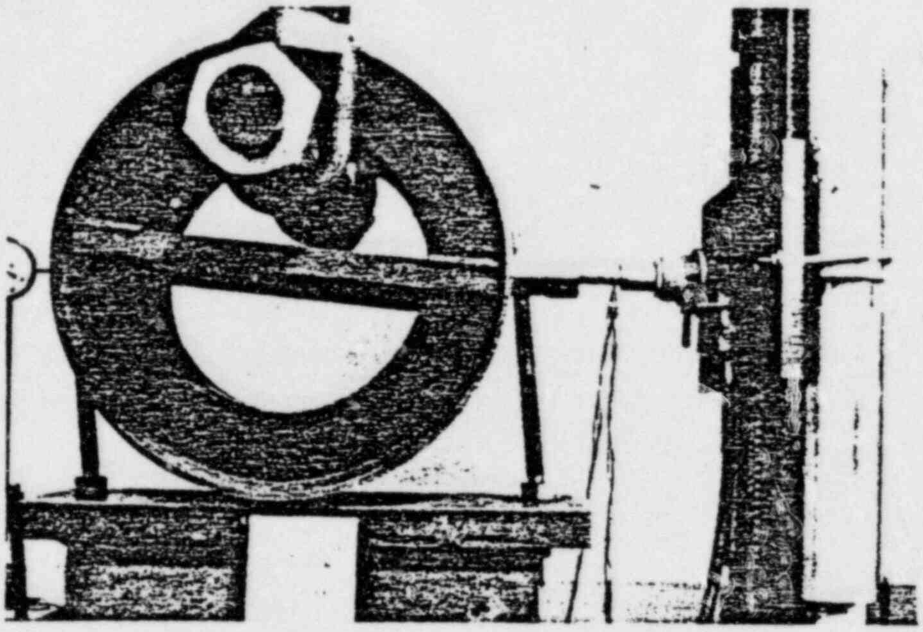


PHOTO 21 : Side Load on 24" Pipe U-Bolt General Deflected Shape

PHOTO 22 :
Detail of U-Bolt
and Hex Nut at
Plate Interface

24" NORMAL LOAD

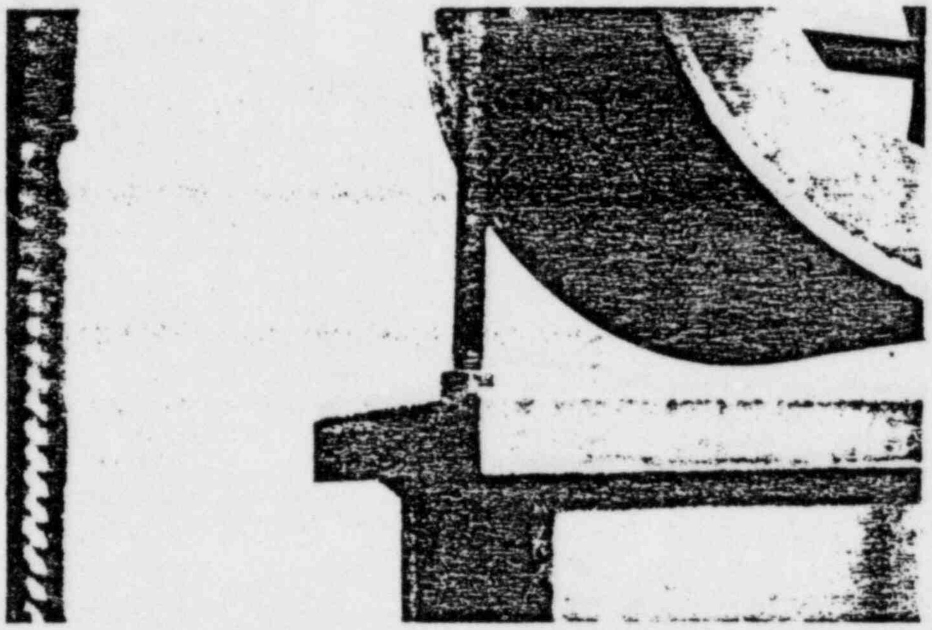


PHOTO 23 : Eminent Failure of U-Bolt under Normal Load

PHOTO 24 :
Failed U-Bolt
at Threaded Section

24" NORMAL LOAD

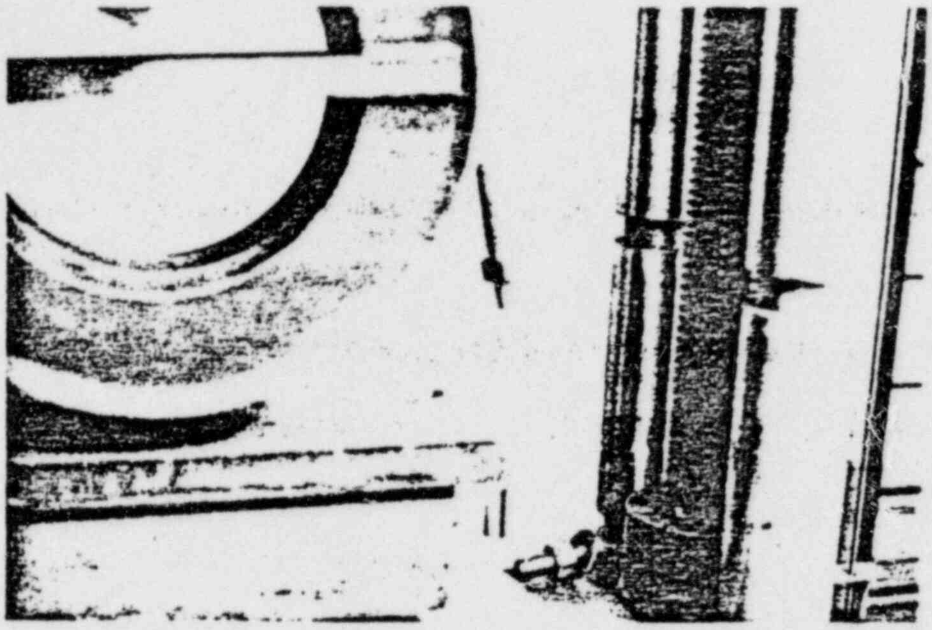


PHOTO 25 : Failed U-Bolt at Threaded Section

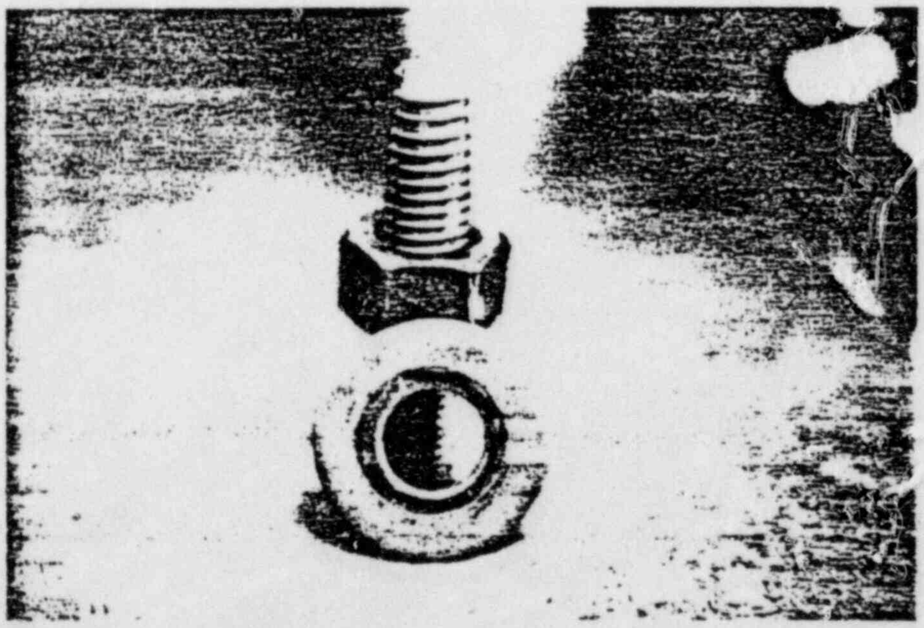


PHOTO 26 : 'Necking' of Threaded Section of U-Bolt
and Damaged Washer due to Bearing

APPENDIX VII

CERTIFIED MATERIAL TEST REPORTS

CERTIFIED MATERIAL TEST REPORT

1/2 INCH ROD

1423 East Sixth Street
Little Rock, AR 72203

AFCO STEEL

FOR INFORMATION ON

MATERIAL CERTIFICATION

TO: Brown & Root Inc.
Texas Utilities
Glen Rose, Texas

YOUR ORDER # CPF-1310-S
OUR ORDER # 50543

The material listed below is supplied in accordance with the following specifications based on the review of the material manufacturer's certified mill test report and the requirements of your p.o.

- [ ] ASTM Specification ______
- [x] ASME Specification SA36
- [x] ASME Section III, Subsection NF Class 1 Component Supports, 1974 Edition W'74 Addenda.
- [ ] Paragraphs ______
- [ ] Other ______

This material was procured and controlled by our Quality Assurance Program, Rev.5, ASME-NCA-3800 Supplement, Rev.0, dated 1/28/82 Approved by your BRV-12913 dated 2/3/82.

Item	Pieces	Description	Heat #	Other
21	358	R. ROD ½"ø x 20'-	16134	CODE 134
24	332	↓	↓	
			RIR NO. 18477	

Prepared by/date JW 2/25/82 Checked by/date RTO 3/3/82

- [x] CMTR (QSC Number w/exp. date)
- [ ] CMTR (Approved Vendor)
- [ ] Ultrasonic report
- [ ] Other ______

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FOR INFORMATION ONLY

CERTIFICATE ... COMPLIANCE

Material Furnished To:	No. ___
AFCO Steel Little Rock, Arkansas	Date: 1/18/8_
Customer Order No. 11408 Delivery Copy No. 15728	ASME Quality System Cert. No. QSC-327 Expiration Date: March 31, 1984

TYPE	DESCRIPTION	TESTS PERFORMED
ASME SA-36	750 Pieces 1/2" x 20' Rounds Heat Number 16134	Chemical and Physical (See attached CMTR from Auburn Steel Company)
	AFCO STEEL QUALITY ASSURANCE Mill ✓ Current Approved Warehouse ___ Service ___ Other ___ Approved by Quality Control Date 1-28-82 By [signature]	CPF 1310 5 Item 24
	"ASME QUALITY SYSTEM CERTIFICATE (MATERIALS) QSC-327 MARCH 31, 1984"	... ED ON RIR NO. 18477

This is to certify that this material has been supplied in accordance with the Quality System Program approved by the ASME as required by Section NCA-3800 of the Code.

This is to certify that the material described above and tested or examined as shown, meets or exceeds specification requirements noted

- [ ] ASTM A-36
- [X] ASME SA-36 (1980 Edition thru Summer 1981 Addenda, Subsection NF-2000, Class 3, Section III NCA-3800, 10CFR21)
- [ ] ___

[signature] 1/18/82
QA Manager — Date

Page 20 of 22

AUBURN STEEL COMPANY INC • Auburn, N. Y. 13021

[illegible] PO Box [illegible]

FOR INFORMATION ONLY

DATE 12-18-81

CUSTOMER P.O. #674911-N

PHYSICAL AND CHEMICAL TESTS

1308

SHIPMENT NO. 12-1-1079

Heat No.	Description	Yield Point	Tensile Strength	Elong. %	Red. %	Bends	CHEMICAL ANALYSIS C	Mn	P	S		Specifications or Remarks
	ROUND			8"GL		180°						
16134	½"RD	45,130	63,080	24.5		½D	.14	.52	.017	.038		
		45,390	63,590	27.0		½D						

CODE

MATERIAL CONFORMS TO THE FOLLOWING SPECIFICATIONS:

ASTM A36-77
ASME SA36

G. J. Guoza

I certify the above results to be correct as contained in the records of the company

Senior Metallurgist

THIS MATERIAL PRODUCED UNDER QUALITY ASSURANCE PROGRAM IN ACCORDANCE WITH SECTION 3 OF NCA-3800 AND ALSO CONFORMS WITH 10-CFR-21.

THIS PRODUCT WAS PRODUCED IN ACCORDANCE WITH Q.A. PROGRAM REVISION 1 DATED 1-2-81.

CPF 1305
Item 24

DuBOSE STEEL
QA REVIEW
SATISFACTORY
[signature] 1/19/82
INITIAL DATE

AFCO Steel
PO# 11408

FOR INFORMATION ONLY

AFCO STEEL
QUALITY ASSURANCE
Mill ✓ Current Approved Warehouse
Service
Other
Approved by Quality Control
Date 1-28-82 By [signature]

THIS INSPECTION DOCUMENTED ON
RIR NO. 18477

Pg 21 of 22

AUBURN STEEL CO. INC.
austeel
AUBURN, N.Y. 13021

FOR INFORMATION ONLY

CERTIFICATE OF COMPLIANCE

THIS MATERIAL PRODUCED BY AUBURN STEEL COMPANY, INC. AND SOLD TO DUBOSE STEEL INC. ON PURCHASE ORDER 6719-11 WAS PRODUCED IN ACCORDANCE WITH AUBURN STEEL COMPANY, INC. QUALITY ASSURANCE MANUAL REVISION 1 DATED 1-1-81 AND AUDITED BY DUBOSE STEEL INC. ON OCTOBER 10, 1980.

AUBURN STEEL CO., INC.

RICHARD A. BUCHAN
MANAGER QUALITY ASSURANCE

AFCO Steel
PO# 11408

CPF 13105
Item 24

AFCO STEEL
QUALITY ASSURANCE

Mill ✓ Current Approved Warehouse
Service
Other
Approved by Quality Control
Date 1-28-82 By [illegible]

[illegible] INSPECTION
[illegible]TED ON
[illegible] NO. 18477

Page 22/22

CERTIFIED MATERIAL TEST REPORT

1 INCH ROD

B. OWIIU ROOT, INC.
QUALITY ASSURANCE DEPARTMENT
CONFORMANCE CERTIFICATE

PROJECT: TUGCO JOB NO.: UNIT ______ PAGE 1 OF 1

(1) VENDOR: AFCO STEEL	(2) ADDRESS OF VENDOR FACILITY: LITTLE ROCK, AR
(3) PURCHASE ORDER NO.: CPF-1074-S	(4) SPECIFICATION NO.: --- REV.: - (5) DRAWING NO.: ---- REV.: -
(6) ITEM DESCRIPTION(S): QA MATERIAL SPEC. ASME SEC III SUB SEC. NF (CLASS 1) 1974 - W1974 SA36 AFCO REF: 50382 LOAD 4	(7) NO. OF ITEMS: 42 (8) NO. RELEASED: 5 (9) COMPLETE: ☐ YES ☒ NO

(10) SERIAL OR IDENTIFICATION NO(S):

ITEM #38 - 25 pcs. 1⌀ x 40 - (A22020)
39 - 25 pcs. 1⅛⌀ x 20 - (1-8926).
40 - 12 pcs. 1½⌀ x 40 - (M04231).
40 - ONE pc. 1½⌀ x 20 - (M04231).
41 - 25 pcs. 2⌀ x 20 - (M00827).
42 - 10 pcs. 2½⌀ x 20 - (E09111).

(11) RECORDS TRANSMITTAL LIST

Records checked (√) below are being transmitted with this certificate as required by the Brown & Root Document Data Sheet.

X Material Certifications	___ Operating Elec. Test Records	___ Visual Inspection Records
___ Heat Treat Records	___ Non-Operating Elec. Test Records	___ Dimensional Inspect. Records
___ RT Film & Records	___ Pressure Test Records	___ Cleanliness Records
___ PT/MT Records	___ Seat Tightness Test Records	___ Painting Records
___ UT Records	___ Performance Test Records	___ Packaging Records
___ Approved Stress Report	___ Weld. Personnel Qual. Certs.	___ Spare Parts List
___ Approved Design Analyses	___ NDE Personnel Qual. Certs.	___
___ Special Handling Instruc.	___ Nameplate Facsimile	___
___ Operating Manuals	___ Code Data Report(s)	___

(12) REMARKS

Deviations: ☒ None ☐ Listed Below

FOR INFORMATION ONLY.

(13) VENDOR CERTIFICATION

THE VENDOR CERTIFIES that the item(s) described above are in conformance with the requirements of the Brown & Root Specification with the approved deviations listed above; are suitable for the purpose intended; are free from defects in design, workmanship, and materials; and are new and of specified quality. A copy of this completed Conformance Certificate will be included with the bill of lading and shipped with the item(s) to Brown & Root, Inc. at the address designated in the procurement documents.

VENDOR AUTHORIZED SIGNATURE:	TITLE:	DATE:
James C. Williams	QA SPECIALIST	9/25/81

(14) RELEASE STATEMENT

The Vendor has certified that the items above meet all contractual requirements. Brown & Root has reviewed evidence supporting this Certificate and, except as noted under "Remarks" above, has verified conformance to requirements. This Certificate does not waive any rights Brown & Root may have under the Purchase Order including the right to reject the item(s) upon discovery of deficiencies during or after arrival at destination.

Final Surveillance: ☐ Performed ☒ Waived

SIGNATURE OF B&R SURVEILLANCE SPECIALIST:	DATE:	TELECOPY NUMBER IF WAIVED (COPY ATTACHED):	DATE:
	/ /	SW 1971	9/25/81

The item(s) described above are hereby released by Brown & Root Quality Assurance. Shipment may be made subject to authorization by

AFCO STEEL
QUALITY ASSURANCE
Current Approved
Mill 1 Warehouse
Service
Other
Approved by Quality Control
Date 6-29-81 By DDH

NORTH STAR STEEL COMPANY

1678 RED ROCK ROAD BOX 43189
SAINT PAUL, MINNESOTA 55104

CERTIFIED TEST REPORT

81-30
[illegible]
[illegible]5

HEAT # A31029
SIZE 1" ø

98528

CHEMICAL ANALYSIS

C	Mn	P	S	Si	Sn	Cu	Ni	Cr	Mo	Cb	V	Other
18	69	012	032	20	011	23	11	14	024			

CPF-1074-S

SPECIMEN AREA	YIELD KIPS	YIELD K.S.I.	TENSILE KIPS	TENSILE K.S.I.	GA LENGTH	ELON %	BEND	R.A. %		GRADE	DATE ROLLED
.785	40.5	51.6	57.6	73.4	8.0	34.3	OK			A36-77a	6/12/81
									ASME SA 36 - 77A Section II, 1978, Summer Addenda		

THIS MATERIAL HAS BEEN PRODUCED AND TESTED IN ACCORDANCE WITH THE REQUIREMENTS OF APPLICABLE A.S.T.M. SPECIFICATIONS UNLESS OTHERWISE LISTED BELOW. WE HEREBY CERTIFY THAT THE ABOVE TEST RESULTS ARE REPRESENTATIVE OF THOSE CONTAINED IN THE RECORDS OF THE COMPANY. BEND TEST CONFORMS TO ACI 318 71 (1976 SUPPLEMENT).

SIGNED Steve [illegible] Tech.

DATE [illegible] Brown

APPROVED BY

SWORN AND SUBSCRIBED TO BEFORE ME

THIS ____ DAY ____

(Notary Public)

MY COMMISSION EXPIRES ____

THIS CERTIFICATE IS NOTARIZED ONLY WHEN REQUESTED

MATERIAL COMPLIES WITH ASME SECTION III, SUBSECTION NF, FOR CLASS 2 COMPONENT SUPPORTS, 1974 EI THROUGH WINTER ADDENDA 1974, FOR MATERIAL FURNISHED.

USPCO STEEL
QUALITY ASSURANCE

Current | Approved

Mill ✓ Warehouse
Service
Other

Approved by Quality Control
Date 6-29-81 By [illegible]

NORTH STAR STEEL COMPANY

1678 RED ROCK ROAD BOX 43189
SAINT PAUL, MINNESOTA 55164

CERTIFIED TEST REPORT

81-300
QA Stock

SIZE 1" ø

98508

CHEMICAL ANALYSIS	C	Mn	P	S	Si	Sn	Cu	Ni	Cr	Mo	Cb	V.	Other
	18	69	012	032	20	011	23	11	14	024			

SPECIMEN AREA	YIELD KIPS	YIELD K.S.I.	TENSILE KIPS	TENSILE K.S.I.	GA. LENGTH	ELON %	BEND	R/R %		GRADE	DATE ROLLED
.785	40.5	51.6	57.6	73.4	8.0	26.3	OK			A36-77a	6/12/81
									ASME SA 36 - 77A Section II, 1978, Summer Addenda		

THIS MATERIAL HAS BEEN PRODUCED AND TESTED IN ACCORDANCE WITH THE REQUIREMENTS OF APPLICABLE A.S.T.M. SPECIFICATIONS UNLESS OTHERWISE LISTED BELOW. WE HEREBY CERTIFY THAT THE ABOVE TEST RESULTS ARE REPRESENTATIVE OF THOSE CONTAINED IN THE RECORDS OF THE COMPANY. BEND TEST CONFORMS TO ACI 318-71 (1976 SUPPLEMENT).

SIGNED Steven J. Schmidt Lab Tech.

DATE 6/12/81

APPROVED BY

SWORN AND SUBSCRIBED TO BEFORE ME

THIS ____ DAY ____

(Notary Public)

MY COMMISSION EXPIRES ____

THIS CERTIFICATE IS NOTARIZED ONLY WHEN REQUESTED.

MATERIAL COMPLIES WITH ASME SECION III, SUSECTION NF, FOR CLASS 2-COMPONENT SUPPORTS, 1974 EDITIO THROUGH WINTER ADDENDA 1974, FOR MATERIAL FRURNISHED.

FOR INFORMATION ONLY

CPF 10745

AFCO STEEL

MATERIAL CERTIFICATION

To BROWN & ROOT INC. Your Order # CPF-10745-

TEXAS UTILITIES Our Order # 50382

GLEN ROSE, TEXAS

The material listed below is supplied in accordance with the following specifications based on the review of the material manufacturer's certified mill test report and the requirements of your P.O.

[X] ASTM Specification A36

[X] ASME Specification SA36

[X] ASME Section III, Subsection NF Class 1 Component Support, 1974 Edition W 1974 Addenda.

[ ] Paragraphs

[ ] Other

This material was procured and controlled by our Quality Assurance Program, revision 5, approved by your BRV 12616 dated 5-21-81.

Item	Pieces	Description	Heat #	Other
38	25	1ø x 40 ROD	A22020	
39	25	1⅛ø x 20	1-3926	
40	12	1½ø x 40	M04231	
40	ONE	1½ø x 20	M04231	
41	25	2ø x 20	M00827	
42	10	2½ø x 20	E09111	

Prepared by James C. Williams Date 9-25-81

Checked by Robert F. Oates Date 9/25/81

Attachments

[X] CMTR (Manufacturer's)
[X] CMTR (Approved Vendor)
[ ] Ultrasonic Report
[ ] Other

FOR INFORMATION ONLY

AISC

CERTIFIED MATERIAL TEST REPORT

1/2 INCH HEX NUT

nps industries, inc.
10420 metric boulevard
austin, texas 78758
telephone 512-836-4161

FOR INFORMATION ONLY

DATE: 2/15/83

CERTIFICATE OF CONFORMANCE

REFERENCE: Texas Utilities Services, Inc.
P. O. Number CP-0046A.1/CPPA 25899
NPS Order No.: NA-1336
Item Number(s): 11, 12, 13, 16, 17

We certify that the materials supplied on NPSI Shipping Notice AUS-15313 conform to the referenced purchase order and to the applicable requirements of ASME Section III, Subsection NF, Class 1, 1974 Edition, Winter 1974 Addenda.

for Plant Manager of Quality Assurance

A.S.M.E. Certificate of Authorization Number N-2323-2 expires on July 13, 1985.

RIR 21249

a subsidiary of nuclear power services inc.

nps industries, inc.
10420 metric boulevard
austin, texas 78758
telephone 512-836-4161

MATERIAL TRACER RECORD FOR SALES ORDERS

Production Release: 60237
Code: ASME III/1

ITEM NO.	DESCRIPTION	MIC. NO.	ITEM NO.	DESCRIPTION	MIC. NO.
11	SMPP-06	5923NR SA193GB7			
12	SMPP-08	7933NR SA193GB7			
13	SMPP-10	5362NR SA193GB7			
16	FHN-04	7696NB SA307GB			
17	FHN-03	7695NB SA307GB			

FOR INFORMATION ONLY

RIS 21249

Q.A. REVIEW: L DeWitt
DATE: 2/15/83

#o

MODULUS — TEST REPORT

To: Power & Engineering Products
157 Helen Street
South Plainfield, N.J. 07080

OUR ADDRESS: MODULUS CORPORATION
SCREW AND BOLT DIVISION
1000 MODULUS ROAD
MT. PLEASANT, PA. 15666

DESCRIPTION OF MATERIAL AND SPECIFICATIONS

SIZE	DESCRIPTION	CUSTOMER ORDER NO.	OUR ORDER NO.	SPECIFICATION
	UoC Hvy Hex Nut	N-1138	200195	SA 307-B
		NPS ORDER NO. AUS-3325		
	~~Pepco's Quality System Certificate QSC-100 Expires 3/3/83~~	ITEM #2 - QTY. 10,332		
		#4 - QTY. 1,000		

CHEMICAL ANALYSIS

SIZE	LOT NO.	HEAT NO.	C	Mn	P	S		NO.	Cr	Mo
1/2-13 nuts	R 31135	N 98225	.09	.43	.005	.04/.09	NB	471		
3/8-11 nuts	R 30844	L 67228	.09	.48	.006	.04/.09	NB	472		
3/4-10 nuts	R 30537	L 85667	.09	.41	.005	.04/.09	NB	473		
7/8-9 nuts	R 42755	N 32163	.13	.44	.008	.323	NB	474		

FOR INFORMATION ONLY

MECHANICAL PROPERTIES

SIZE	TENSILE STRENGTH LBS.	TENSILE STRENGTH P.S.I.	PROOF LOAD P.S.I.	PROOF LOAD ELONG.			HARDNESS BHN	HARDNESS R_B	HEAT NO	QUANTITY
1/2-13 nuts			91613	O.K				88-99		23000
			91613	O.K				91-93		
5/8-11 nuts			90265	O.K				87-91		16000
			92720	O.K				87-89		
3/4-10 nuts			91817	O.K				90-92		16500
			92814	O.K				87-89		
7/8-9 nuts			90409	O.K						7000
			93073	O.K						

NPSI RECV INSPECTION
CODE ACCEPTED
NPT ☐ Q-1 ☐ OCC ☒
QC [illegible] DATE 5-20-80

NPSI AUSTIN
MIC NO. [illegible]
PO NO. AUS 3325
SHEET 1 OF 1

RIR 12496

Q. A. ACCEPTED
DATE [illegible]

MAGNETIC GAGE THICKNESS MEASUREMENTS FOR GALVANIZING OR PLATING

1	Materials purchased under this order have been produced
2	in accordance with a Quality System Program meeting the
3	requirements of Section III of the ASME Code as approved
4	by PEPCO. Quality Control Manual Rev. 8 (4/79). Bolts
5	and nuts domestic manufacture.
TOTAL	
AVERAGE	

CONFORMS TO SPECIFICATIONS ASME SA 307-B ✓

WE HEREBY CERTIFY TO THE BEST OF OUR KNOWLEDGE AND BELIEF THAT THIS IS TRUE AND CORRECT IN EVERY RESPECT.

DO NOT WRITE IN THIS SPACE

METALLURGICAL DEPT.
SEP 9 1980

CERTIFIED MATERIAL TEST REPORT

1 INCH HEX NUT

QAA-G040
10/22/81

nps industries, inc
10420 metric boulevard
austin, texas 78758
telephone 512-836-4161

DOC. REVIEWED NPSI
Q.A. [illegible] DATE 1/27/82

MATERIAL TRACER RECORD

MARK NO. 7 EHN-11(0+,300) REV. ____ PROD. RELEASE 15100 CODE ASME

ITEM NO.	01	02	03	04	05	06	07	08	09	10
MIC. NO.							641540			
ITEM NO.	11	12	13	14	15	16	17	18	19	20
MIC. NO.										
ITEM NO.	21	22	23	24	25	26	27	28	29	30
MIC. NO.										

SUBASSEMBLIES

DRAWING/ITEM NO.

MATERIAL	MIC. NO.

DRAWING/ITEM NO.

MATERIAL	MIC. NO.

DRAWING/ITEM NO.

MATERIAL	MIC. NO.

DRAWING/ITEM NO.

MATERIAL	MIC. NO.

DRAWING/ITEM NO.

MATERIAL	MIC. NO.

FOR INFORMATION ONLY

Q.A. REVIEW ____

THIS INSPECTION DOCUMENTED ON RIR NO. 17697

pg 65 of 72

BETHLEHEM STEEL CORPORATION
Industrial Fast. Divs. - Western Region

320-3082
JJ34-4865-00

331
971525-00 1 2 24 51 3626 140 XO

COLLECT

WINCO NUCLEAR FASTENERS INC
8700 SW 26TH SUITE A
PORTLAND OR 97219

WINCO NUCLEAR FASTENERS INC
8700 SW 26TH SUITE A
PORTLAND OR 97219

11/20/81 SEATTLE WA
RETL REDCAWAY TFR

13 CARTONS STEEL MATL 729

MATERIAL MEETS OR EXCEEDS
THE REQUIREMENTS OF SA 307 GB
Q.A. DOCUMENTATION REVIEW
INT'L DATE 1/26/82

I HAVE COUNTED THE CONTAINERS ON ... AND ... THAT THE COUNT AGREES WITH THIS BILL OF LADING

1 PALLET - 35#
FURN A/M CONV

2370 .B BN NUT HVY HX DC BLKN SA 307-768 GR B
(2575 009 463)

1	300	1	128

2430 .B BN NUT HVY HX WF BLKN SA 307-768 GR B

2	200	1-1/8	118
3	320	1-1/2	416
4	20	1-3/4	41
			703

FOR INFORMATION ONLY

This is to certify that the material listed has been tested and inspected in accordance with the methods prescribed in the applicable specification and with respect to properties or characteristics for which no such methods are prescribed, in accordance with standard mill testing and inspection practices. Based upon such tests and inspection practices the undersigned has approved said material as fulfilling the requirements of said specification.

Chief Metallurgist

R Hawk 11-25-81

2 REP ACT TESTS

NPSI REC'V INSPECTION
CODE ACCEPTED
NPT ☐ Q-1 ☐ QCC ☑
QC DATE

QUALITY CONTROL
APPROVED
BY CSR DATE 11-23-81

NPSI AUSTIN
MIC NO. 6405 NB
PO NO. 32-523
SHEET 1 OF 2

INSPECTION ... FROM Seattle PART OF 2 NO 2

DOCUMENTED ON

RIR NO. 17697

Pg 66 of 72

SHIPPING LIST

FOR INFORMATION ONLY

BETHLEHEM STEEL CORPORATION
METALLURGICAL DEPARTMENT

11/20/81	32G-3082	RETL REDDAWAY TFR	SEATTLE

WINCO NUCLEAR FASTENERS INC
8730 S W 26th Suite A
Portland Or 97219

MATERIAL MEETS OR EXCEEDS THE REQUIREMENTS OF SA307GB
Q.A. DOCUMENTATION REVIEW INT'L [illegible] DATE 1/26/82

SHIPPED TO PORTLAND, OR

pg 67 of 72

REPORT OF MECHANICAL AND CHEMICAL TESTS

Customer's Order No.	Order No.	Heat No.	Description	Thickness	Yield Point	Tensile Strength	Elong. %	Red. %	Bend	C	Mn	P	S		Specification
331	JJ 34-4865-00														
2370 BBB	NUT HVY HX	DC BLKN SA	307-76a Gr B												
1	300	HRB 91-94	1"									max .04	max .05		
2430 BBB	NUT HVY HX	WF BLKN SA	307-76a gr B												
2	200	BHN 156	1-1/8"									.04	.05		
3	320	HRB 82-89	1-1/2"									.04	.05		
4	20	BHN 149	1-3/4"									.04	.05		

We certify the above listed material to be the last completed set of mechanical tests for the stock size indicated.

THIS INSPECTION DOCUMENTED ON RIR NO. 17697

NPSI RECV INSPECTION CODE ACCEPTED
NPT ☐ DI ☐ QCC ✓
QC [signature] DATE 1/26/82

NPSI AUSTIN
HIC NO. 6905 NB
TO NO. 32-923
SHEET 2 OF 2

QUALITY CONTROL APPROVED BY CSR DATE 11-23-81

TO MKA Lib FROM Seattle PART 2 OF 2 MFS. NO. 3

DEPARTMENT OF CIVIL ENGINEERING AND ENGINEERING MECHANICS

Carleton Materials Laboratory
(212) 280-3522 280-3145

Engineering Terrace Building
Amsterdam Avenue at 120th Street

DATE Aug.27, 29 & Sept.2, 3, 1975
MADE FOR NPS Industries, Inc.
235 Moore St.
Hackensack, N.J.07601

MACHINE USED
TESTED BY G. Anderson
WITNESS

REPORT OF TESTS

Lateral Load Tests of Heavy Duty U-Bolts

Test Specimens: Two 4" and two 6" Heavy Duty U-Bolts (7/8" stock, 7/8 - 9 thread) were selected from a group of 3 each submitted by NPS Industries.

How Tested: The test setup is shown on Page 2 of this report. The 4 x 4 x 3/8 angle was bolted to a steel pedestal (14 WF 370 with 1½" pl. top and bottom) bolted to the floor. The U-Bolt was attached to the angle through 15/16 diameter holes.

In all tests, due to the interference fit, a gap, 1/8" - 3/16", was found between the top of the U-Bolt and the pipe. No attempt was made to reduce this gap, but, rather the nuts on both sides of the U-Bolt were tightened so that the pipe slid freely in the U-Bolt.

Each load P/2 indicated in the test setup was monitored by a strain gage load cell calibrated before use. The latest calibration of the testing machine used for the calibration is attached.

All deflections were measured by new standard dial indicators with 1" travel and a 0.001" least reading.

In tests after Test No. 81071 an additional deflection "B" was measured. For one test in each size the deflection "U" was measured relative to the pedestal and in the other test relative to the free end of the angle.

The loading increment of 50 lbs. was found to be too small and was increased as reflected in the data. The tests were stopped at an approximate permanent set of ½" in deflection "U".

Results of Tests: The data recorded for each test will be found on Pages 3 through 6 and plotted deflection "U" versus load "P" on Pages 7 and 8.

Aside from the permanent lateral distortion of the U-Bolts it should be noted that at the conclusion of each test the pipe moved very freely in the U-Bolt. No visual distortions were found in the angles except in Test No. 81078. After this test the corner of the angle above the U-Bolt was bent back approximately 0.1" in 2".

Attachments: Calibration of Testing Machine
Photograph of Test No. 81077, no load.

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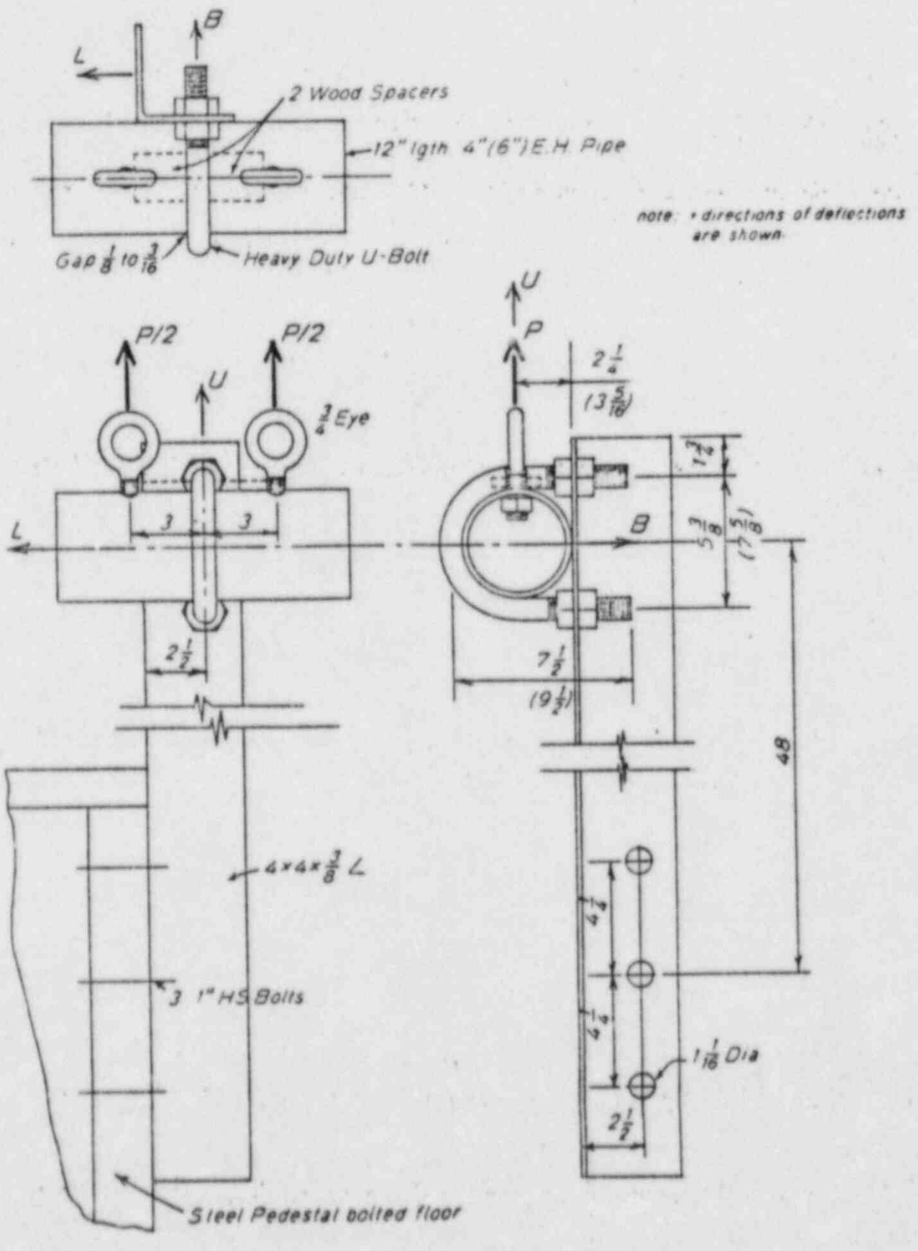
WITNESS

REPORT OF TESTS



TEST SETUP

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WITNESS

REPORT OF TESTS

Lab Test No 81071

6" Heavy Duty U-Bolt, Deflection U measured relative to Supporting Pedestal

Load, P	Deflections, ins.			Set, ins.		
kips	U	L	B	U	L	B
0.31	005	002		--		
0.41	007	.003		-.001	0	
0.5	009	003		—	—	
0.6	011	004		0	0	
0.71	013	001		—	—	
0.8	014	001		0	0	
0.9	018	001		—	—	
1.0	020	001		0	0	
1.1	025	001		—	—	
1.2	025	002		001	001	
1.31	028	002		—	—	
1.42	032	002		001	001	
1.5	033	004		—	—	
1.6	035	004		002	001	
1.8	038	003		.002	001	
2.0	045	003		.004	301	
2.2	050	003		005	002	
2.4	058	004		007	002	
2.64	066	004		009	002	
2.8	072	005		—	—	
3.0	078	006		012	002	
3.2	086	007		017	001	
3.6	.109	007		.032	-.002	
4.0	.181	007		.093	-.003	
4.4	.215	009		.118	-.005	
4.8	.272	.015		.160	-.003	
5.0	.310	.016		.192	-.003	
5.2	.358	019		.235	-.004	
5.4	.399	020		.271	-.003	

DEPARTMENT OF CIVIL ENGINEERING AND ENGINEERING MECHANICS

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MACHINE USED
TESTED BY G. Anderson
WITNESS

REPORT OF TESTS

Lab Test No 51077

6" Heavy Duty U-Bolt, Deflection U measured relative to Free End of Angle

Load, P	Deflections, ins.			Set, ins.		
kips	U	L	B	U	L	B
0.3	003	—	—	—	—	—
0.6	006	004	028	0	-003	002
0.9	010	—	—	—	—	—
1.2	014	003	058	0	-003	002
1.5	017	—	—	—	—	—
1.8	022	.006	081	001	-003	003
2.1	.027	.008	092	—	—	—
2.4	.032	008	106	004	-003	004
2.8	048	009	122	.012	-.002	006
3.0	054	014	.130	.016	-002	007
3.2	060	014	.135	020	-.002	.006
3.4	070	.014	145	028	-002	007
3.6	081	.017	.151	.035	-.002	.007
3.8	.091	018	.160	045	-002	.009
4.0	.104	020	.166	055	-.002	008
4.4	.125	.023	.179	.073	-001	.009
4.8	.154	.027	.192	.100	-.001	.011
5.2	.200	.031	.206	.146	0	.014
5.6	.265	.037	.218	.206	.001	.018
6.0	.335	.042	.233	.272	.001	.026

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Engineering Terrace Building
Amsterdam Avenue at 120th Street

DATE Aug. 27, 29 & Sept. 2, 3, 1975

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Hackensack, N.J. 07601

MACHINE USED
TESTED BY G. Anderson
WITNESS

REPORT OF TESTS

Lab Test No 81076

4" Heavy Duty U-Bolt, Deflection U measured relative to Free End of Angle

Load, P	Deflections, ins.			Set, ins.		
kips	U	L	B	U	L	B
0.4	.001	.007	.009	0	.002	0
0.8	.004	.009	.022	0	-.001	.001
1.2	.006	.009	.035	0	-.001	.002
1.4	.007	.009	.044	0	-.002	.003
1.6	.007	.015	.042	0	-.002	.002
1.8	.009	.009	.056	0	-.004	.004
2.0	.011	.010	.063	0	-.004	.004
2.2	.011	.017	.059	.001	-.002	.005
2.4	.012	.018	.064	.001	-.002	.005
2.6	.014	.020	.070	.001	-.001	.006
2.8	.015	.022	.075	.002	-.001	.007
3.0	.017	.023	.080	.002	-.001	.008
3.2	.018	.024	.085	.003	-.001	.009
3.4	.020	.024	.094	.004	-.001	.011
3.6	.022	.026	.097	.005	-.001	.014
3.8	.024	.029	.103	.006	-.001	.015
4.0	.027	.030	.109	.008	-.001	.017
4.2	.030	.033	.116	.010	0	.020
4.4	.034	.034	.128	.012	0	.024
4.6	.038	.036	.135	.015	0	.028
4.8	.042	.039	.140	.018	0	.032
5.0	.046	.040	.157	.022	.002	.040
5.2	.051	.042	.166	.025	.002	.046
5.6	.060	.043	.188	.031	.002	.057
6.0	.071	.047	.225	.040	.003	.085
6.4	.083	.051	.255	.050	.005	.112
7.2	.118	.067	.289	.083	.015	.143
8.0	.166	.078	.370	—	—	—
9.6	.286	.135	.490	.244	.026	.362
10.0	.330	.197	.520	.289	.021	.407

DEPARTMENT OF CIVIL ENGINEERING ...

...ton Materials Laboratory
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... Terrace Building
Ams... Avenue at 120th Street

Date: Aug.27, 29 & Sept.2, 3, 1975

For: NPS Industries, Inc.
235 Moore St.
Hackensack, N.J.07601

Machine used:
Tested by: G. Anderson
Witness:

REPORT OF TESTS

Lab Test N° 81079

4" Heavy Duty U-Bolt, Deflection U measured relative to Supporting Pedestal

Load, P kips	Deflections, ins.			Set, ins.		
	U	L	B	U	L	B
0.4	.003	.007	.006	0	0	.001
.8	.009	.008	.016	.001	0	.001
1.2	.013	.008	.025	.002	0	.001
1.6	.019	.010	.033	.002	0	.001
2.0	.024	.011	.042	.002	0	.001
2.4	.029	.013	.050	.003	0	.002
2.8	.033	.017	.059	.003	0	.003
3.0	.036	.019	.063	.004	.001	.003
3.2	.039	.021	.068	.005	.001	.003
3.4	.042	.022	.072	.006	.002	.004
3.6	.045	.024	.077	.007	.002	.005
3.8	.049	.024	.082	.009	.002	.006
4.0	.054	.027	.088	.011	.002	.007
4.2	.059	.027	.093	.014	.002	.008
4.4	.065	.028	.100	.017	.002	.009
4.6	.069	.029	.104	.019	.001	.011
4.8	.075	.029	.110	.023	.001	.012
5.0	.081	.031	.116	.025	0	.014
5.5	.099	.038	.119	.036	.001	.017
6.0	.119	.039	.129	.051	0	.020
6.5	.156	.043	.143	.079	0	.024
7.0	.209	.047	.163	.118	0	.028
8.0	.248	.051	.179	.190	0	.035
10.0	.470	.063	.199	.347	.003	.050

DEPARTMENT OF CIVIL ENGINEERING

Carleton Materials Laboratory
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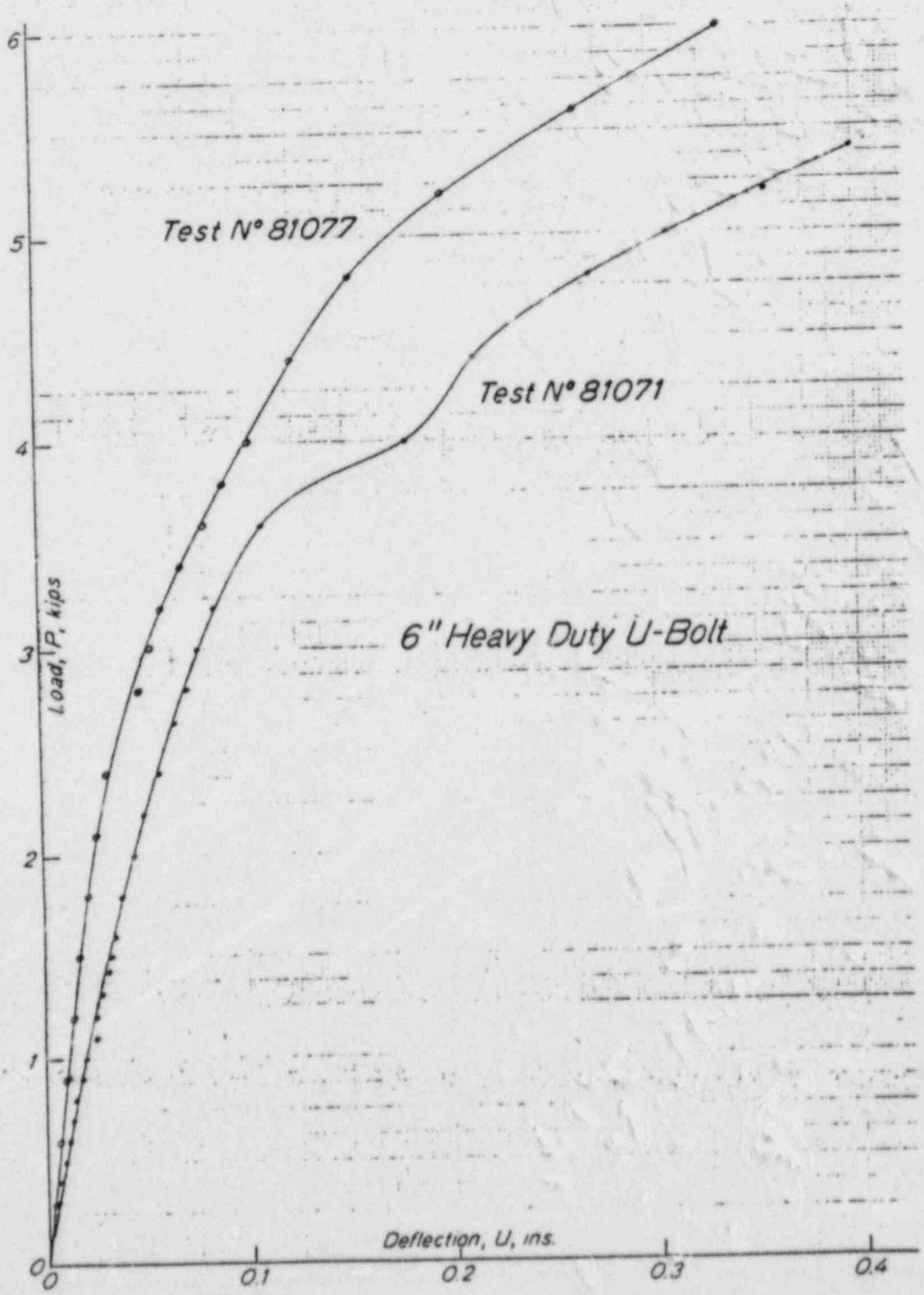
MACHINE USED
TESTED BY G. Anderson
WITNESS

REPORT OF TESTS



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TESTED BY G. Anderson

WITNESS

REPORT OF TESTS