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APOLLO - LEM DOCKING COMBINED  
PROBE AND DROGUE ASSEMBLIES  
STATIC STRUCTURAL TEST

March 1967

TR 332077  
CTR 02332077

Contract NAS9-150, Exhibit I, Paragraph 5.5.12

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SPACE and INFORMATION SYSTEMS DIVISION



TECHNICAL REPORT INDEX/ABSTRACT

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<p>Apollo - LEM Docking Probe Assembly                  Apollo - LEM Docking Drogue Assembly</p>							
ABSTRACT							
<p>The static structural tests were performed to demonstrate that the Apollo - LEM docking probe and drogue assemblies would sustain loads imposed subsequent to capture latch.</p> <p>Limit loads were applied without yielding and ultimate loads were applied without failure.</p>							
- ii -							
SID 67-317							

C O N T E N T S

Section		Page
	Introduction . . . . .	1
I	Description of Test Specimens . . . . .	2
II	Test Conditions . . . . .	2
III	Test Setup. . . . .	2
IV	Test Procedure . . . . .	3
V	Test Results. . . . .	4
VI	Conclusions . . . . .	4
	Appendix	
	Test Data - Test Conditions I, II, III, IV and V . . . . .	A-1 - A-402

## I L L U S T R A T I O N S

Figure		Page
1	Probe Orientation and Instrumented Component Identification . . . . .	6
2	Pitch Control Beam "A" in Contact with Drogue photo No. 7008-81-764B . . . . .	7
3	Pitch Control Beams "B" and "C" in Contact with Drogue, photo No. 7008-81-769B . . . . .	8
4	Probe Pitch Control Beam Strain Gage Installations and Identification . . . . .	9
5	Probe Support Beam Strain Gage Installations and Identification . . . . .	10
6	Probe Cylinder Strain Gage Installations and Identification . . . . .	11
7	Schematic - Deflection Indicators on Probe Identified by Recorder Channel Number . . . . .	12
8	Drogue Position and Orientation for Test Condition I and Test Condition III . . . . .	13
9	Drogue Position and Orientation for Test Condition II and Test Condition IV . . . . .	14
10	Strain Gage Locations on Drogue . . . . .	15
11	Axial Strain Gage Locations on Drogue. . . . .	16
12	Dial Indicator Orientation on Drogue Support Fittings	17
13	Test Setup for Test Condition I and Test Condition III	18
14	Resolution of Moment and Axial Loads . . . . .	19
15	Test Setup for Test Condition V . . . . .	20

T A B L E S

Number		Page
1	Combined Probe and Drogue Geometry and Loads	5

R E F E R E N C E S

- (a) TR 332077
- (b) Laboratory Notebook M243701,  
pages M 243730 through M 243739

## I N T R O D U C T I O N

Static structural tests were performed on the Apollo - LEM docking probe and drogue assemblies to ultimate loads for conditions imposed subsequent to capture latch. These tests were conducted during February 1967.

The tests were conducted by the Structures Test Group of Laboratories and Test at the Space and Information Systems Division of North American Aviation, Incorporated, Downey, California.

The tests were performed in accordance with TR 332077, written by the Apollo Engineering Structures Group, to certify the S/C 101 structural system as required by Certification Test Requirements (CTR 02332077). This report is the final test report as required by Exhibit I, paragraph 5.5.12 of Contract NAS9-150.

### III. TEST SETUP (Continued)

#### I. DESCRIPTION OF TEST SPECIMENS

The test articles were an Apollo - LEM docking probe assembly, (V36-575101-101), from Spacecraft 2S-2, and an Apollo - LEM docking drogue assembly, (V28-575201) Serial Number 06362 YAT 5606.

#### II. TEST CONDITIONS

The five test conditions presented in Table 1 subjected the Apollo - LEM docking probe and drogue assemblies to the subsequent-to-capture-latch maximum design loads. Temperature correction factors were included in determining the applied-at-room temperature static test loads.

#### III. TEST SETUP

The probe assembly was mounted to a V36-316050 Apollo Command Module docking ring. The probe piston stroke was adjusted and fixed according to the adjustment procedure of TR 332077, Reference (a), to a length 0.75 inch less than the fully extended position. The probe orientation and instrumented component identification are shown in Figure 1. The docking ring was bolted to an octagonal, back-up fixture through which the test loads were applied. This fixture could be rotated 180 degrees to put either one pitch arm in contact with the drogue, Figure 2, or two pitch arms in contact, Figure 3. Figures 4, 5 and 6 show the strain gage locations on the probe elements. Figure 7 shows deflection measurements taken on the probe.

The drogue assembly was mounted in a test fixture equipped with six simulated LEM interface fittings. The six fittings permitted the drogue to be rotated in 60 degree increments relative to the probe, i.e., the Apollo C/M "X" axis. Figures 8 and 9 show the drogue in the two positions required for this series of tests. Figures 10 and 11 show the strain gage locations on the drogue, and Figure 12 shows how deflection measurements were taken at the drogue support fittings.

Figure 13 is a typical view of the loading arrangement used for Test Conditions I through IV. Note the two horizontal load cylinders at the top (one at either side of the docking ring) and one at the bottom. Figure 14 shows how these cylinders were loaded to apply the combined axial load and moment. The shear load was divided between two cylinders, one on either side at Sta. 107.25, and the five cylinders loaded by means of an Edison Load Maintainer. Figure 15 shows the loading arrangement for the T. C. V. In this instance, two cylinders were equally loaded to apply half of the required tension load. The probe was fully retracted and the manual latch engaged. The cable and pulley arrangement was used in all tests to balance the dead weight of the probe, docking ring and backup structure.

All channels of instrumentation were electrically connected to a 100-channel recorder. The dial indicators shown in Figure 12 were manually read and recorded.

#### IV. TEST PROCEDURE

The test conditions were conducted in the order I, III, II, IV, V. Test Conditions I and II, with one pitch arm in contact with the drogue, Figures 2 and 8, had the same mechanical setup. Test Condition I was performed first, with the loads applied in ten percent increments to 130 and five percent increments from 135 to 150. Test Condition III was then initiated by switching the loading cylinder pressure lines to a second set of pre-calibrated channels on the Edison unit, and the loading followed, using the same increments.

The changeover to set up for Conditions II and IV required rotating the probe and its backup structure 180 degrees to put two pitch arms in contact with the drogue, Figure 3. The drogue was rotated 60 degrees to the position of Figure 9. Test Condition II was then performed, using 20 percent increments to 100, ten percent increments to 130 and five percent to 150 percent. Test Condition IV followed, using the same loads and increments as Test Condition III.

#### IV. TEST PROCEDURE (Continued)

After the completion of Test Condition IV, a second changeover was made to the Test Condition V configuration of Figure 15. Test Condition V was then performed, applying the axial tension load in 20 percent increments to 100, ten percent increments to 130 and five percent increments to 150 percent.

#### V. TEST RESULTS

The required test data are presented graphically as Appendix A. Visual inspection of the test articles and review of the test data indicate that the probe and drogue sustained limit load (100 percent), ultimate load (135 percent), and overtests to 150 percent with no indications of yielding or failure.

#### VI. CONCLUSIONS

The test was performed in accordance with TR 332077, Reference (a). The applied test loads were current and satisfactory.

Because the test article sustained 100 percent of ultimate load without failure, the test satisfied the requirements set forth in CTR 02332077, and in conjunction with the satisfactory completion of test requirements set forth in CTR's 02332014 (SID 67-99) and CTR 02332015 (SID 67-318), completes the certification of the probe and drogue. Therefore, the flight constraints against the related structures of Spacecraft 101 and subsequent Block II spacecraft will be removed.

TABLE 1  
COMBINED PROBE AND DROGUE GEOMETRY AND LOADS

TEST CONDITION	No. of pitch arms contacting drogue face	DESIGN LIMIT LOADS			* Applied Test Loads					
		Axial F <sub>3</sub> lb	Shear F <sub>4</sub> lb	Moment in.-lb	Axial (F <sub>3</sub> ) Pounds		Shear (F <sub>4</sub> ) Pounds		Moment Inch-pounds	
					Limit	Ult.	Limit	Ult.		Limit
I Max. tip force at - 65°F temperature	1	3688	2446	28104	3688	4,980	2446	3,300	28104	38,000
II Max. tip force at - 65°F temperature	2	3688	2446	28104	3688	4,980	2446	3,300	28104	38,000
III Max. tip force at + 250°F temperature	1	2958	2256	32052	3400	2,600	2600	3,510	36900	49,750
IV Max. tip force at + 250°F temperature	2	2958	2256	32052	3400	2,600	2600	3,510	36900	49,750
V Max. tension at + 250°F temperature	0	-6500	0	0	-7450	-10,050	0	0	0	0

\* Applied Test Load (Limit) = Design limit load x temperature Corr. factor ( $T_k$ )

\* Applied Test Load (Ultimate) = Design limit load x  $T_k$  x 1.35\*\* ←  
Temperature Corr. Factor ( $T_k$ ) for -65°F = 1.00

Temperature Corr. Factor ( $T_k$ ) for +250°F = 1.15

Applied Test Load (overload) = applied test load (limit) x 1.5

WHERE ARE LOADS FROM



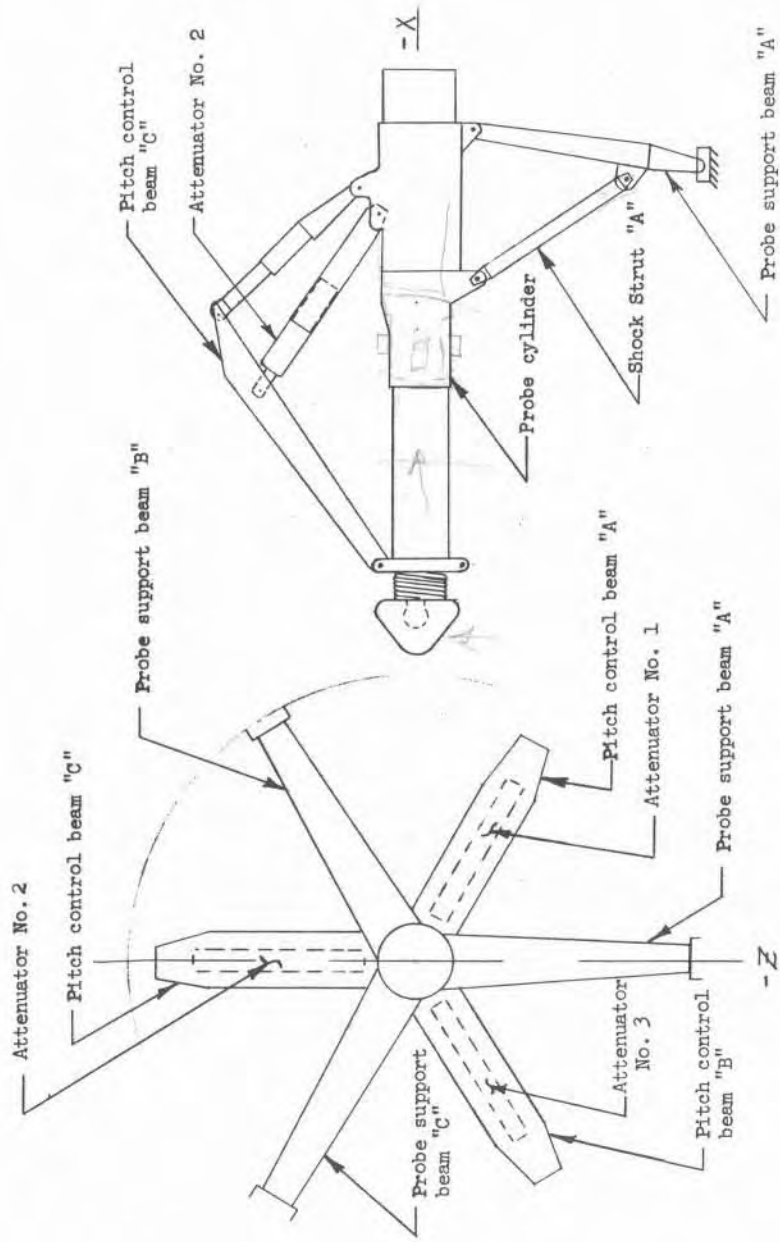


FIGURE 1. PROBE ORIENTATION AND INSTRUMENTED COMPONENT IDENTIFICATION



Figure 2. ONE PITCH CONTROL BEAM (A) IN CONTACT WITH DROPLET

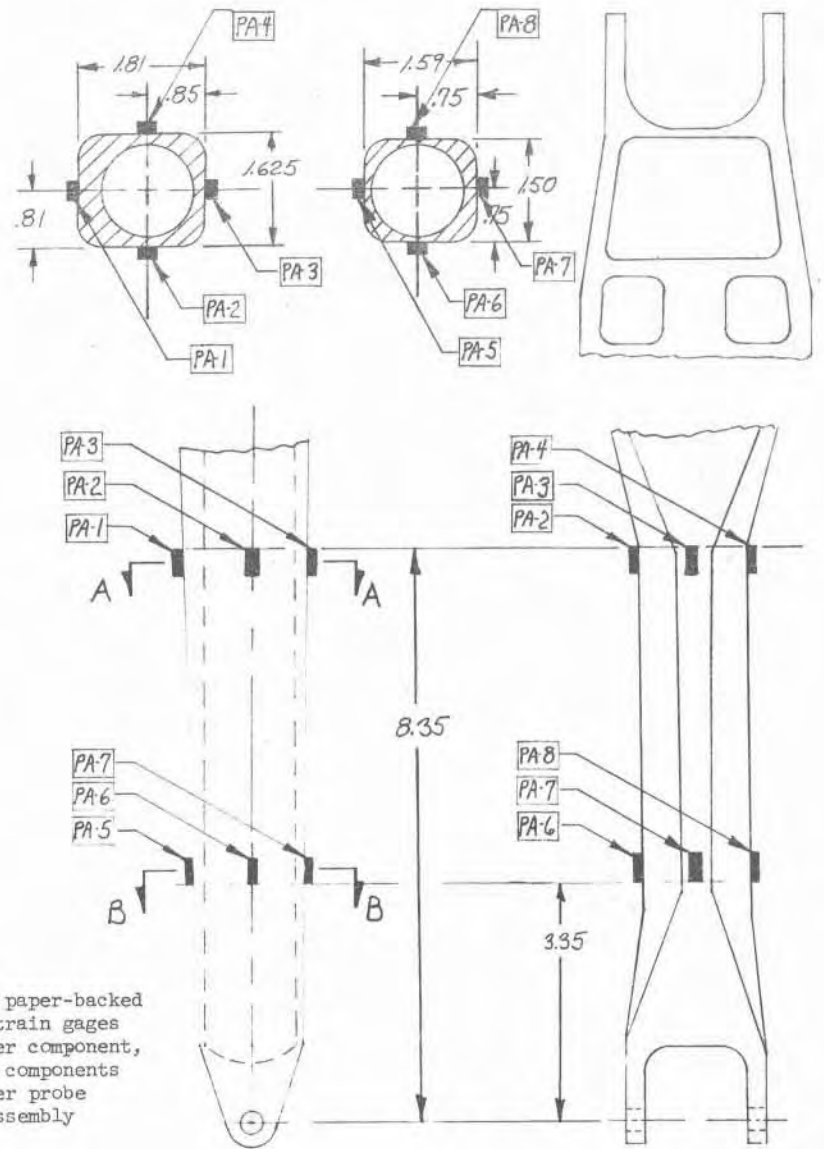
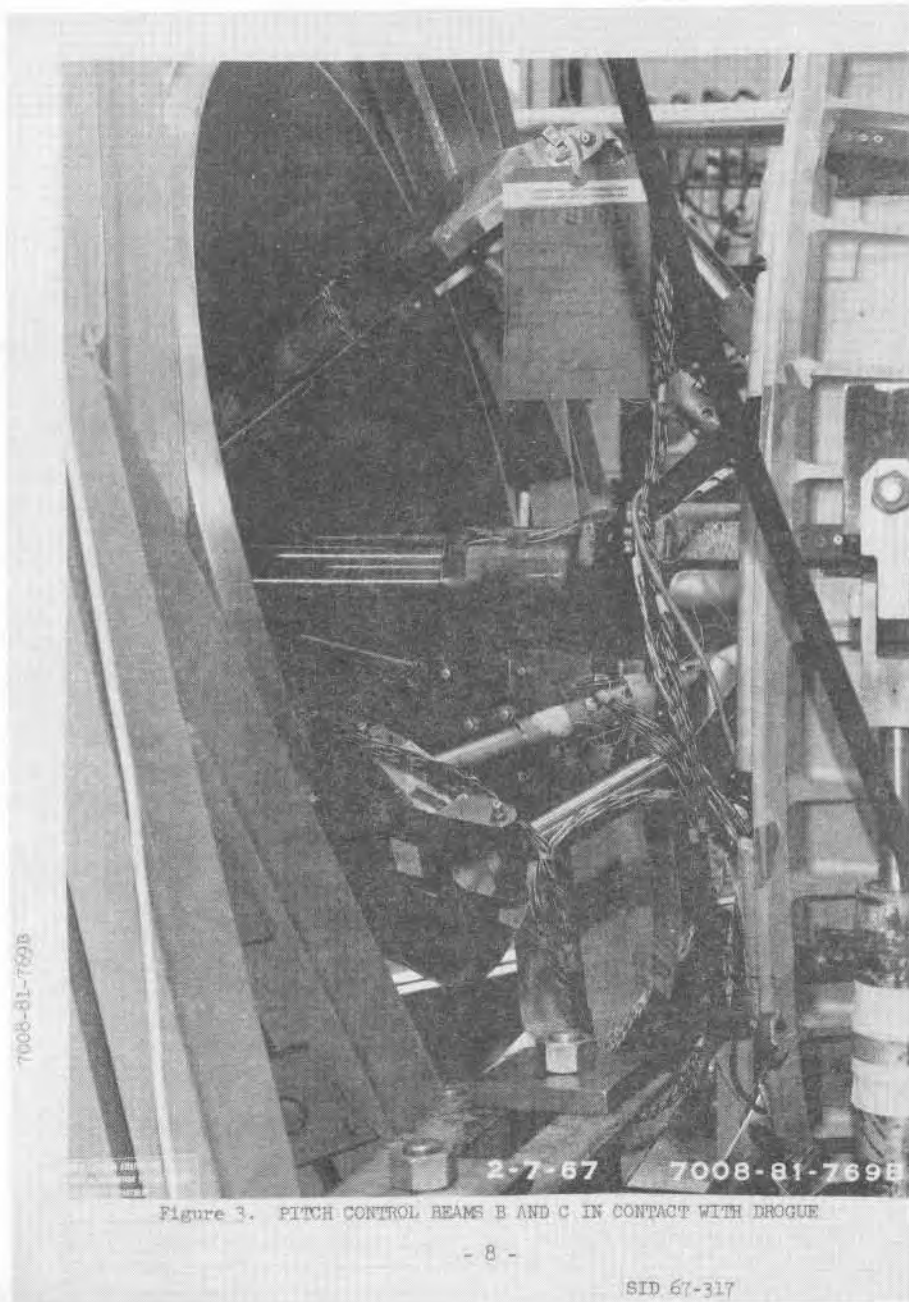


FIGURE 4. PROBE PITCH CONTROL BEAM STRAIN GAGE INSTALLATIONS AND IDENTIFICATION

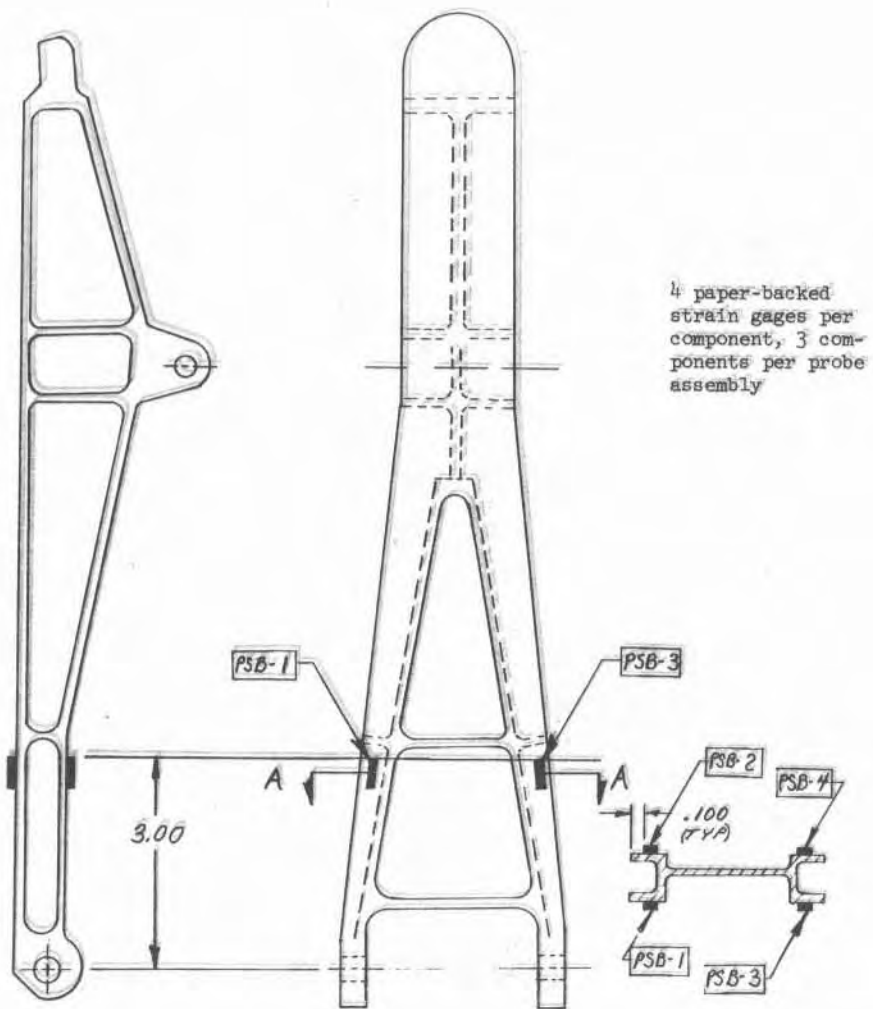


FIGURE 5. PROBE SUPPORT BEAM STRAIN GAGE INSTALLATIONS AND IDENTIFICATIONS

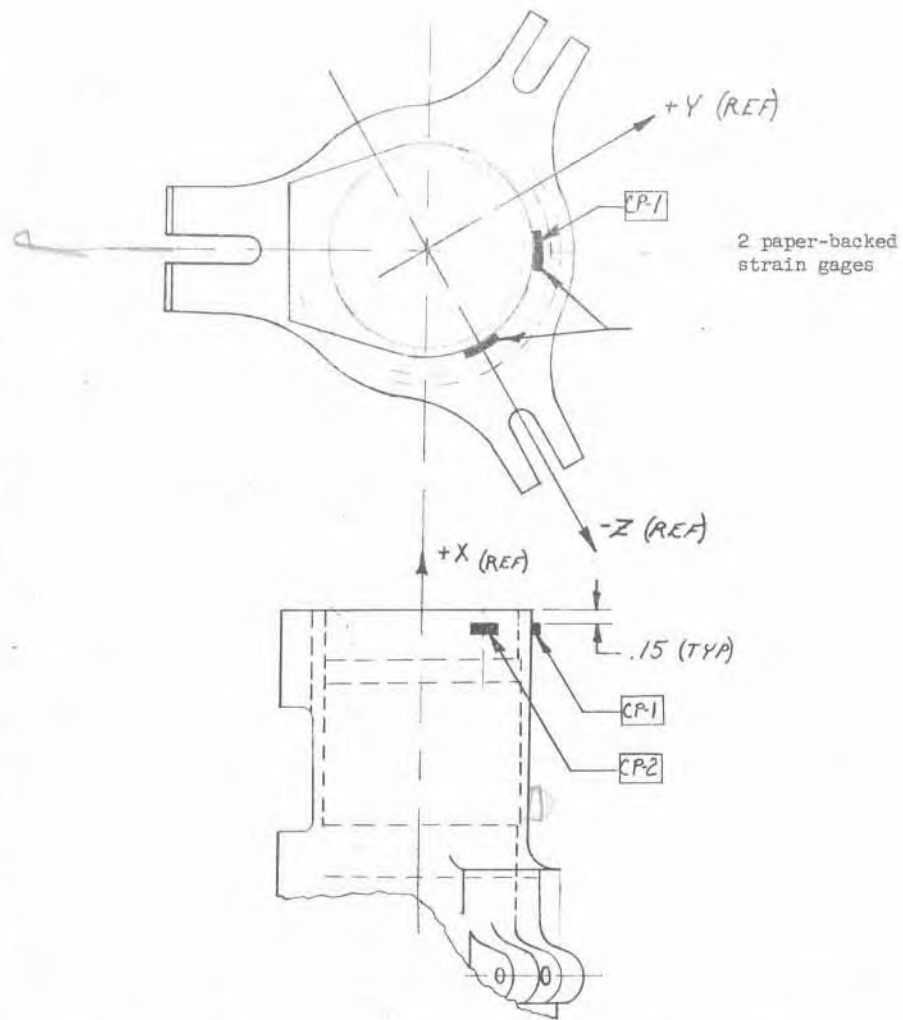


FIGURE 6. PROBE CYLINDER STRAIN GAGE INSTALLATIONS AND IDENTIFICATIONS

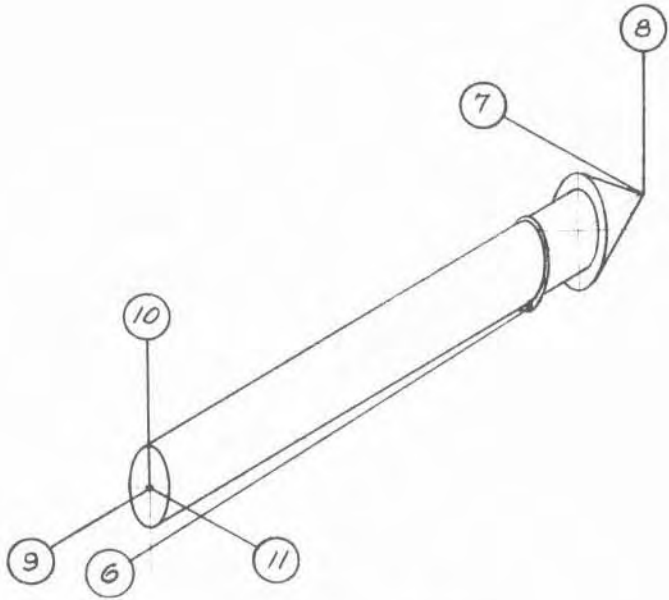
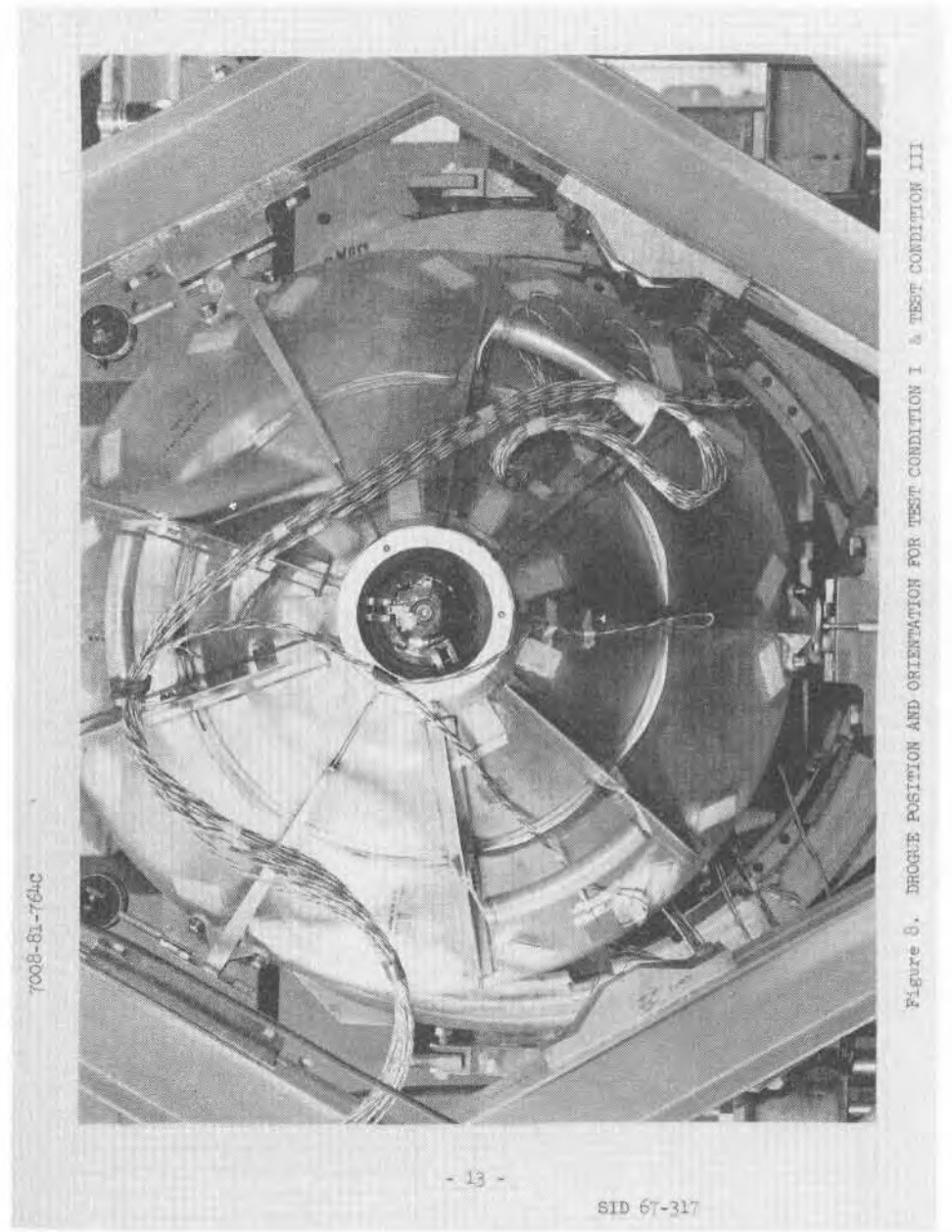


FIGURE 7

SCHEMATIC - DEFLECTION INDICATORS ON PROBE IDENTIFIED BY RECORDER CHANNEL NUM



7008-81-764c

Figure 8. PROBE POSITION AND ORIENTATION FOR TEST CONDITION I & TEST CONDITION III



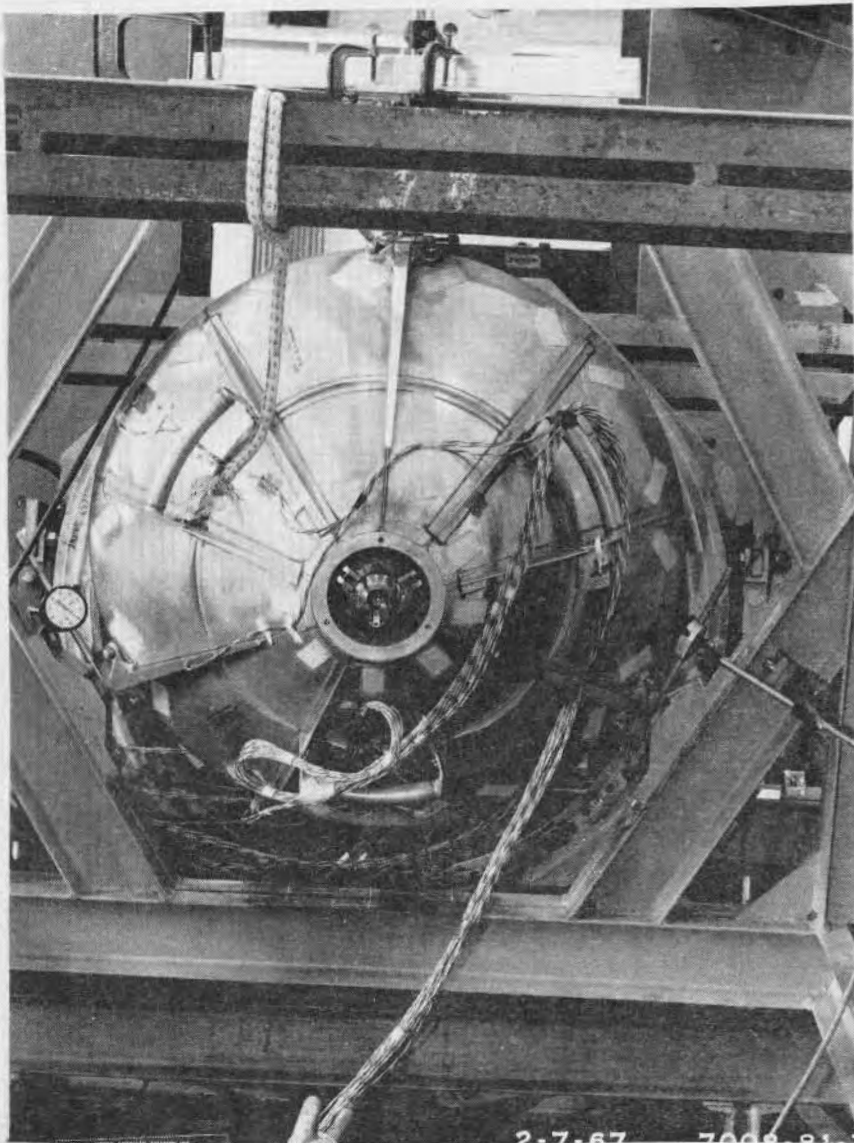


Figure 9  
DROGUE POSITION AND ORIENTATION FOR TEST CONDITION II AND TEST CONDITION IV

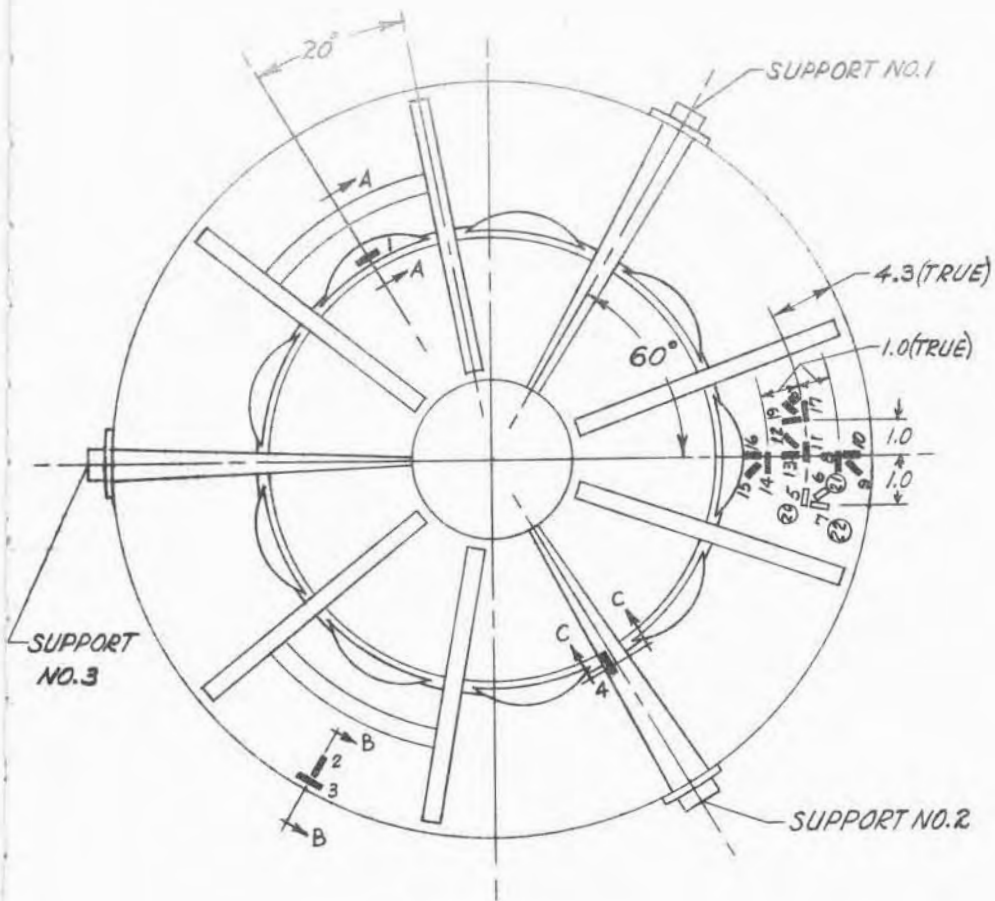
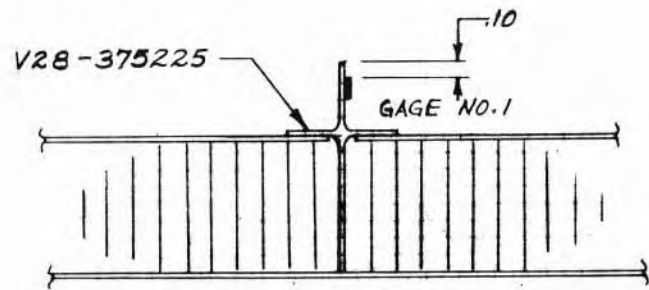


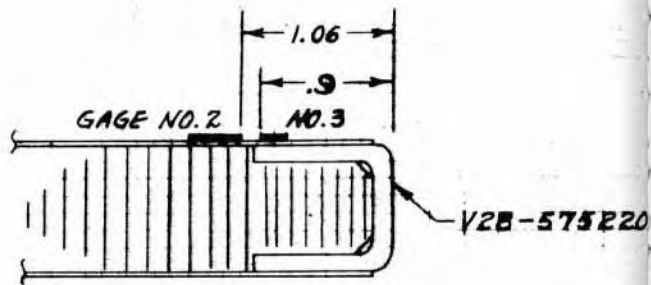
Figure 10

STRAIN GAGE LOCATIONS ON DROGUE

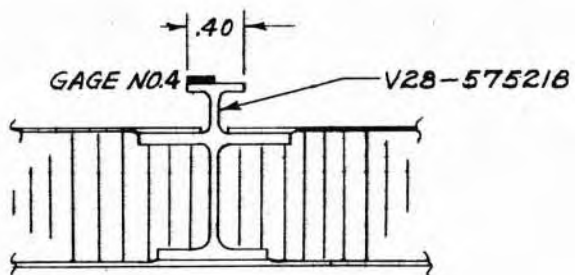
1. For rosette type gages:
  - coded gages are on outside face sheet
  - coded gages are back to back. (20) (21) (22) on inside face sheet.
2. See Figure 11 for axial gage sections



SECTION A-A



SECTION B-B



SECTION C-C

Figure 11  
AXIAL STRAIN GAGE LOCATIONS ON DROGUE

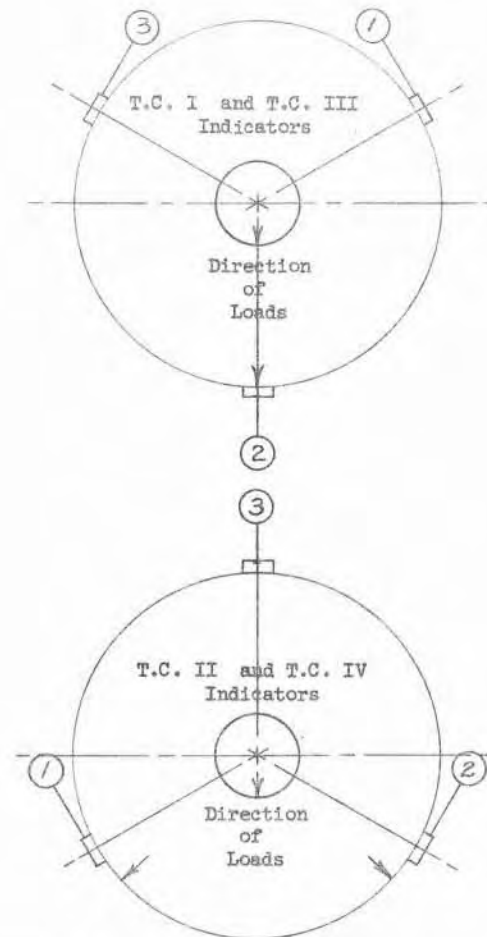


Figure 12  
DIAL INDICATOR DEFLECTION MEASUREMENTS  
ON DROGUE SUPPORT FITTINGS

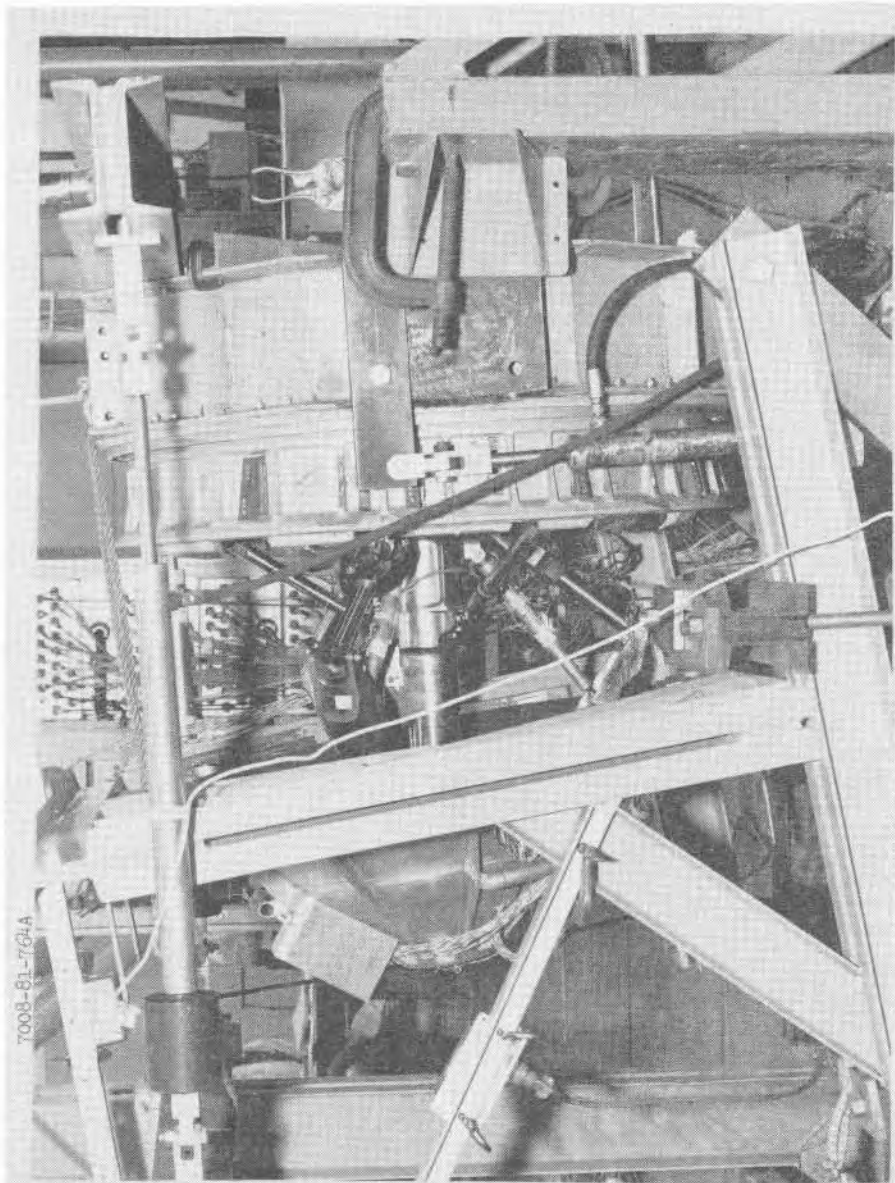
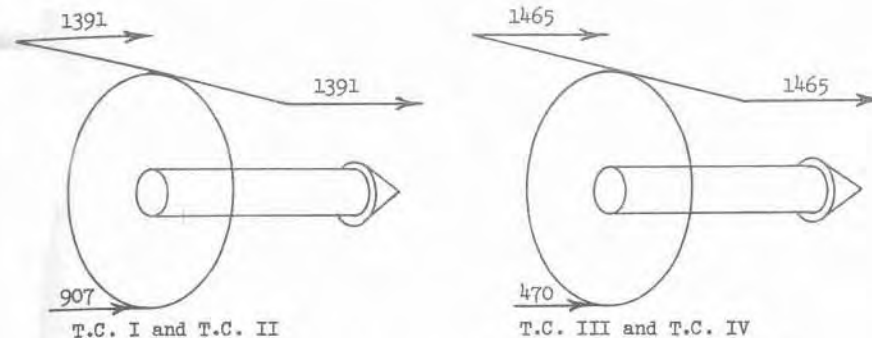


Figure 13. TEST SETUP FOR TEST CONDITION I AND TEST CONDITION III



T.C. I and II LOADS

$$\text{Limit Axial Load} = \frac{3688}{2} = 1844 \text{ lb} \quad \text{Limit Mom. Couple} = \frac{28,104 \text{ in-lb}}{30 \text{ in.}} = 936.8 \text{ lb}$$

$$\frac{1844}{\rightarrow} + \frac{937}{\rightarrow} = \frac{2781 \text{ lb}}{\rightarrow} + 2 = 1390.5 \text{ lb per cylinder}$$

$$\frac{1844}{\rightarrow} + \frac{937}{\downarrow} = \frac{907 \text{ lb}}{\rightarrow}$$

T.C. III and IV LOADS

$$\text{Limit Axial Load} = \frac{3400}{2} = 1700 \text{ lb} \quad \text{Limit Moment Couple} = \frac{36,900 \text{ in-lb}}{30 \text{ in.}} = 1230 \text{ lb}$$

$$\frac{1700}{\rightarrow} + \frac{1230}{\rightarrow} = \frac{2930}{\rightarrow} + 2 = 1465 \text{ lb per cylinder}$$

$$\frac{1700}{\rightarrow} + \frac{1230}{\downarrow} = \frac{470}{\rightarrow}$$

Figure 14

RESOLUTION OF MOMENT AND AXIAL LOADS

7000-81-7163

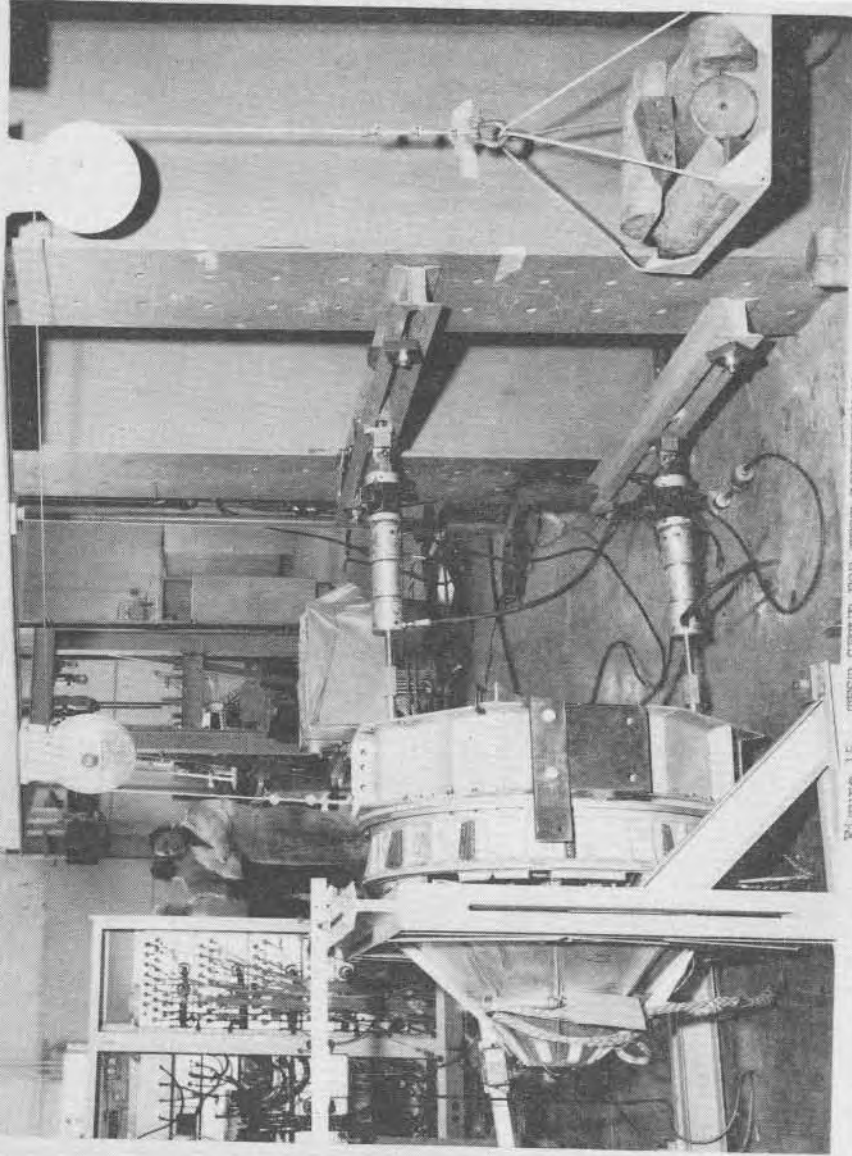


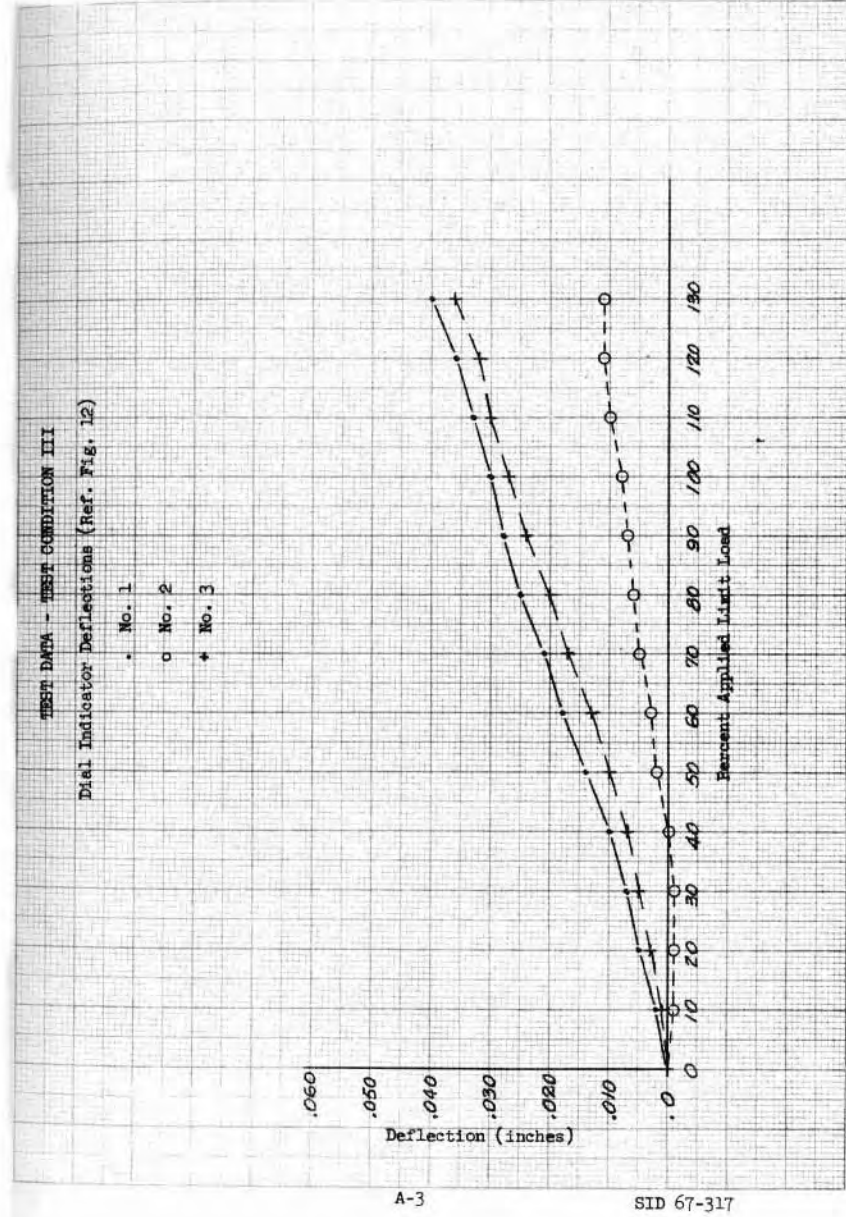
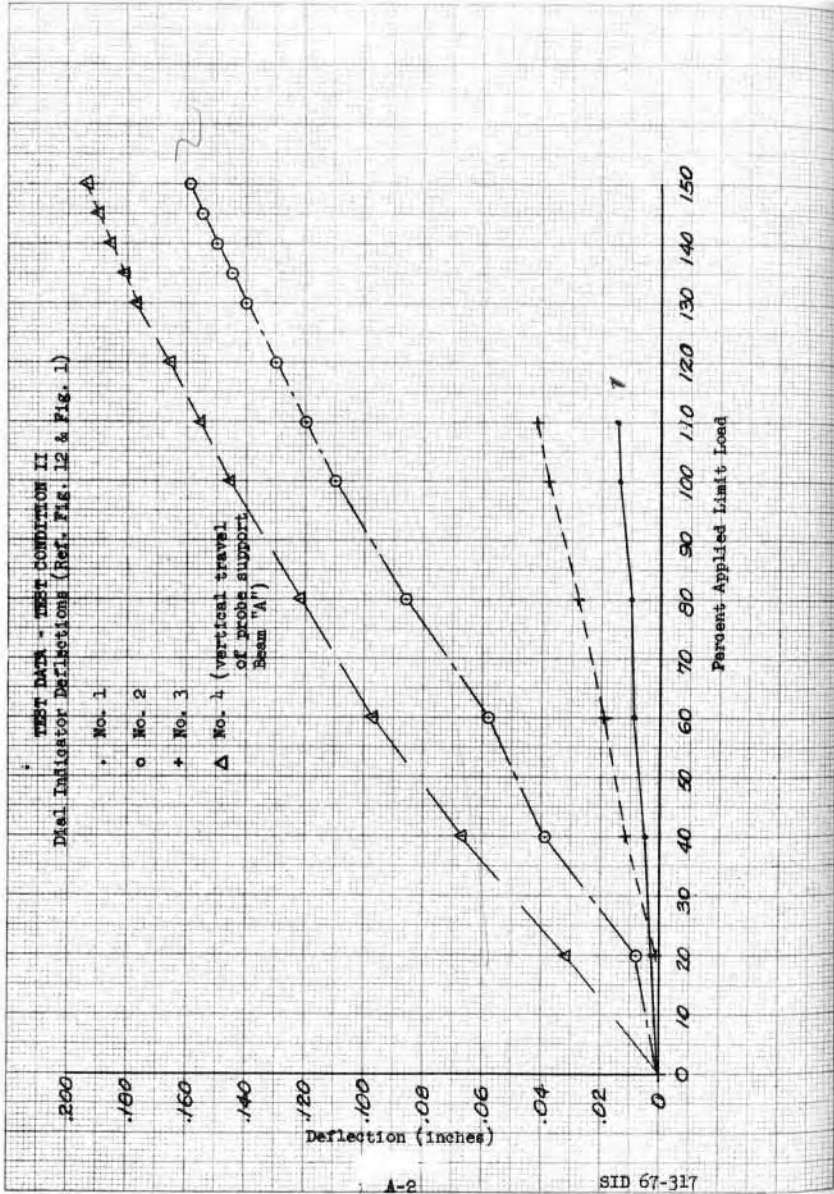
Figure 15. TEST SETUP FOR TEST CONDITION V

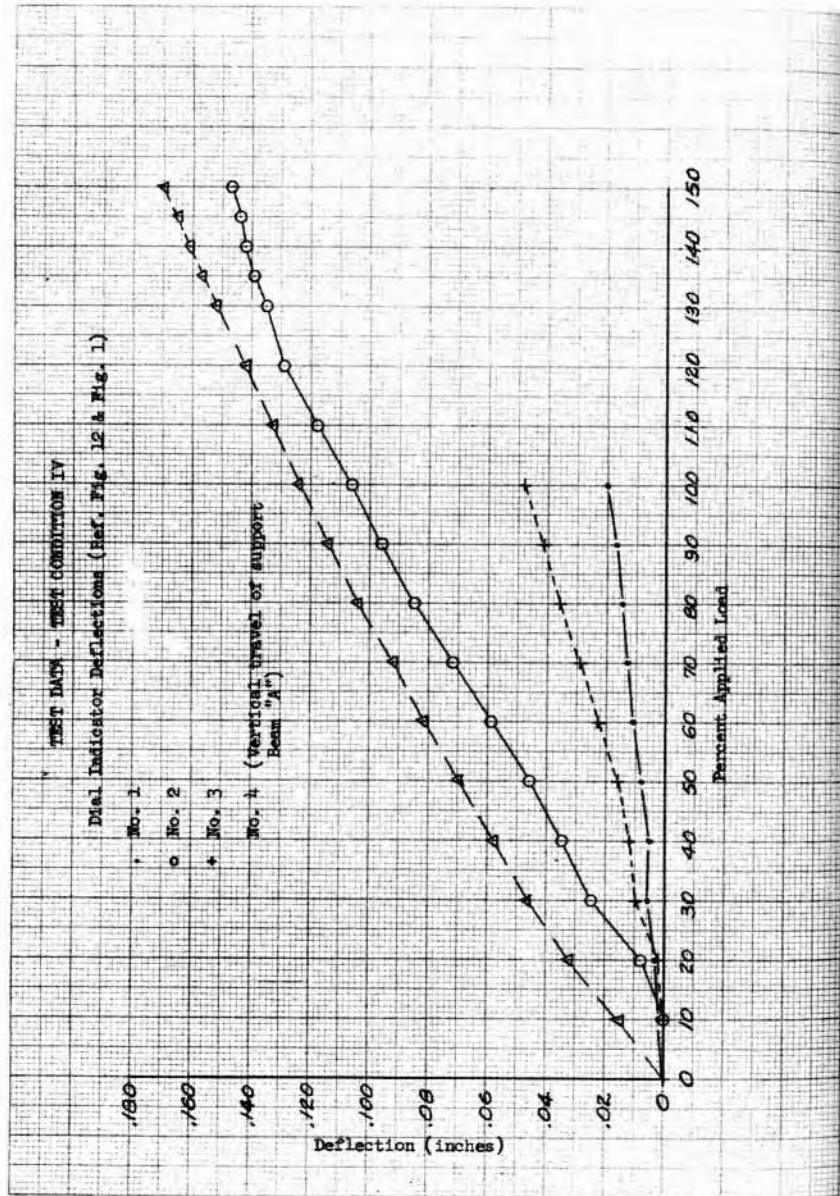
APPENDIX A

TEST DATA - TEST CONDITIONS I, II, III, IV, V



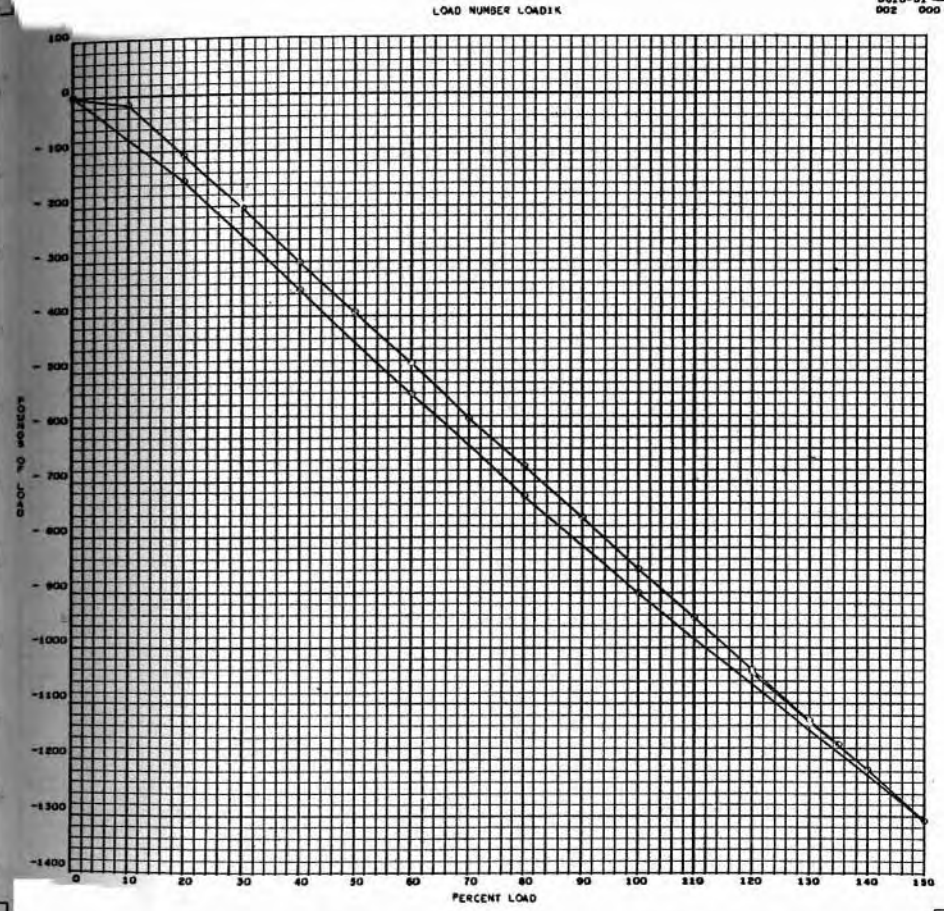






A-4

SID 67-317

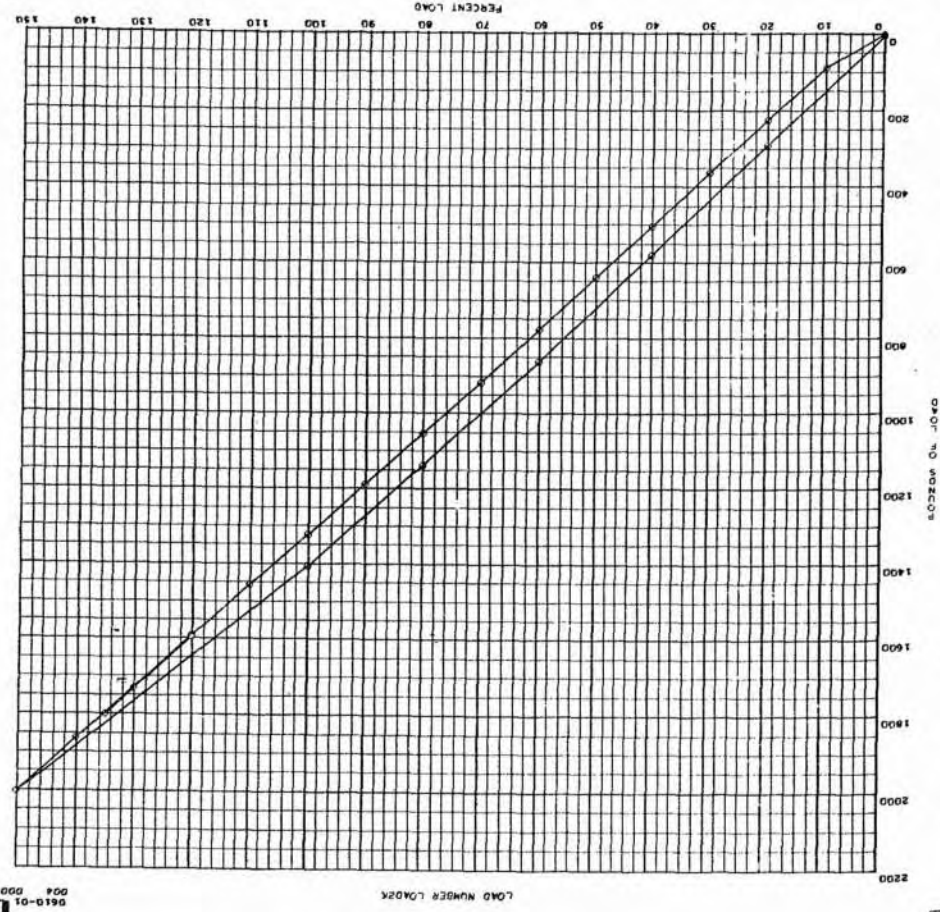


A-5

SID 67-317

SID 67-317

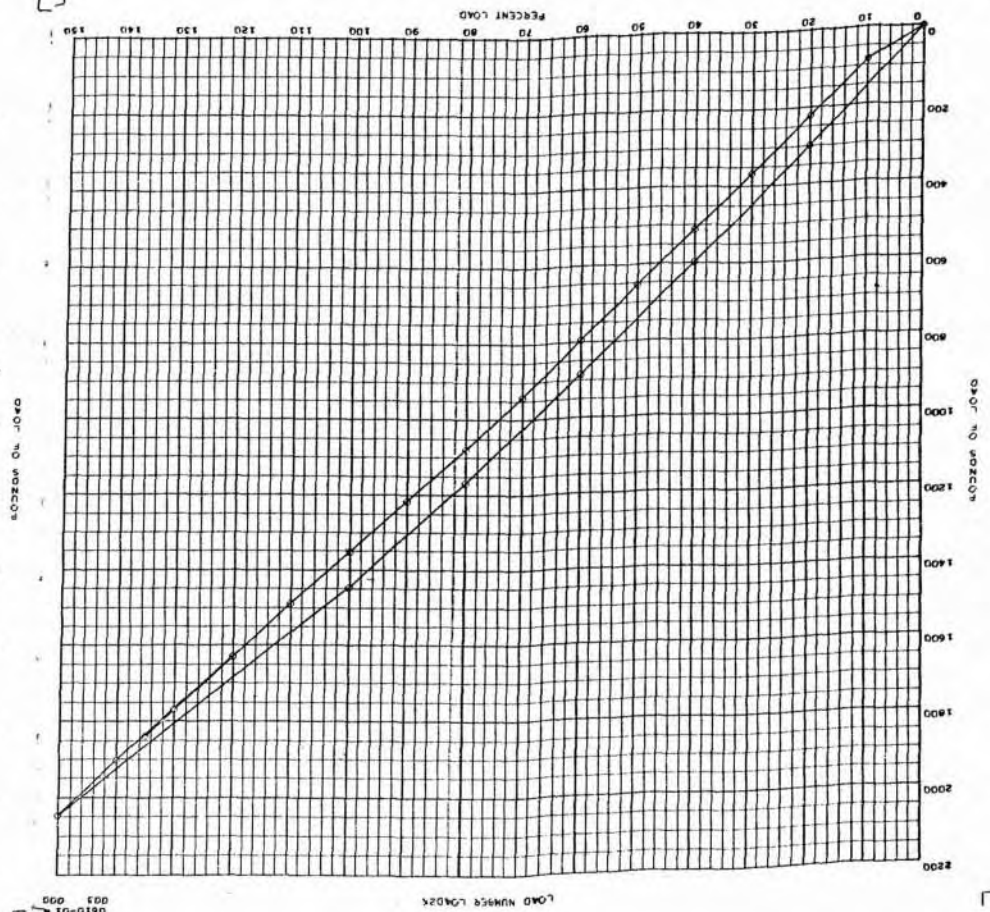
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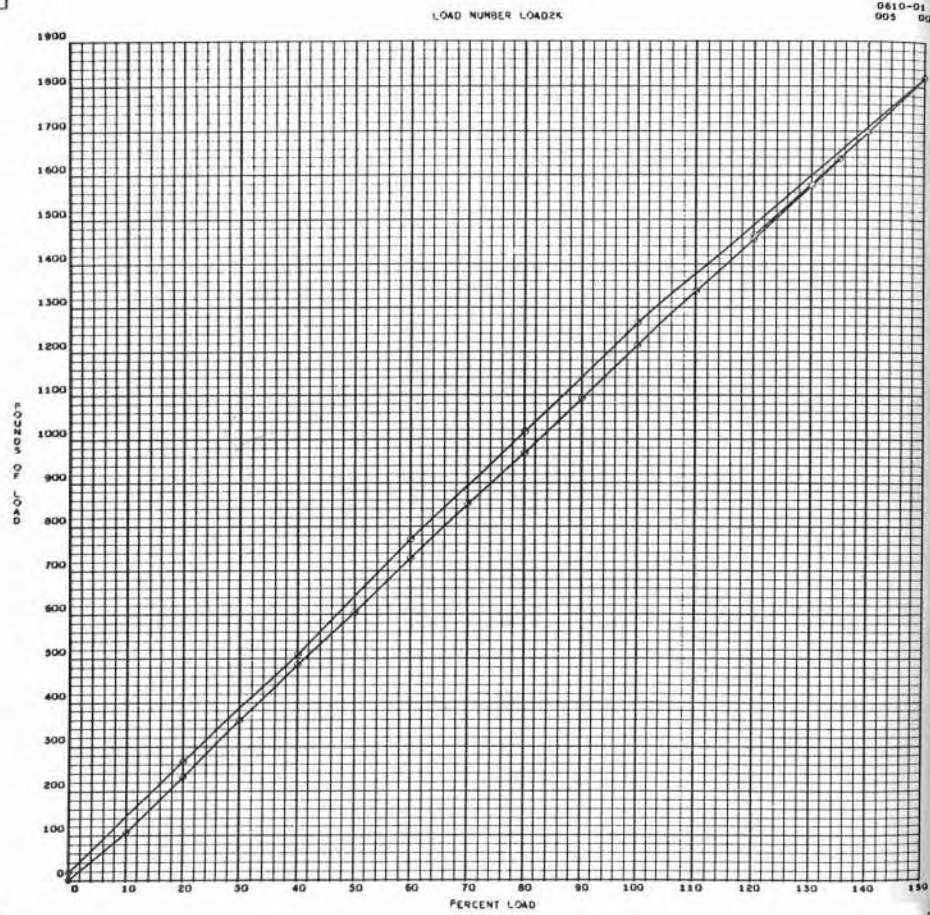
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A-6



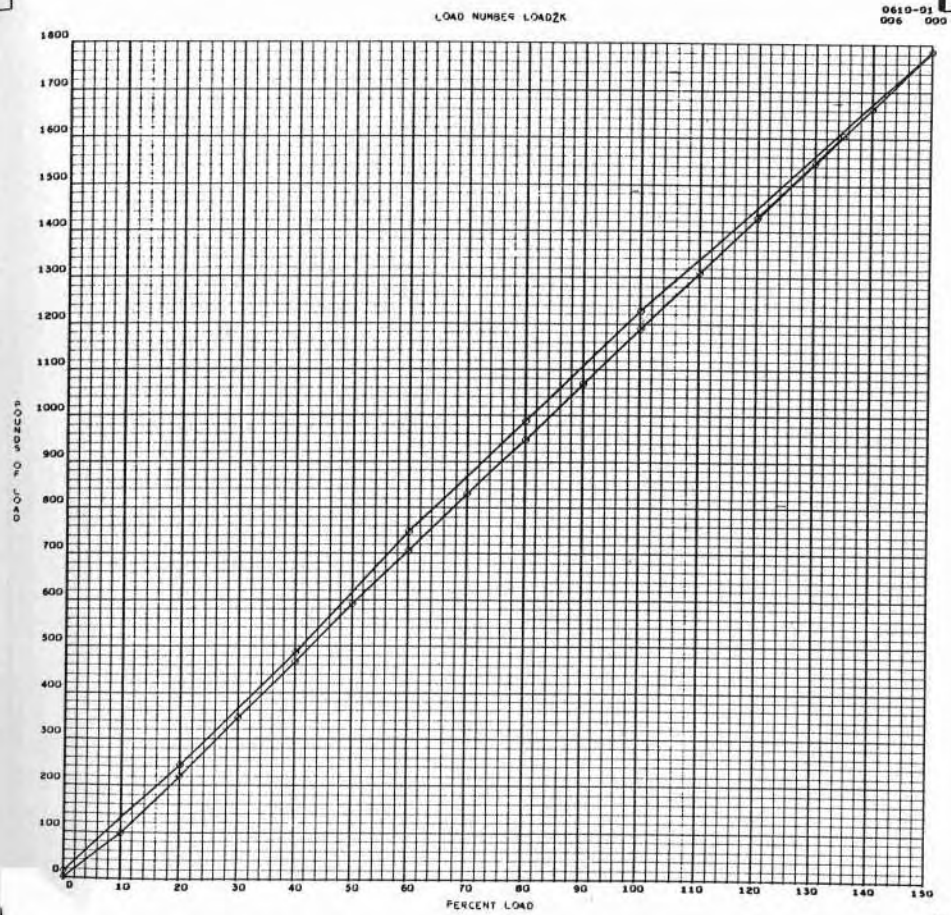
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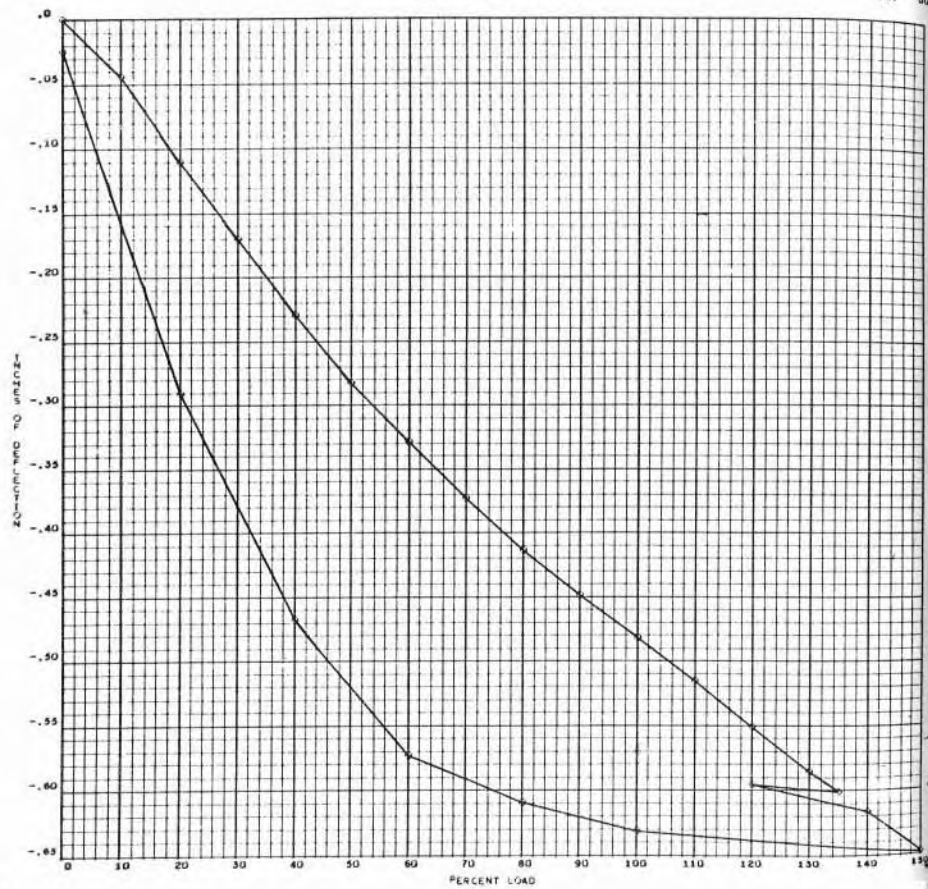


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SID 67-317

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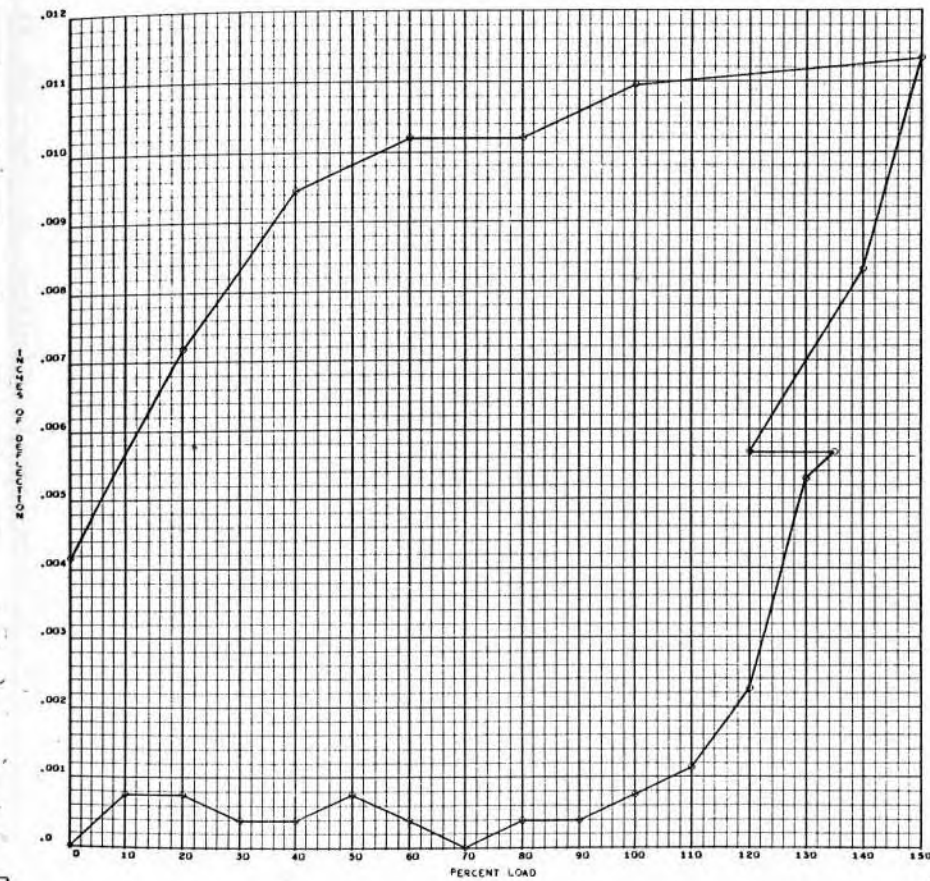


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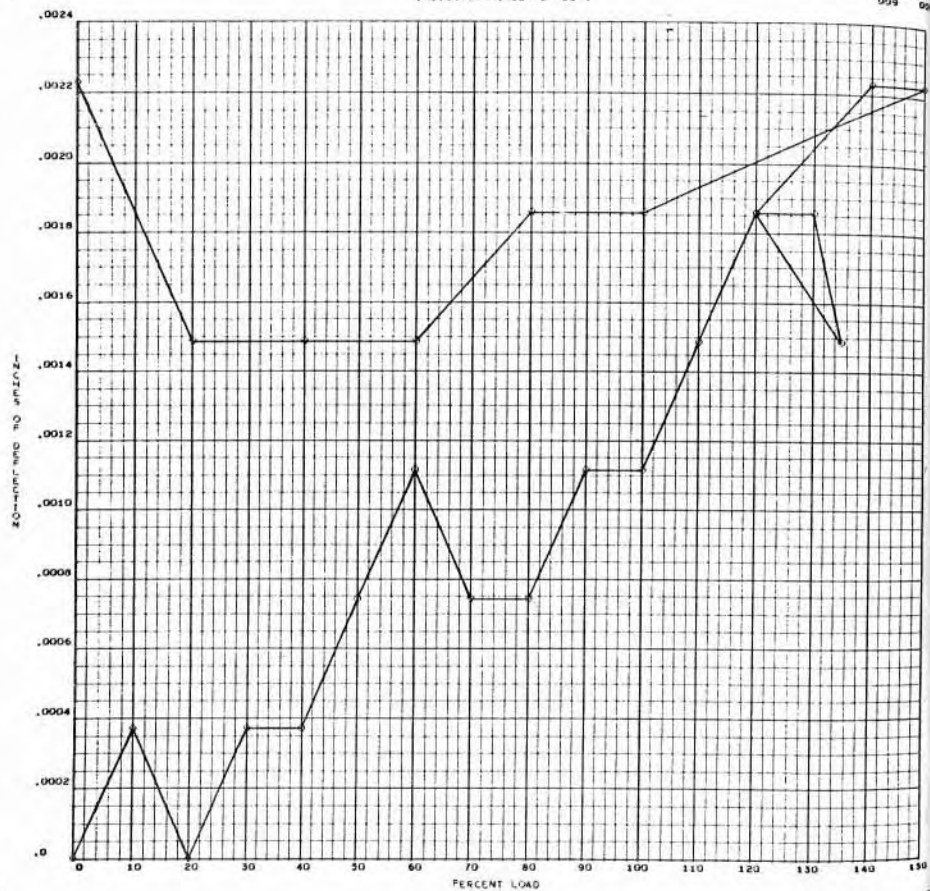


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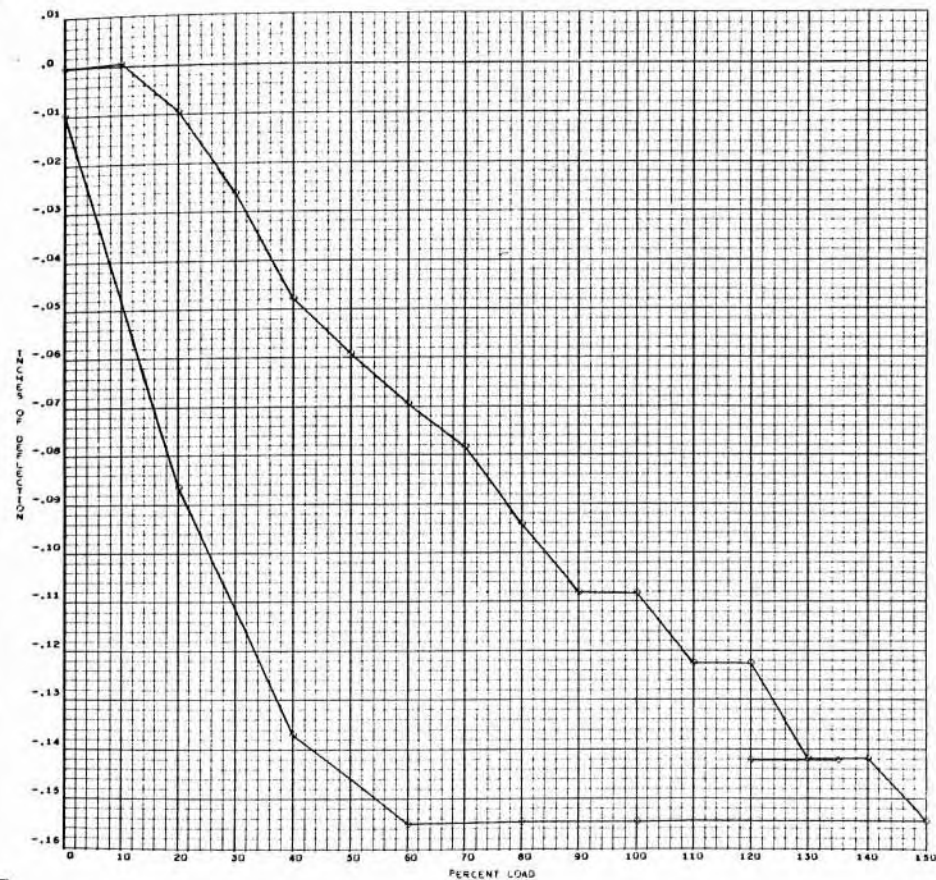


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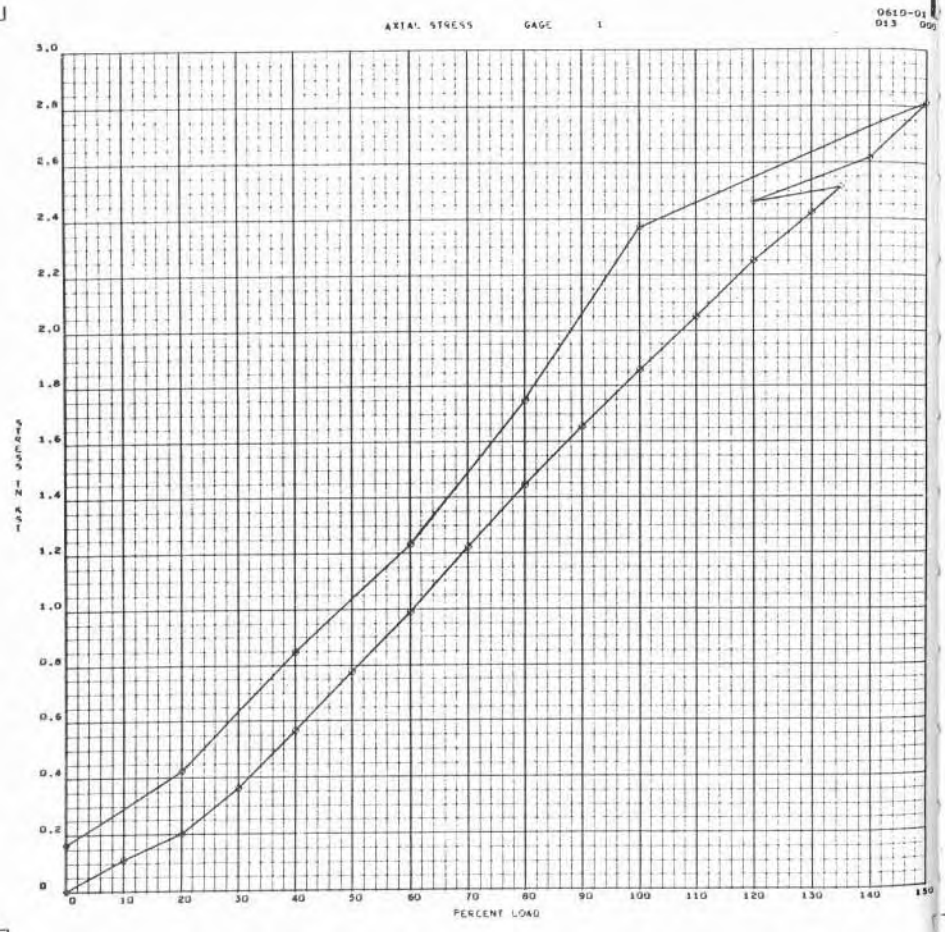


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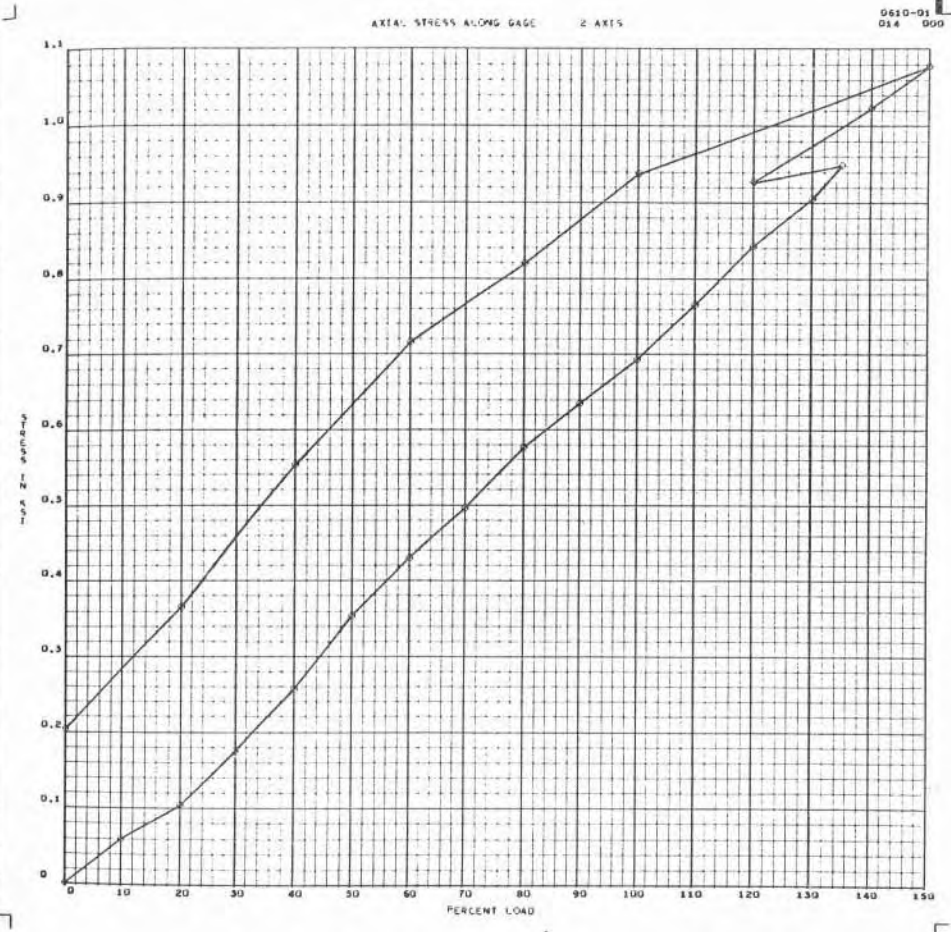






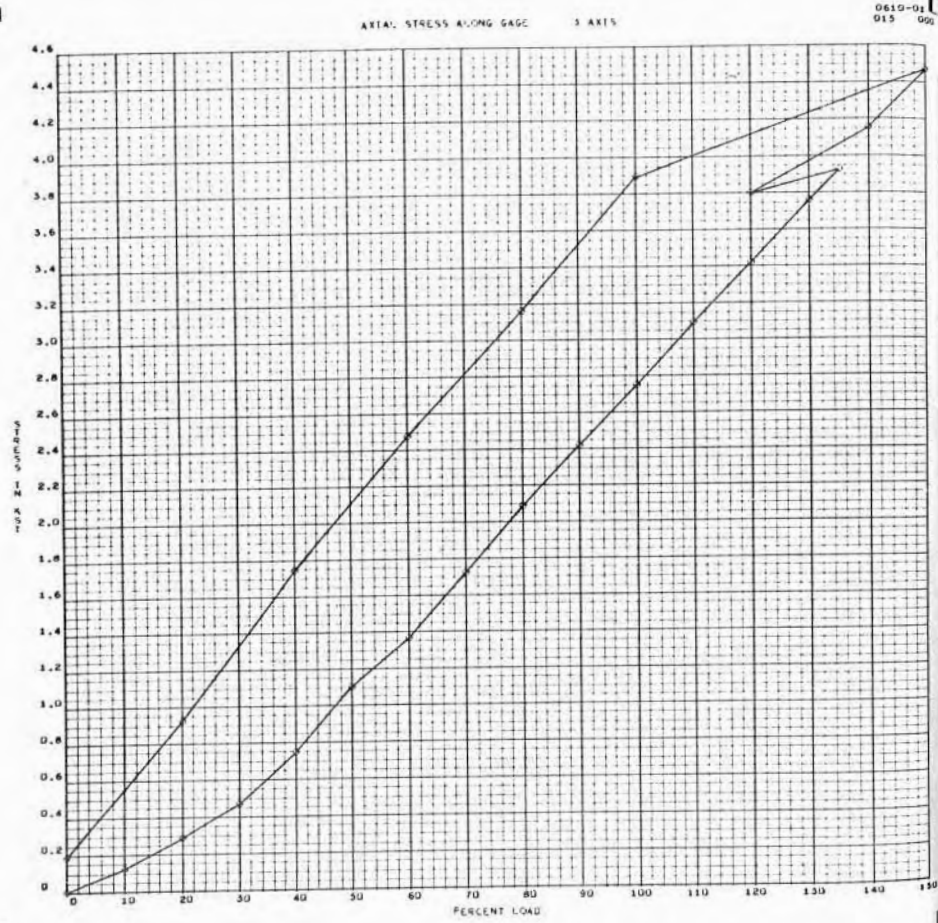
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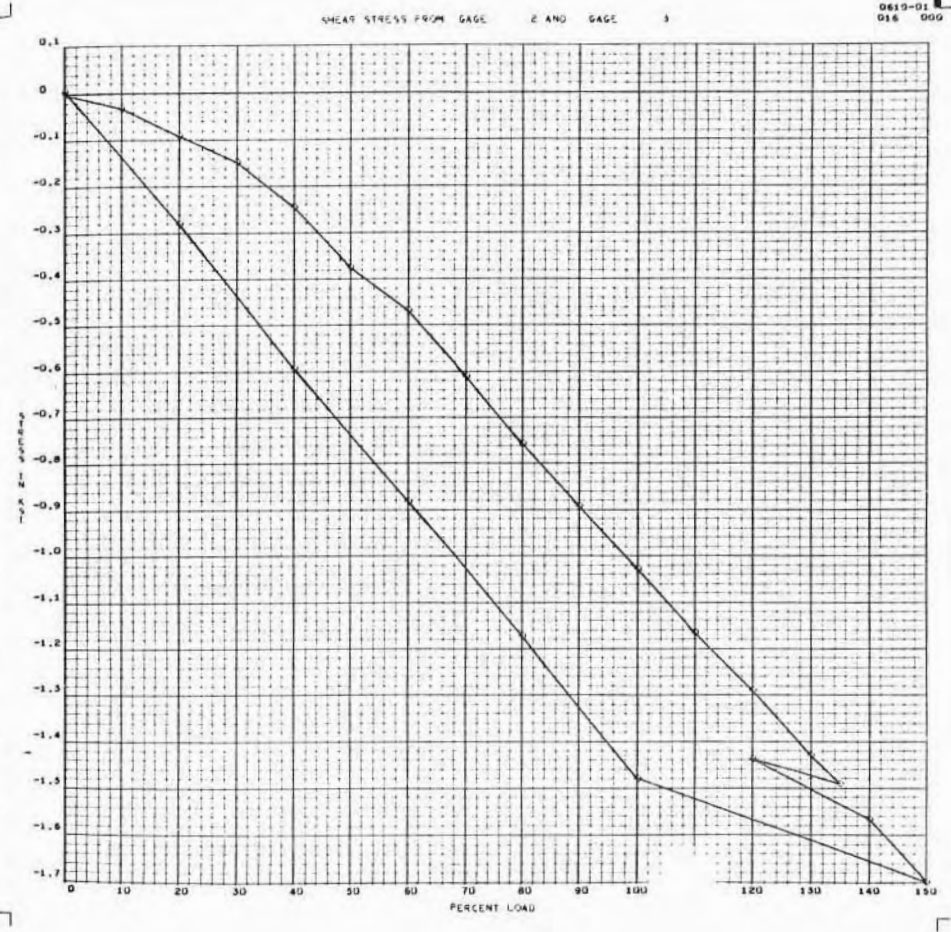
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SID 67-317



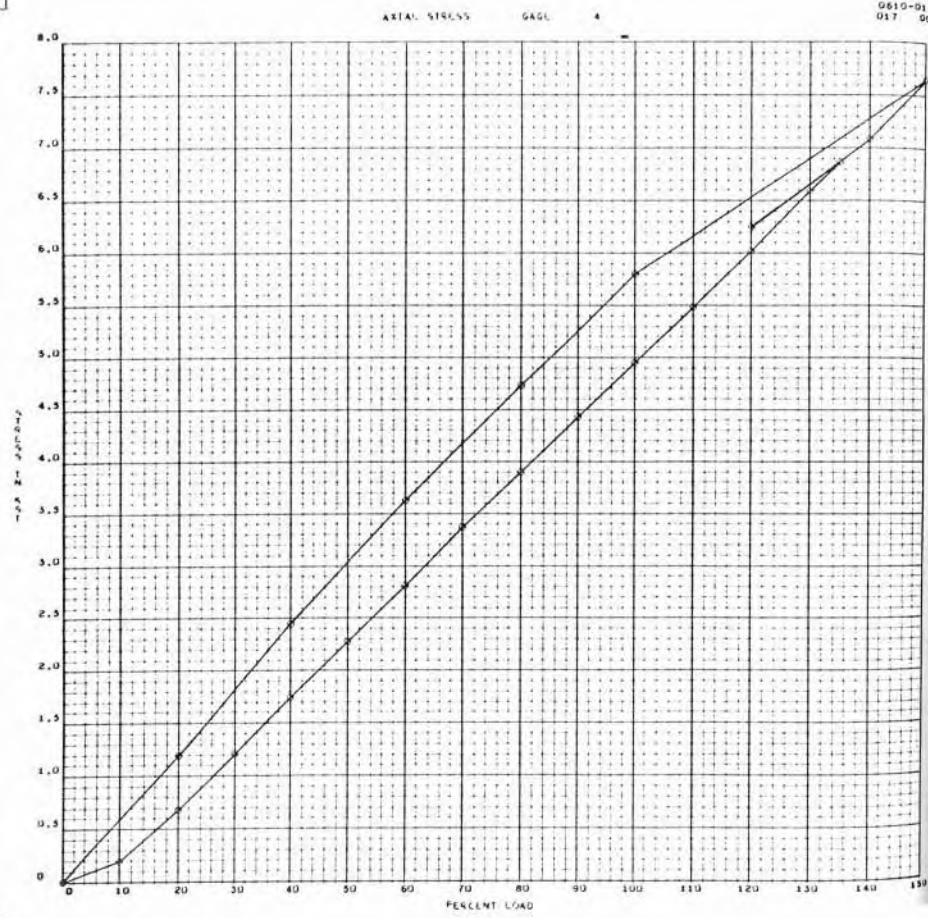
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SID 67-317



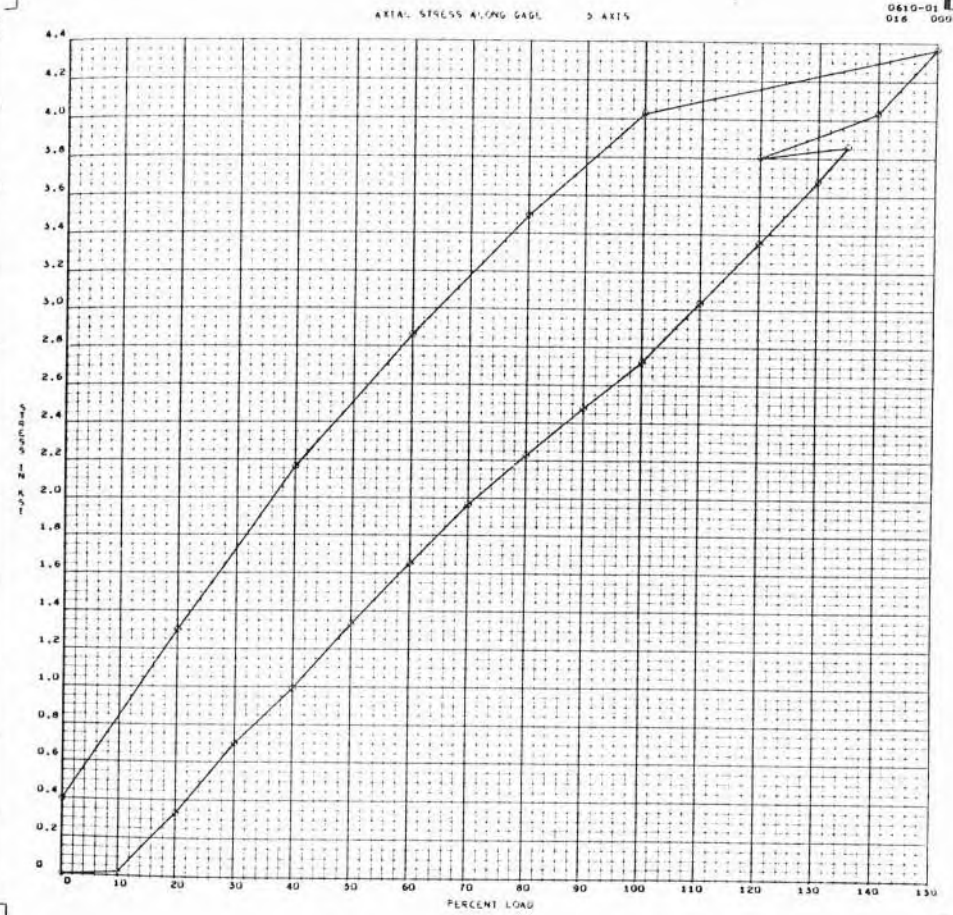
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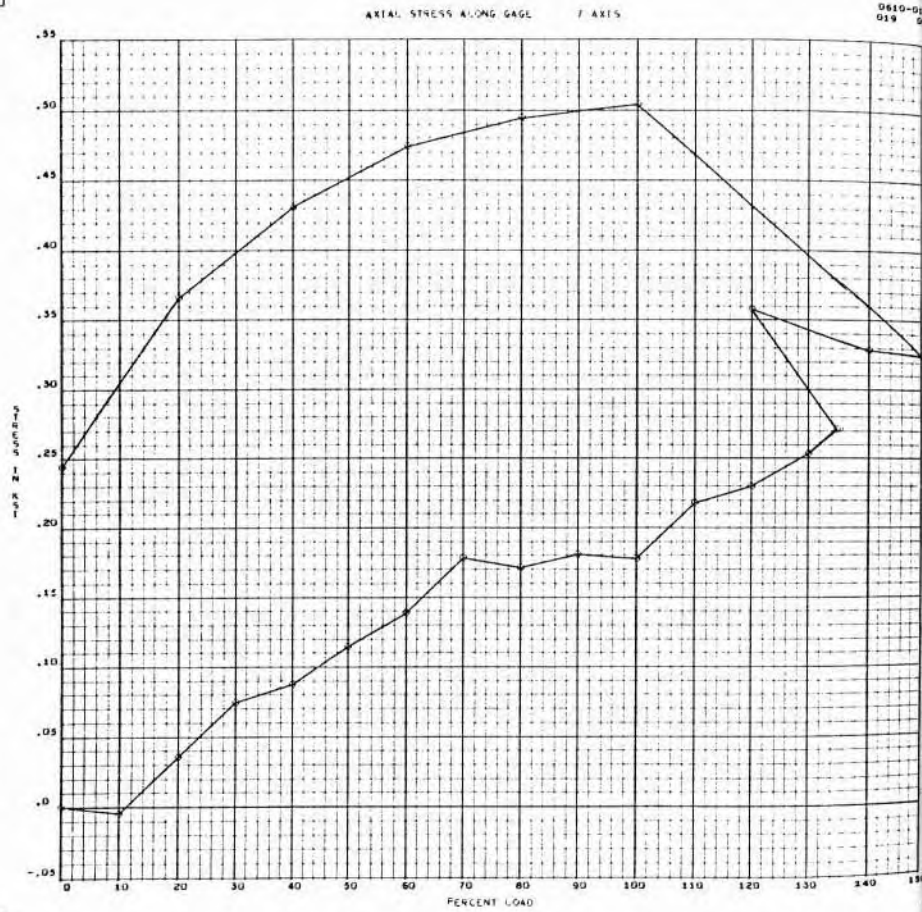
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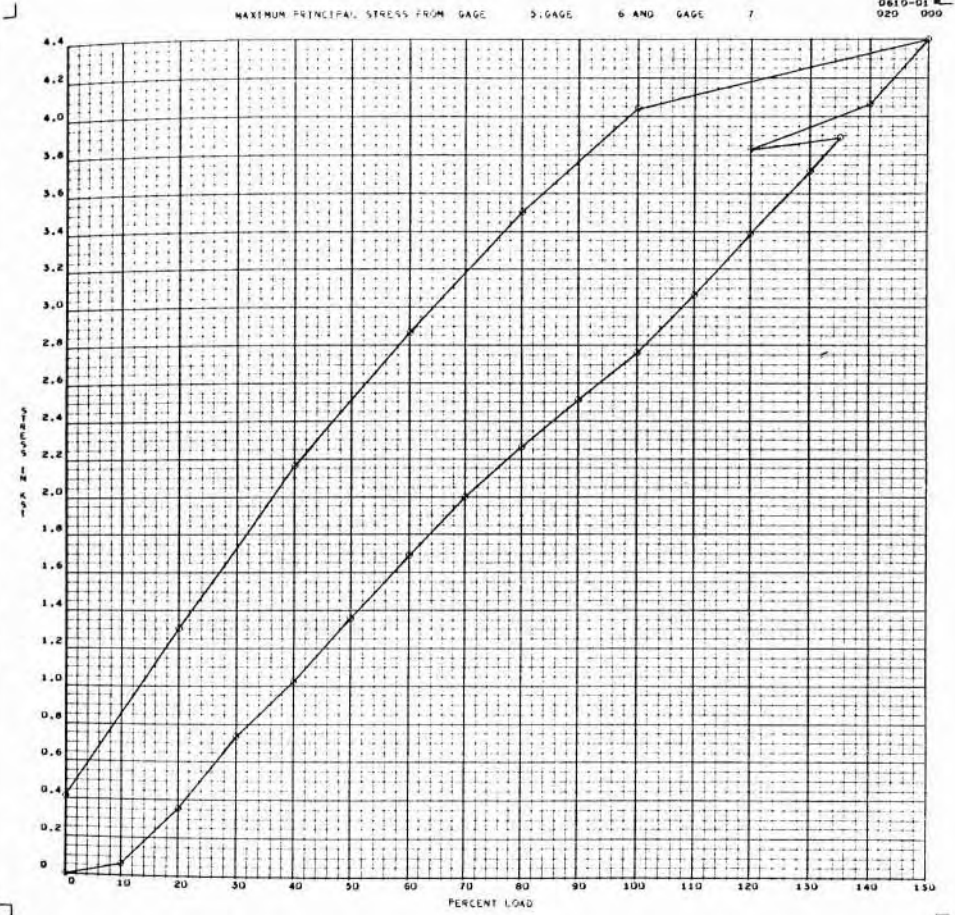
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SID 67-317



A-22

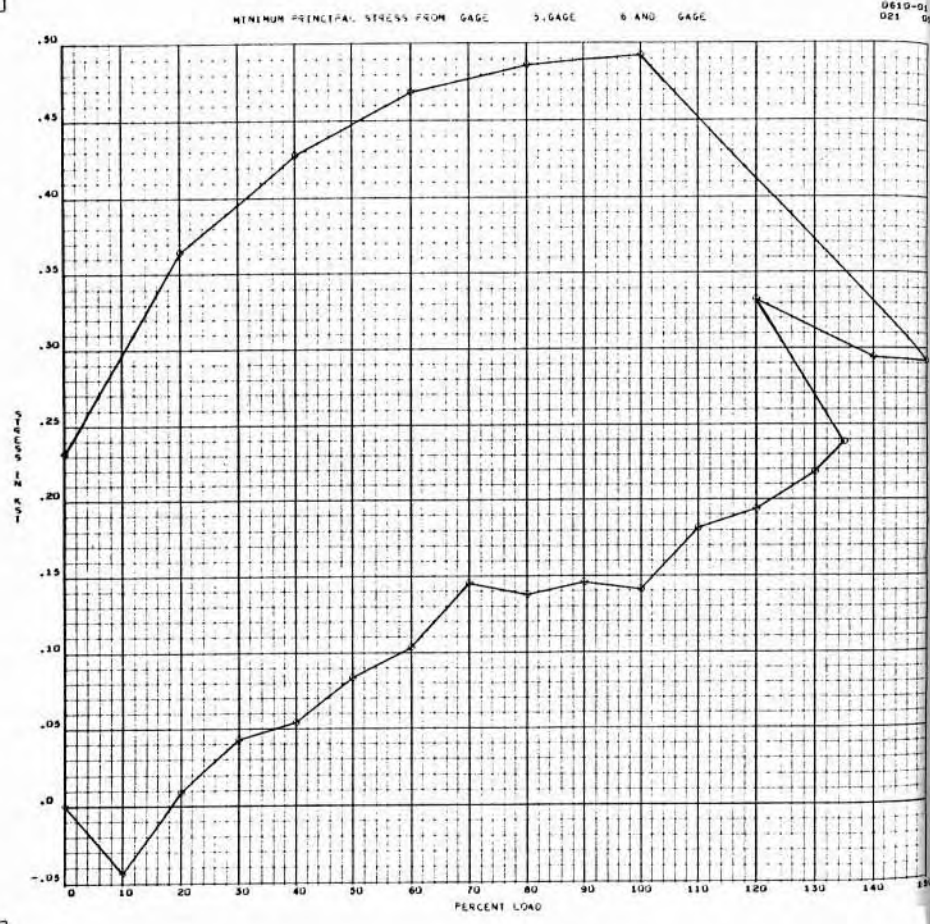
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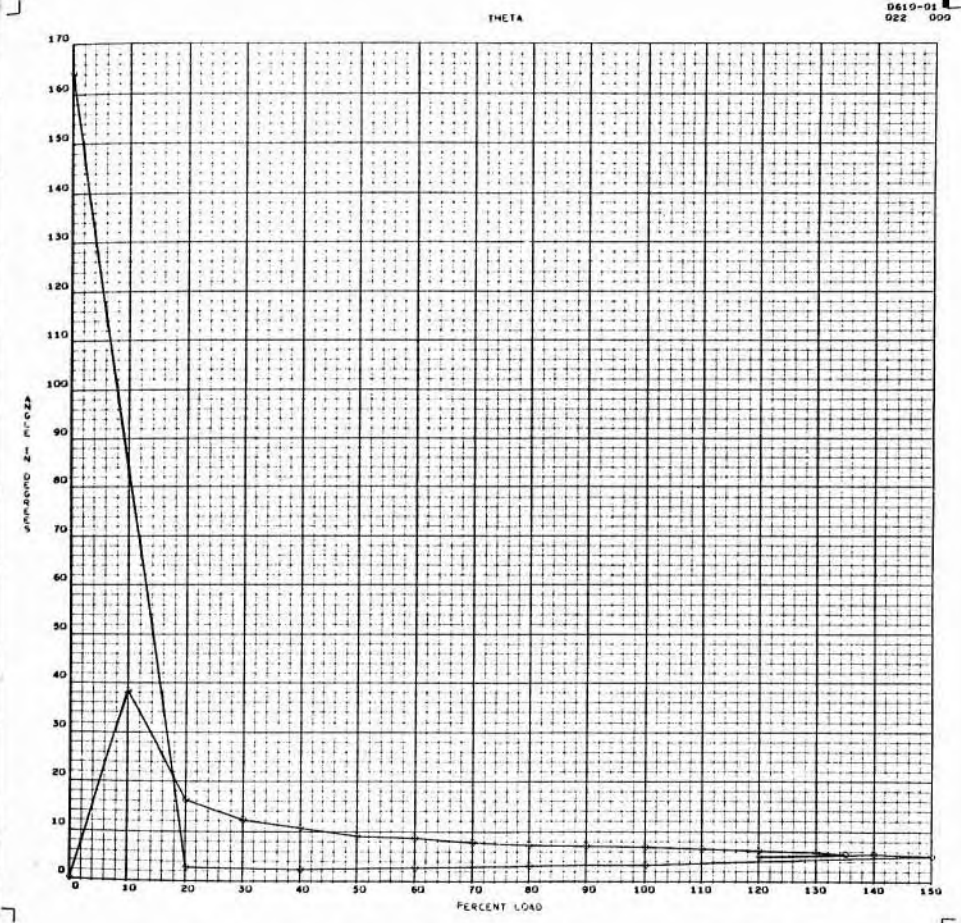
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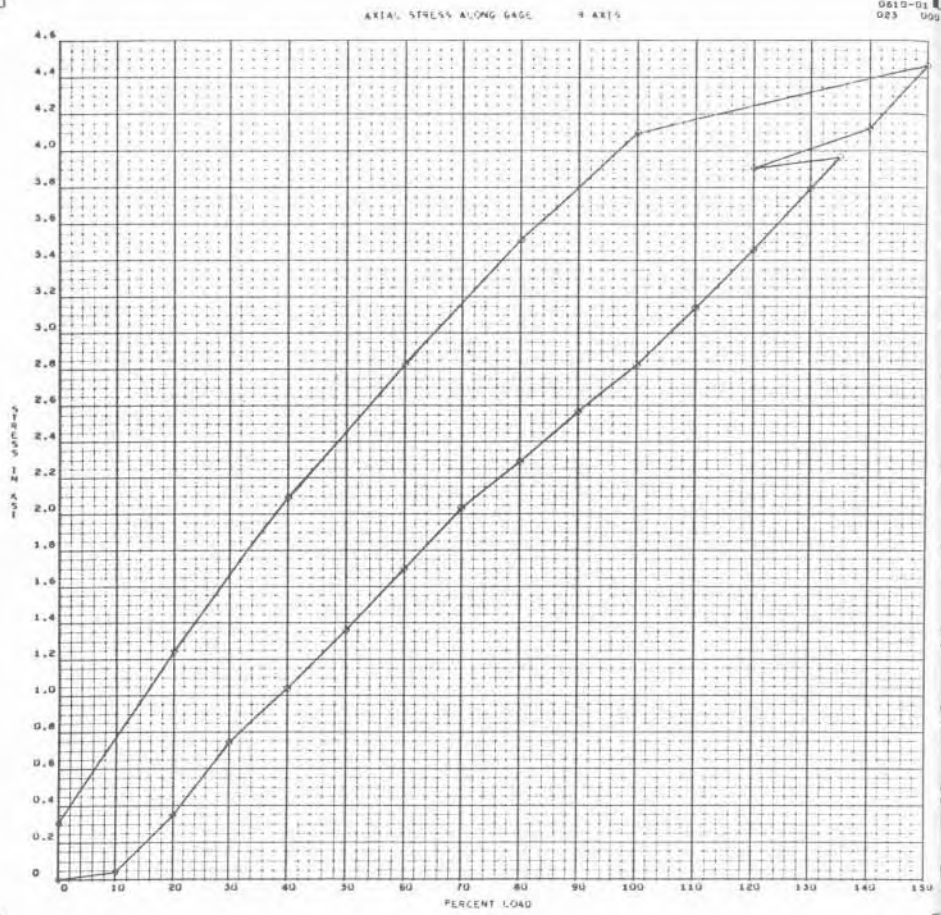
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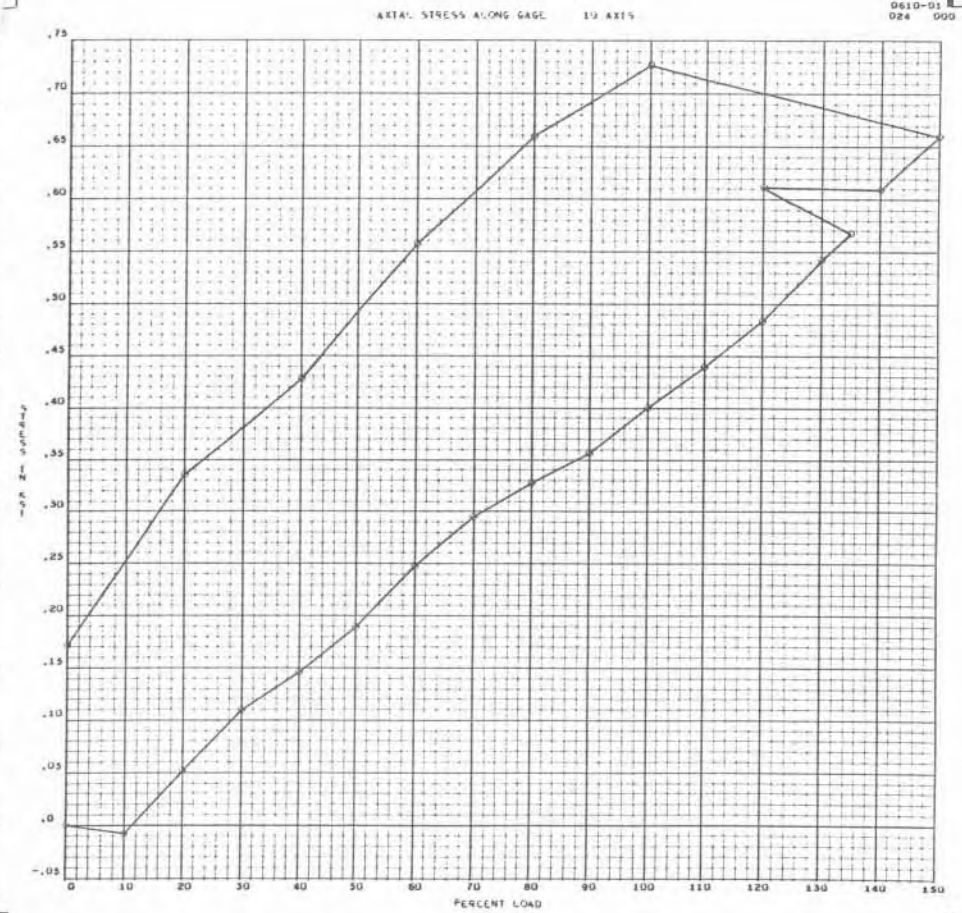
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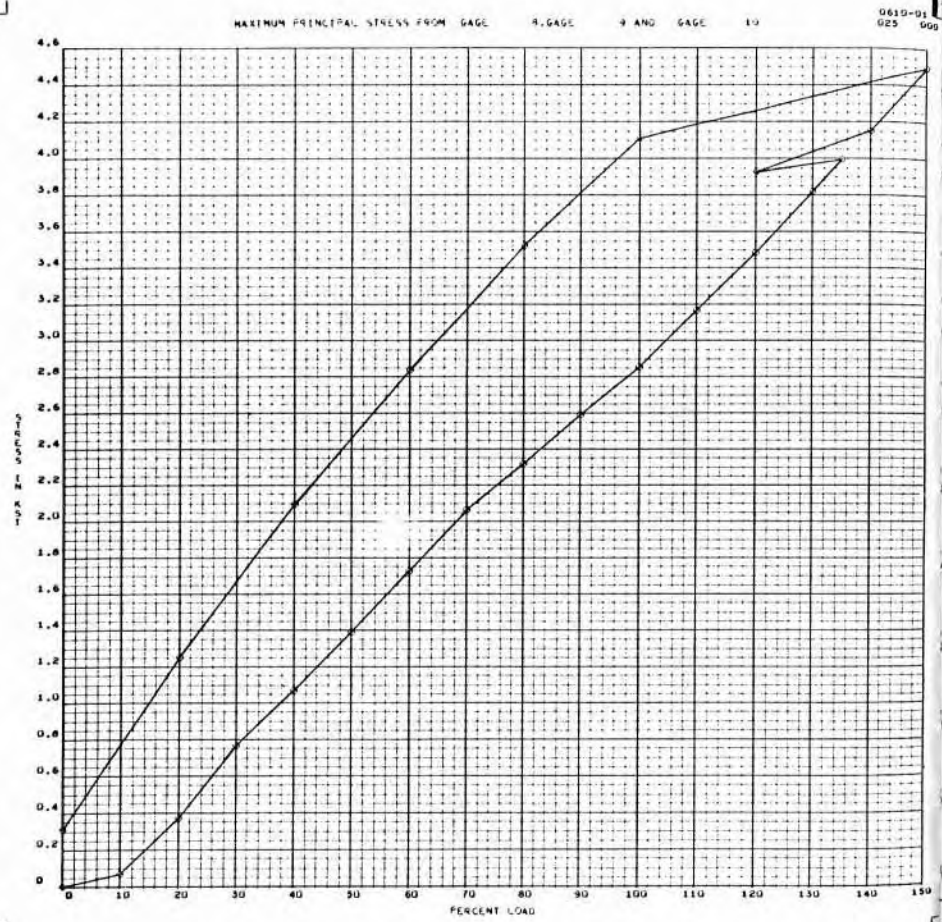
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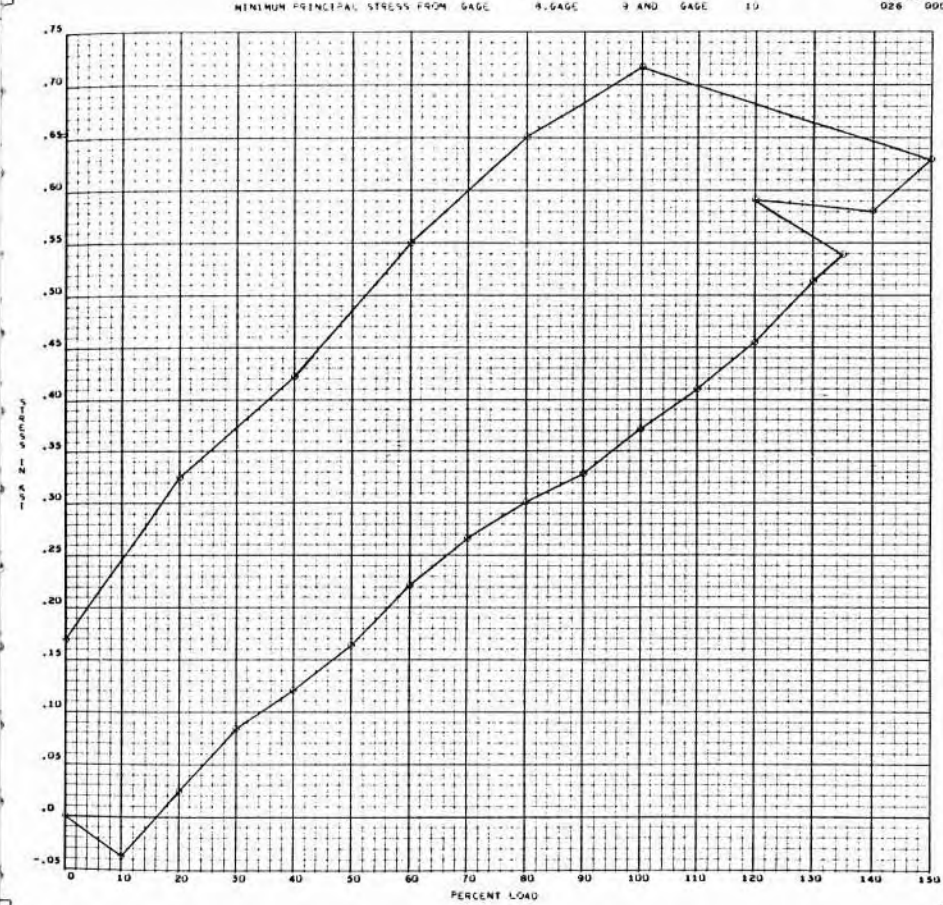
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SID 67-317



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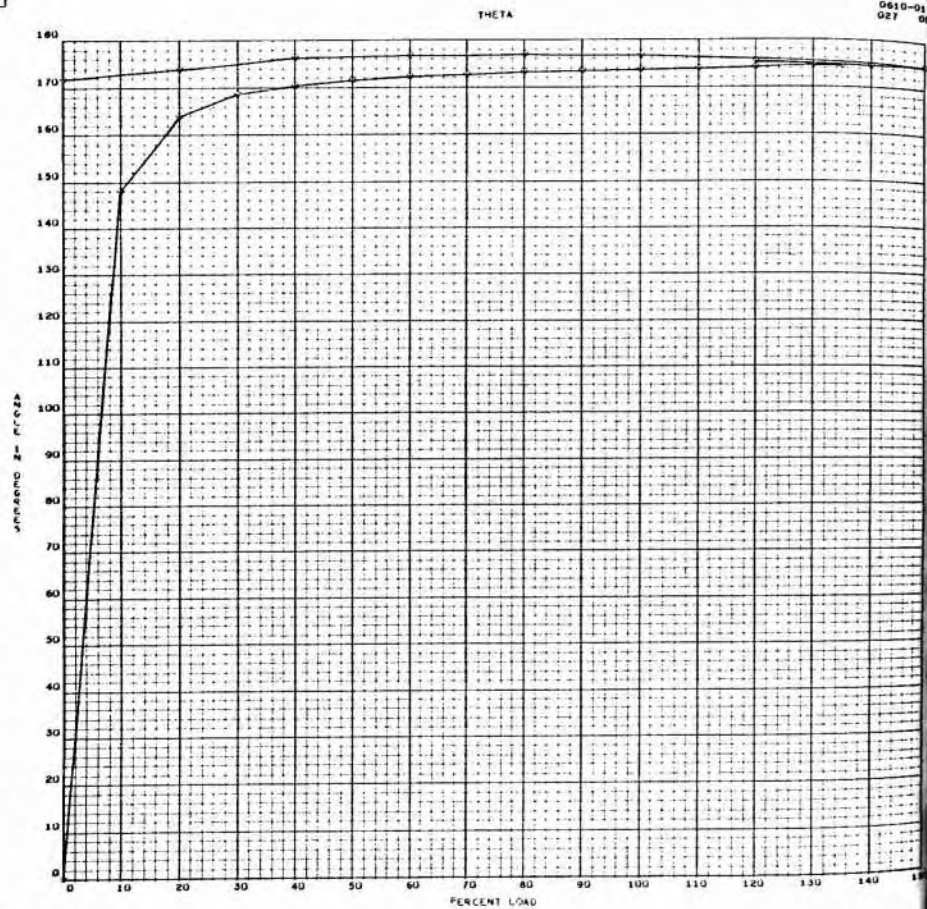
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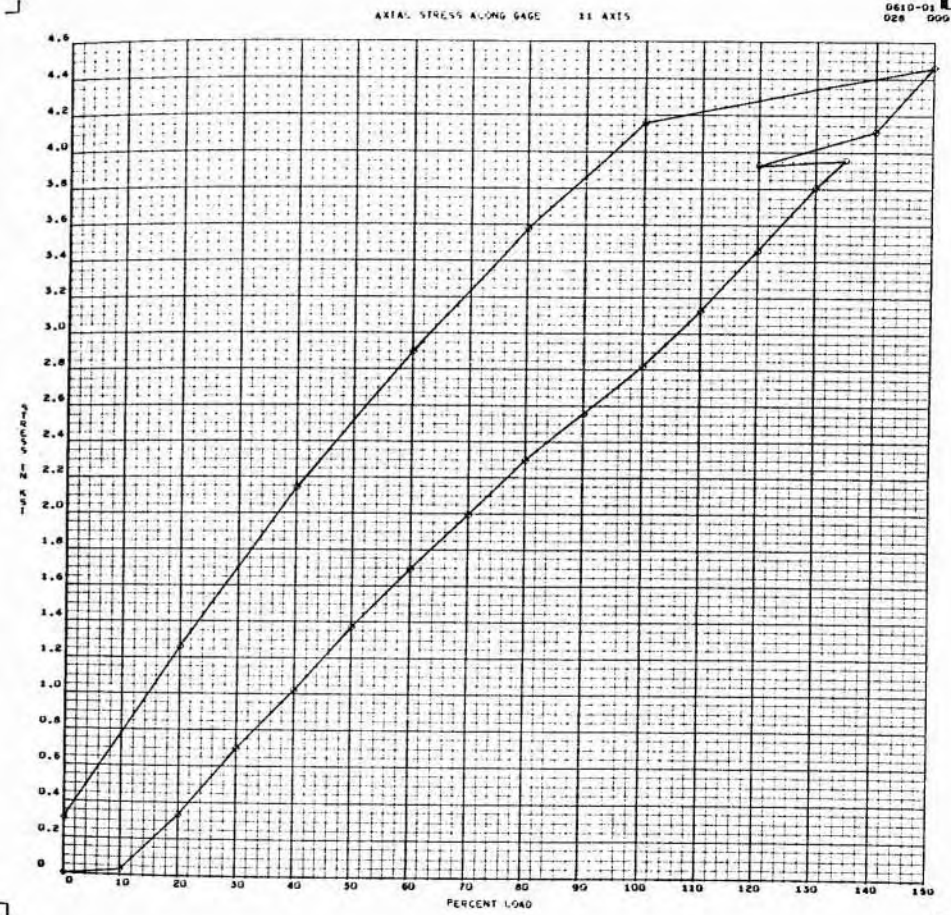
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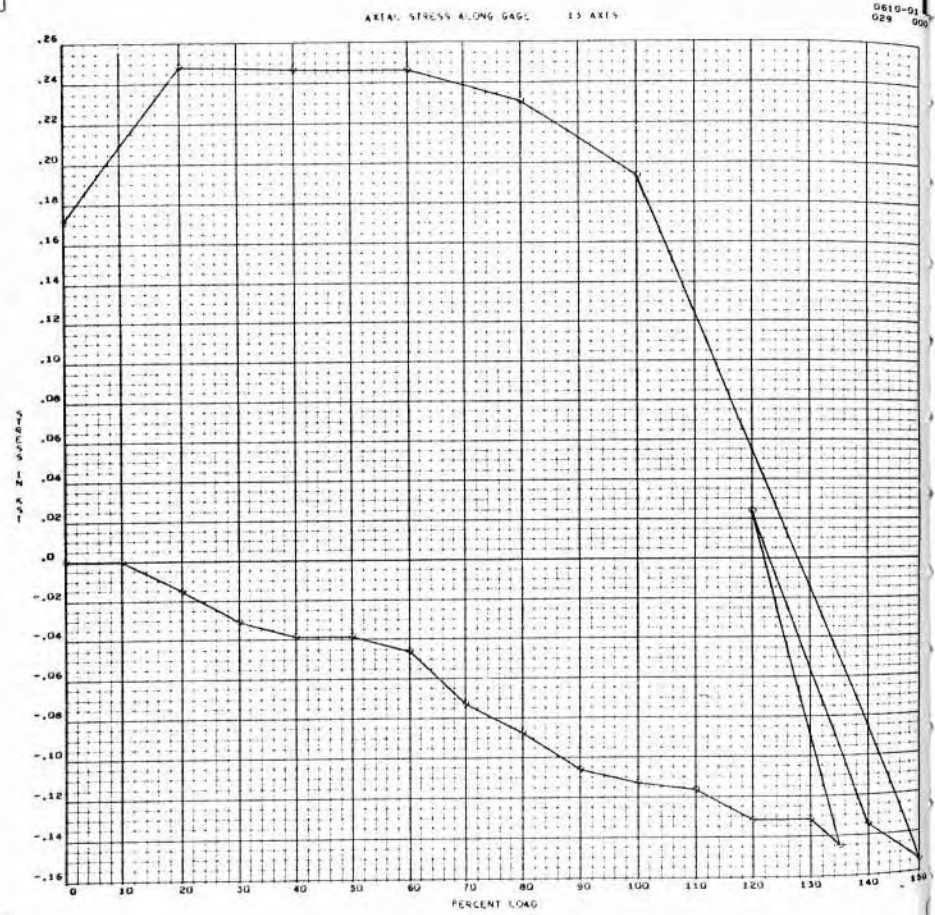
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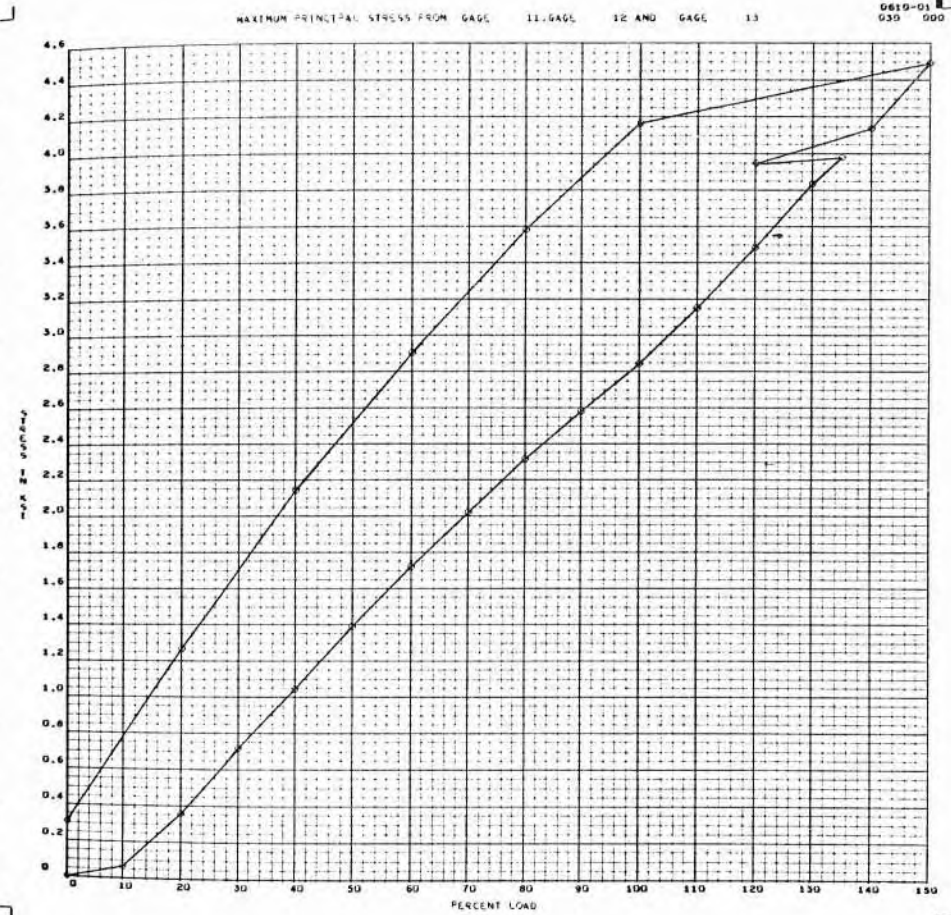
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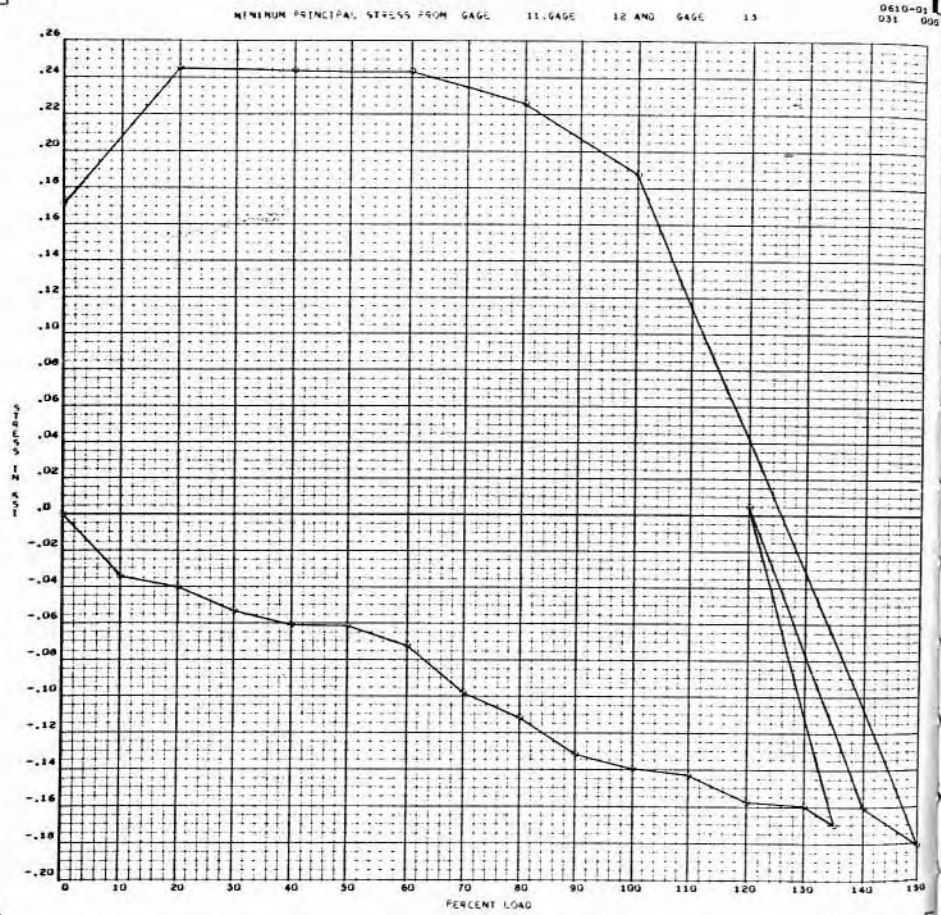
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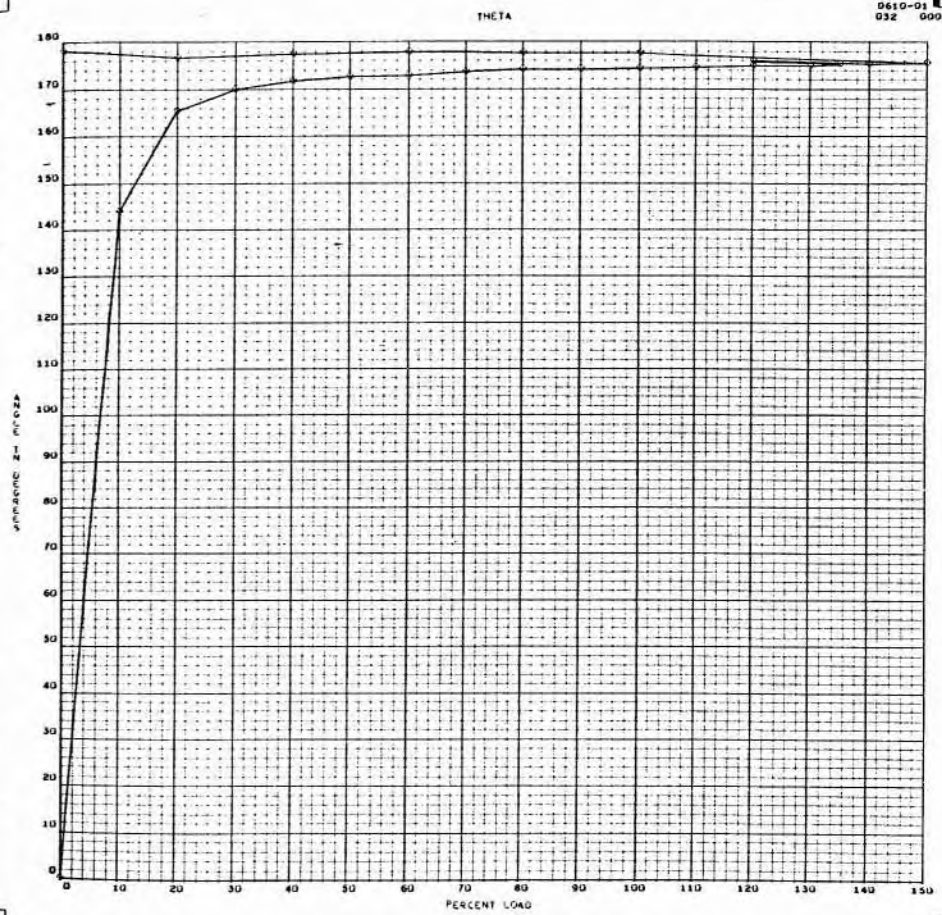
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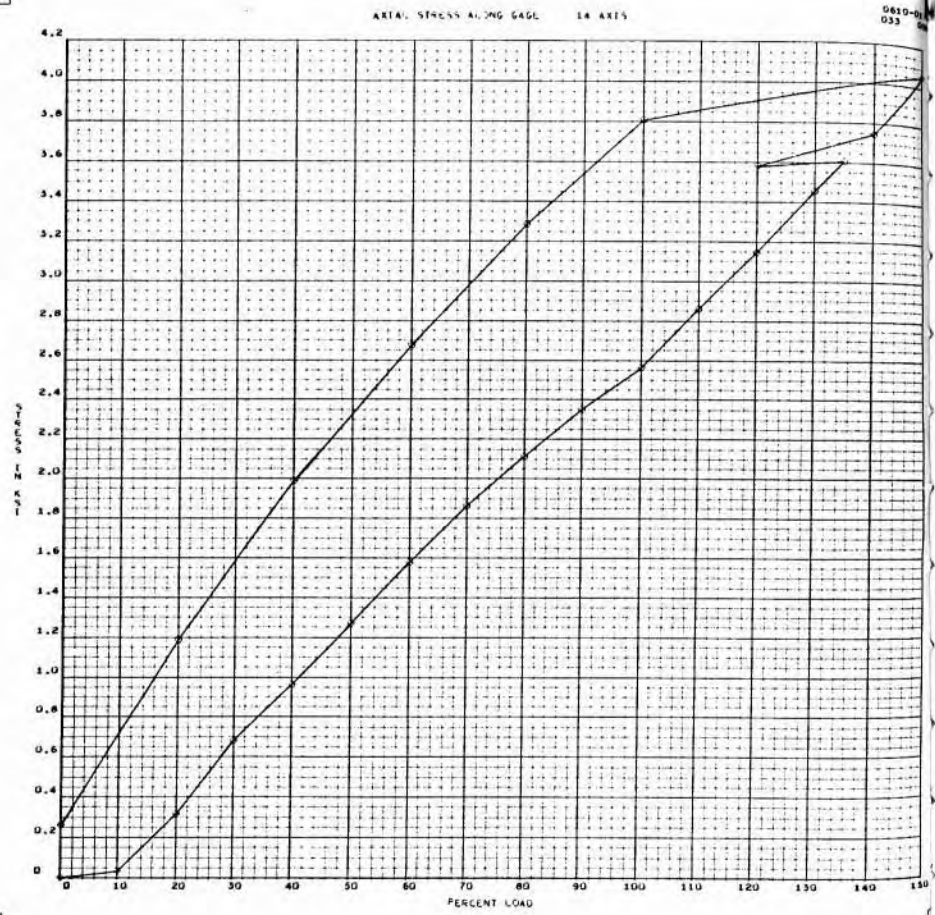
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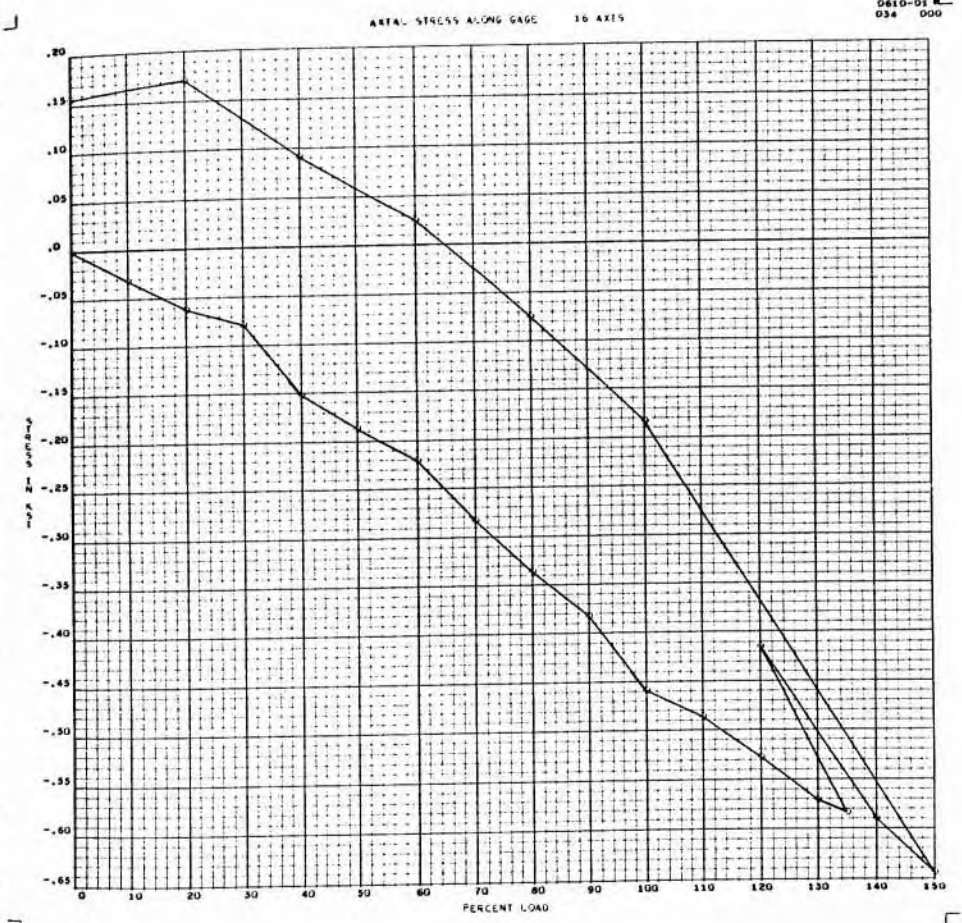
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SID 67-317



A-36

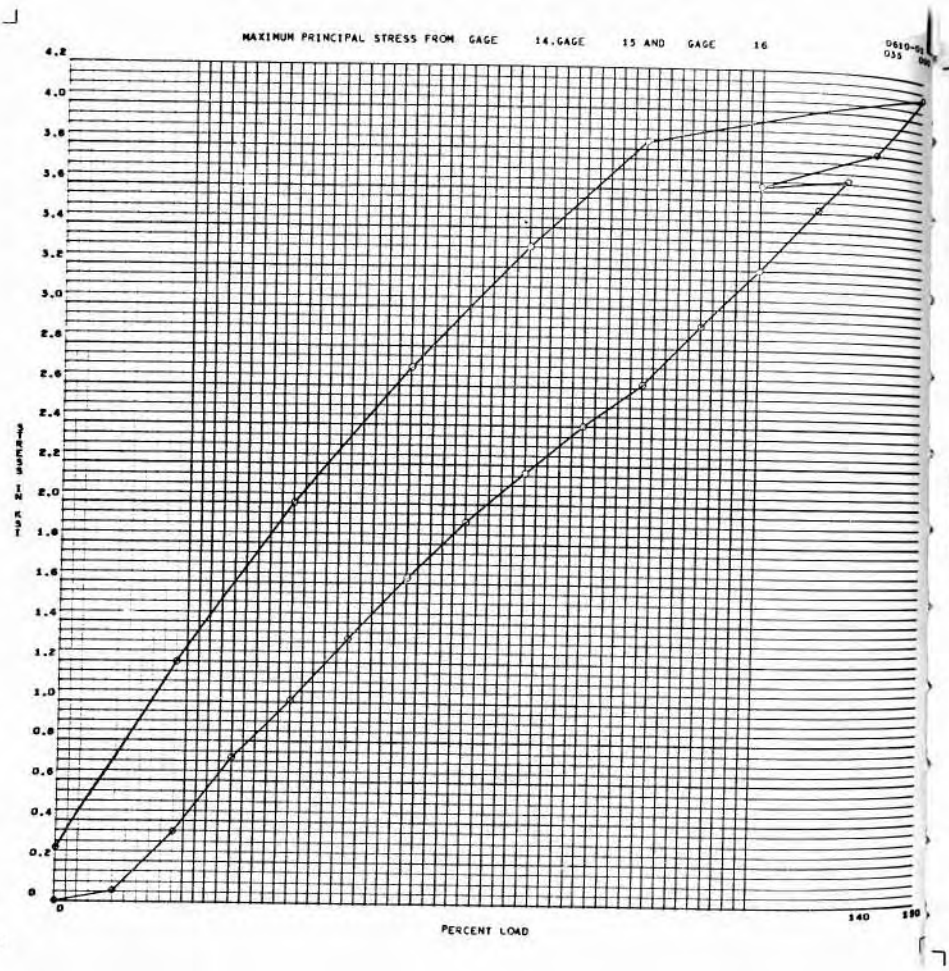
SID 67-317



A-37

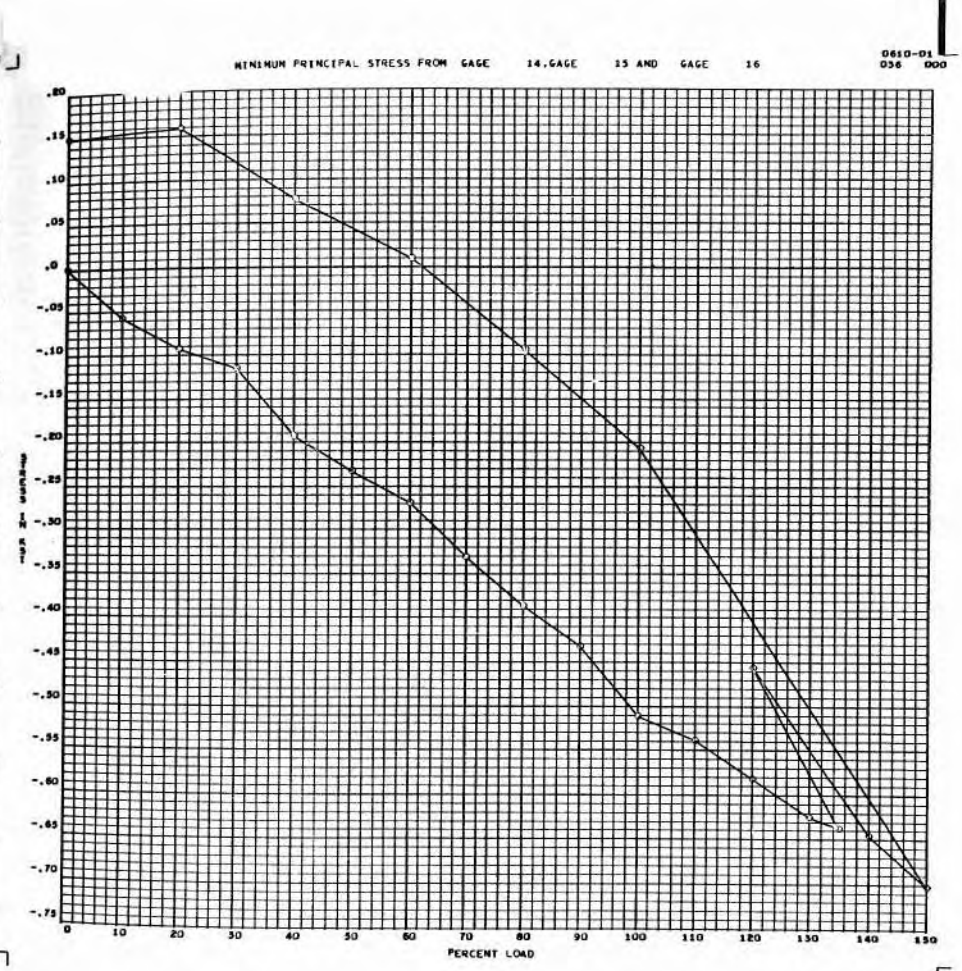
SID 67-317





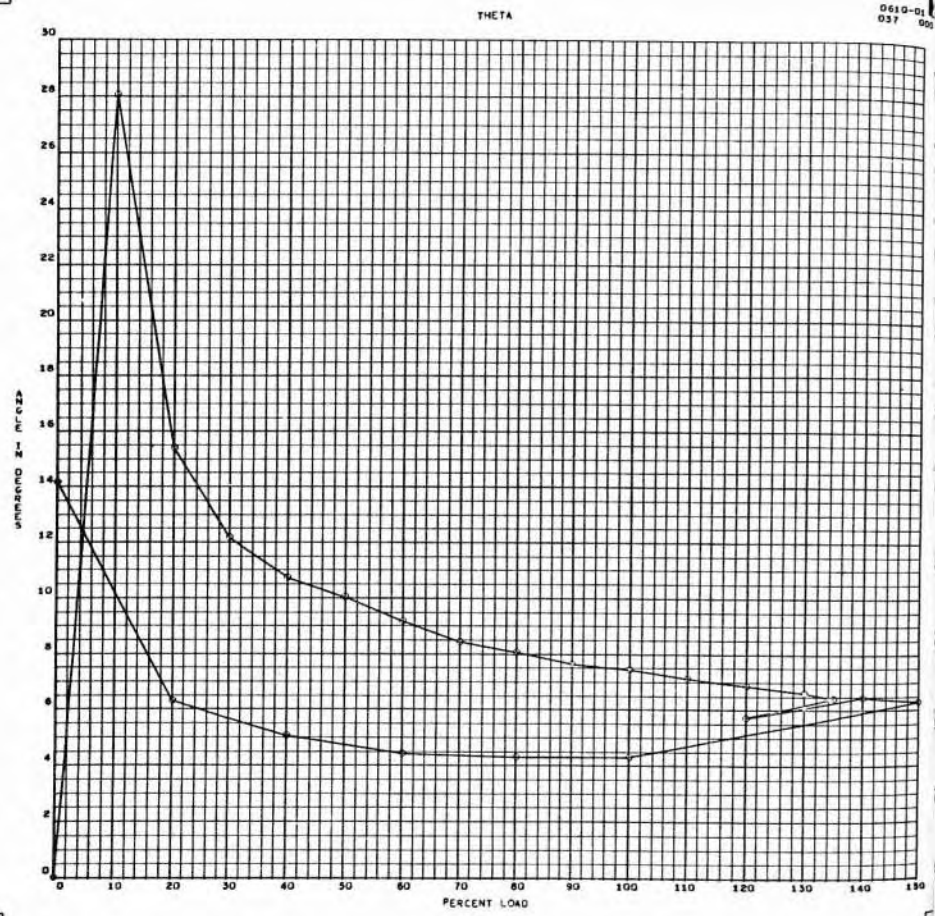
A-38

SID 67-317



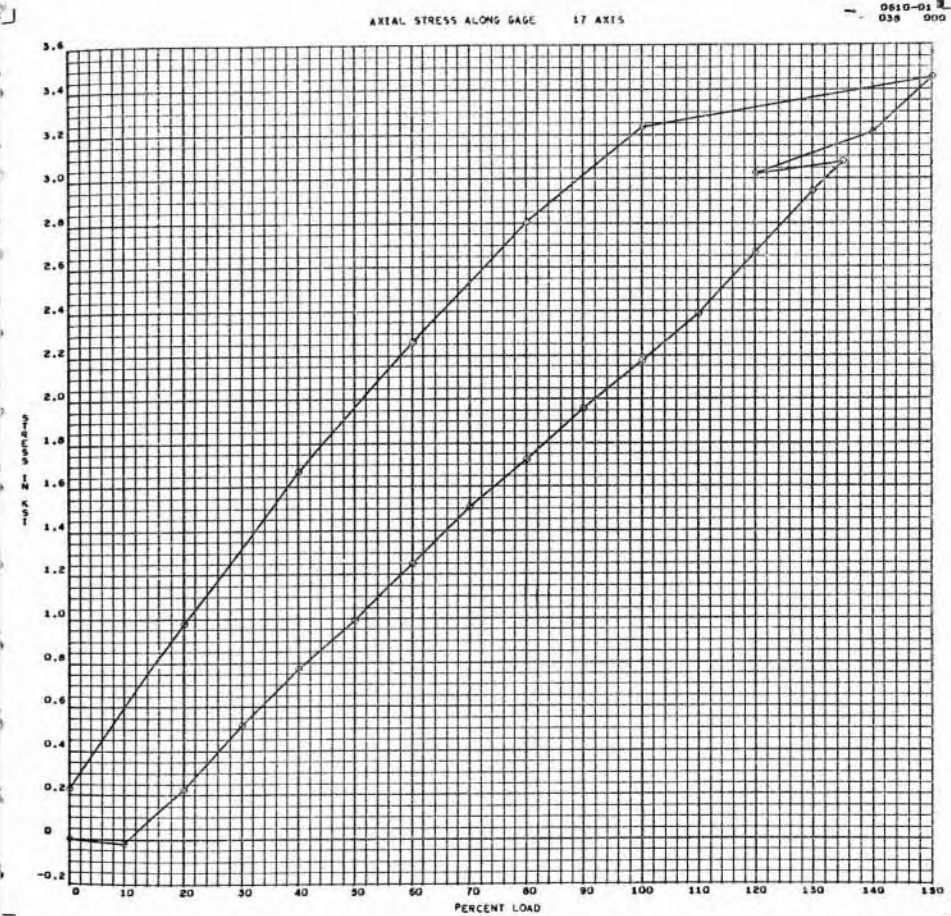
A-39

SID 67-317



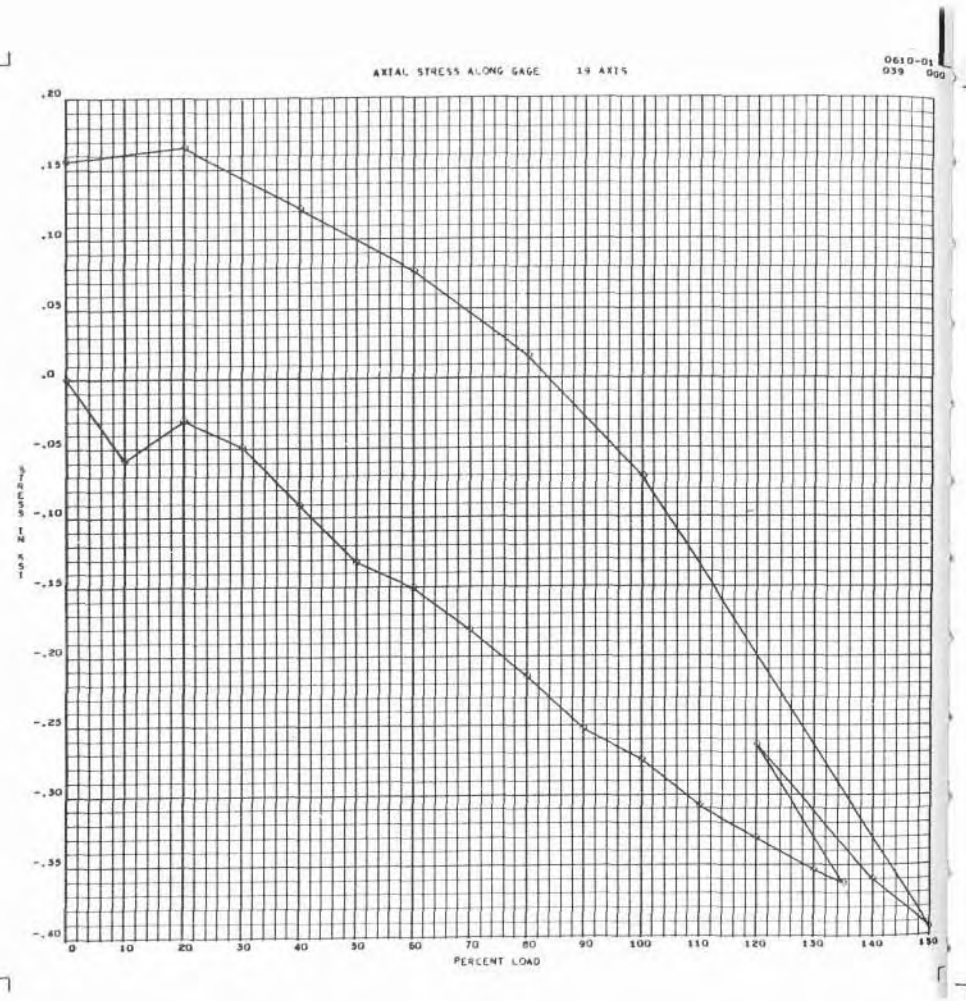
A-40

SID 67-317



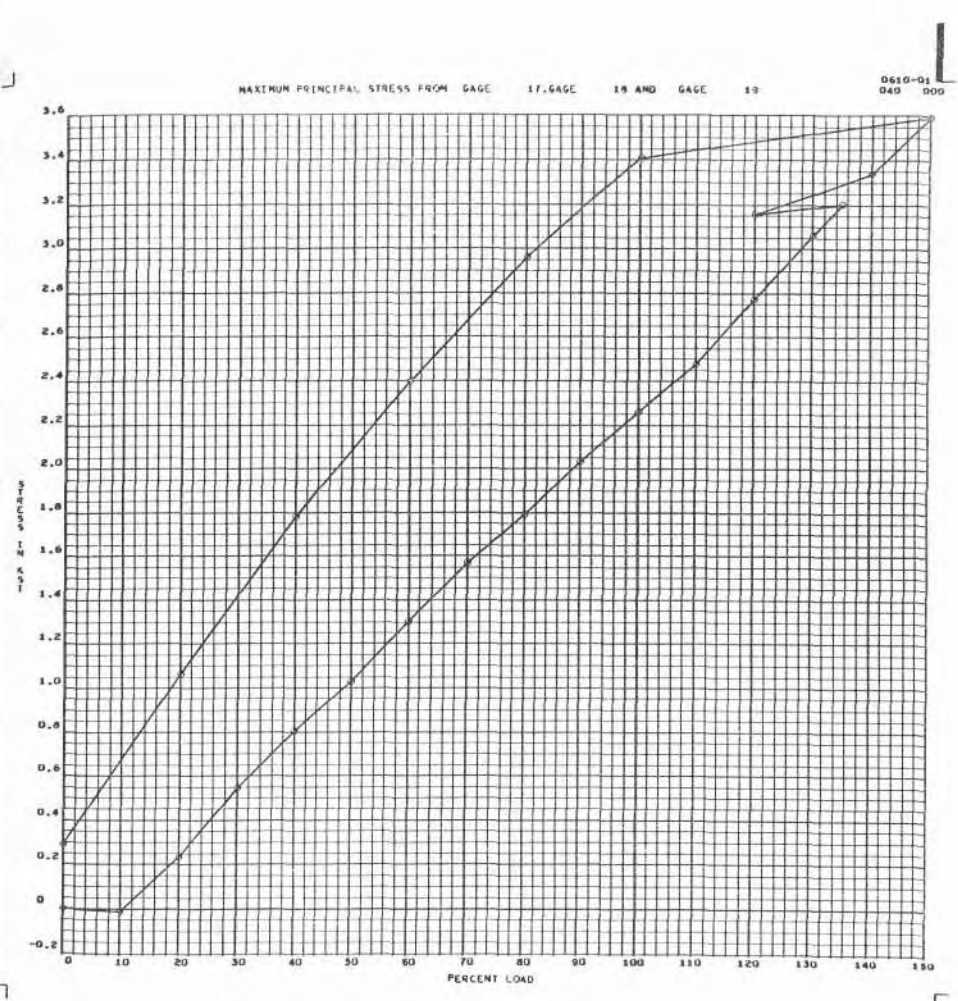
A-41

SID 67-317



A-42

SID 67-317



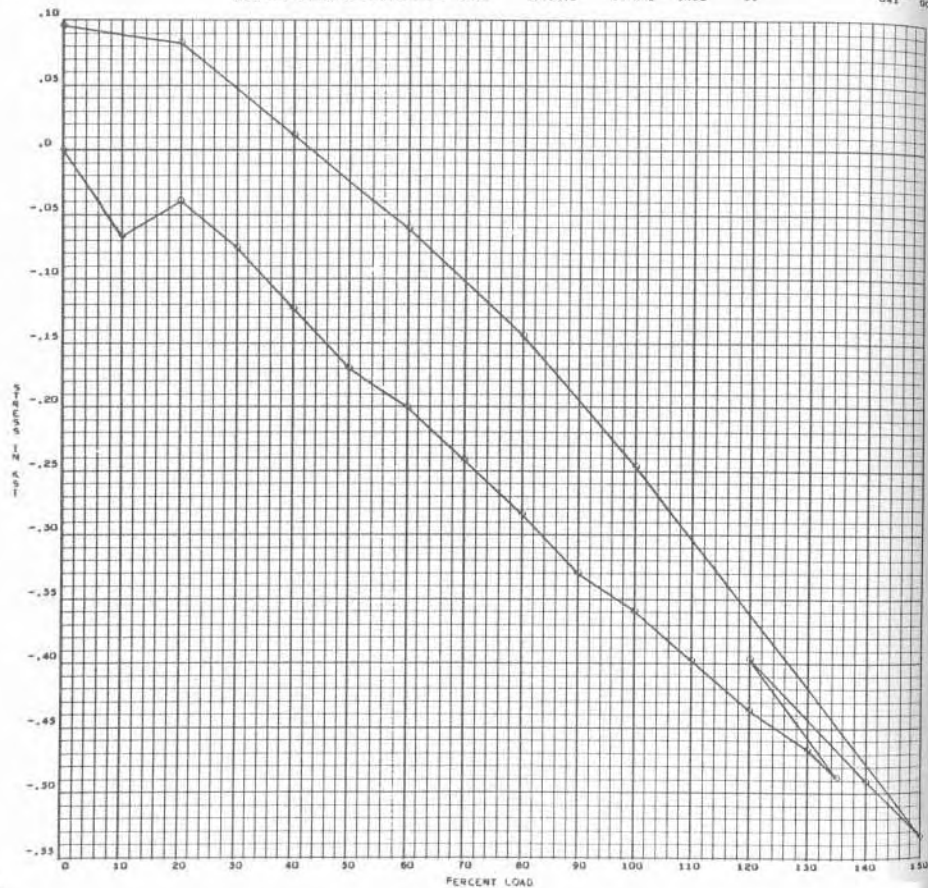
A-43

SID 67-317



MINIMUM PRINCIPAL STRESS FROM GAGE 17, GAGE 18 AND GAGE 19

0810-01  
041 000

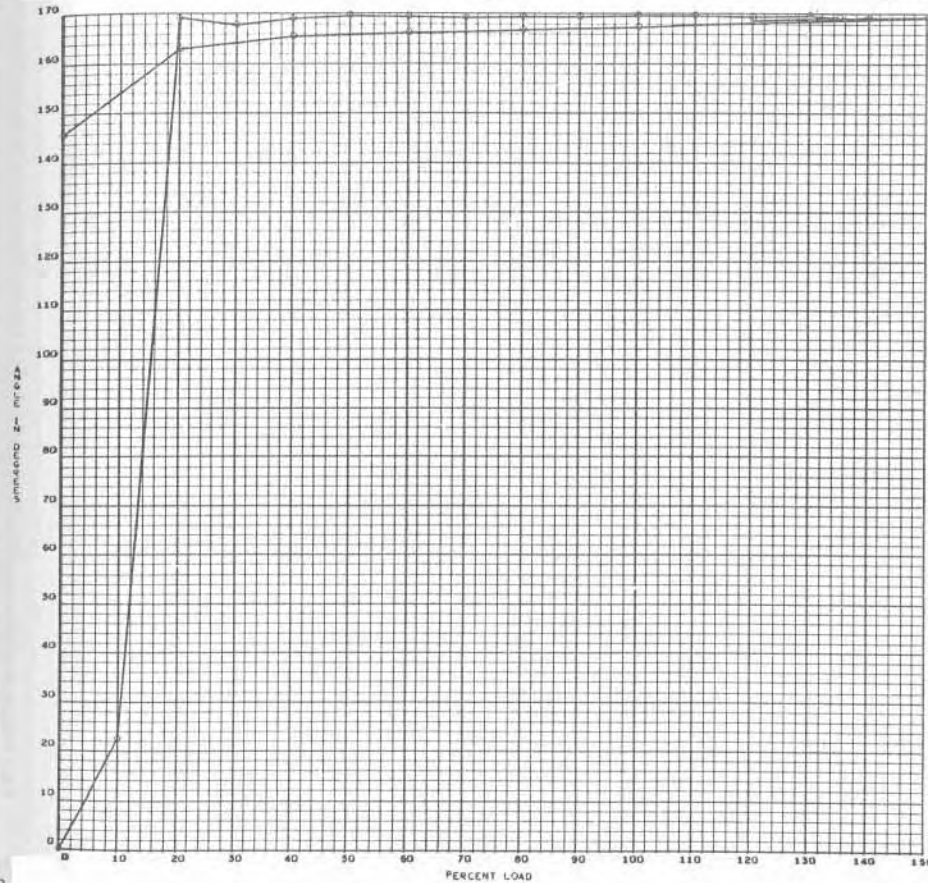


A-44

SID 67-317

THETA

0810-01  
042 000

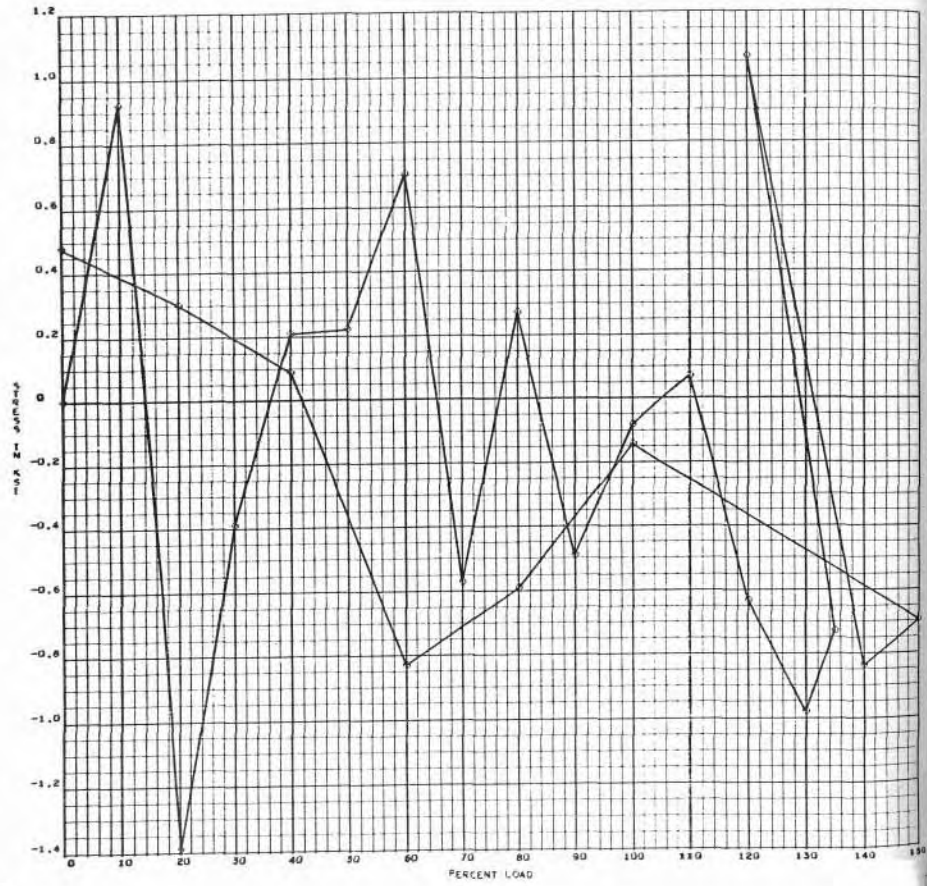


A-45

SID 67-317

AXIAL STRESS GAGE DUMMY

0610-01  
043 000

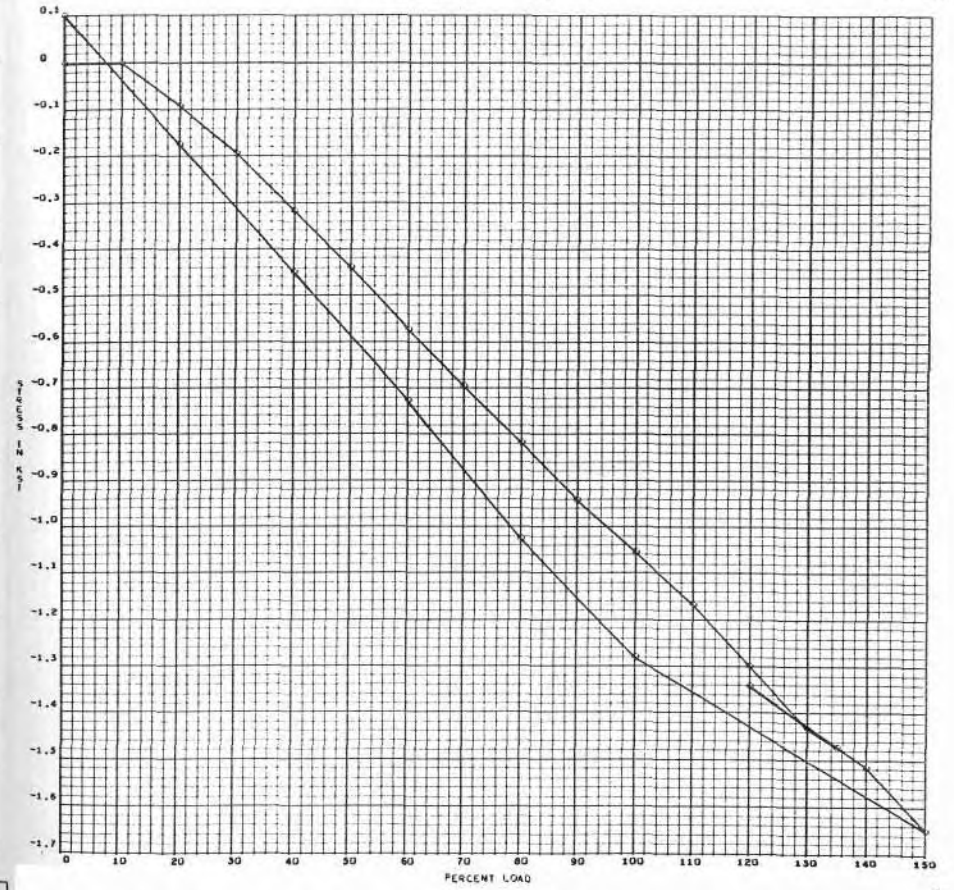


A-46

SID 67-317

AXIAL STRESS GAGE 21

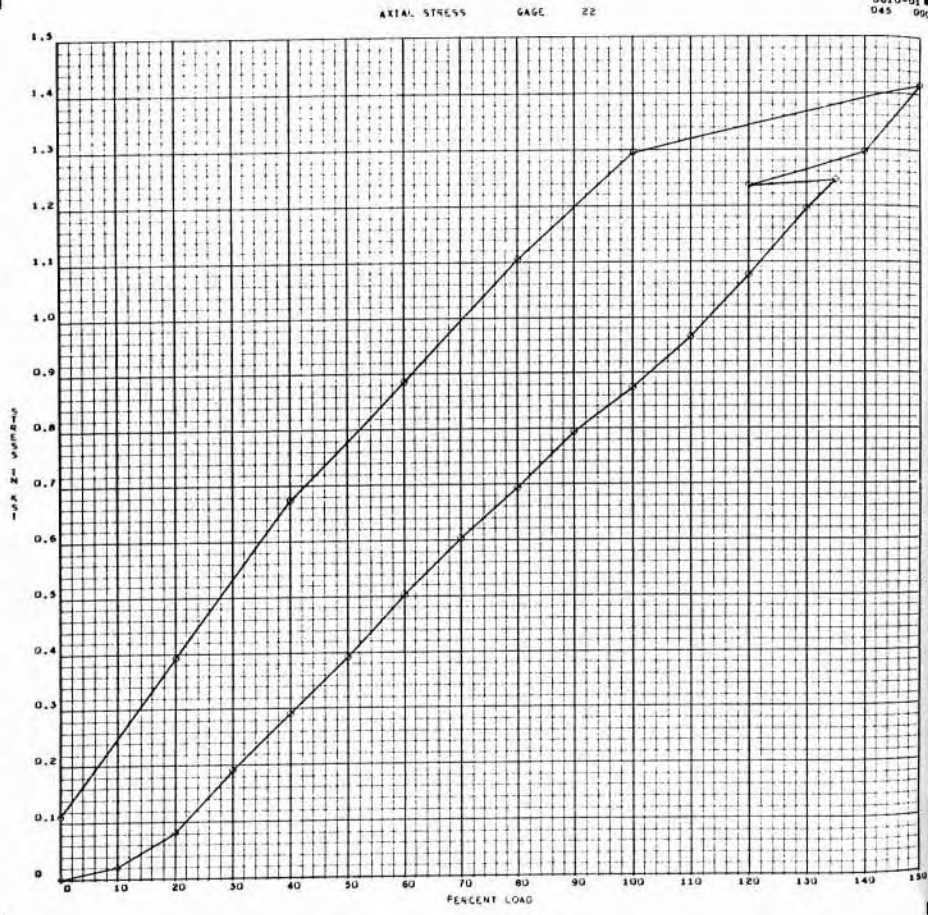
0610-01  
044 000



A-47

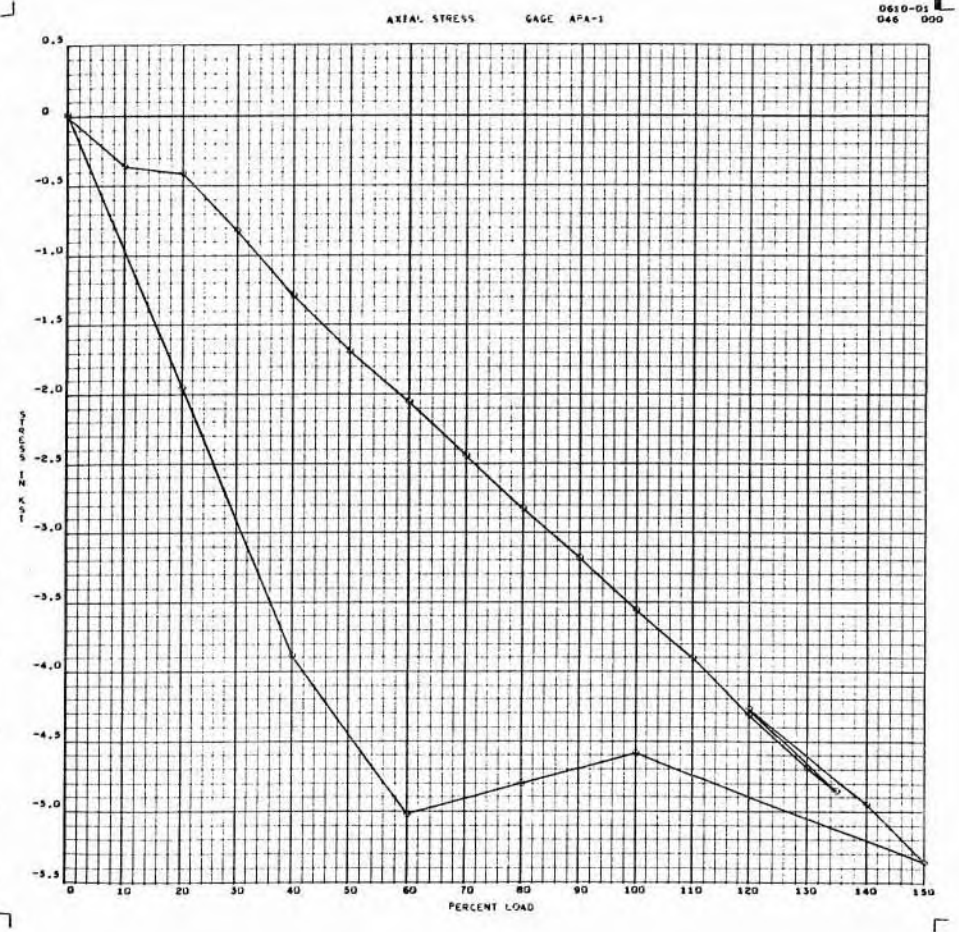
SID 67-317





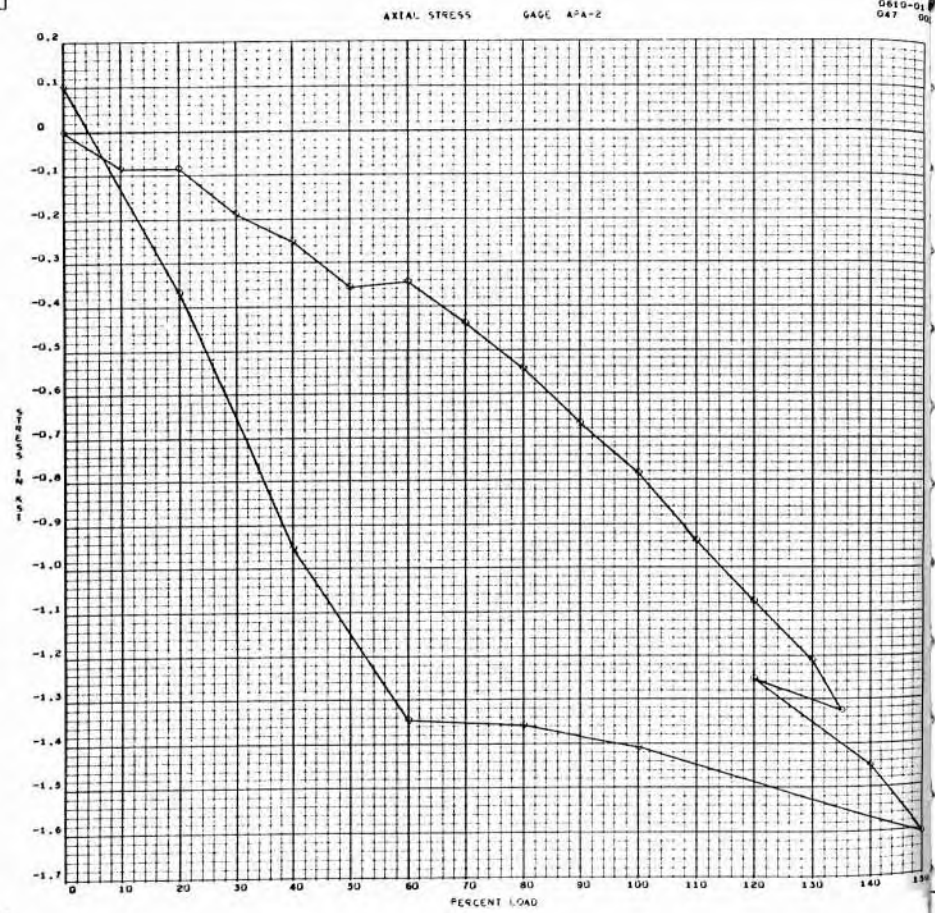
A-48

SID 67-317



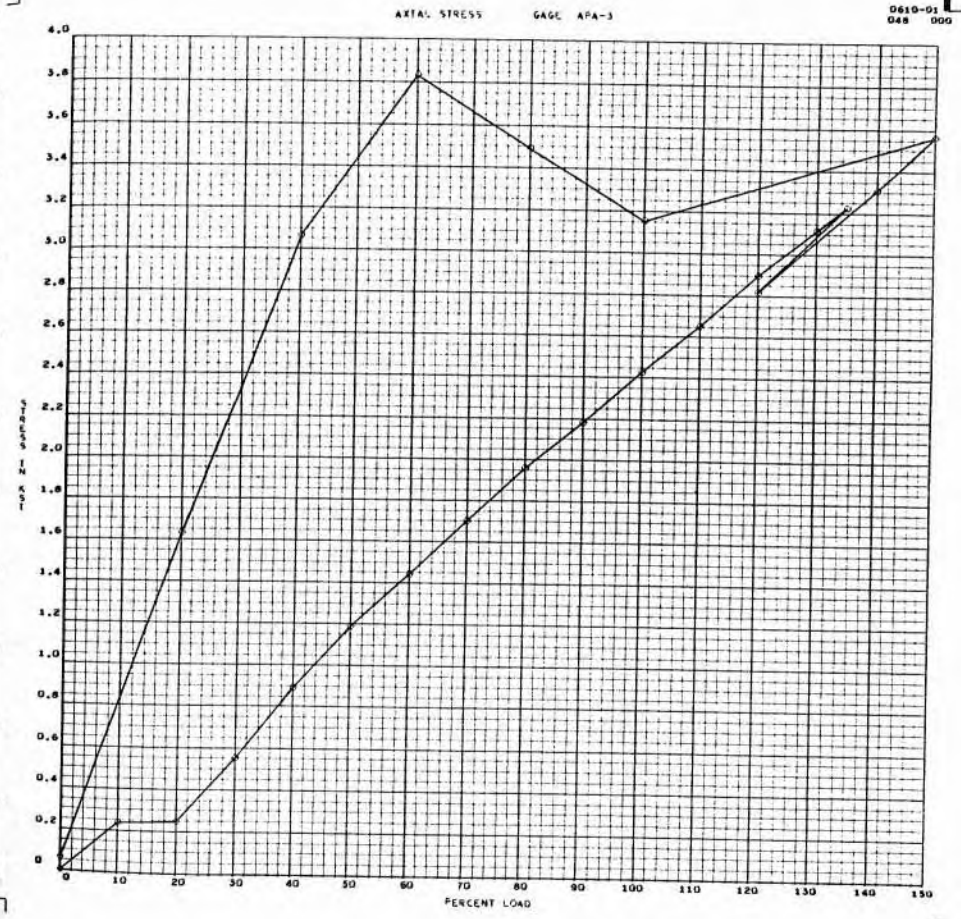
A-49

SID 67-317



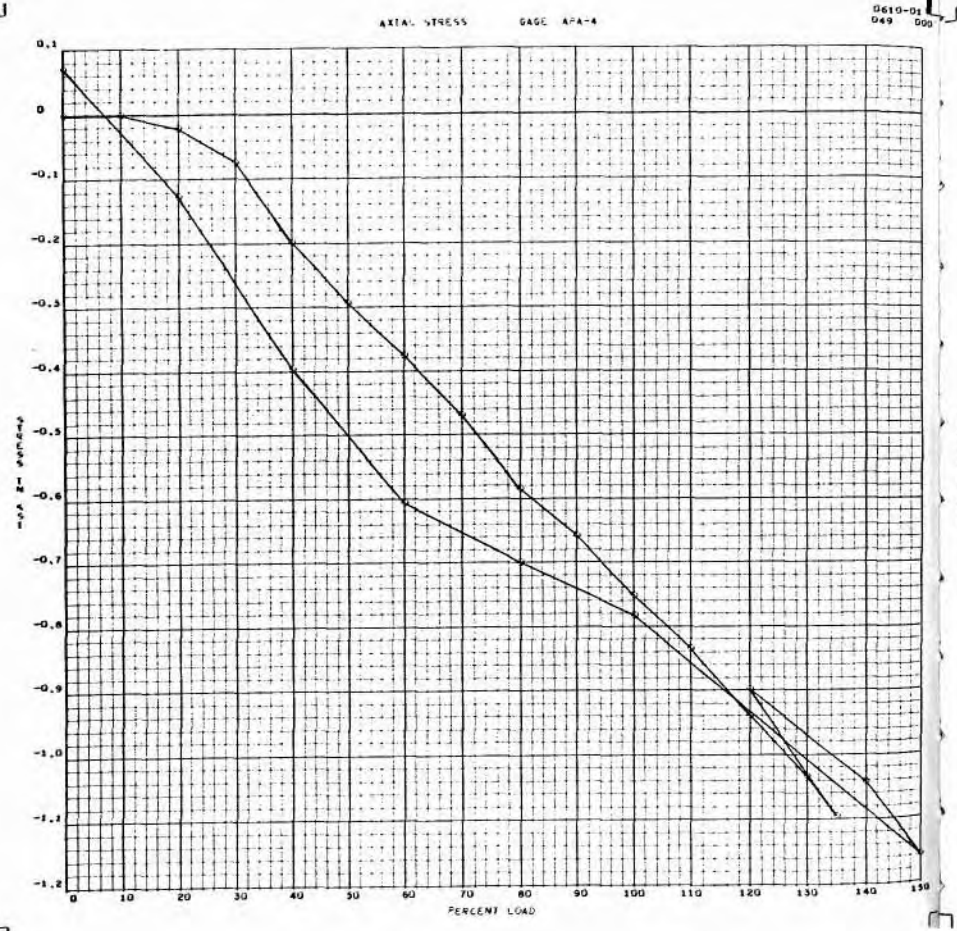
A-50

SID 67-317



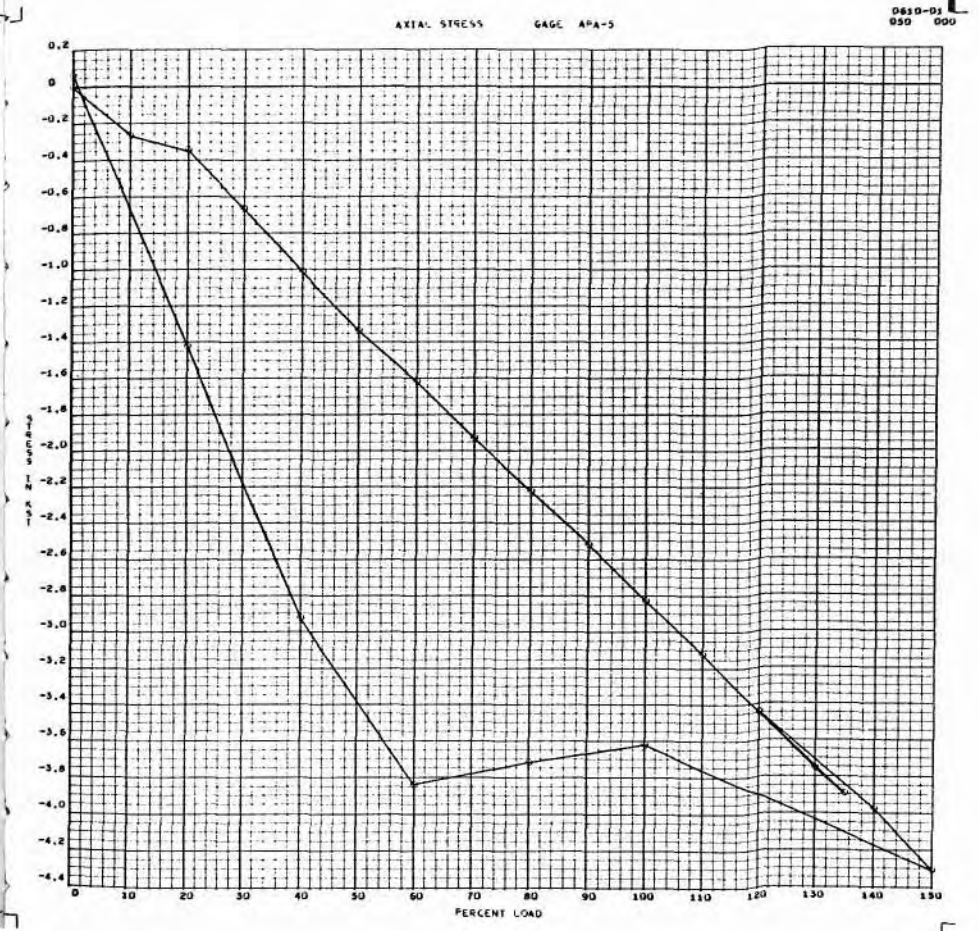
A-51

SID 67-317



A-52

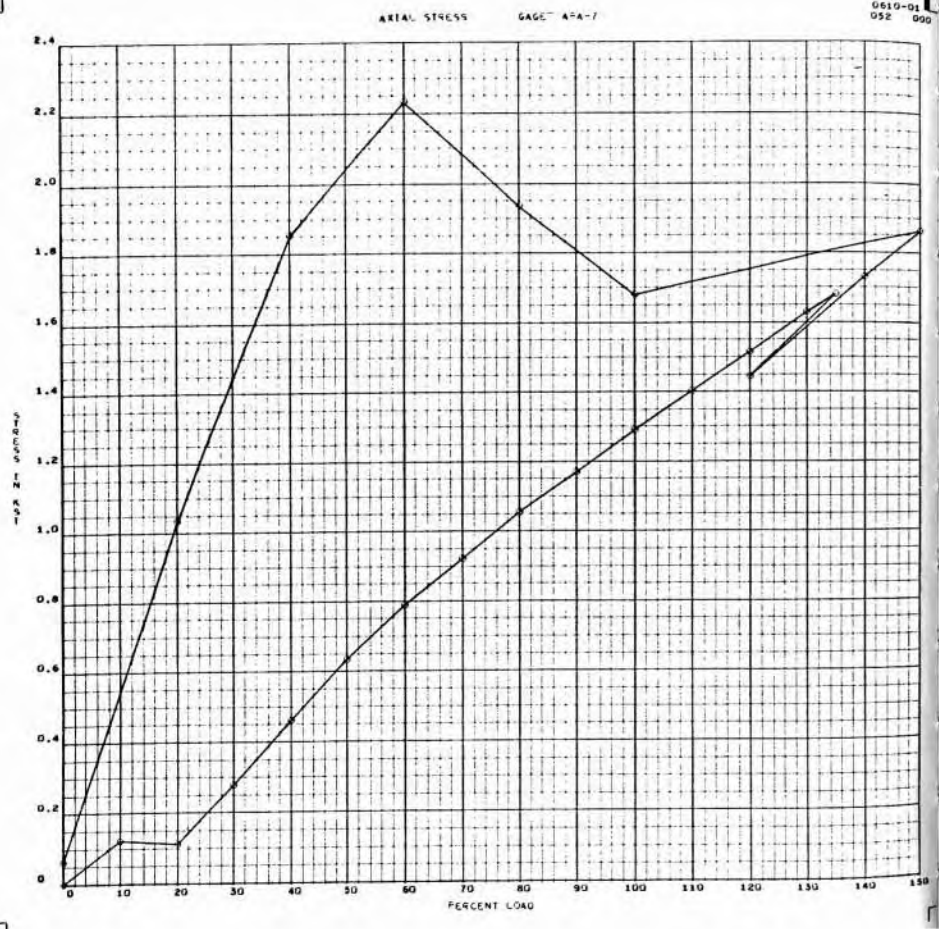
SID 67-317



A-53

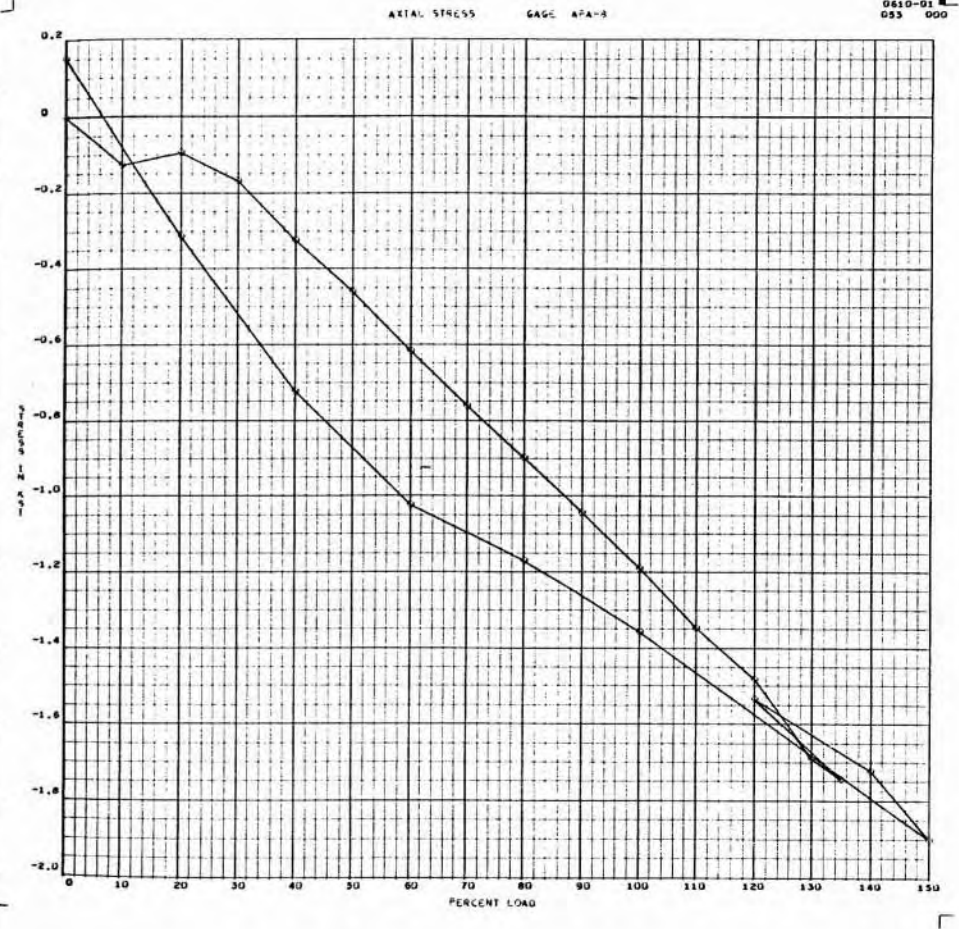
SID 67-317





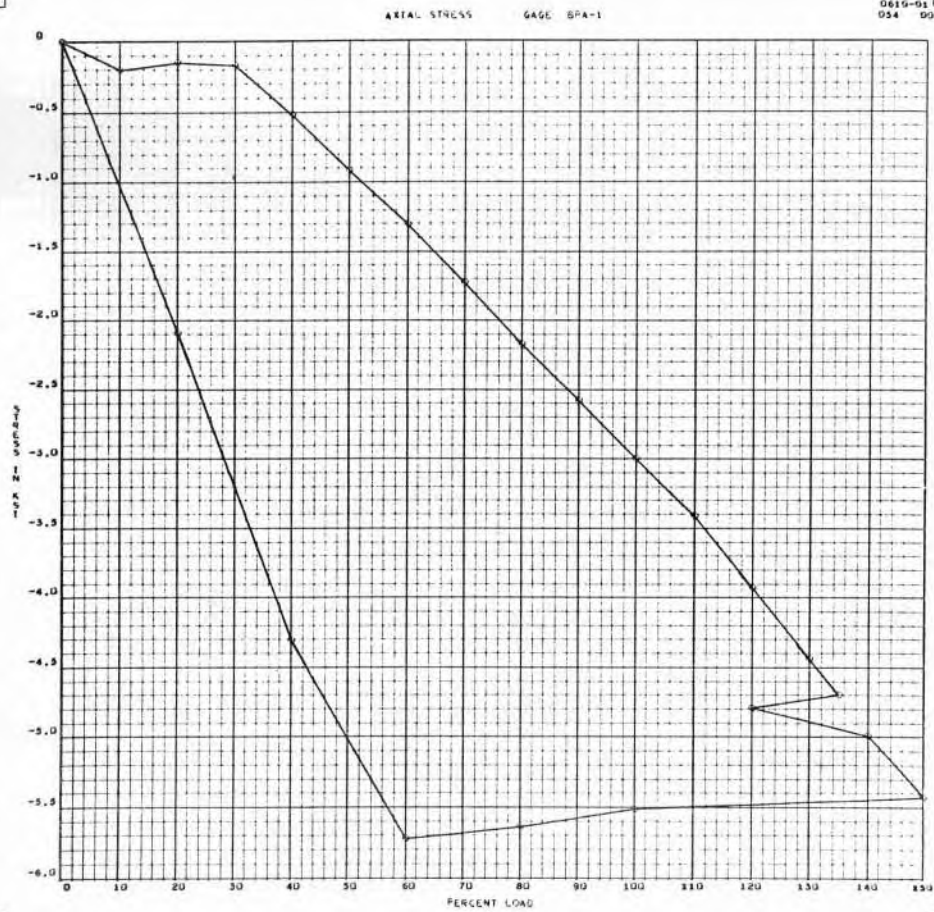
A-54

SID 67-317



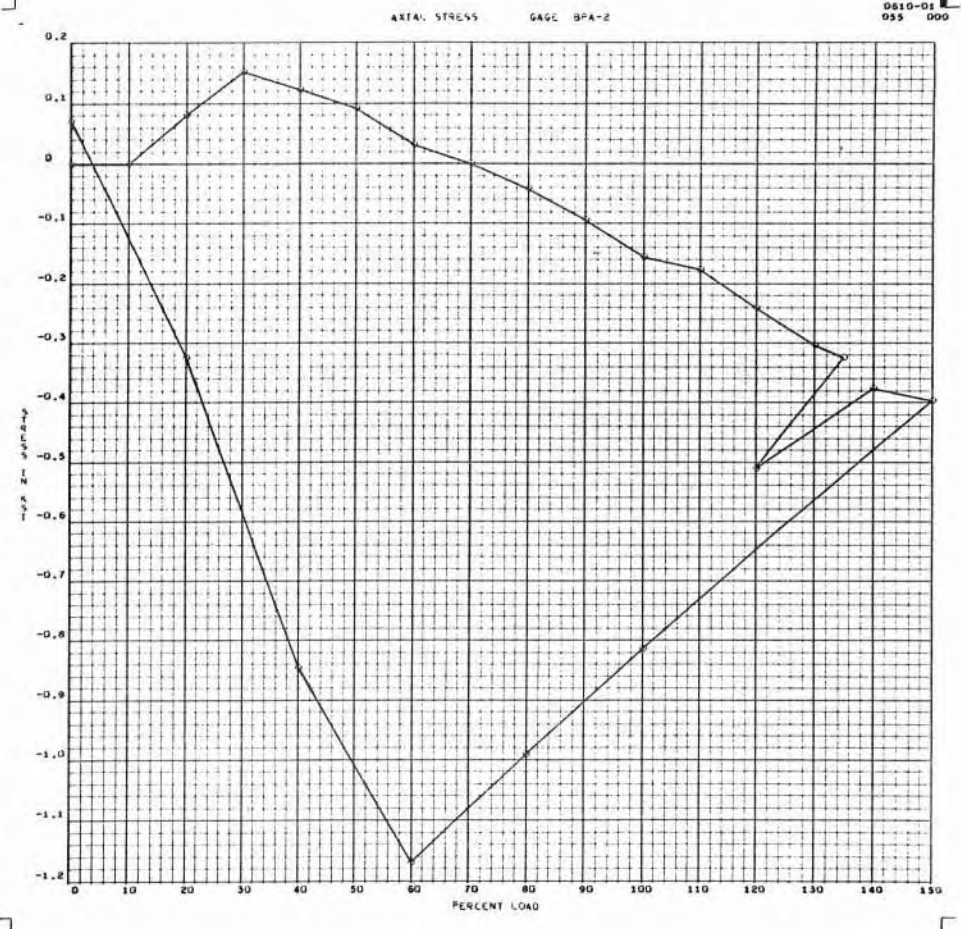
A-55

SID 67-317



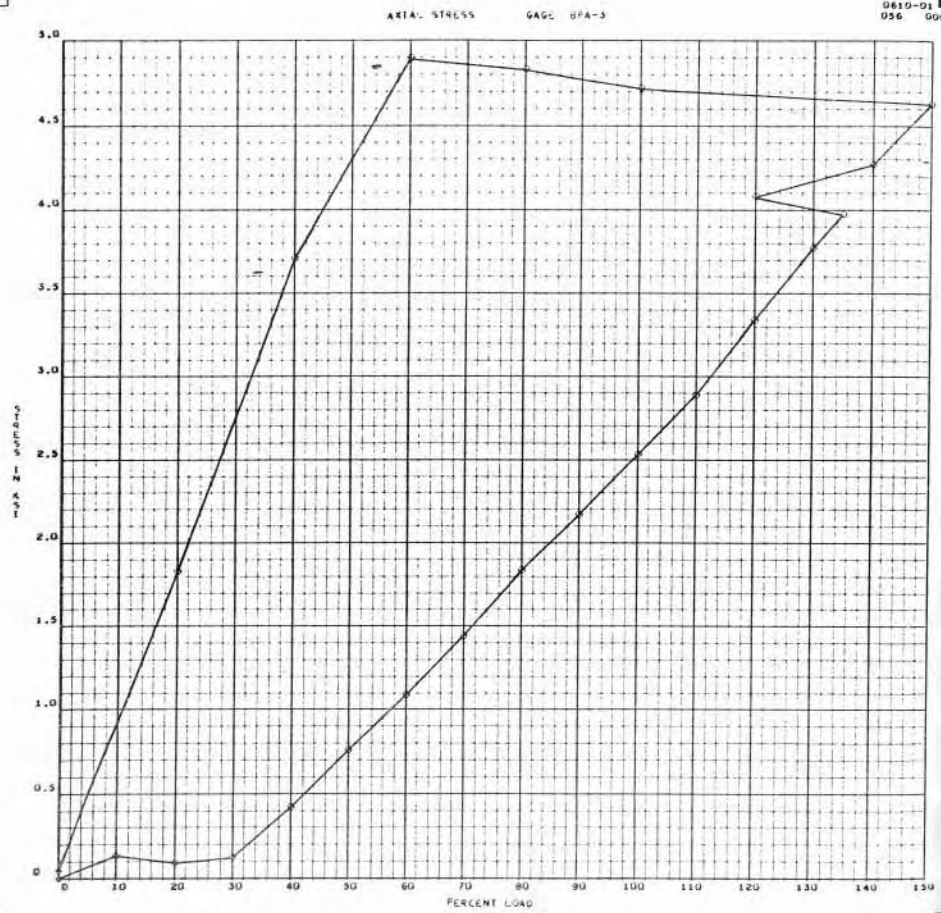
A-56

SID 67-317



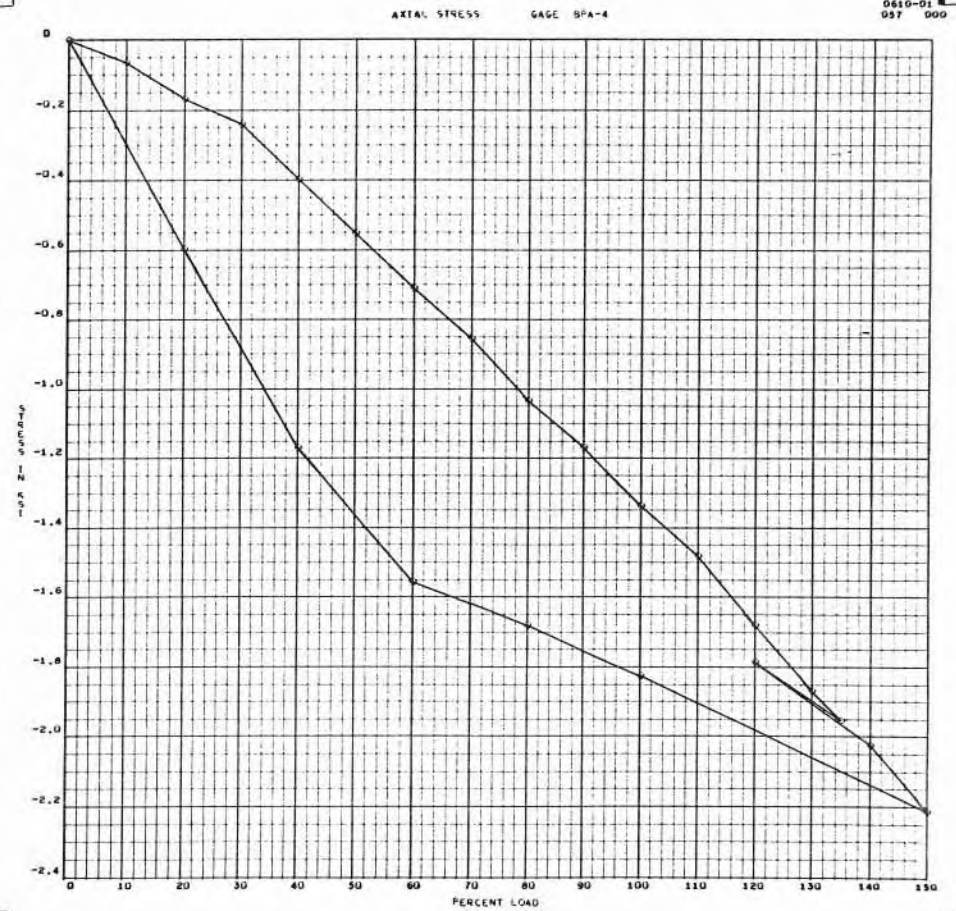
A-57

SID 67-317



A-58

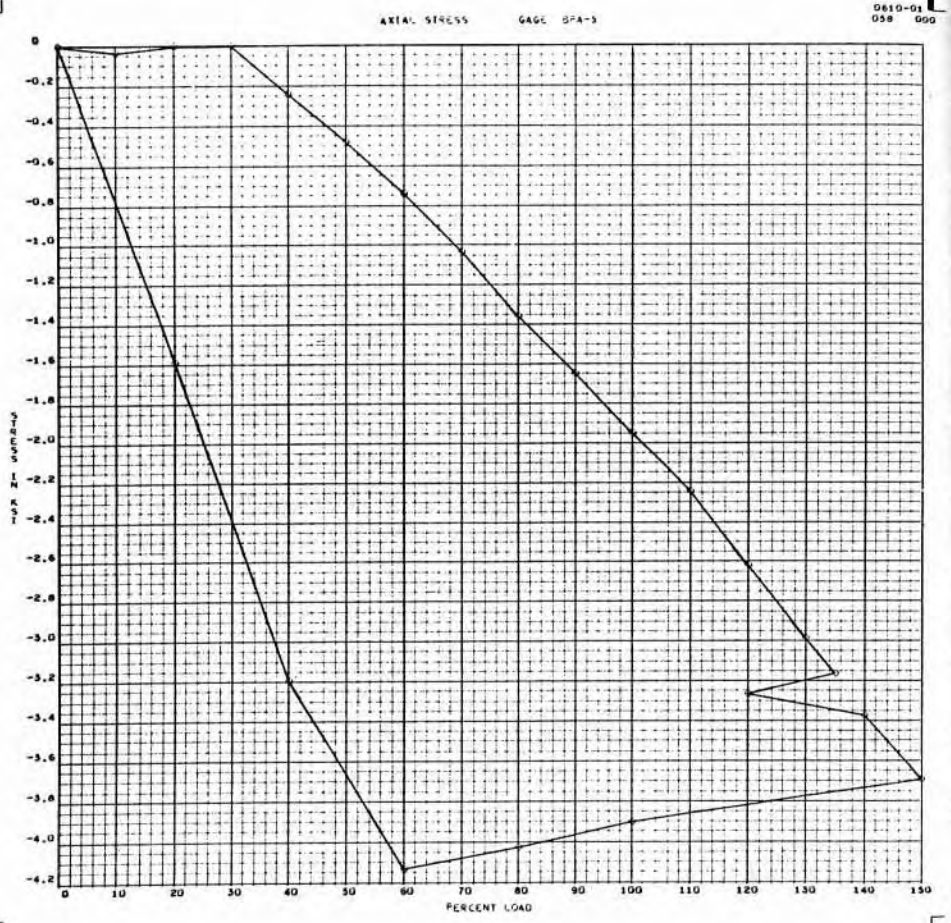
SID 67-317



A-59

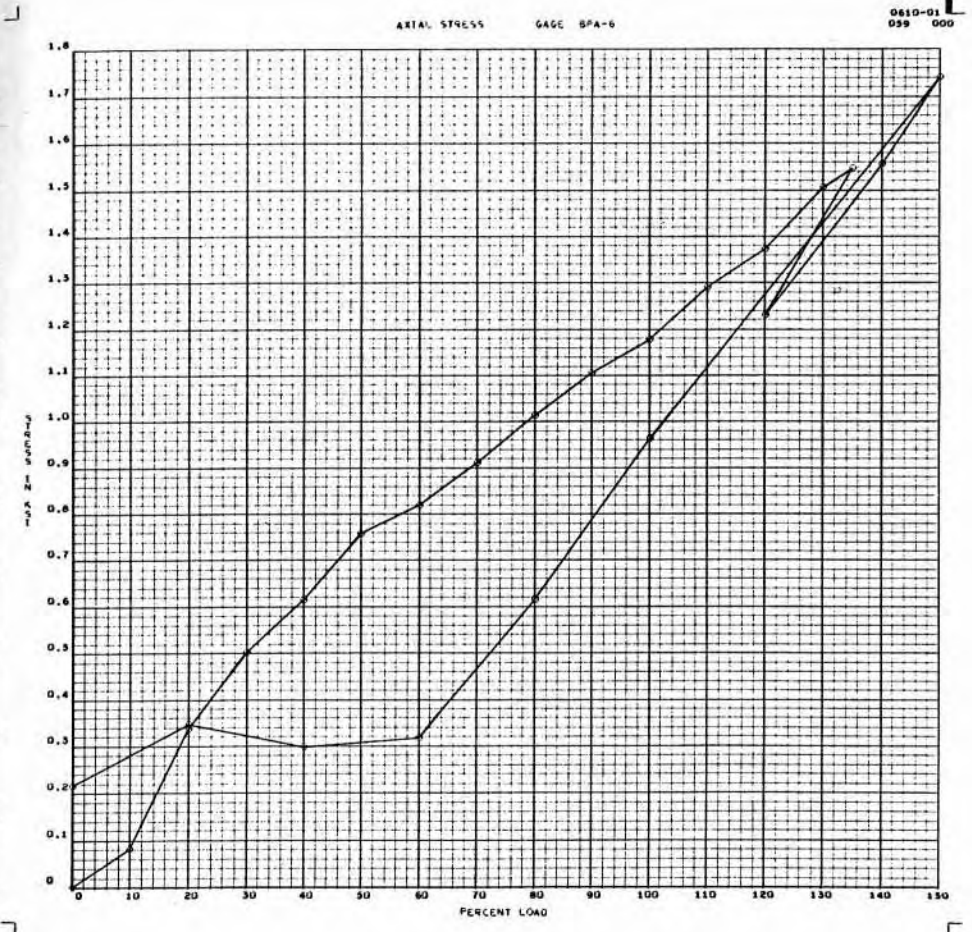
SID 67-317





A-60

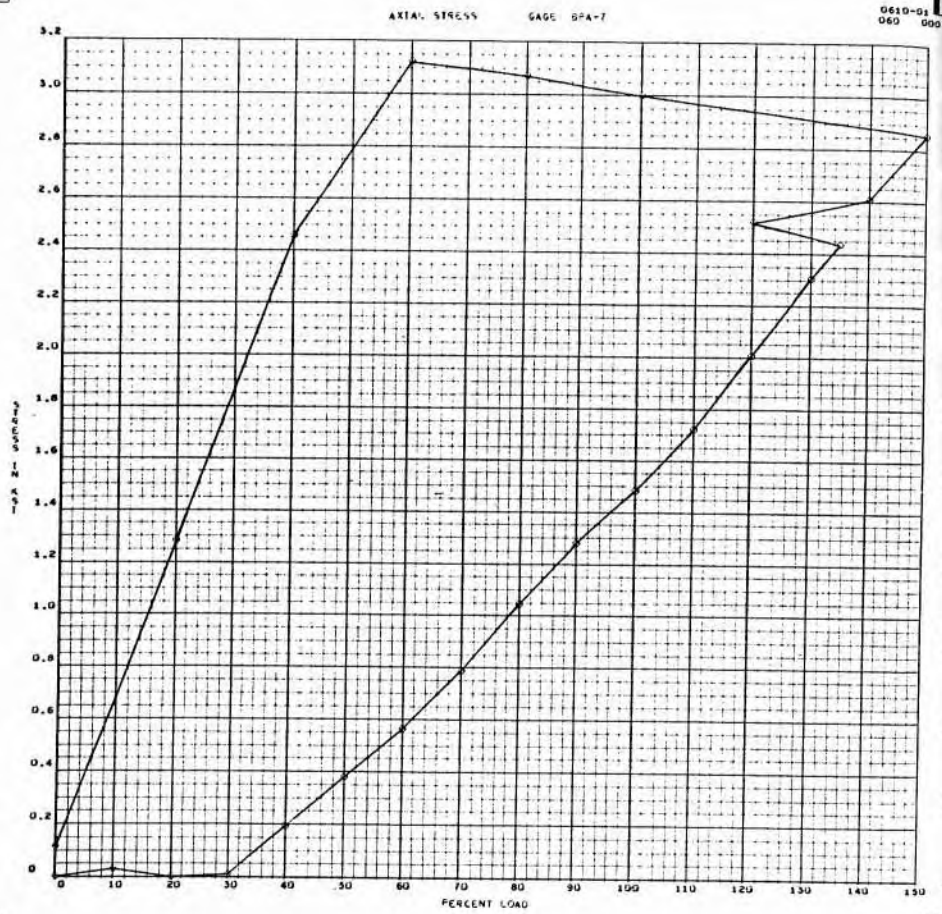
SID 67-317



A-61

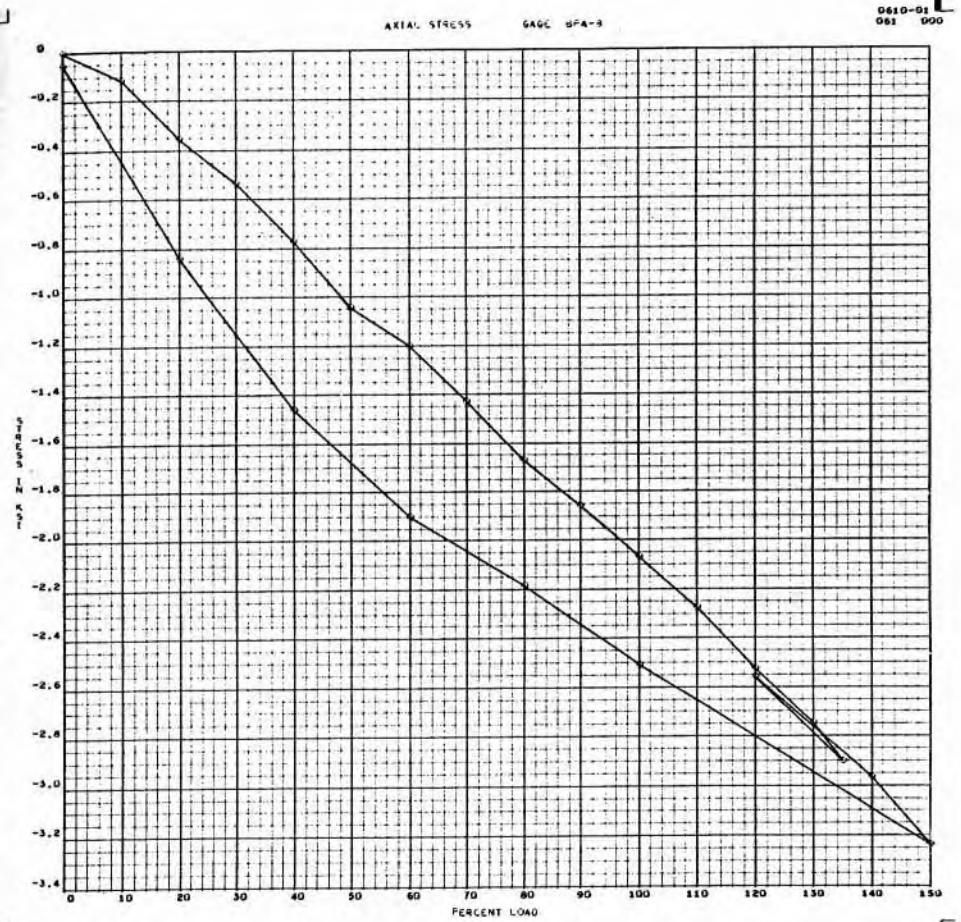
SID 67-317





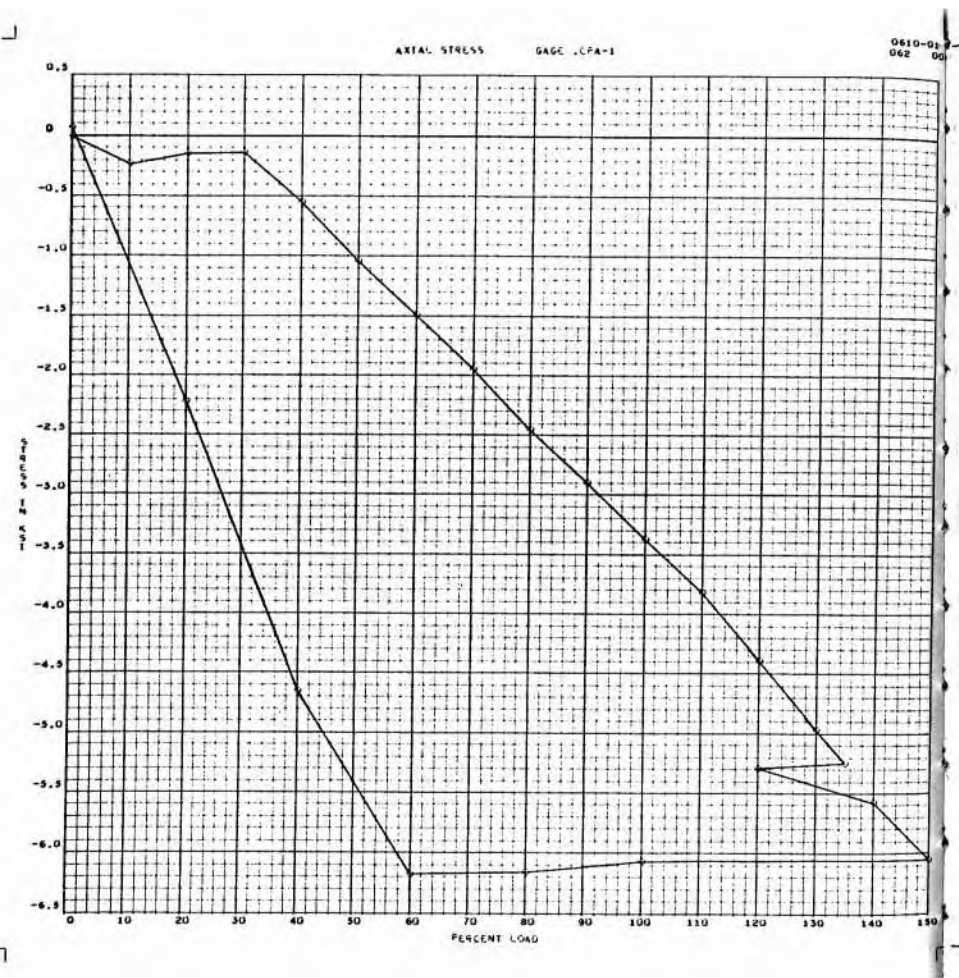
A-62

SID 67-317



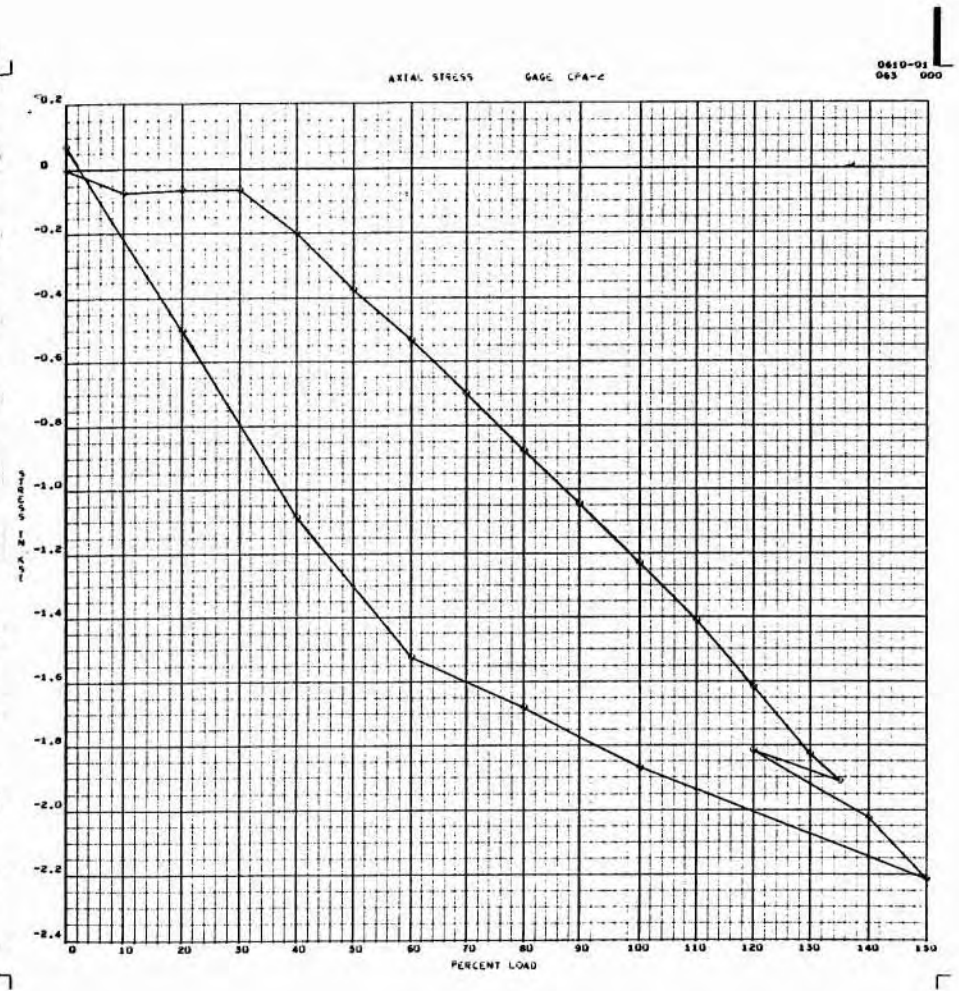
A-63

SID 67-317



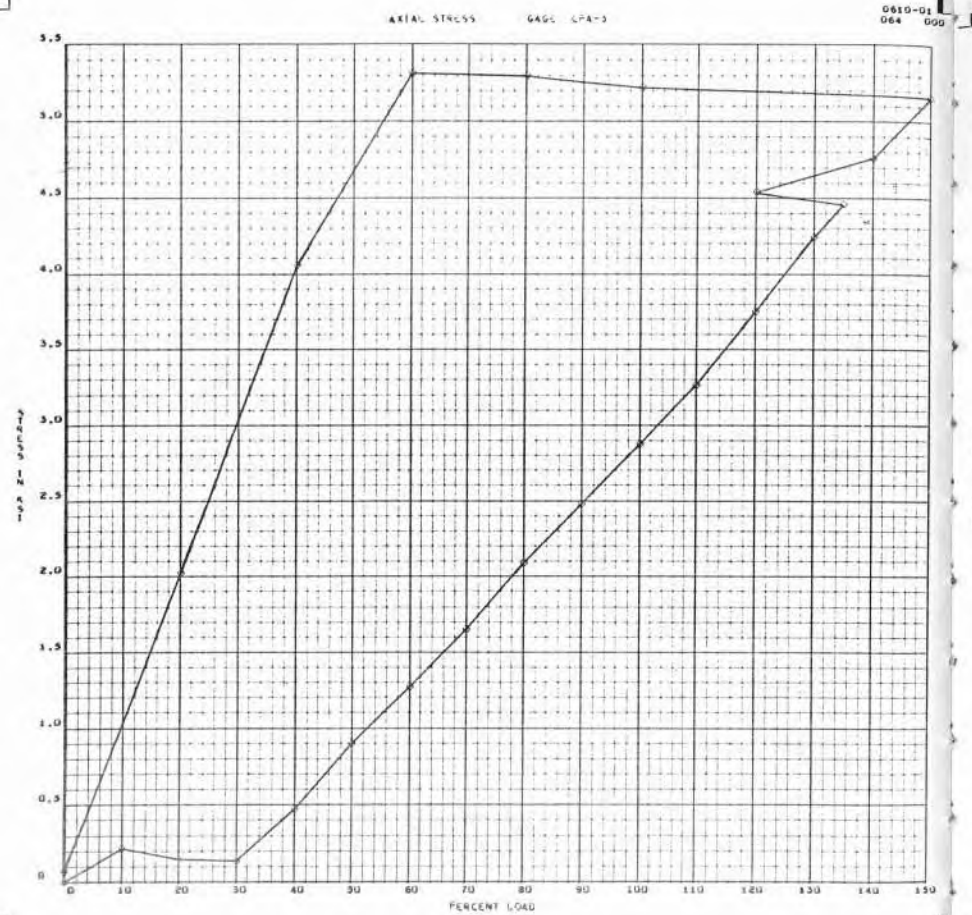
A-64

SID 67-317



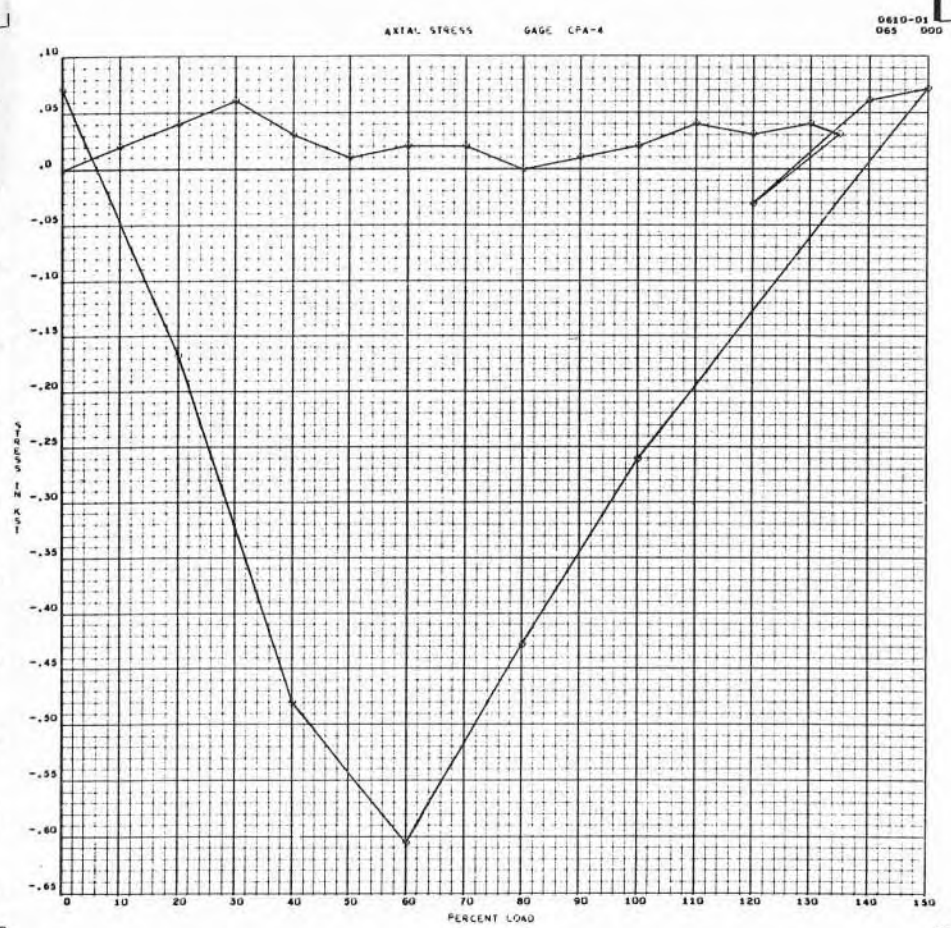
A-65

SID 67-317



A-66

SID 67-317

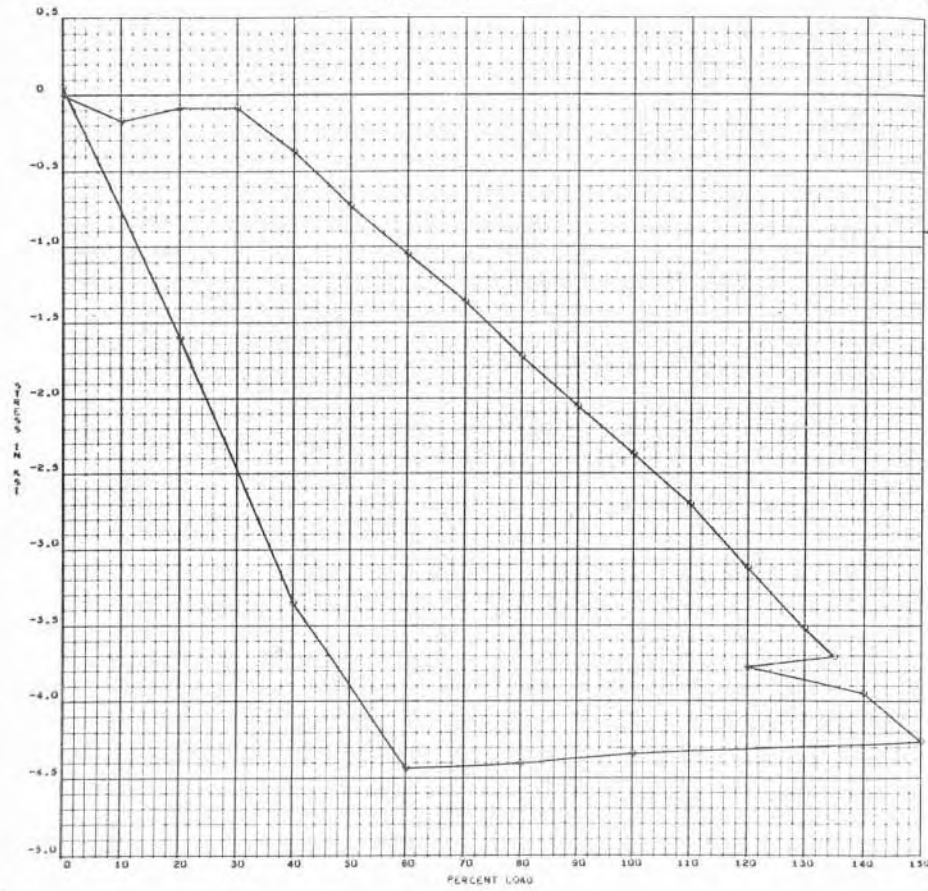


A-67

SID 67-317

0610-01  
068 000

AXIAL STRESS GAGE CPA-3

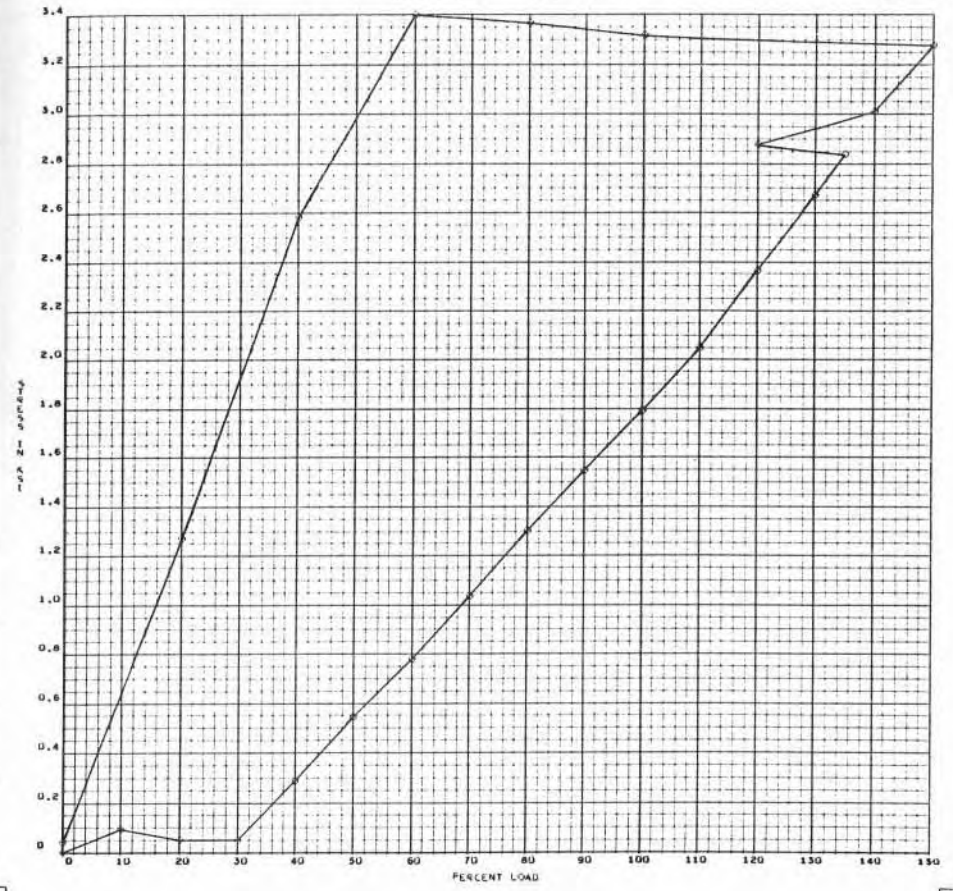


A-68

SID 67-317

0610-01  
068 000

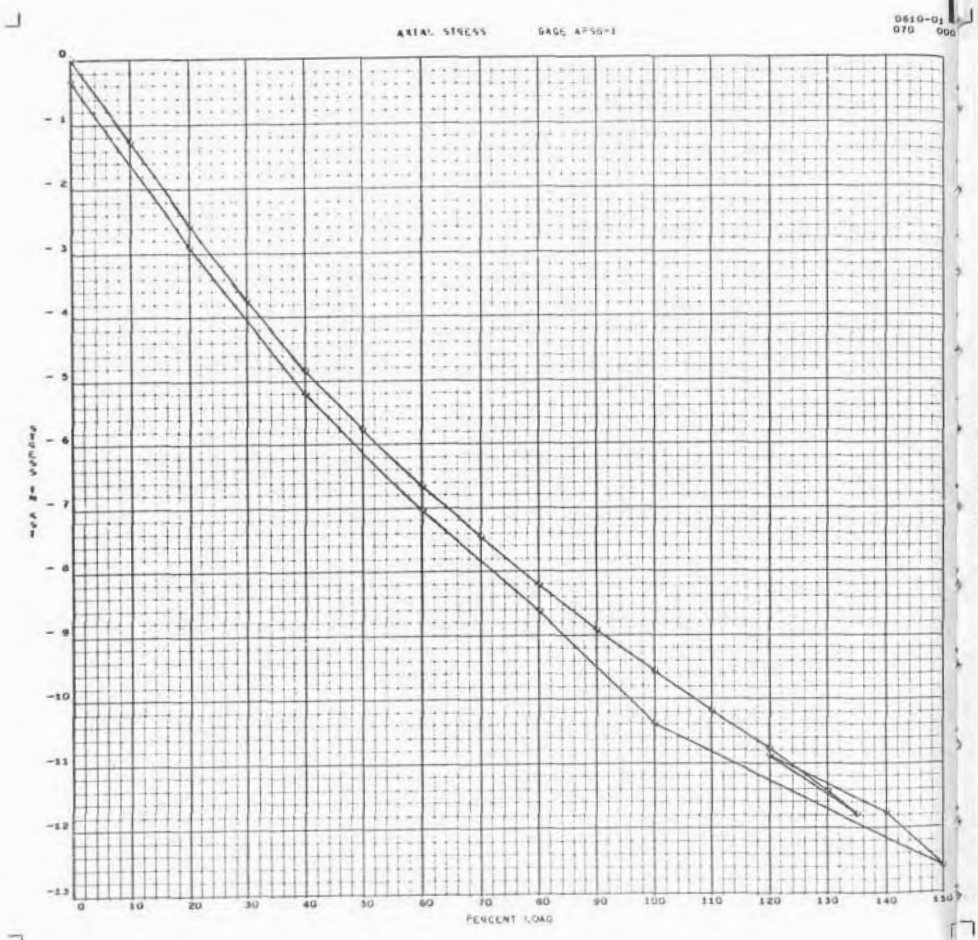
AXIAL STRESS GAGE CPA-7



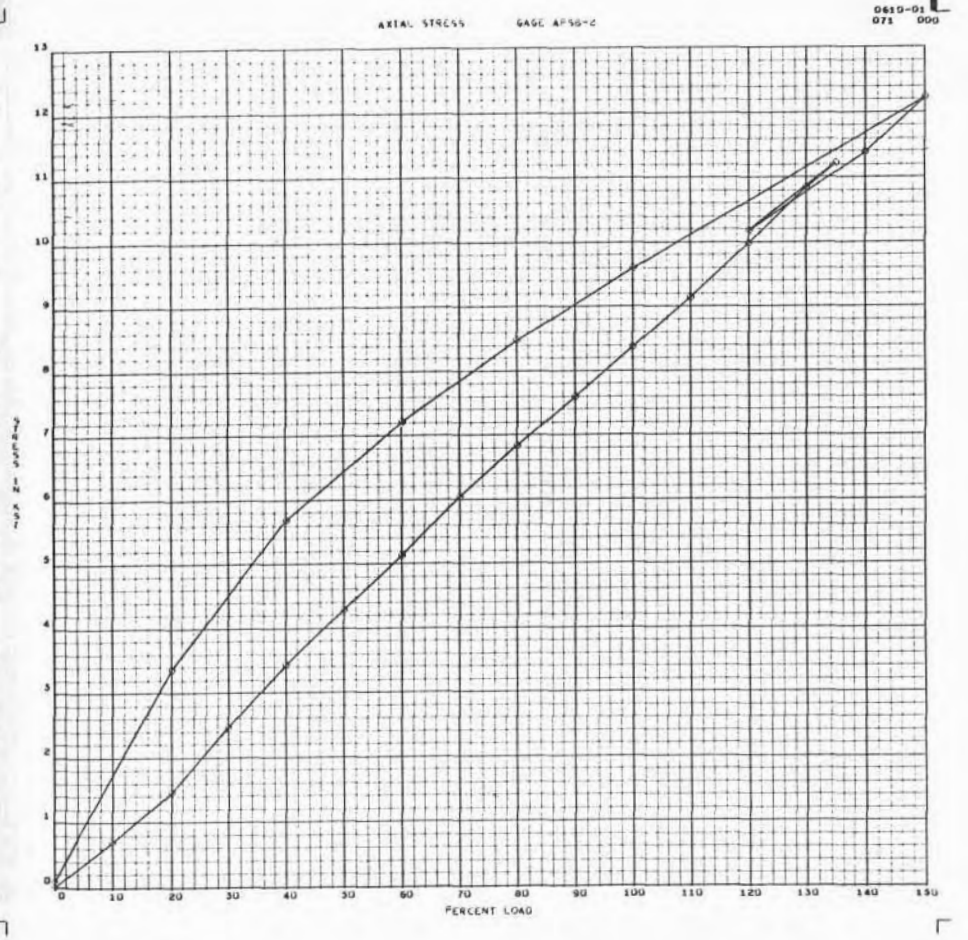
A-69

SID 67-317



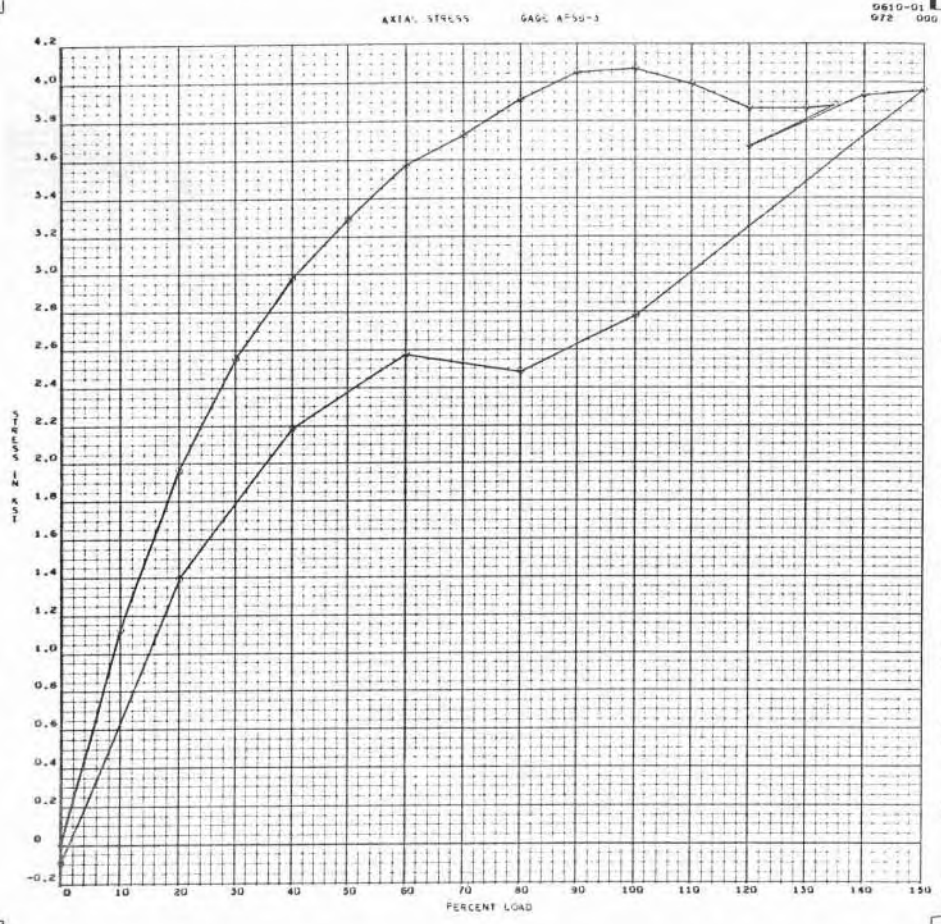


A-70      SID 67-317



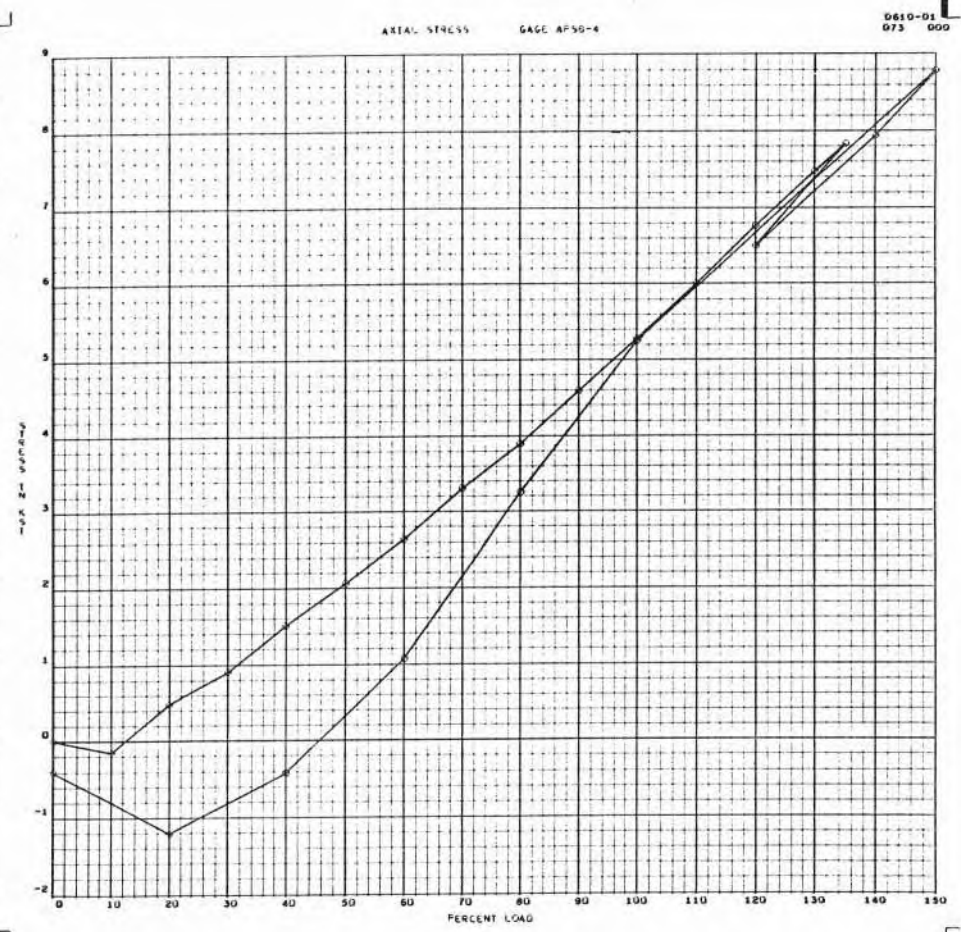
A-71      SID 67-317





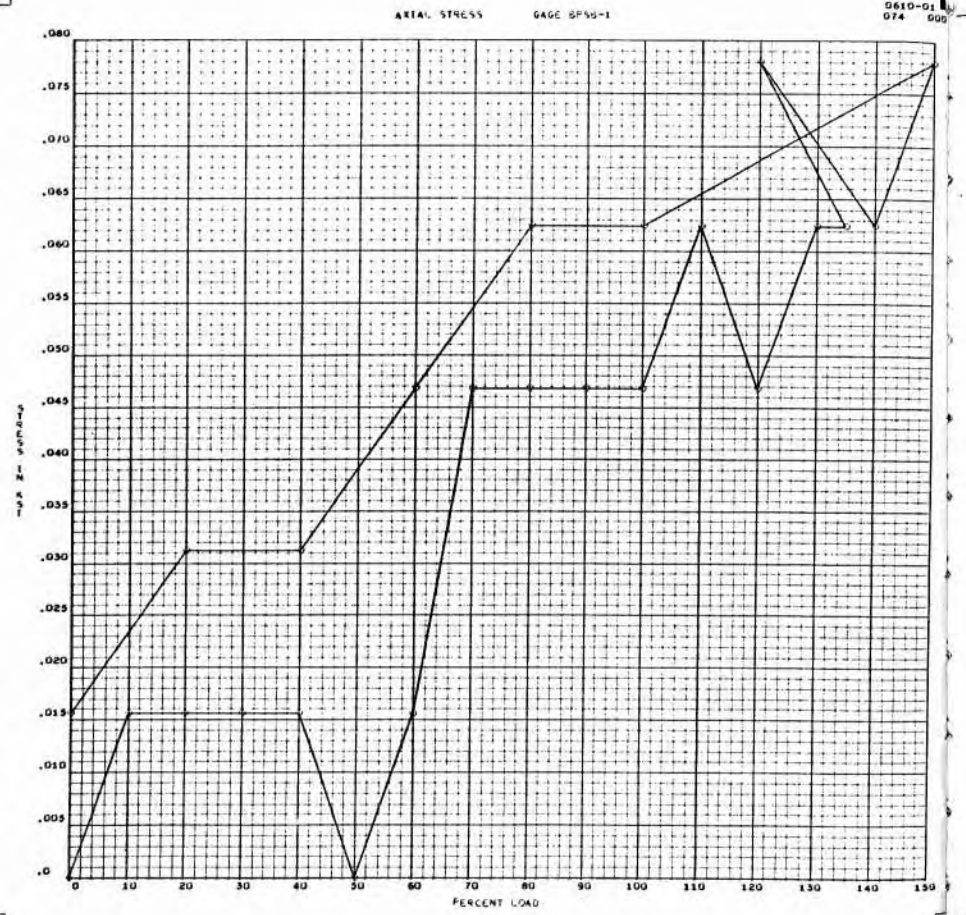
A-72

SID 67-317

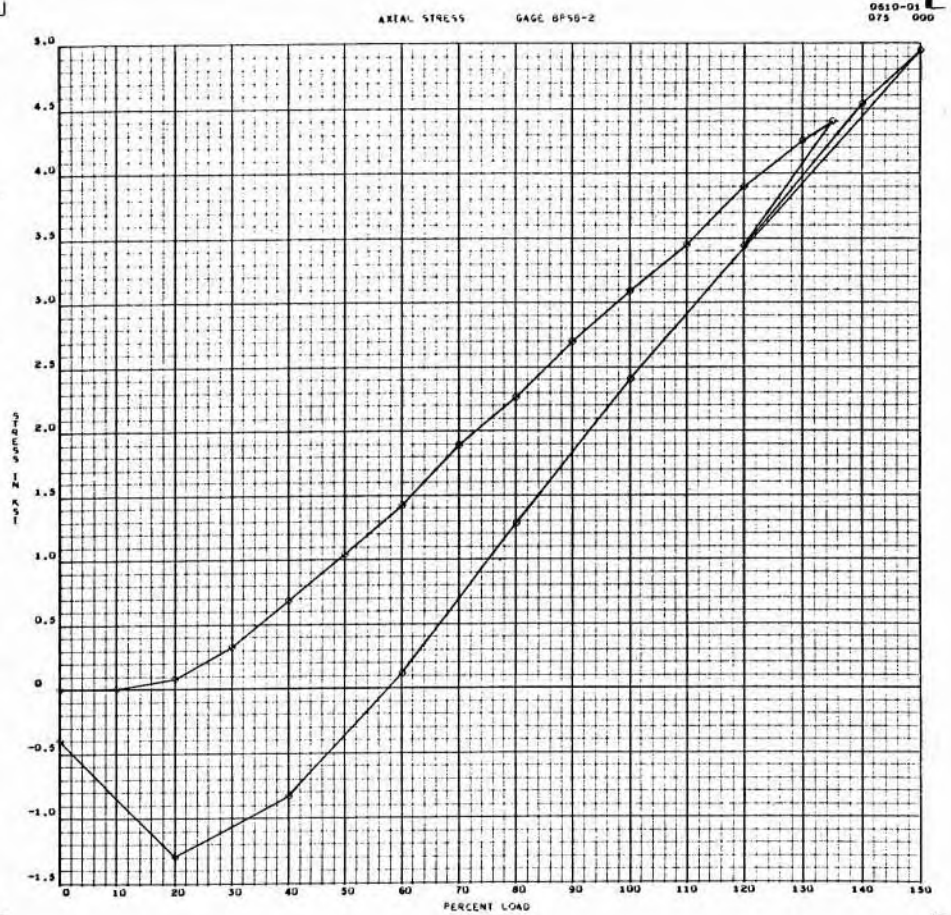


A-73

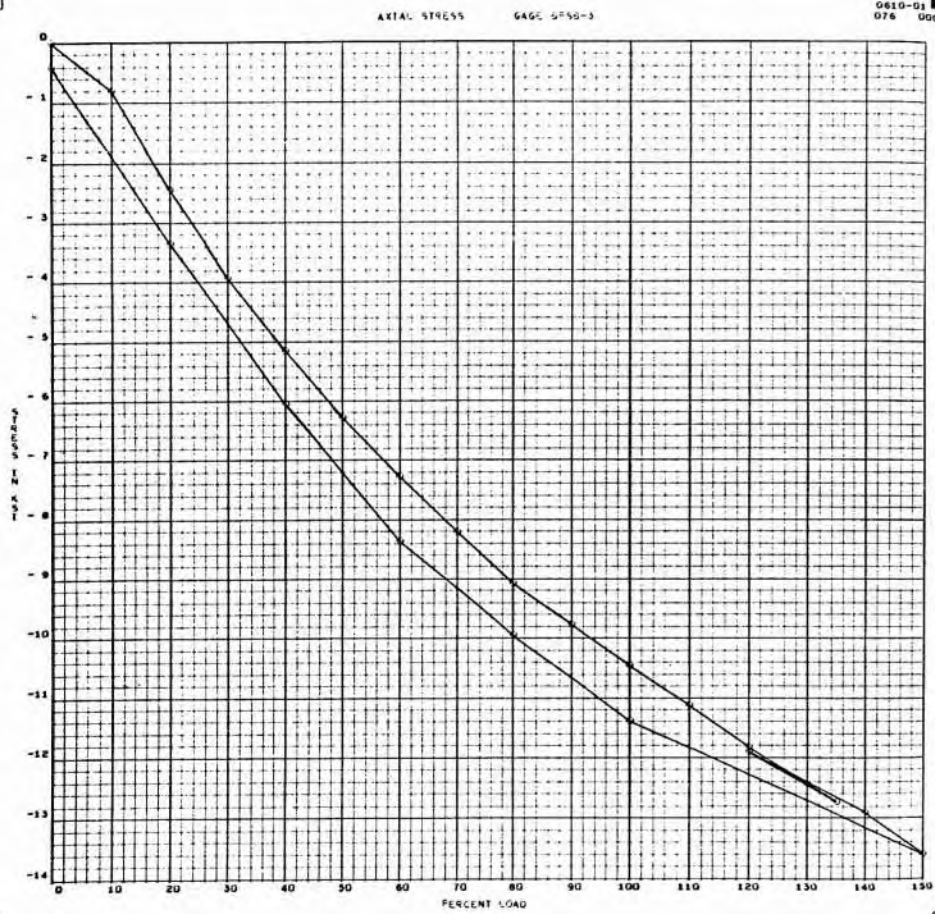
SID 67-317



A-74 SID 67-317

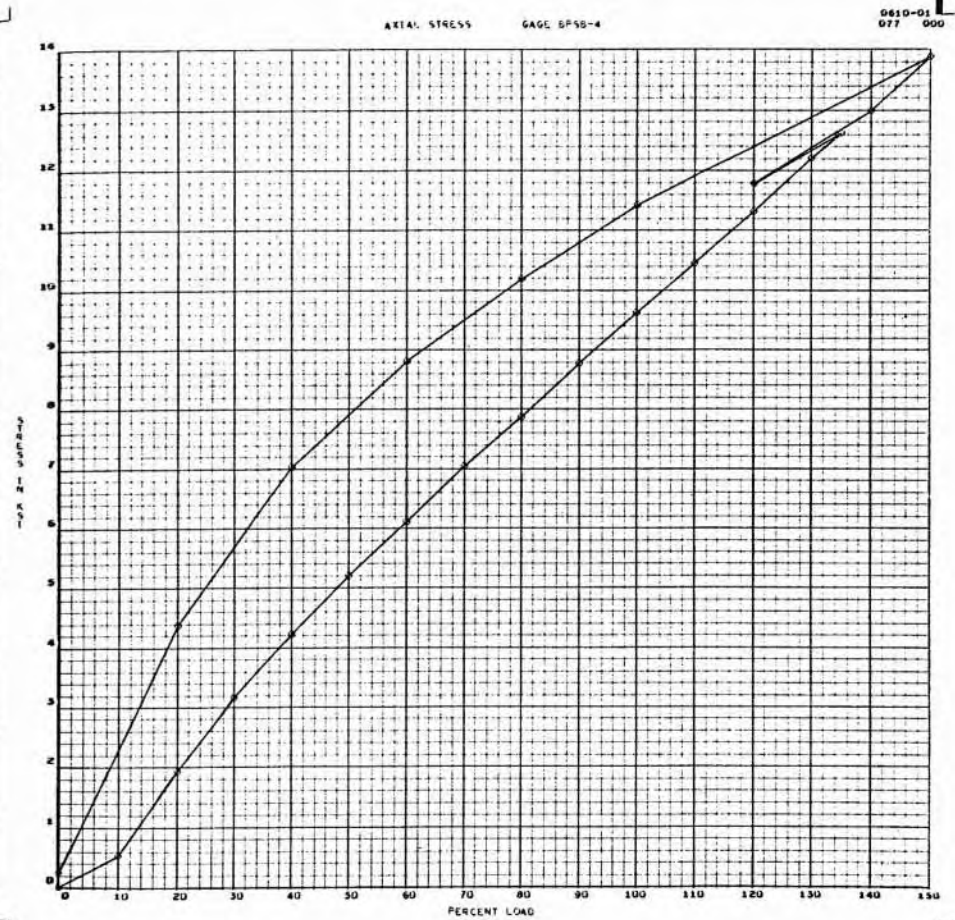


A-75 SID 67-317



A-76

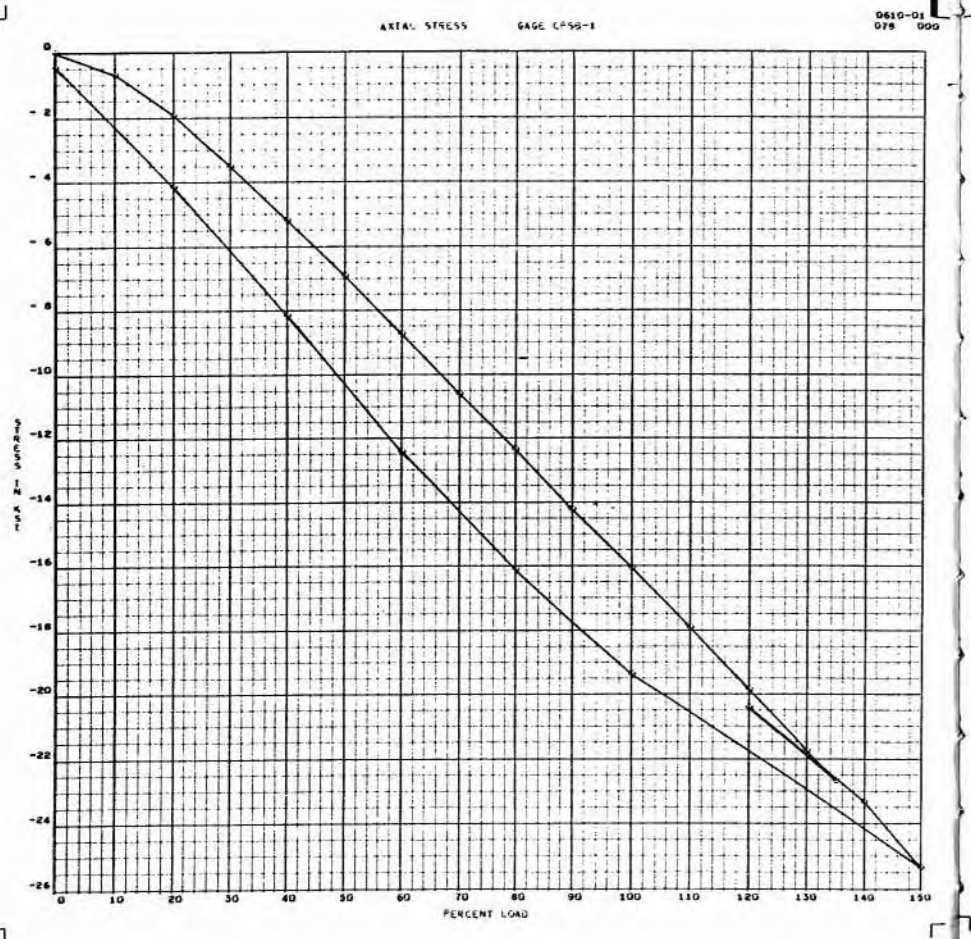
SID 67-317



A-77

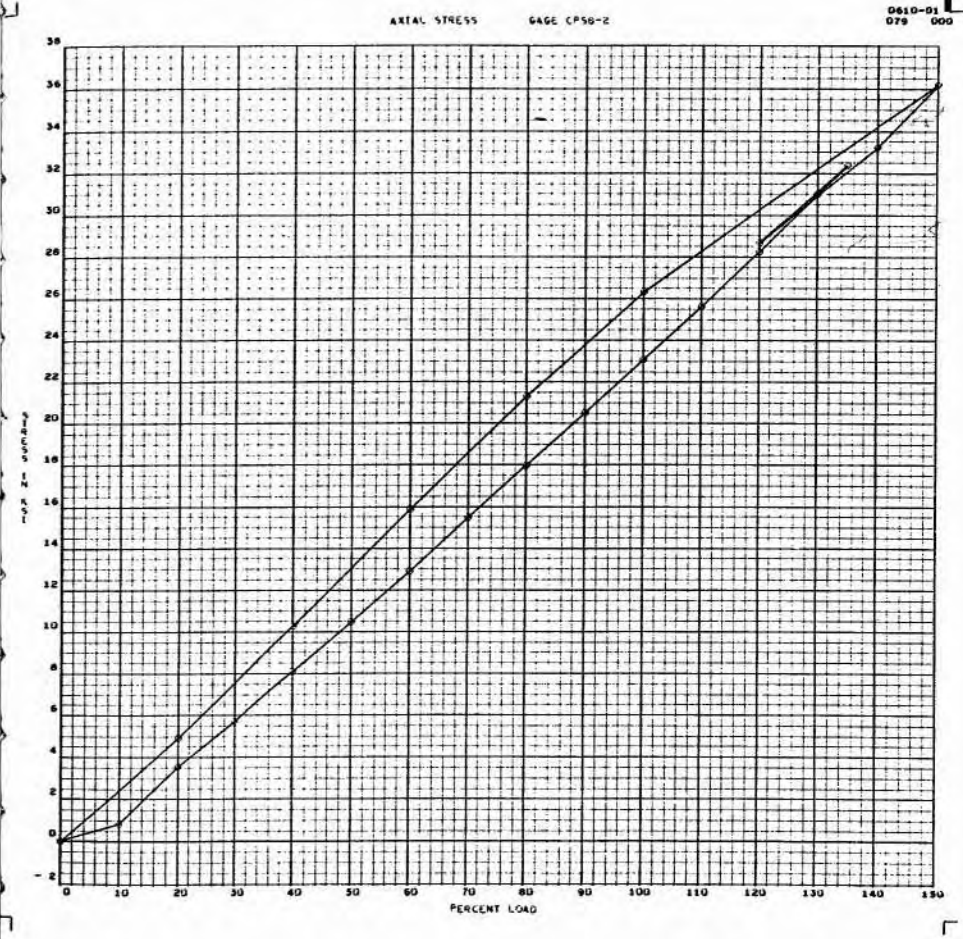
SID 67-317





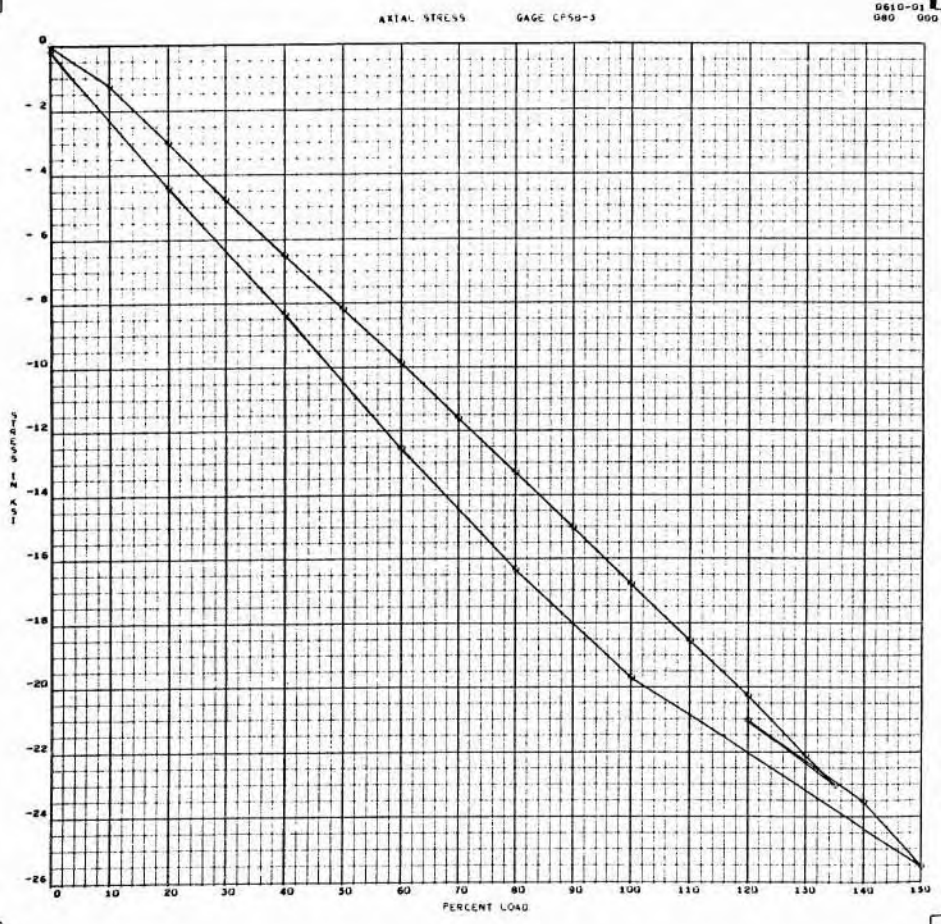
A-78

SID 67-317



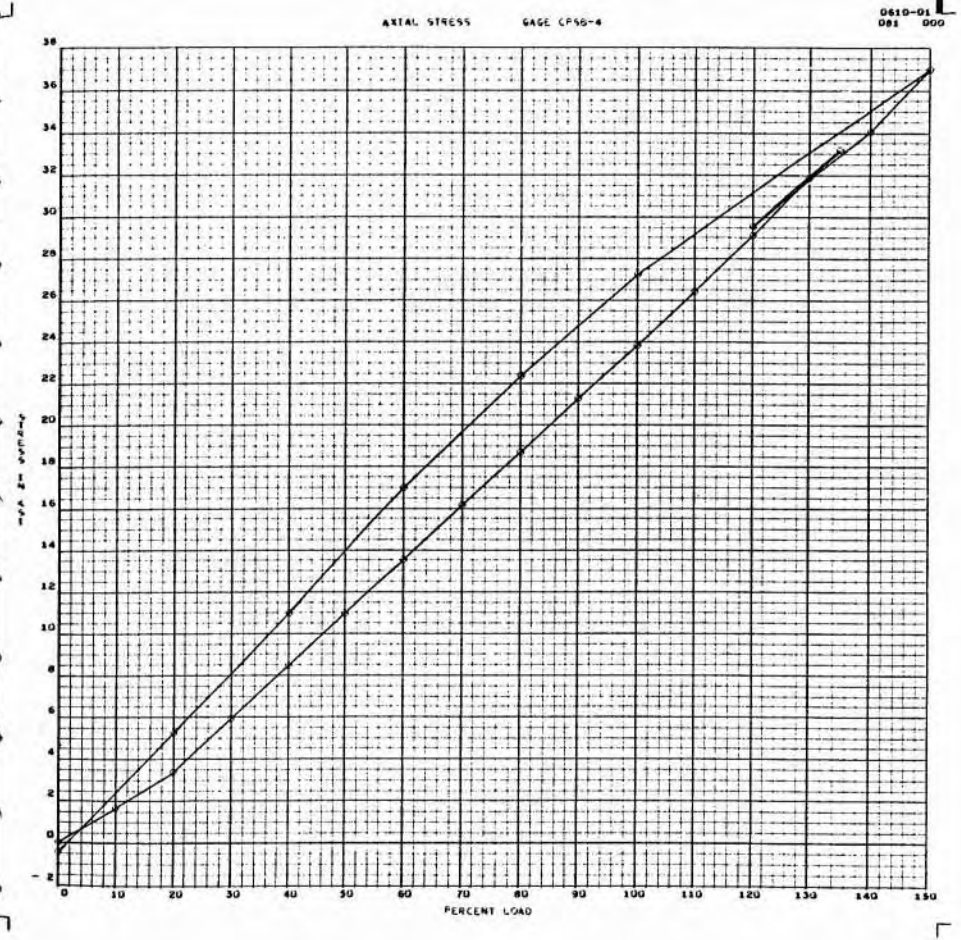
A-79

SID 67-317



A-80

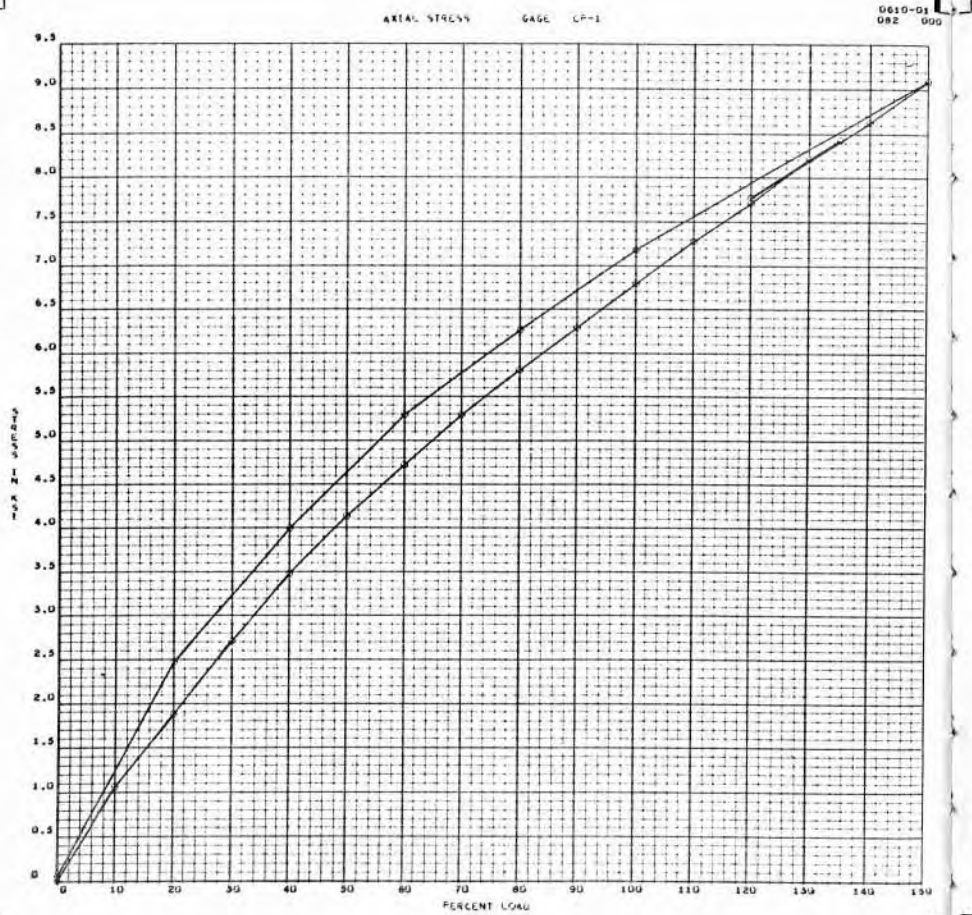
SID 67-317



A-81

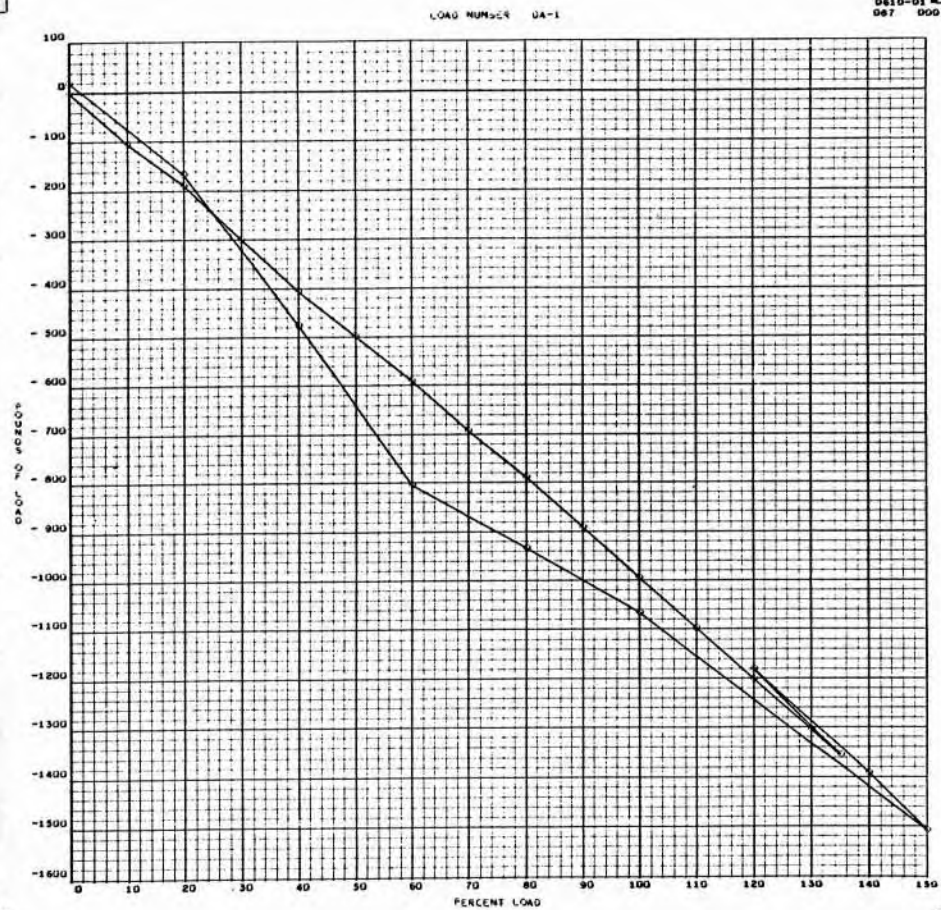
SID 67-317





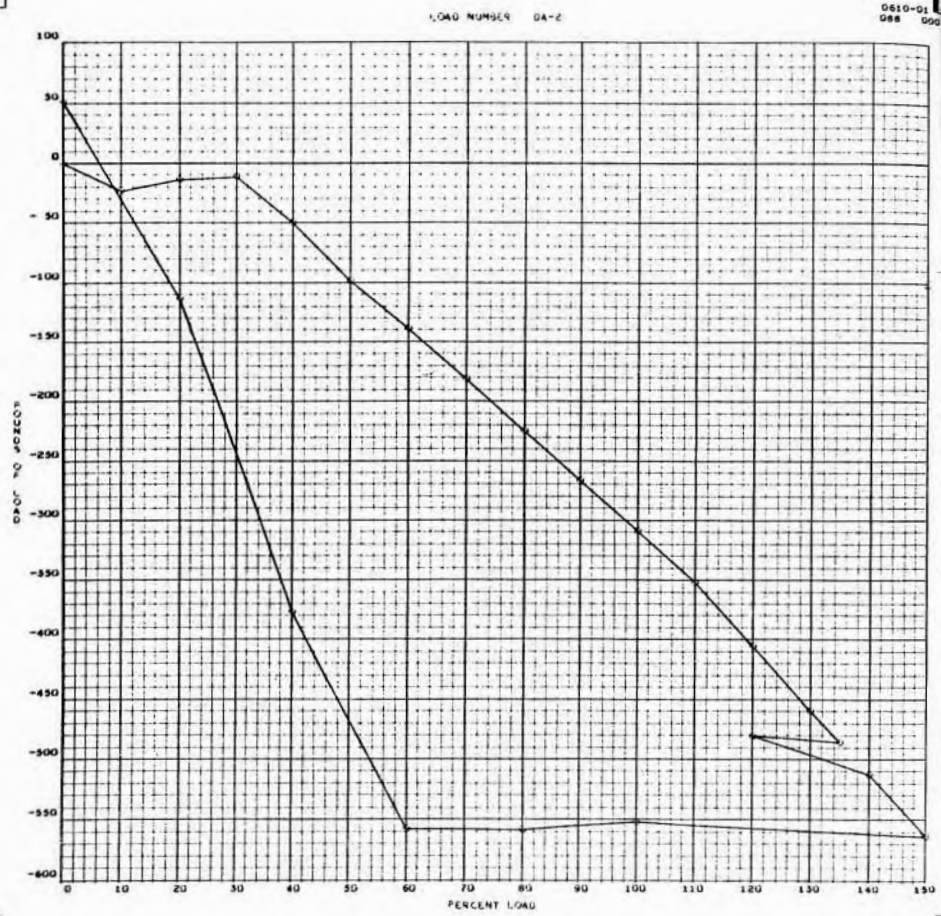
A-82

SID 67-317



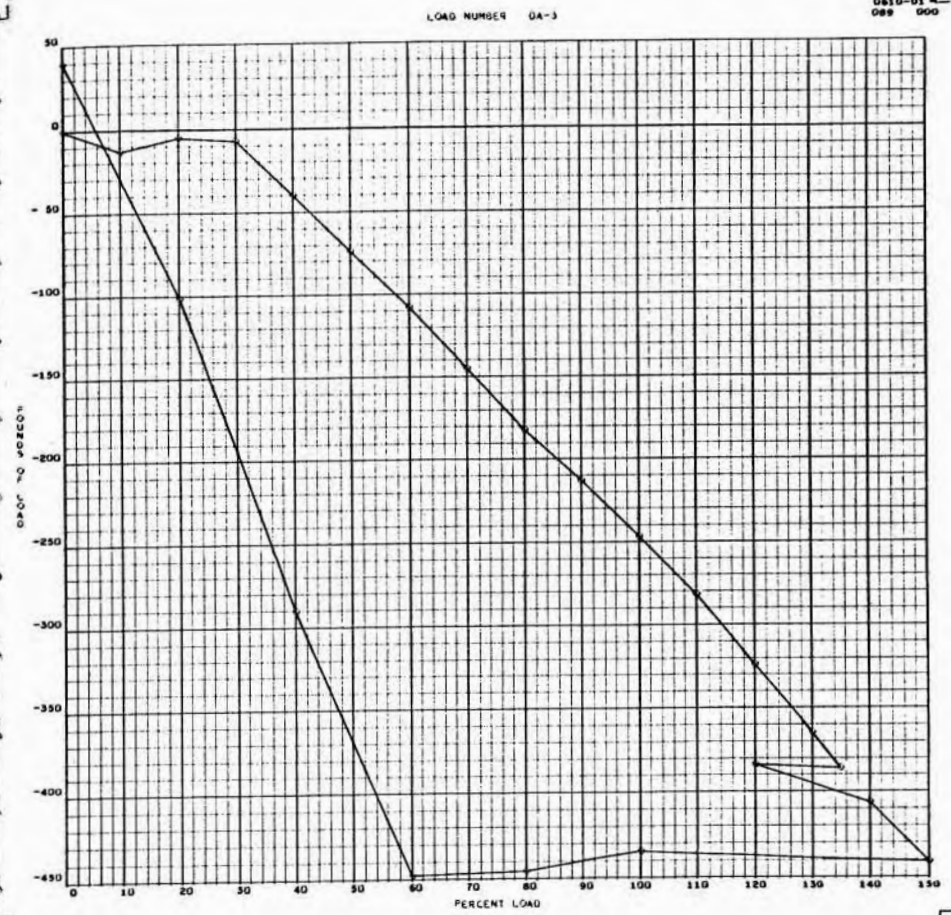
A-83

SID 67-317



A-84

SID 67-317



A-85

SID 67-317

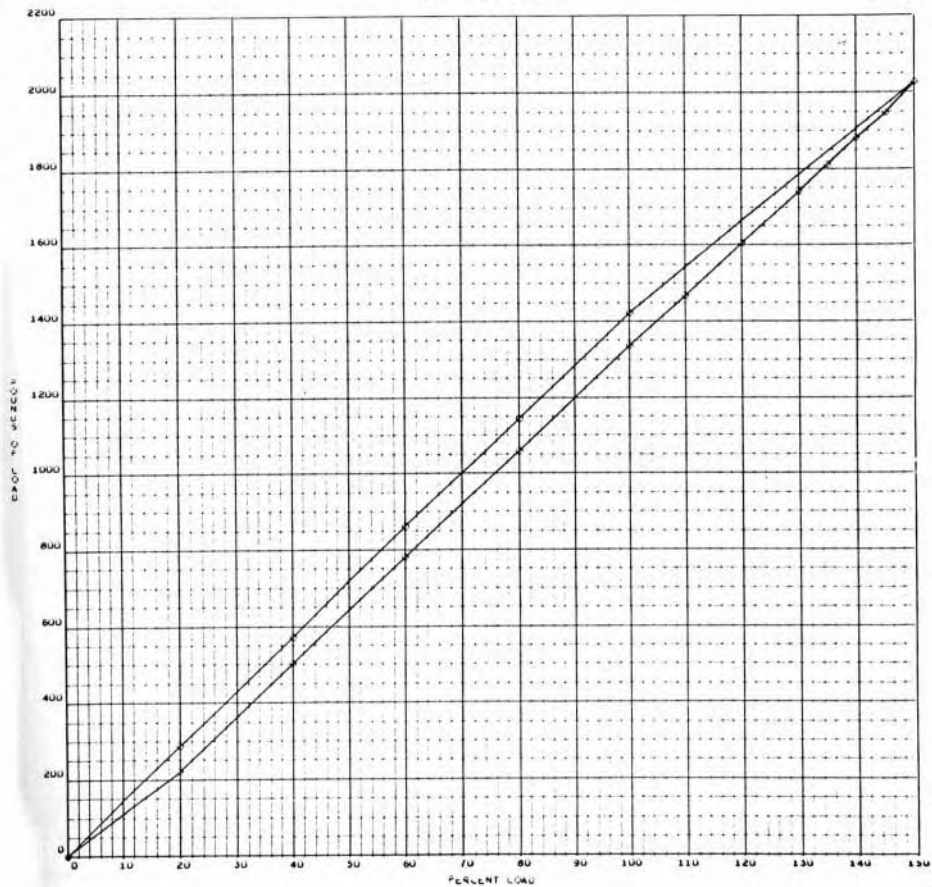
TEST CONDITION II

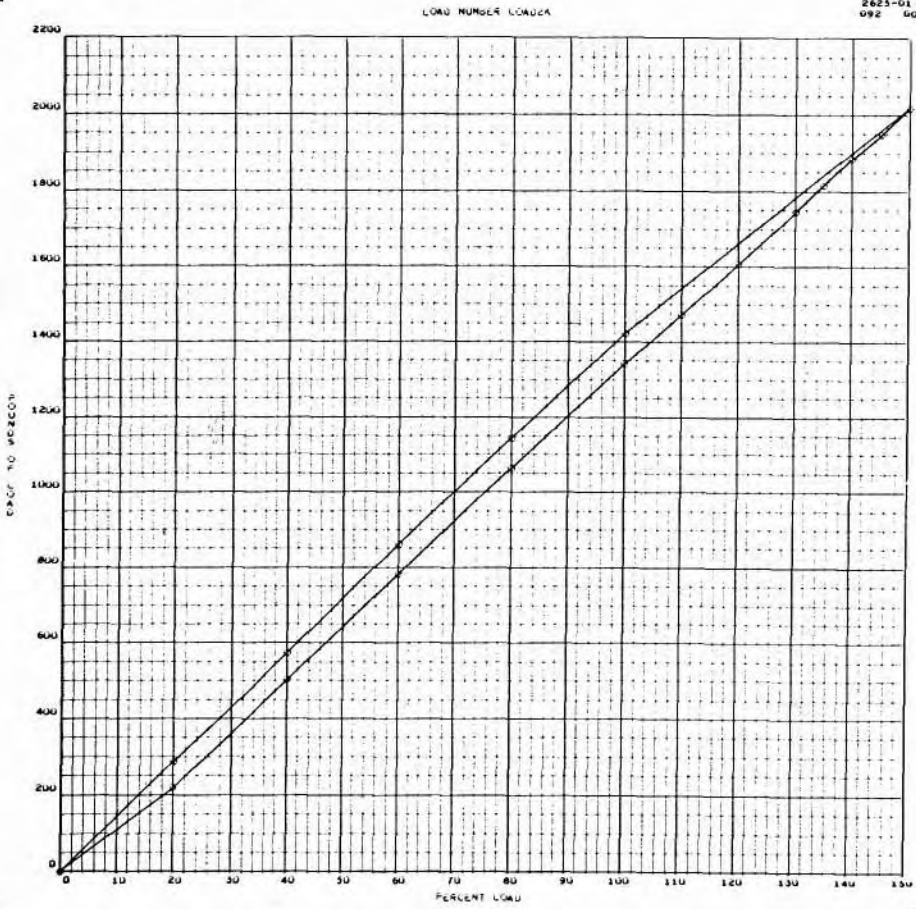
SID 67-317

## LOAD NUMBER LOADER

2625-01

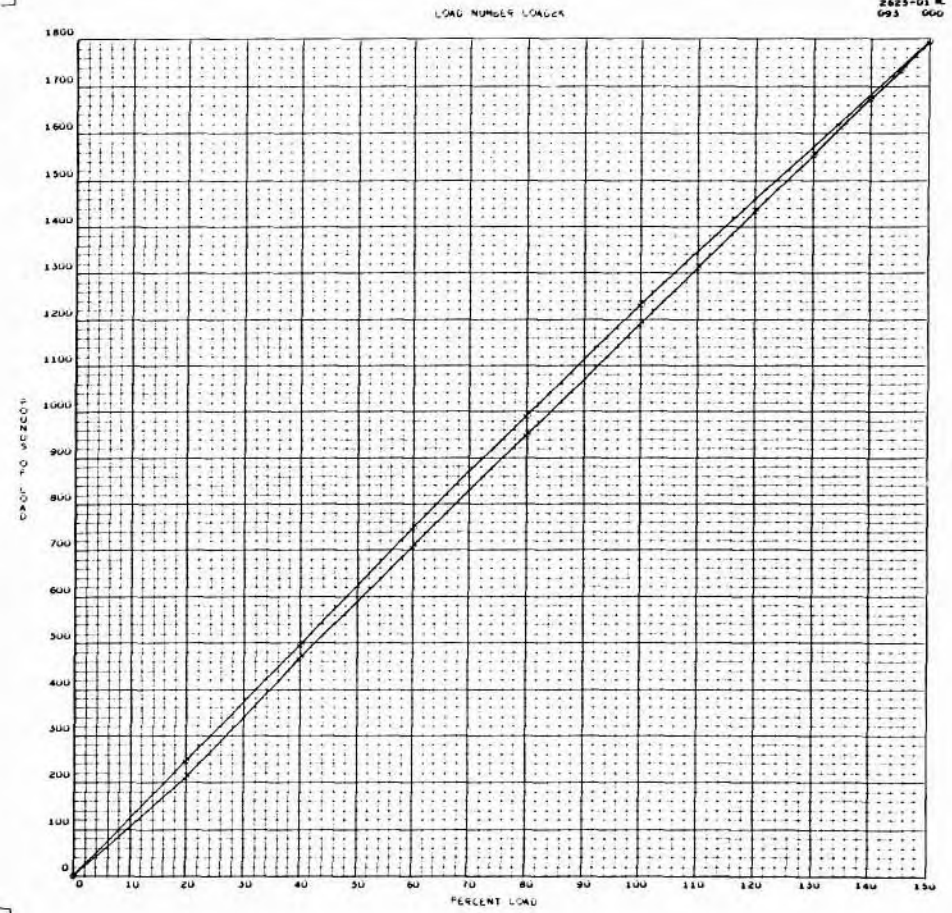
091 000





A-87

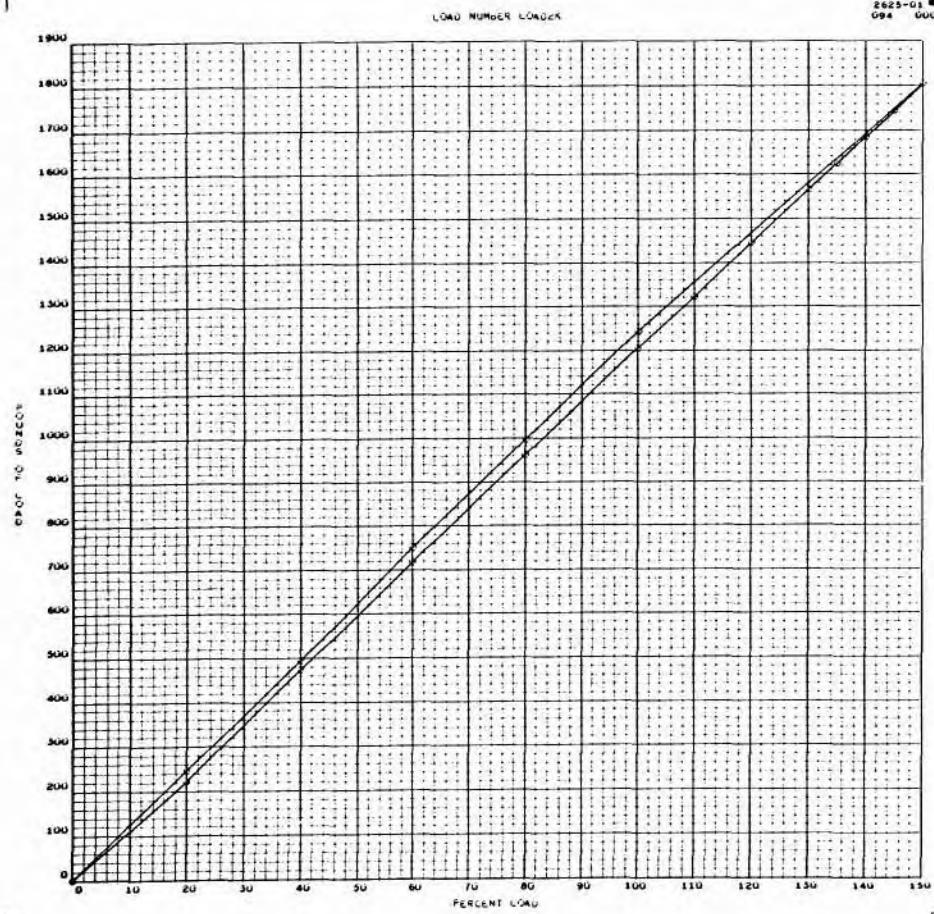
SID 67-317



A-88

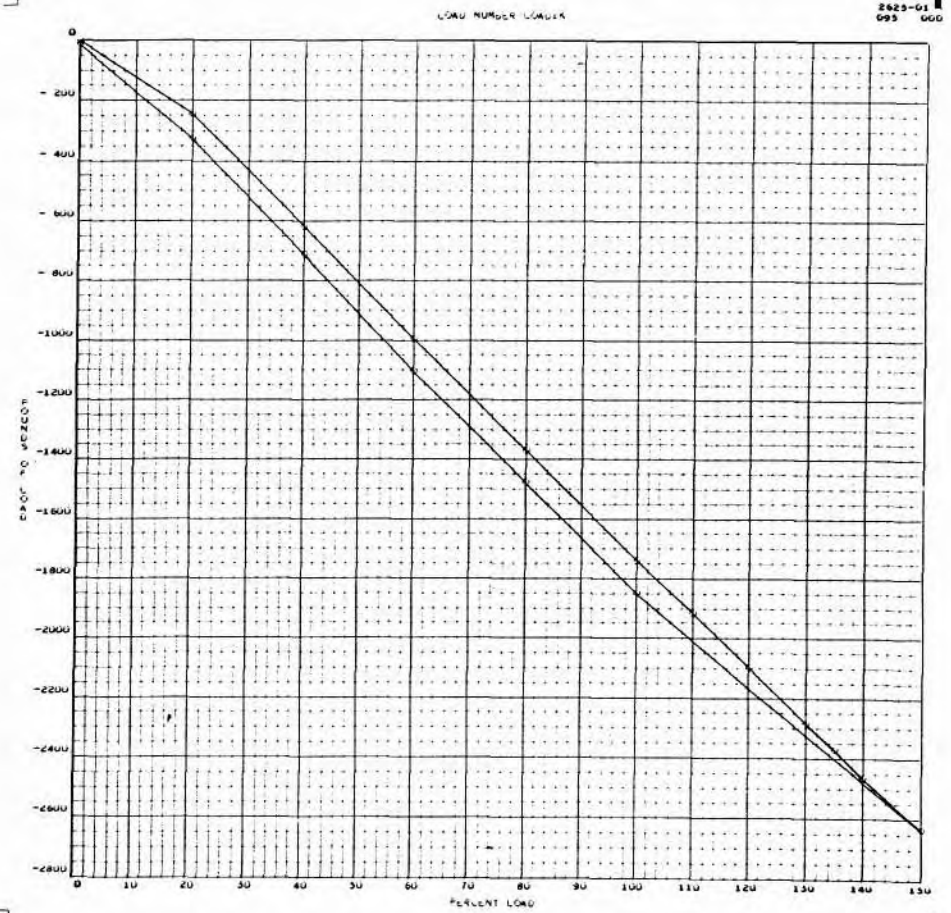
SID 67-317





A-89

SID 67-317

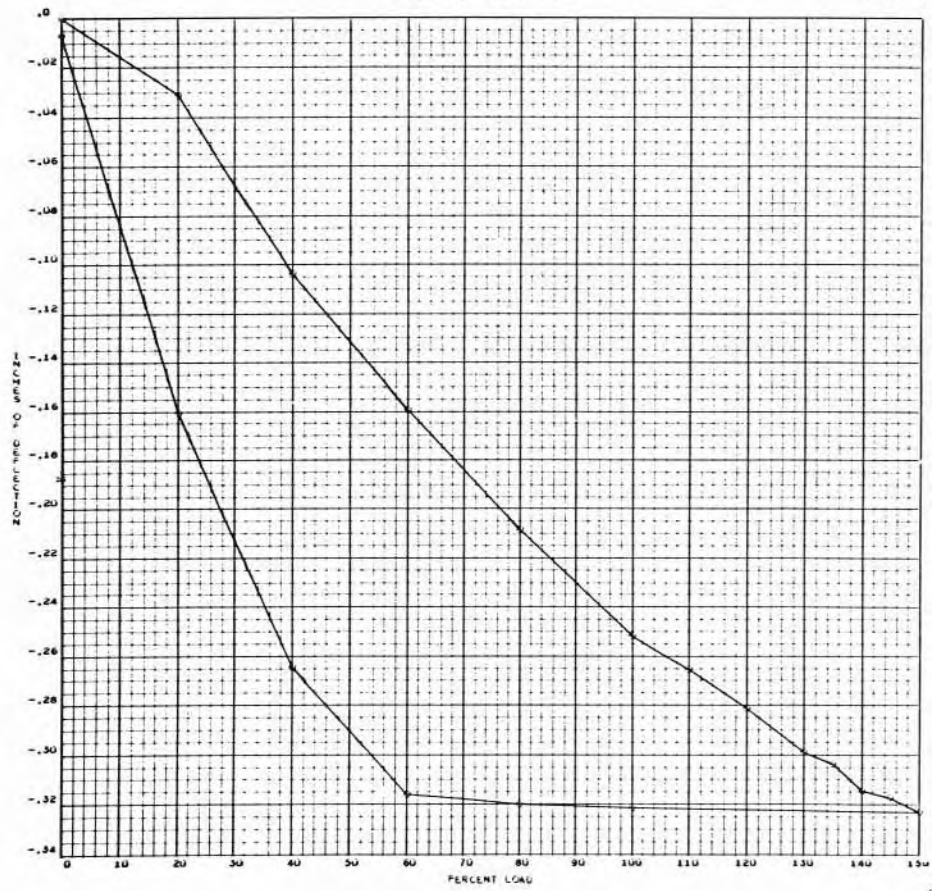


A-90

SID 67-317

INDICATOR NUMBER DEFL

2625-01  
096 000



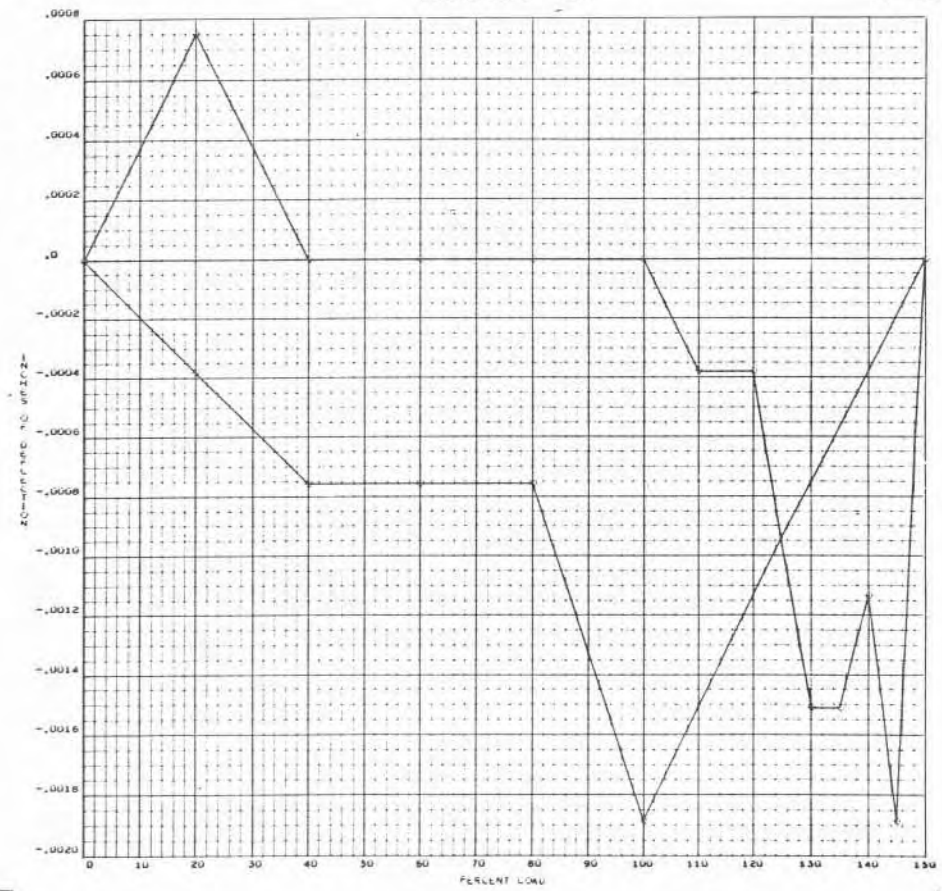
A-91

SID 67-317

INDICATOR NUMBER DEFL

2625-01  
097 000

1401  
April 15

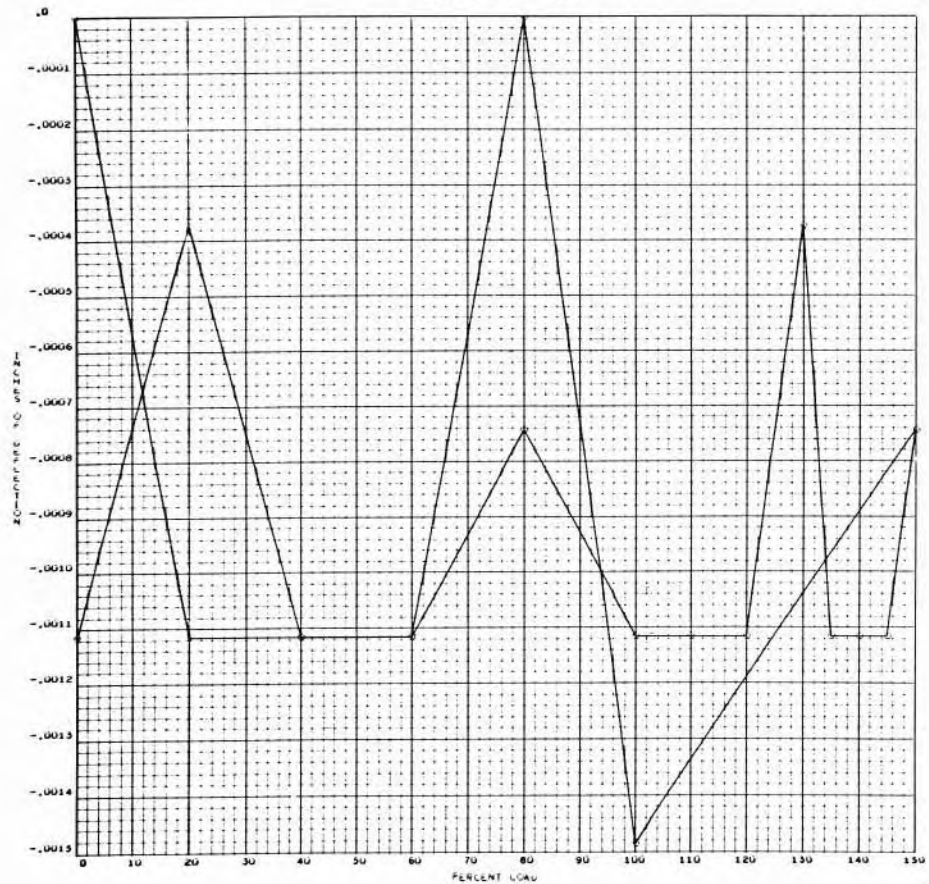


A-92

SID 67-317

INDICATOR NUMBER DEFL

2625-01  
098 000

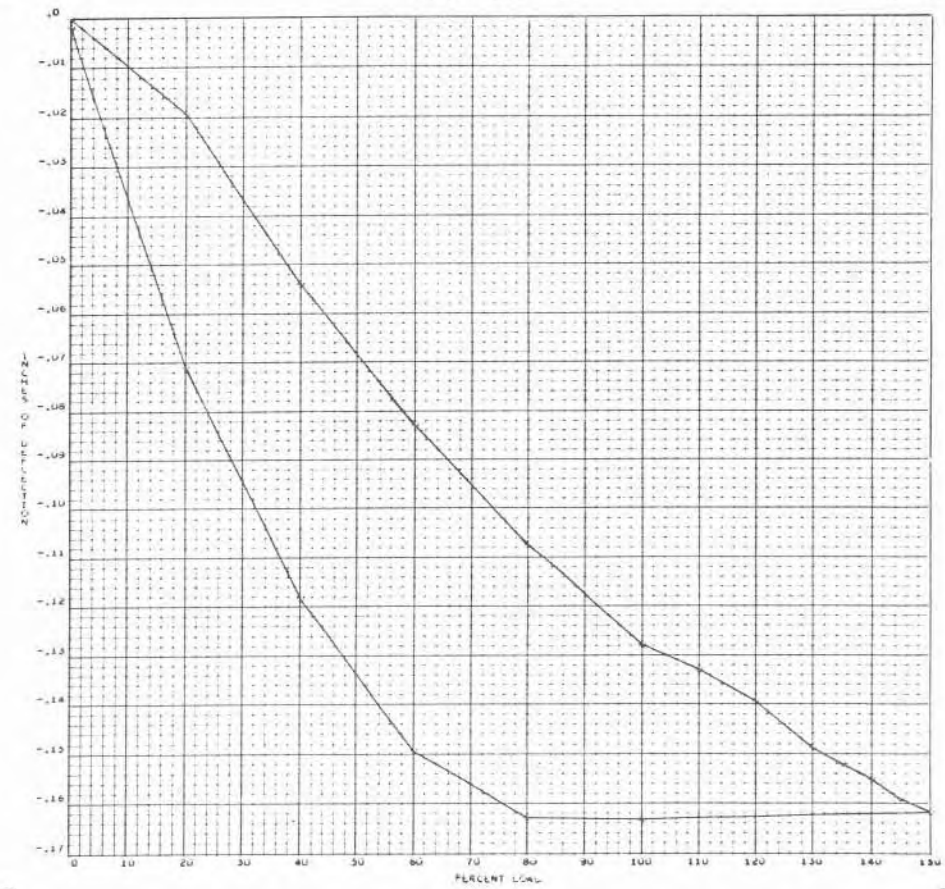


A-93

SID 67-317

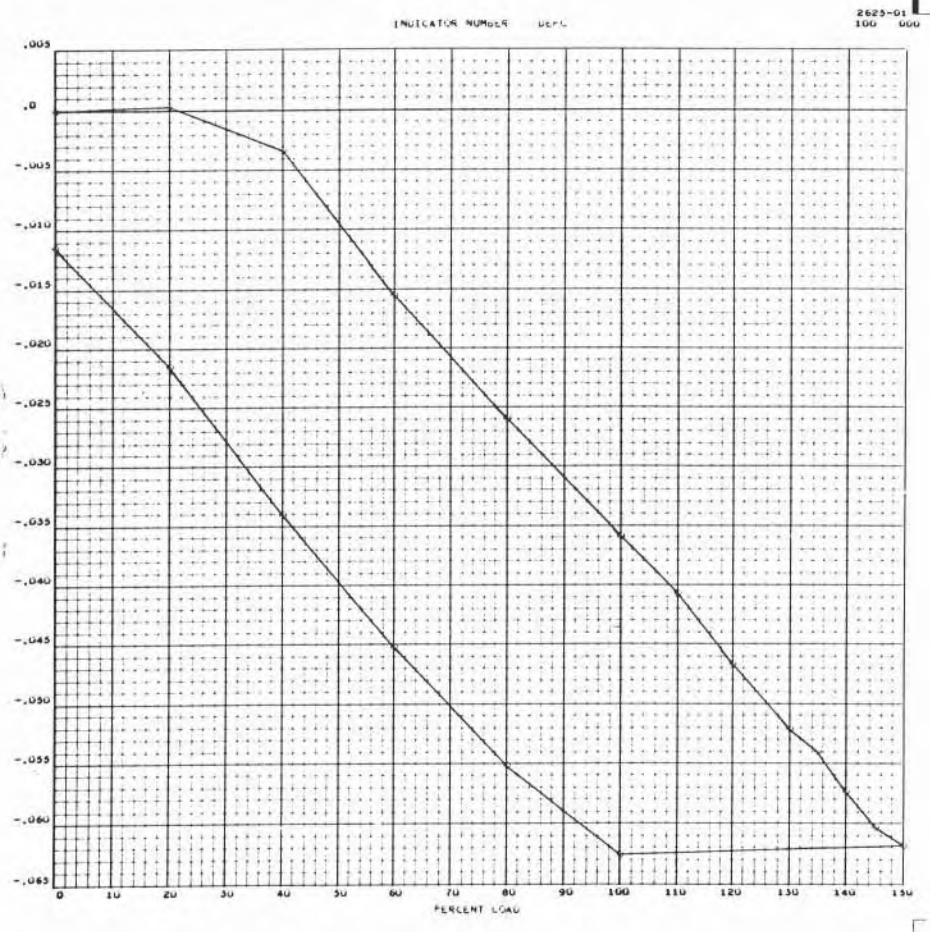
INDICATOR NUMBER DEFL

2625-01  
098 000



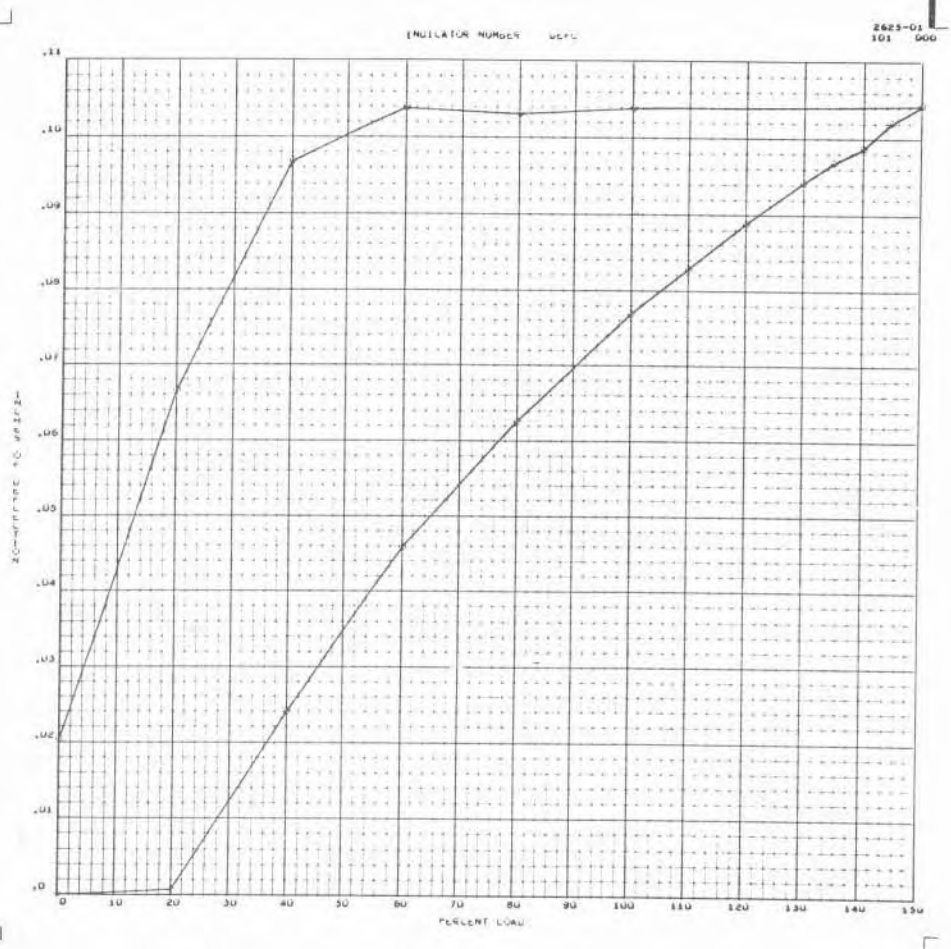
A-94

SID 67-317



A-95

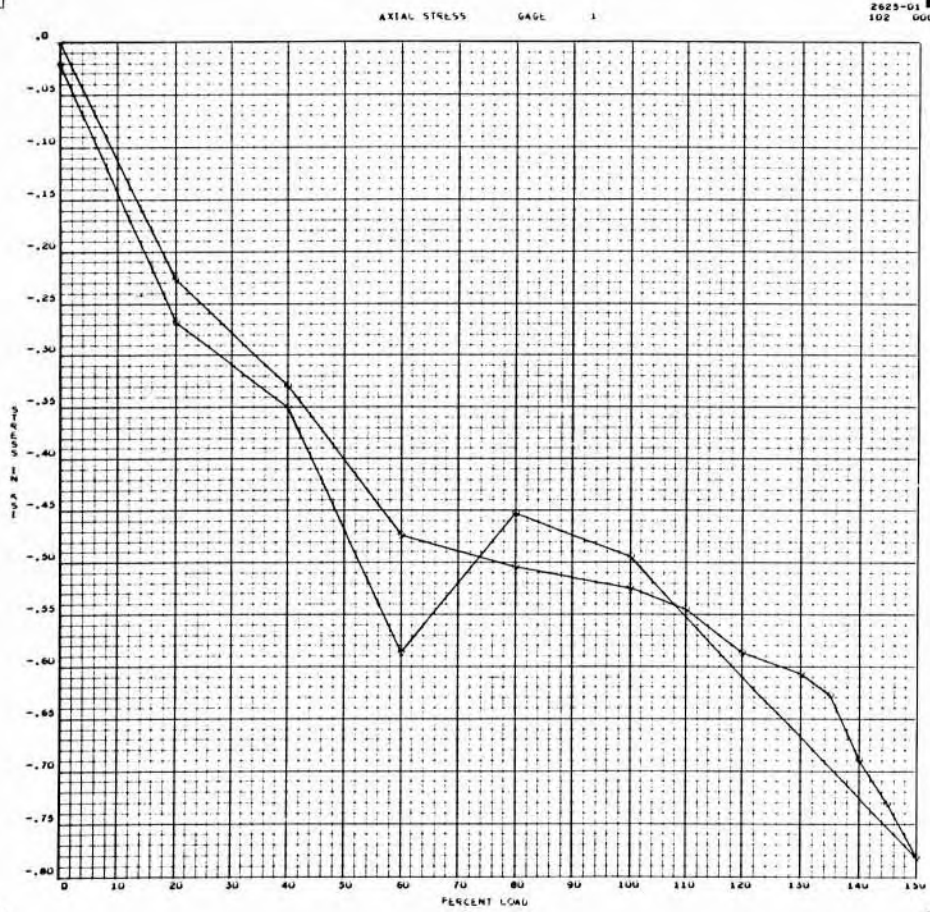
SID 67-317



A-96

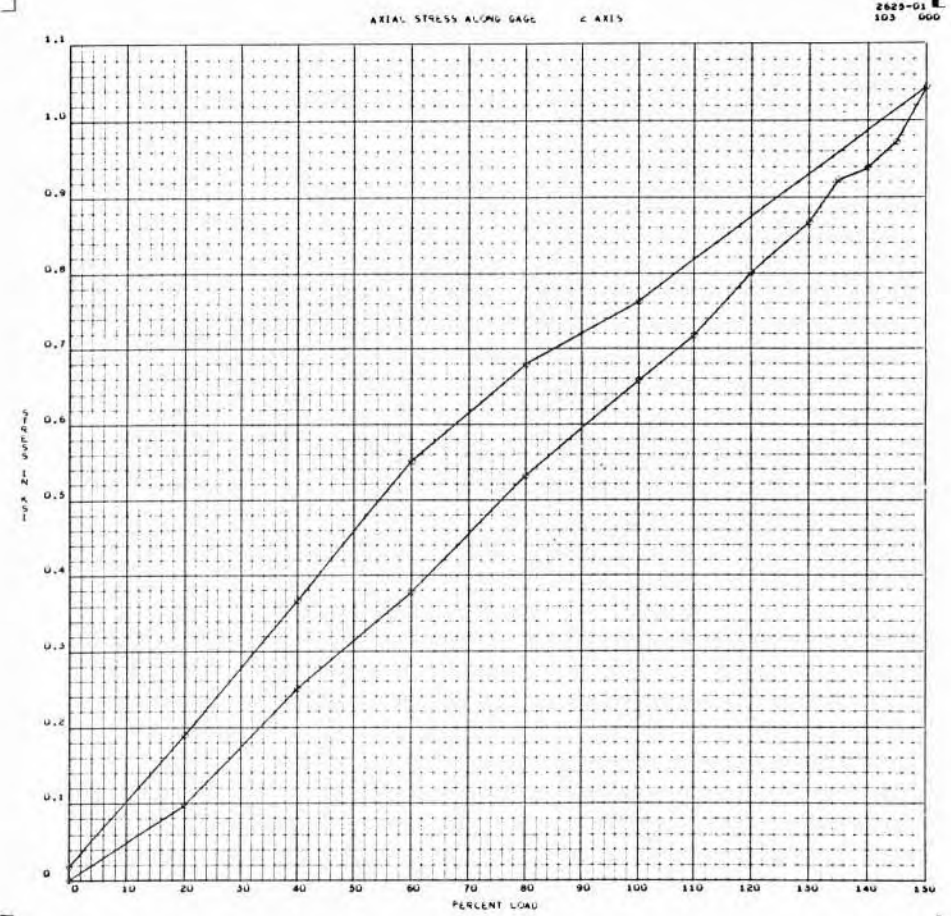
SID 67-317





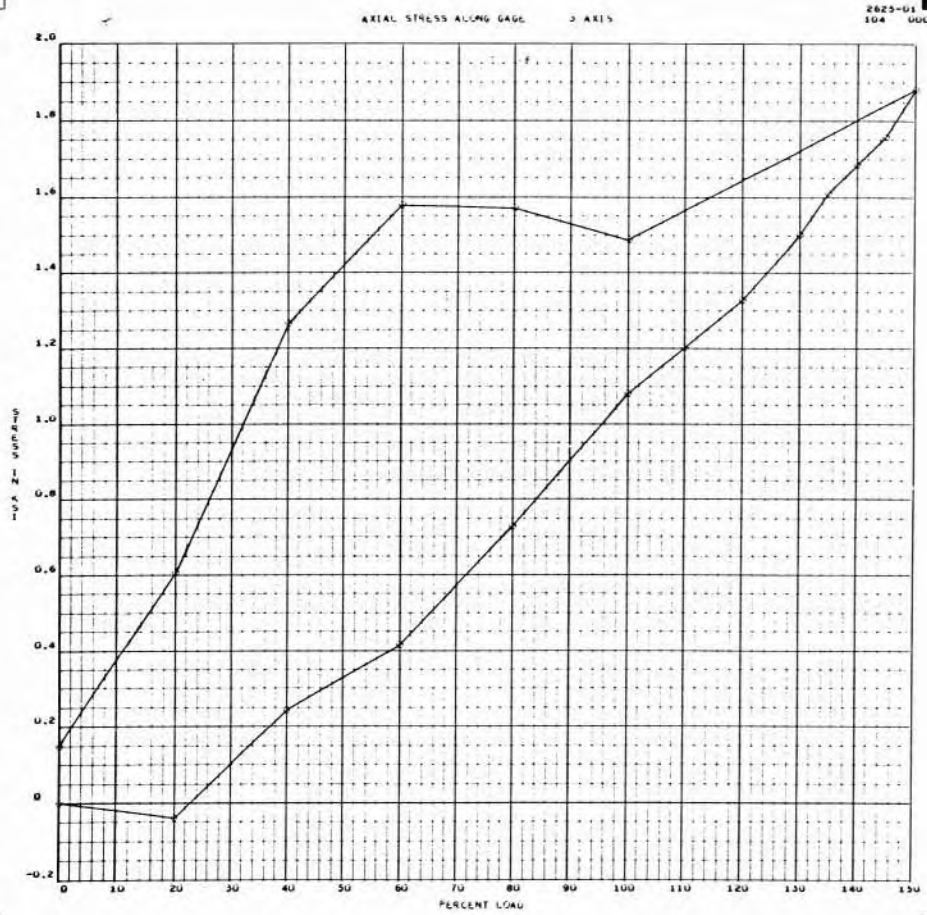
A-97

SID 67-317



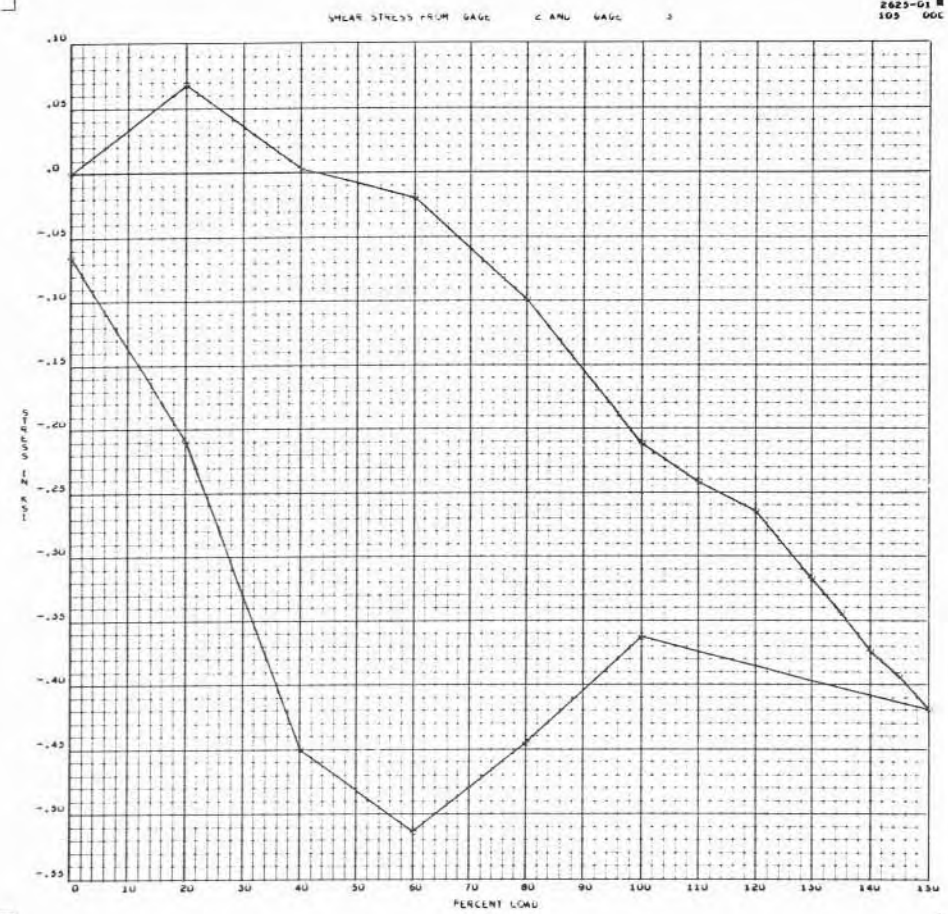
A-98

SID 67-317



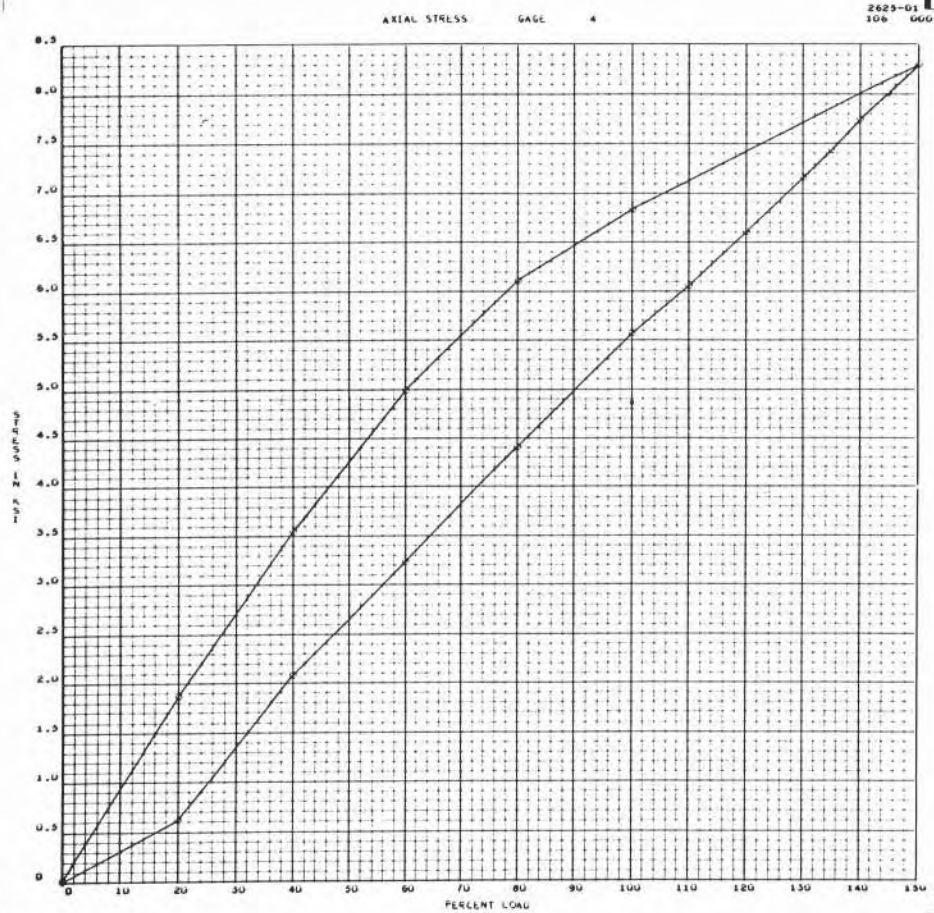
A-99

SID 67-317



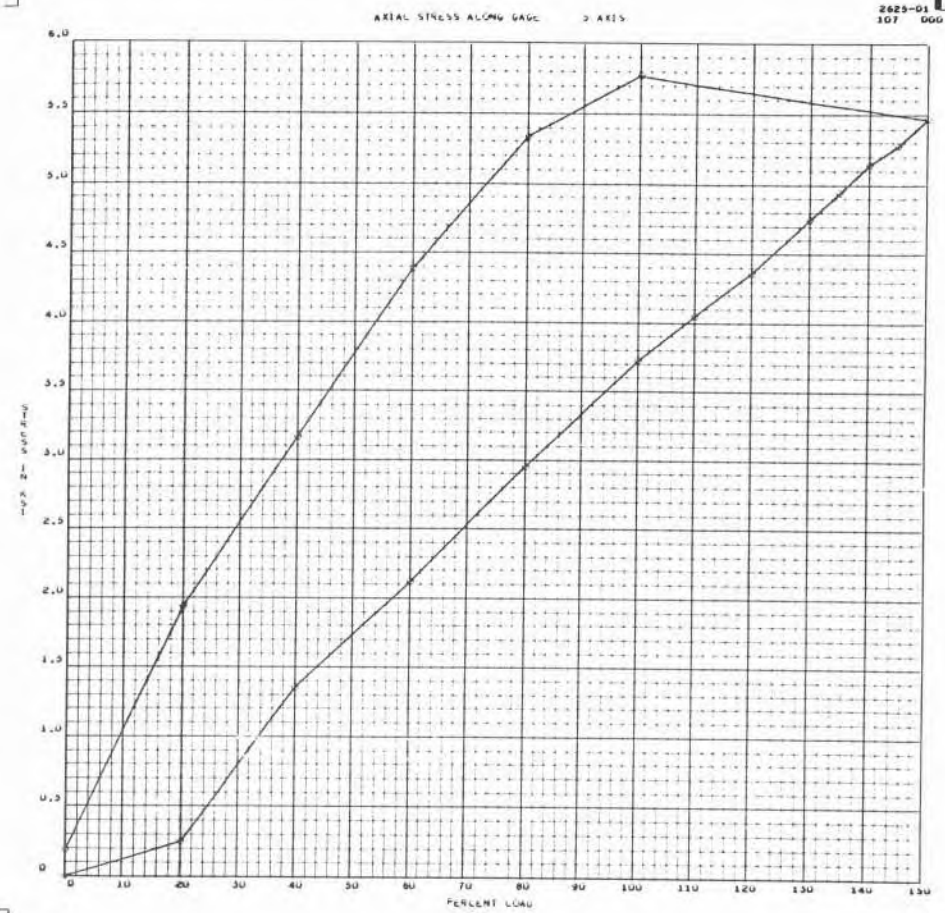
A-100

SID 67-317



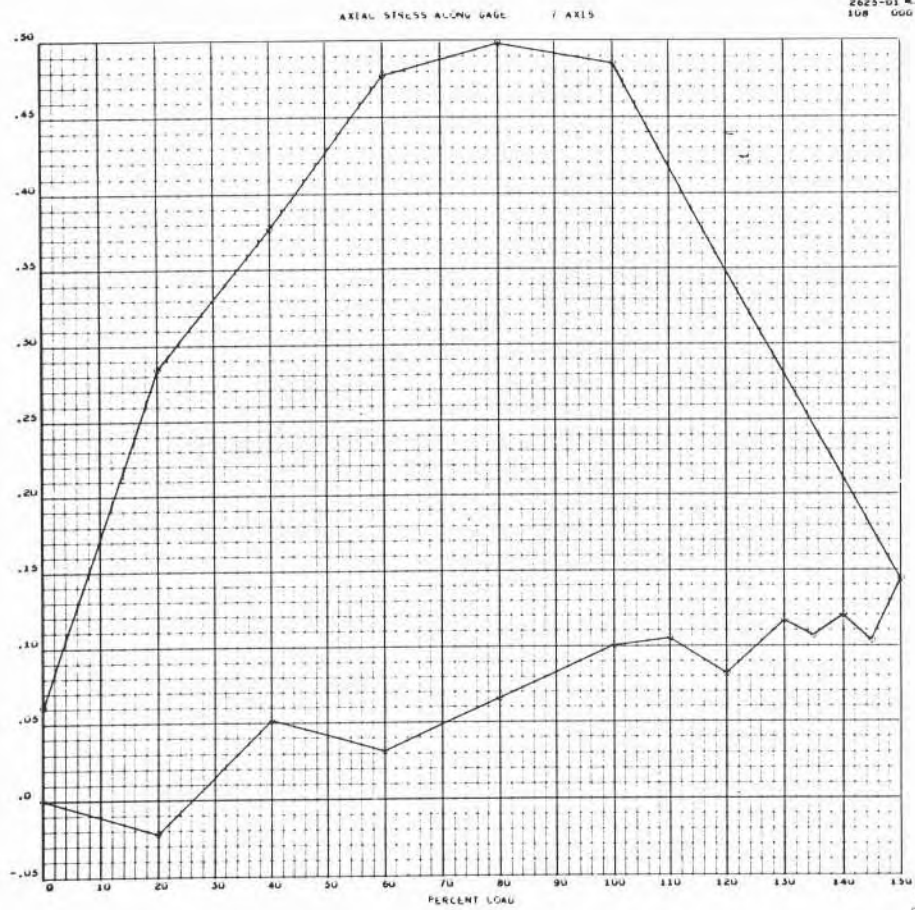
A-101

SID 67-317



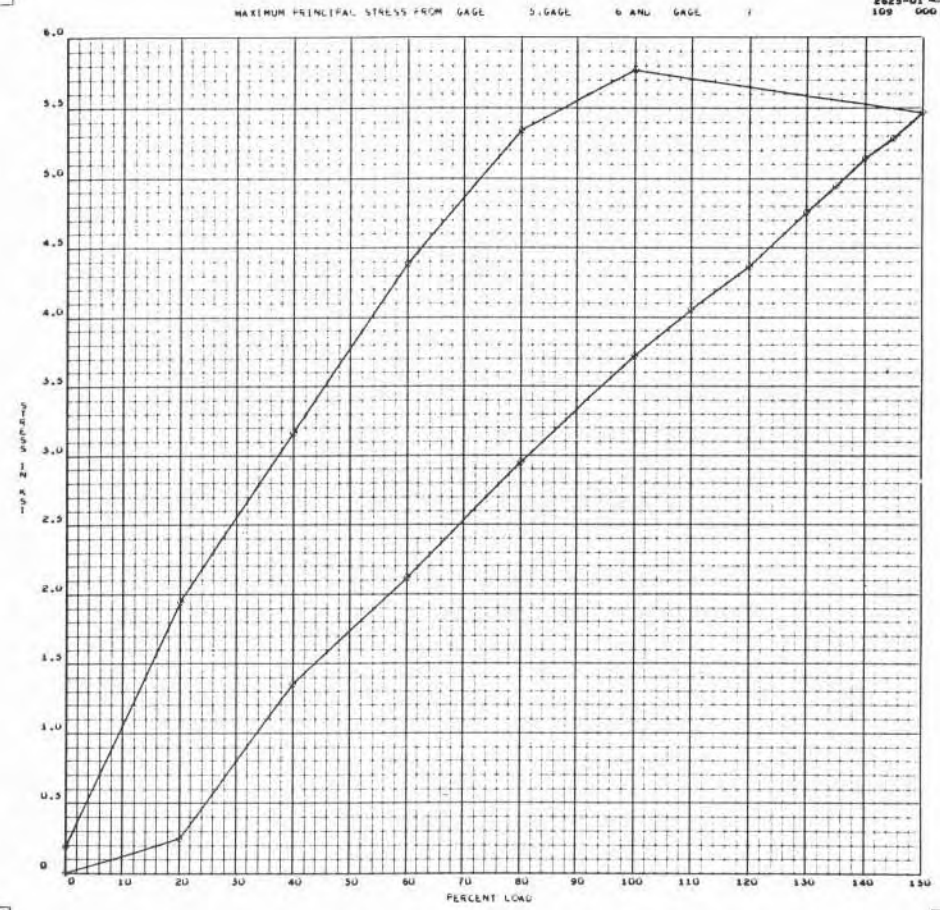
A-102

SID 67-317



A-103

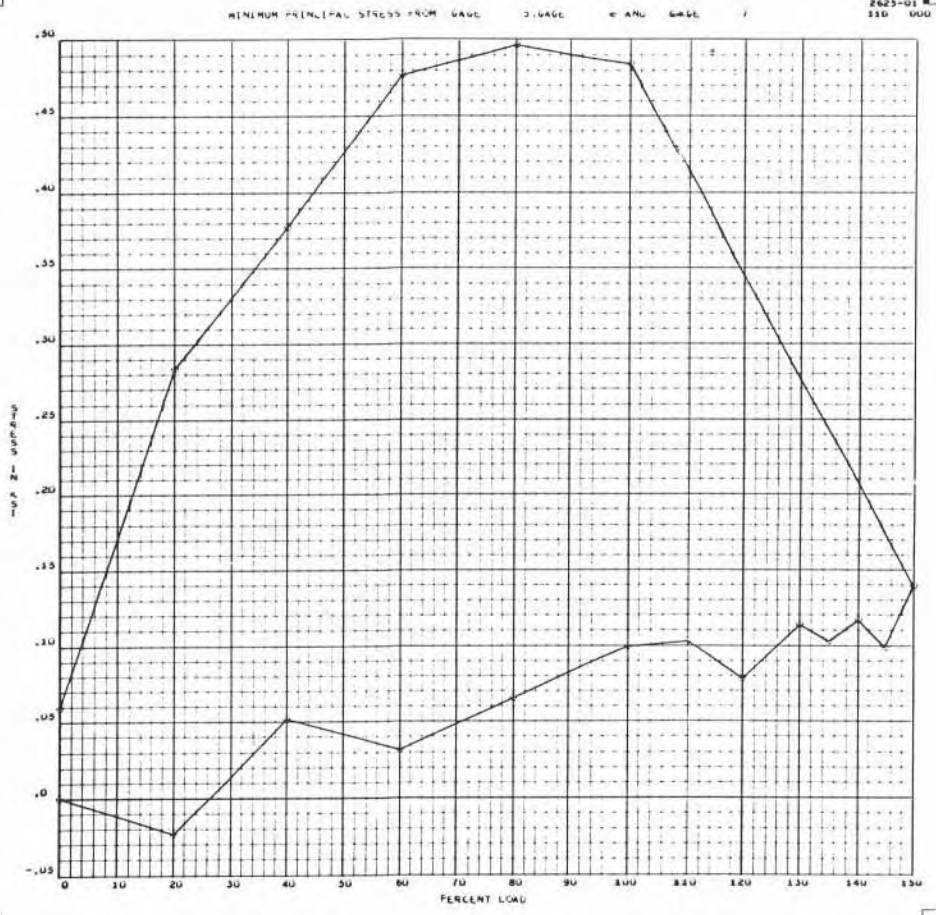
SID 67-317



A-104

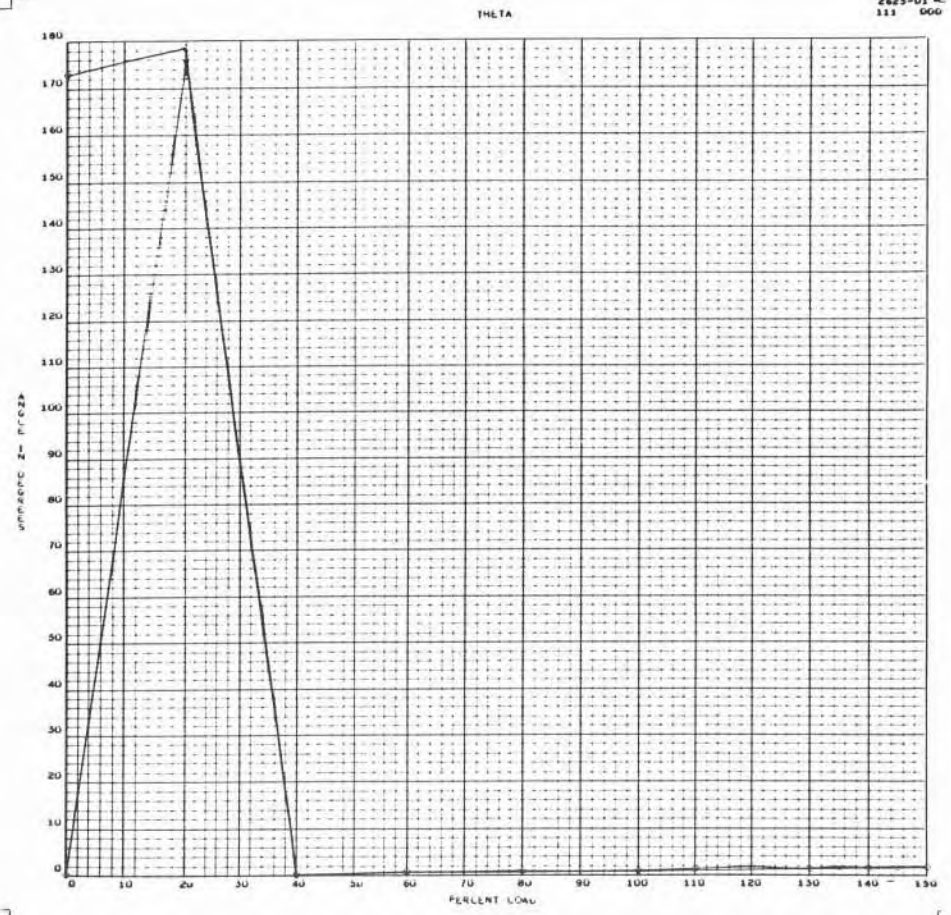
SID 67-317





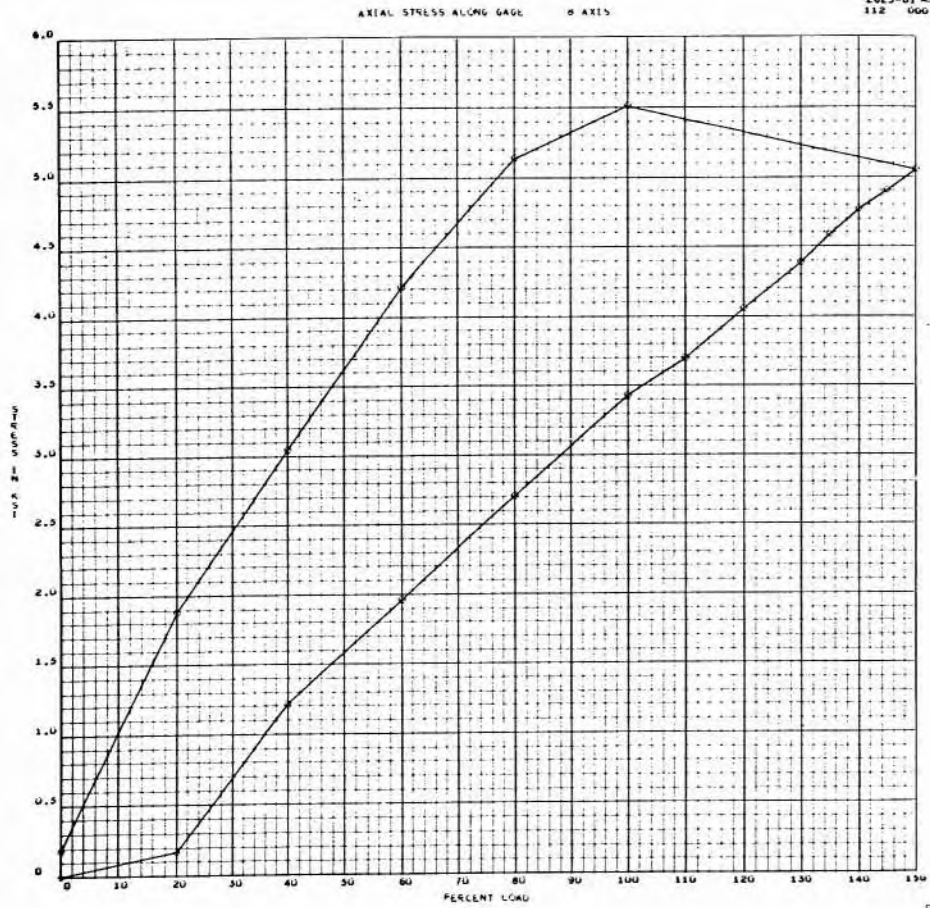
A-105

SID 67-317



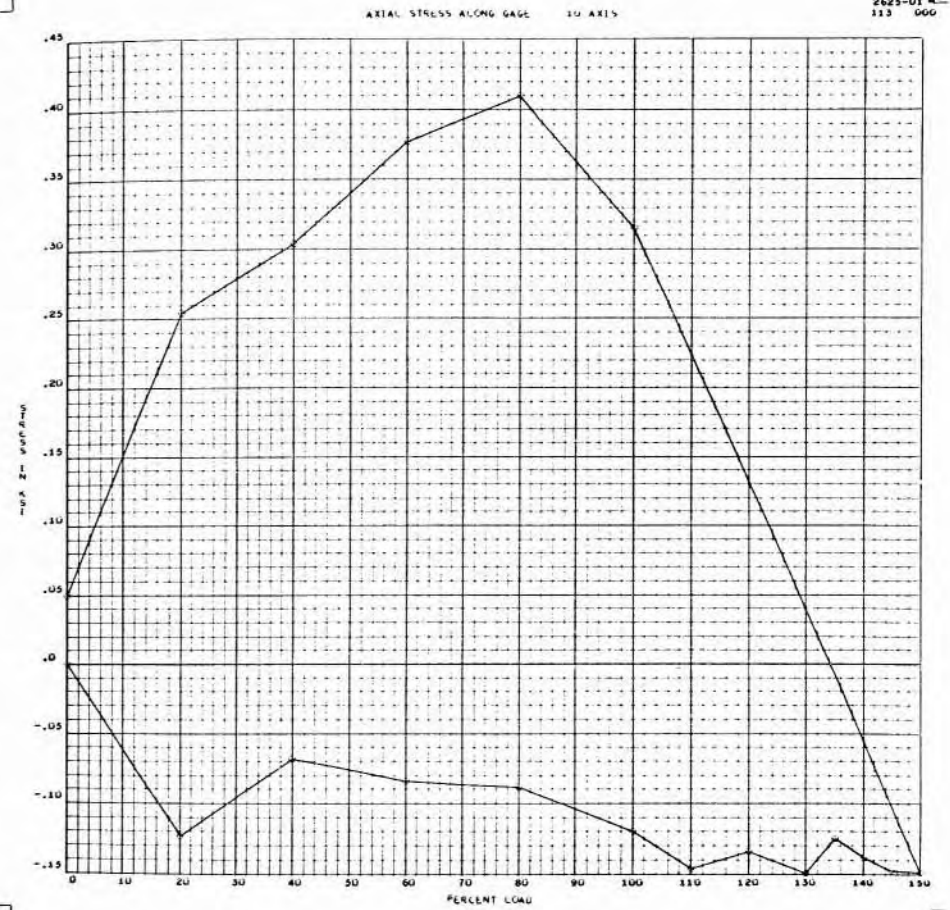
A-106

SID 67-317



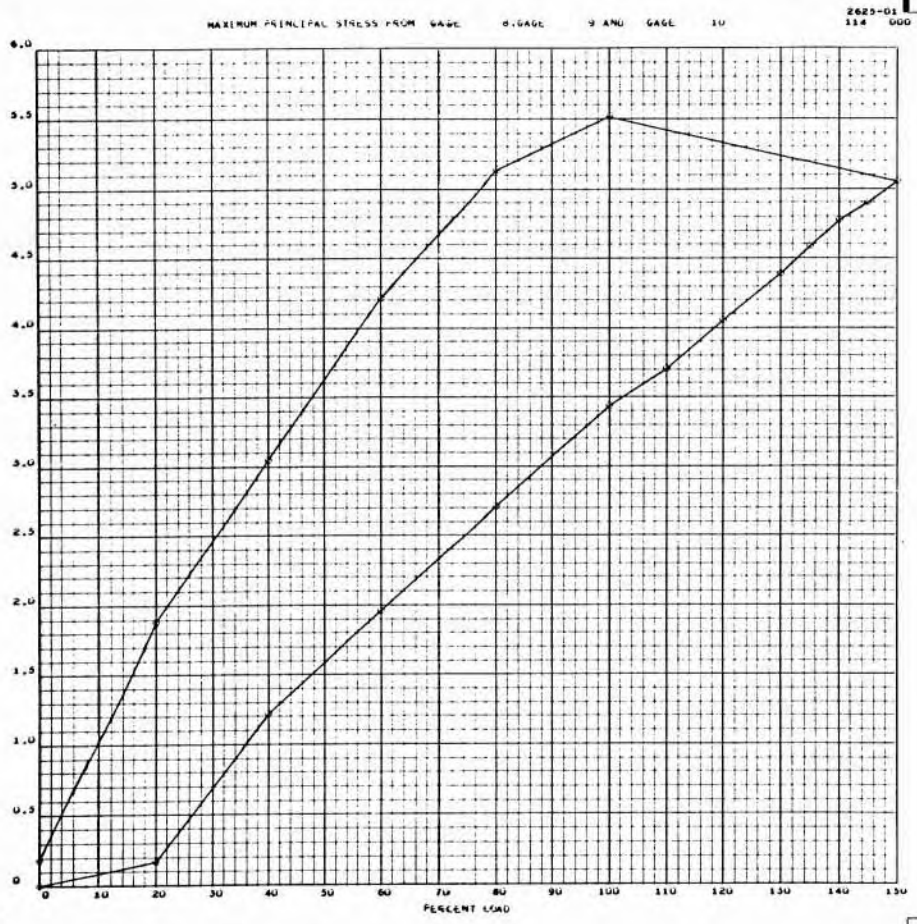
A-107

SID 67-317



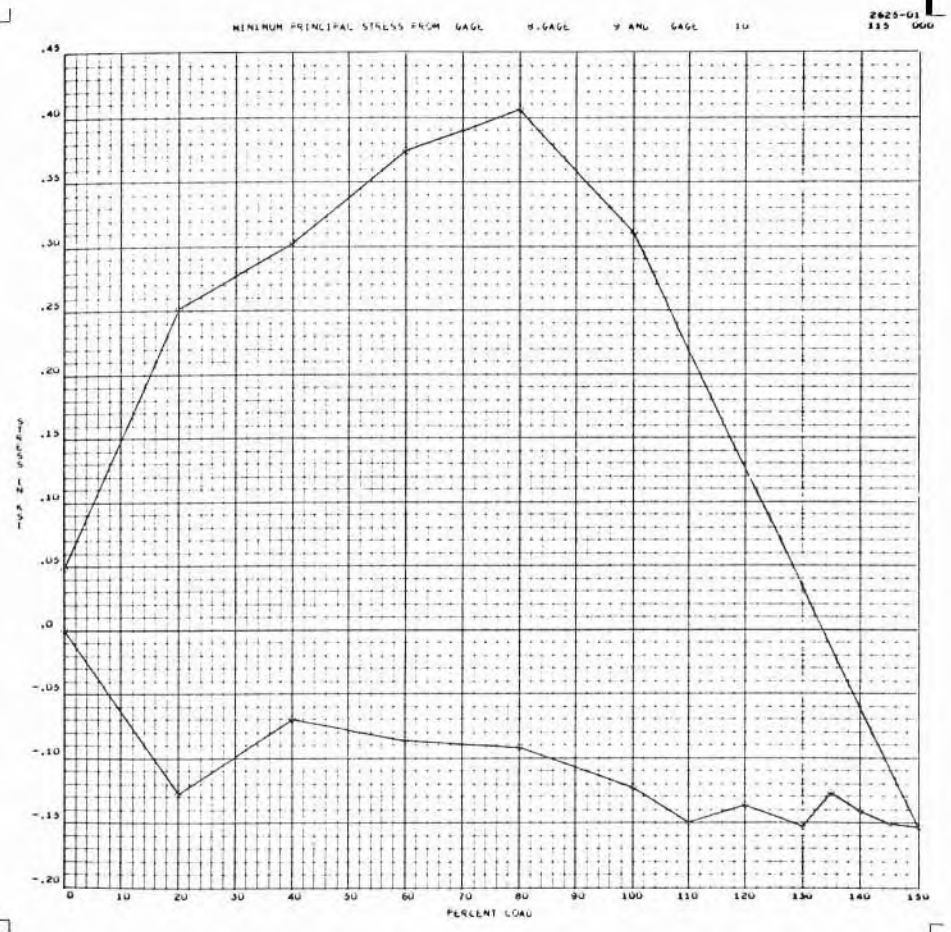
A-108

SID 67-317



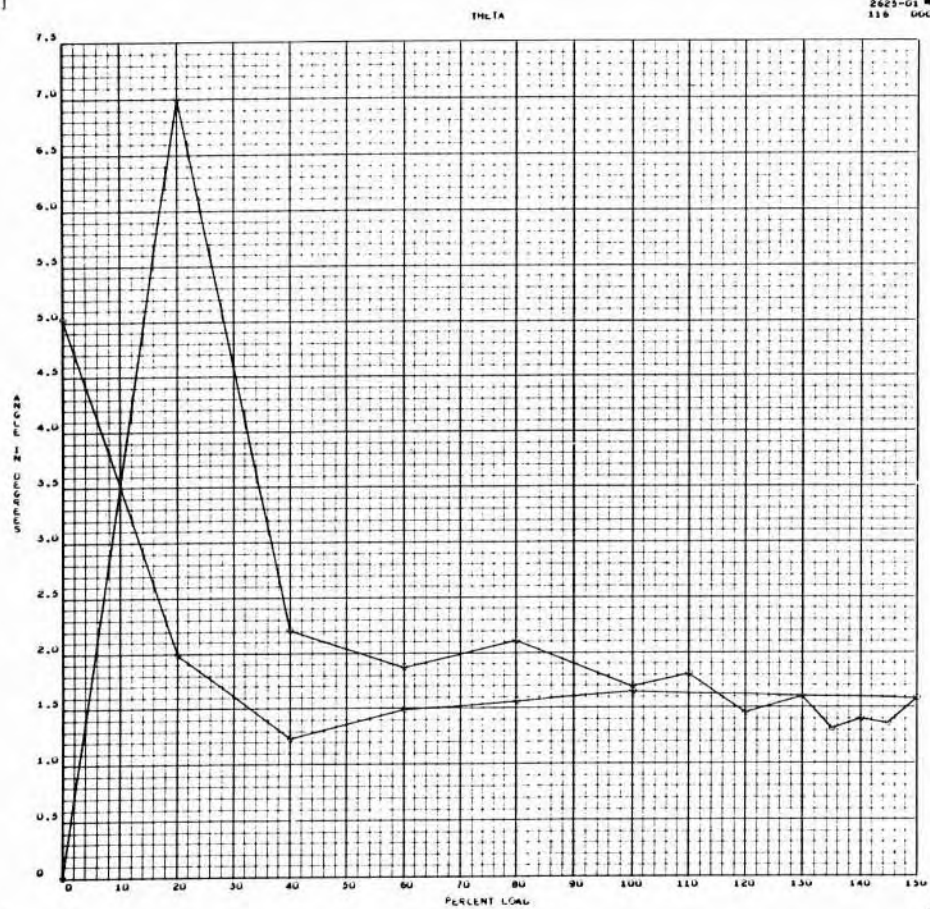
A-109

SID 67-317



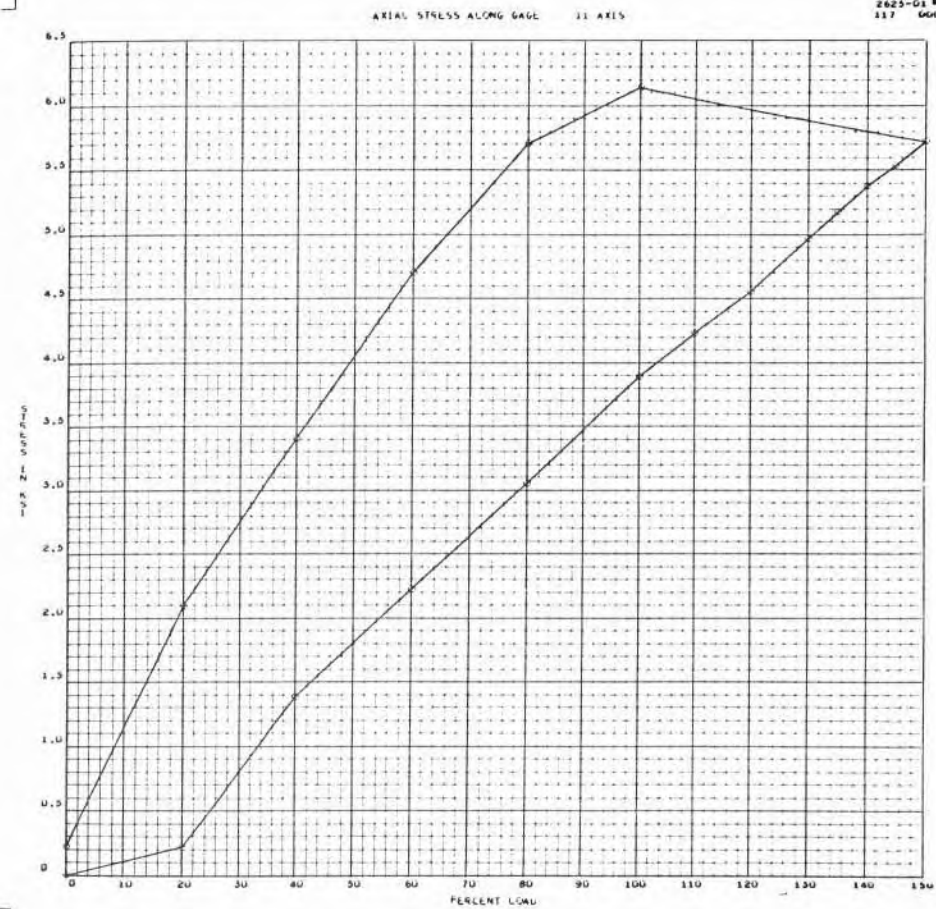
A-110

SID 67-317



A-111

SID 67-317



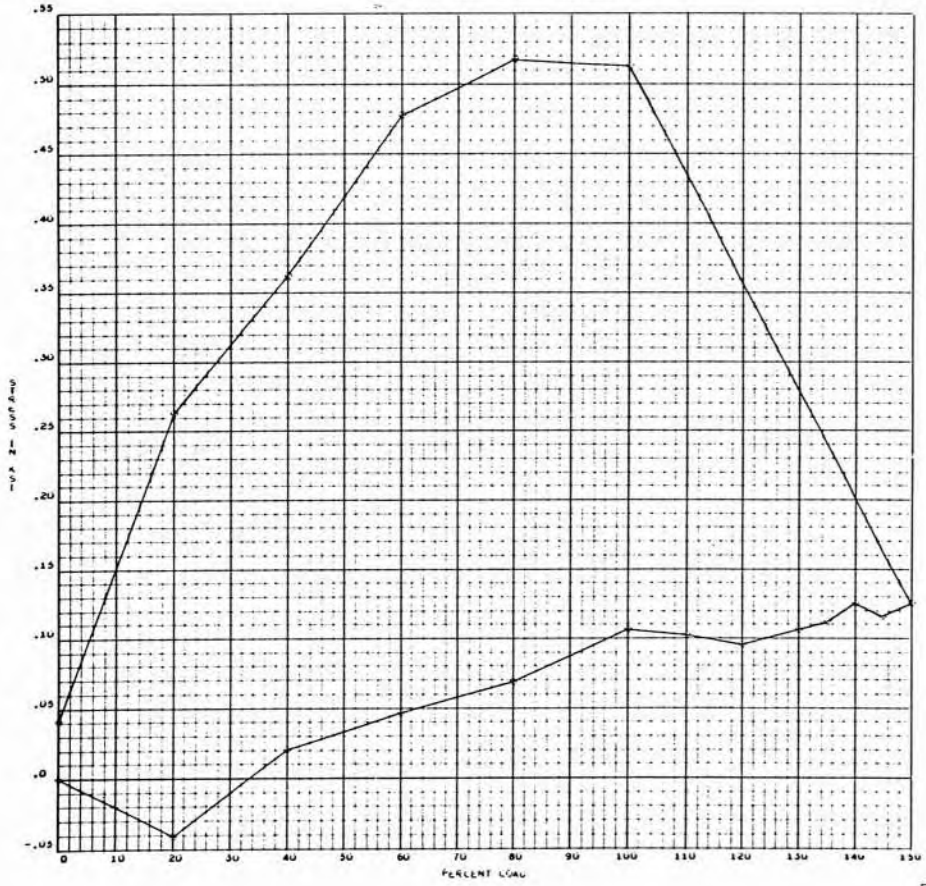
A-112

SID 67-317



2623-D1  
118 000

AXIAL STRESS ALONG GAGE 1,2 AXIS

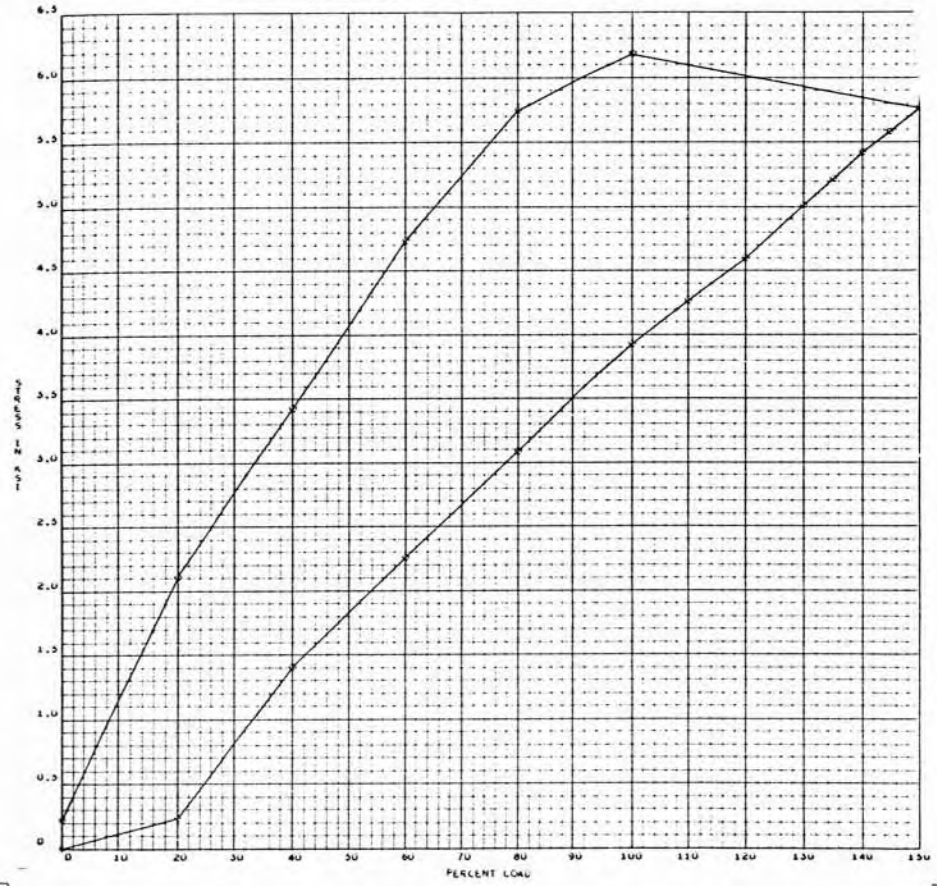


A-113

SID 67-317

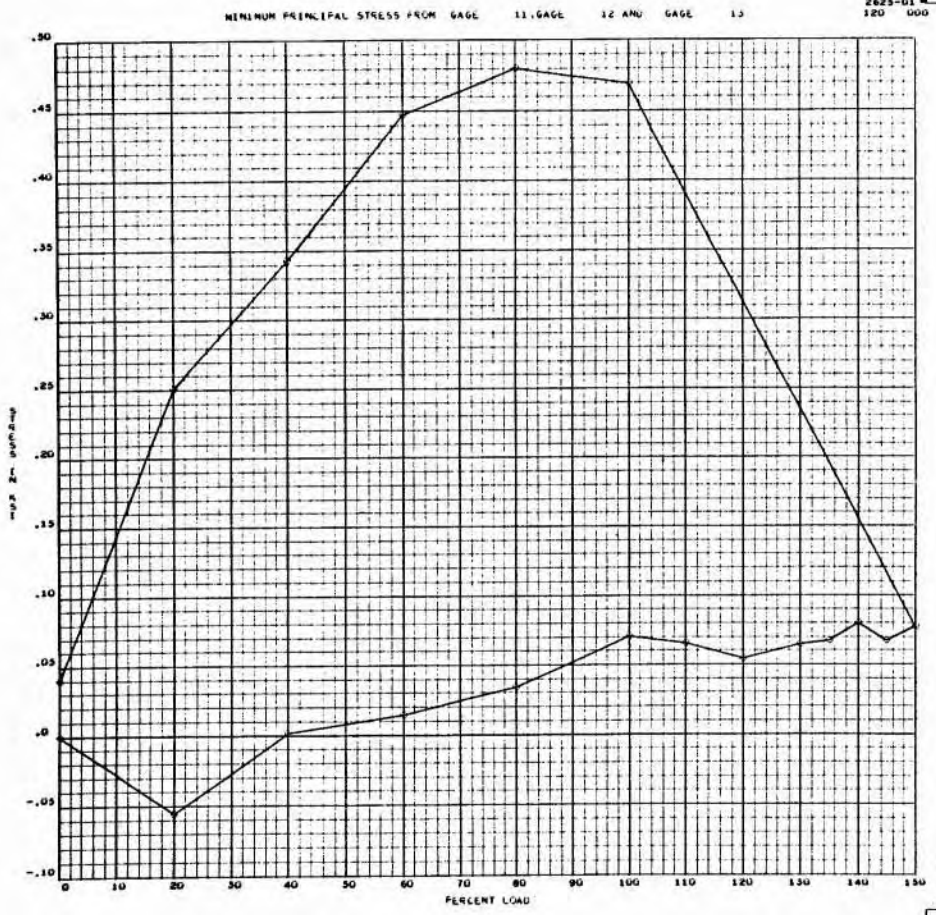
MAXIMUM PRINCIPAL STRESS FROM GAGE 11, GAGE 12 AND GAGE 13

2623-C  
119



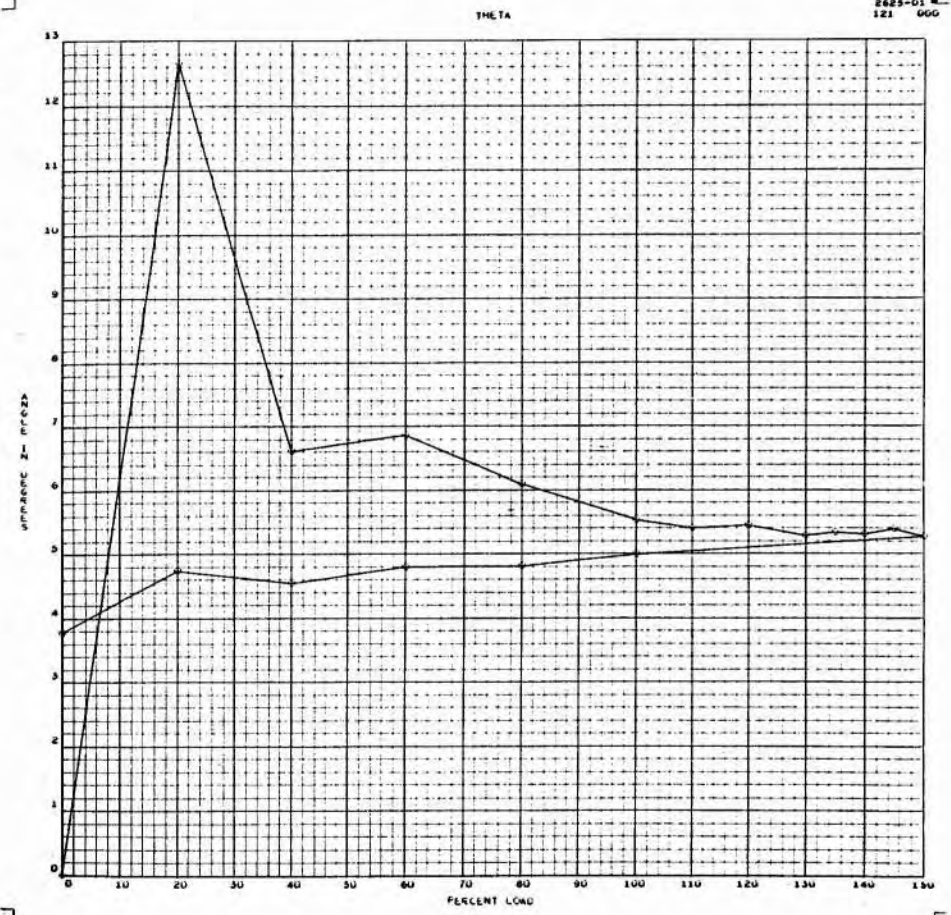
A-114

SID 67-317



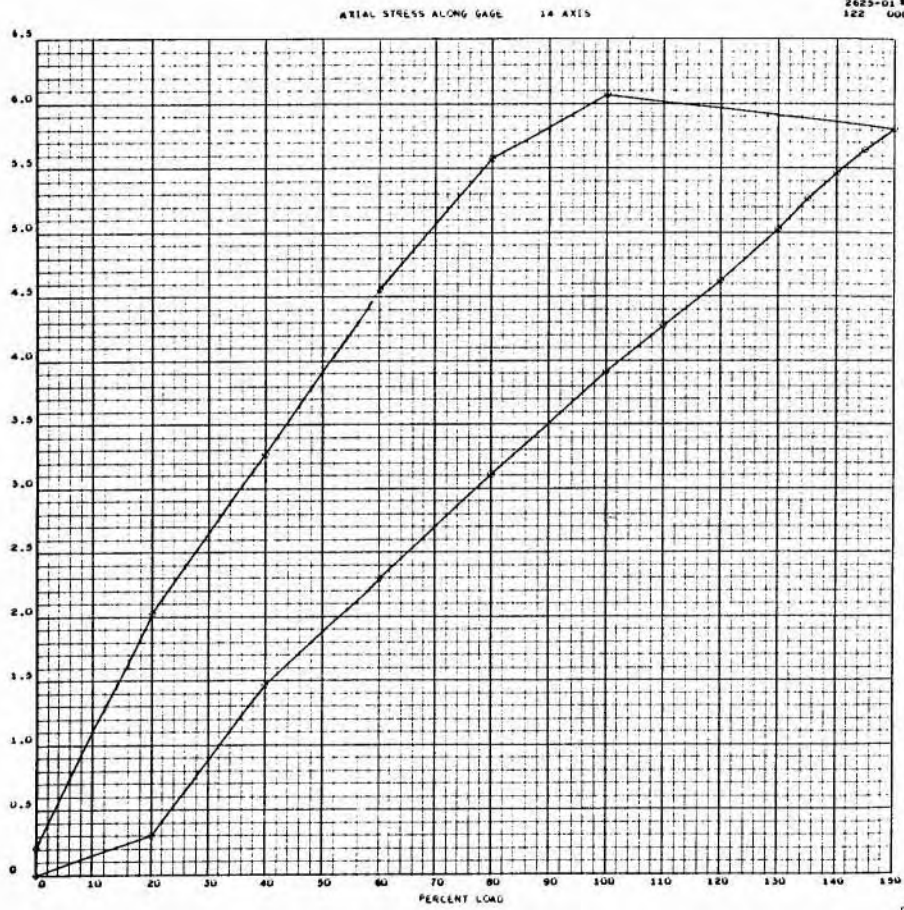
A-115

SID 67-317



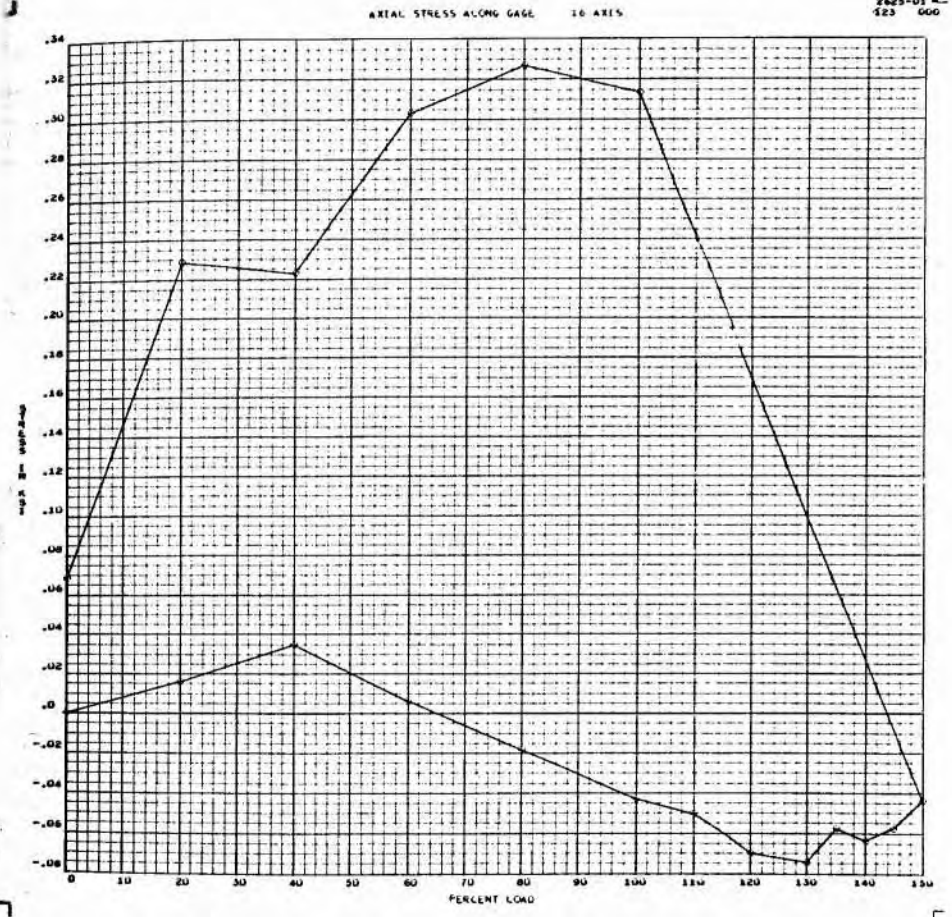
A-116

SID 67-317



A-117

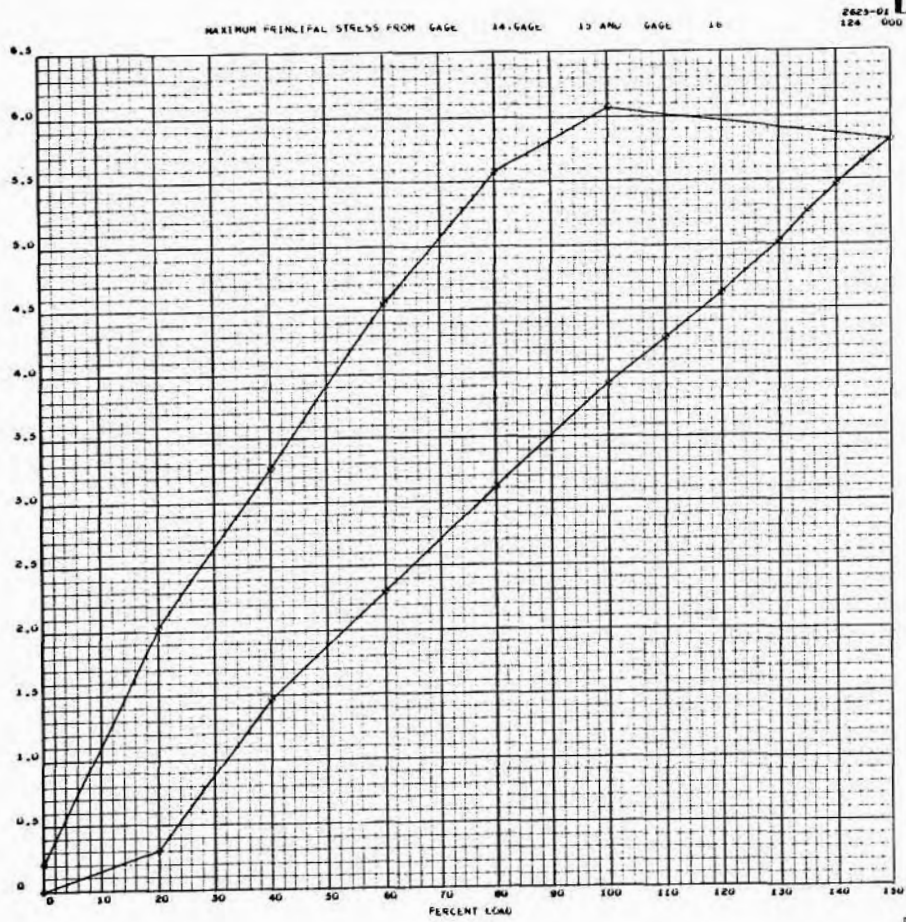
SID 67-317



A-118

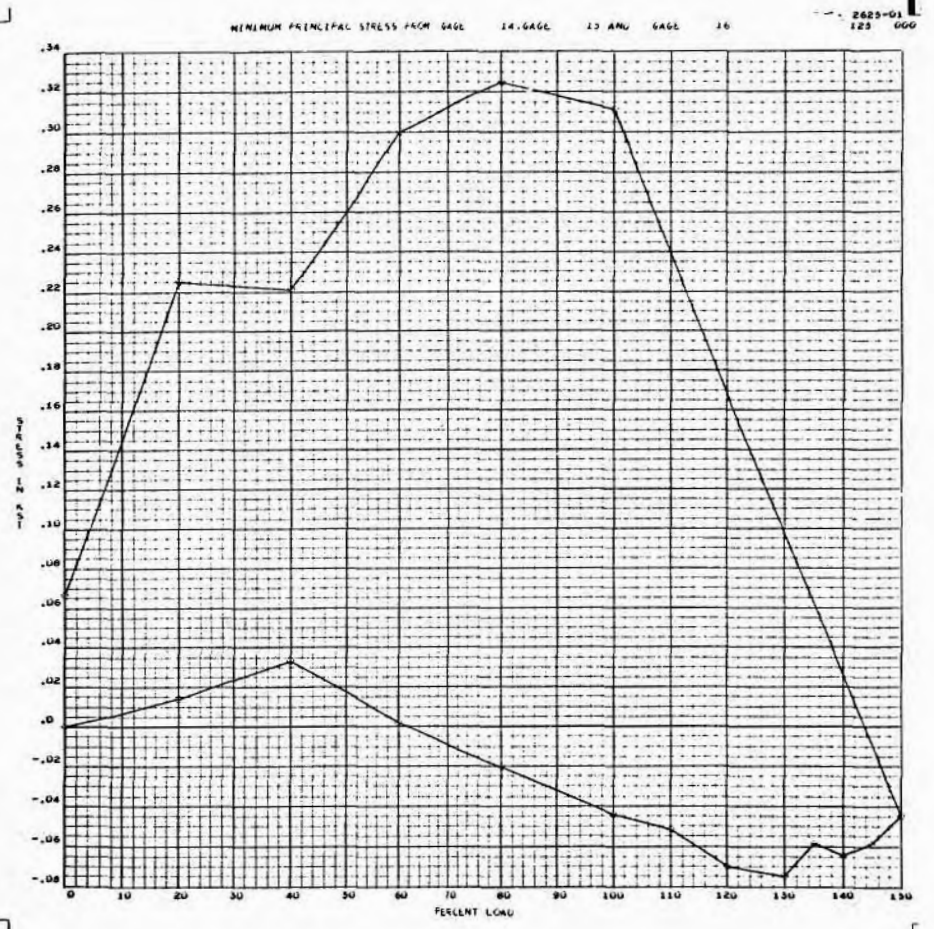
SID 67-317





A-119

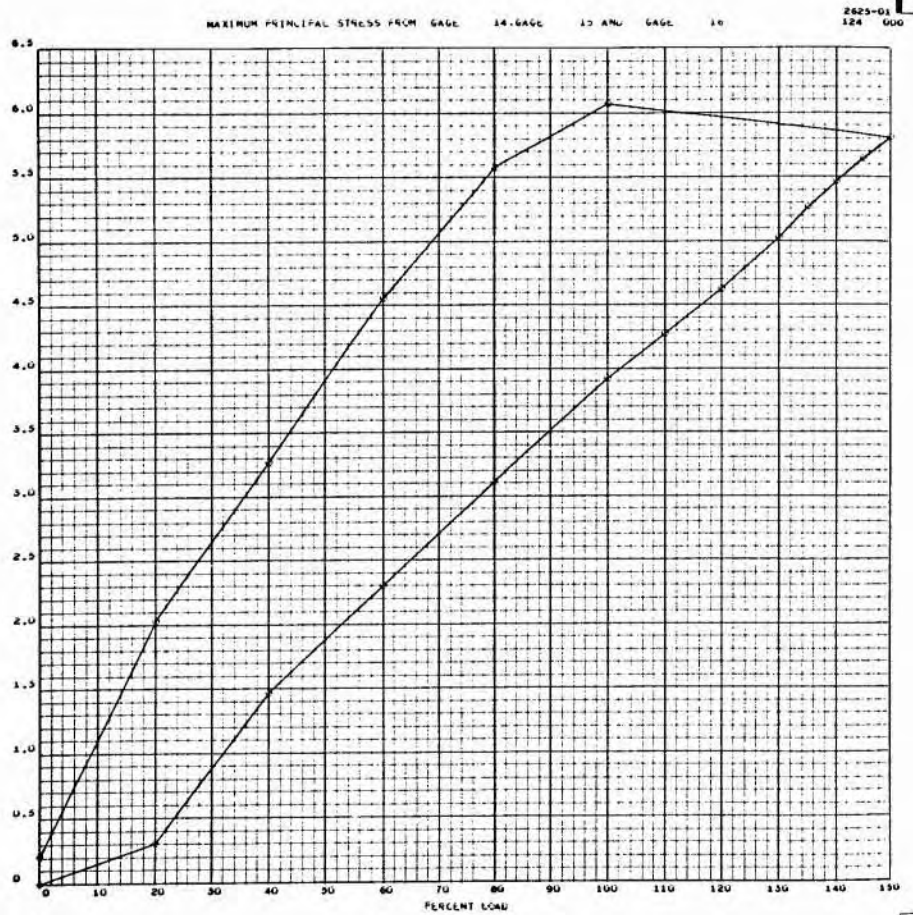
SID 67-317



A-120

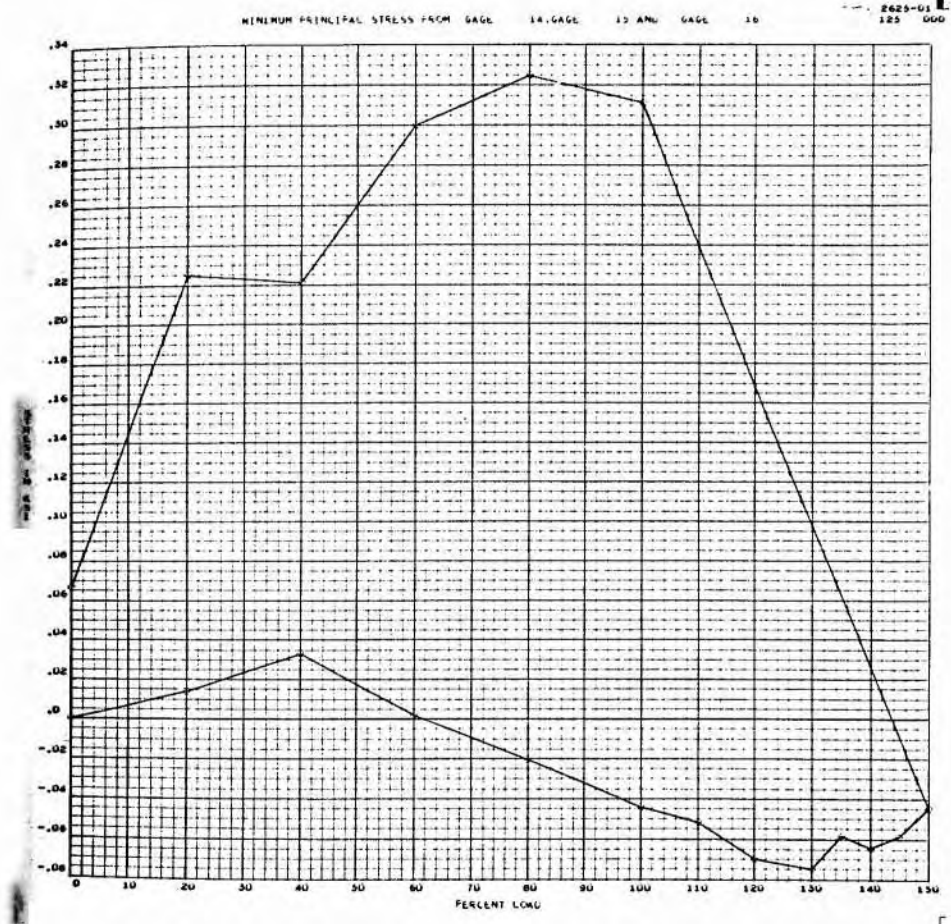
SID 67-317





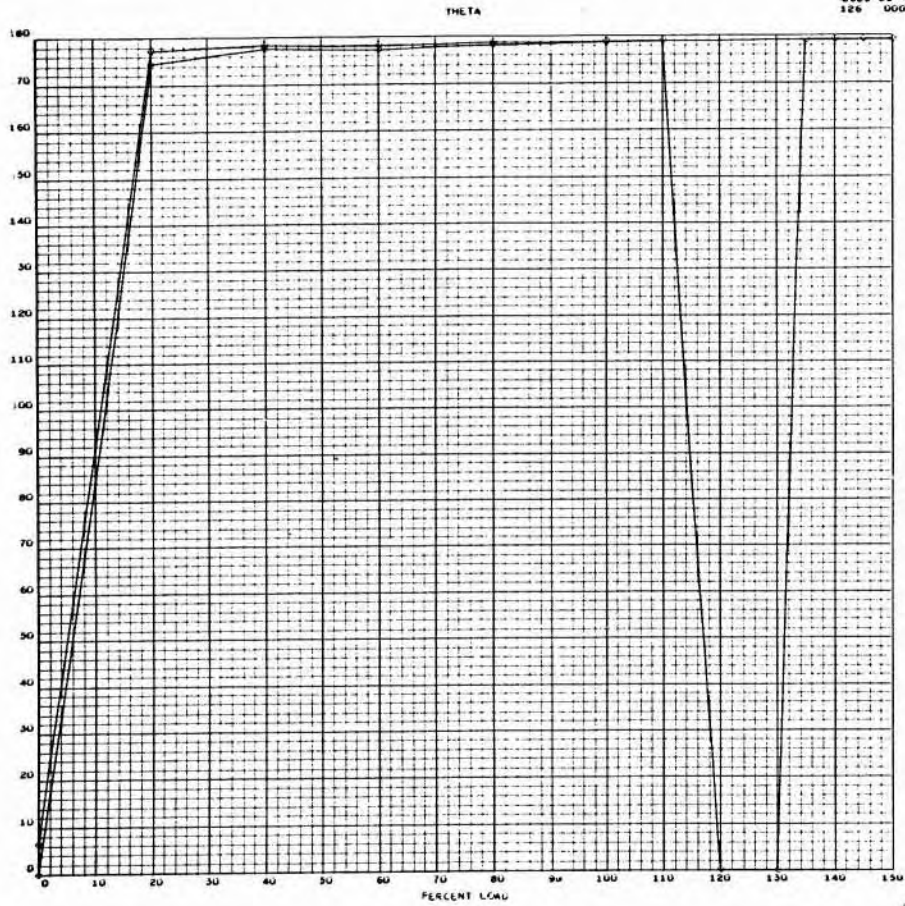
A-119

SID 67-317



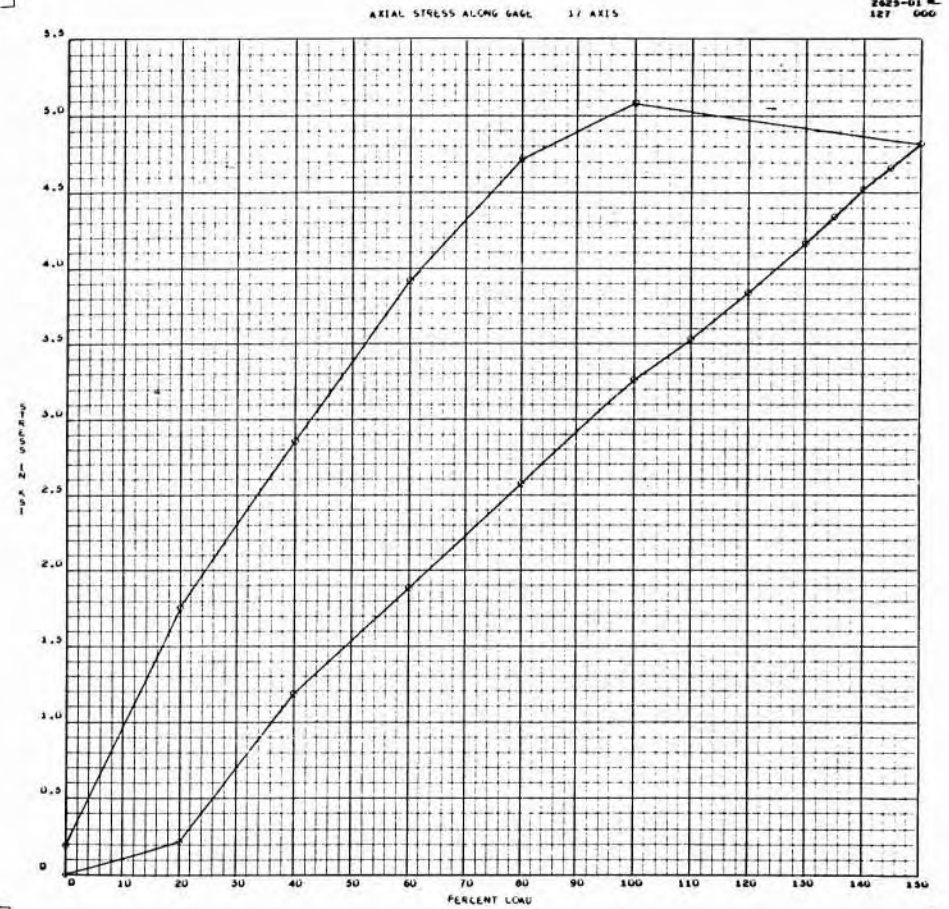
A-120

SID 67-317



A-121

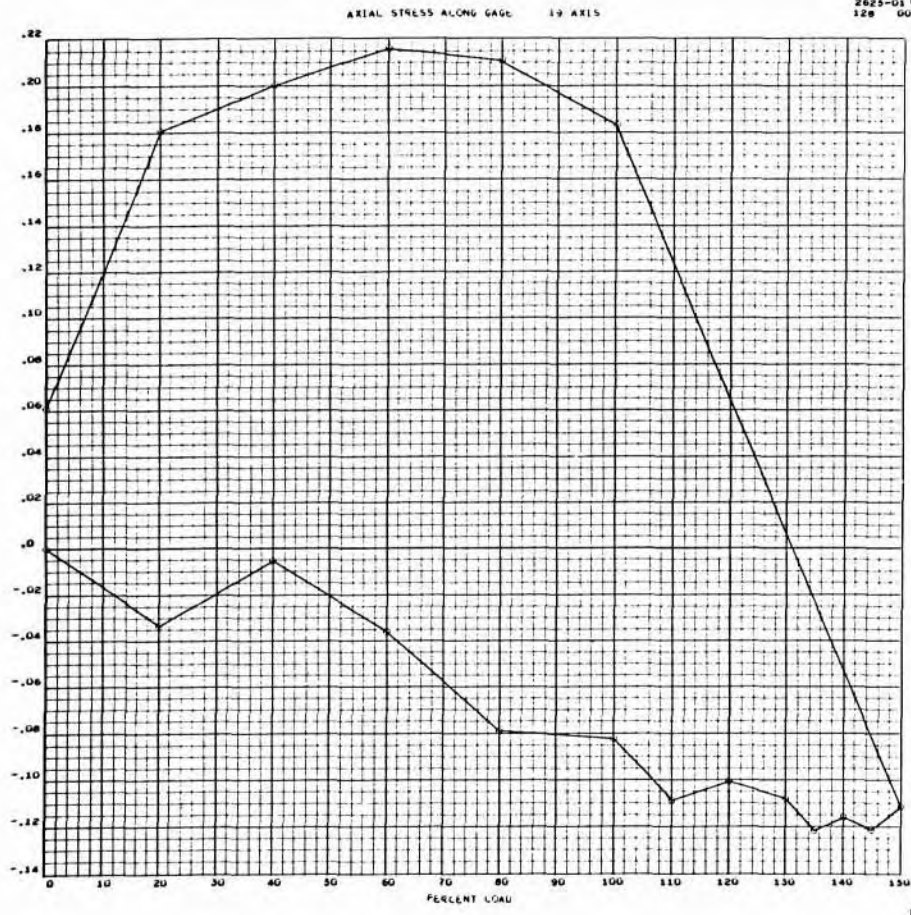
SID 67-317



A-122

SID 67-317

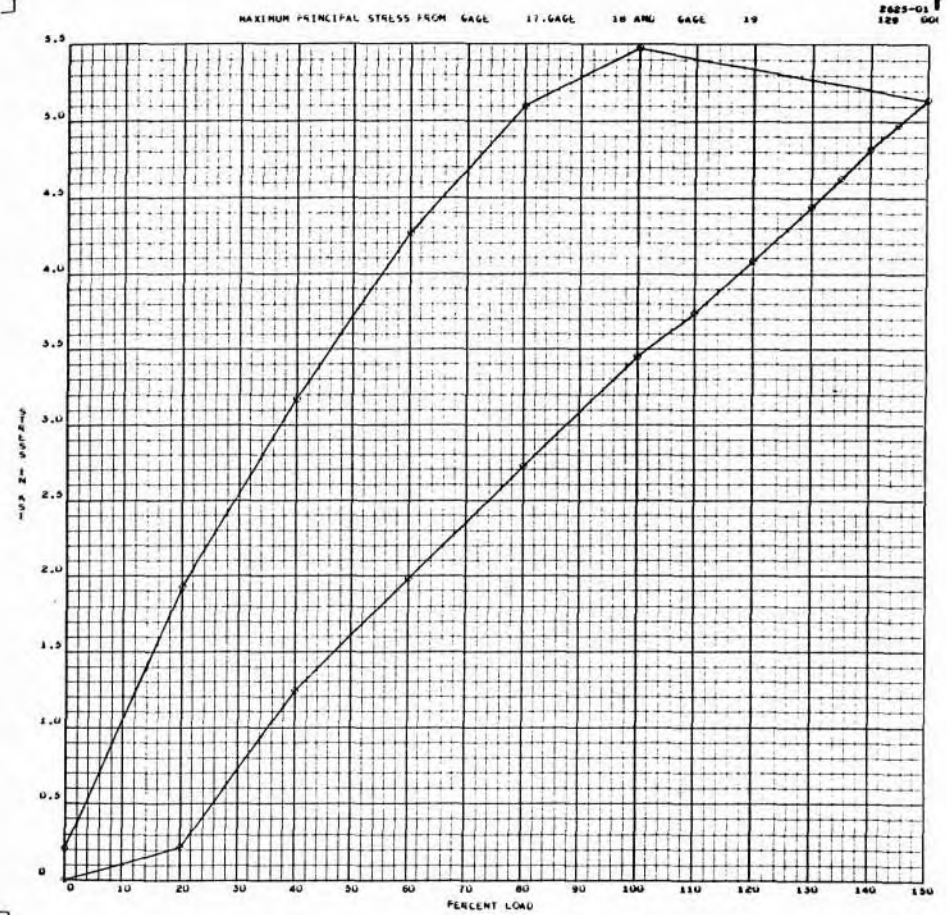
2623-01  
129 000



A-123

SID 67-317

2623-01  
129 001



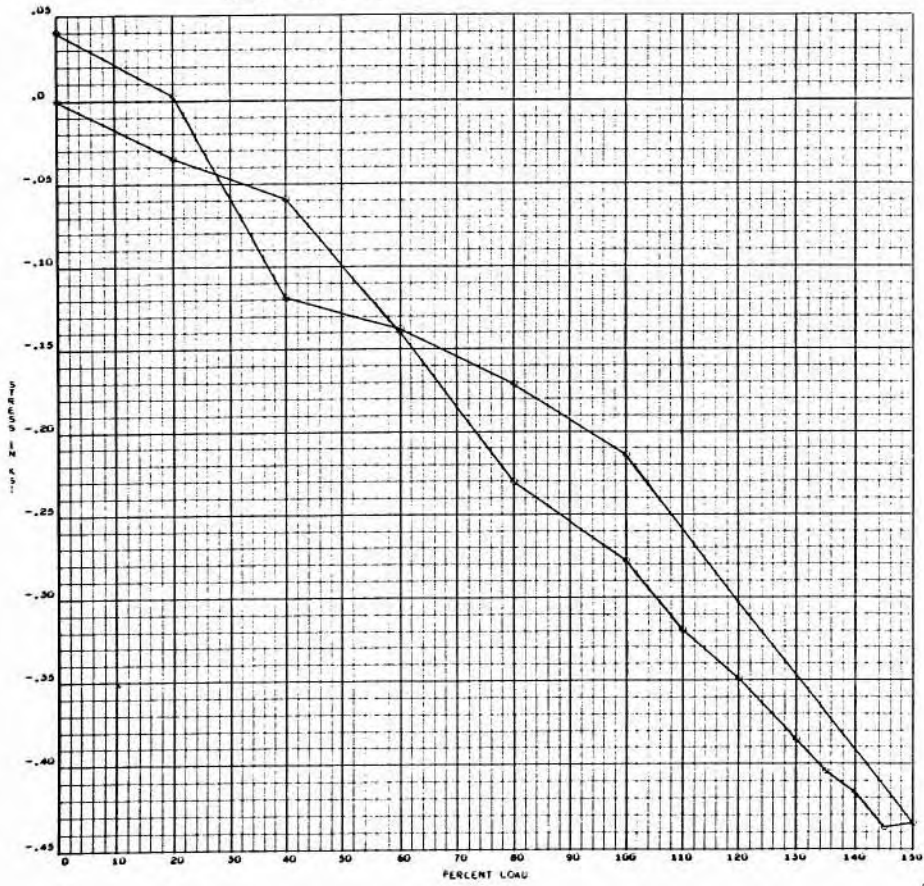
A-124

SID 67-317



MINIMUM PRINCIPAL STRESS FROM GAGE 17, GAGE 18 AND GAGE 19

2623-01  
131 000

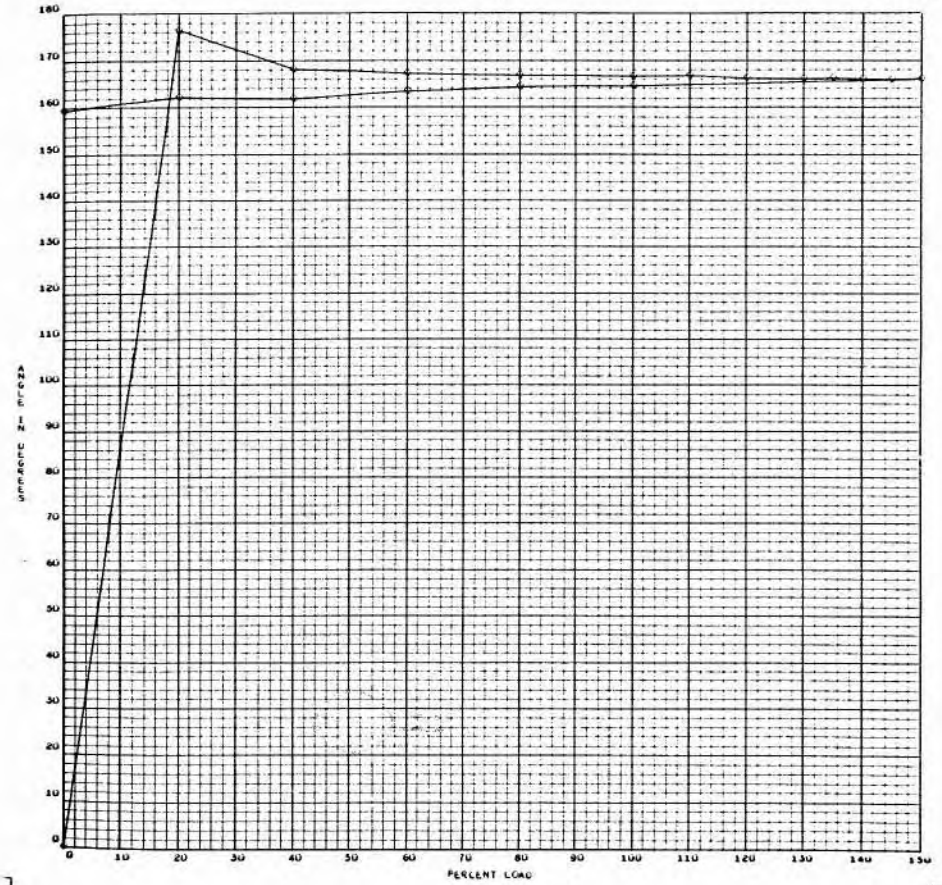


A-125

SID 67-317

THETA

2623-01  
131 000



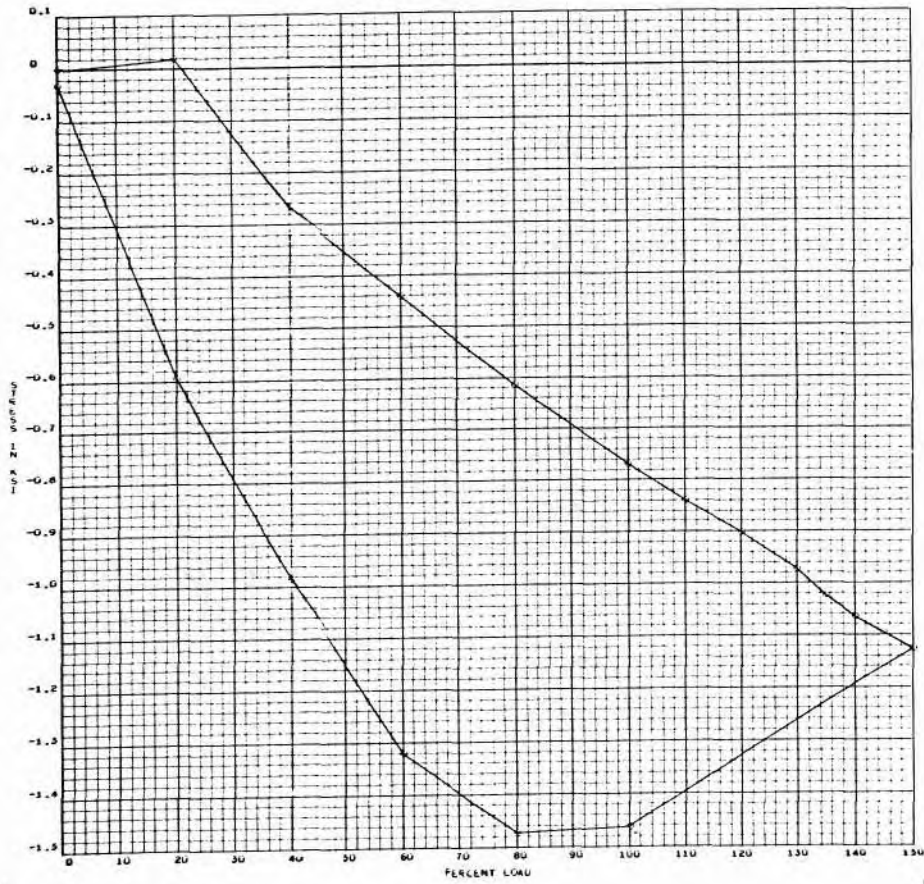
A-126

SID 67-317



AXIAL STRESS GAGE C1

2625-01  
133 000

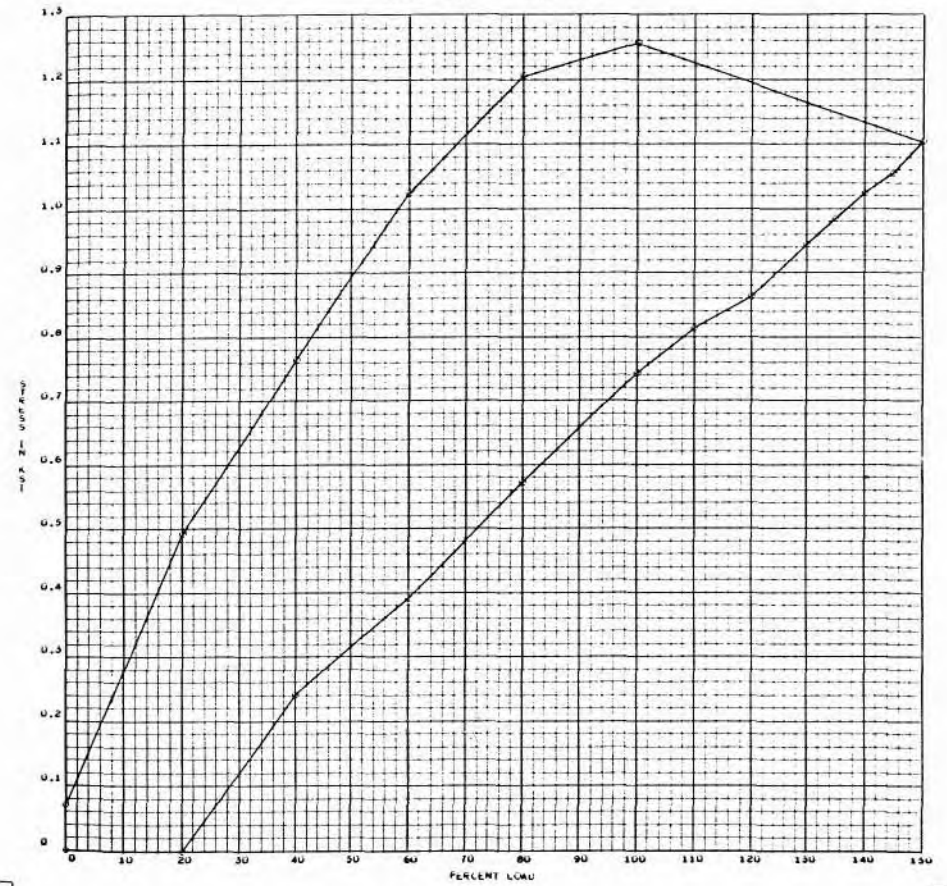


A-127

SID 67-317

AXIAL STRESS GAGE ZC

2625-01  
134 000

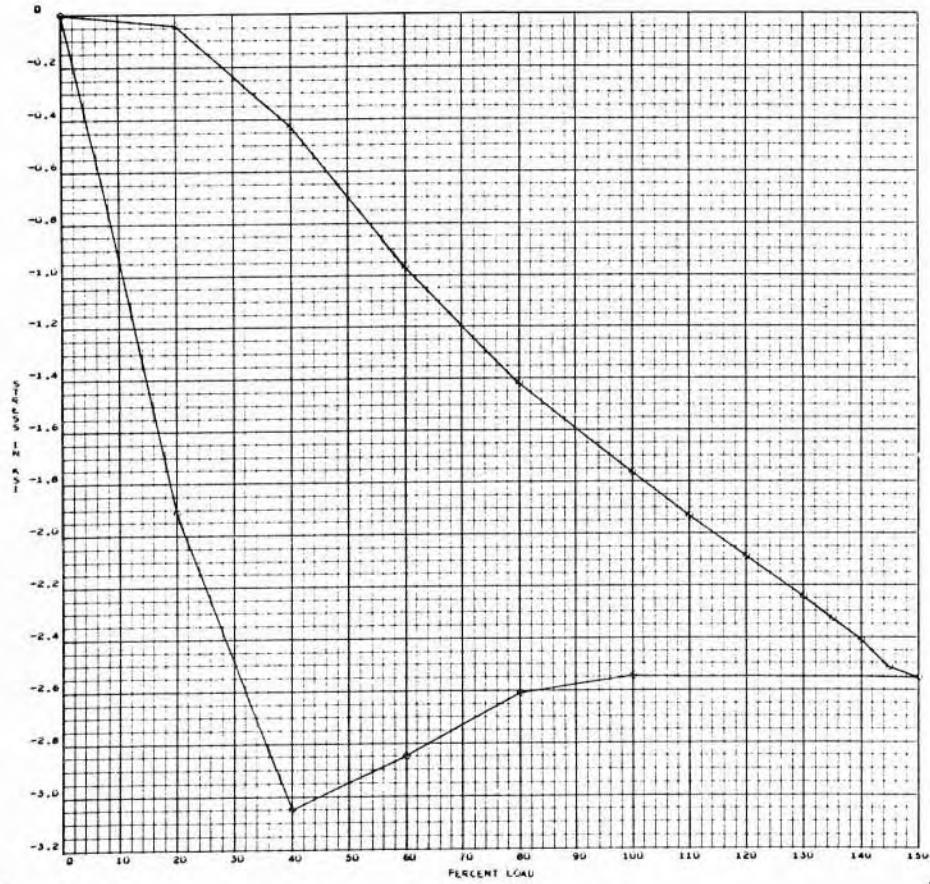


A-128

SID 67-317

AXIAL STRESS GAGE AFA-1

2625-01  
135 000

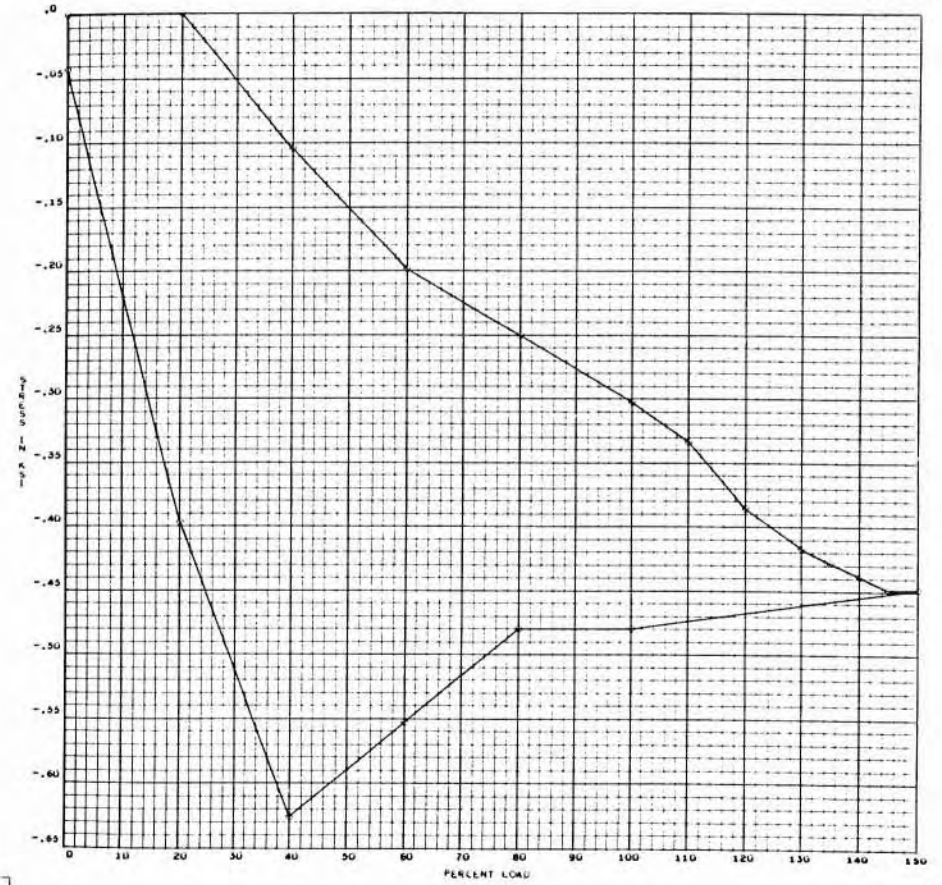


A-129

SID 67-317

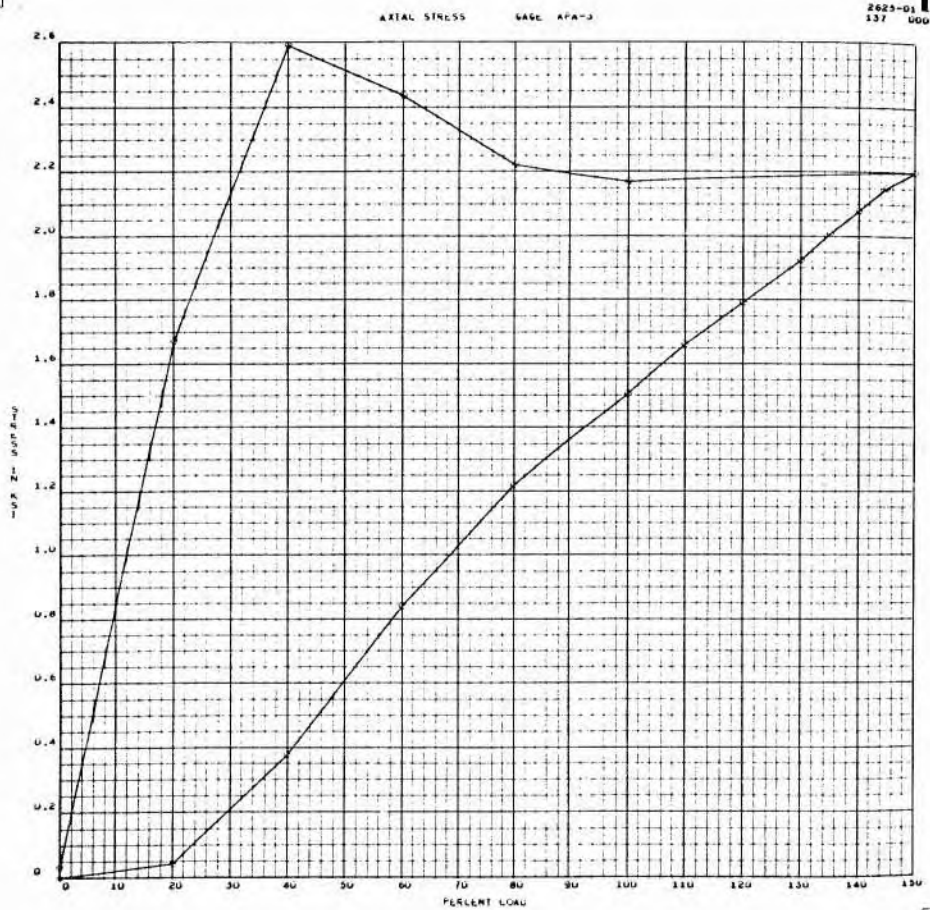
AXIAL STRESS GAGE AFA-2

2625-01  
136 000



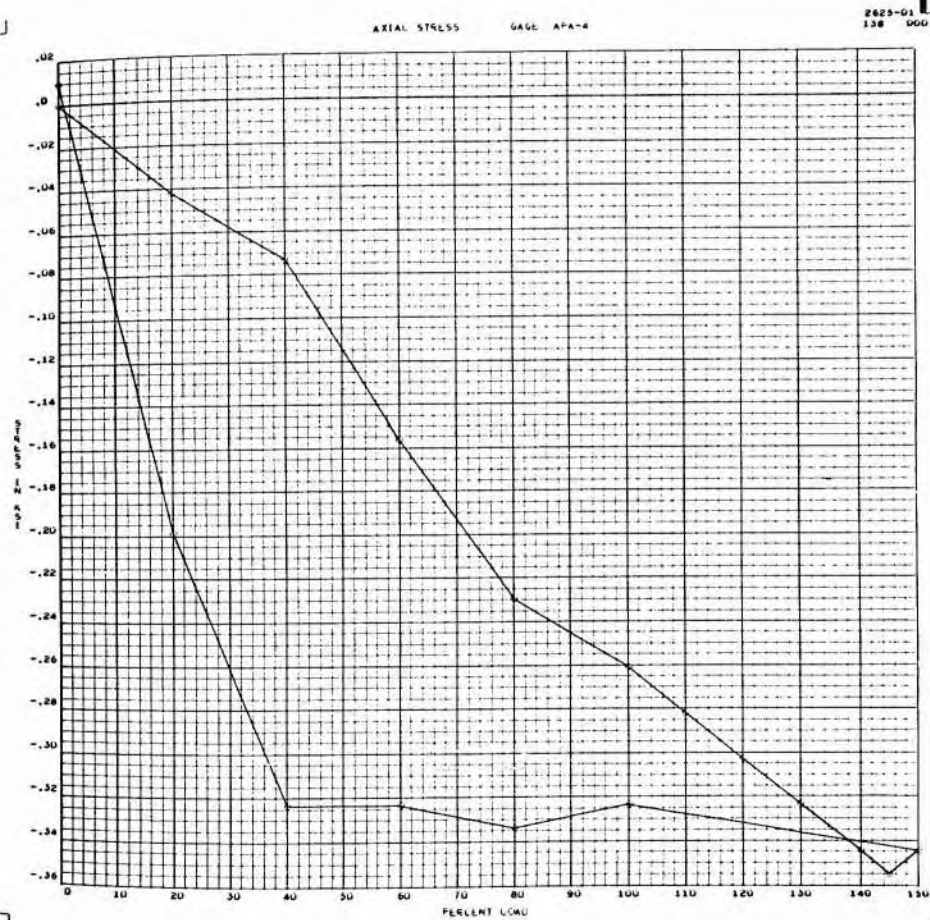
A-130

SID 67-317



A-131

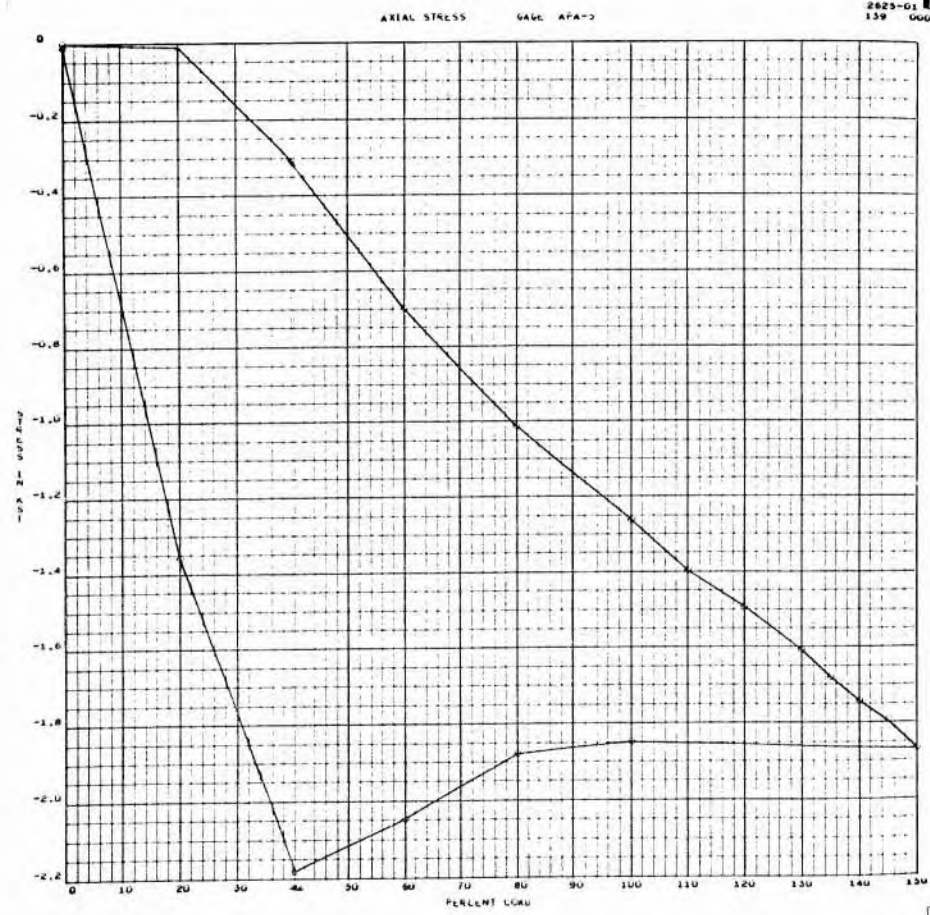
SID 67-317



A-132

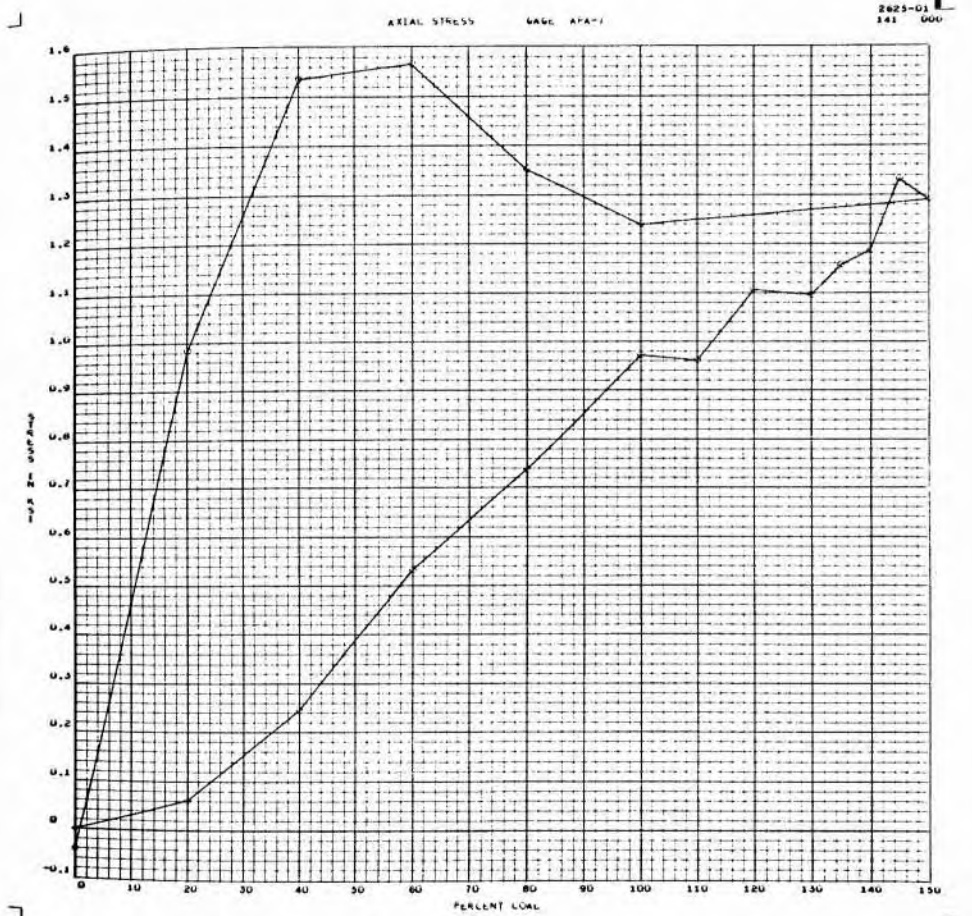
SID 67-317





A-133

SID 67-317



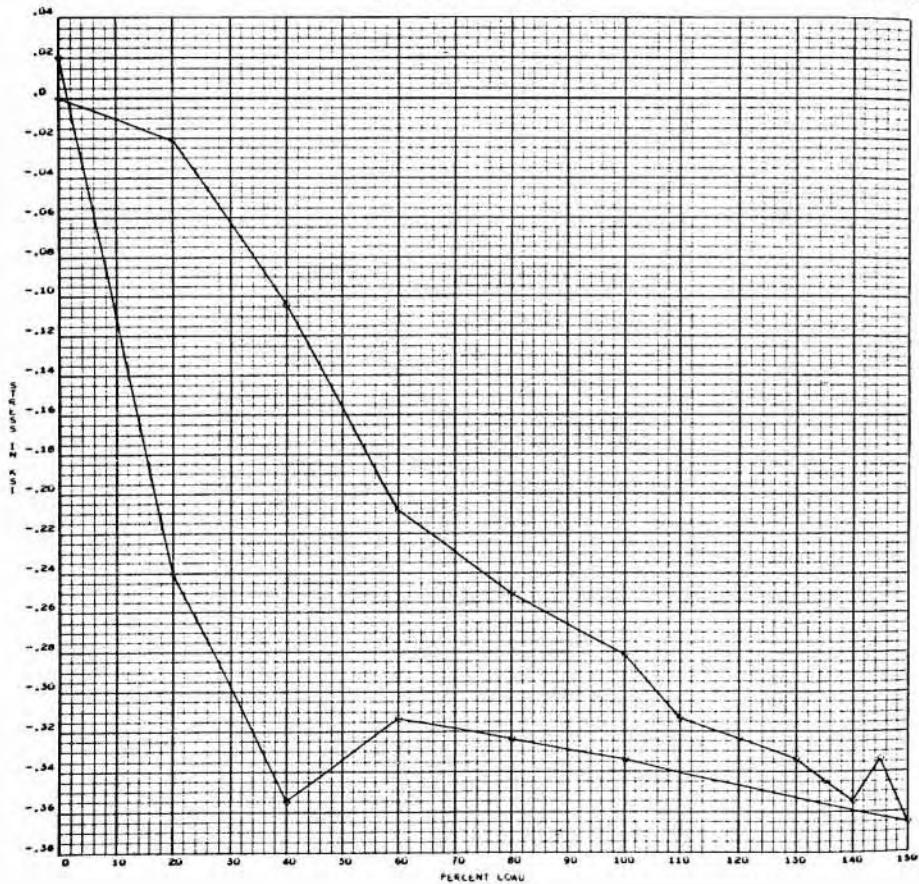
A-134

SID 67-317



2625-01  
142 006

AXIAL STRESS GAGE AFA-8

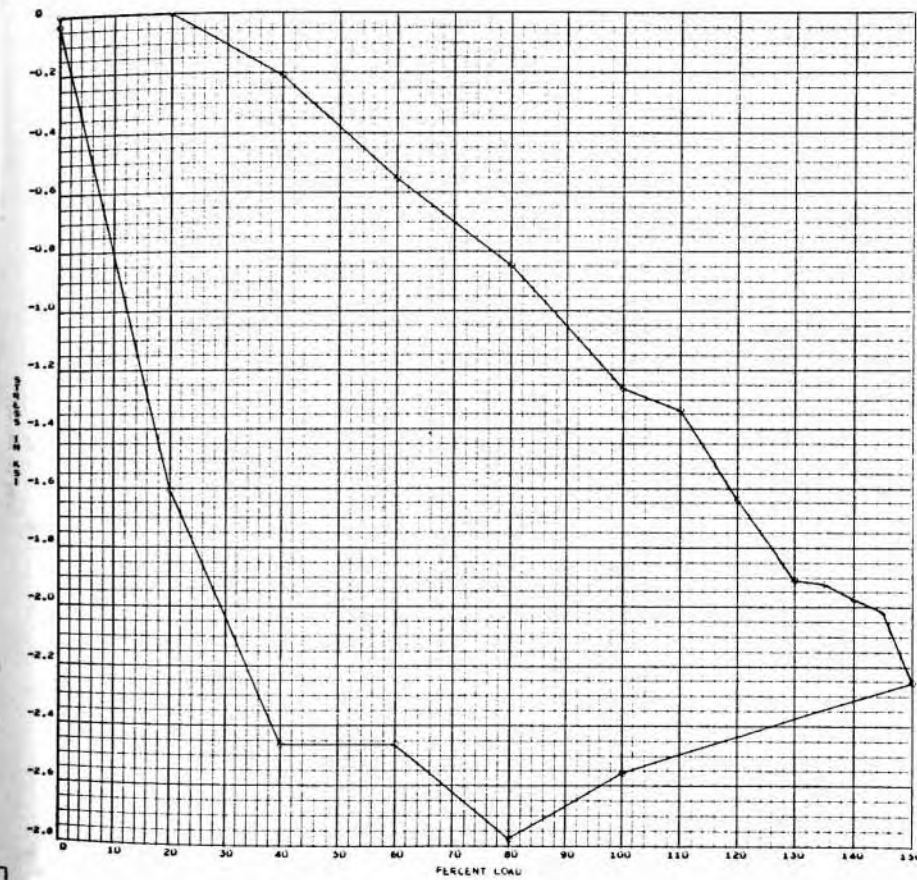


A-135

SID 67-317

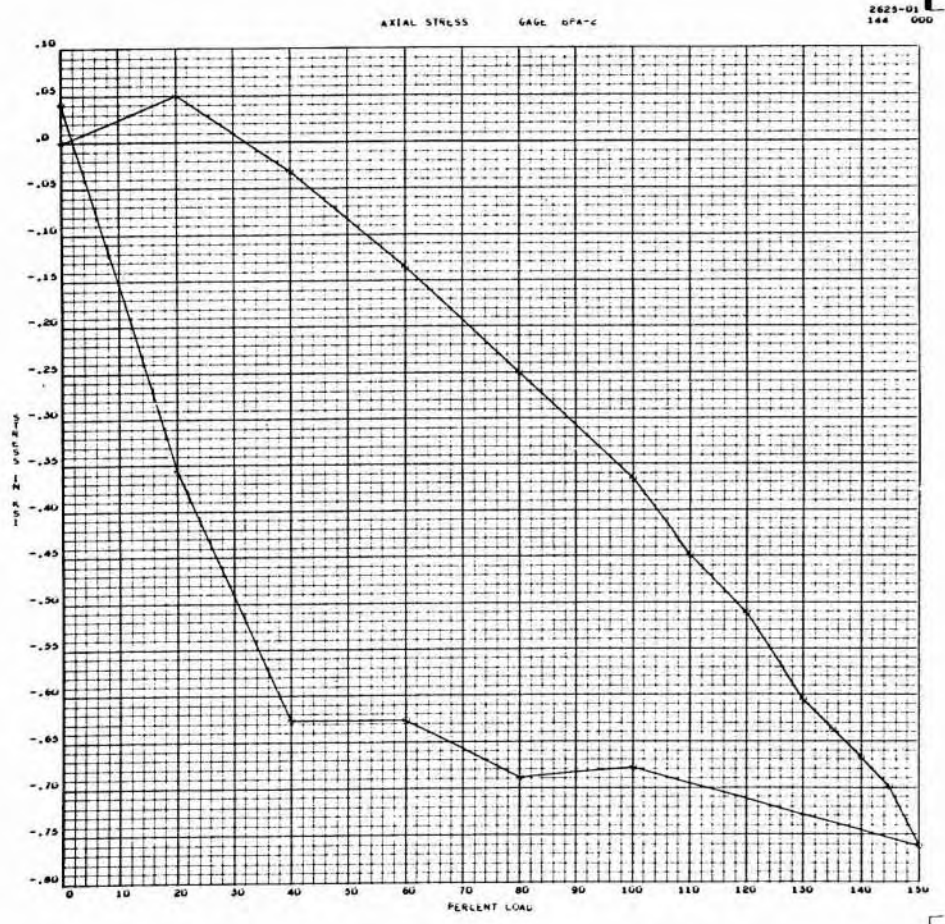
2625-01  
143 006

AXIAL STRESS GAGE DFA-1



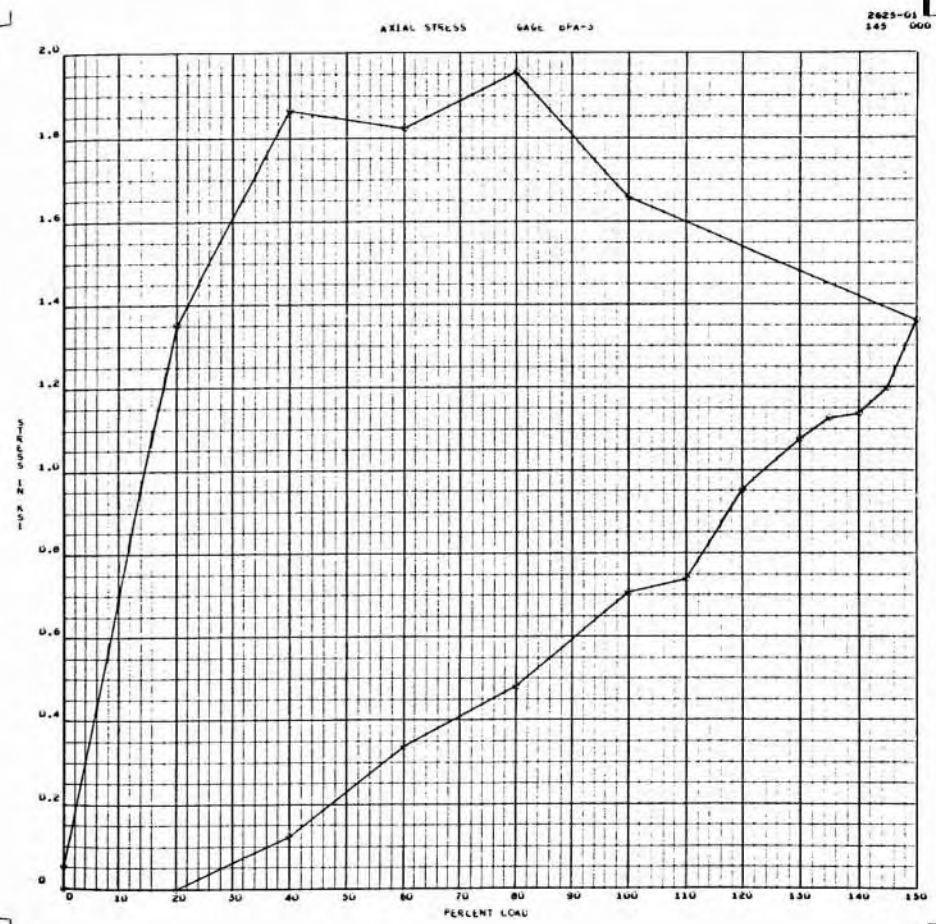
A-136

SID 67-317



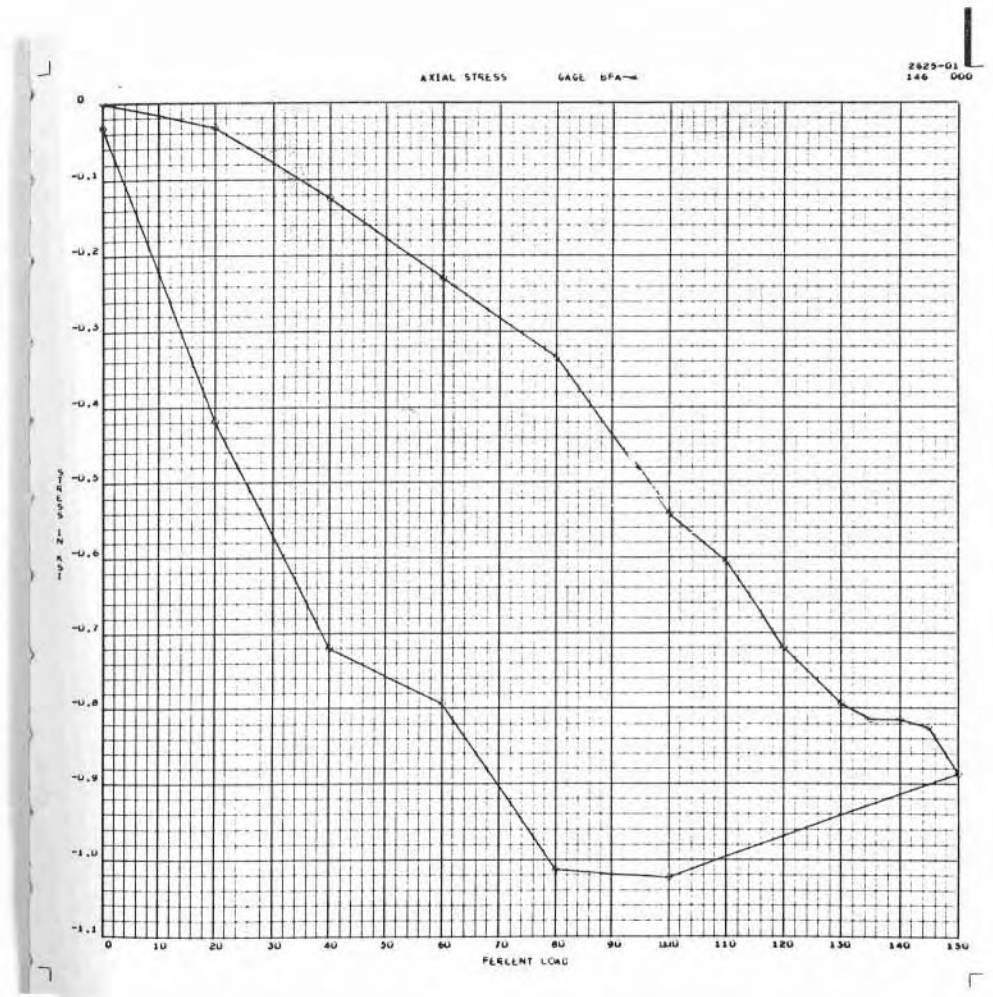
A-137

SID 67-317



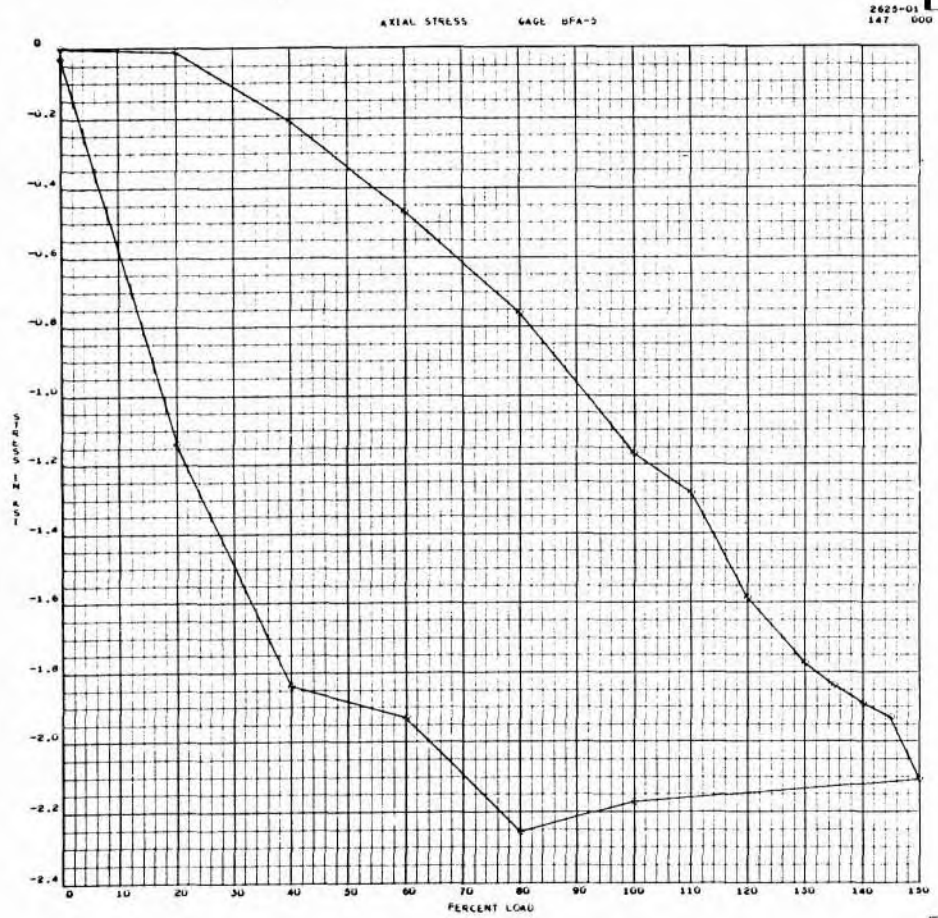
A-138

SID 67-317



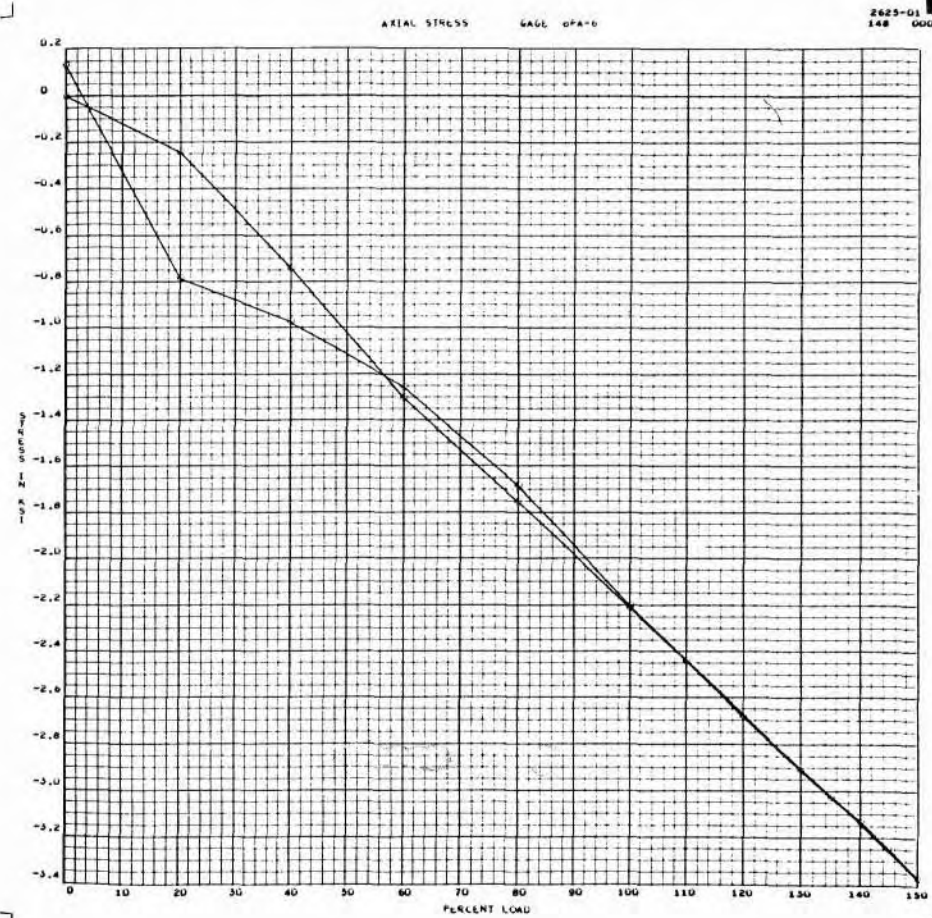
A-140

SID 67-317



A-141

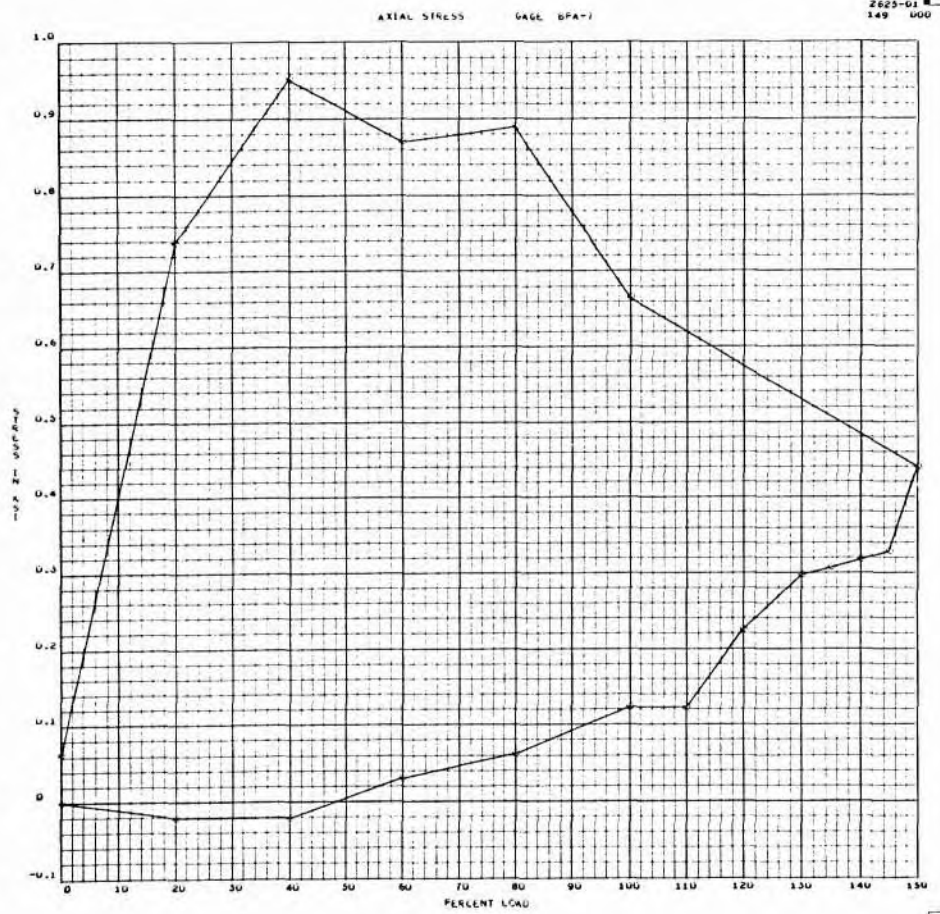
SID 67-317



A-142

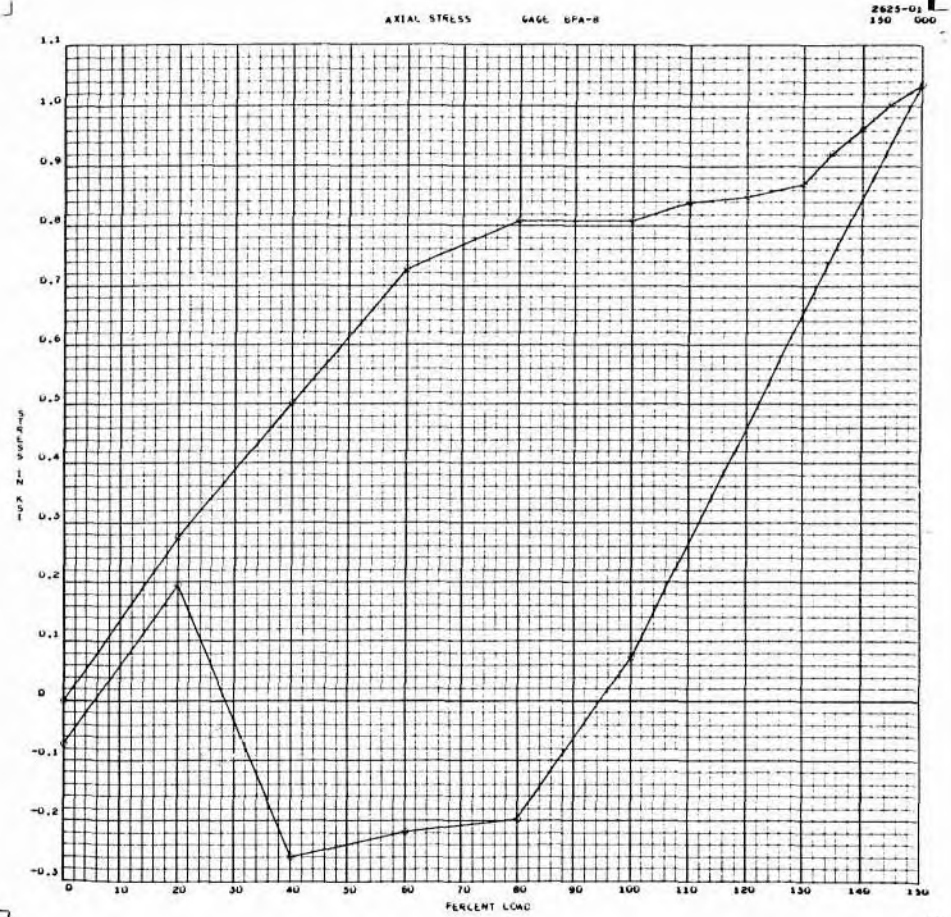
SID 67-318





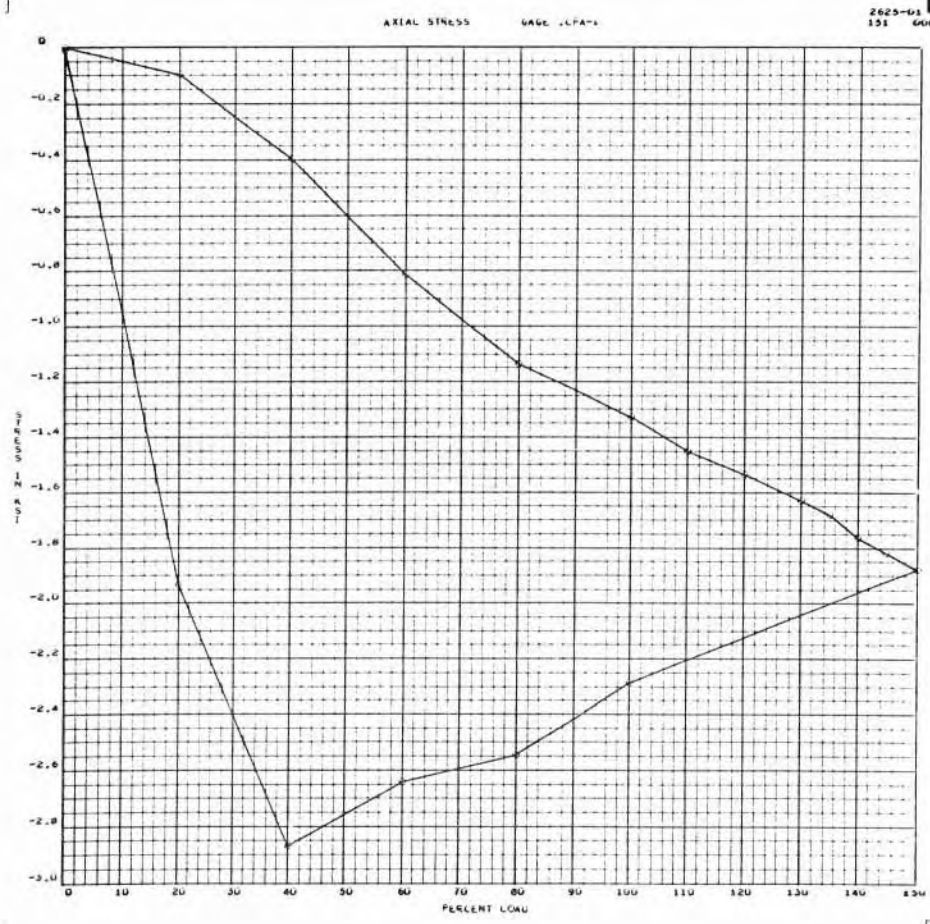
A-143

SID 67-317



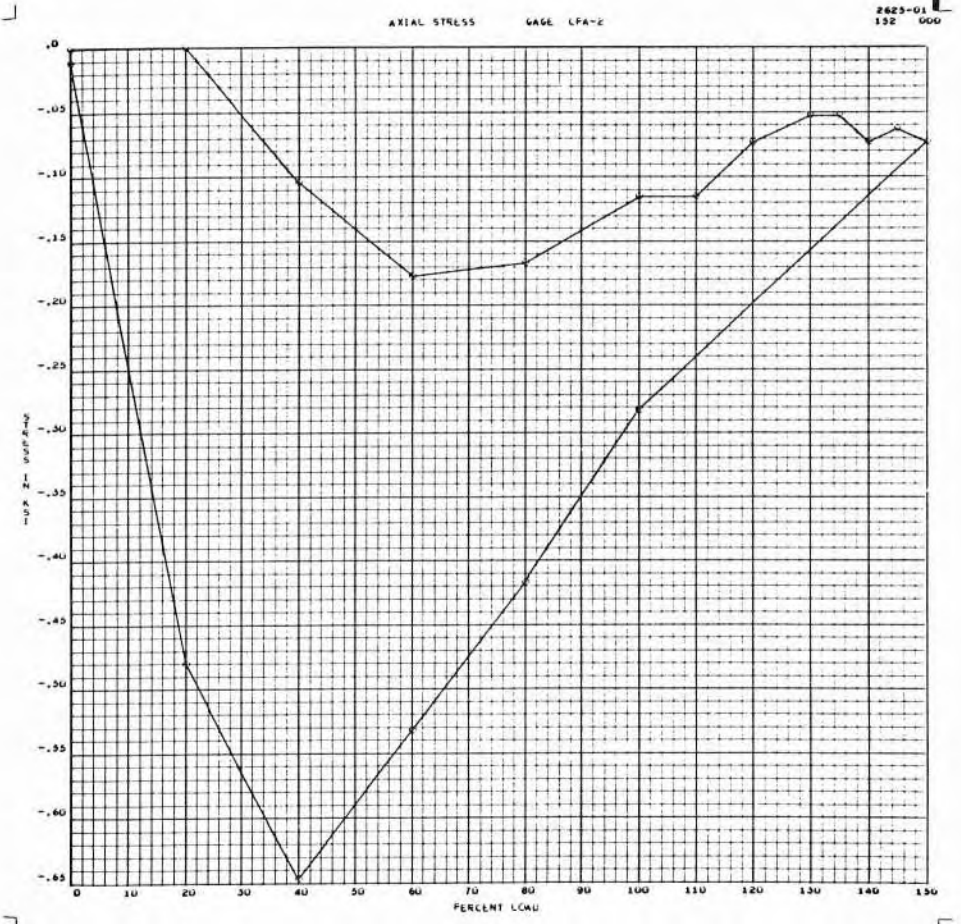
A-144

SID 67-317



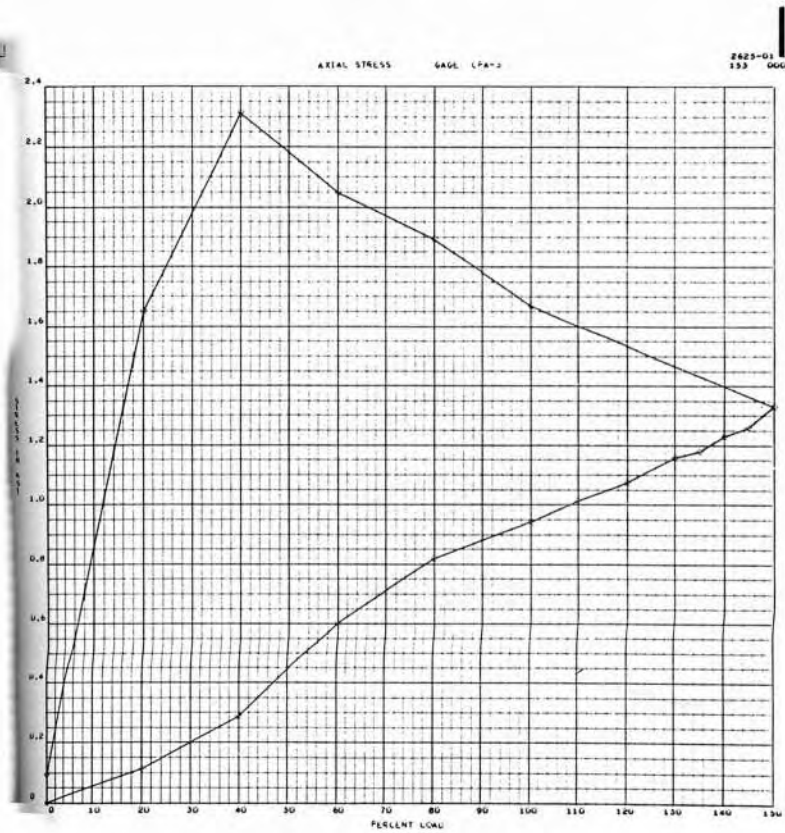
A-145

SID 67-317



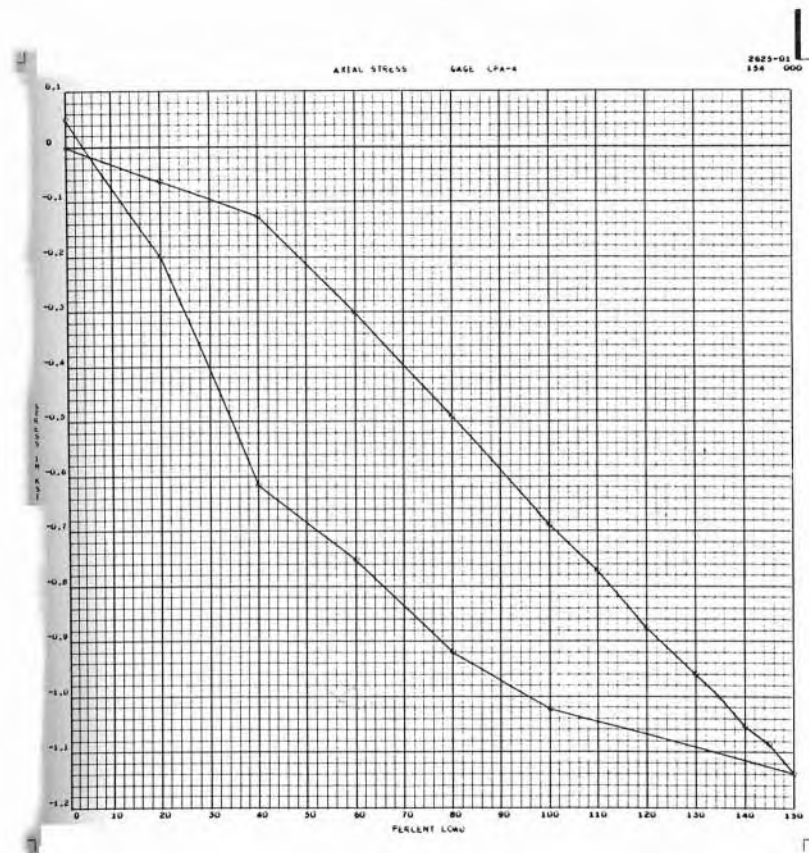
A-146

SID 67-317



A-147

SID 67-317

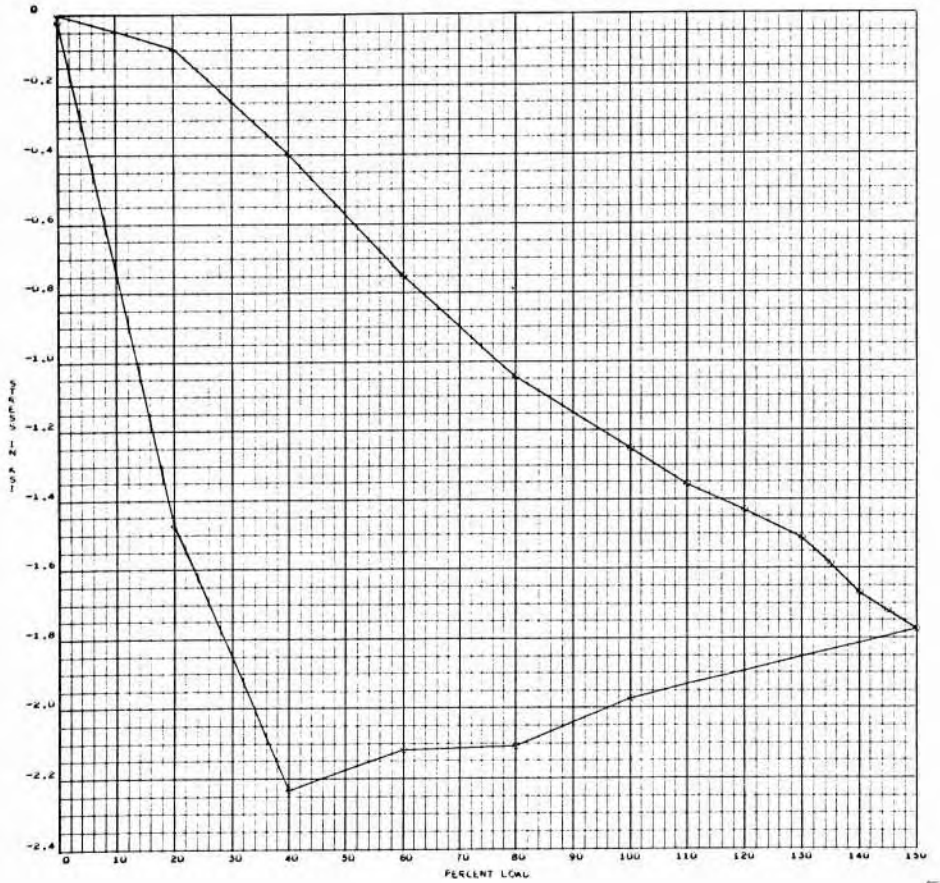


A-148

SID 67-317

AXIAL STRESS GAGE LFA-3

2625-01  
157 000

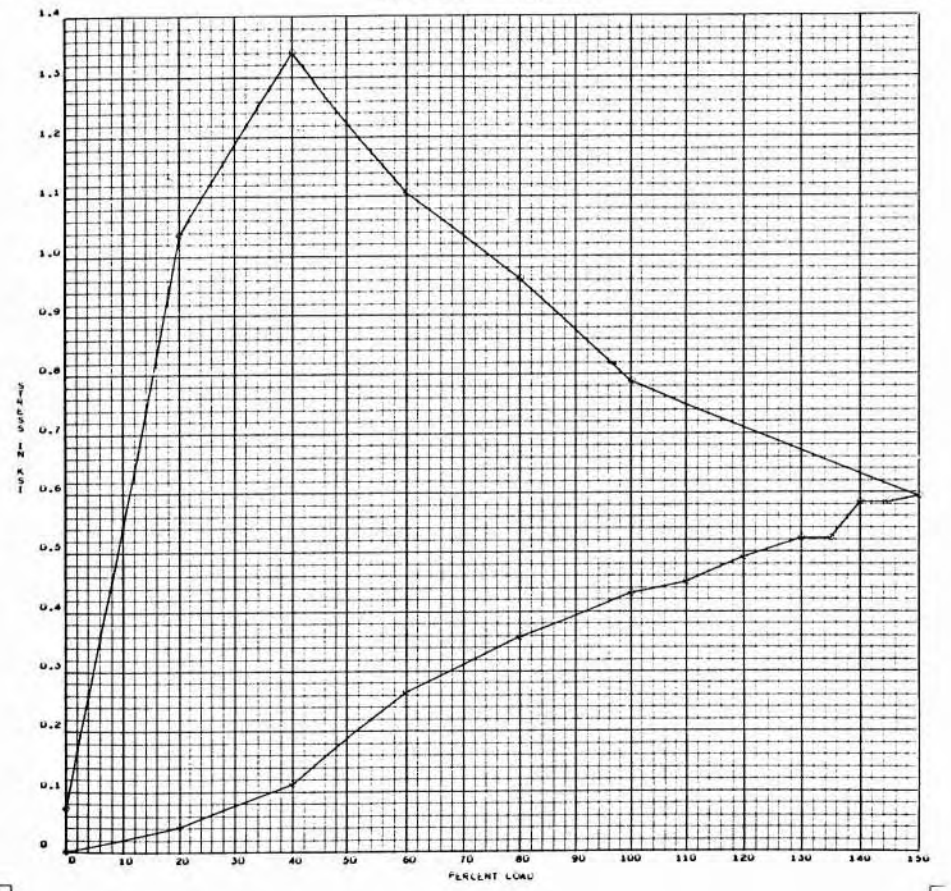


A-149

SID 67-317

AXIAL STRESS GAGE LFA-7

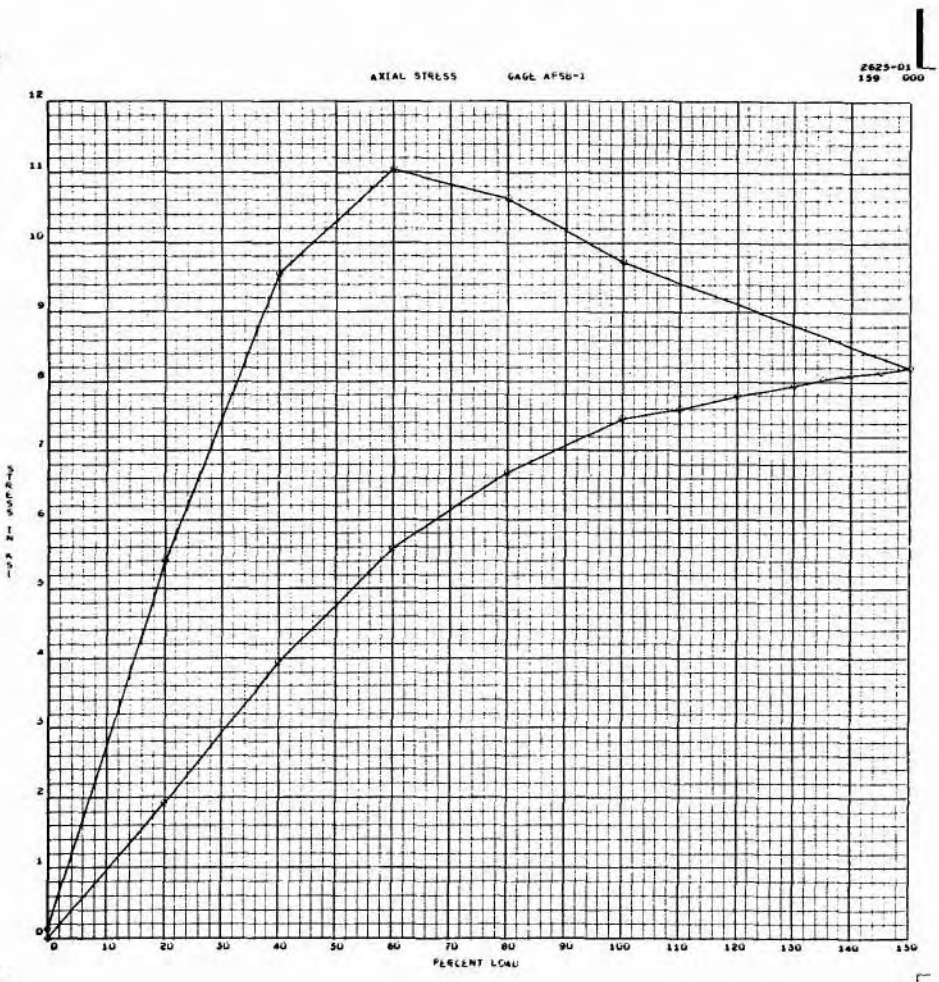
2625-01  
157 000



A-150

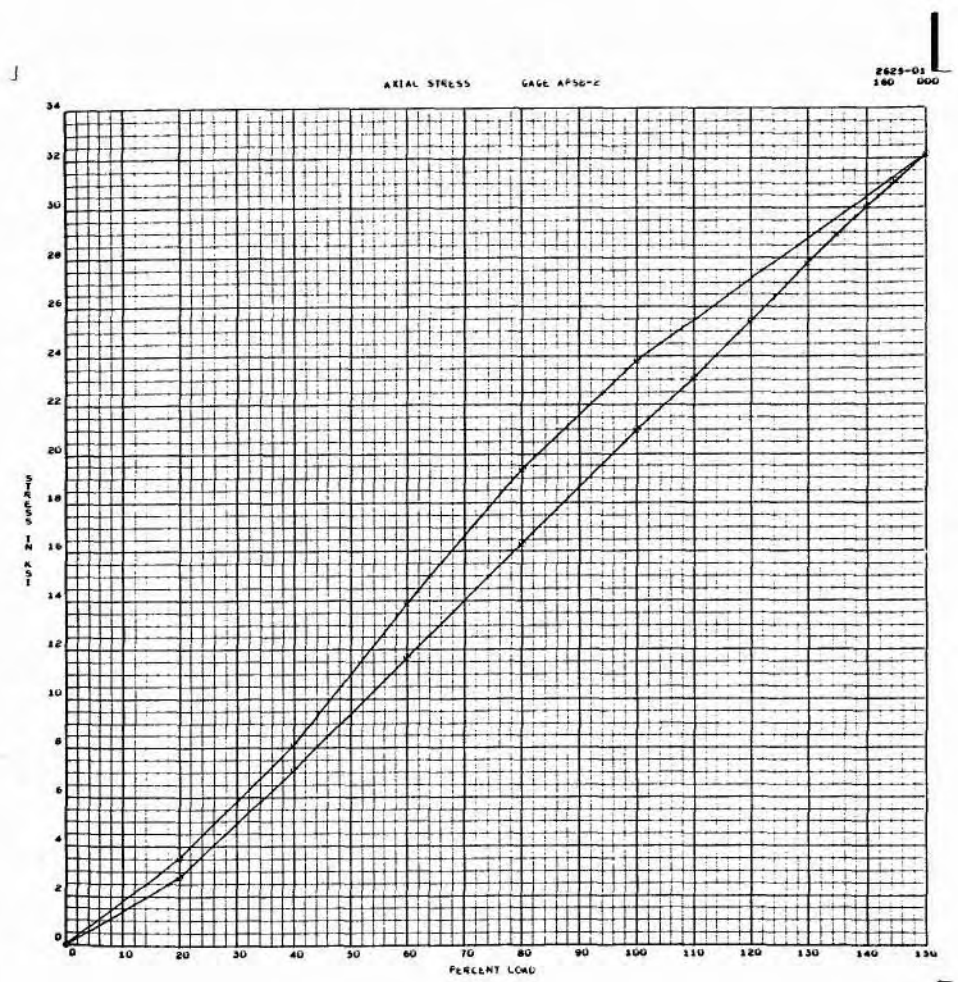
SID 67-317





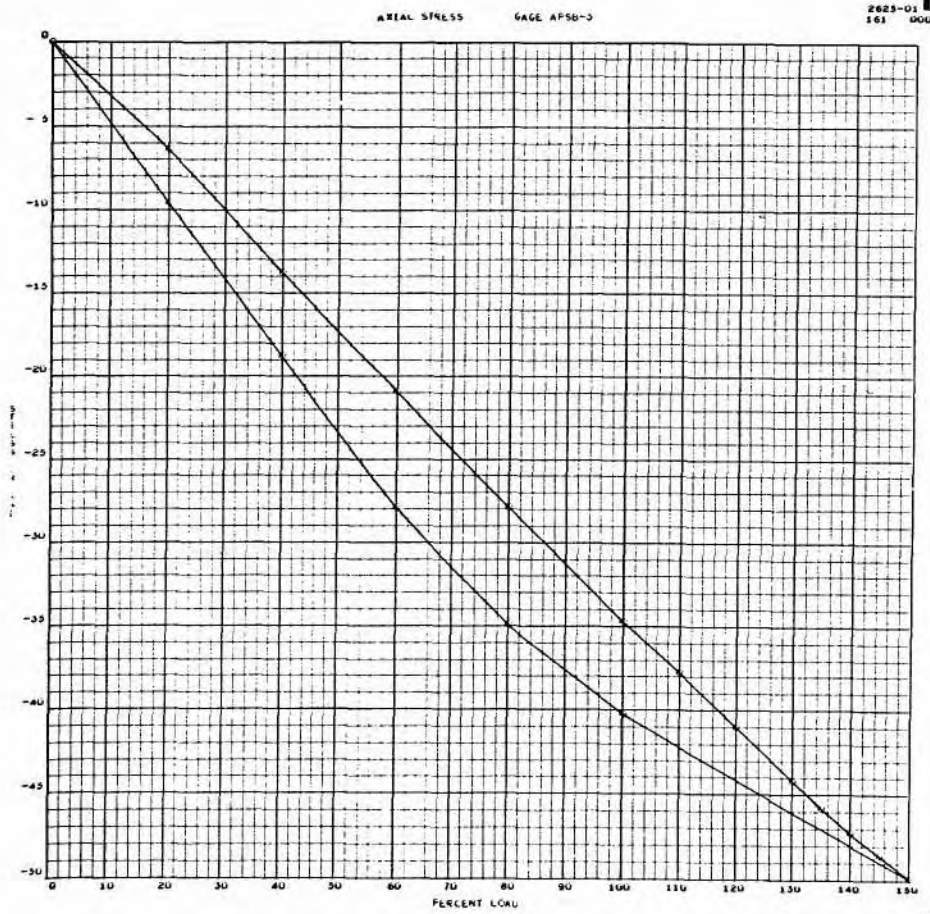
A-151

SID 67-317



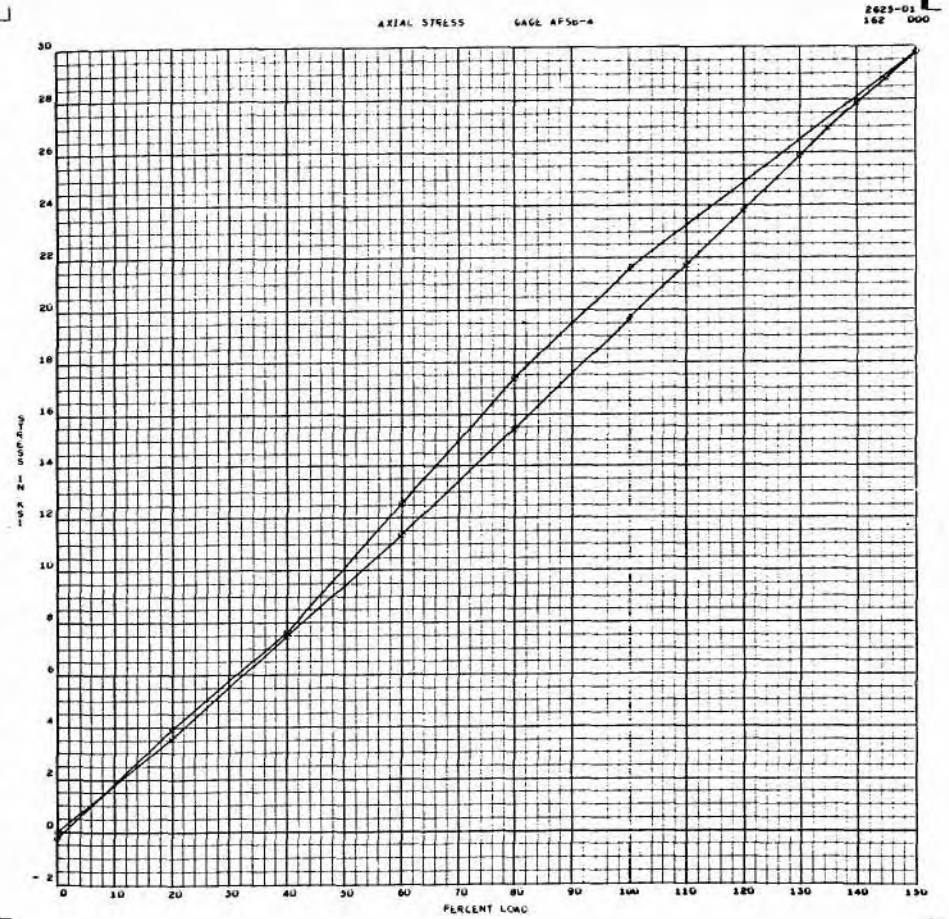
A-152

SID 67-317



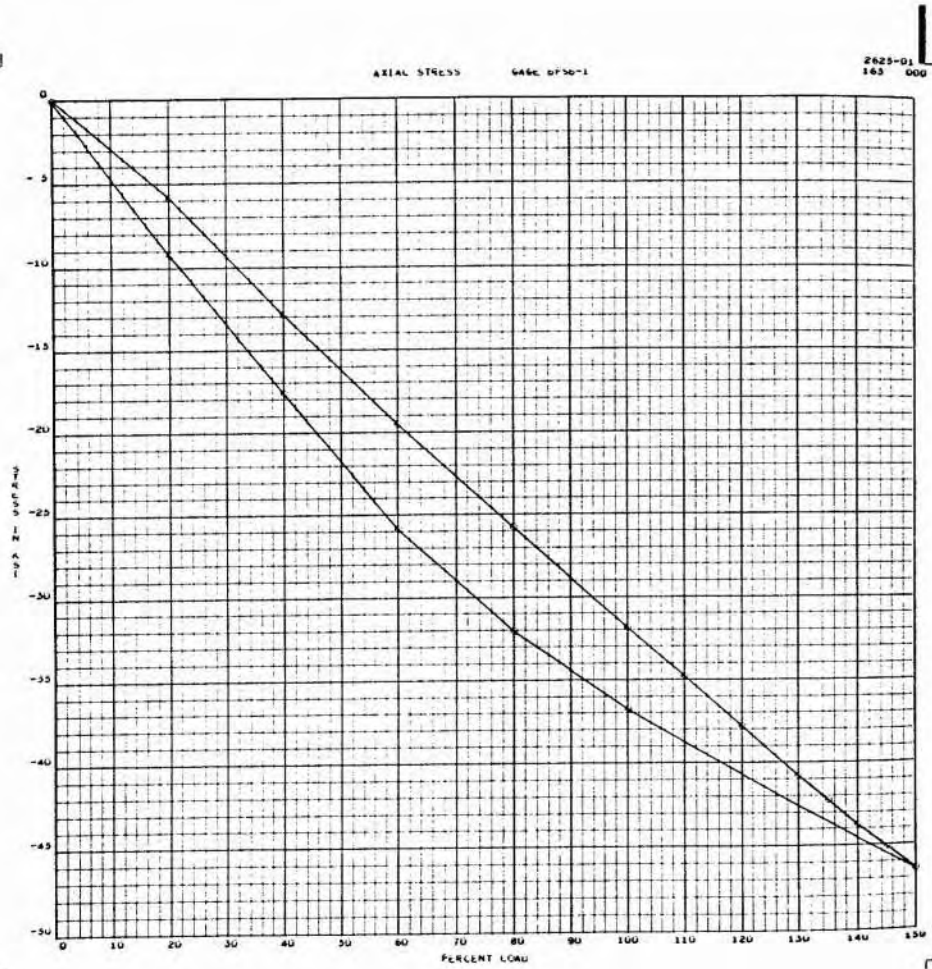
A-153

SID 67-317



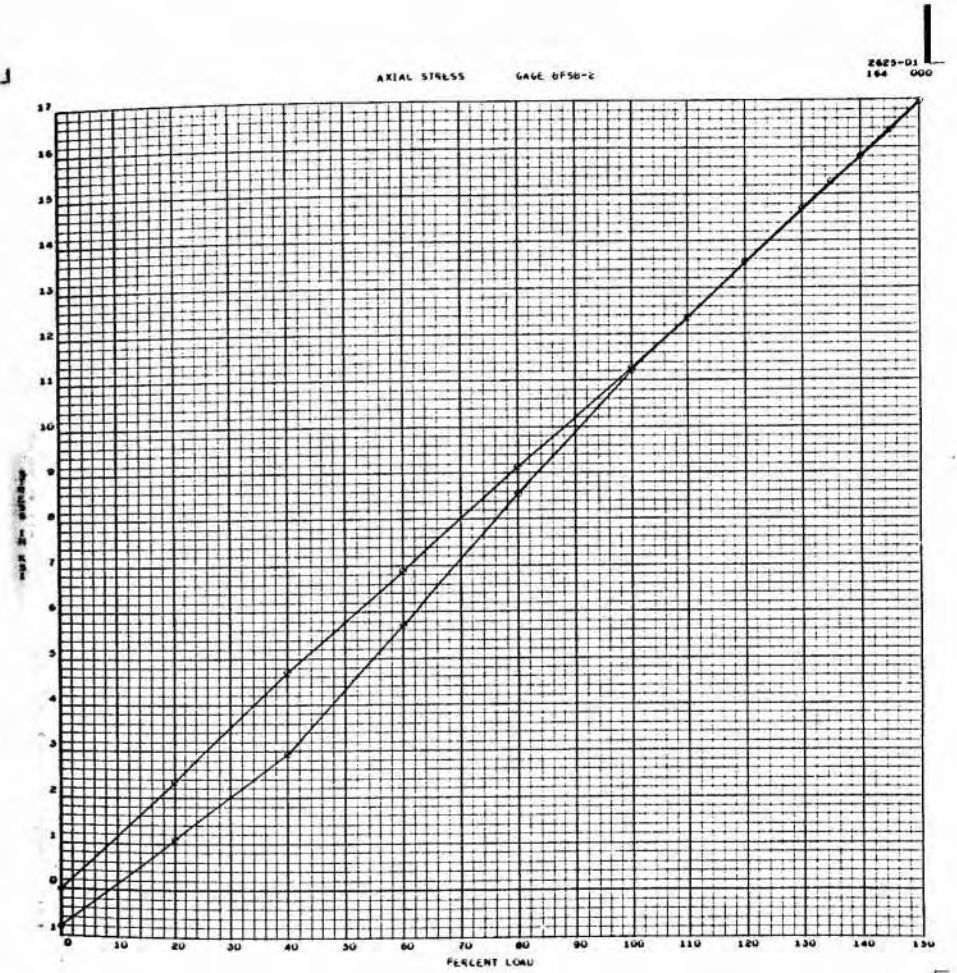
A-154

SID 67-317



A-155

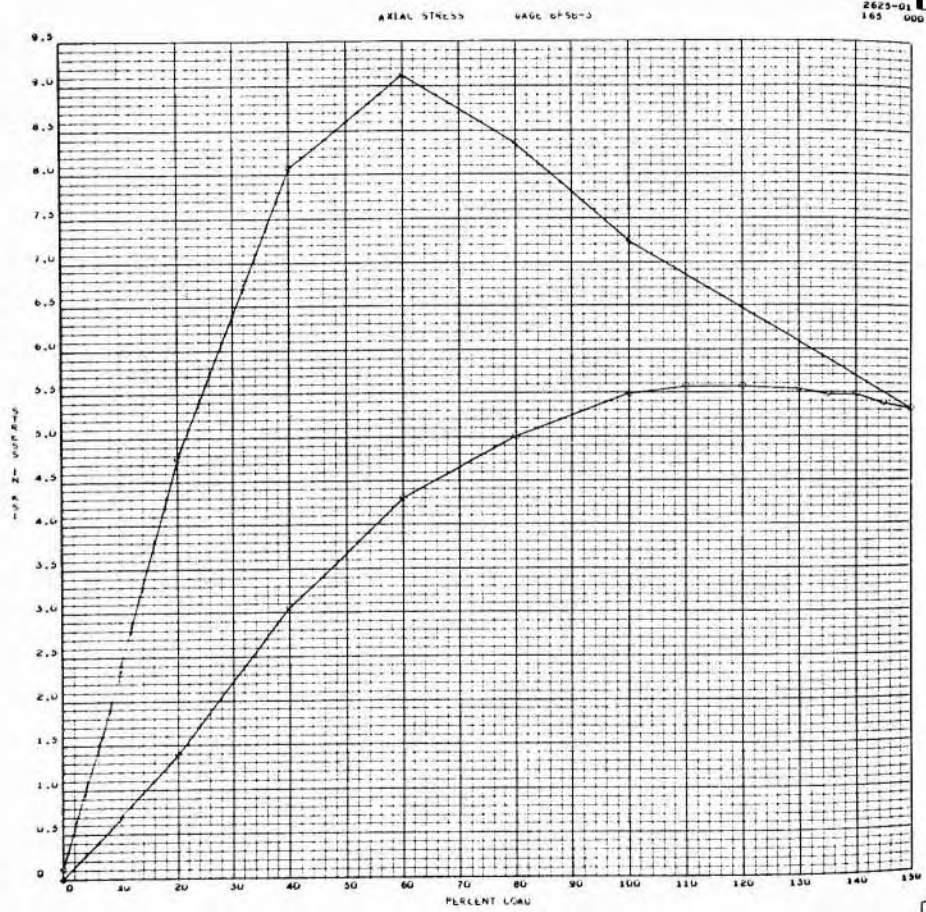
SID 67-317



A-156

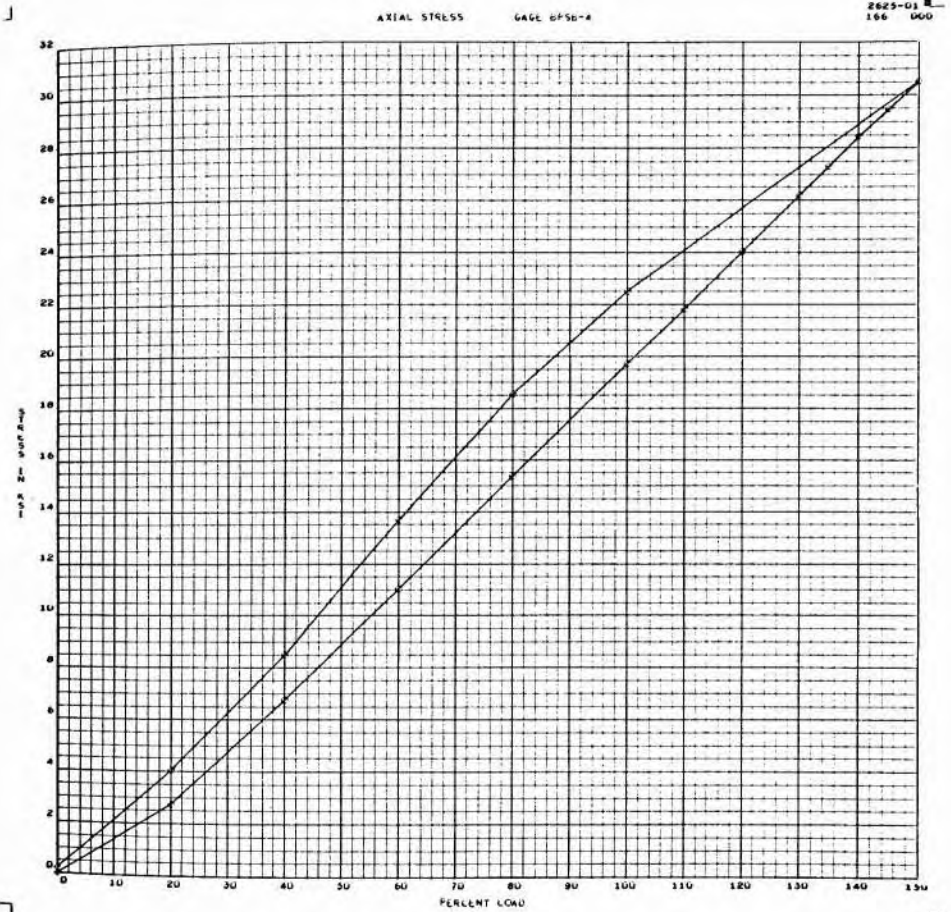
SID 67-317





A-157

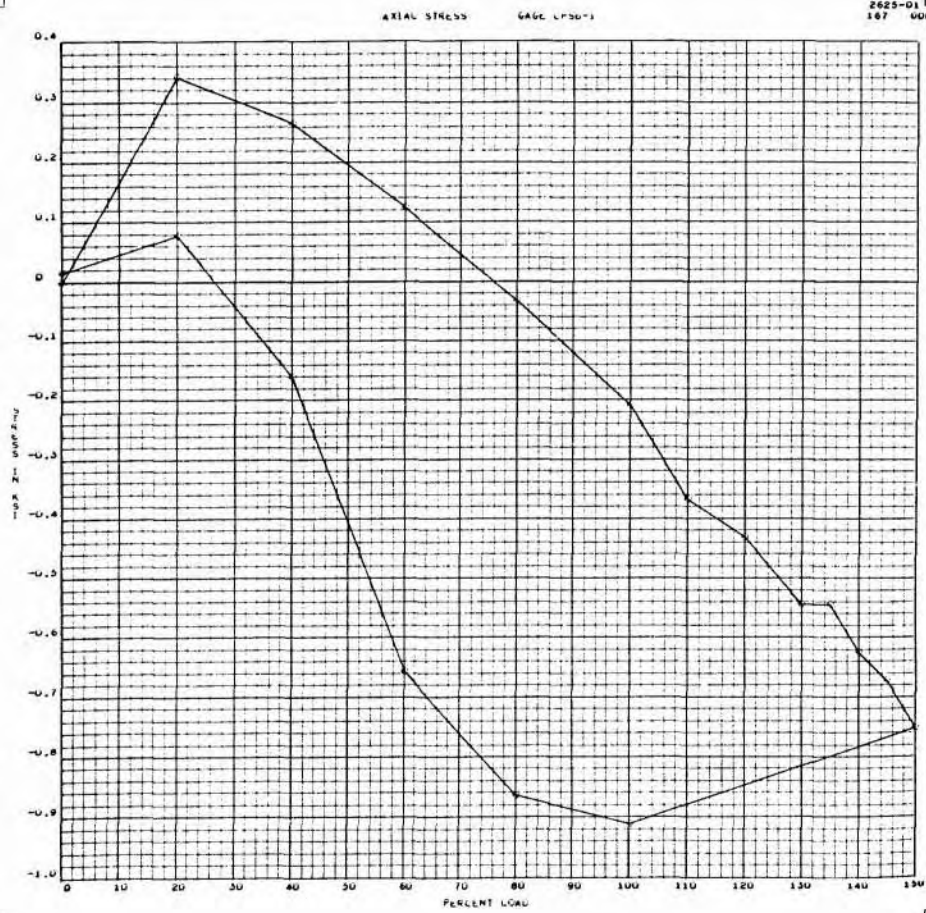
SID 67-317



A-158

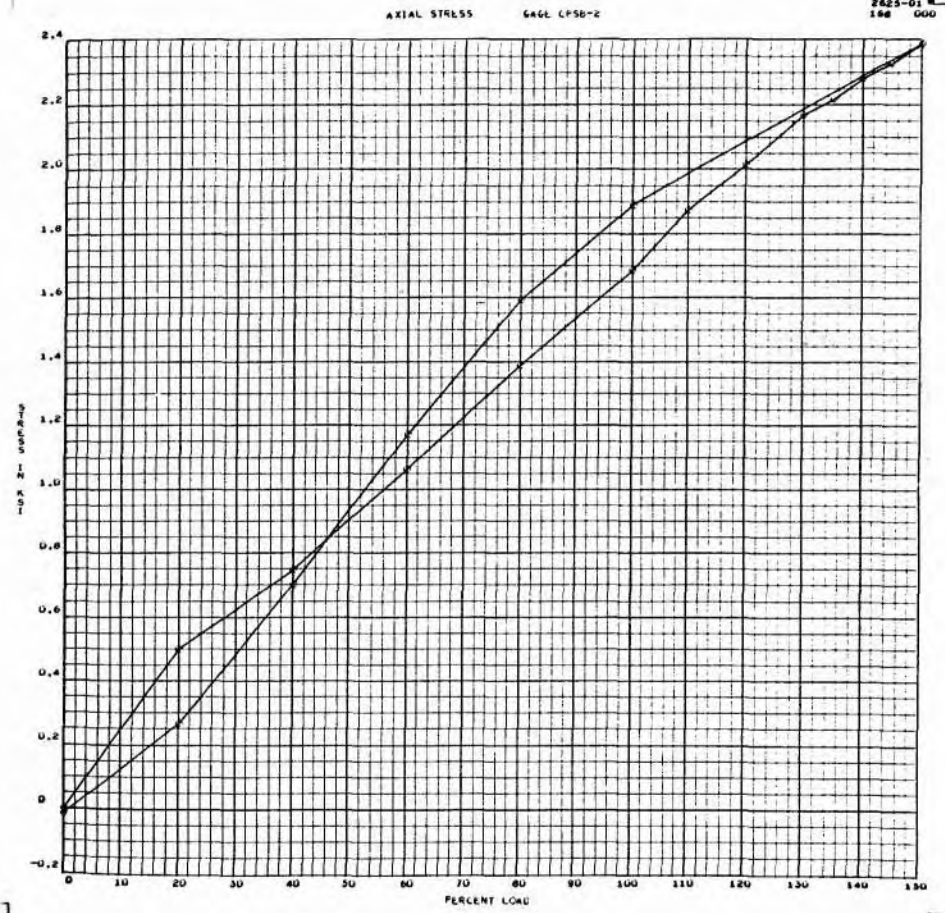
SID 67-317





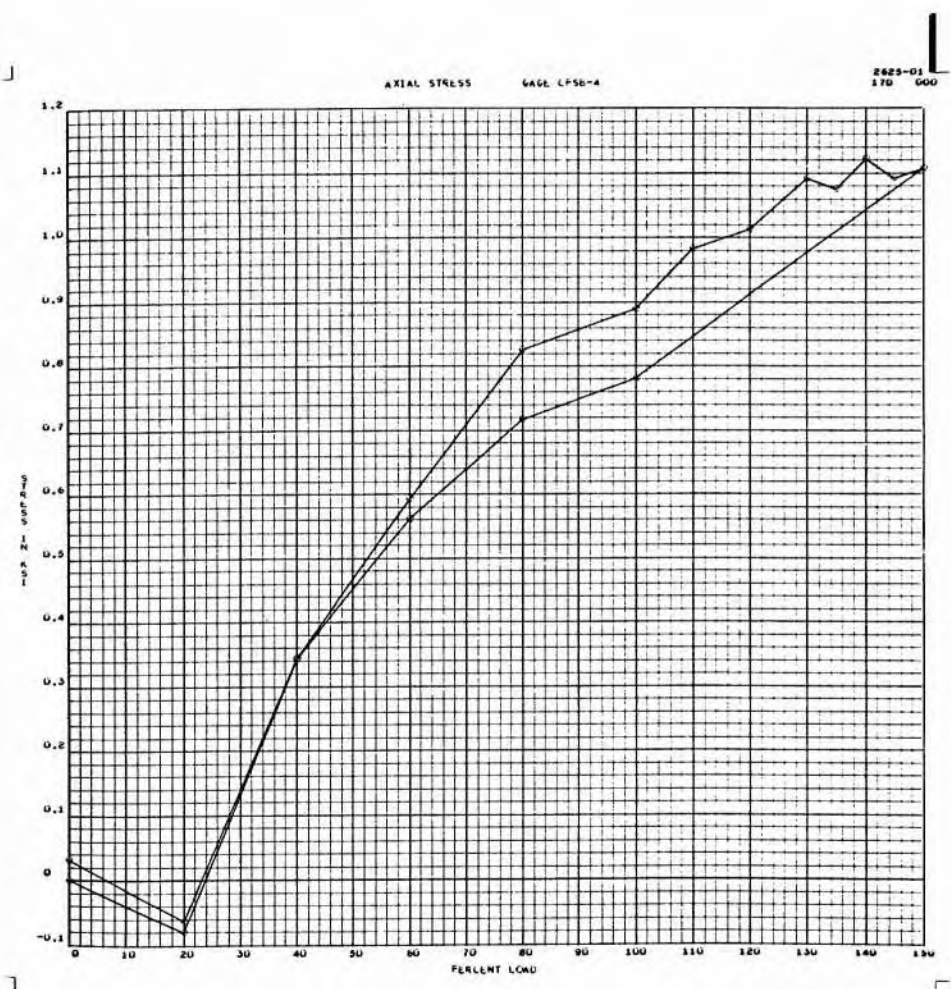
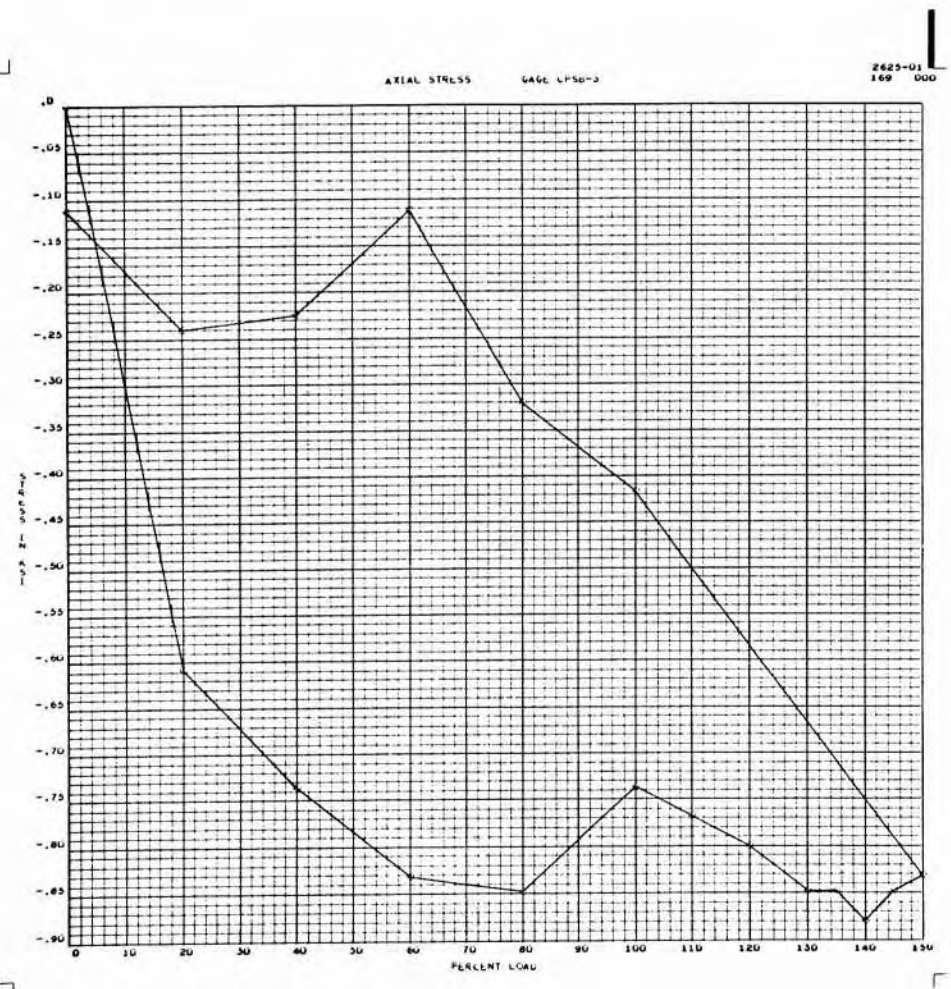
A-159

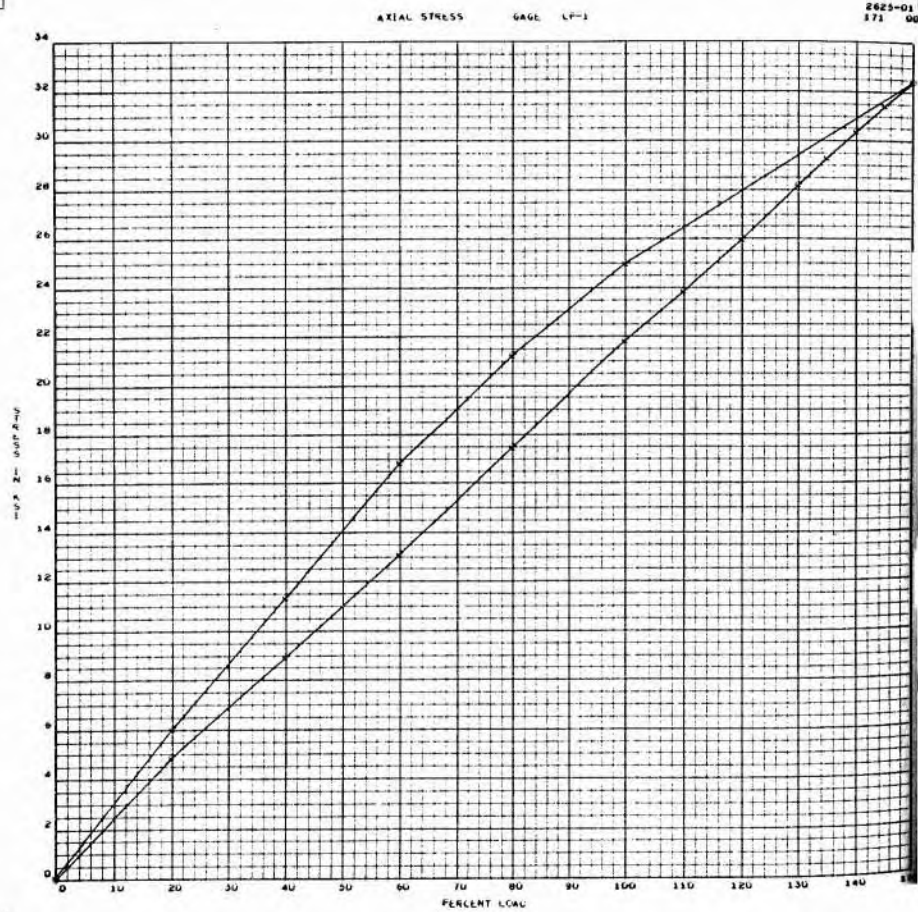
SID 67-317



A-160

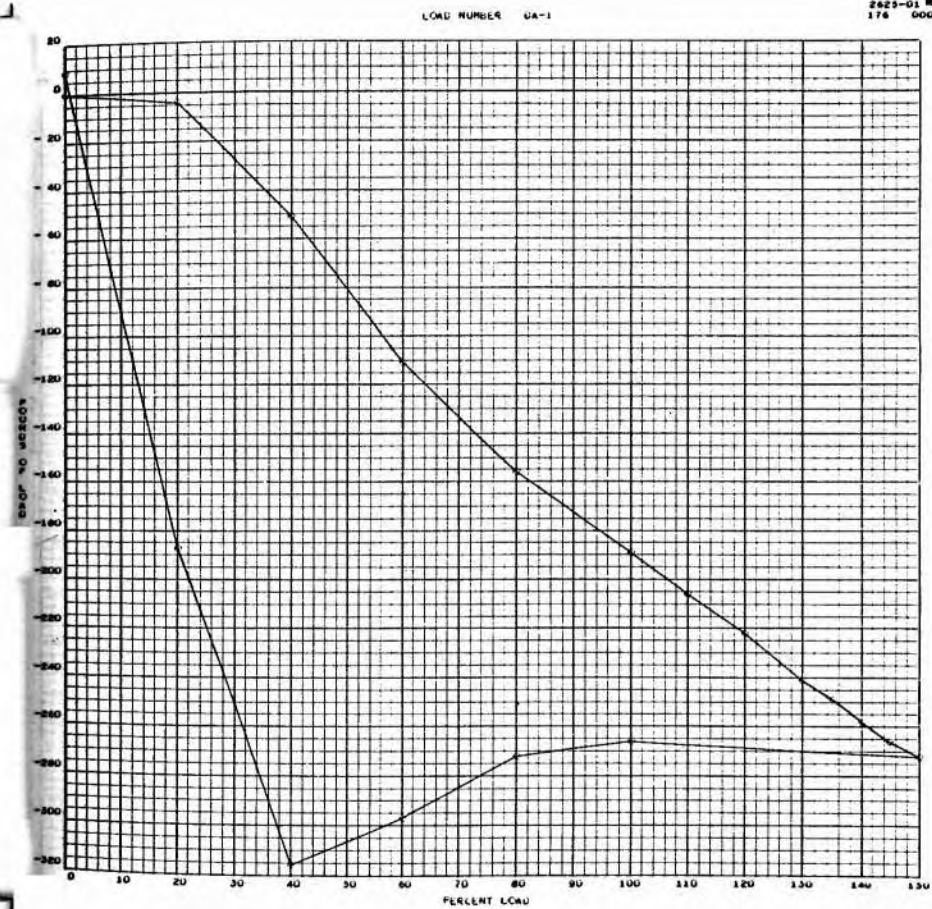
SID 67-317





A-163

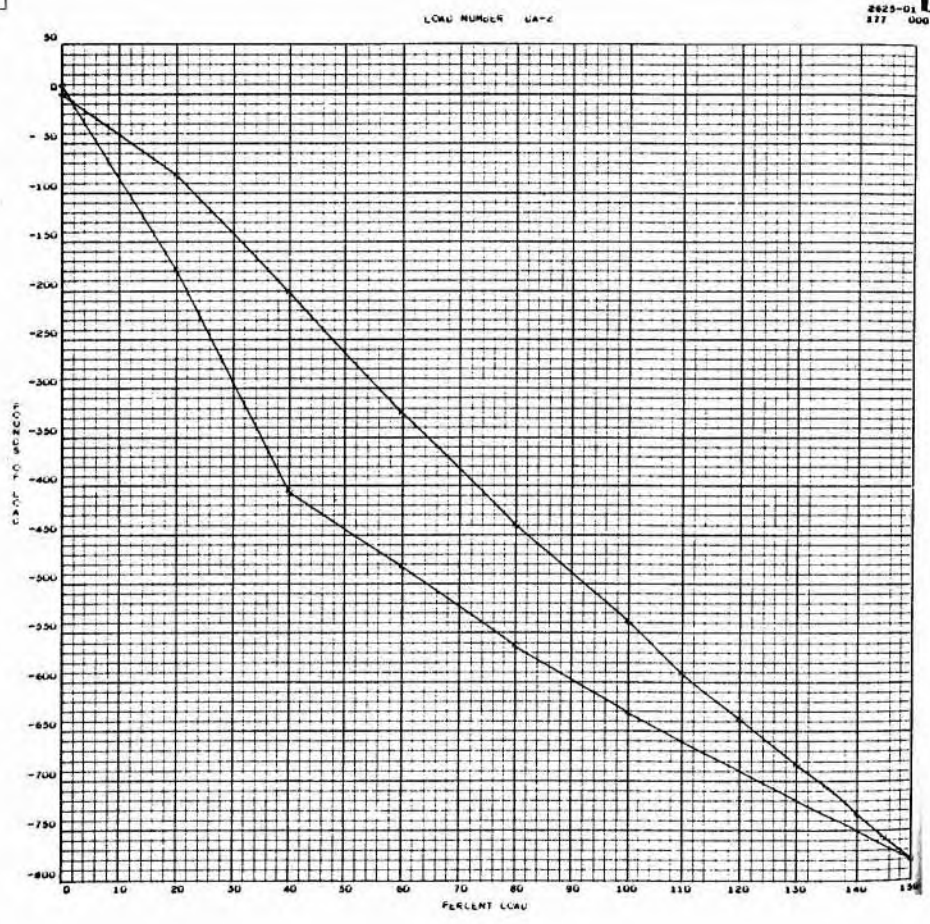
SID 67-317



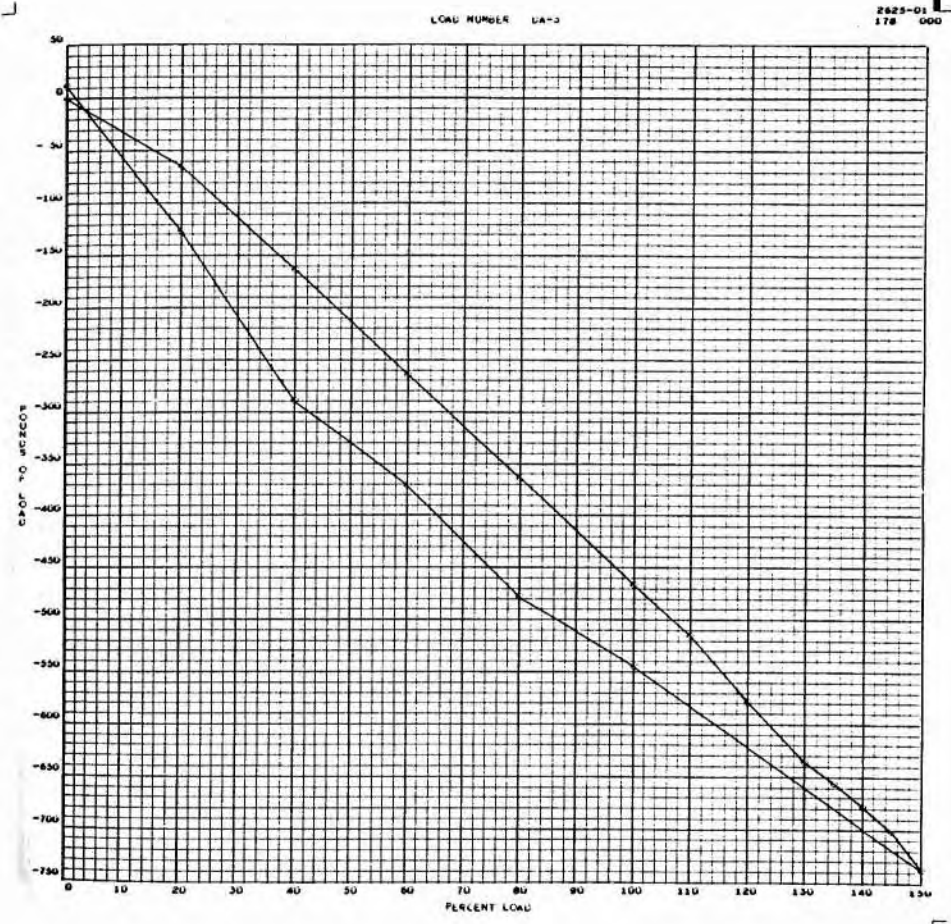
A-164

SID 67-317





SID 67-317

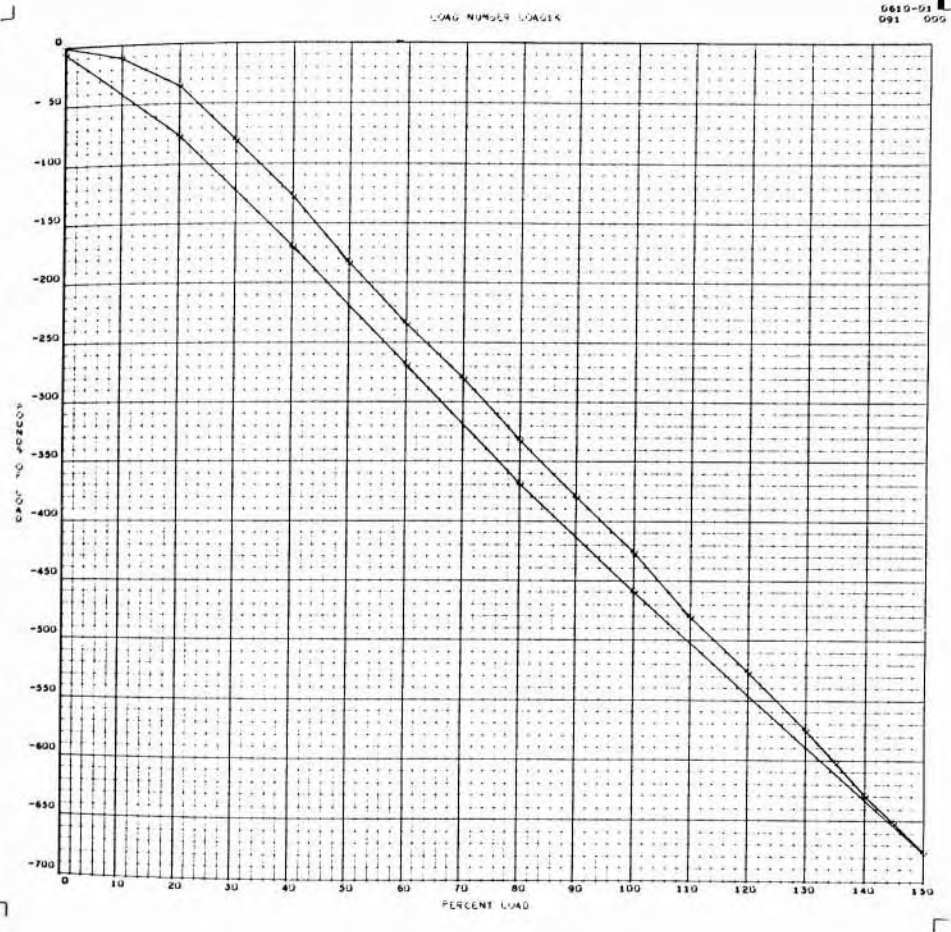


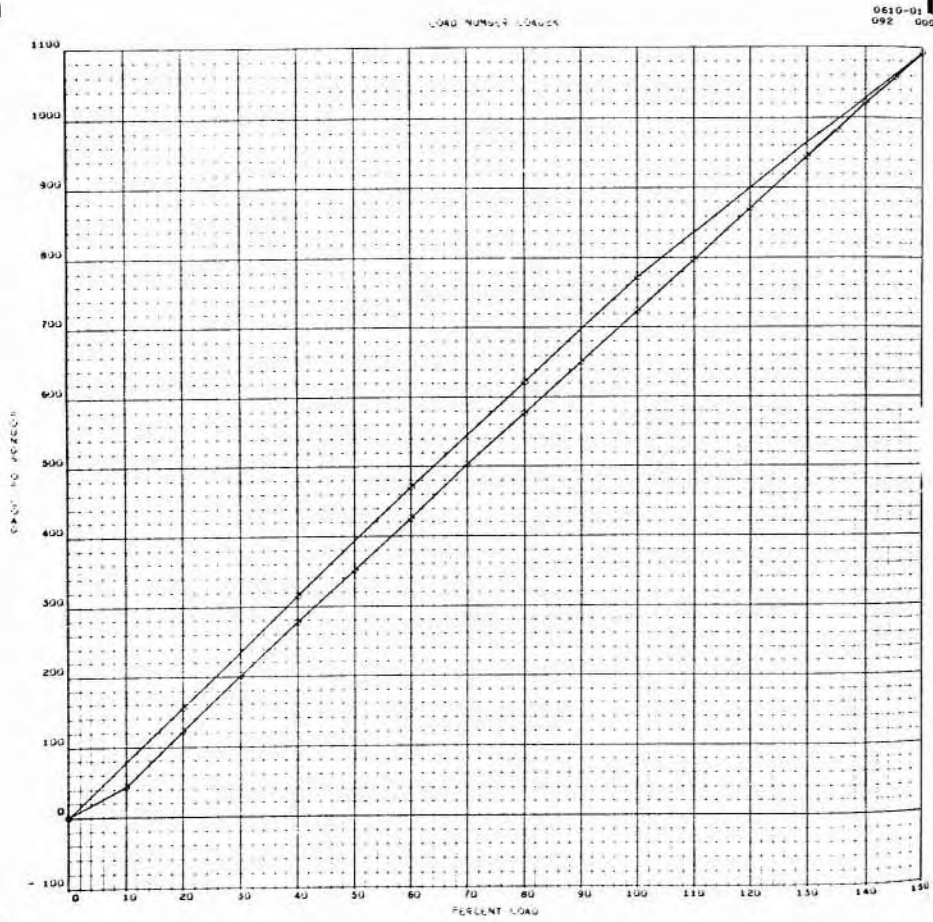
SID 67-317



TEST CONDITION III

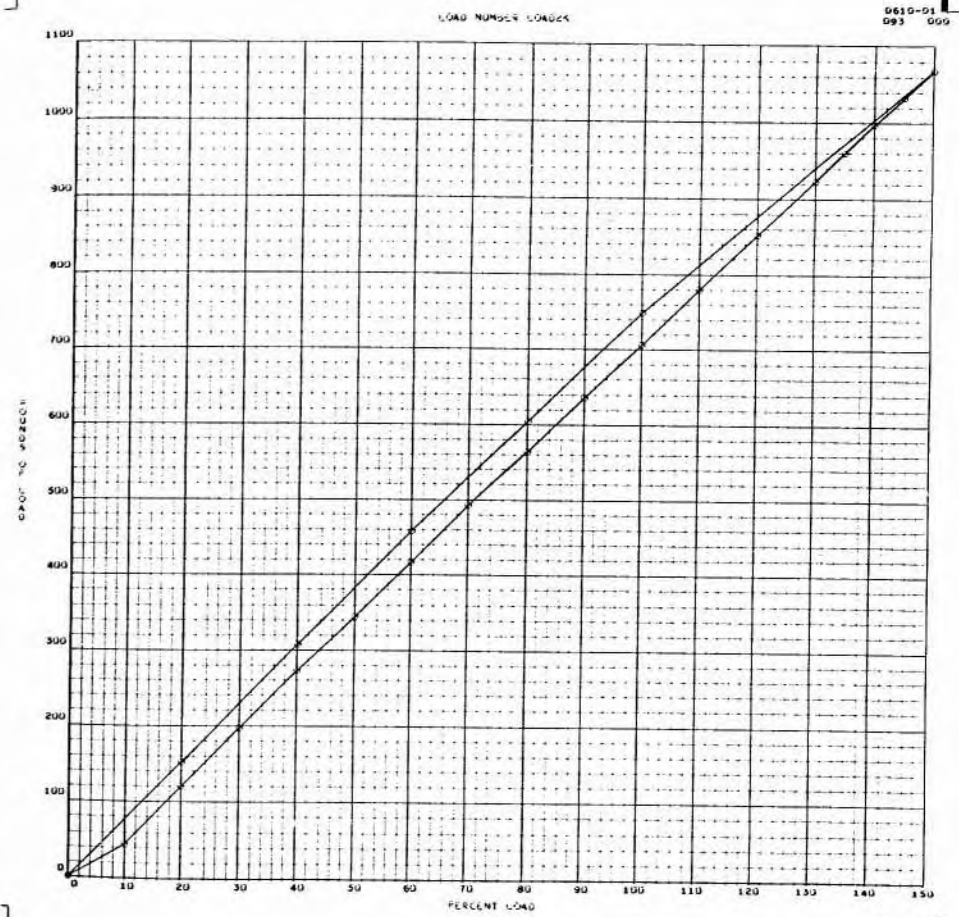
SID 67-317





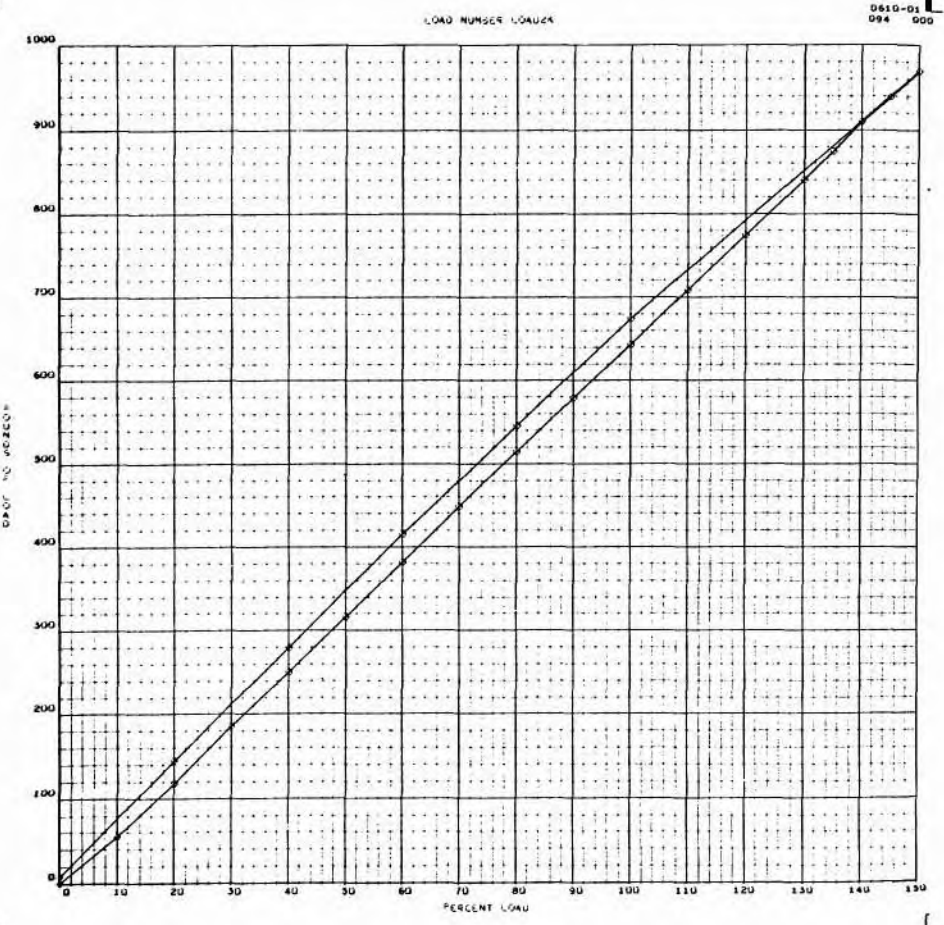
A-168

SID 67-317



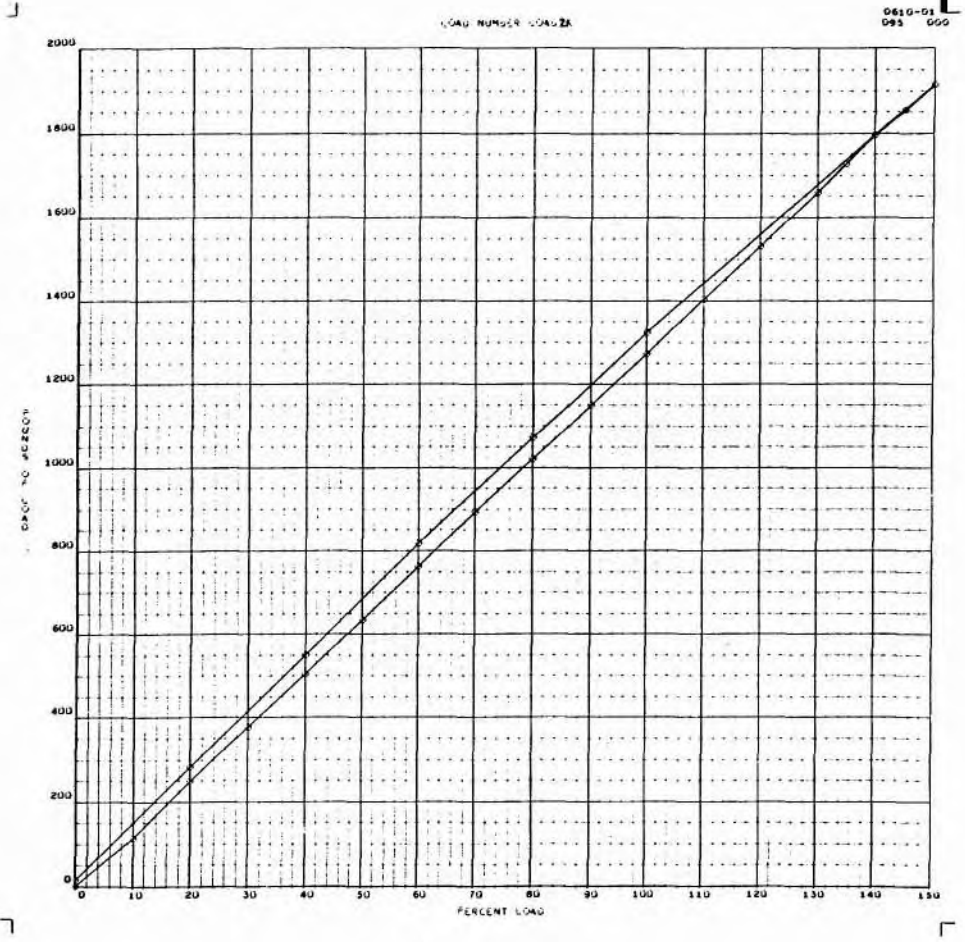
A-169

SID 67-317



A-170

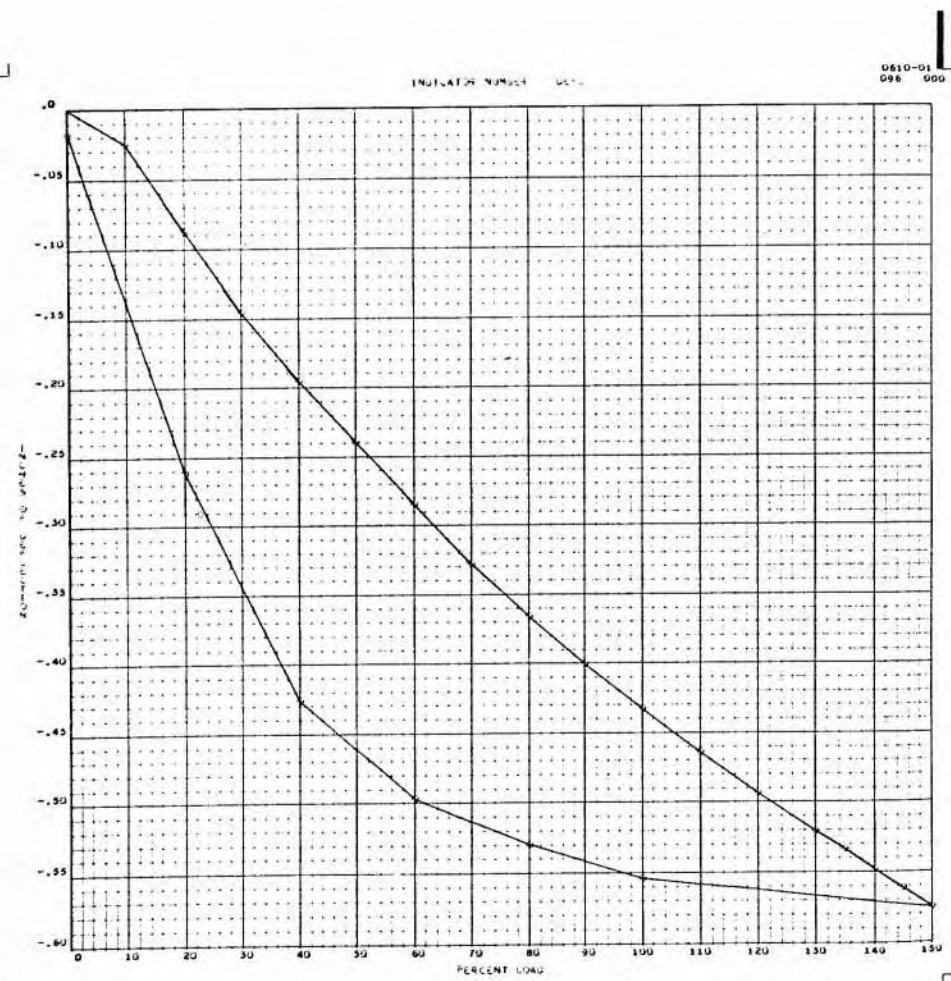
SID 67-317



A-171

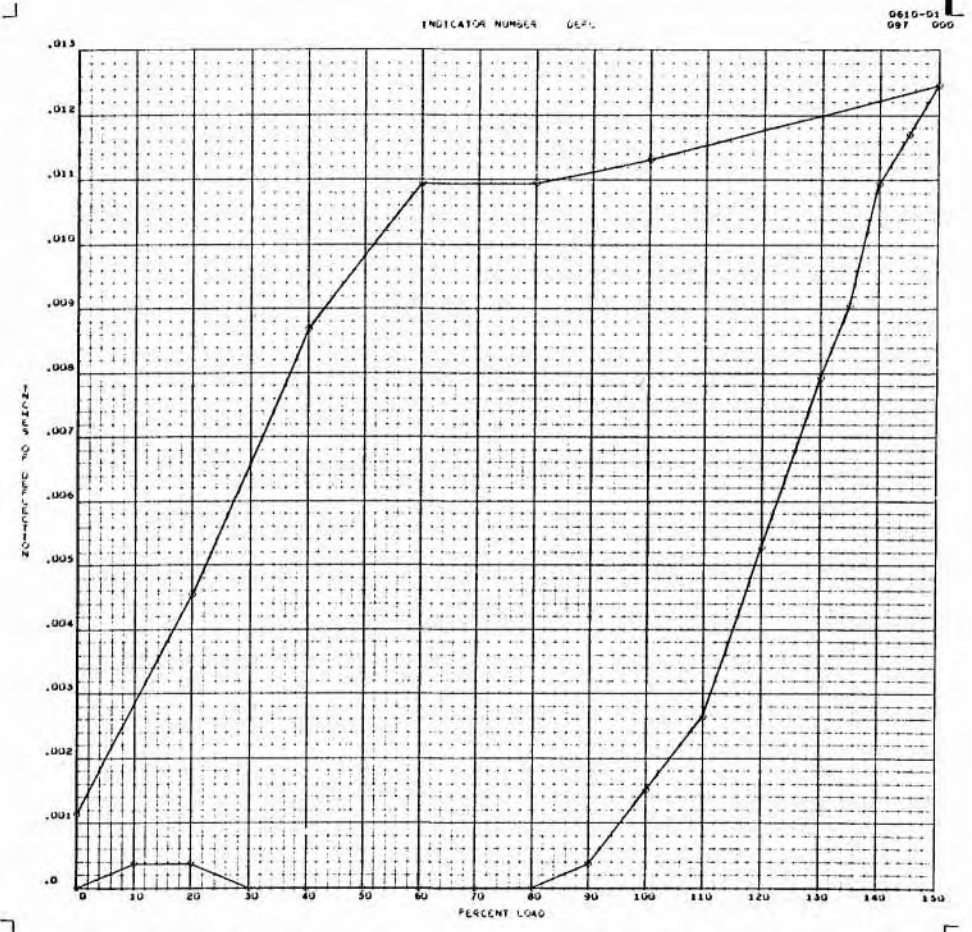
SID 67-317





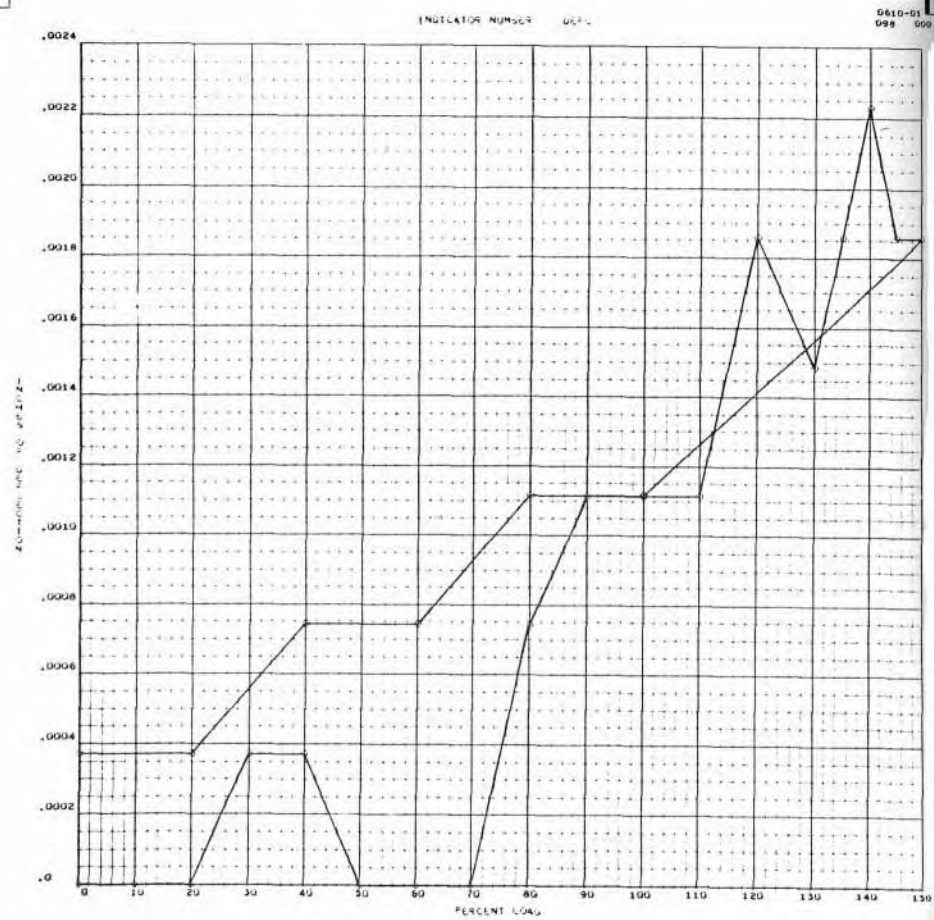
A-172

SID 67-317



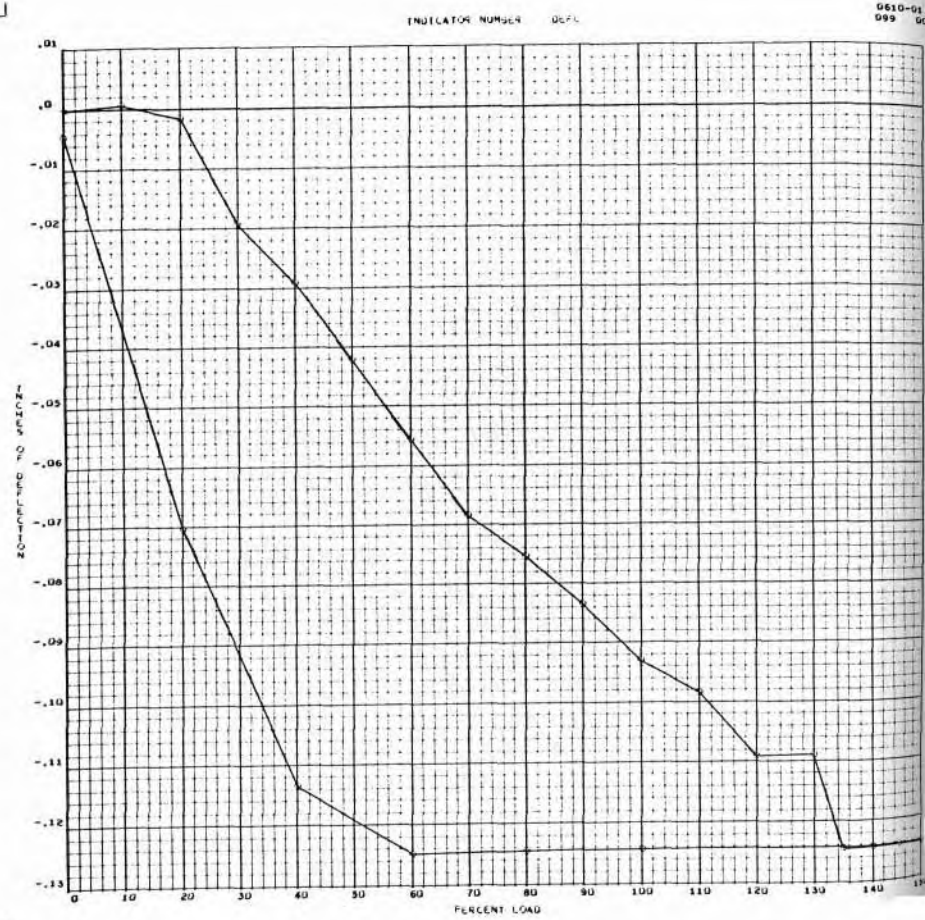
A-173

SID 67-317



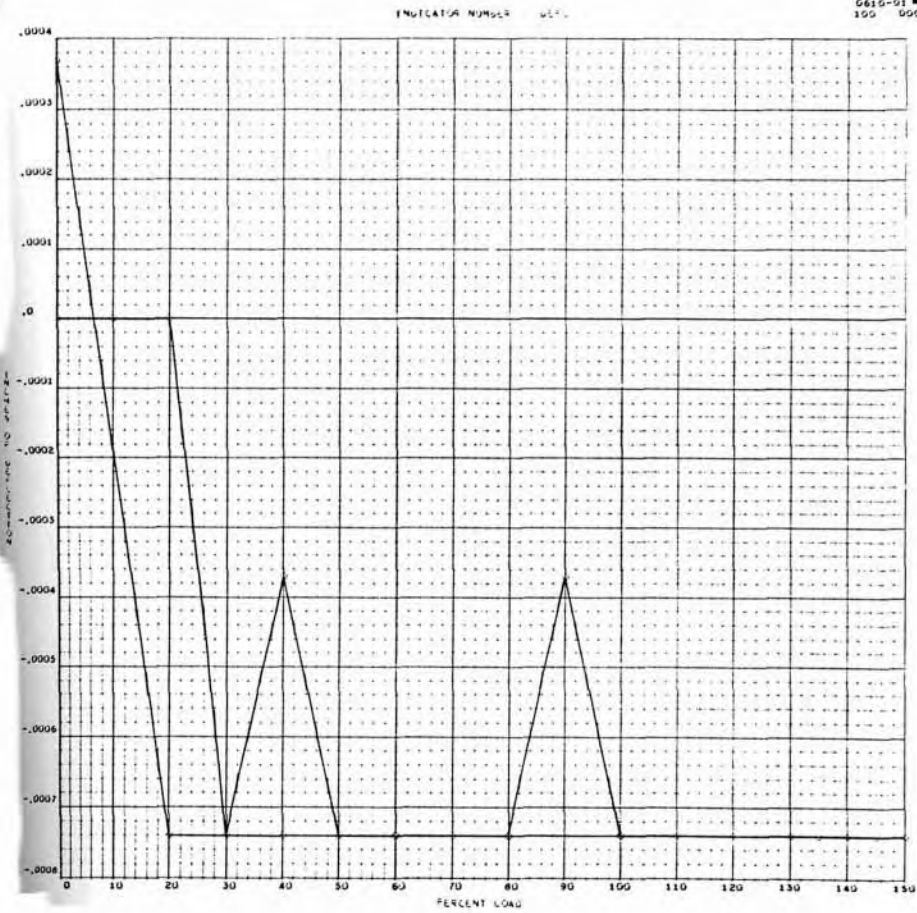
A-174

SID 67-317



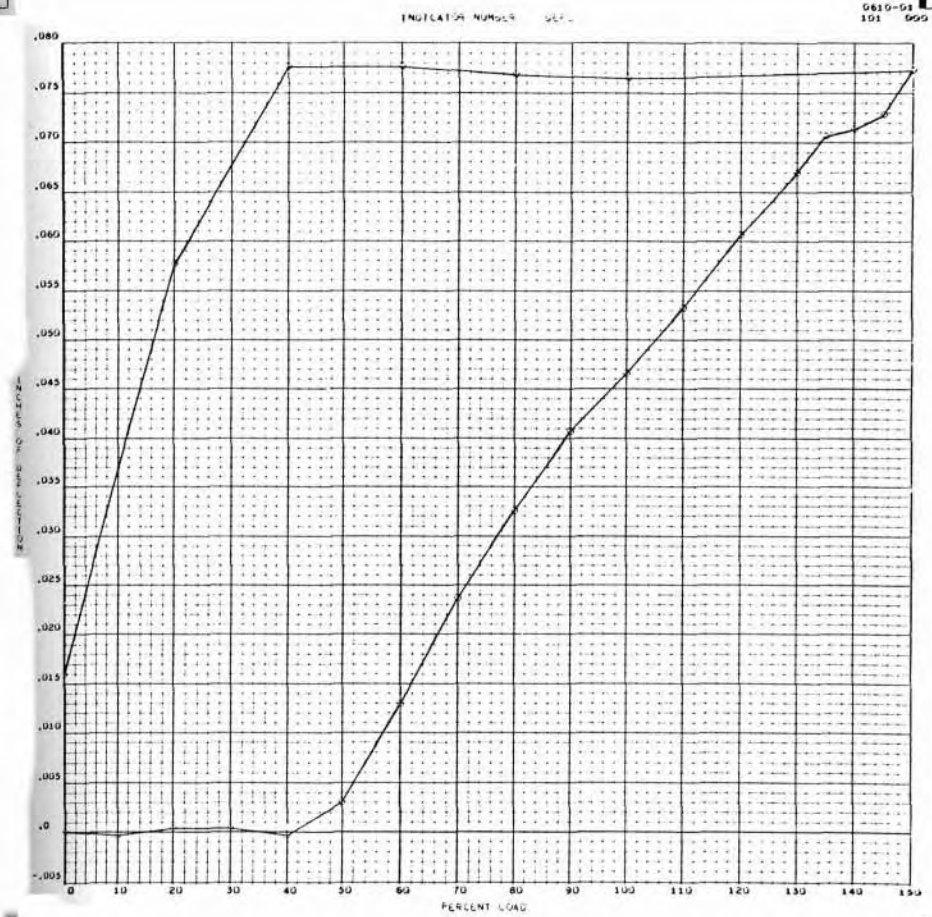
A-175

SID 67-317



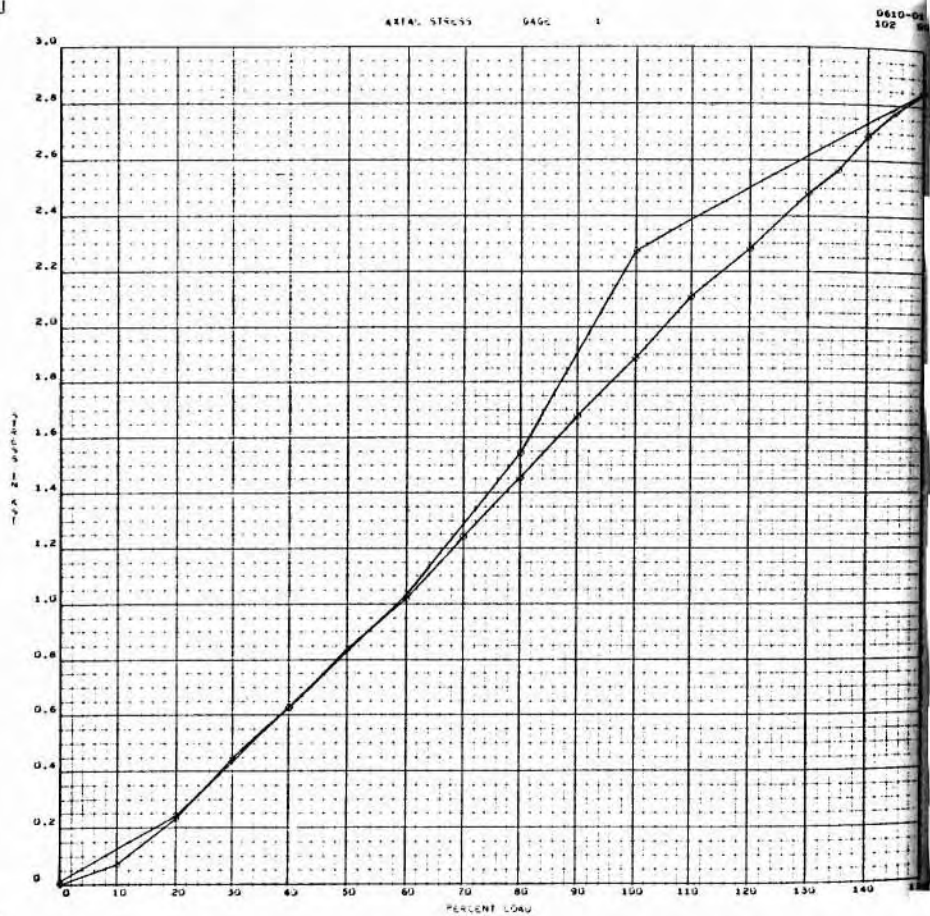
A-176

SID 67-317



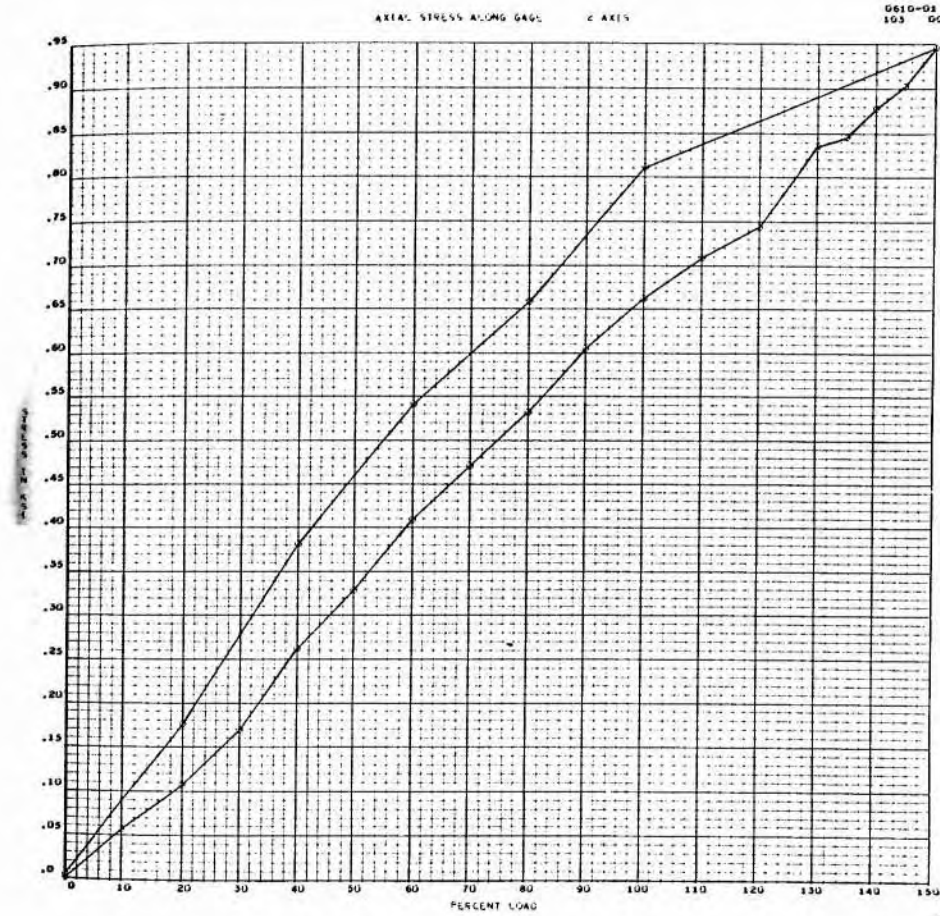
A-177

SID 67-317



A-178

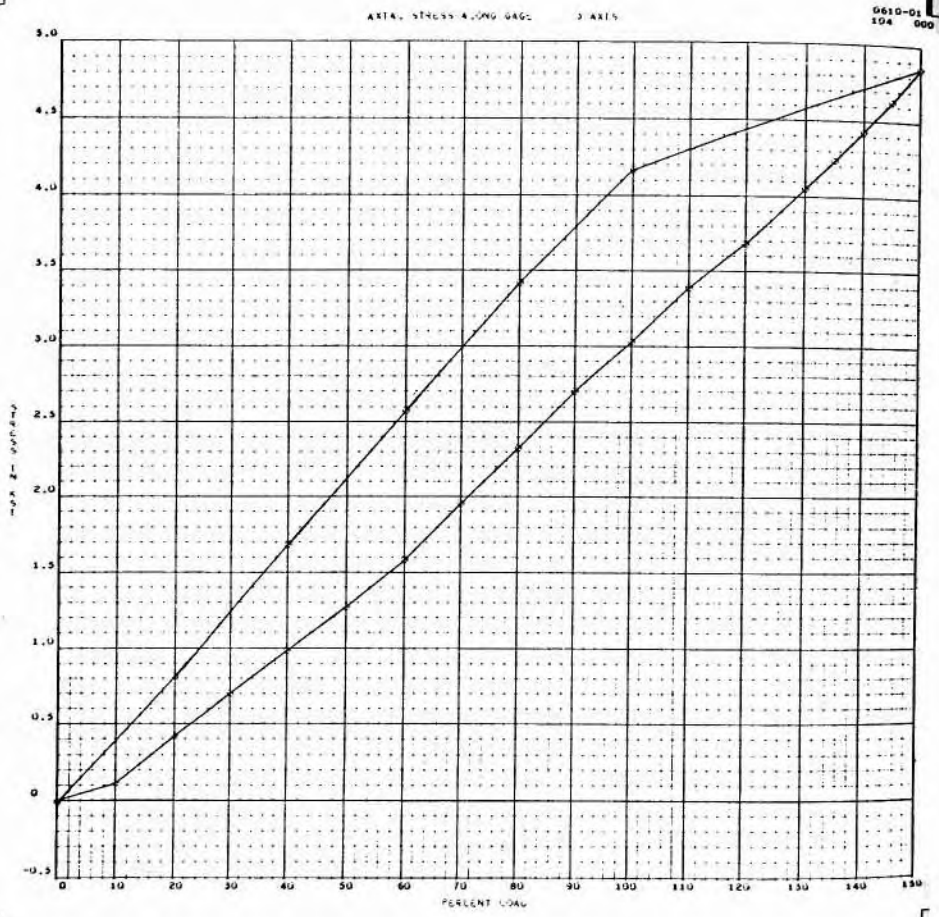
SID 67-317



A-179

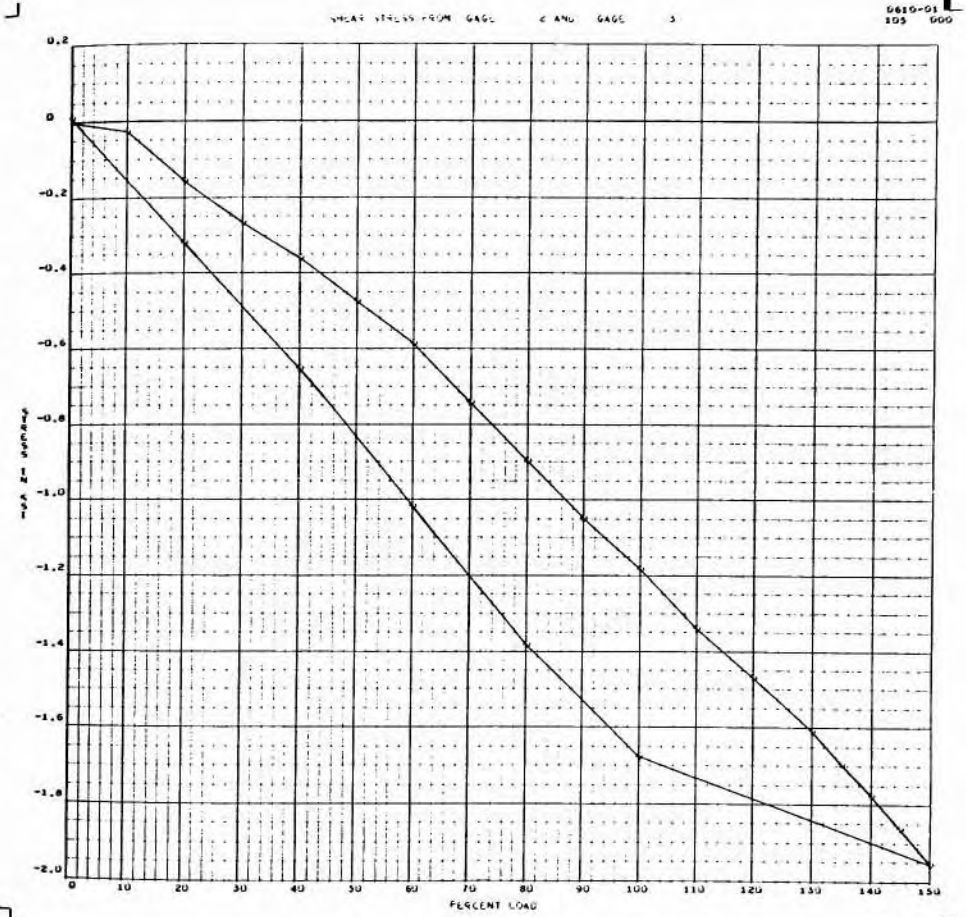
SID 67-317





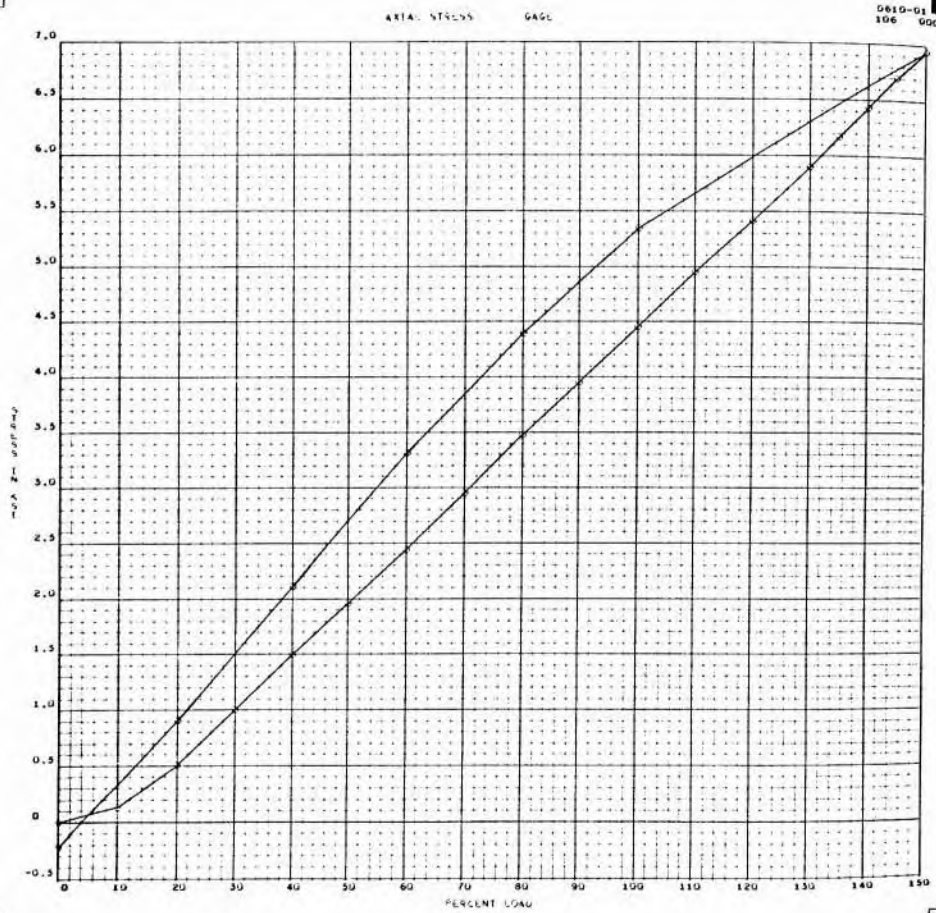
A-180

SID 67-317



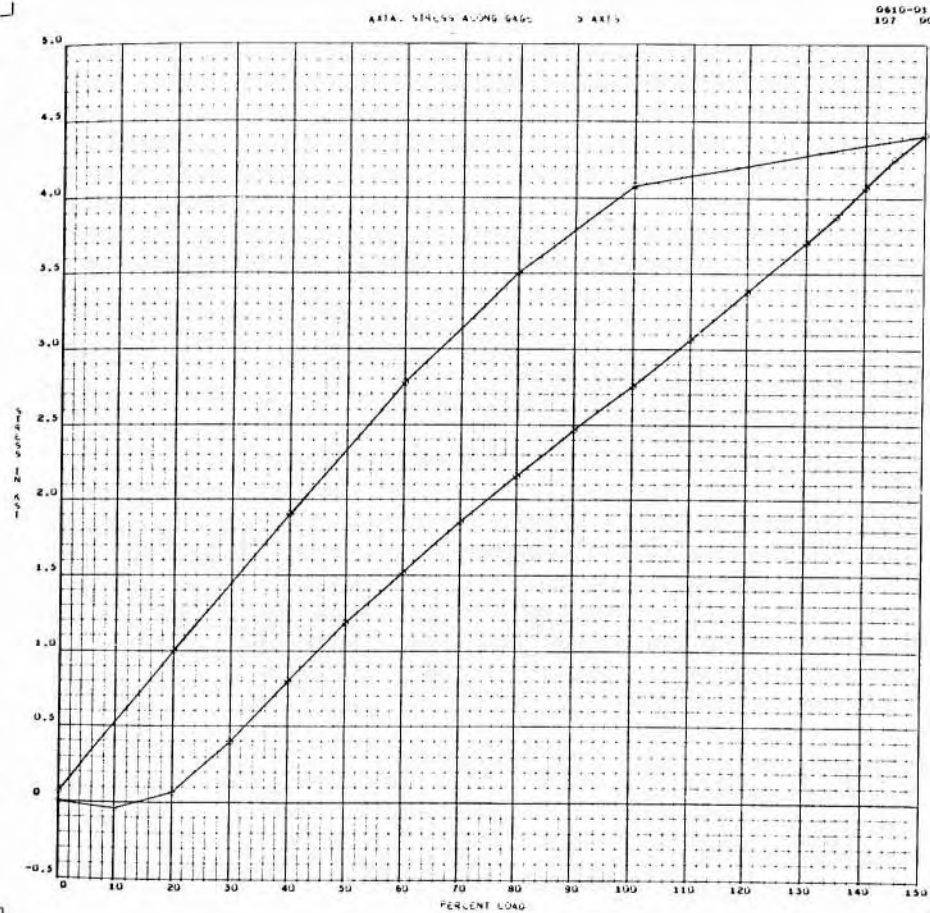
A-181

SID 67-317



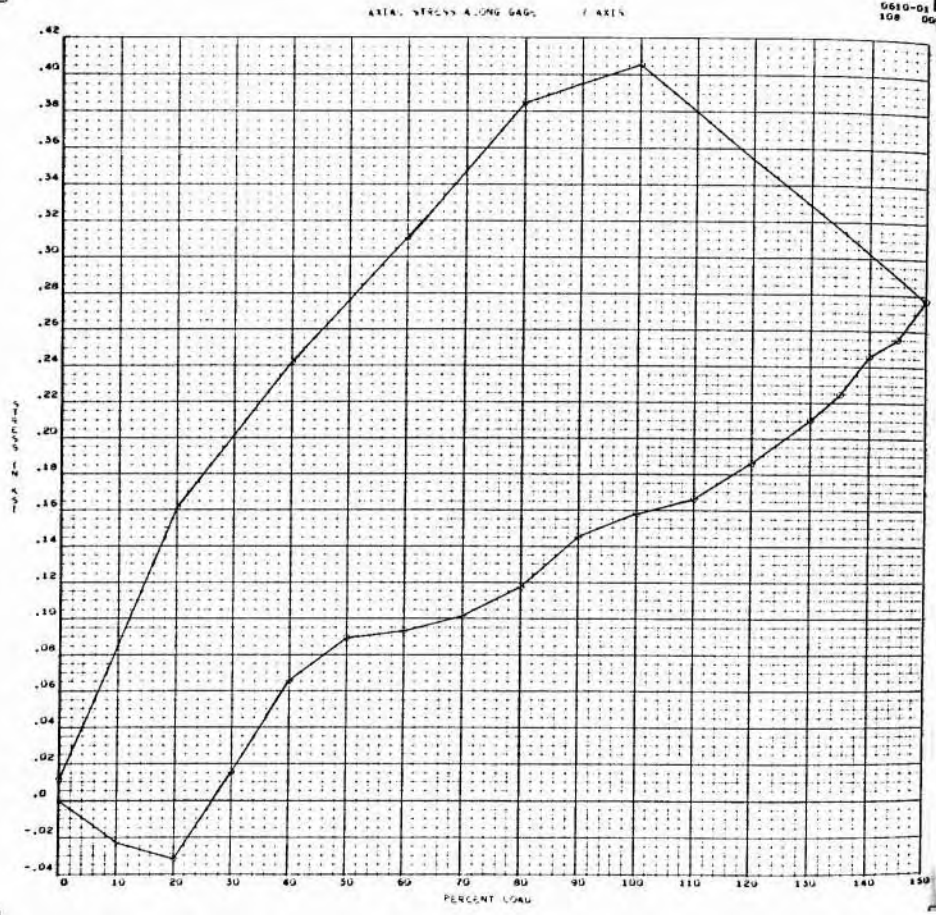
A-182

SID 67-317



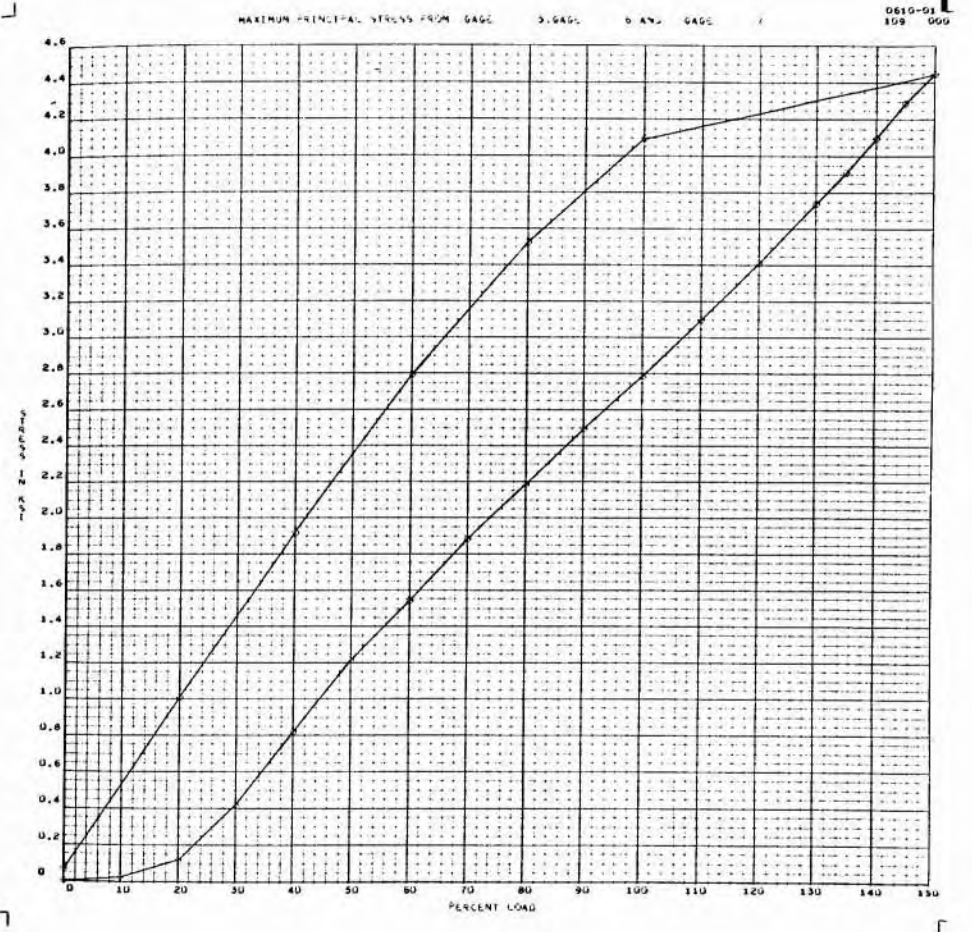
A-183

SID 67-317



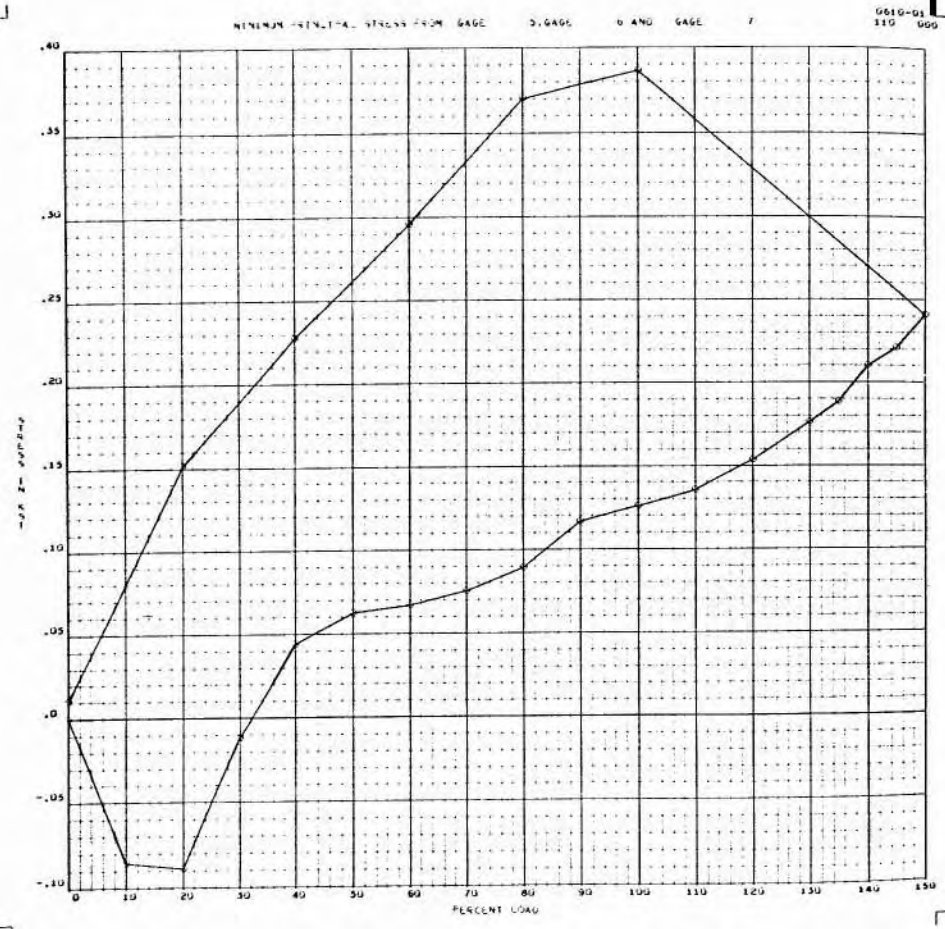
A-184

SID 67-317



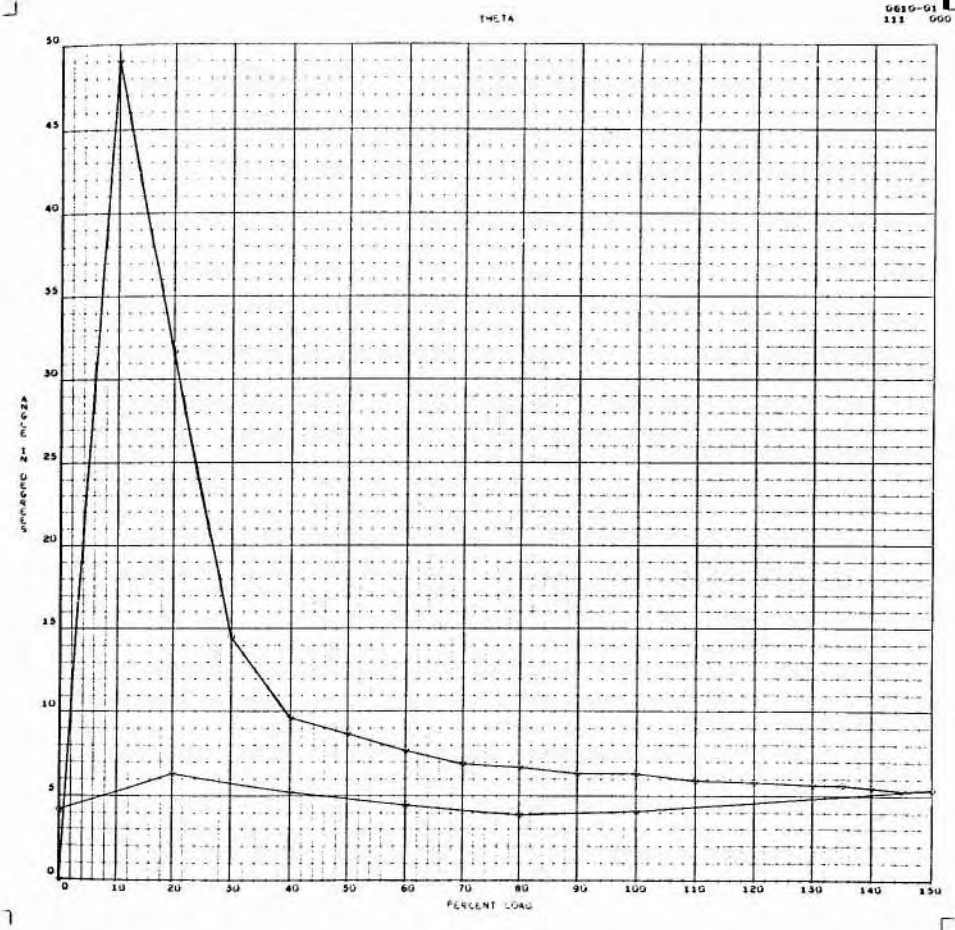
A-185

SID 67-317



A-186

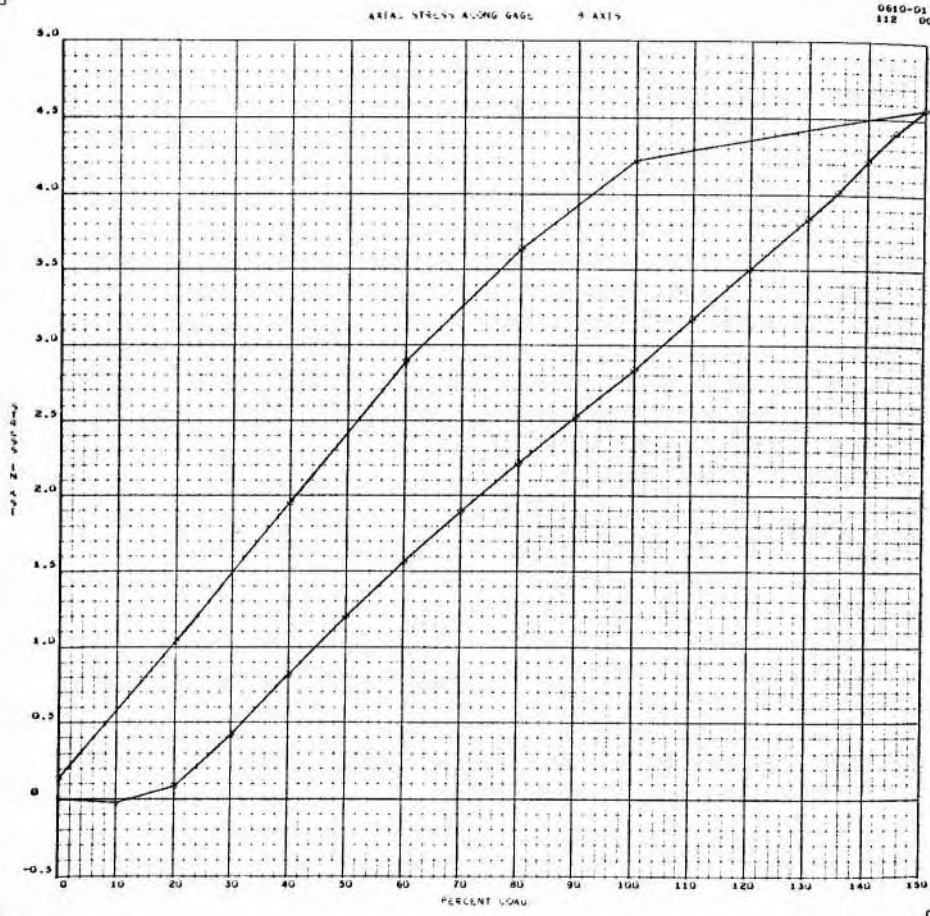
SID 67-317



A-187

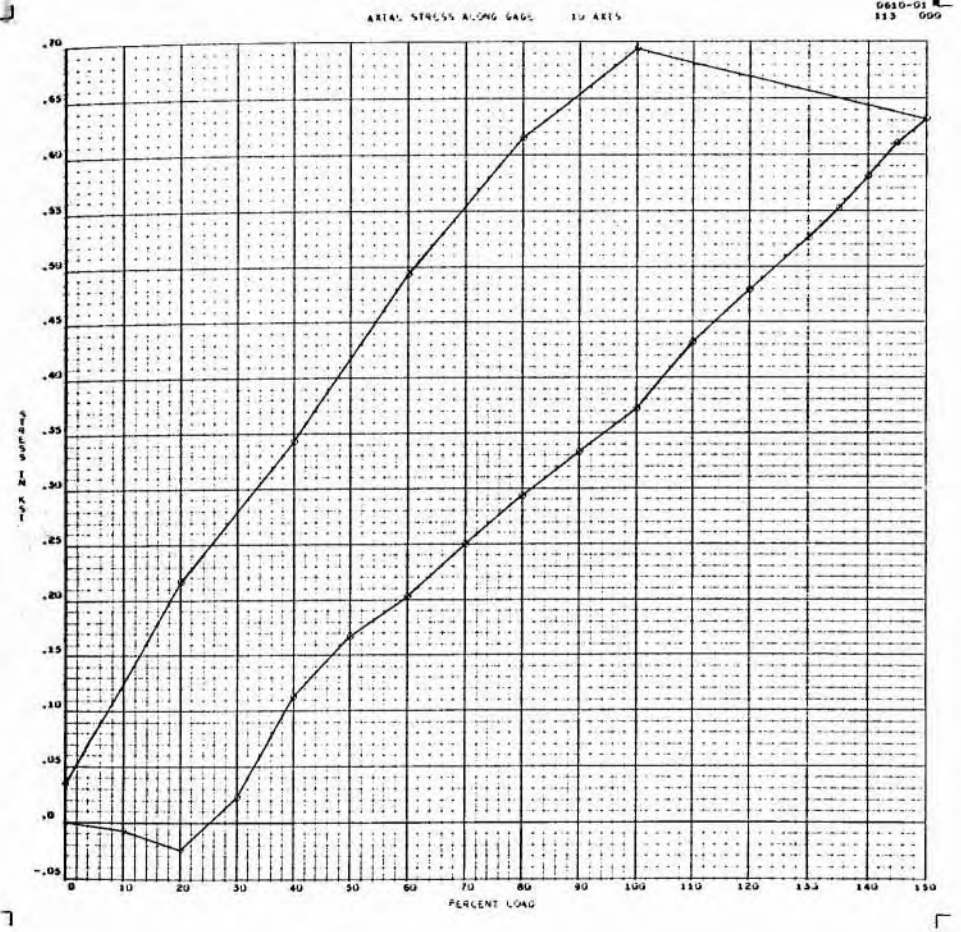
SID 67-317





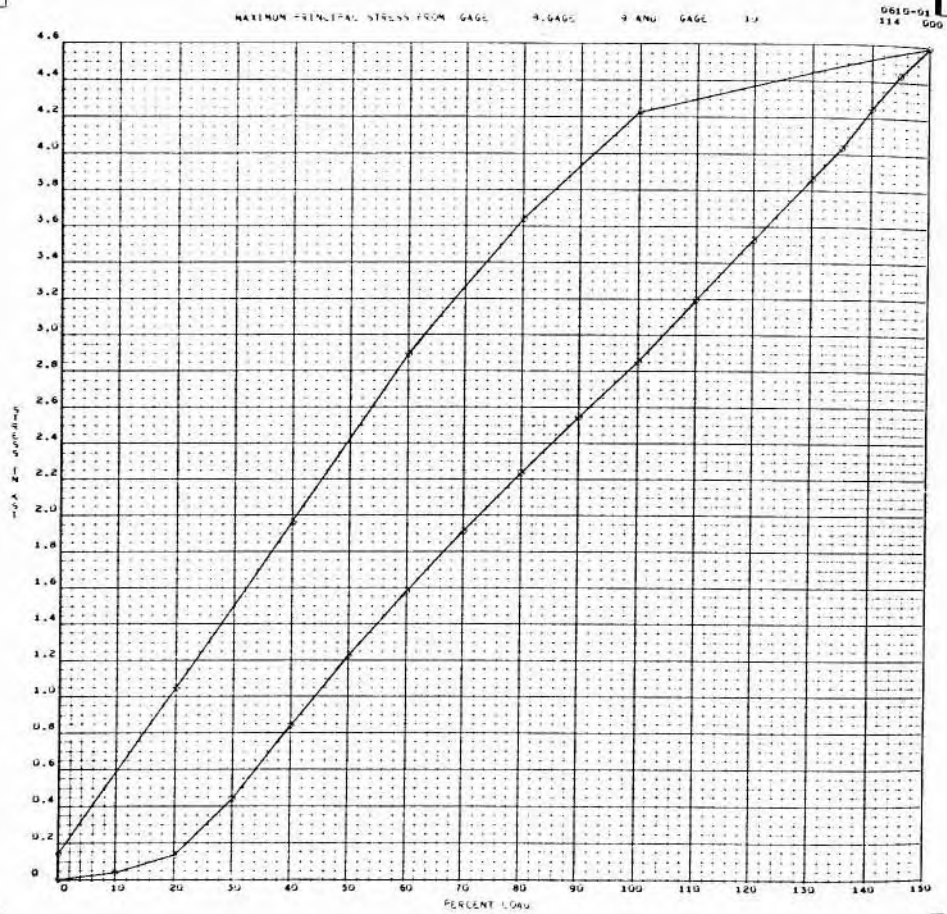
A-188

SID 67-317



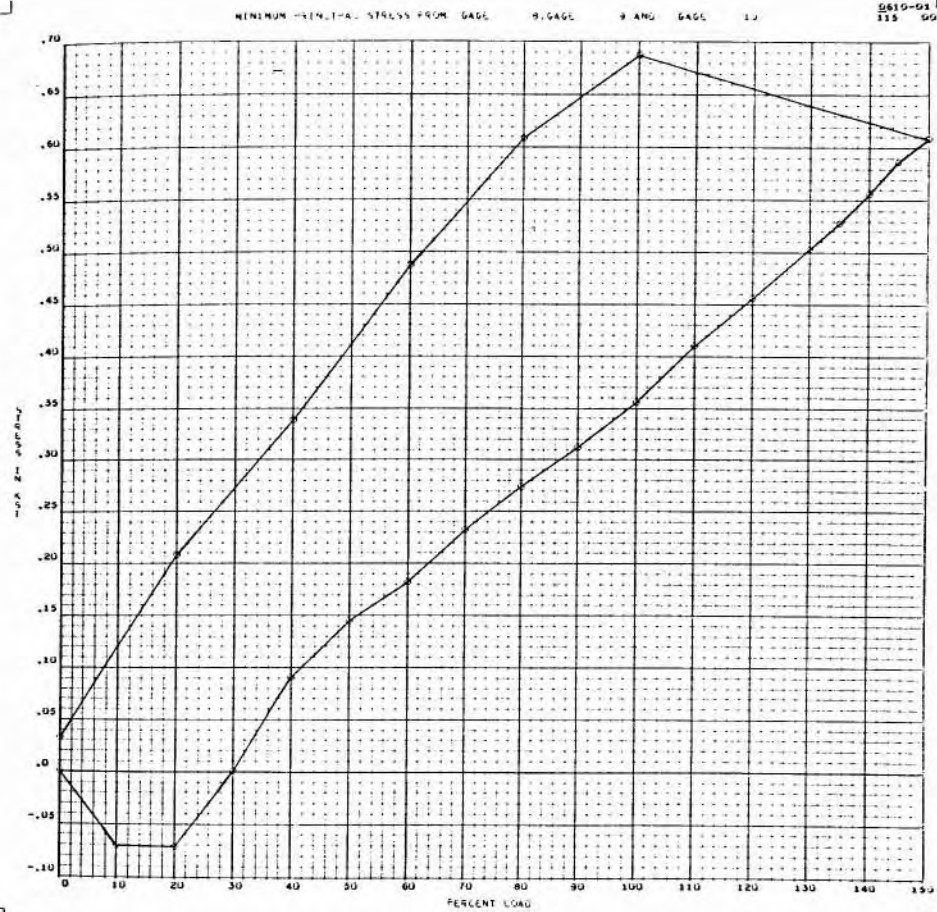
A-189

SID 67-317



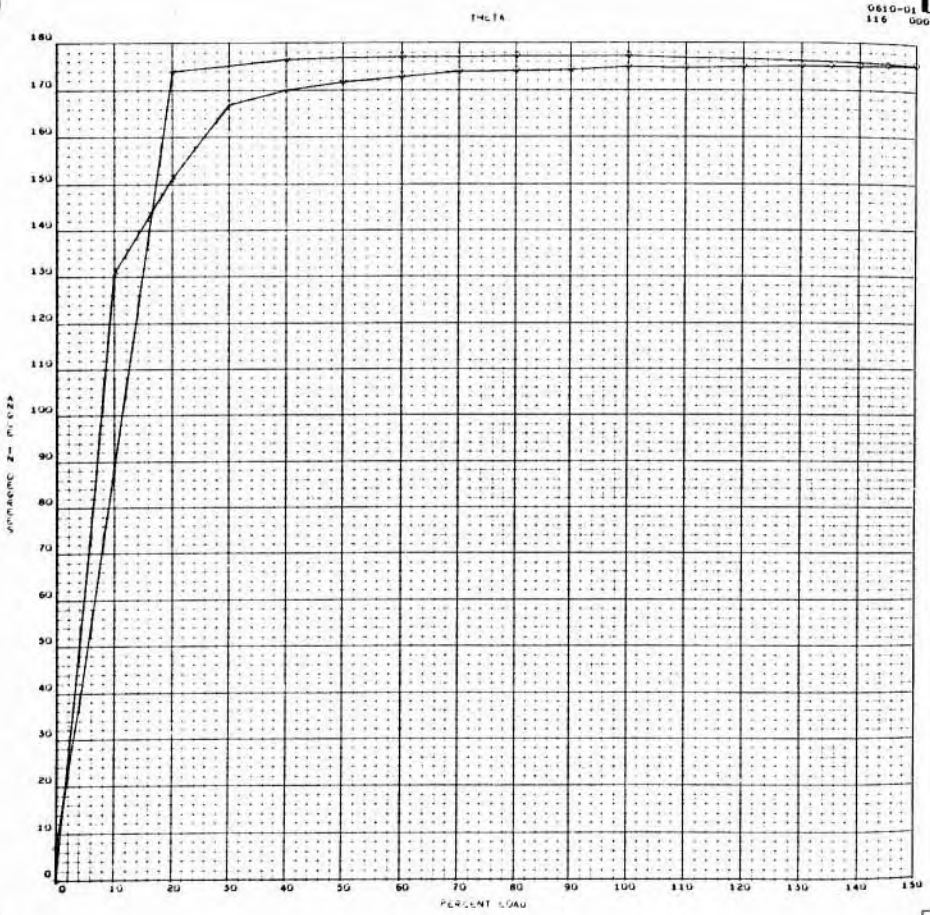
A-190

SID 67-317



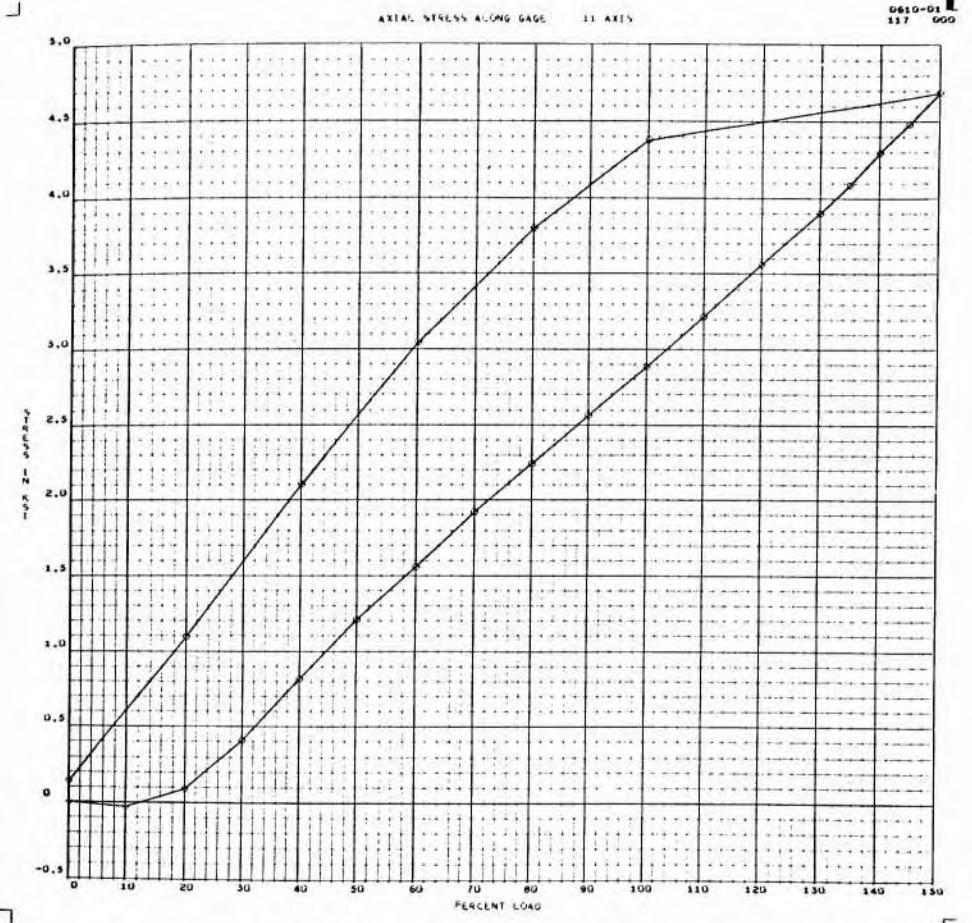
A-191

SID 67-317



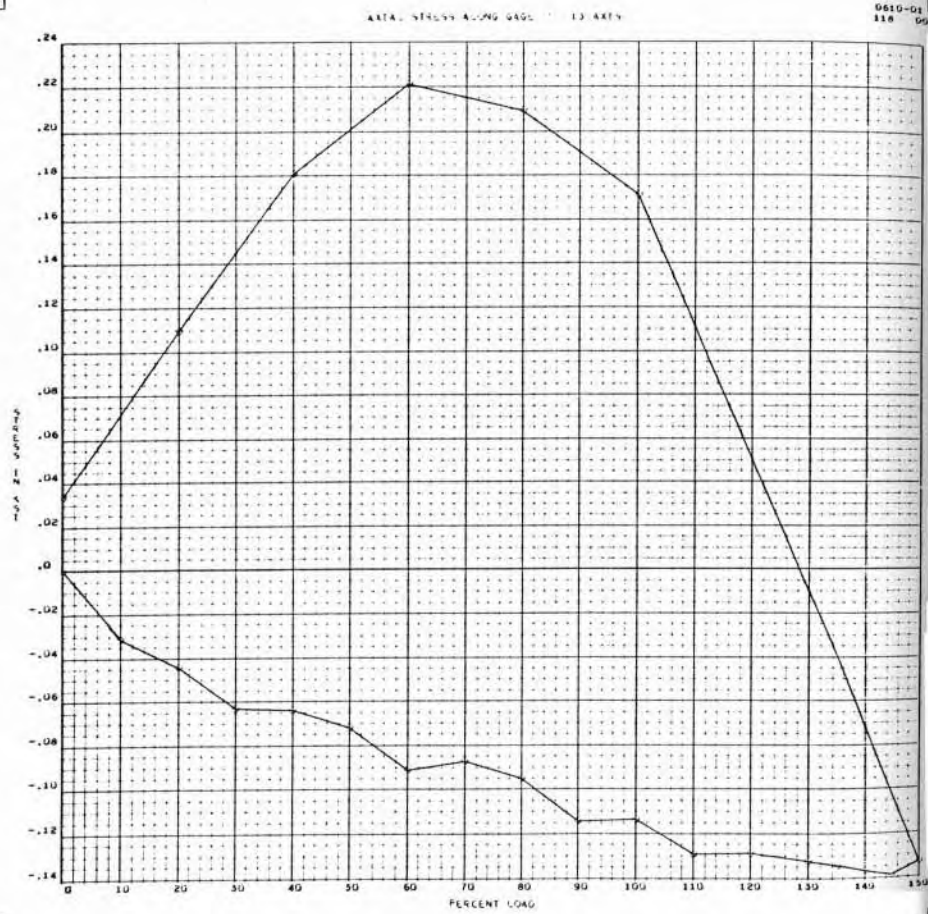
A-192

SID 67-317



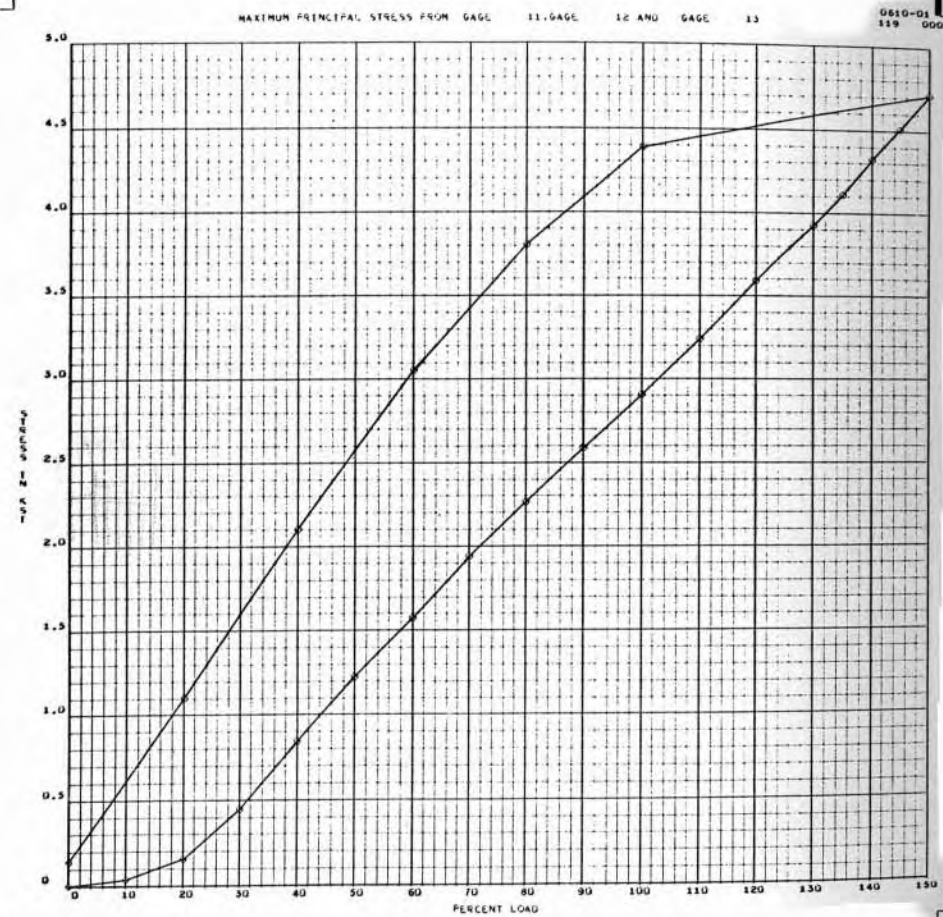
A-193

SID 67-317



A-194

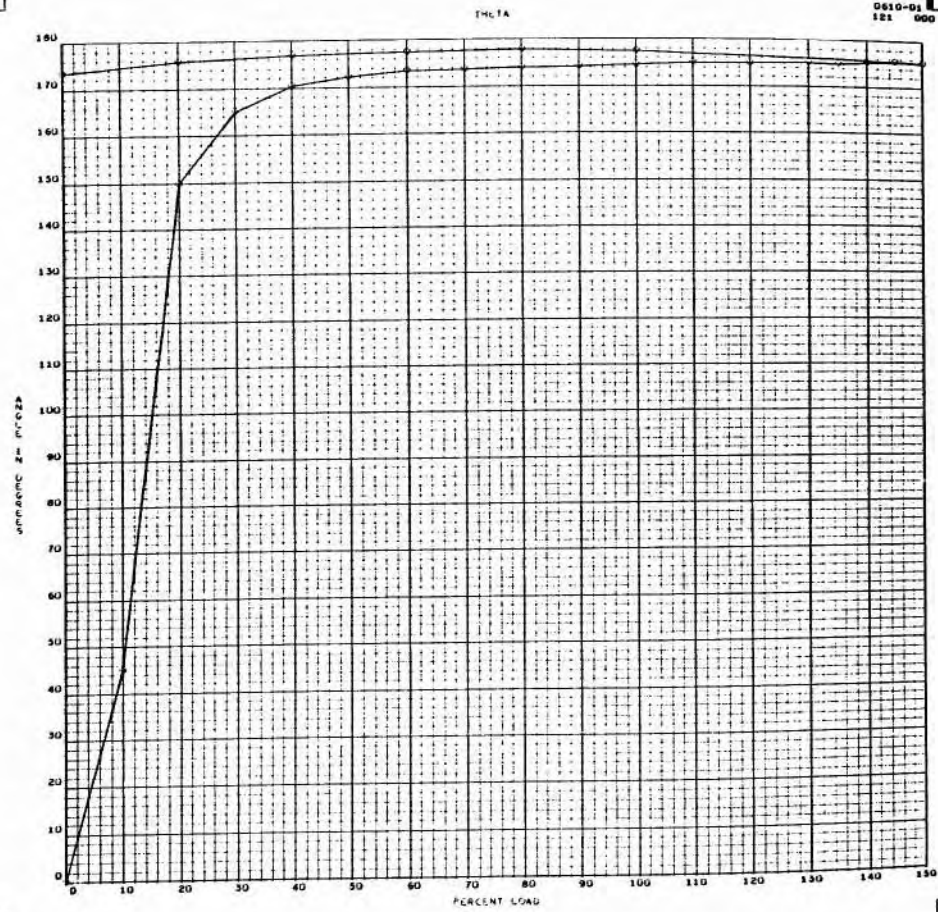
SID 67-317



A-195

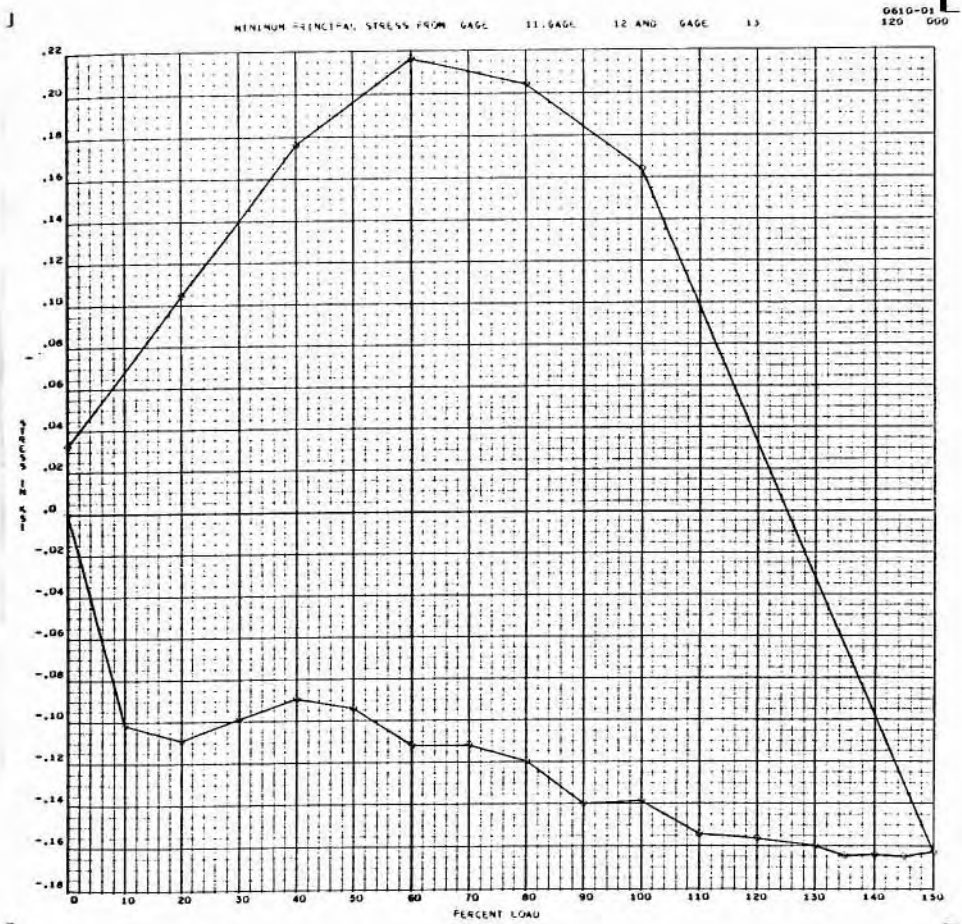
SID 67-317





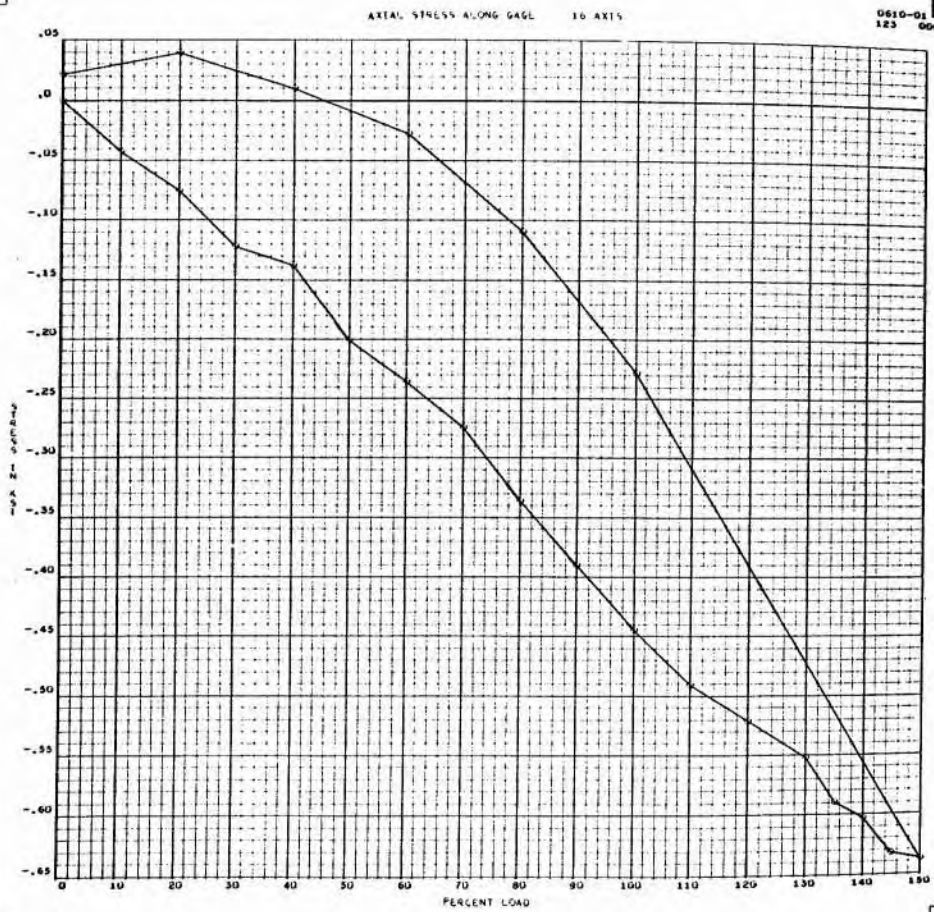
A-197

SID 67-317



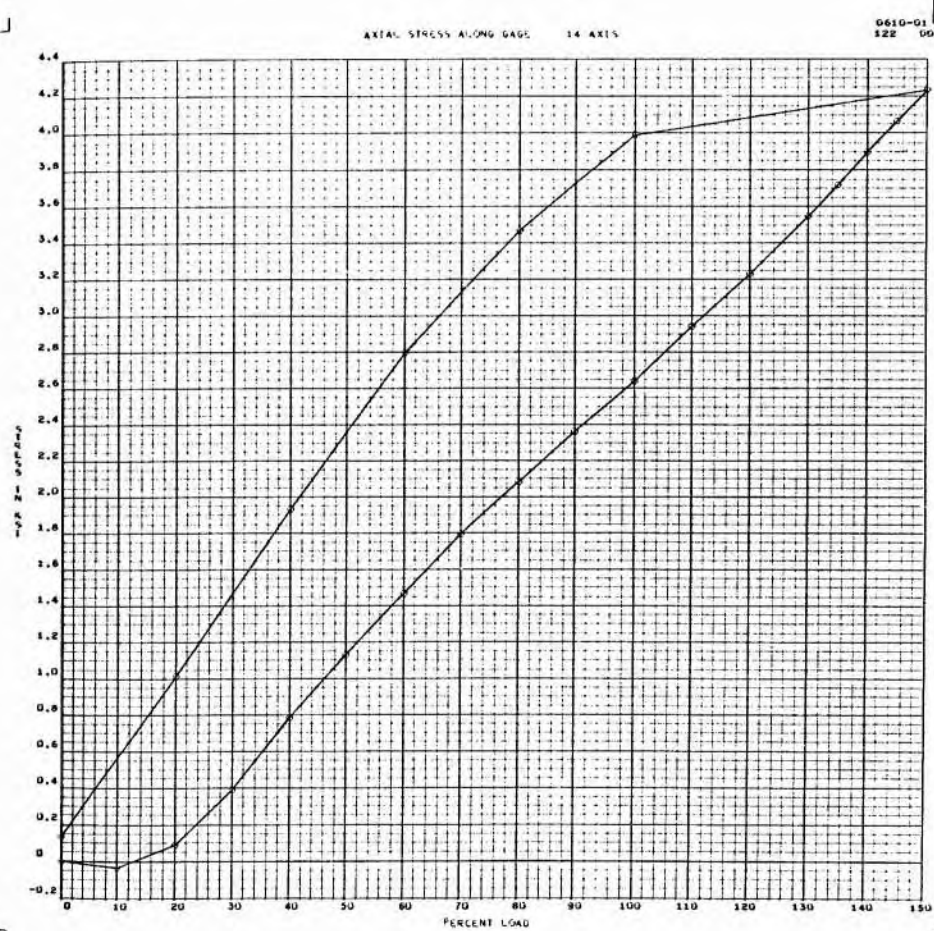
A-196

SID 67-317



A-199

SID 67-317

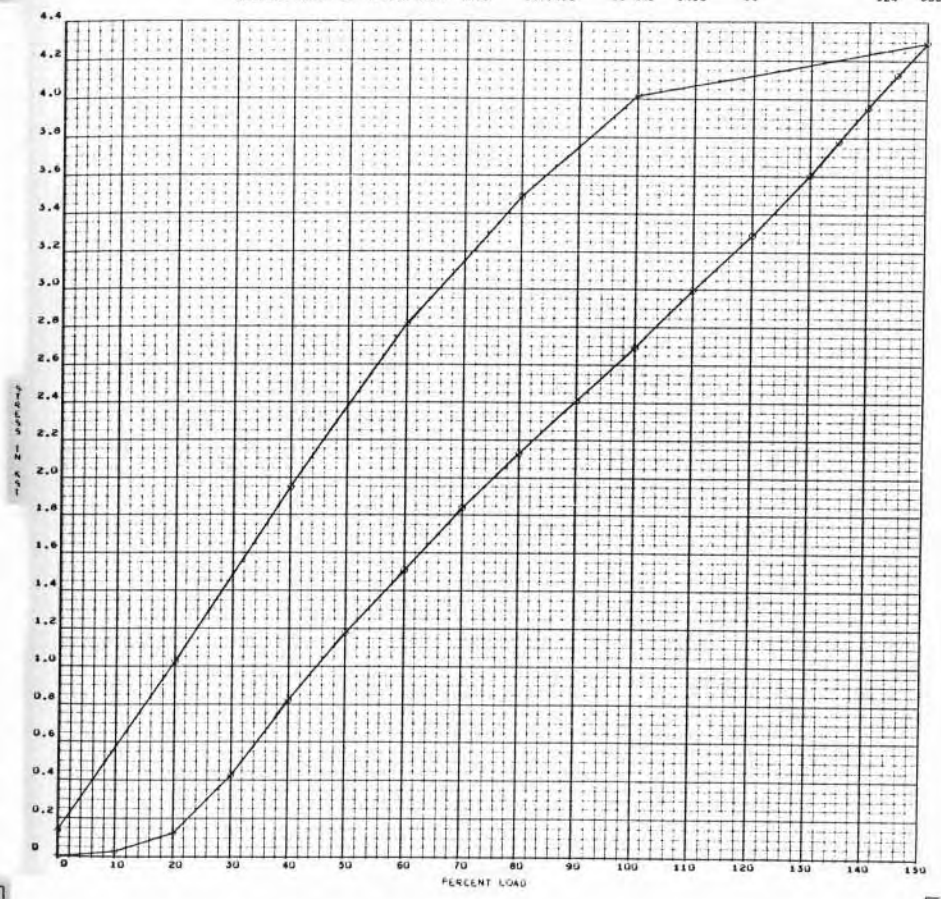


A-198

SID 67-317

MAXIMUM PRINCIPAL STRESS FROM GAGE 14, GAGE 13 AND GAGE 16

0610-01  
124 000

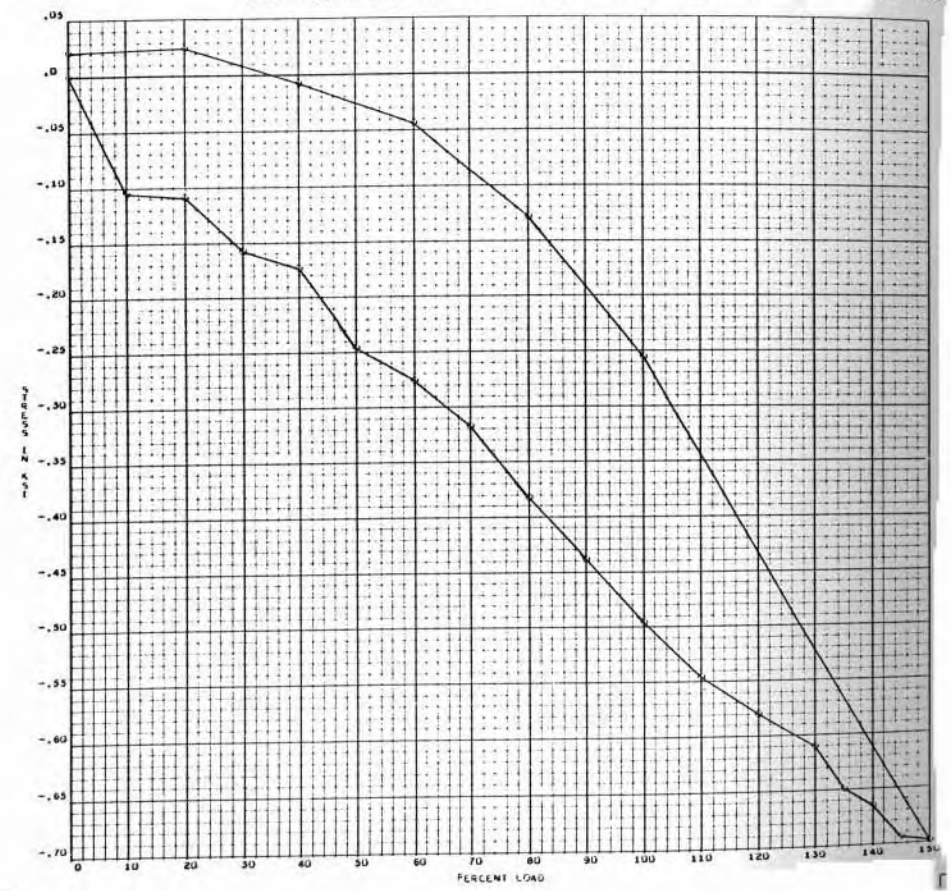


A-200

SID 67-317

MINIMUM PRINCIPAL STRESS FROM GAGE 14, GAGE 13 AND GAGE 16

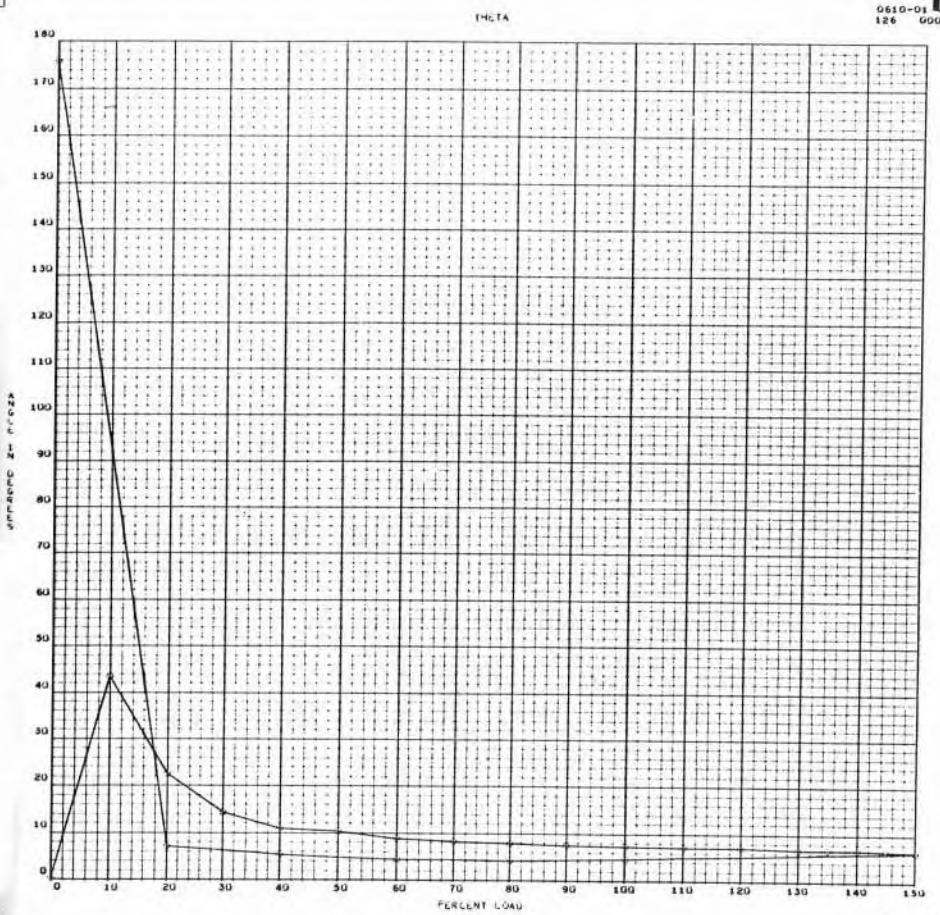
0610-01  
123 000



A-201

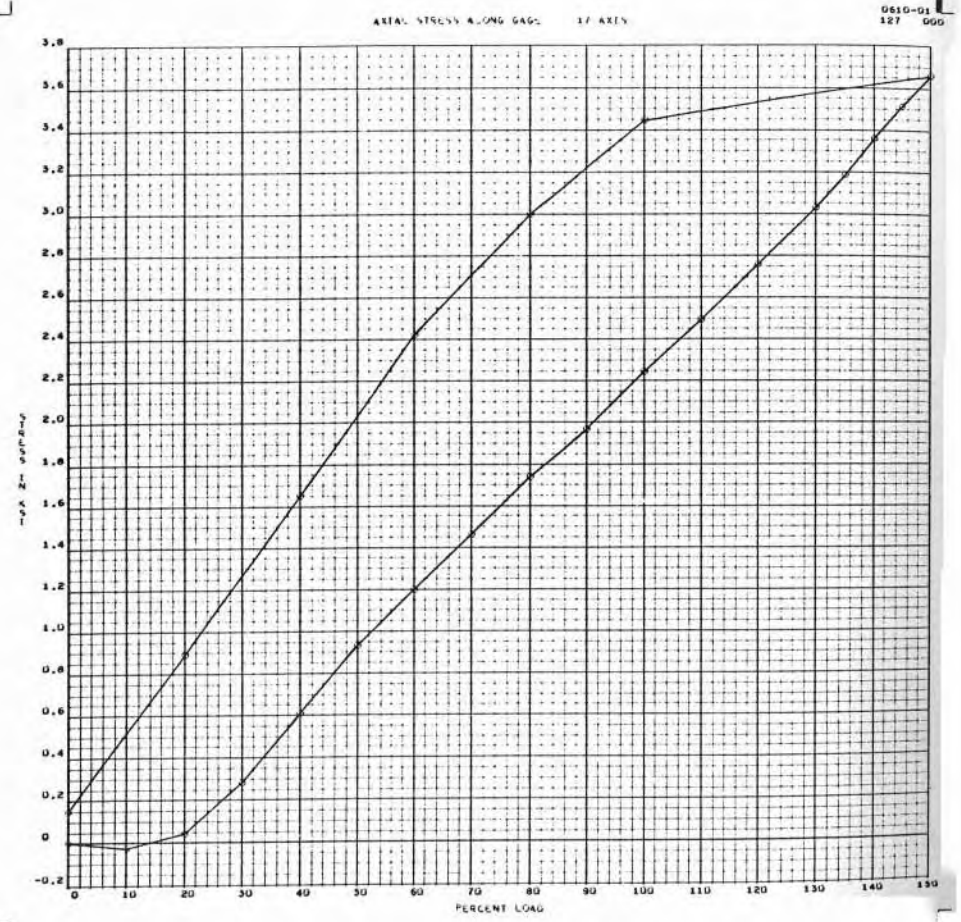
SID 67-317





A-202

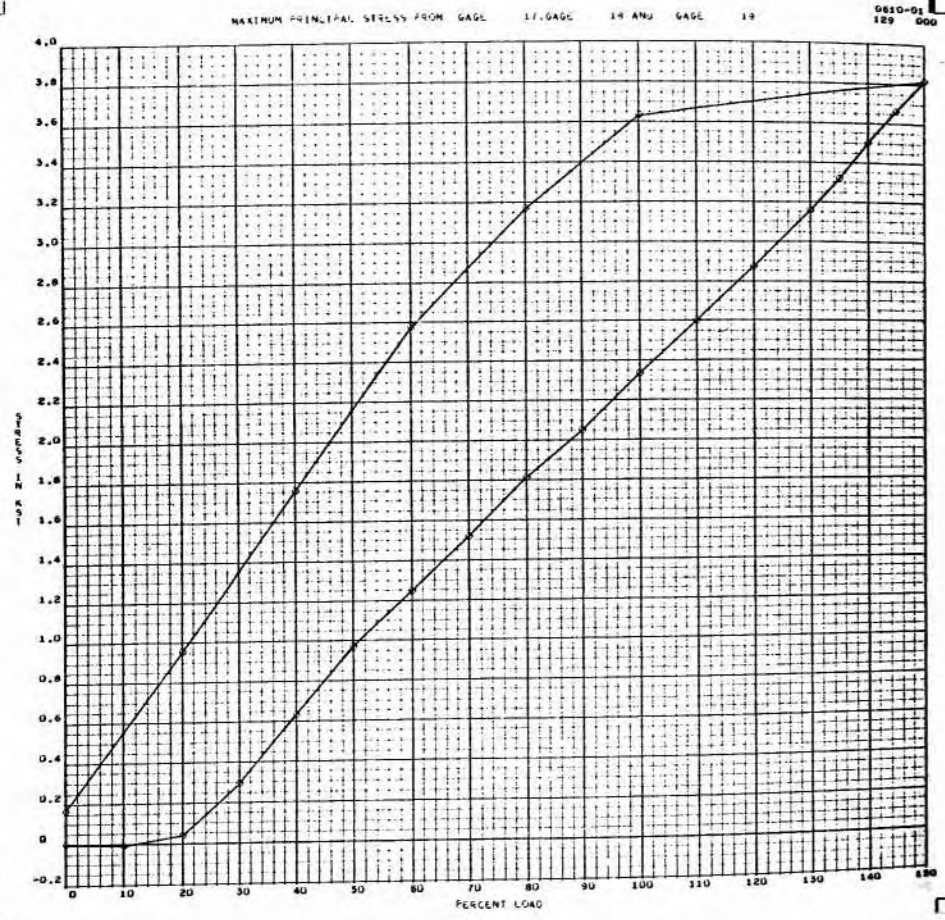
SID 67-317



A-203

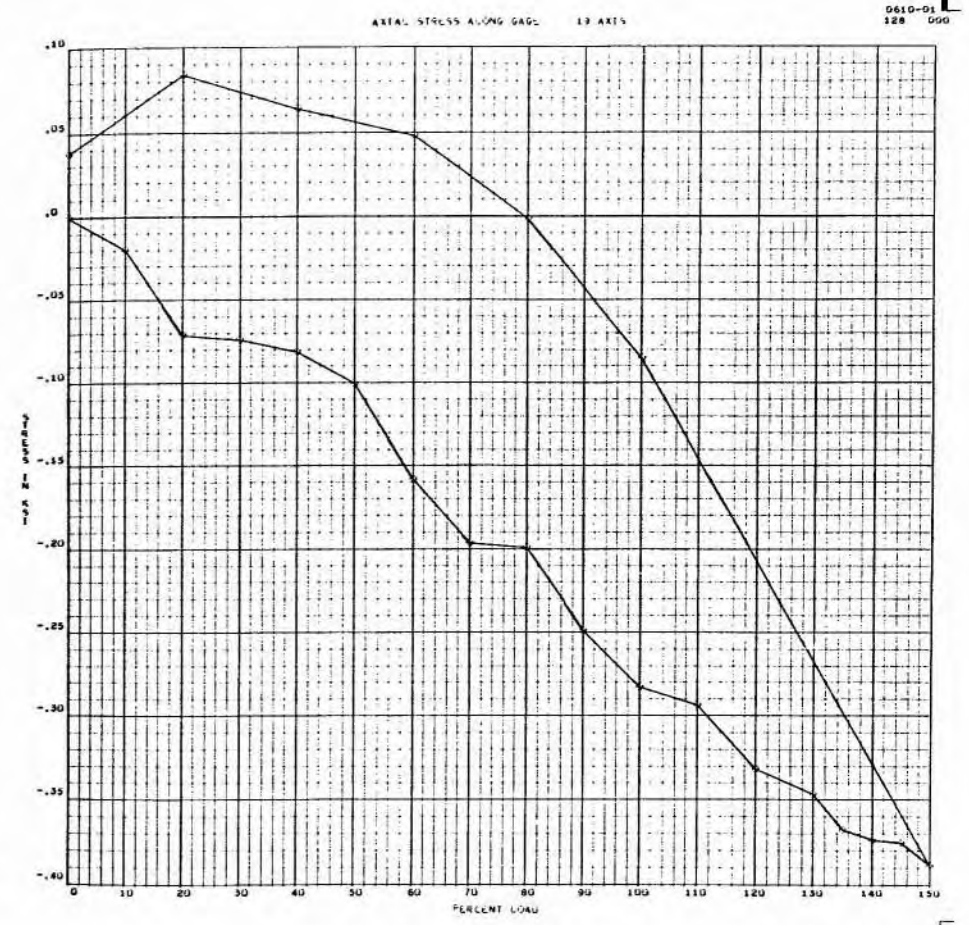
SID 67-317





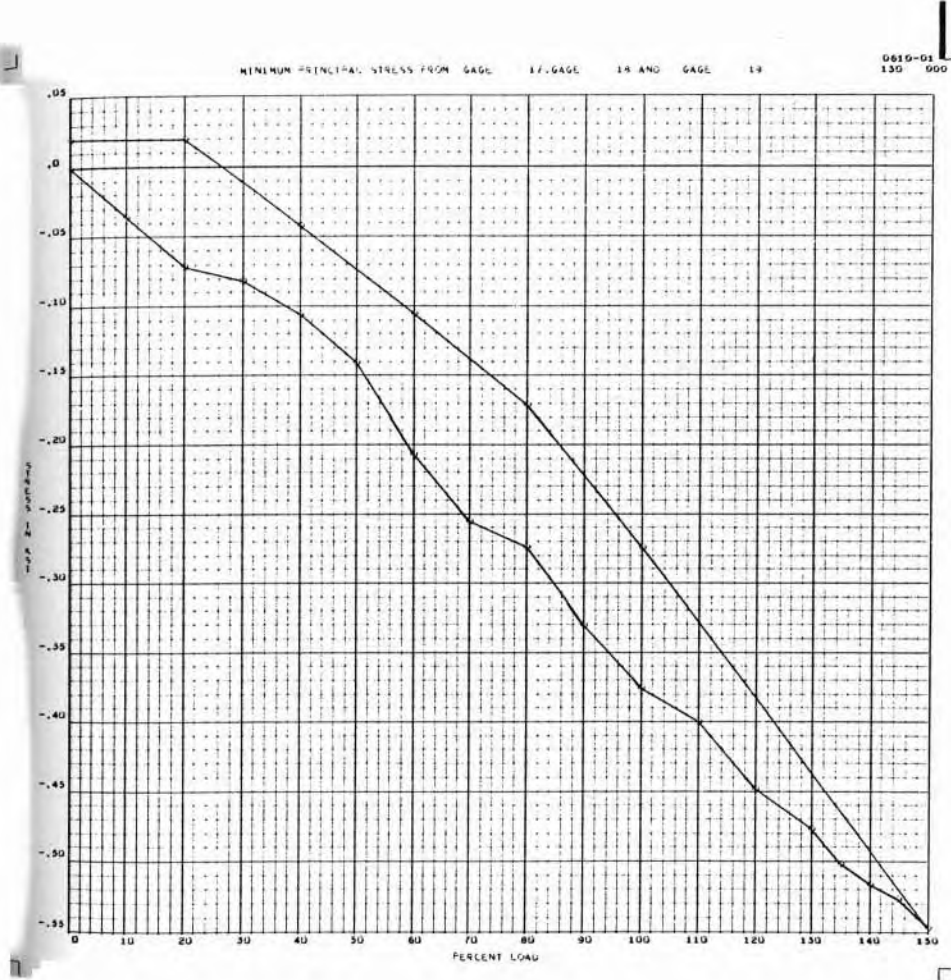
A-205

SID 67-317



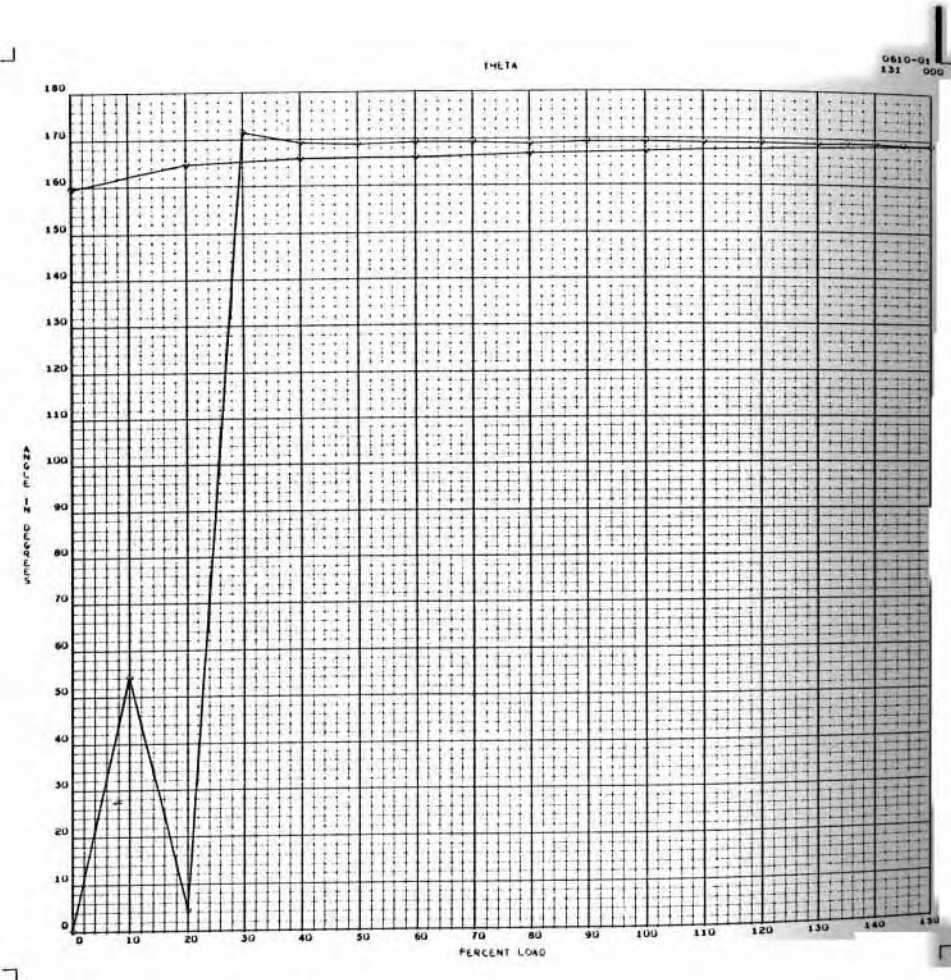
A-204

SID 67-317



A-206

SID 67-317

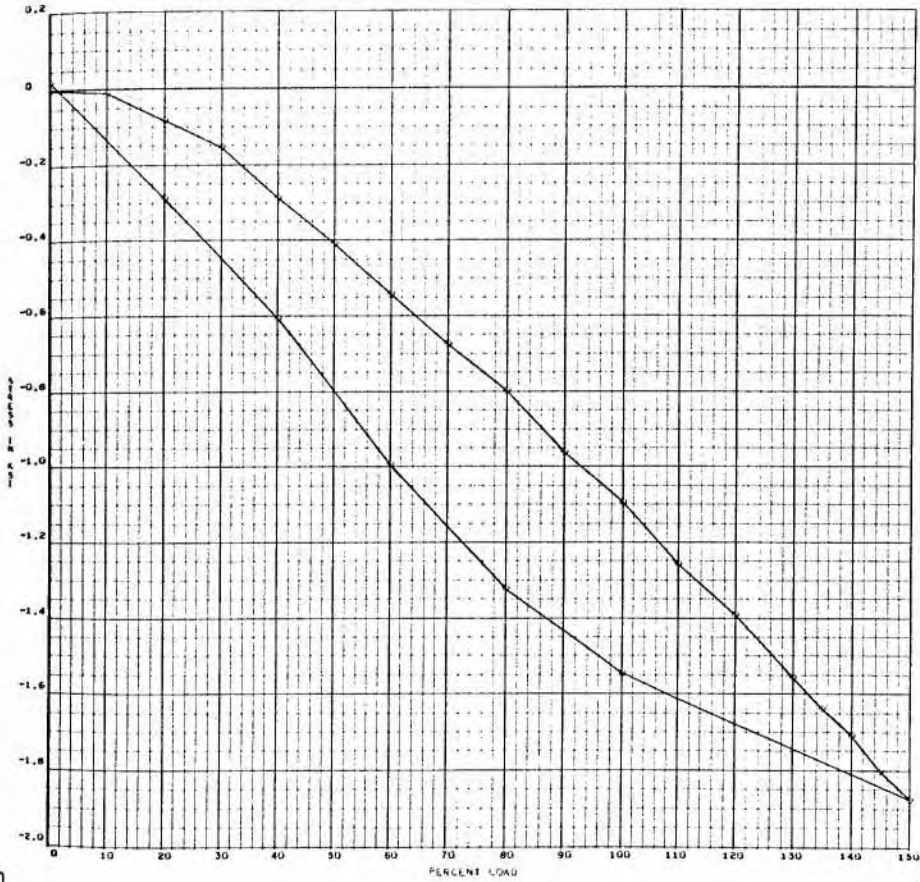


A-207

SID 67-317

AXIAL STRESS GAGE 21

0610-01  
133 000

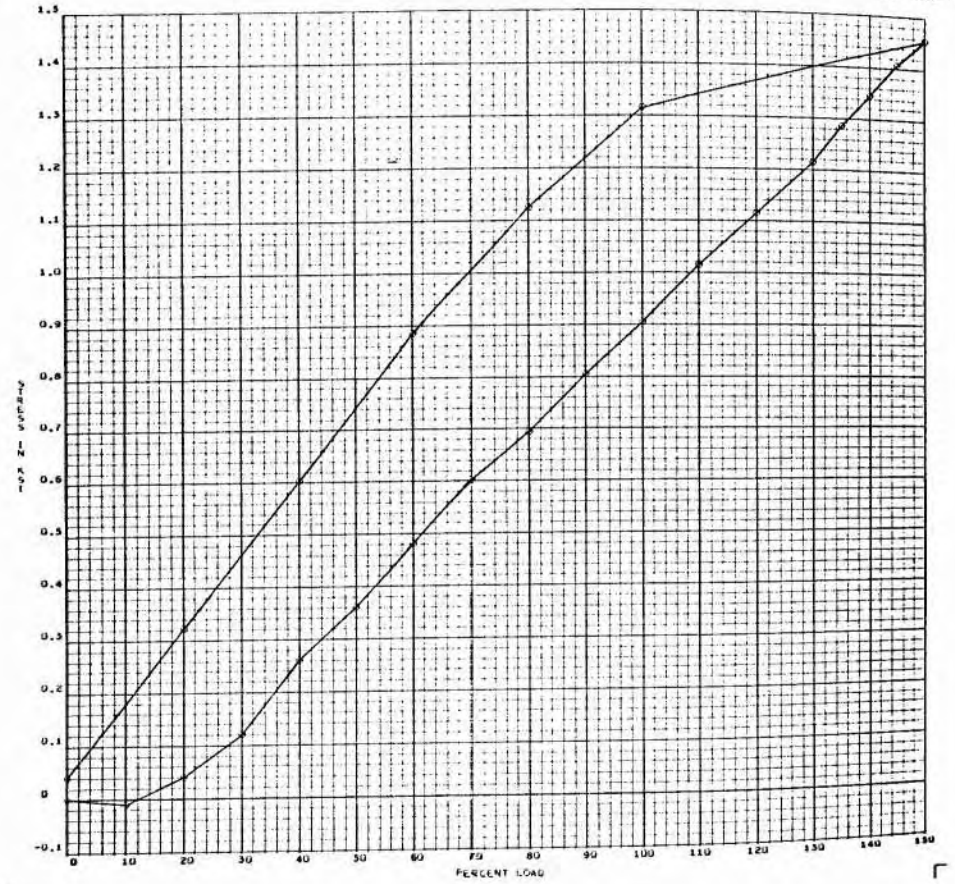


A-208

SID 67-317

AXIAL STRESS GAGE 22

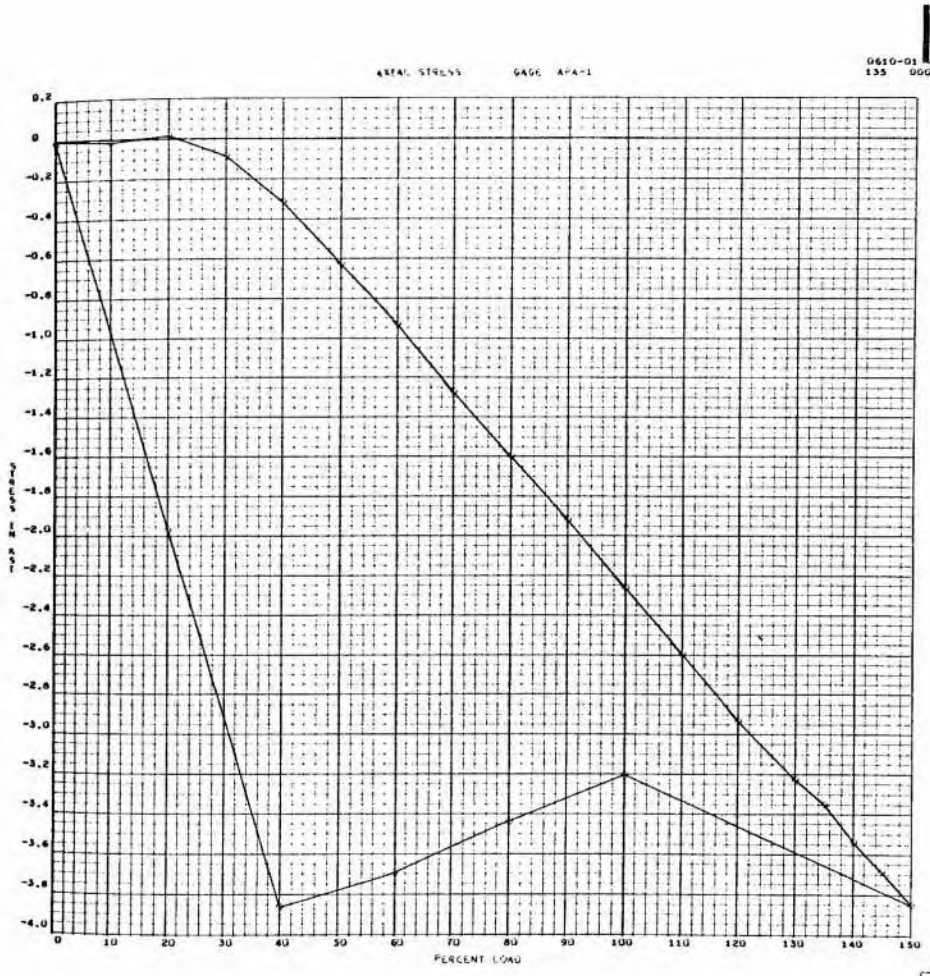
0610-01  
134 000



A-209

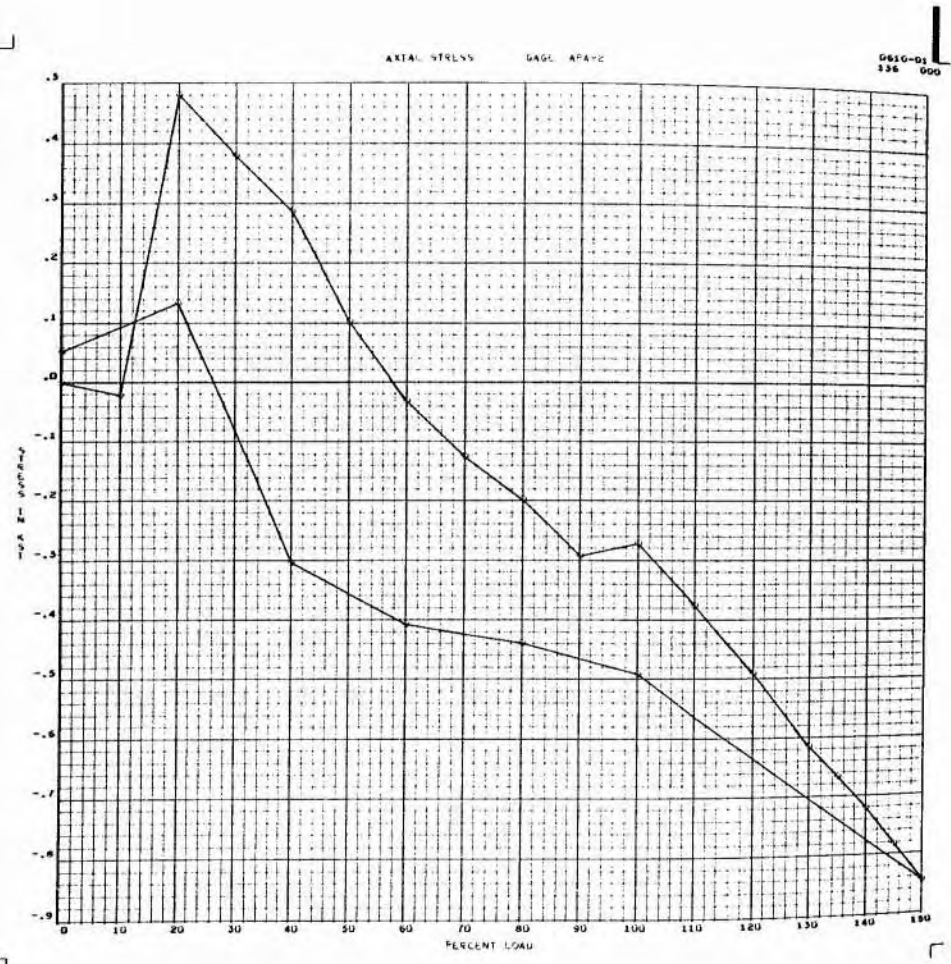
SID 67-317





A-210

SID 67-317



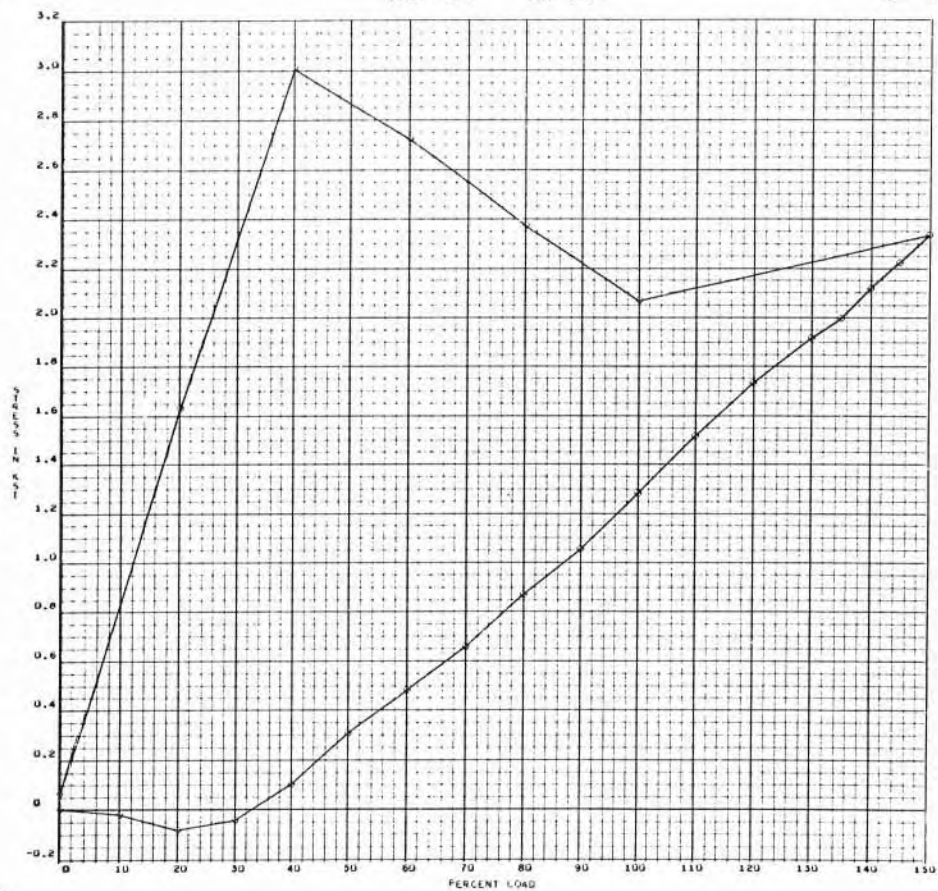
A-211

SID 67-317



AXIAL STRESS GAGE APA-3

0610-01  
137 000

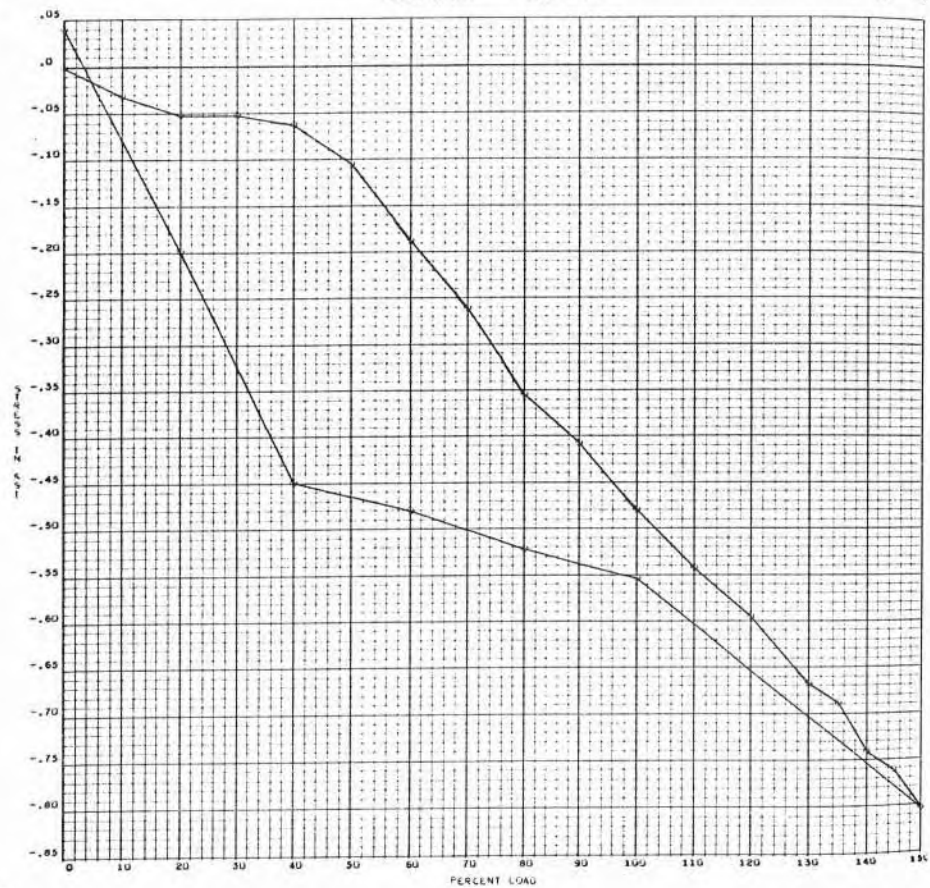


A-212

SID 67-317

AXIAL STRESS GAGE APA-4

0610-01  
138 00

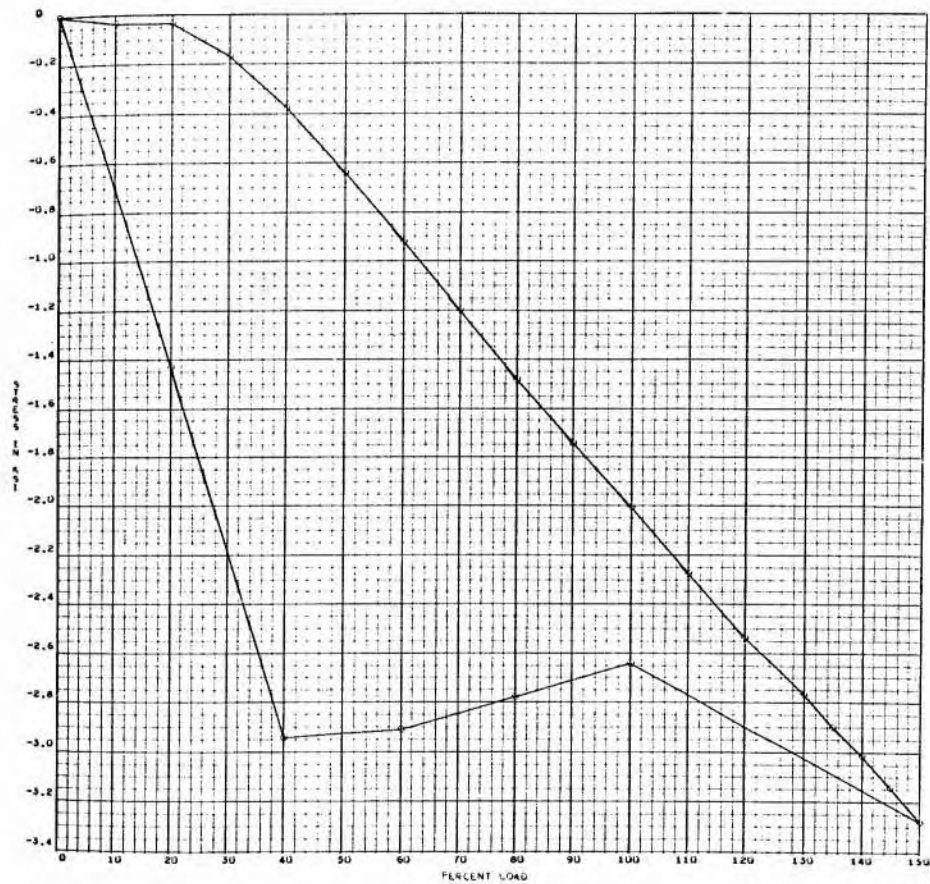


A-213

SID 67-317

AXIAL STRESS GAGE APA-3

0610-03  
139 DGG

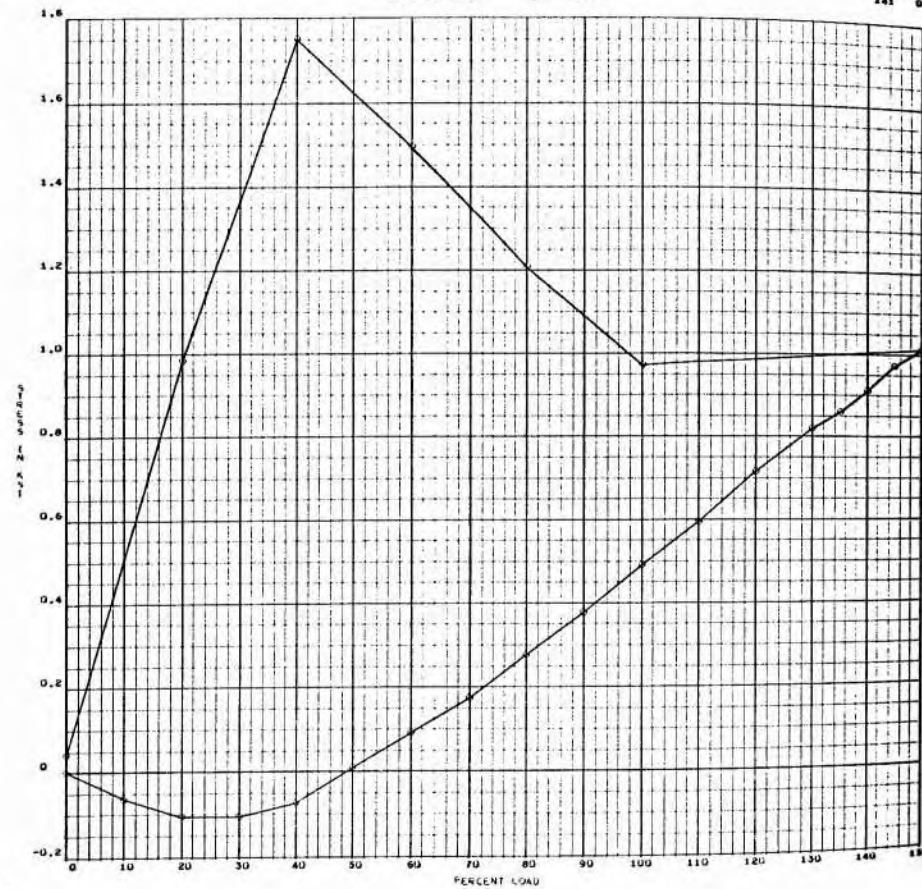


A-214

SID 67-317

AXIAL STRESS GAGE APA-7

0610-03  
141 DGG

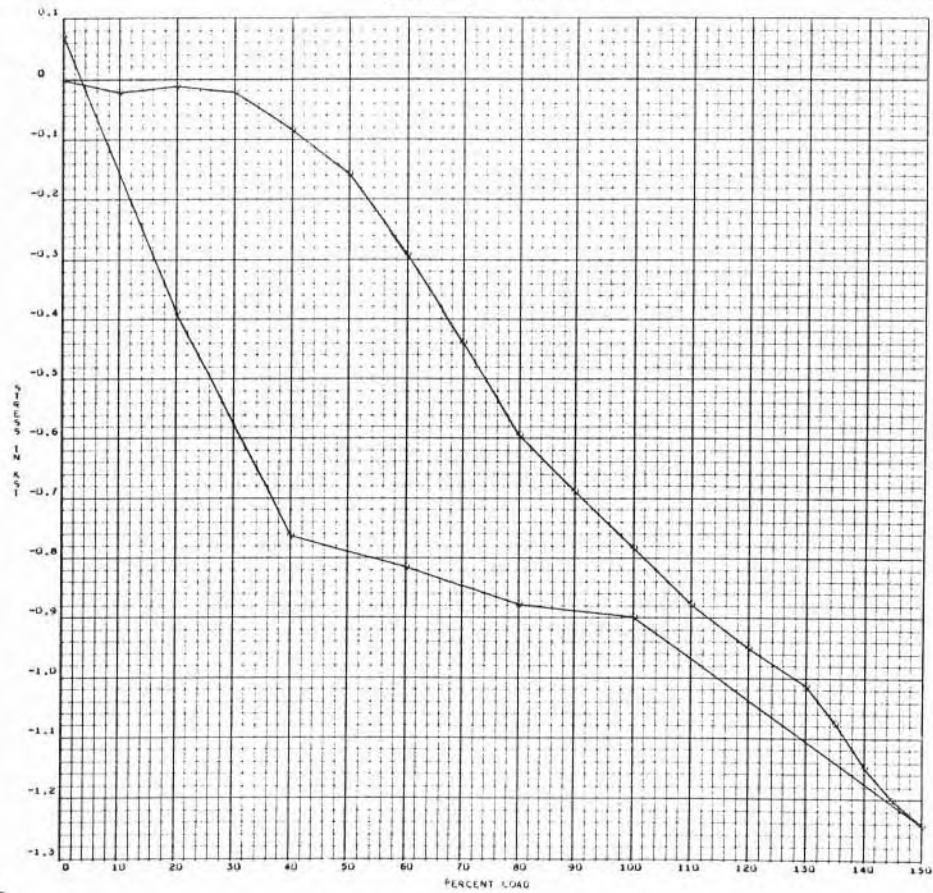


A-215

SID 67-317

AXIAL STRESS GAGE AFA-8

0610-01  
142 000

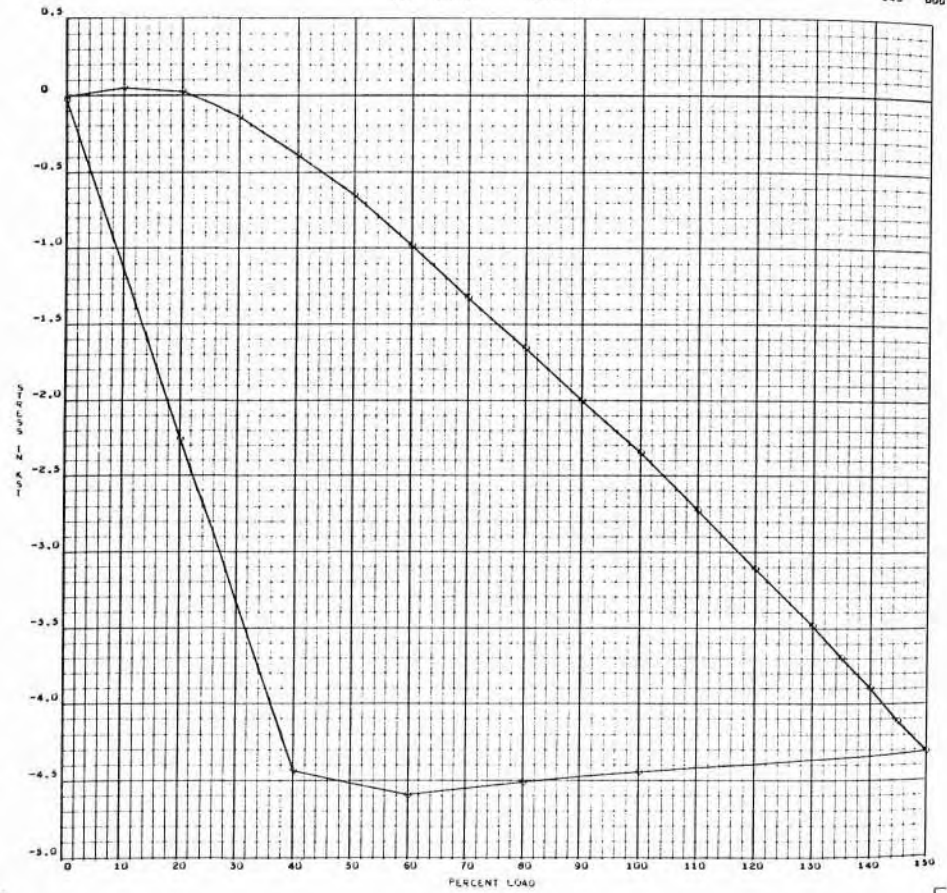


A-216

SID 67-317

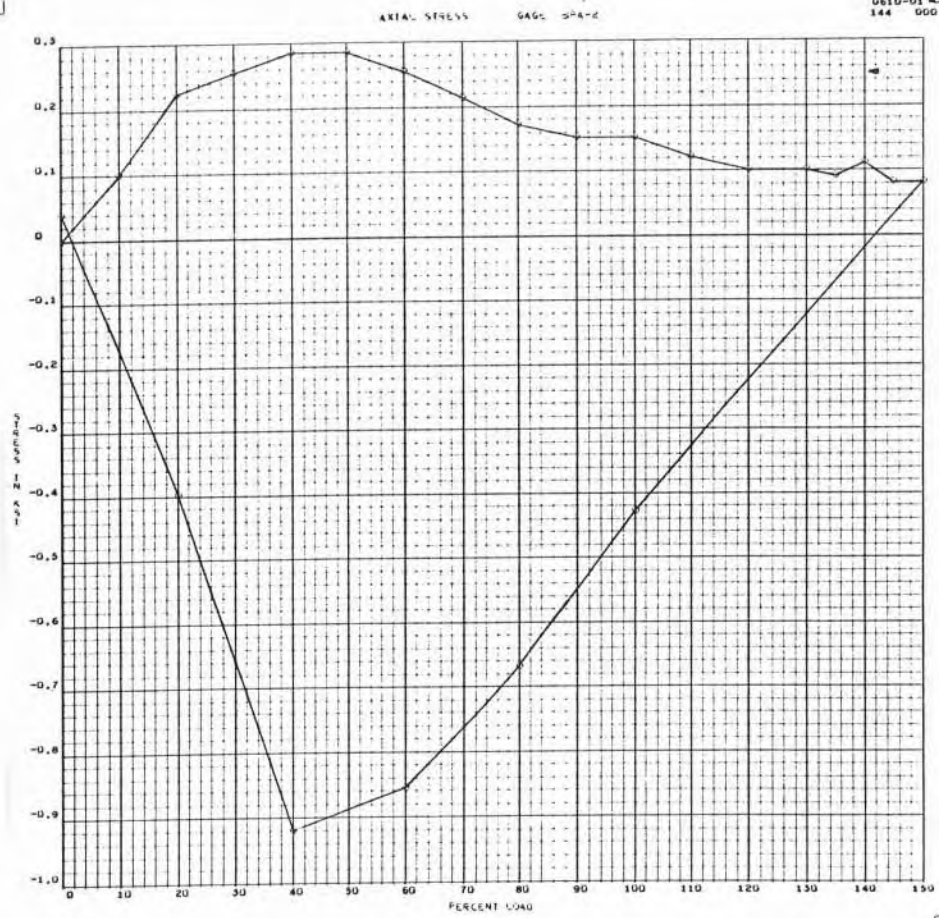
AXIAL STRESS GAGE BPA-1

0610-01  
143 000



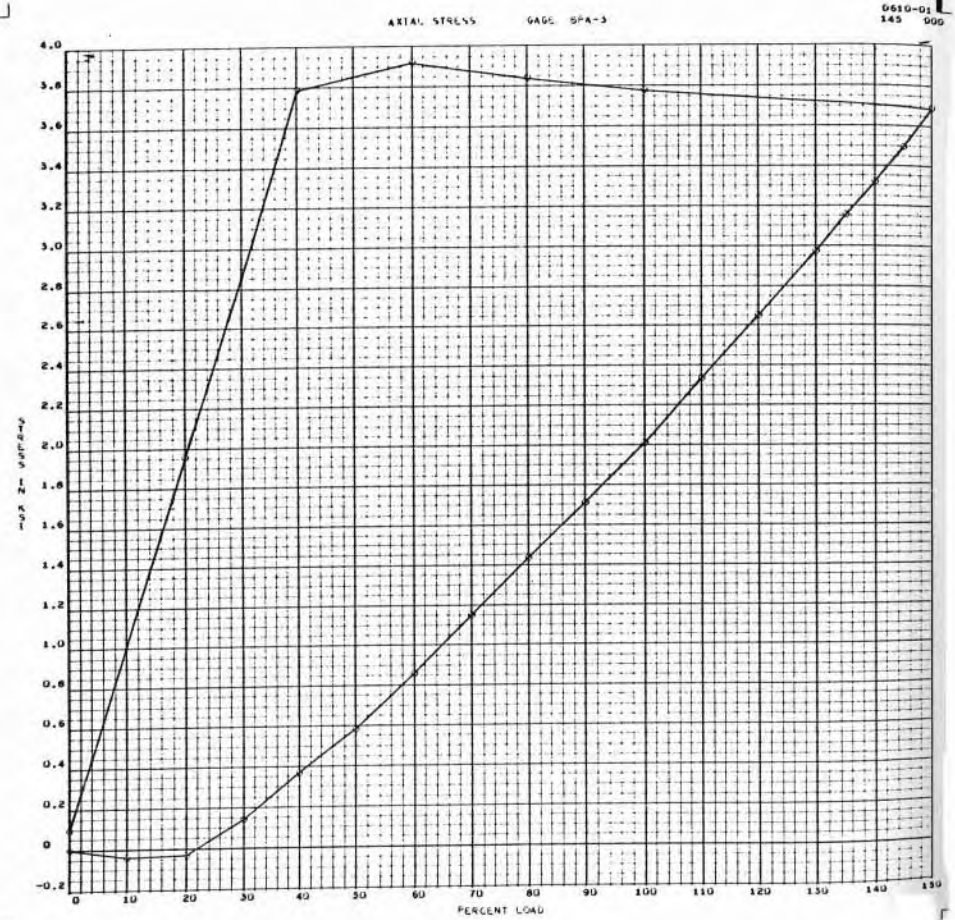
A-217

SID 67-317



A-218

SID 67-317



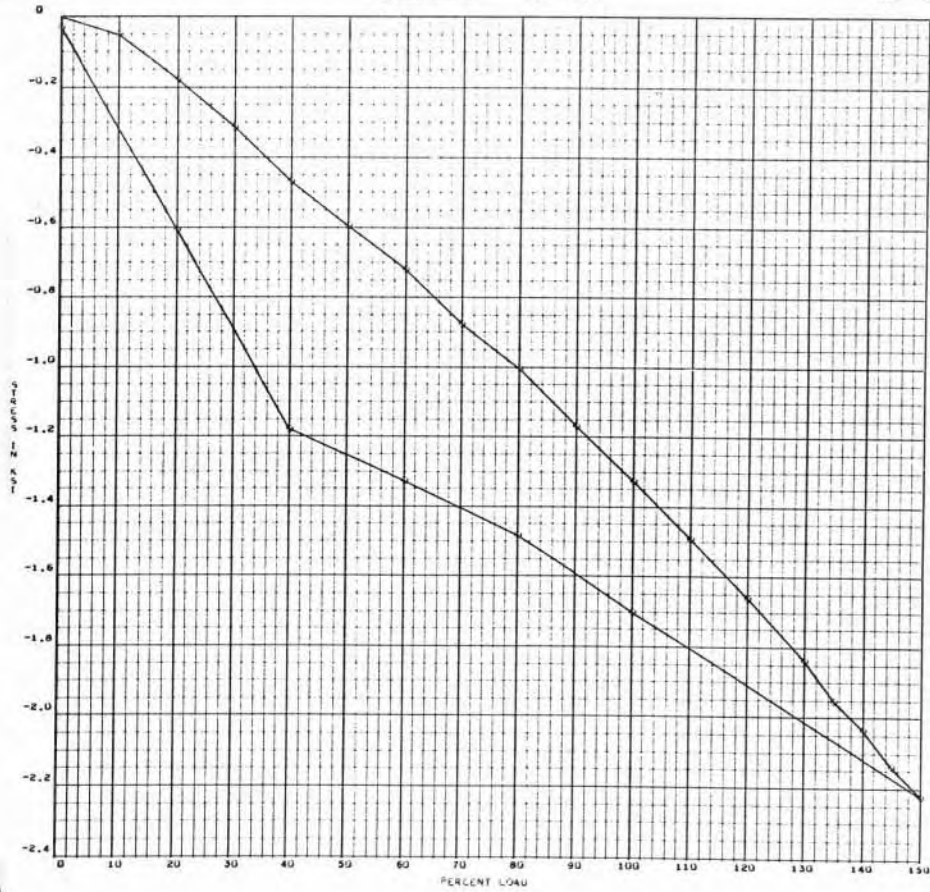
A-219

SID 67-317



AXIAL STRESS GAGE SPA-4

0810-01  
146 000

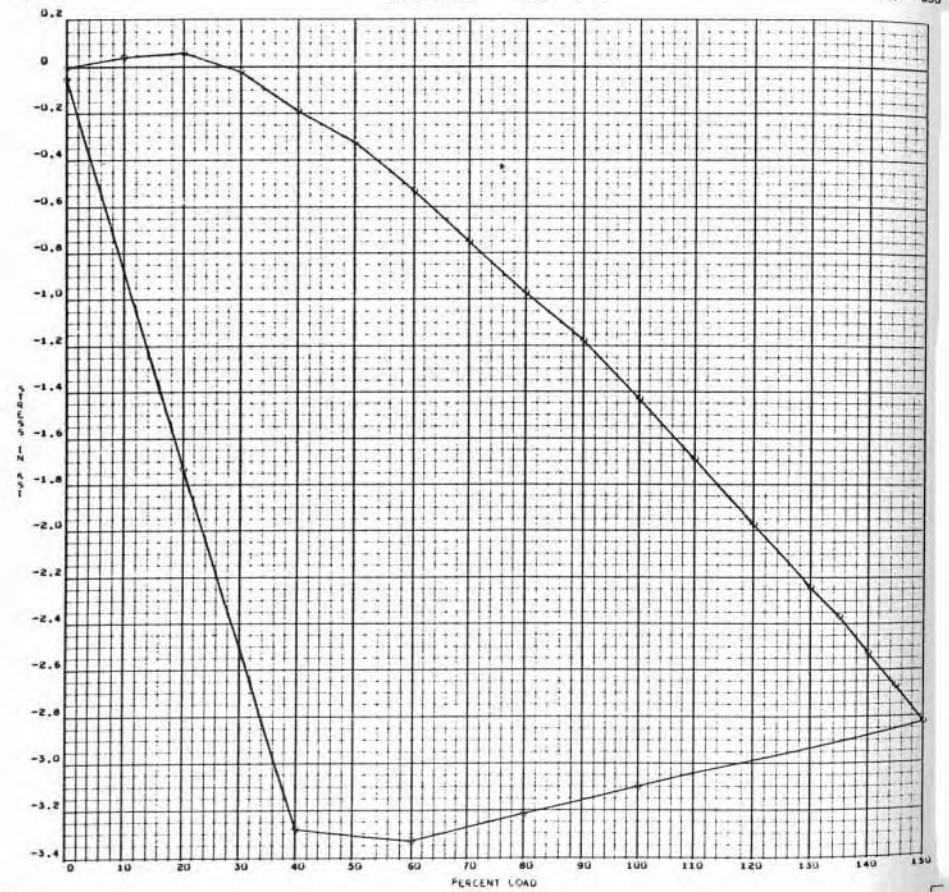


A-220

SID 67-317

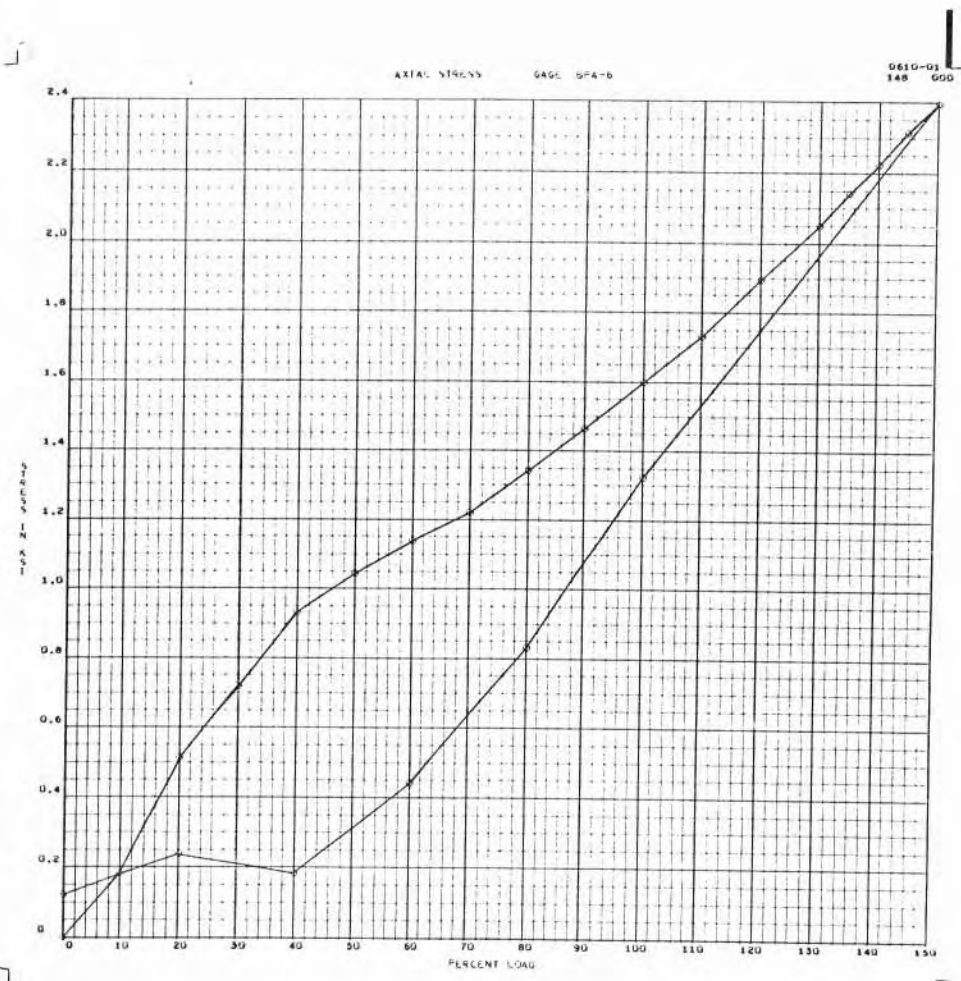
AXIAL STRESS GAGE BPA-5

0810-01  
147 000



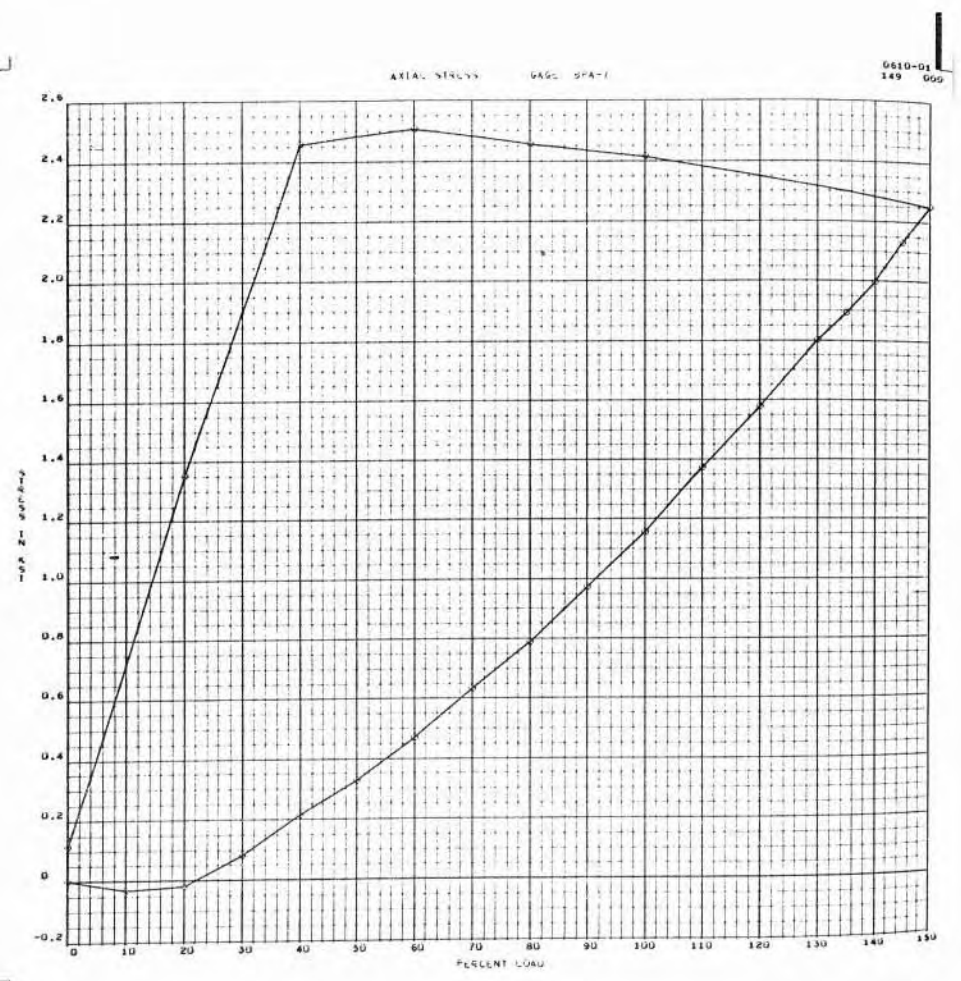
A-221

SID 67-317



A-222

SID 67-317

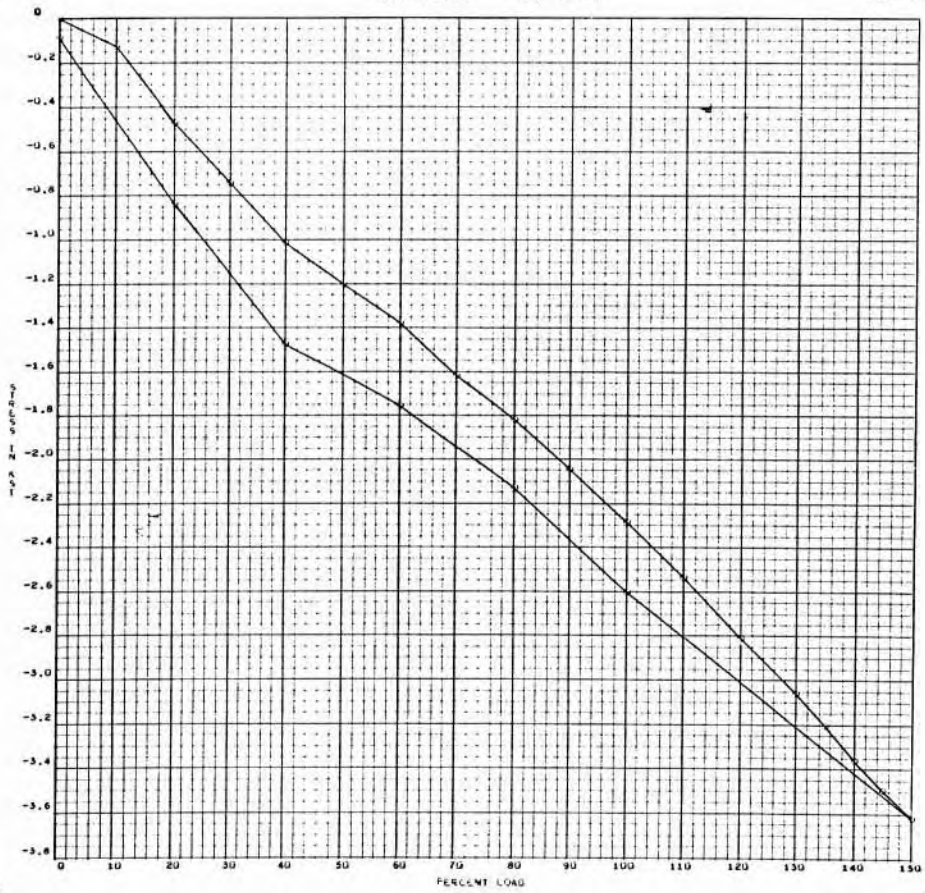


A-223

SID 67-317

AXIAL STRESS GAGE SPA-9

0610-01  
150 500

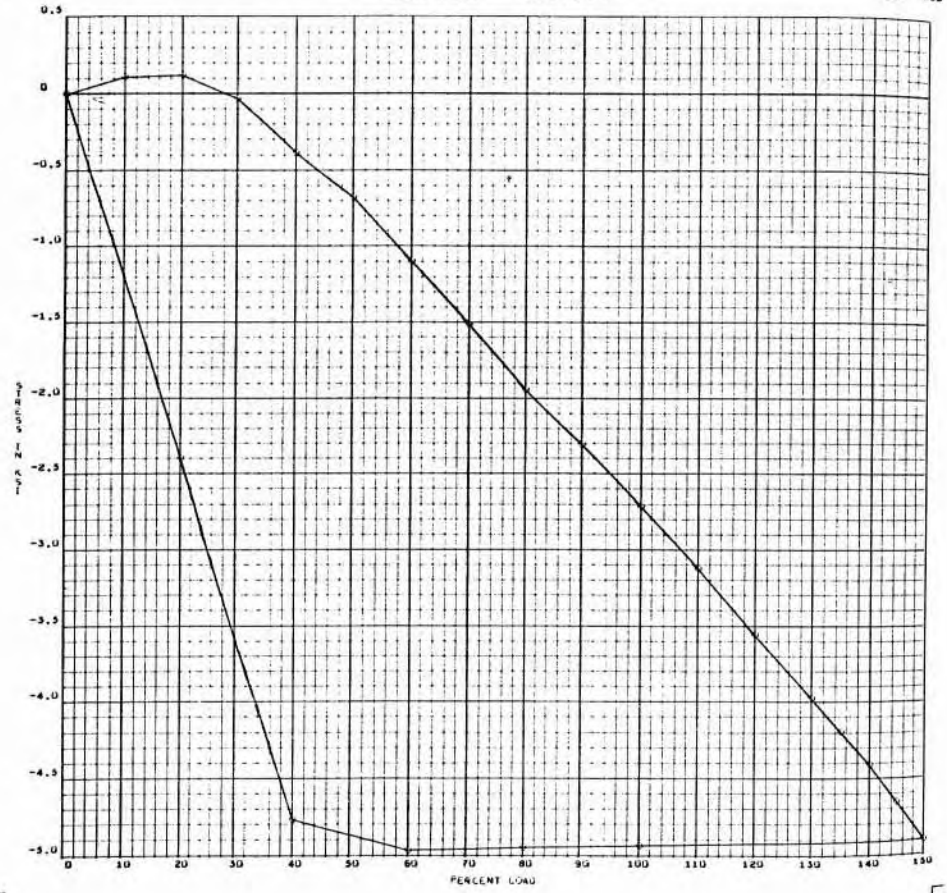


A-224

SID 67-317

AXIAL STRESS GAGE LCPA-1

0610-01  
151 500

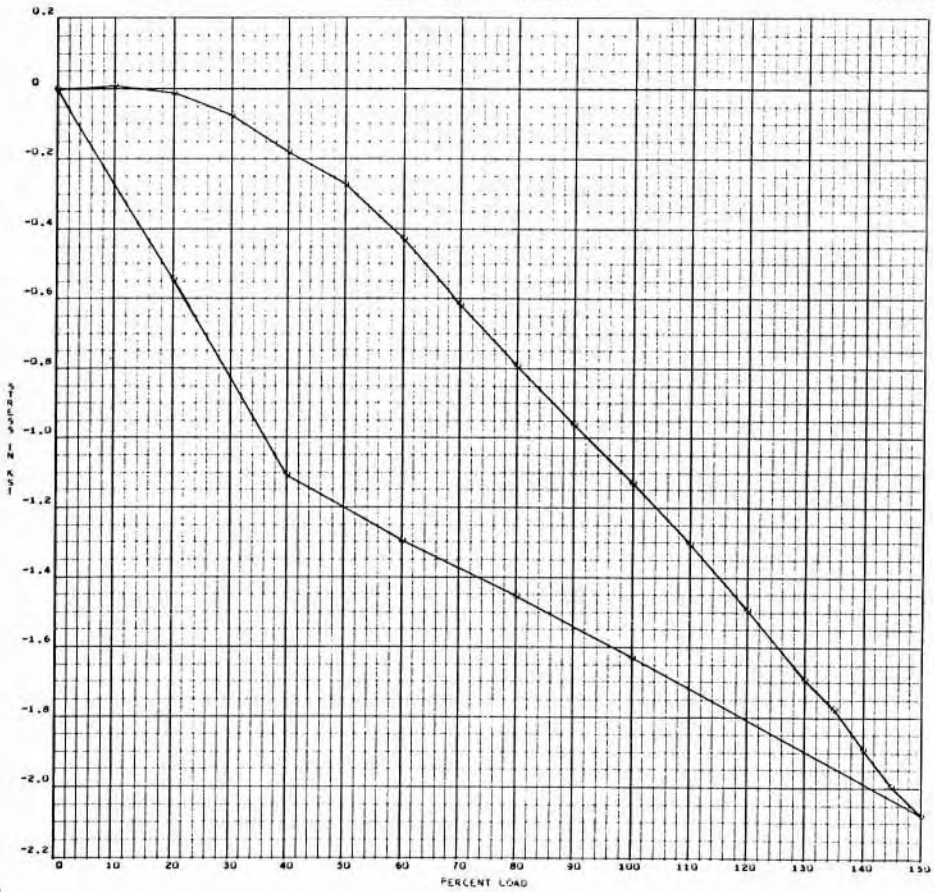


A-225

SID 67-317

AXIAL STRESS GAGE CPA-2

0610-01  
152 000

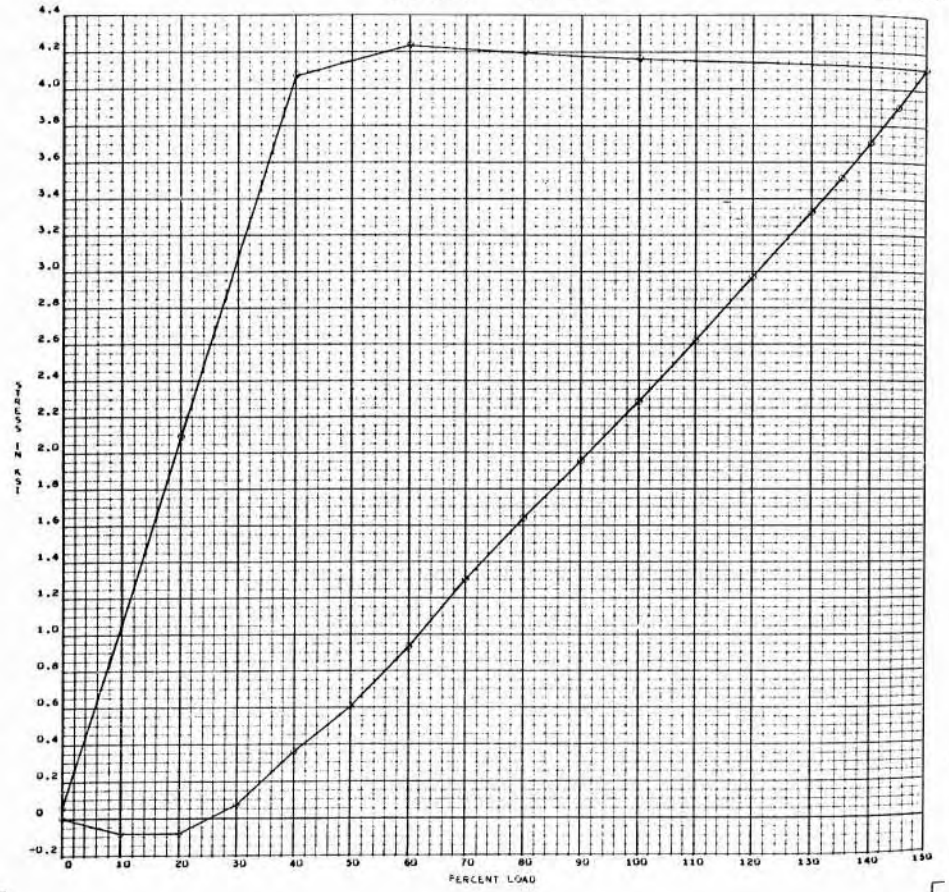


A-226

SID 67-317

AXIAL STRESS GAGE CPA-2

0610-01  
153 000



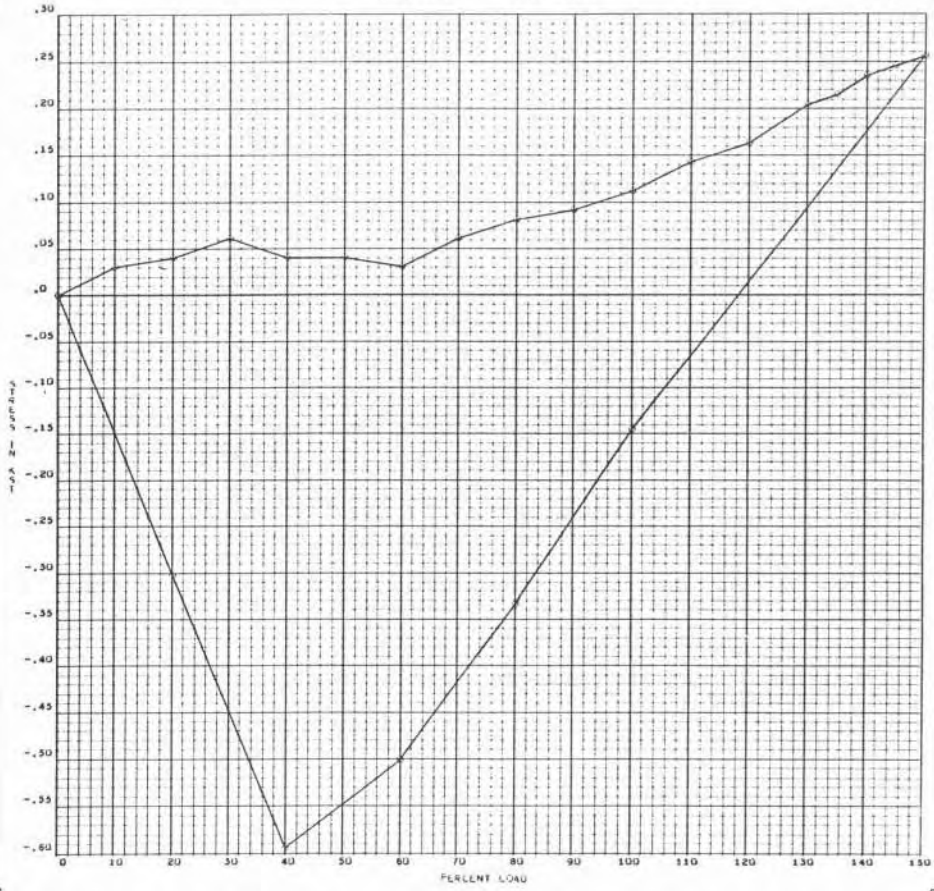
A-227

SID 67-317



AXIAL STRESS GAGE CPA-4

0610-01  
154 000

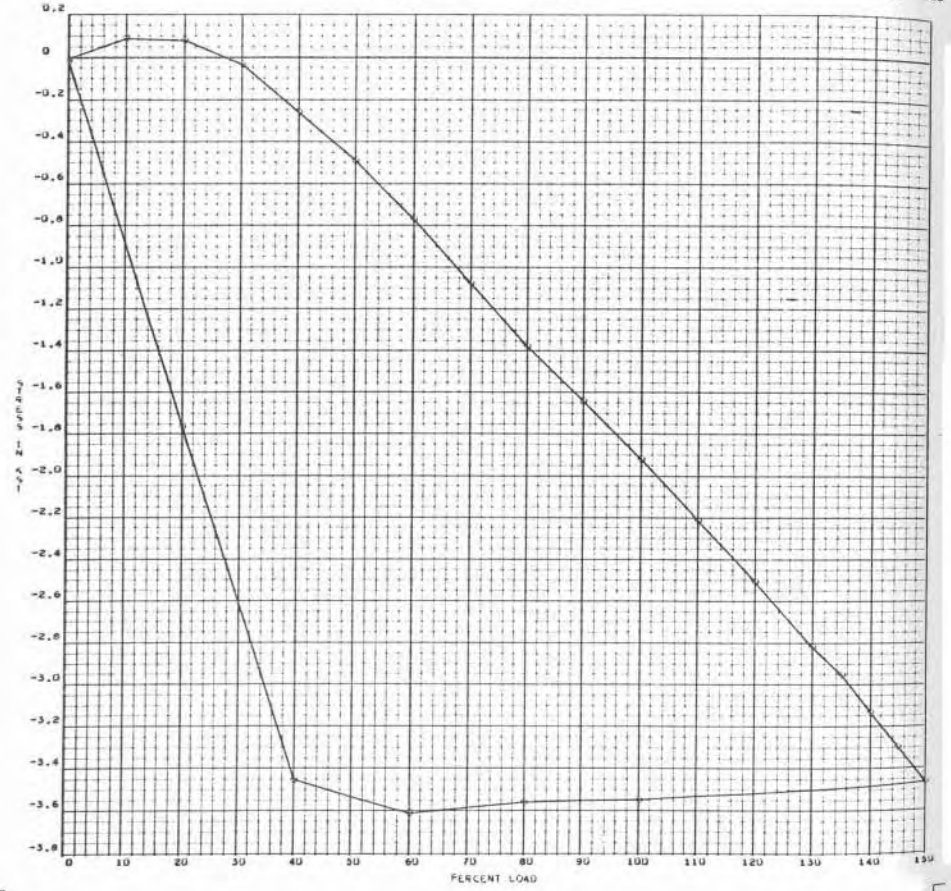


A-228

SID 67-317

AXIAL STRESS GAGE CPA-5

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155 000

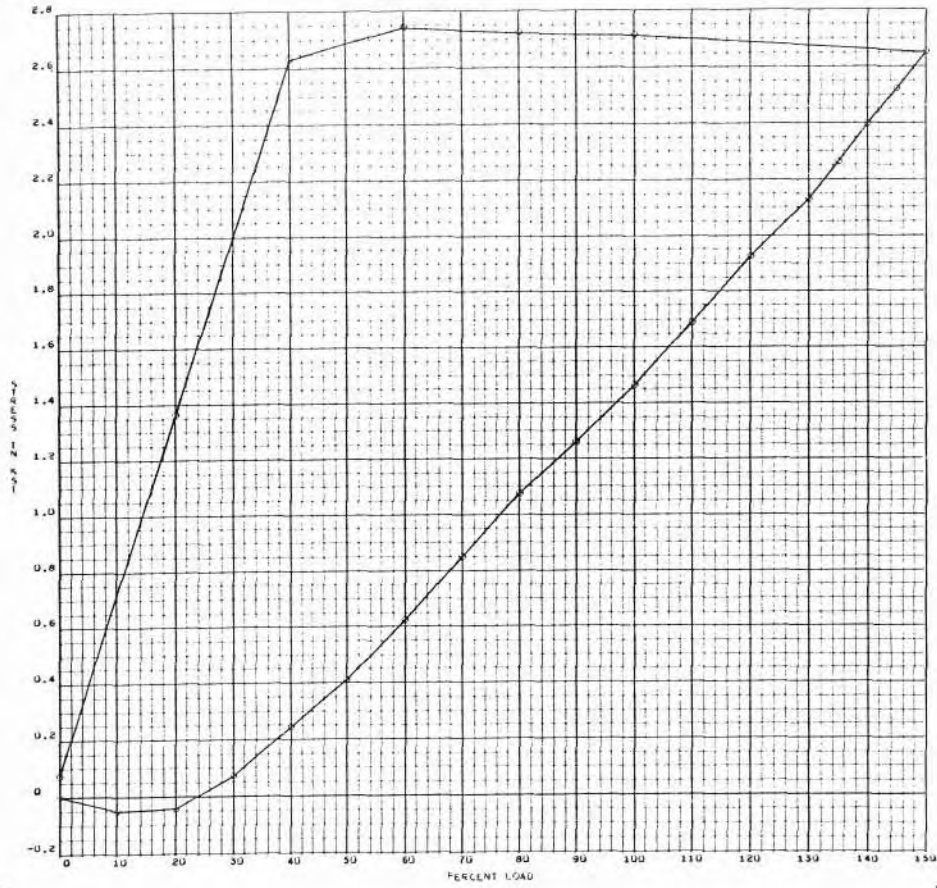


A-229

SID 67-317

AXIAL STRESS GAGE CPA-7

0610-01  
157 000

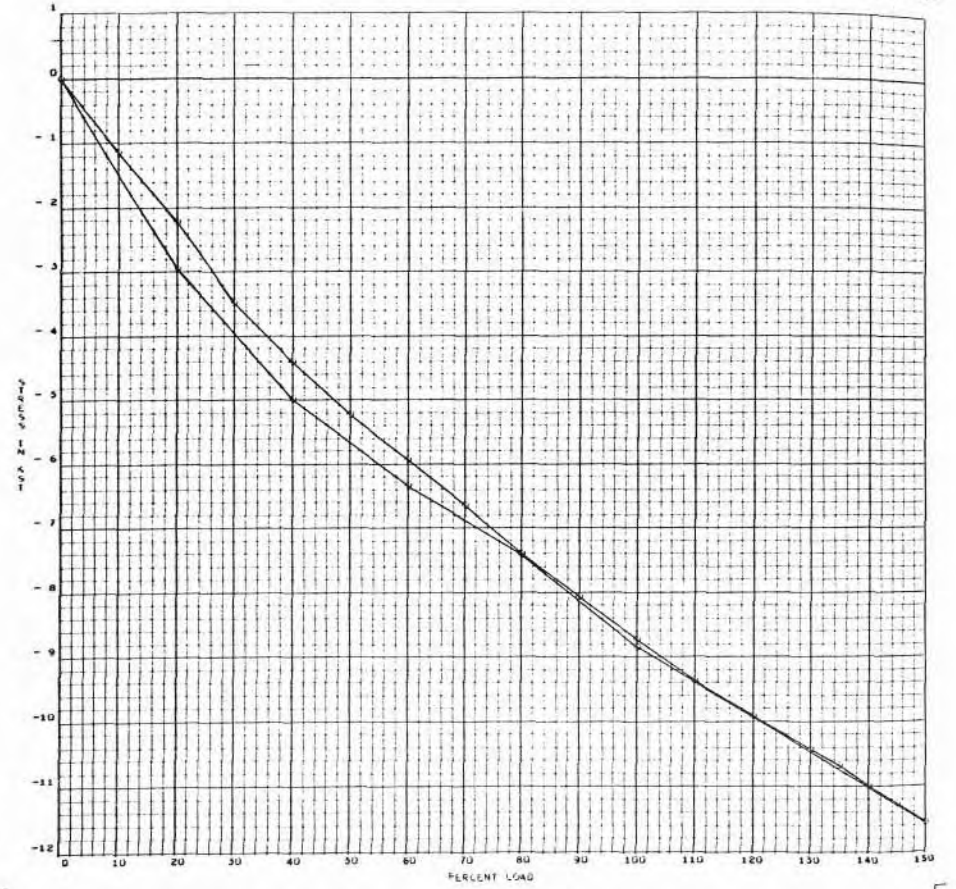


A-230

SID 67-317

AXIAL STRESS GAGE A-59-1

0610-01  
159 000

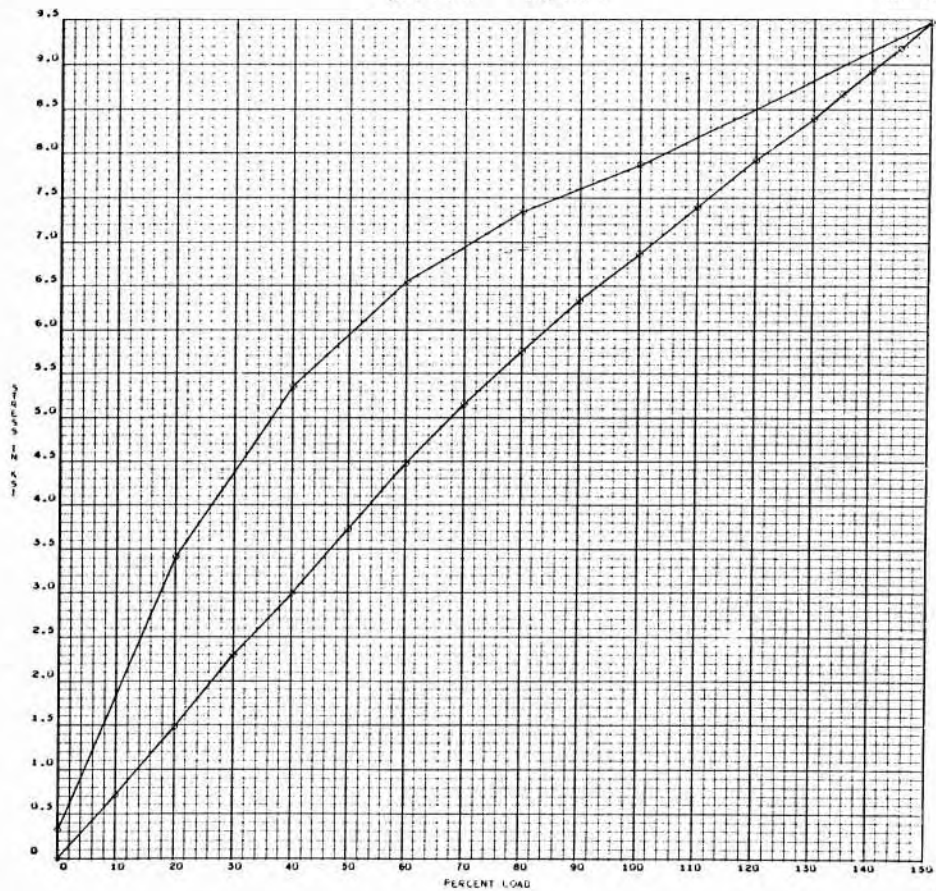


A-231

SID 67-317

AXIAL STRESS GAGE AF50-2

0610-01  
160  
090

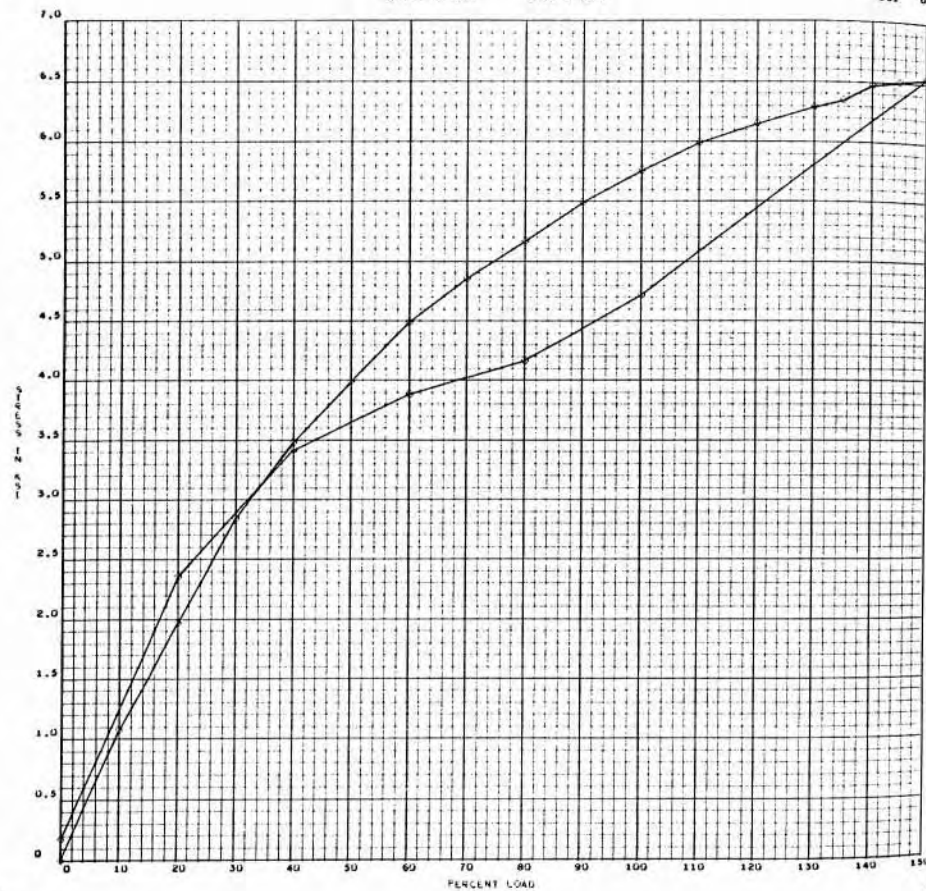


A-232

SID 67-317

AXIAL STRESS GAGE AF50-3

0610-01  
161  
090



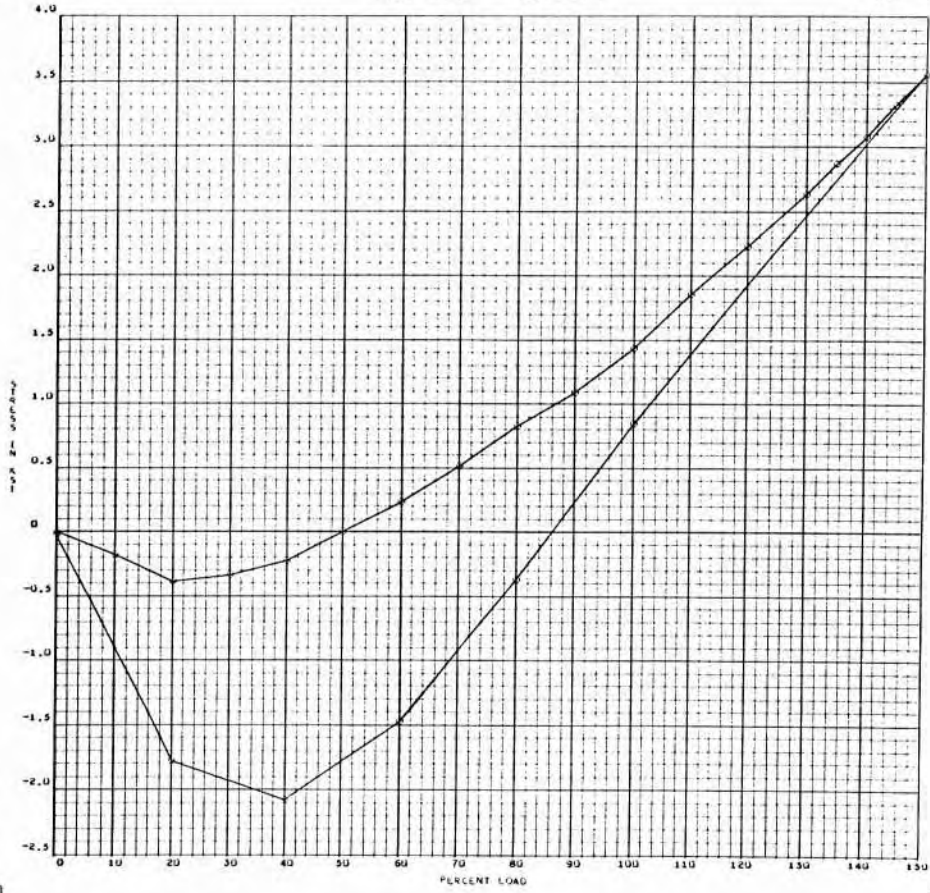
A-233

SID 67-317



AXIAL STRESS GAGE A250-4

0610-01  
163 000

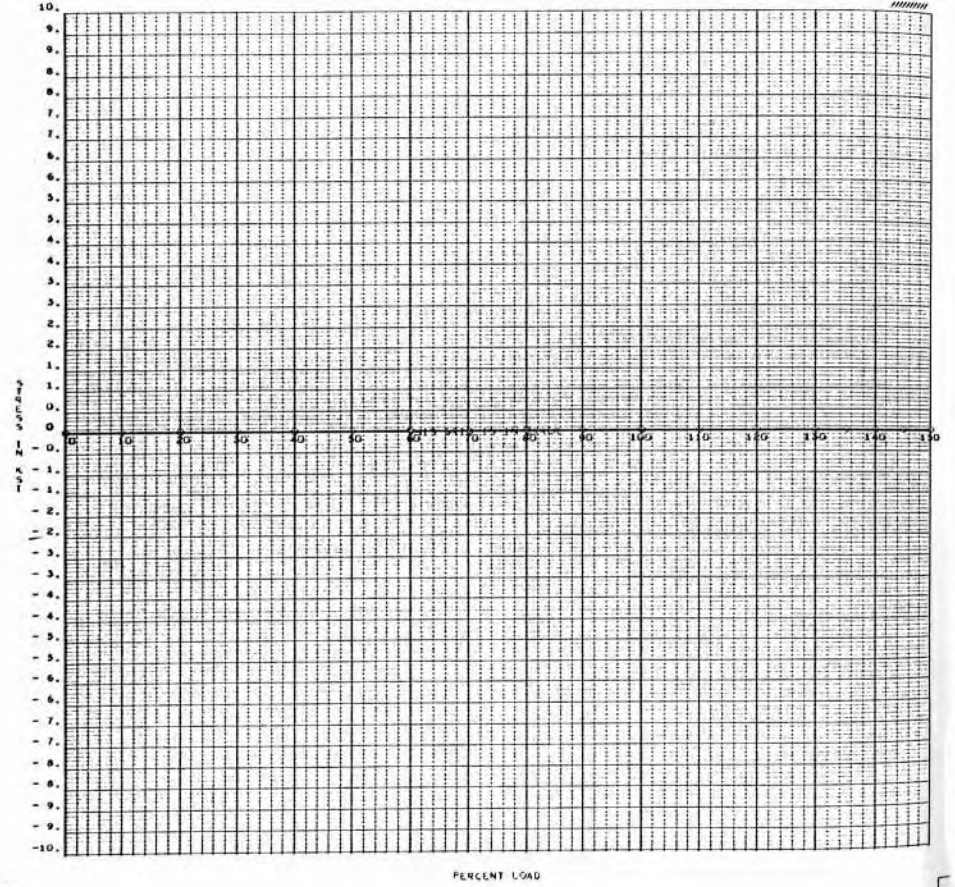


A-234

SID 67-317

AXIAL STRESS GAGE B250-1

0610-01  
163 000



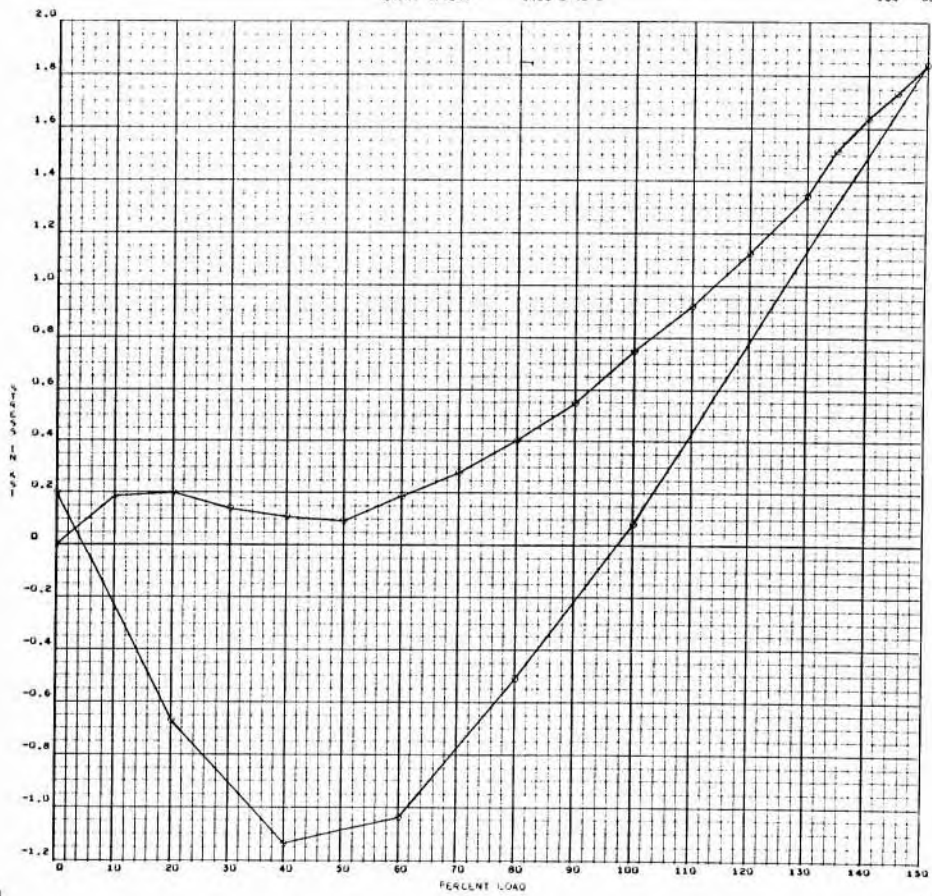
A-235

SID 67-317



AXIAL STRESS GAGE SP45-2

0610-01  
164 000

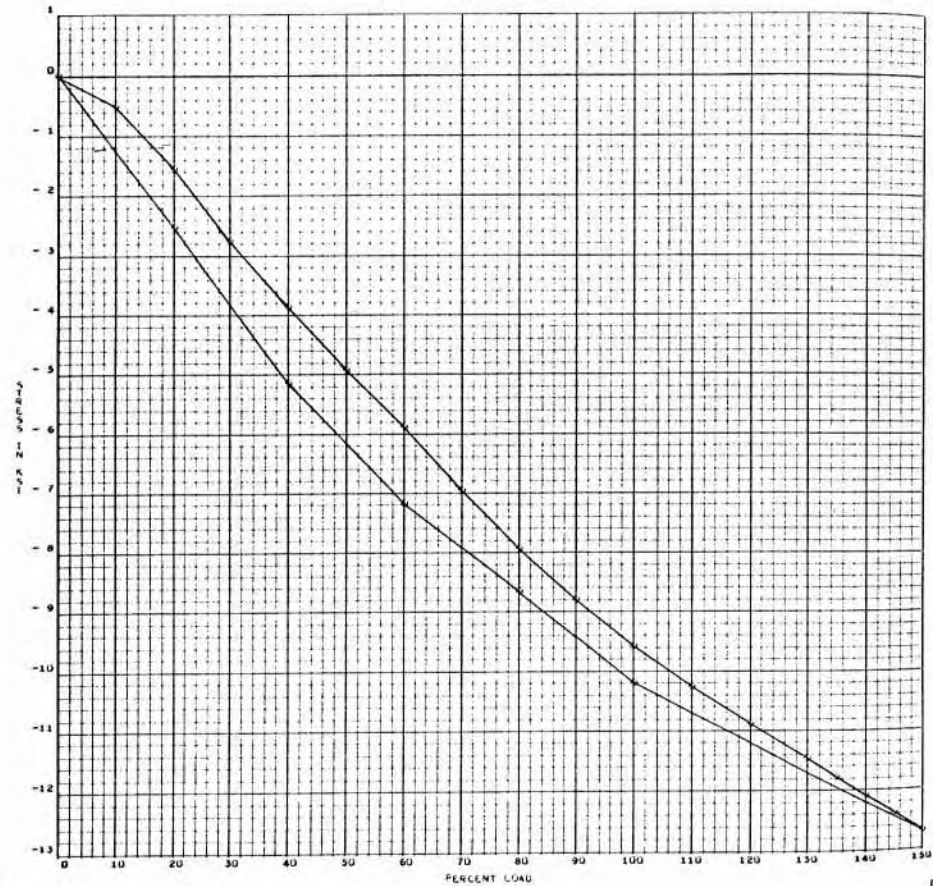


A-236

SID 67-317

AXIAL STRESS GAGE SP45-3

0610-01  
163 000

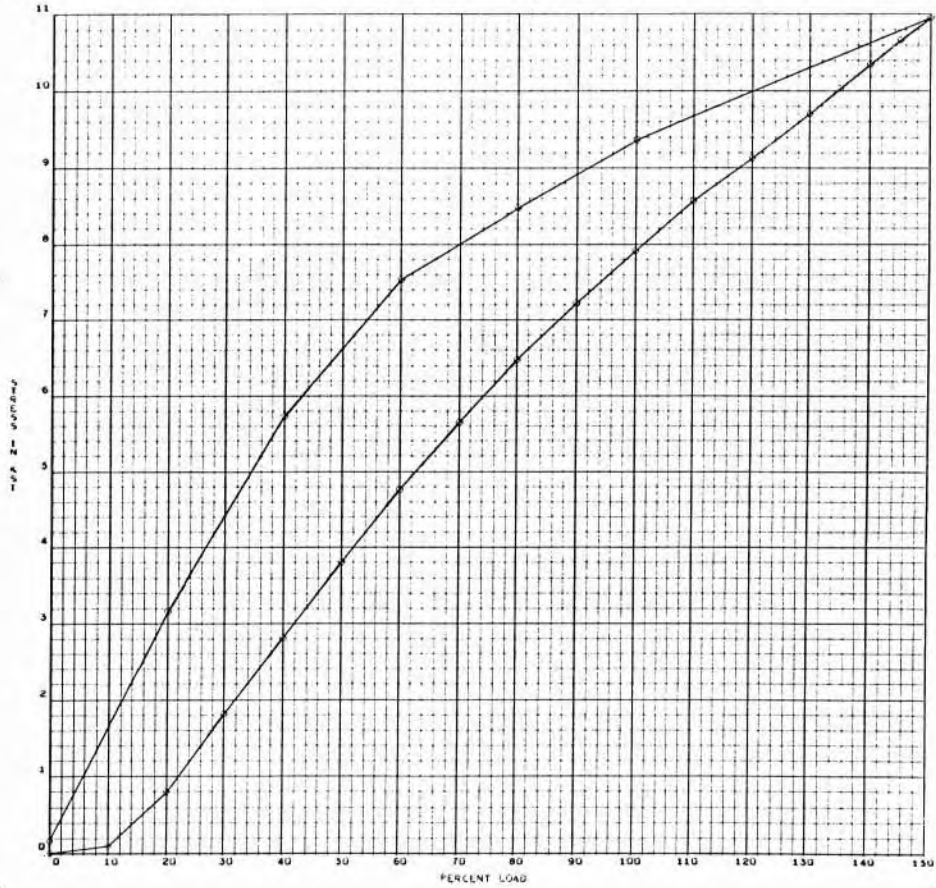


A-237

SID 67-317

AXIAL STRESS GAGE 5250-4

0610-01  
166 000

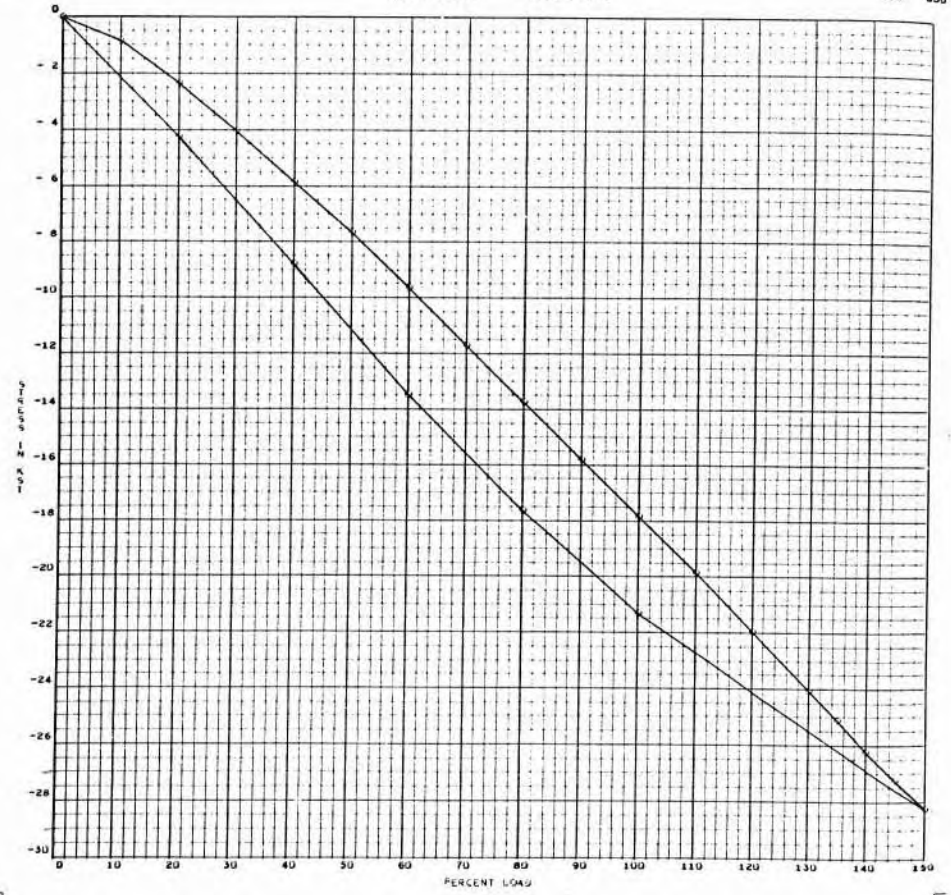


A-238

SID 67-317

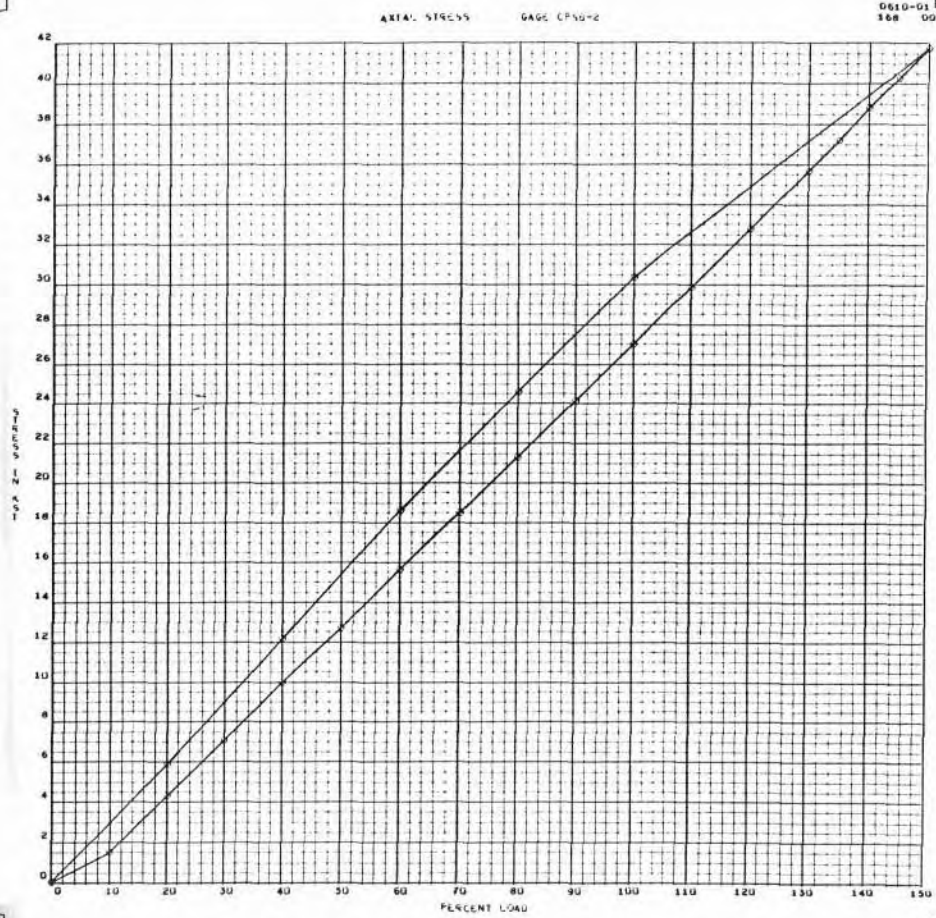
AXIAL STRESS GAGE CP50-1

0610-01  
167 000



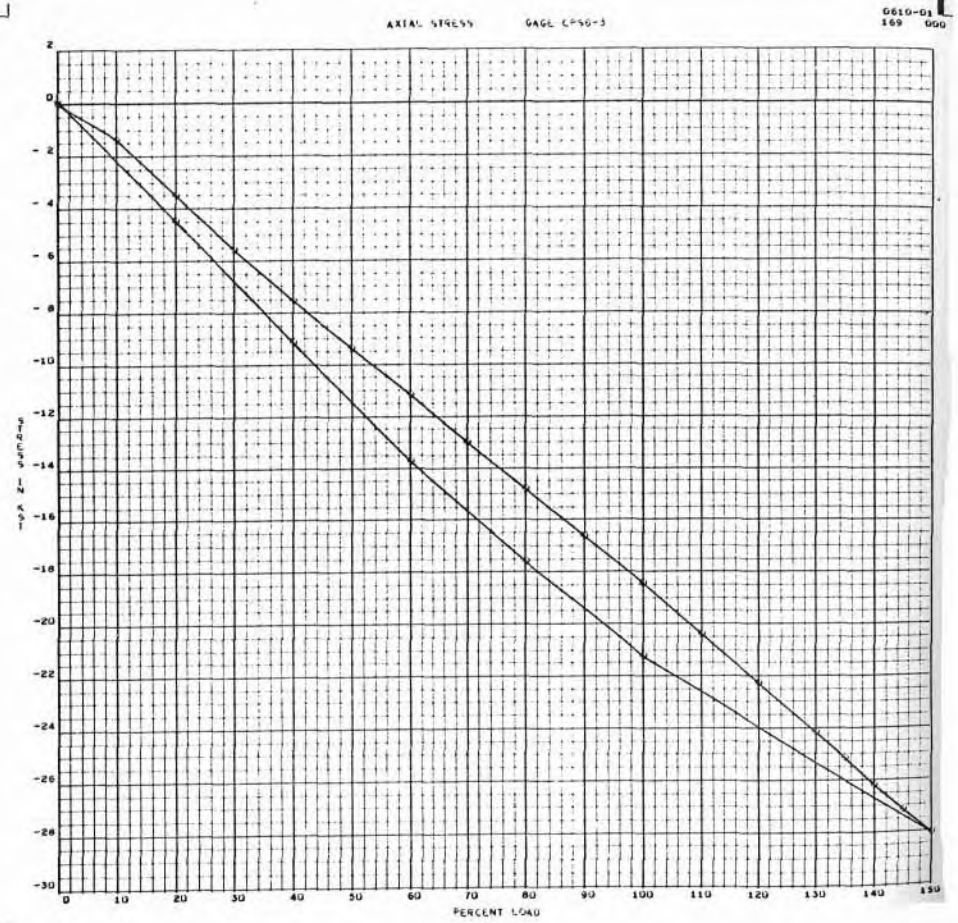
A-239

SID 67-317



A-240

SID 67-317

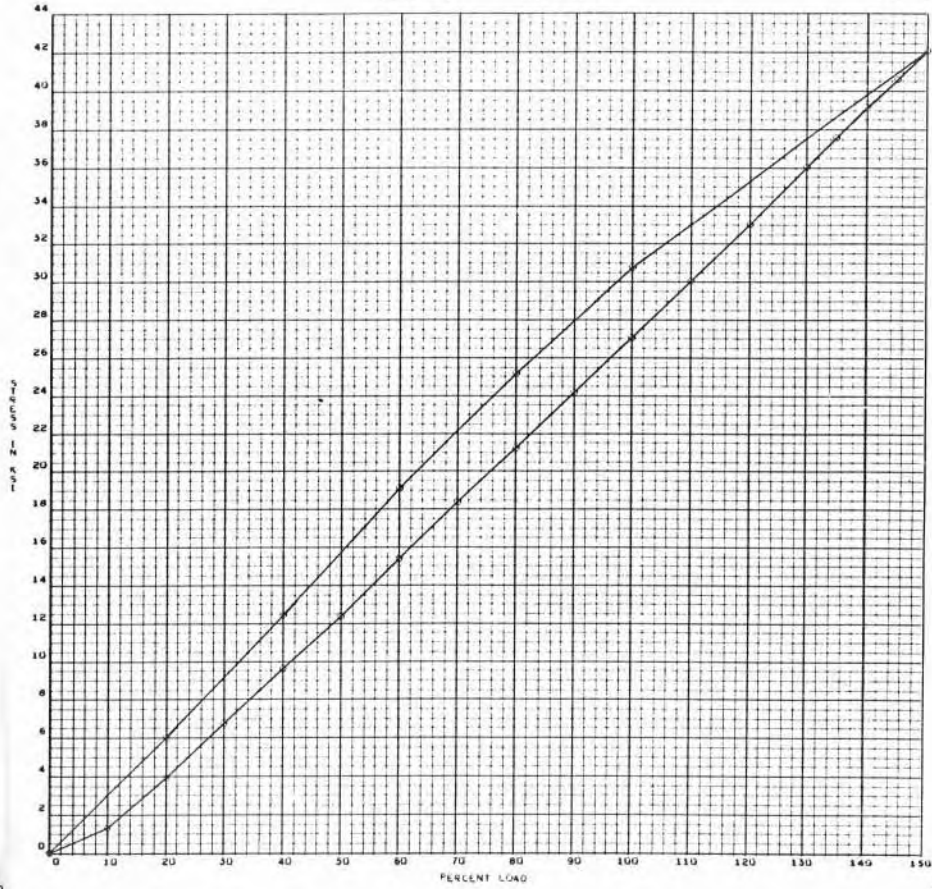


A-241

SID 67-317

AXIAL STRESS GAGE CP55-4

0610-01  
170 000

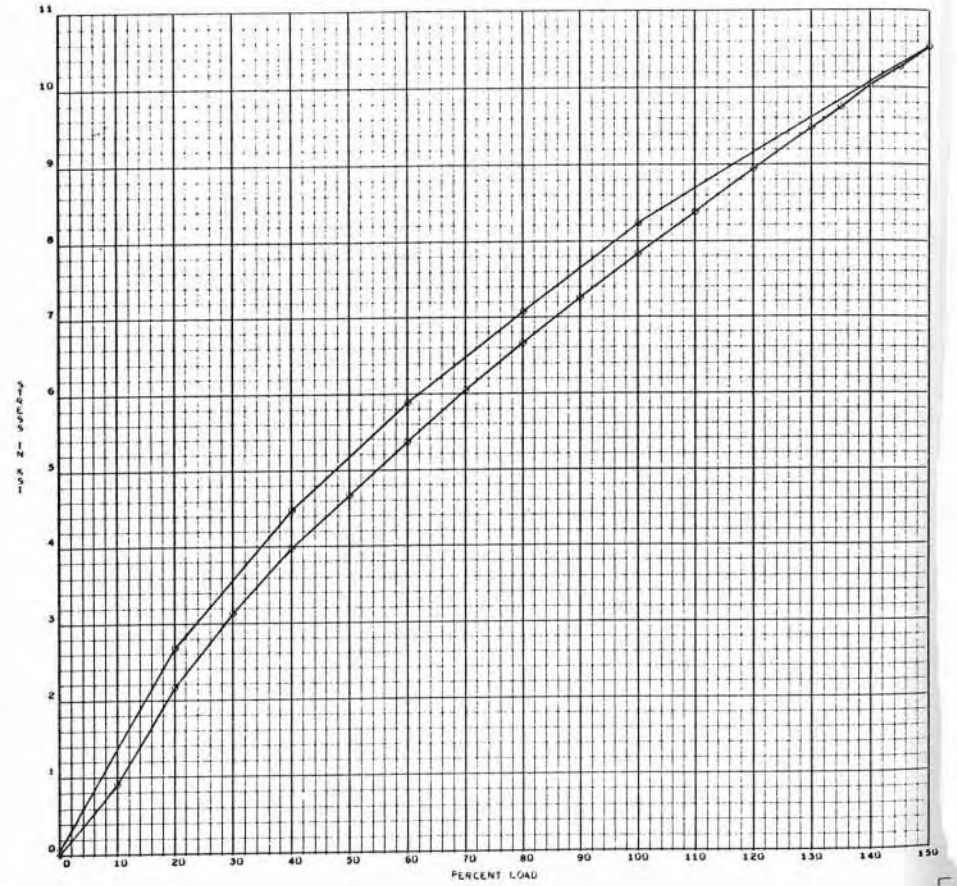


A-242

SID 67-317

AXIAL STRESS GAGE CP-1

0610-01  
171 000



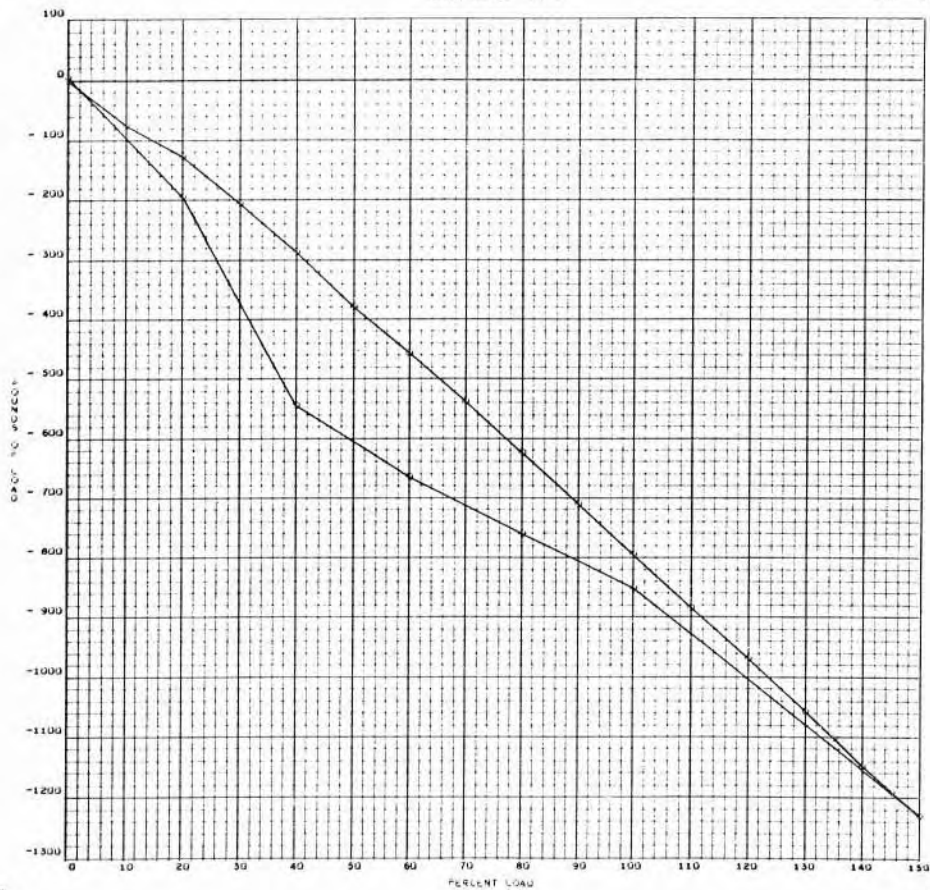
A-243

SID 67-317



LOAD NUMBER UA-1

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176 000

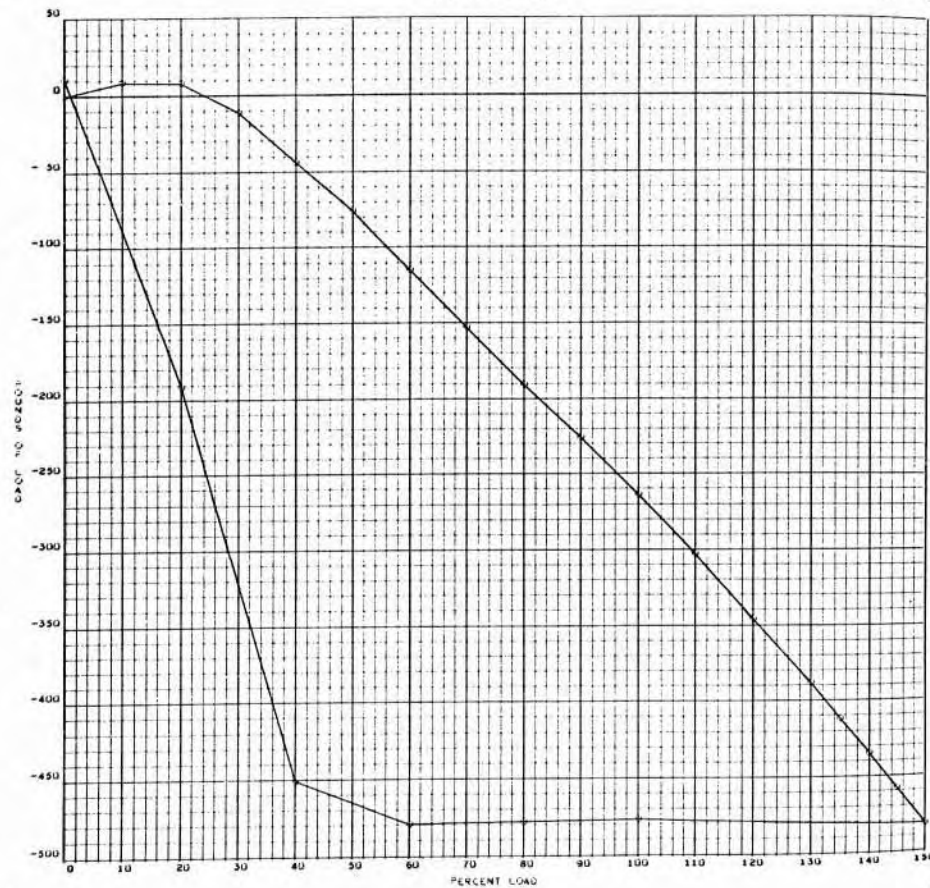


A-244

SID 67-317

LOAD NUMBER UA-2

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177 000

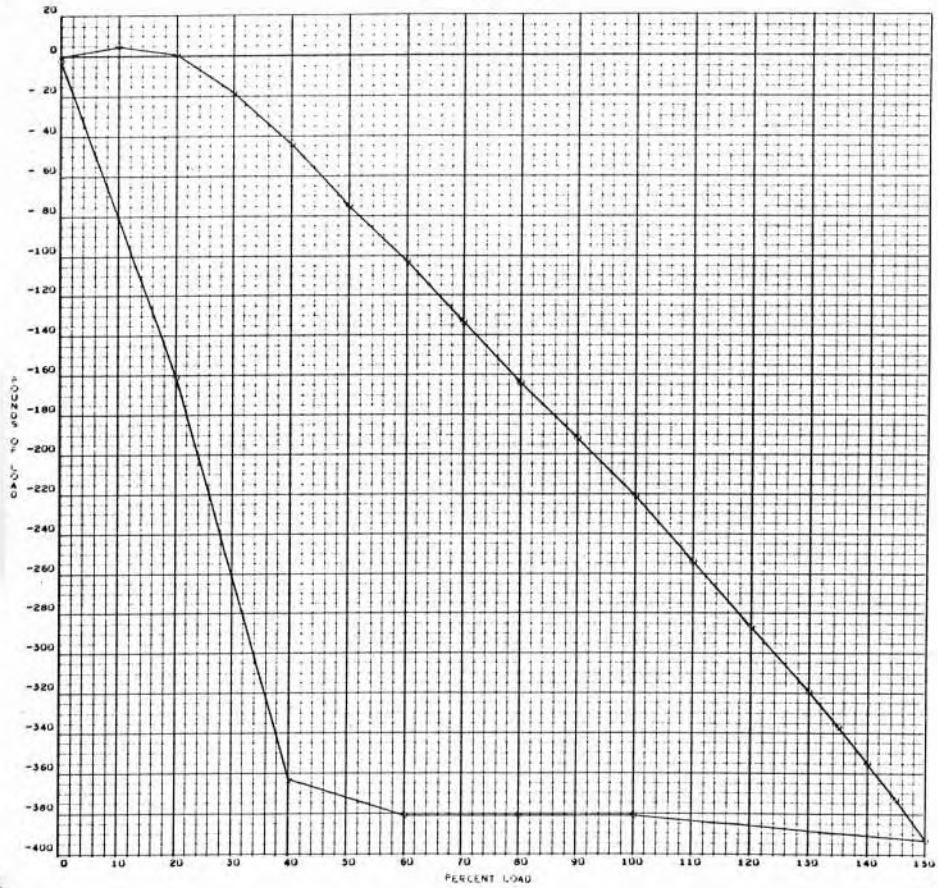


A-245

SID 67-317

LOAD NUMBER 04-3

0610-01  
178 000



TEST CONDITION IV

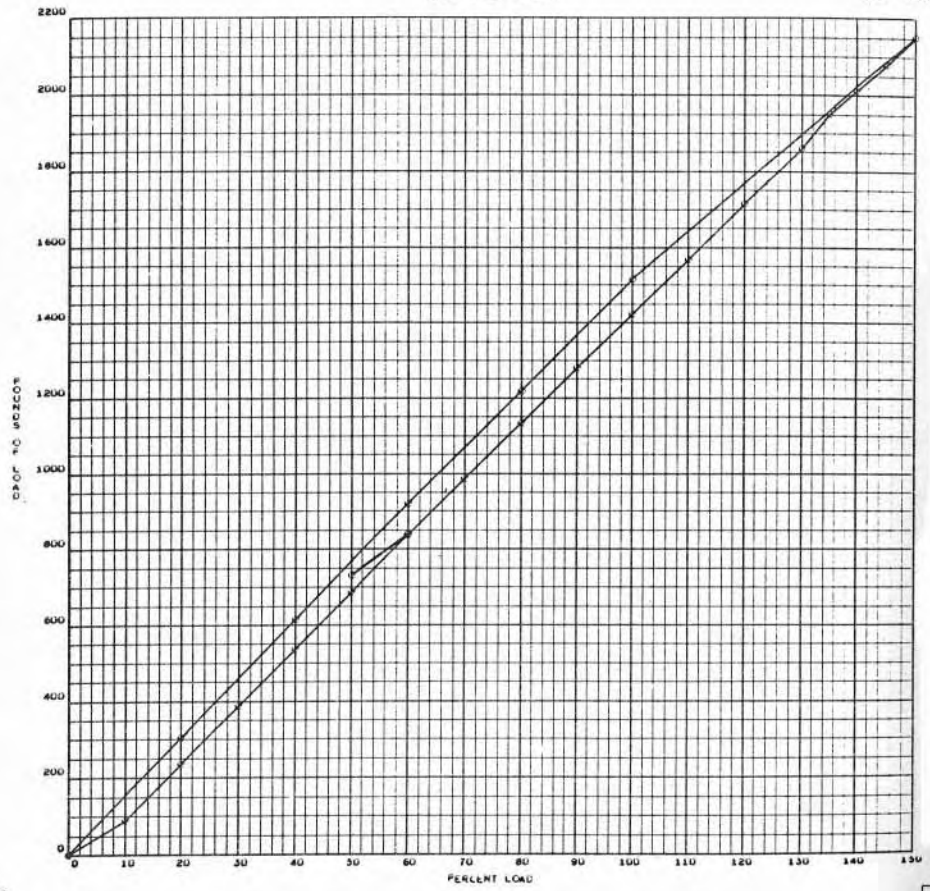
SID 67-317

A-246

SID 67-317

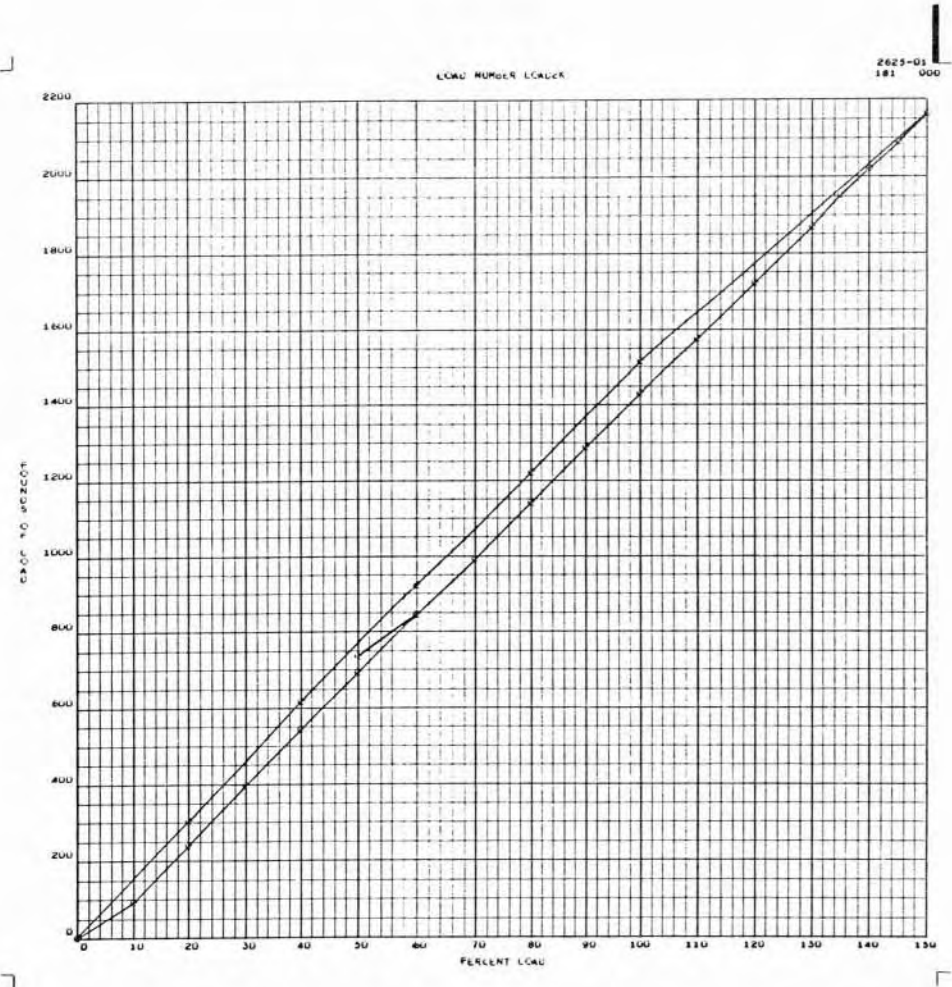
2625-01  
100  
000

LOAD NUMBER LOADS



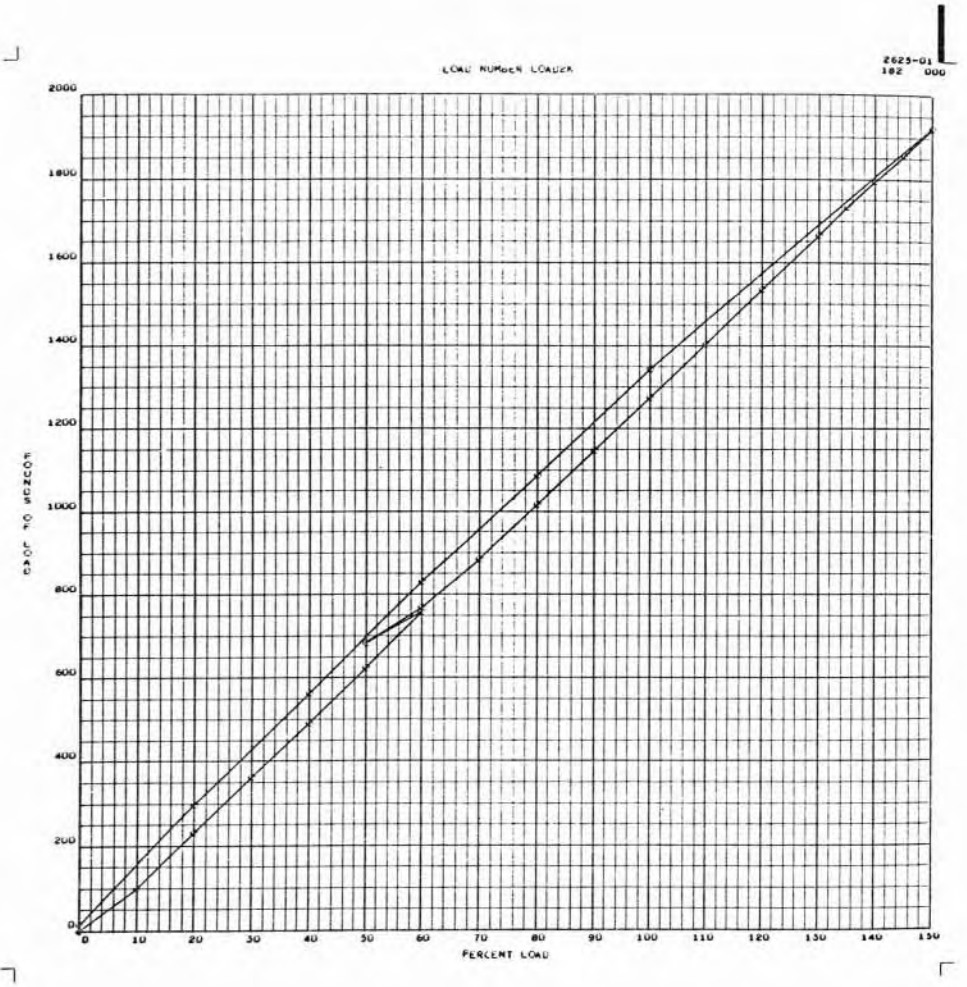
A-247

SID 67-317



A-248

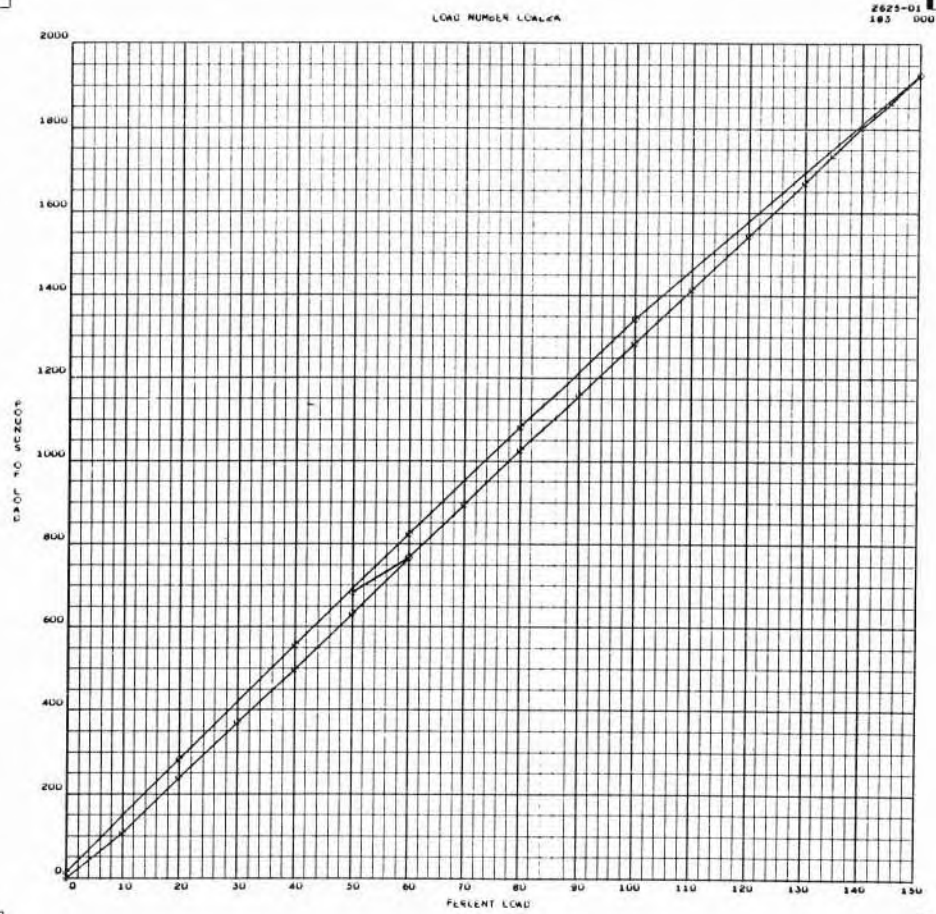
SID 67-318



A-249

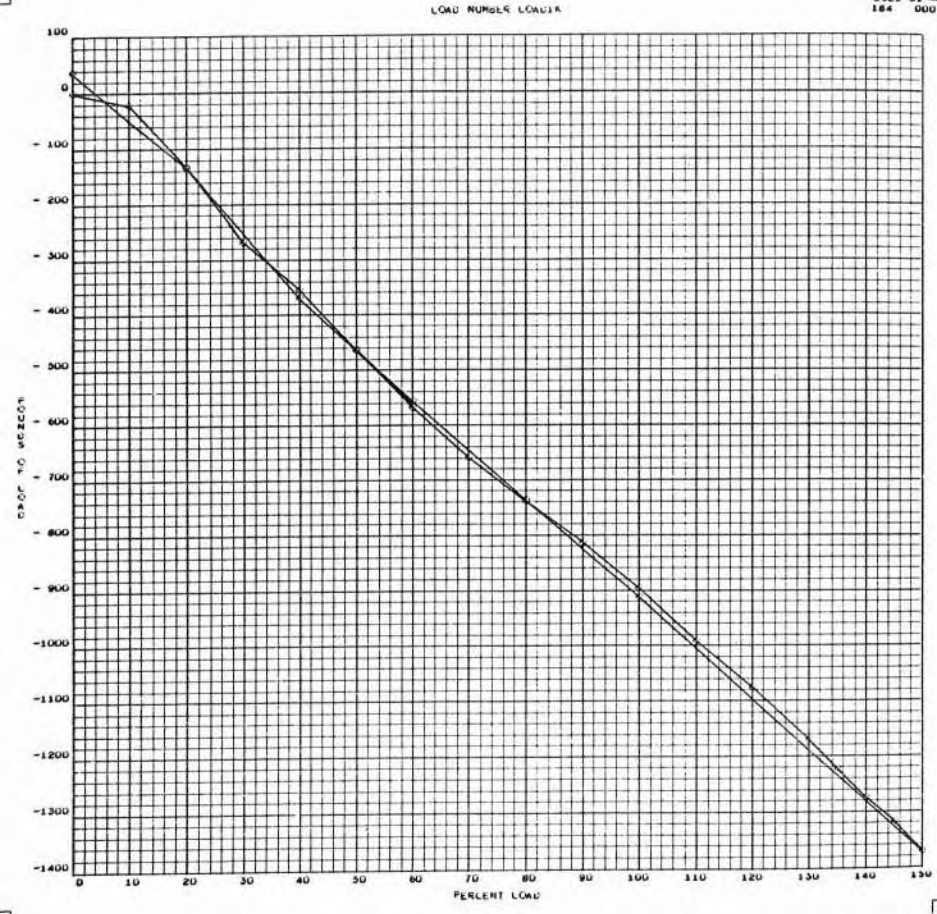
SID 67-317





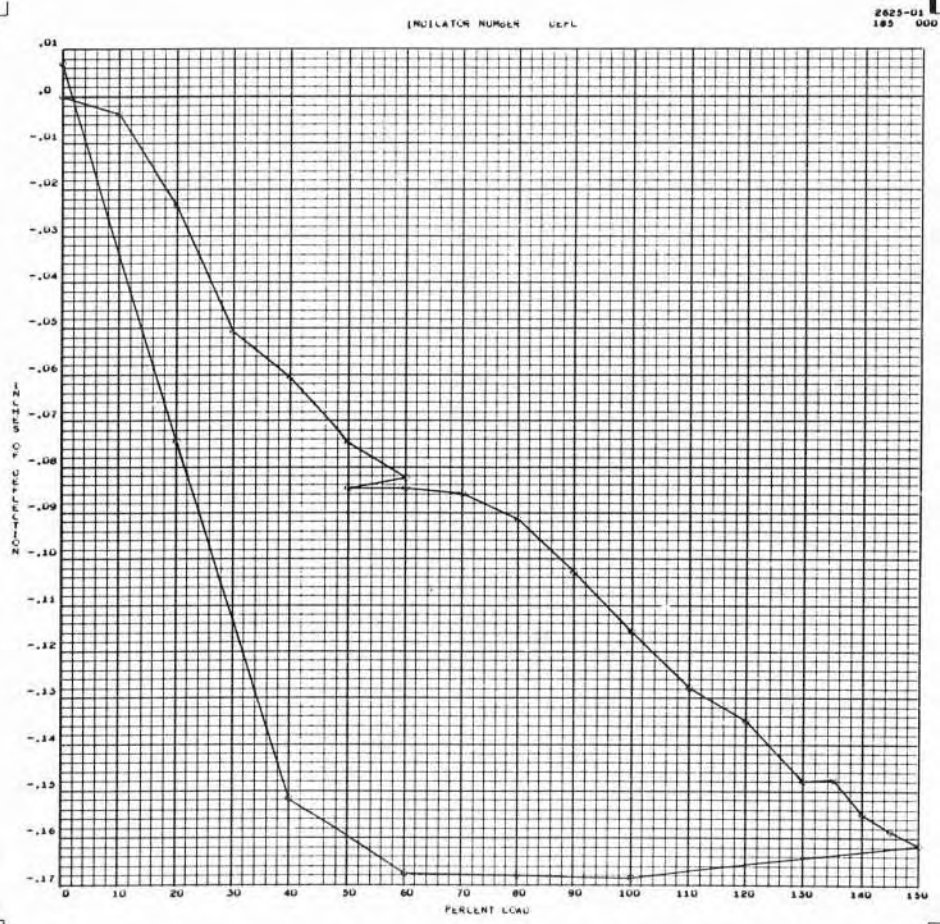
A-250

SID 67-317



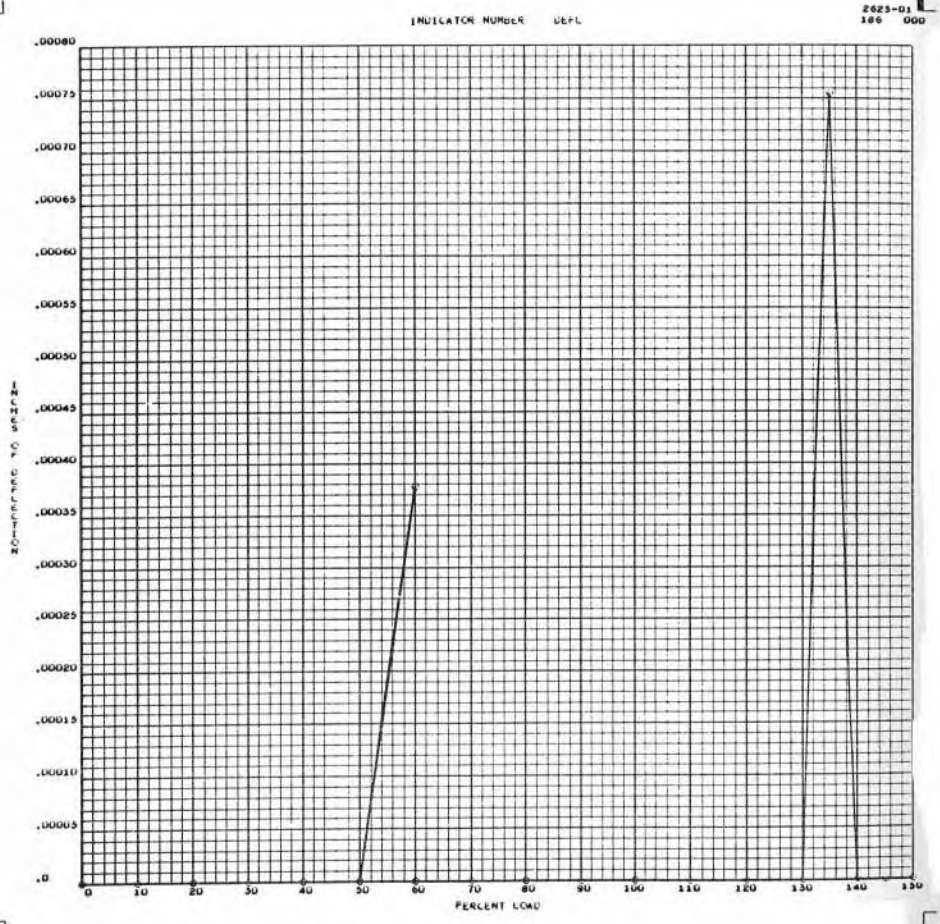
A-251

SID 67-317



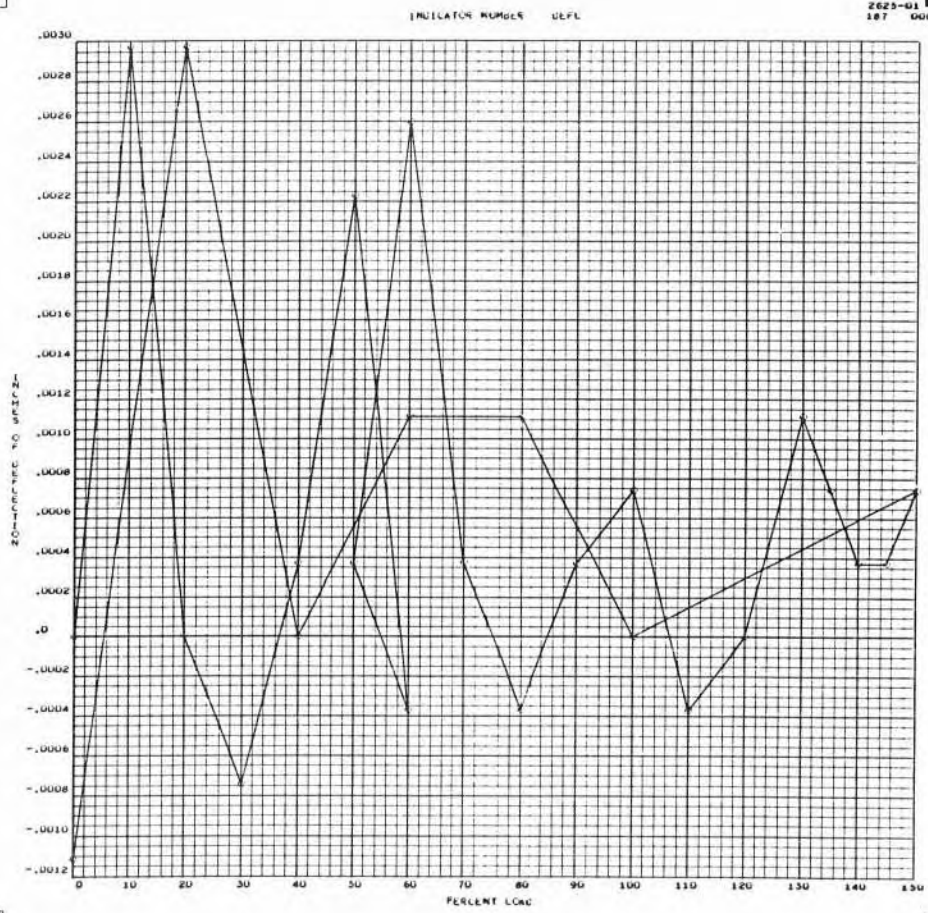
A-252

SID 67-317



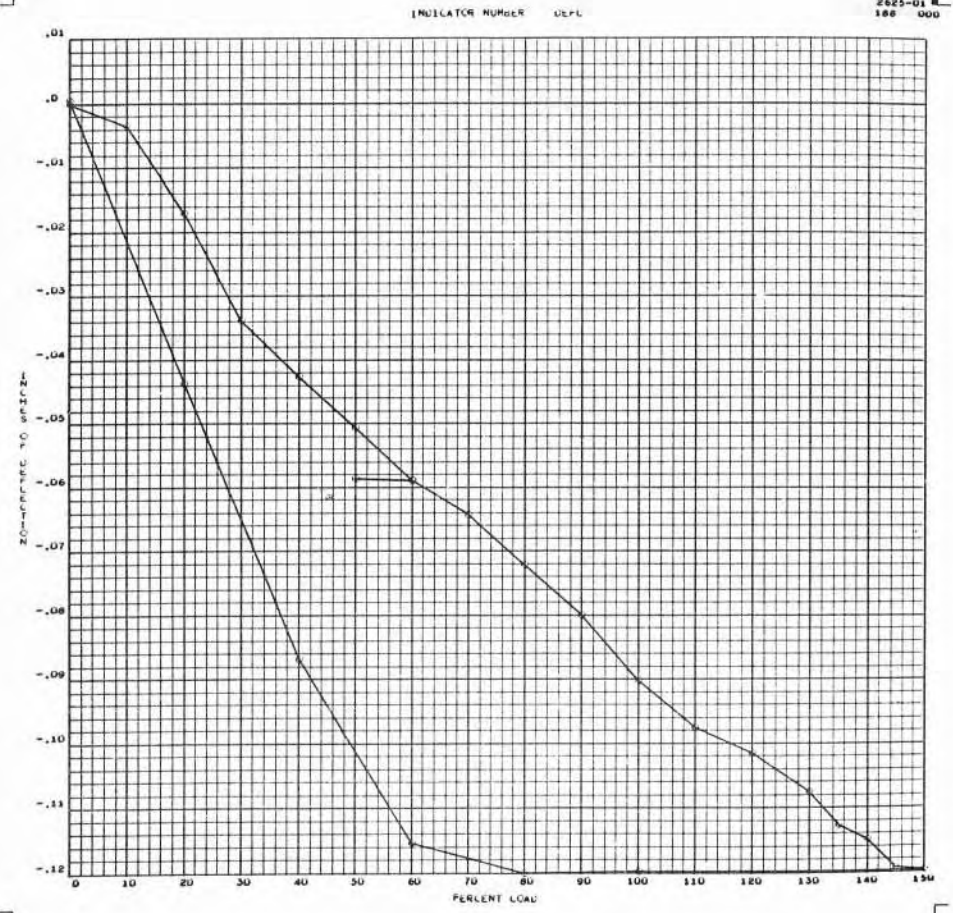
A-253

SID 67-317



A-254

SID 67-317



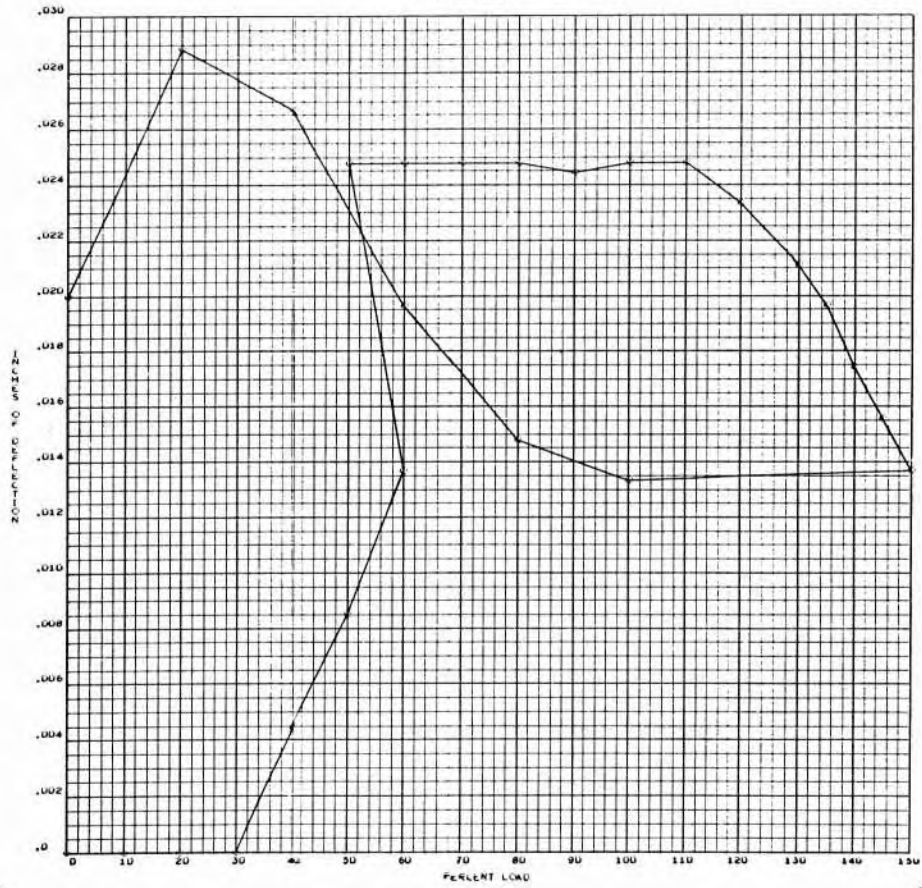
A-255

SID 67-317



INDICATOR NUMBER DEFL

2625-01  
189 000

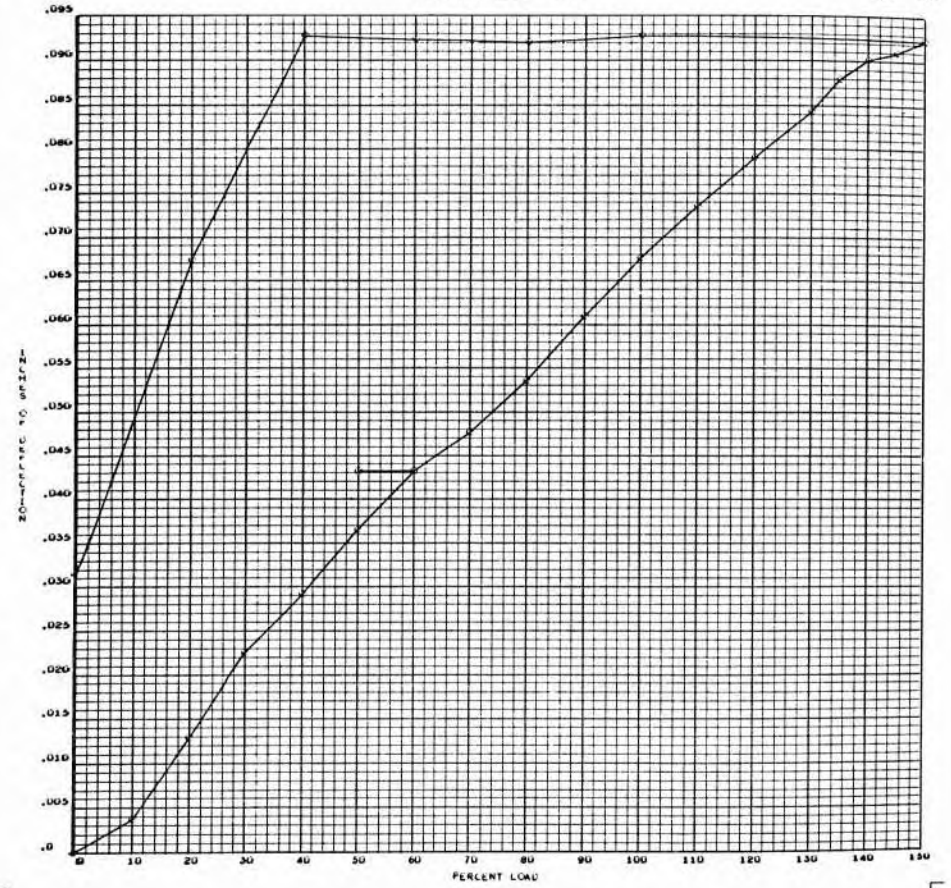


A-256

SID 67-317

INDICATOR NUMBER DEFL

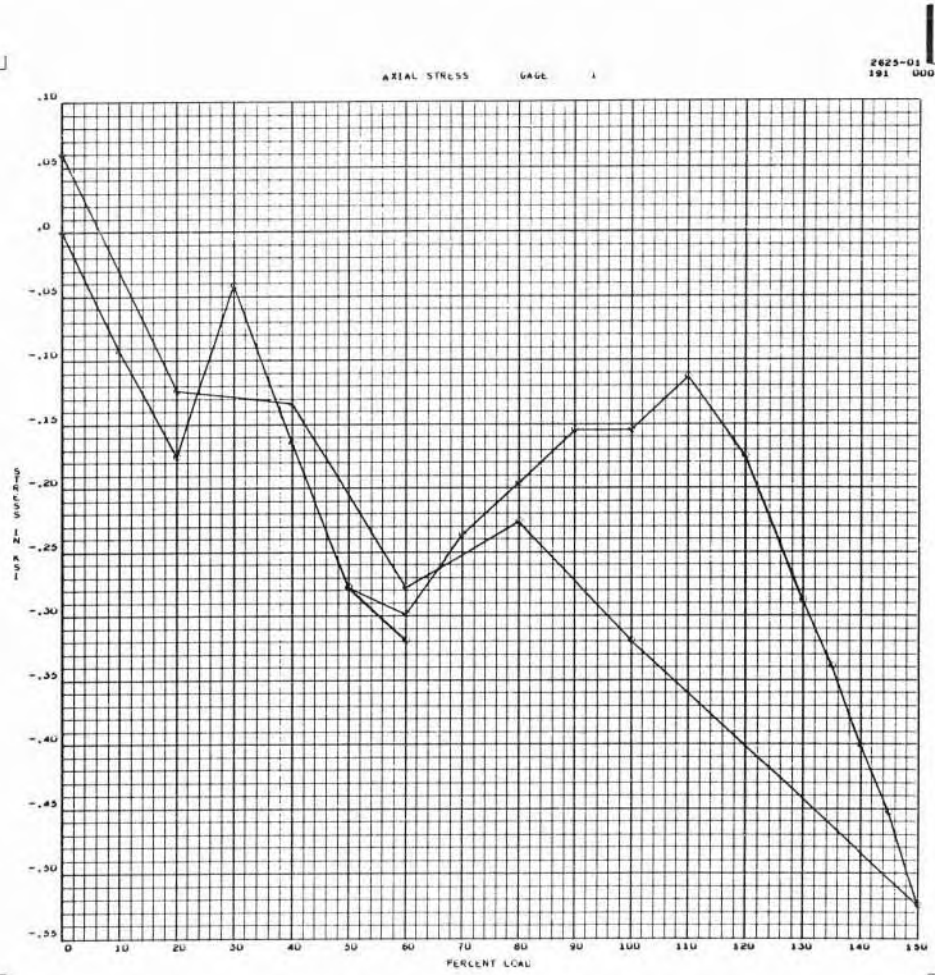
2625-01  
190 000



A-257

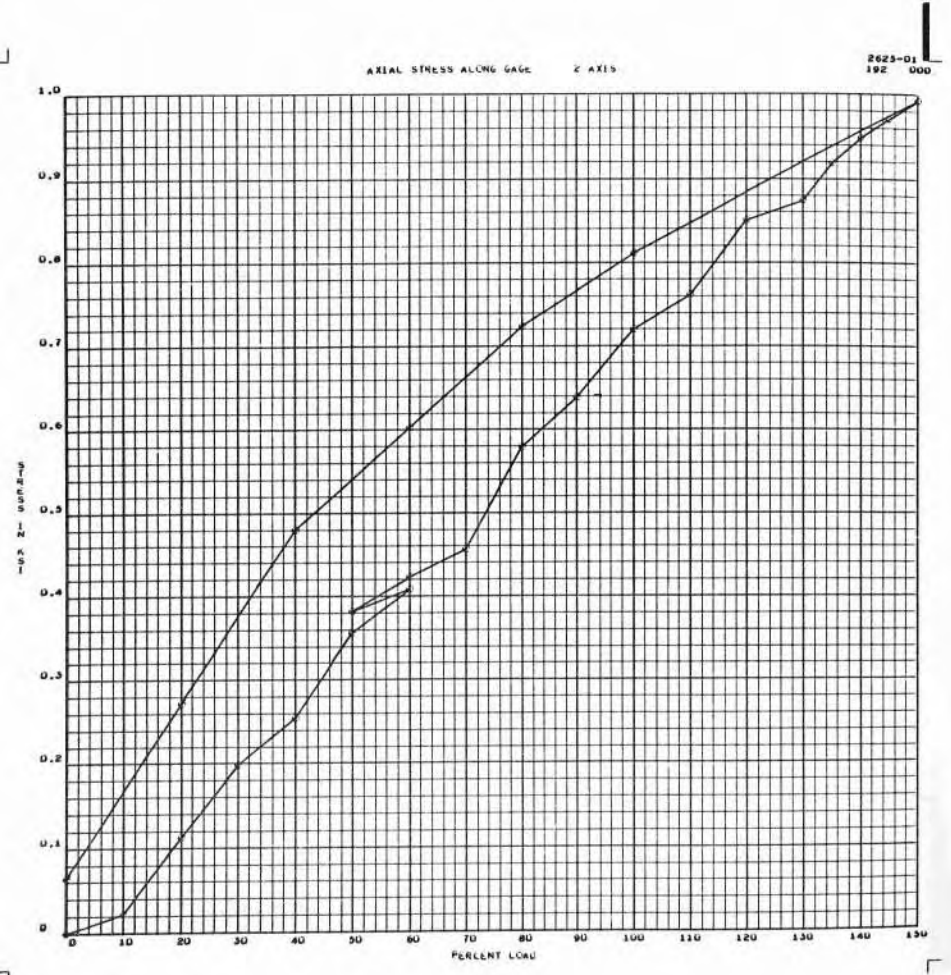
SID 67-317





A-258

SID 67-317

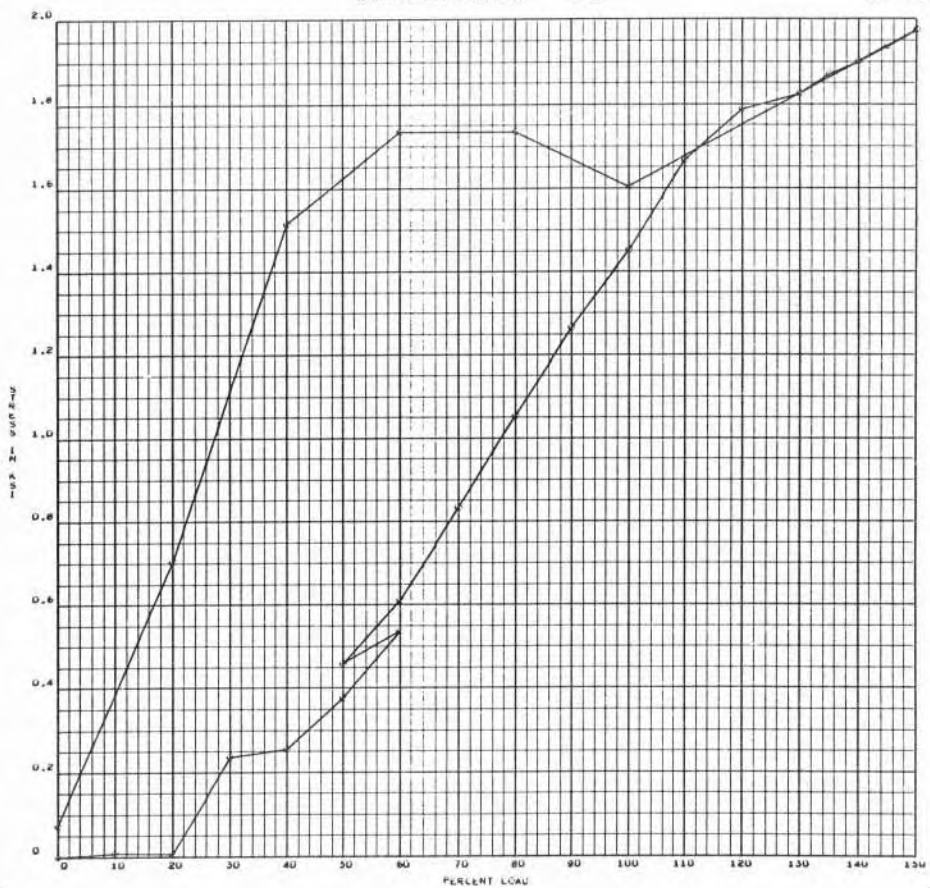


A-259

SID 67-317

AXIAL STRESS ALONG GAGE Z AXIS

2625-01  
193 000

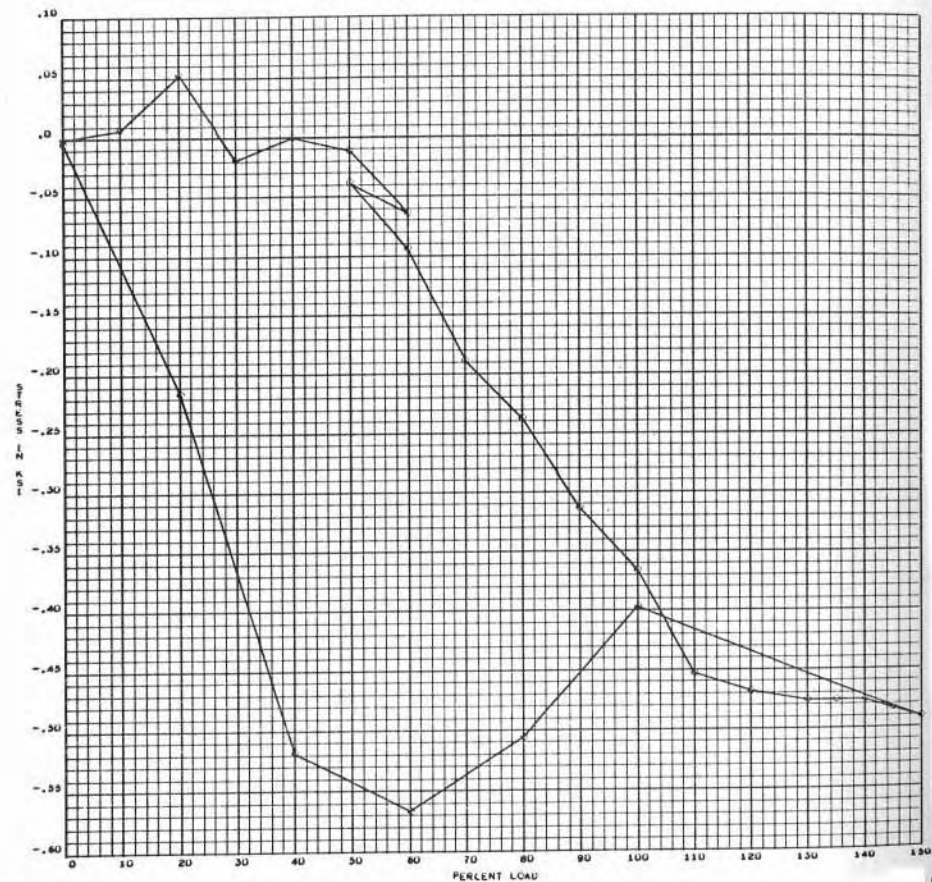


A-260

SID 67-317

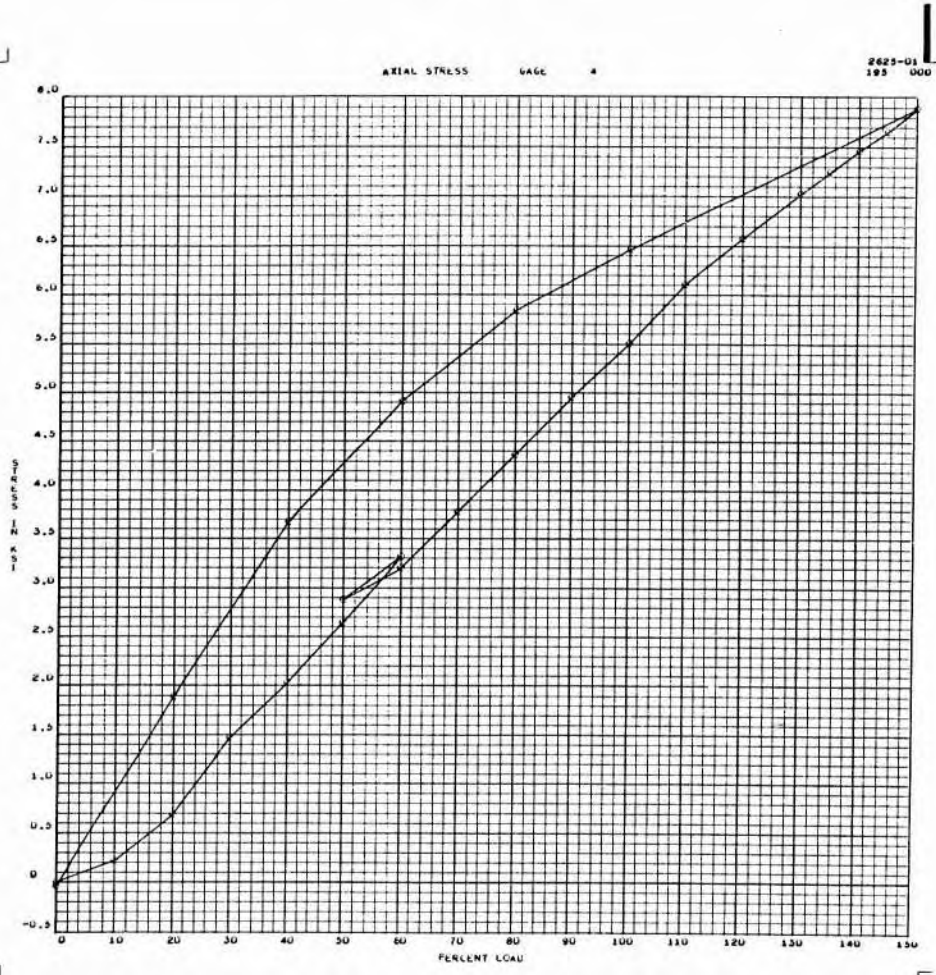
SHEAR STRESS FROM GAGE Z AND GAGE 3

2625-01  
194 000



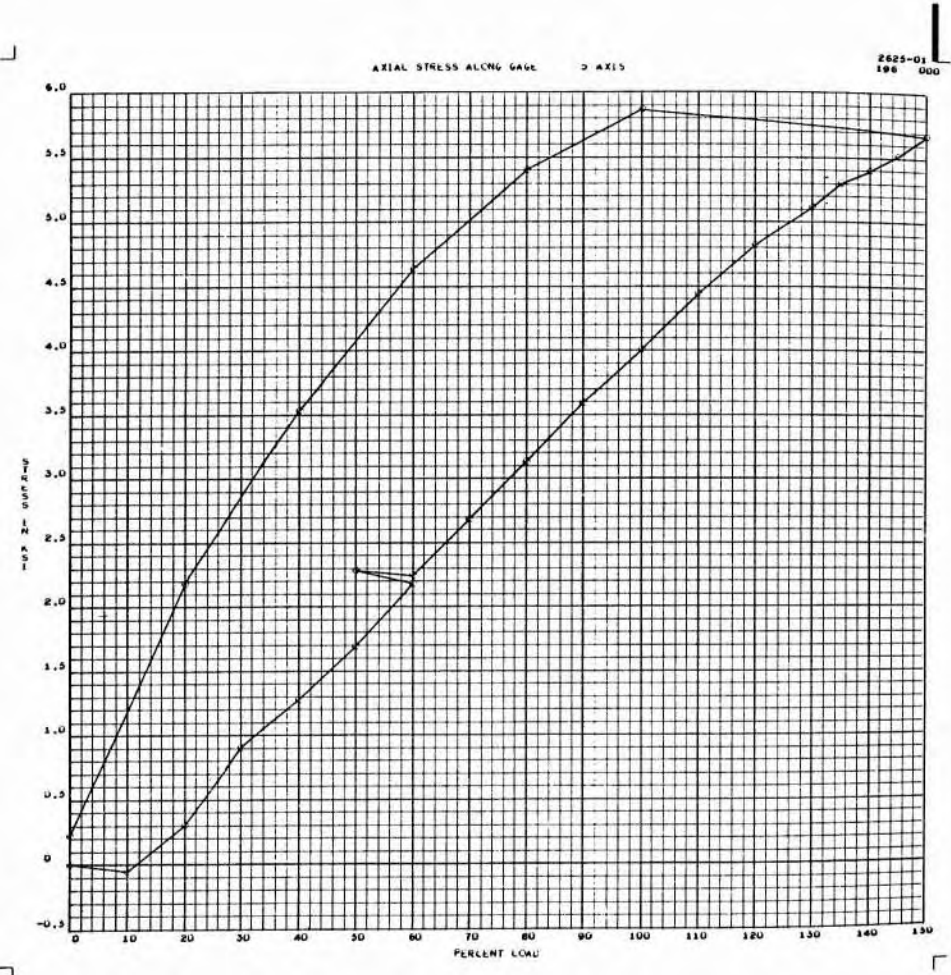
A-261

SID 67-317



A-262

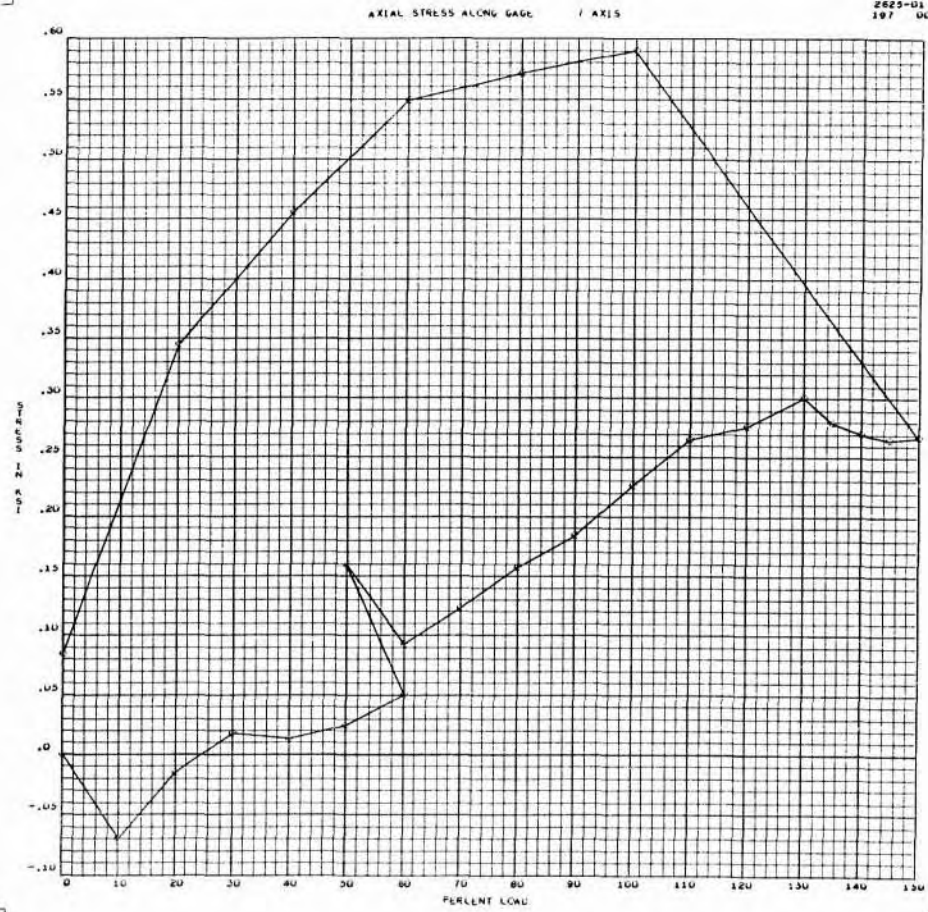
SID 67-317



A-263

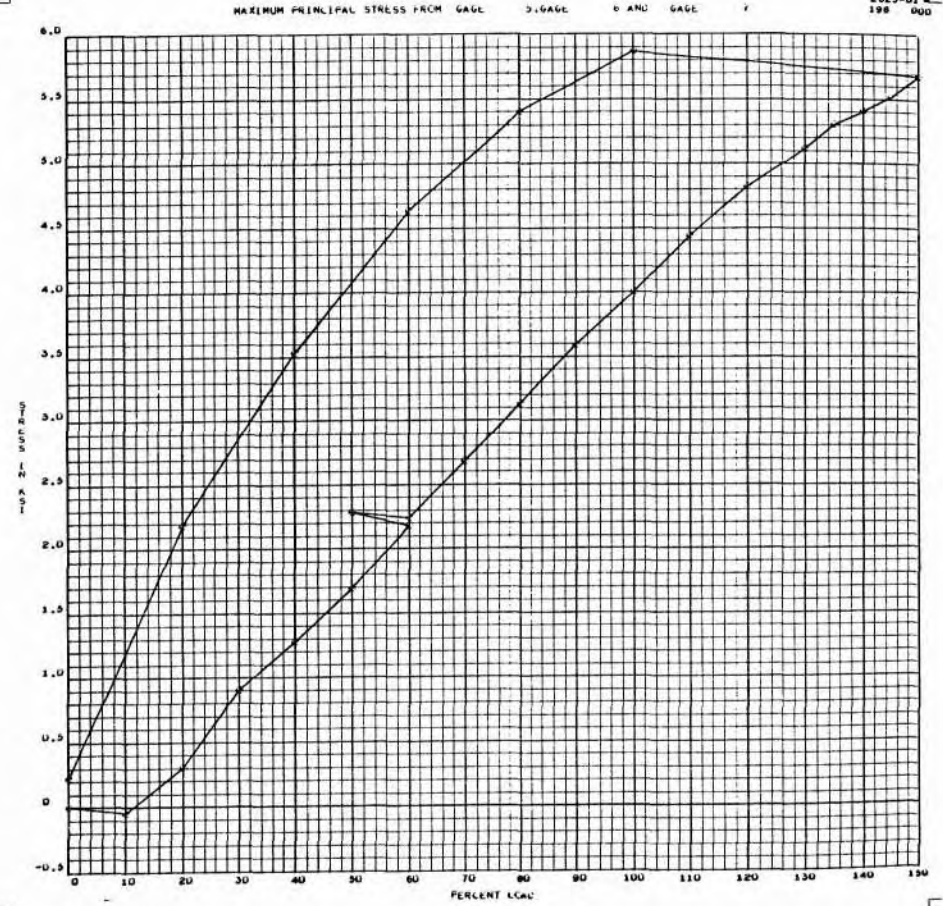
SID 67-317





A-264

SID 67-317



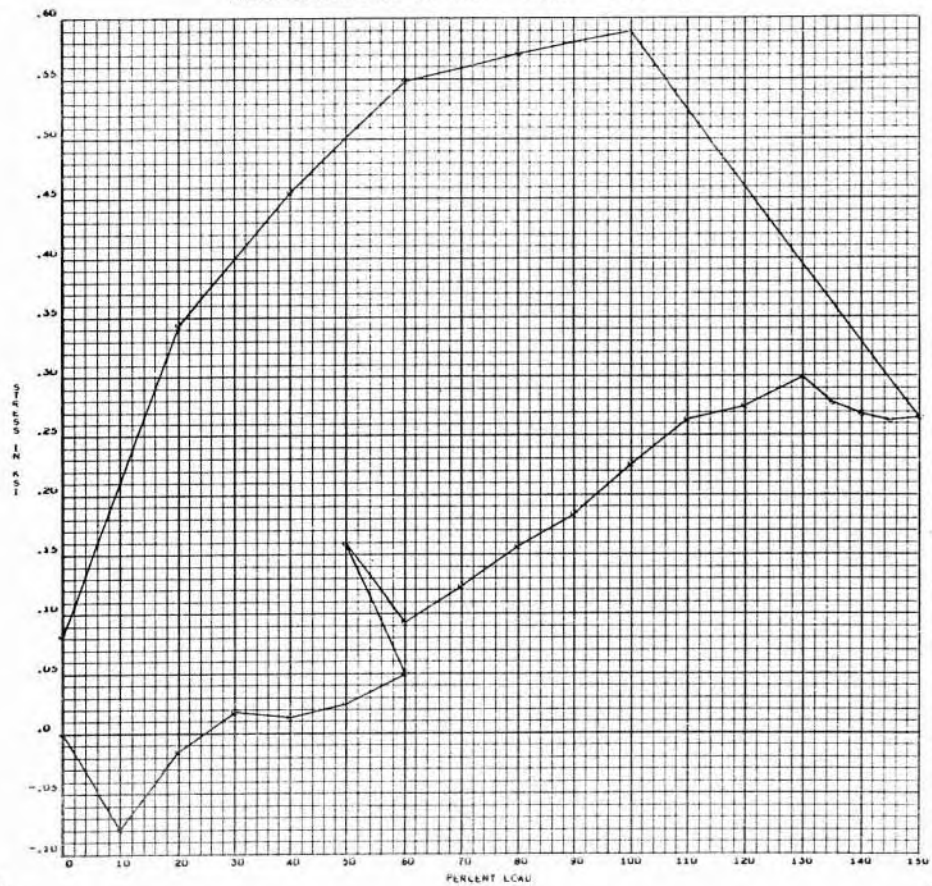
A-265

SID 67-317



MINIMUM PRINCIPAL STRESS FROM GAGE 3, GAGE 6 AND GAGE 7

2625-01  
199 000

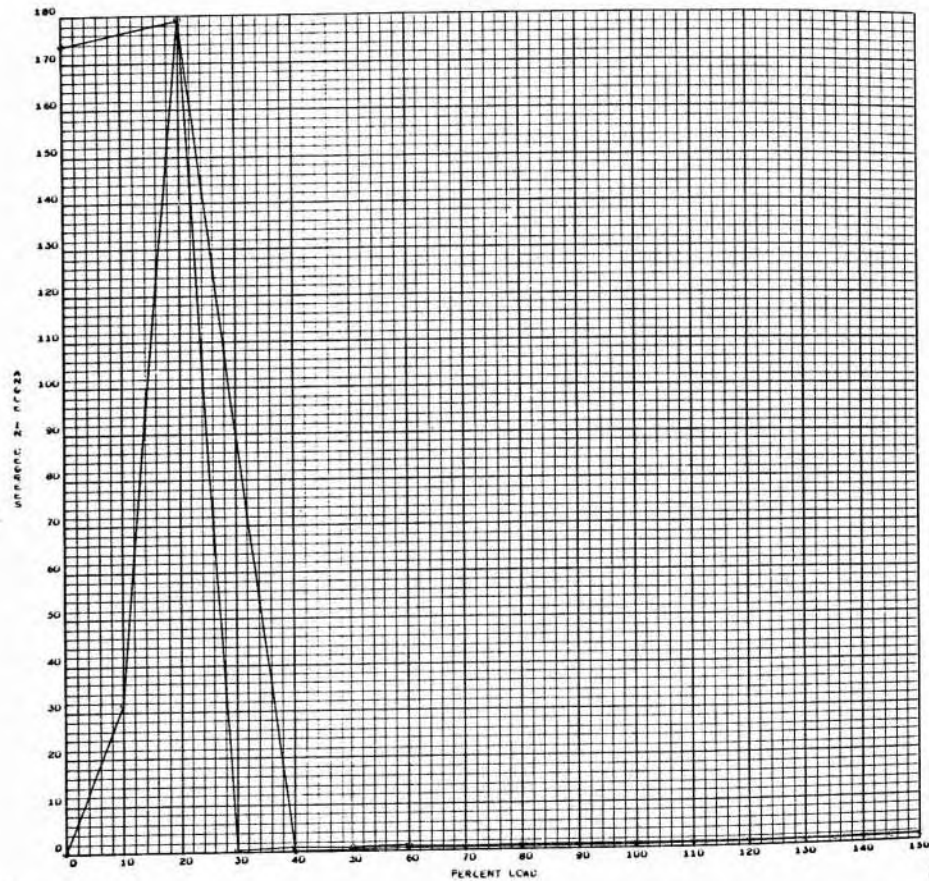


A-266

SID 67-317

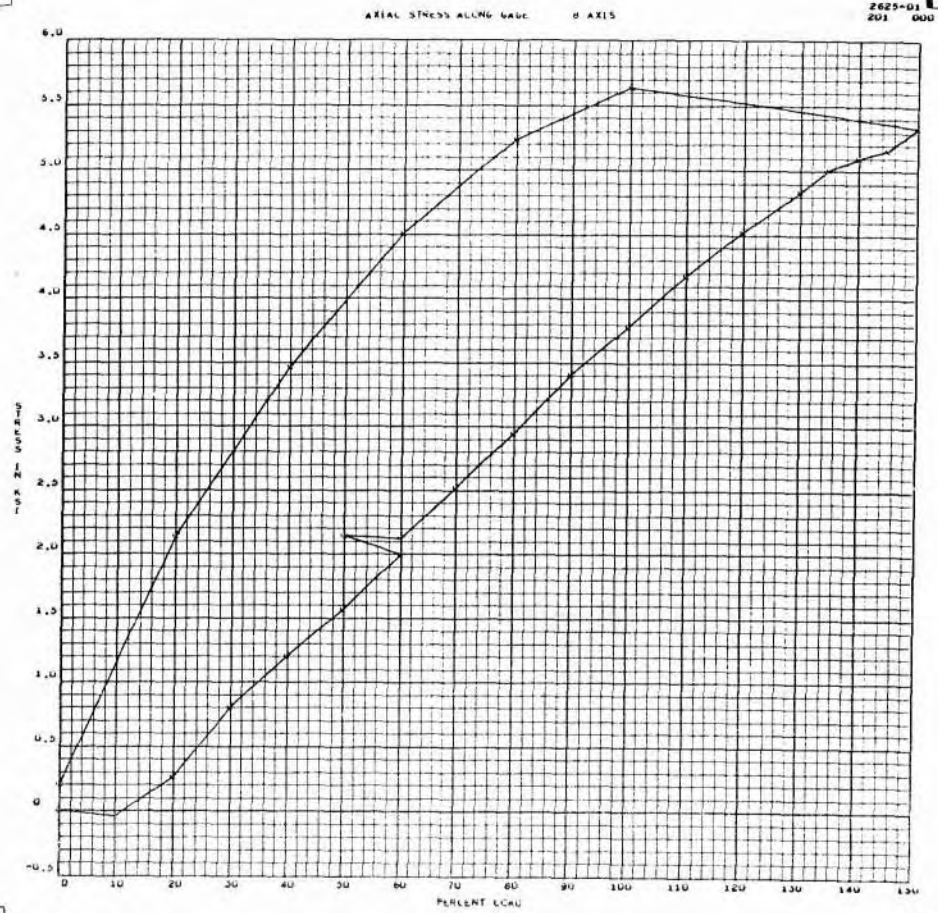
THETA

2625-01  
200 000



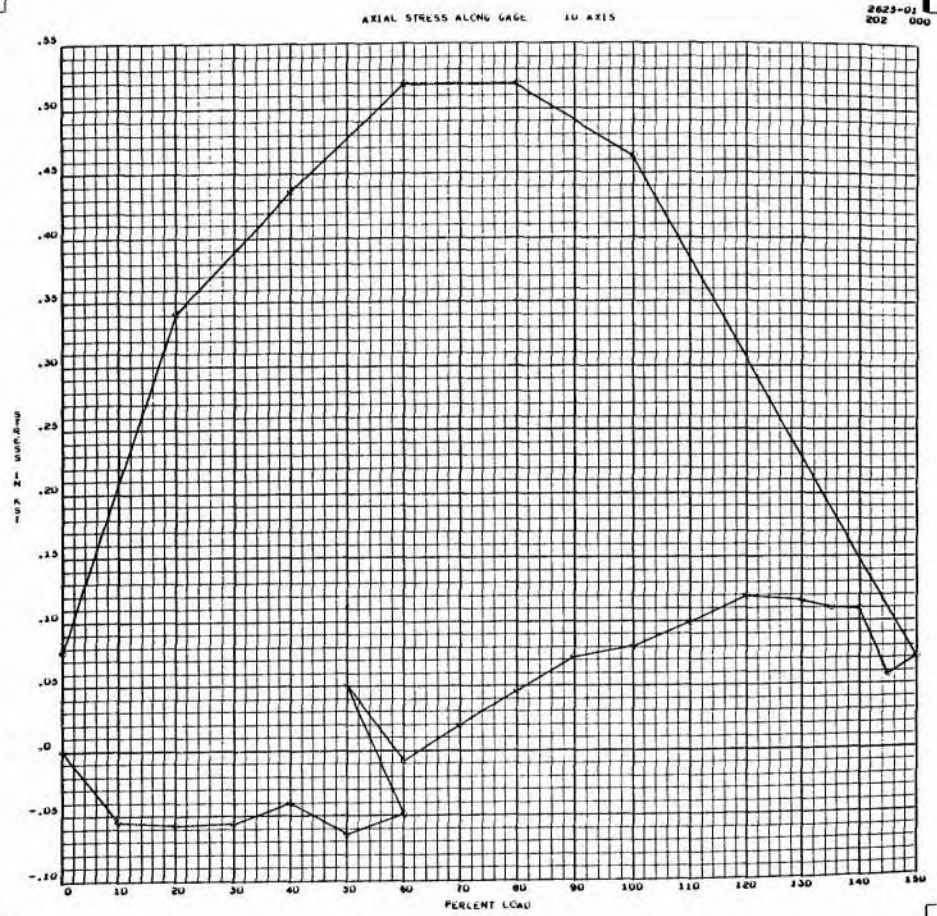
A-267

SID 67-317



A-268

SID 67-317

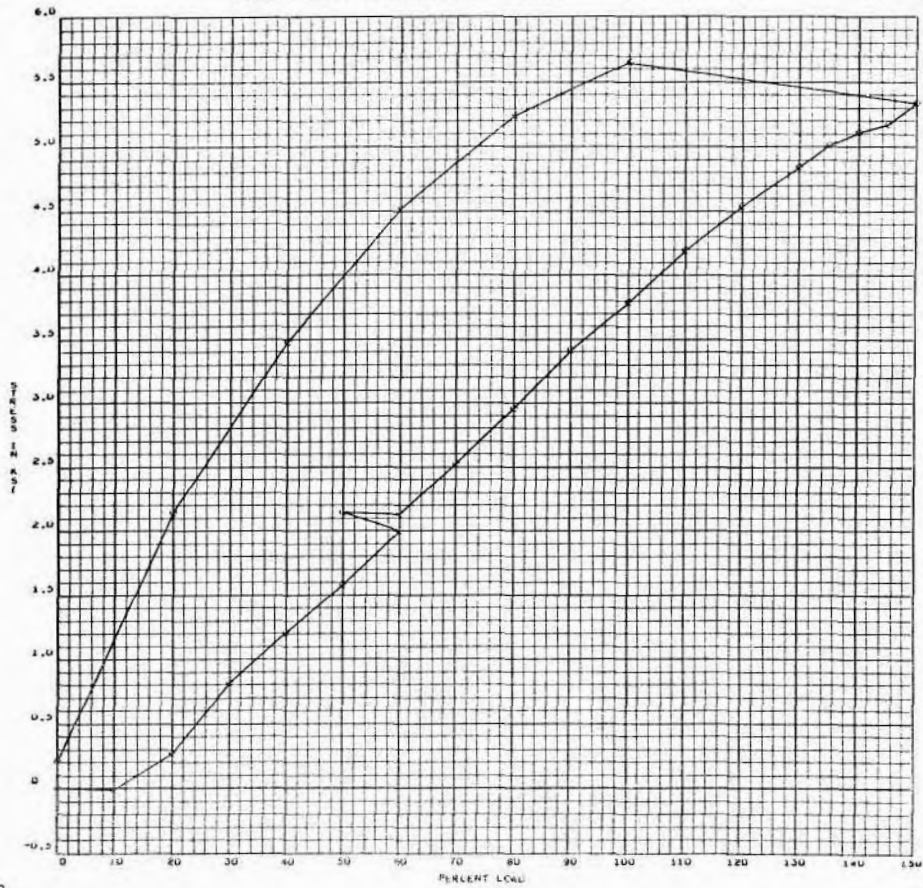


A-269

SID 67-317

MAXIMUM PRINCIPAL STRESS FROM GAGE 8, GAGE 9 AND GAGE 10

2625-01  
203 000

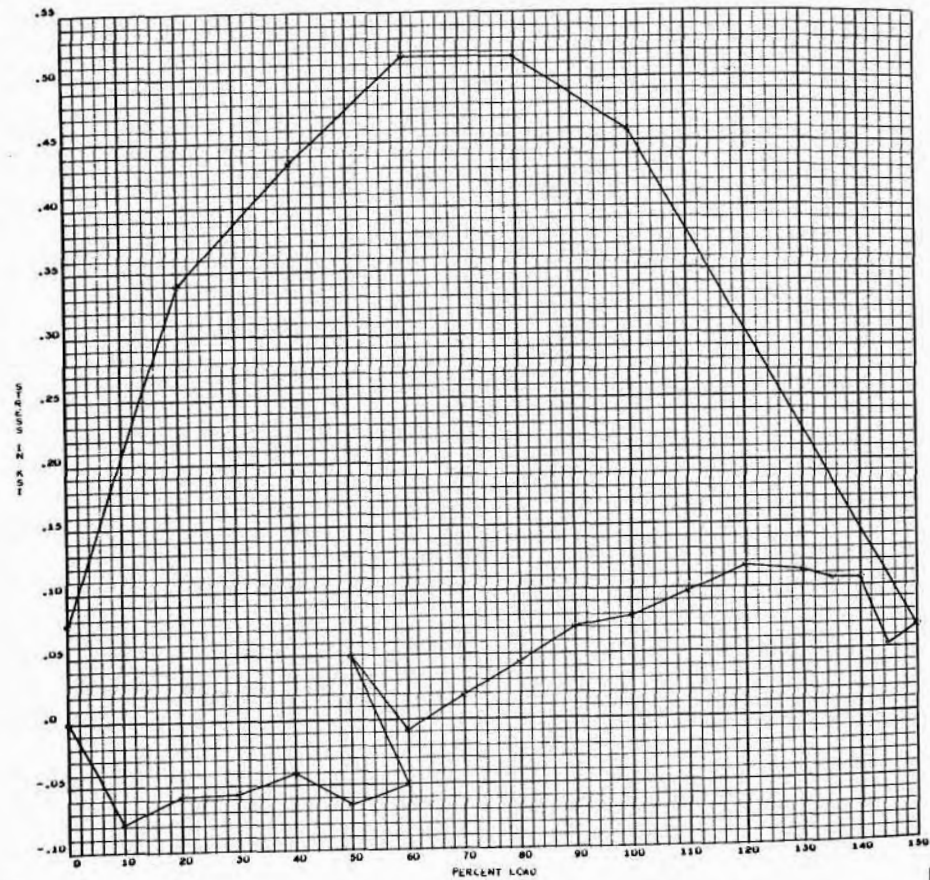


A-270

SID 67-317

MINIMUM PRINCIPAL STRESS FROM GAGE 8, GAGE 9 AND GAGE 10

2625-01  
204 000



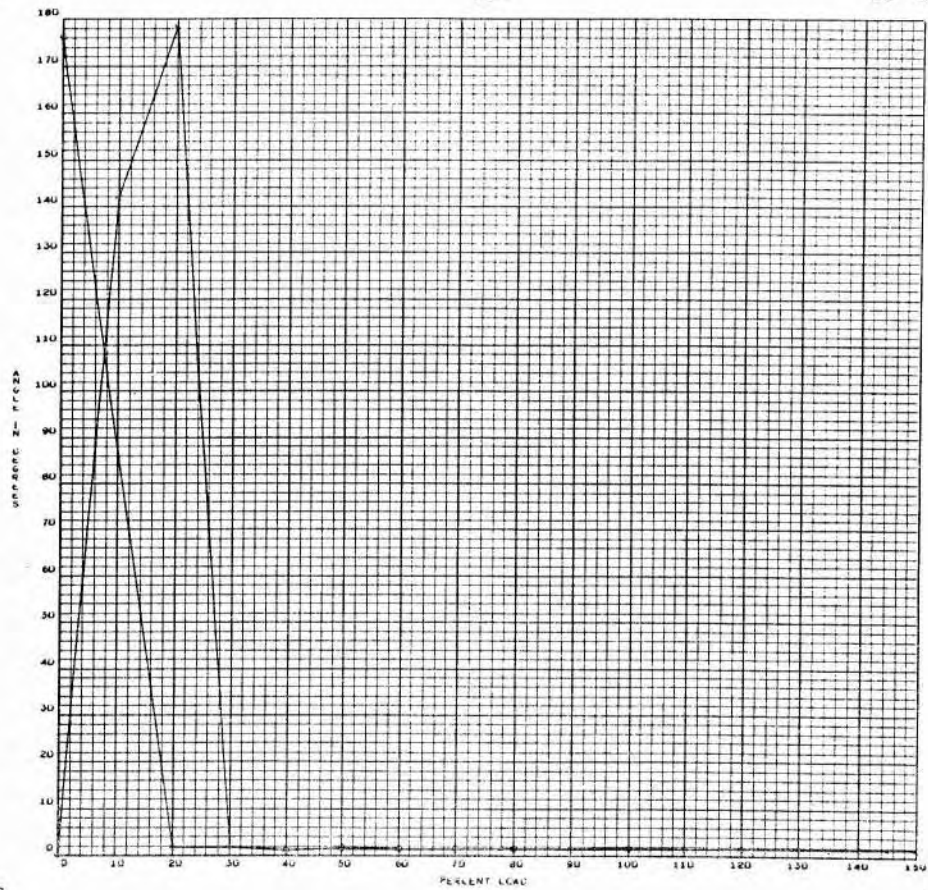
A-271

SID 67-317



THETA

2625-01  
205 000

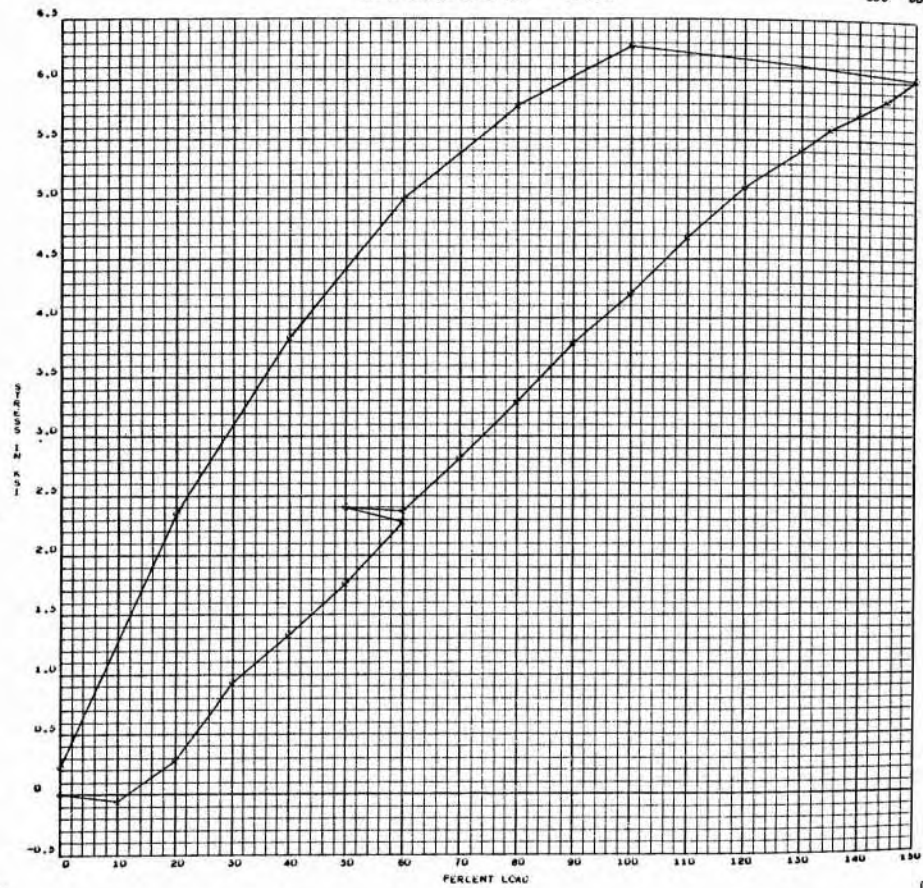


A-272

SID 67-317

AXIAL STRESS ALONG GAGE 11 AXIS

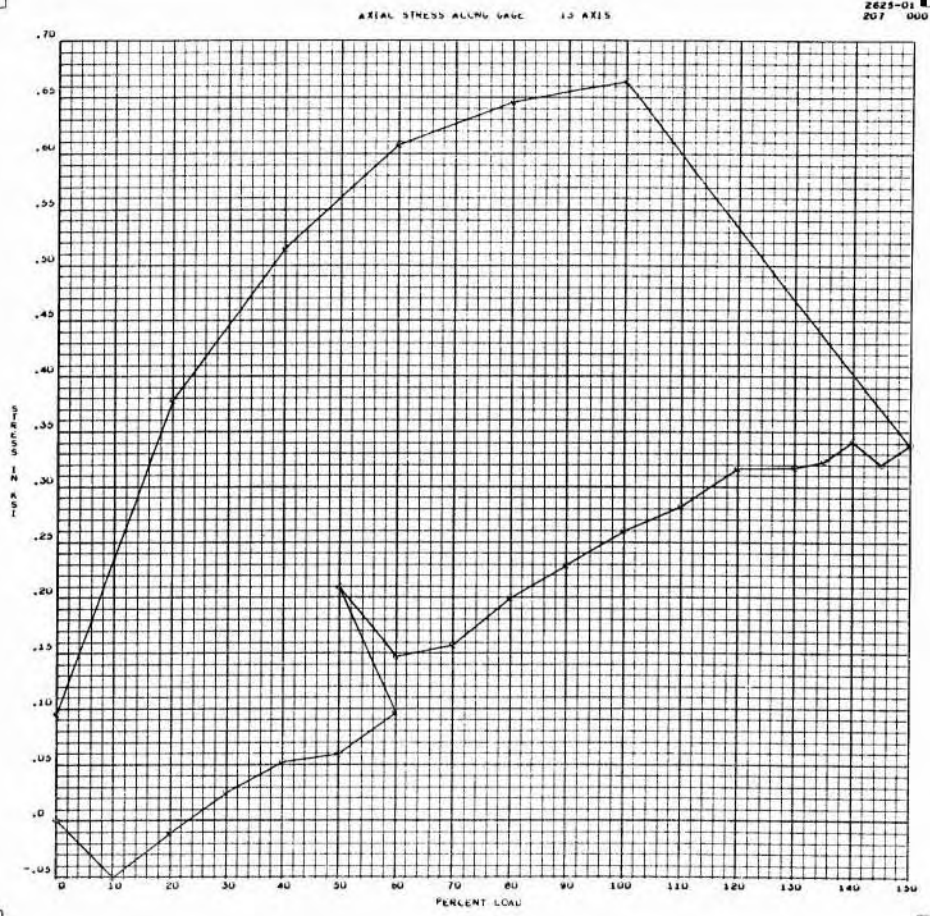
2625-01  
206 000



A-273

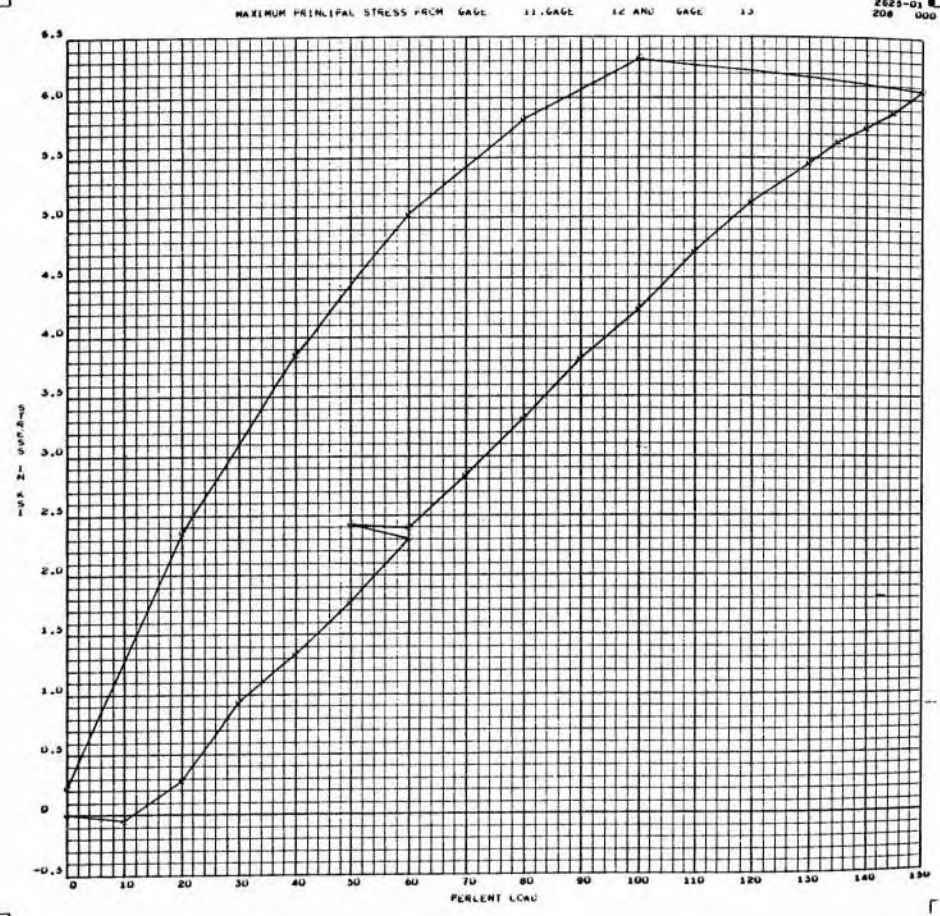
SID 67-317





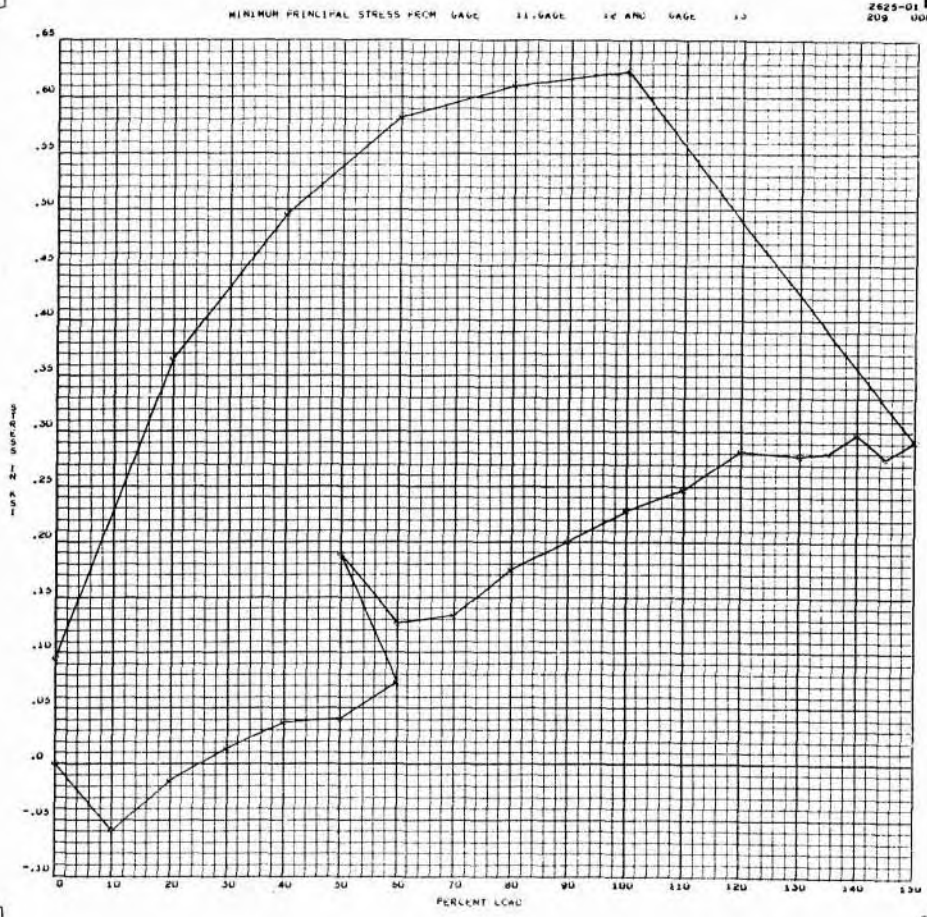
A-274

SID 67-317



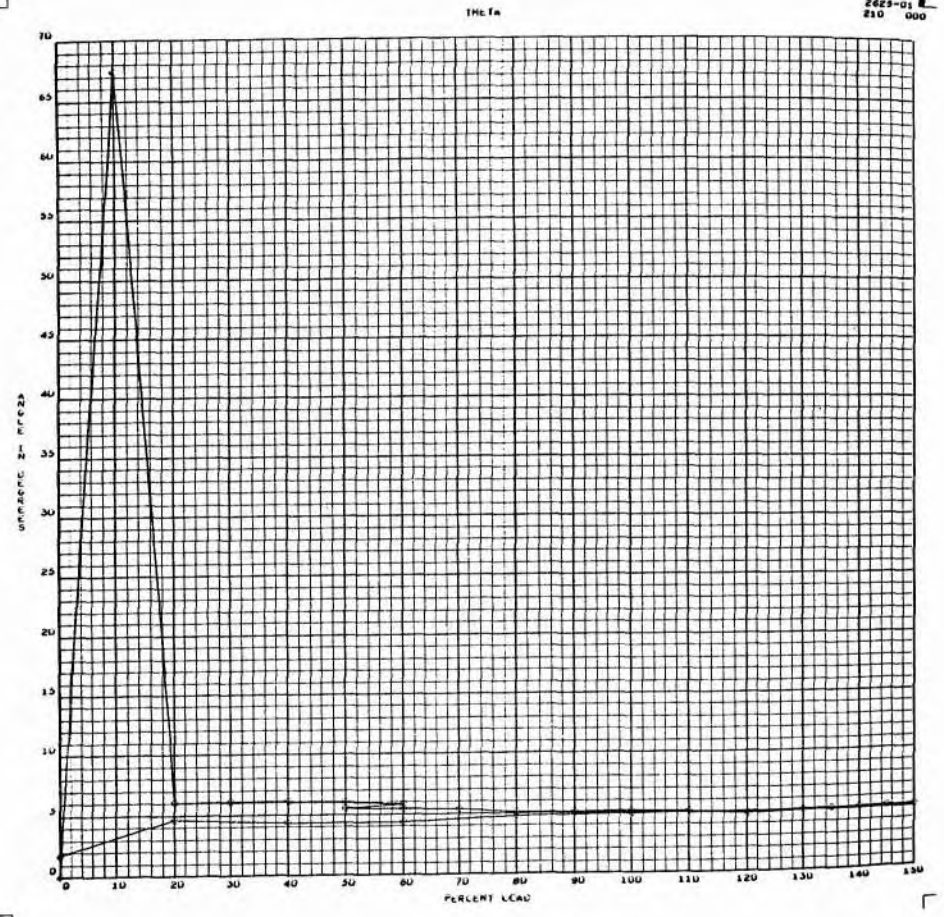
A-275

SID 67-317



A-276

SID 67-317

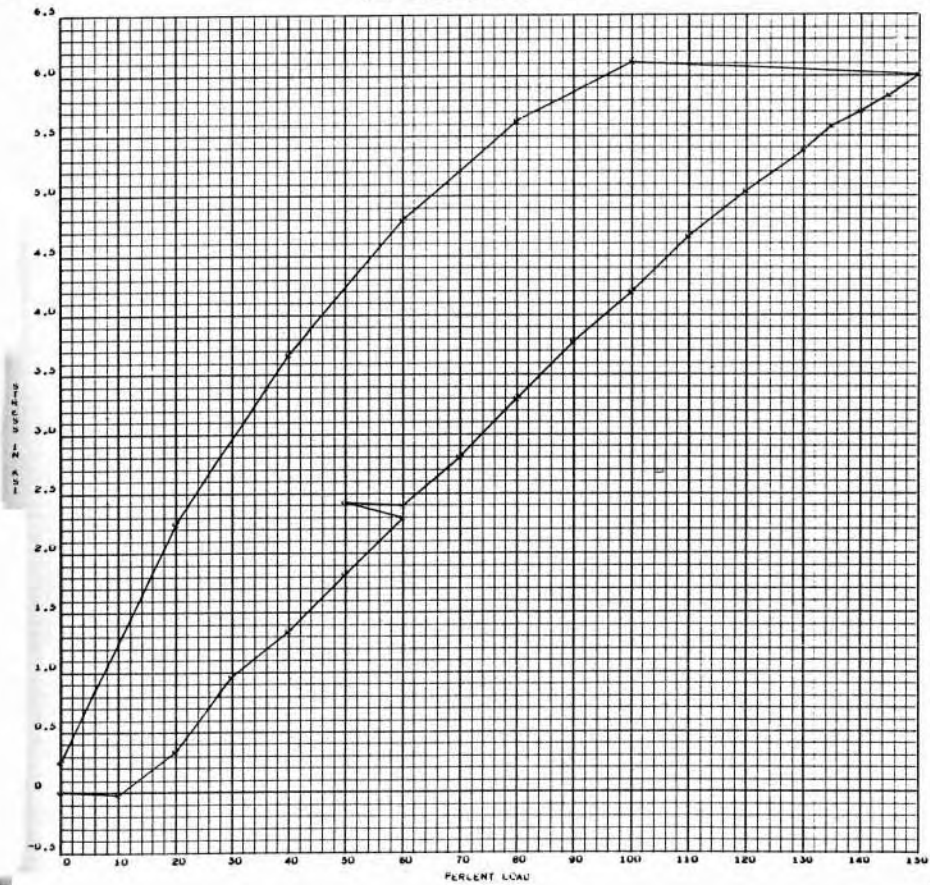


A-277

SID 67-317

AXIAL STRESS ALONG GAGE 14 AXIS

2625-01  
211 000

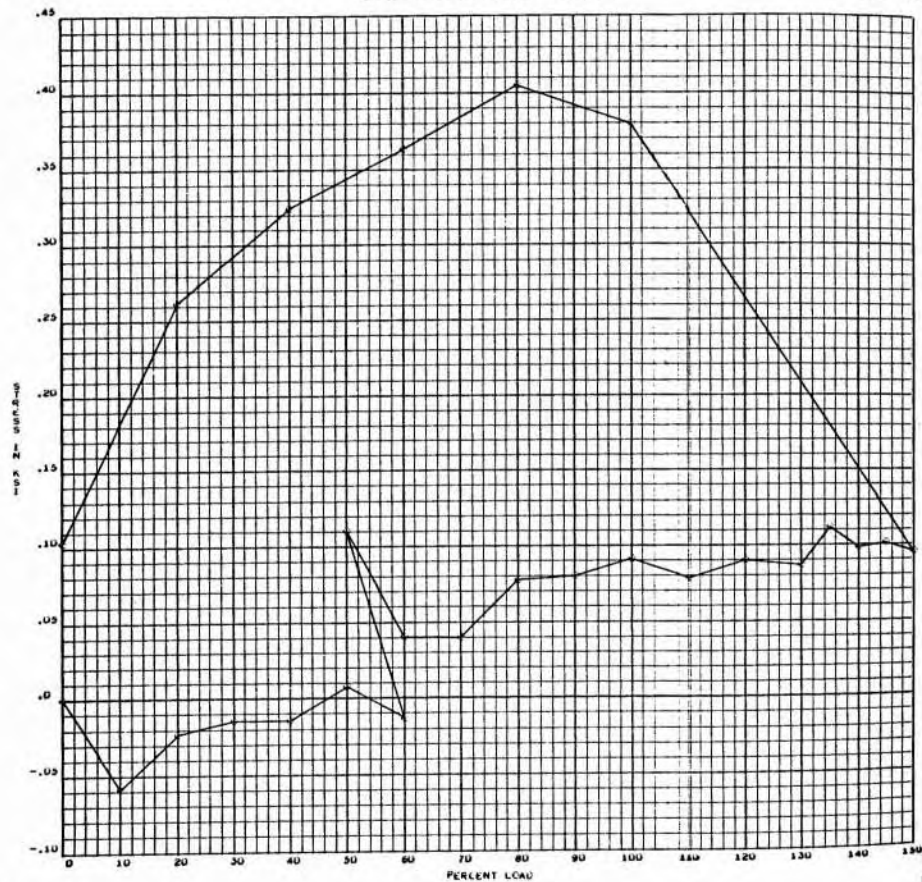


A-278

SID 67-317

AXIAL STRESS ALONG GAGE 10 AXIS

2625-01  
212 000



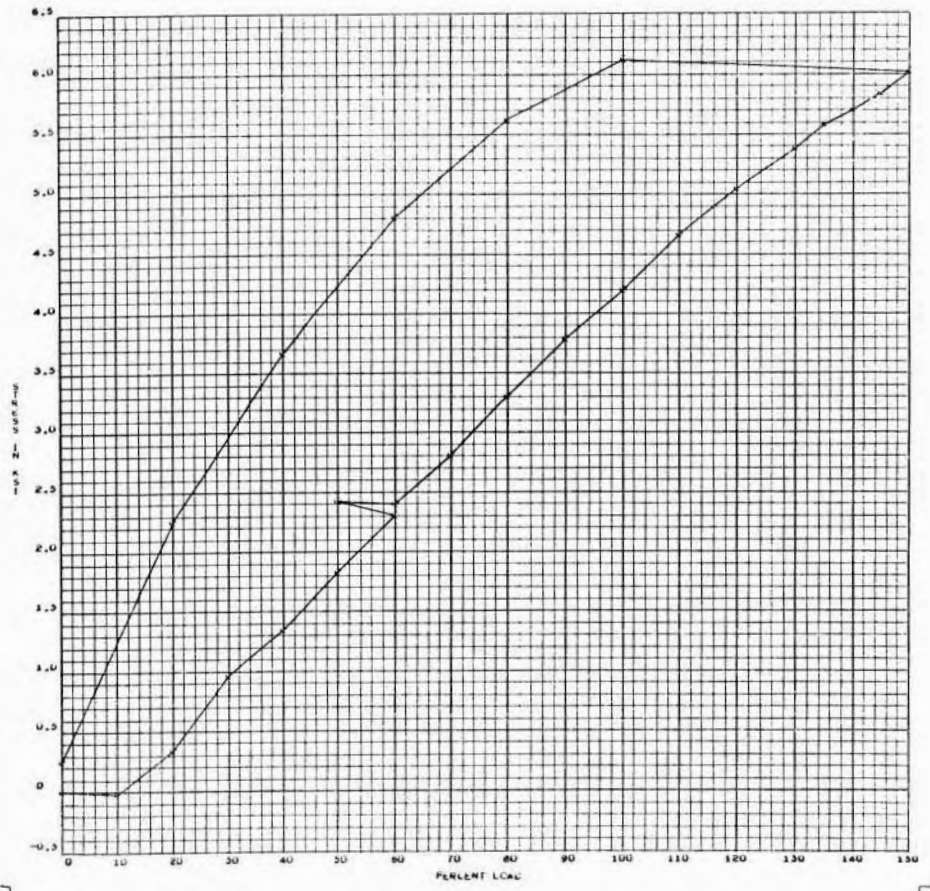
A-279

SID 67-317



MAXIMUM PRINCIPAL STRESS FROM GAGE 14, GAGE 13 AND GAGE 10

2625-01  
213 000

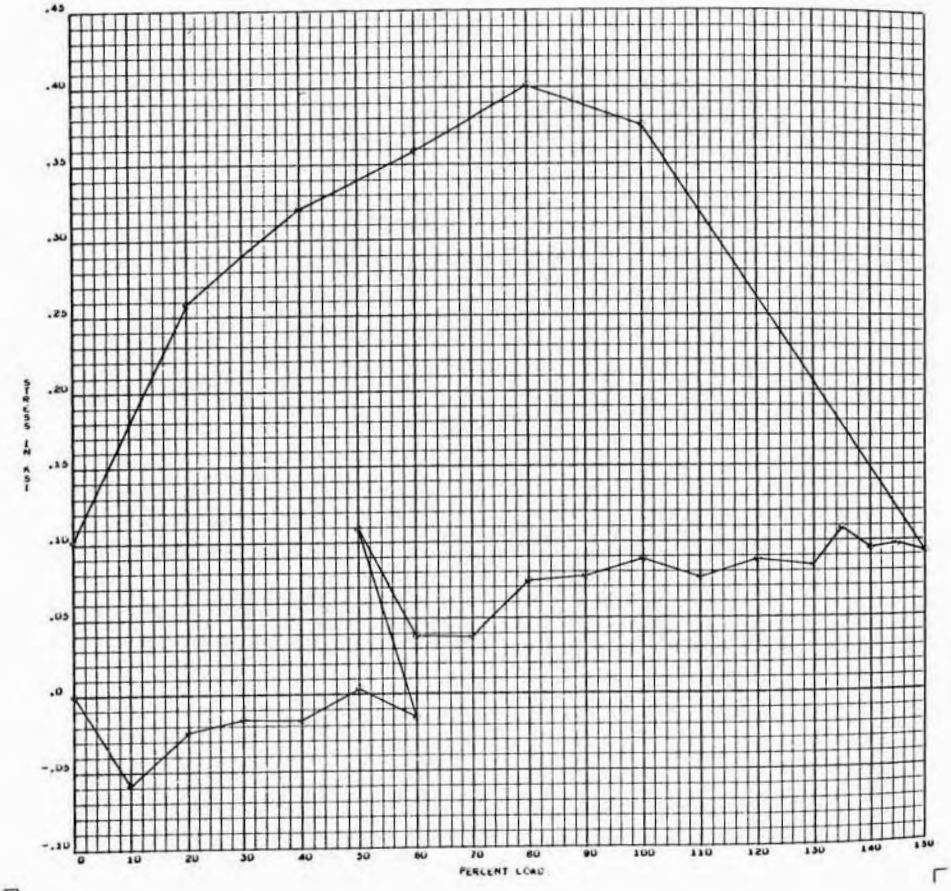


A-280

SID 67-317

MINIMUM PRINCIPAL STRESS FROM GAGE 14, GAGE 13 AND GAGE 10

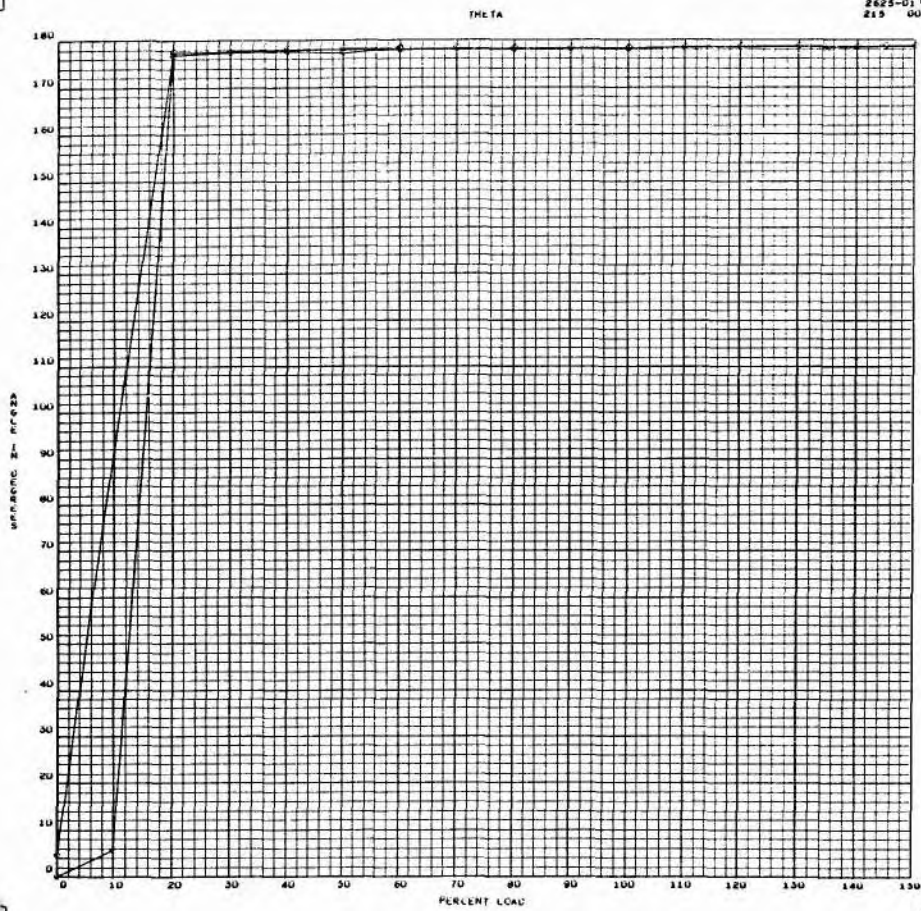
2625-01  
214 000



A-281

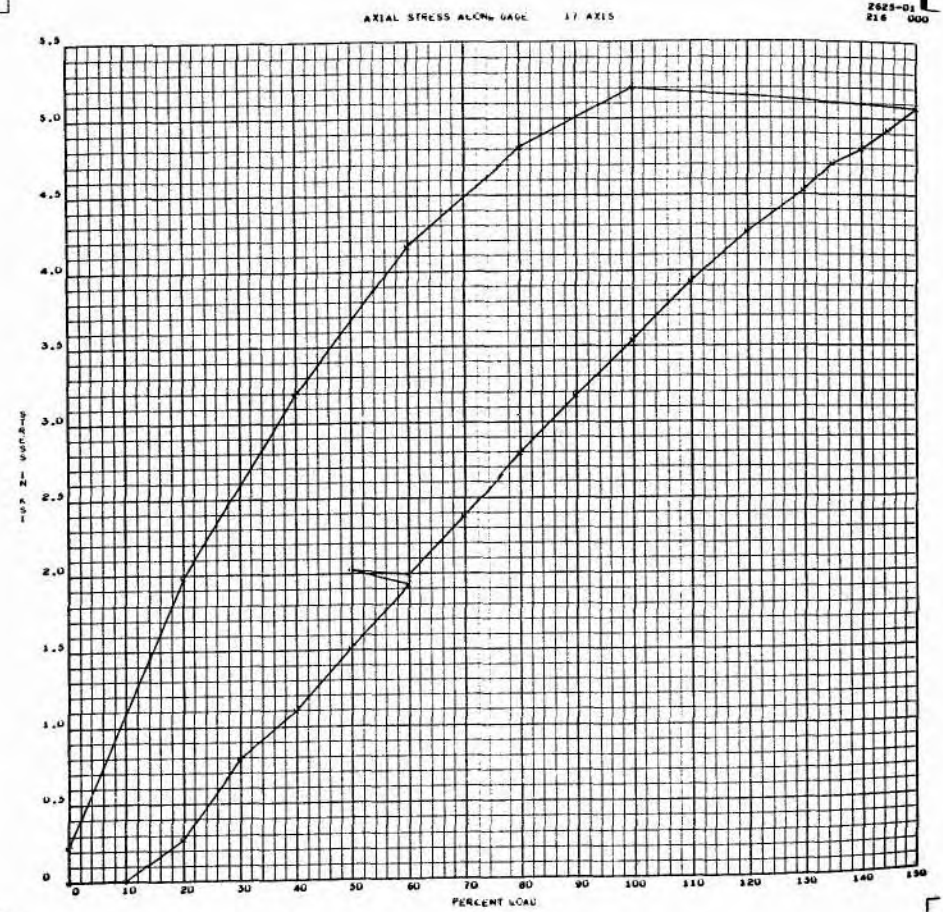
SID 67-317





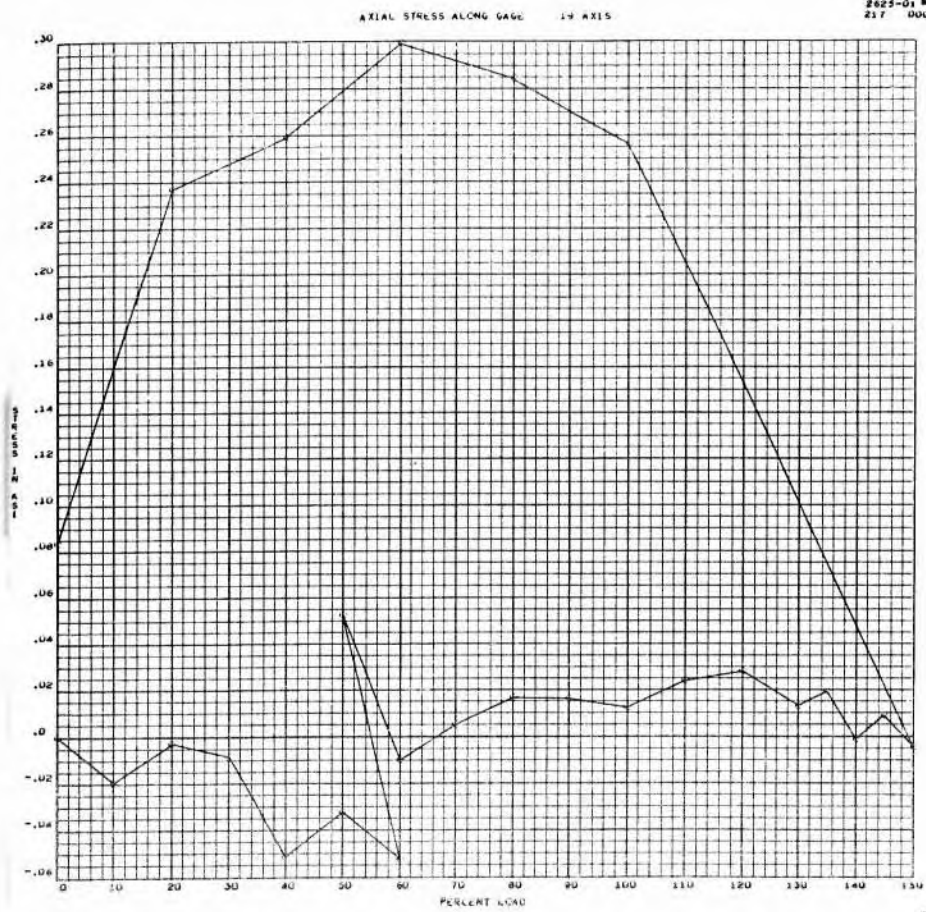
A-282

SID 67-317



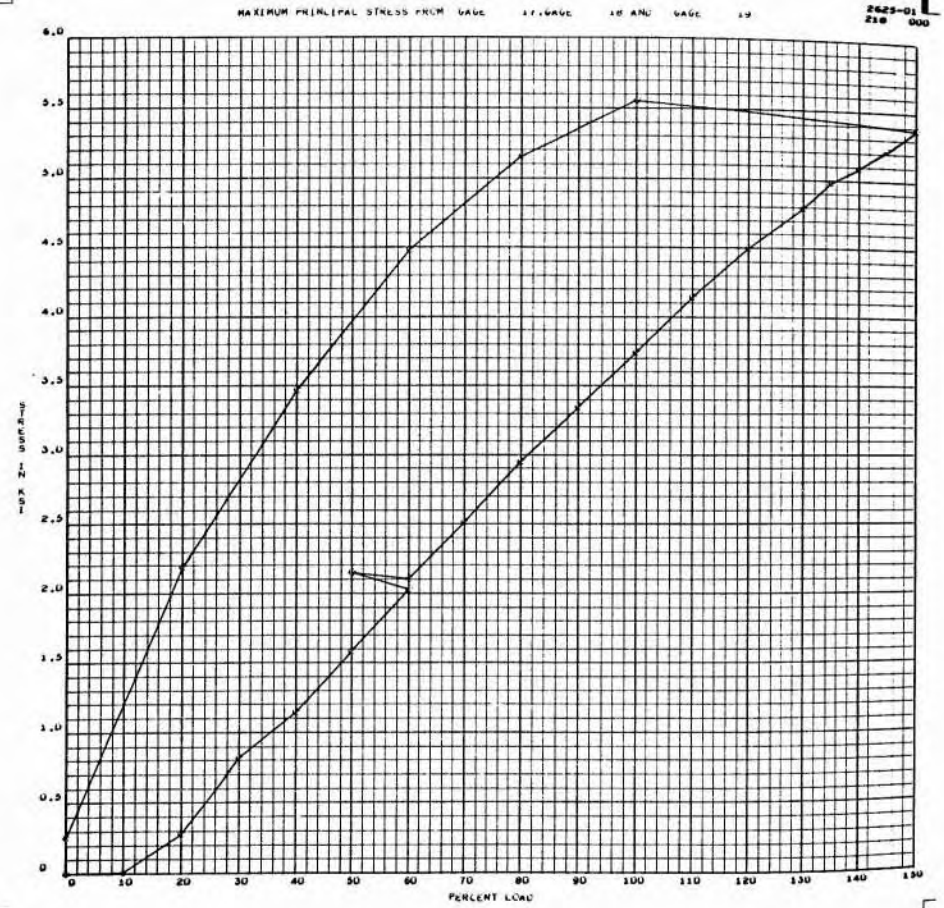
A-283

SID 67-317



A-284

SID 67-317

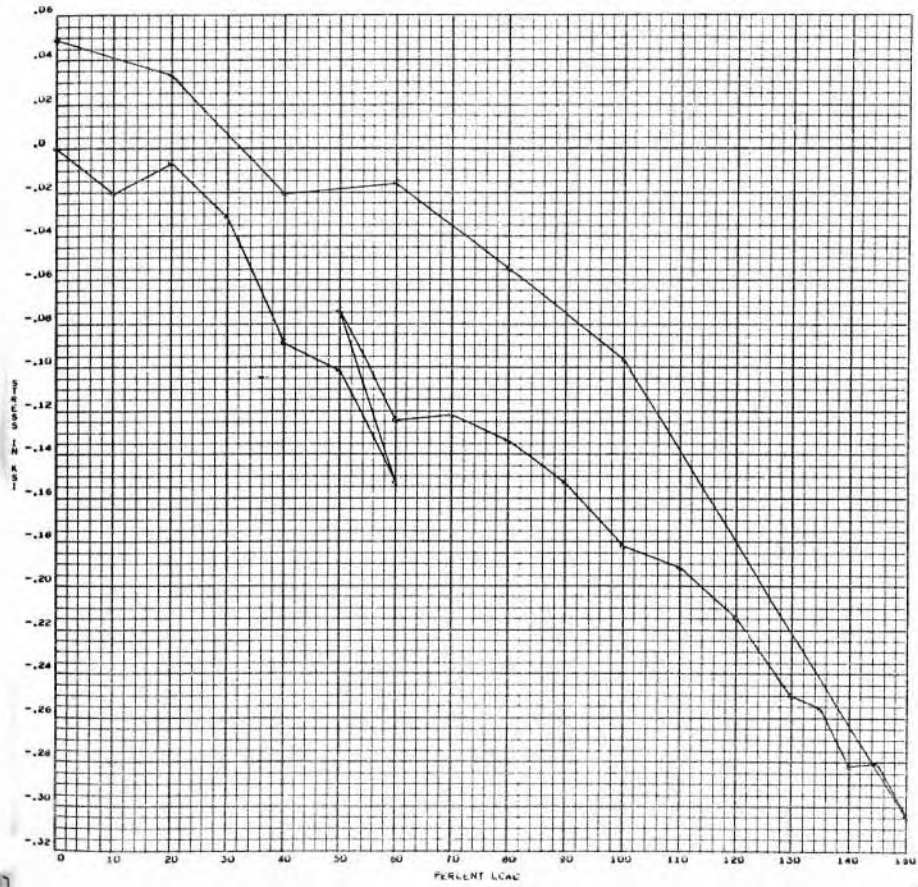


A-285

SID 67-317

MINIMUM PRINCIPAL STRESS FROM WAVE 21 GAGE 18 AND GAGE 19

2625-01  
219 000

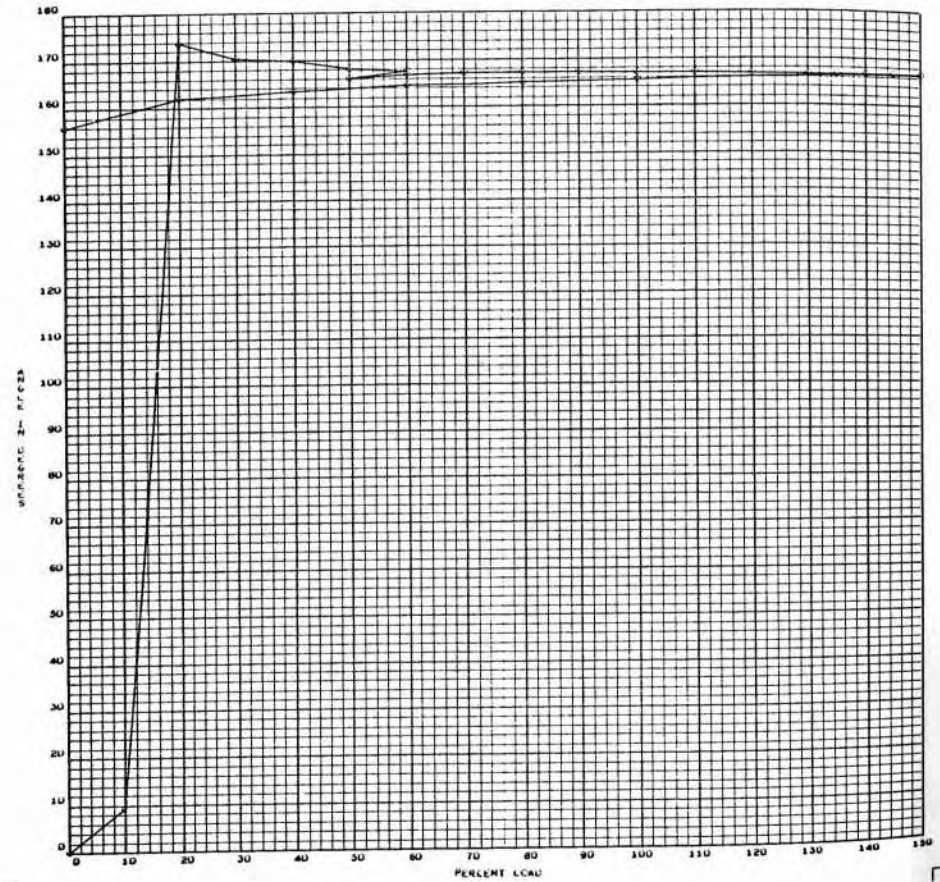


A-286

SID 67-317

THE TA

2625-01  
220 000



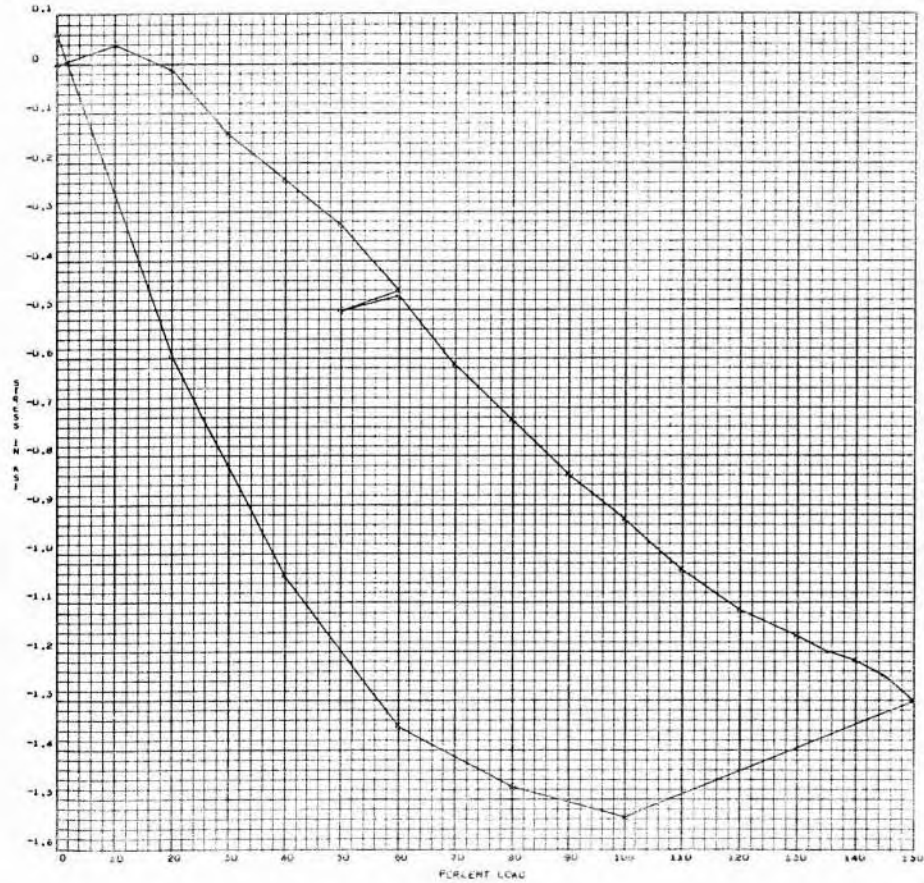
A-287

SID 67-317



AXIAL STRESS GAGE Z1

2625-01  
Z22 000

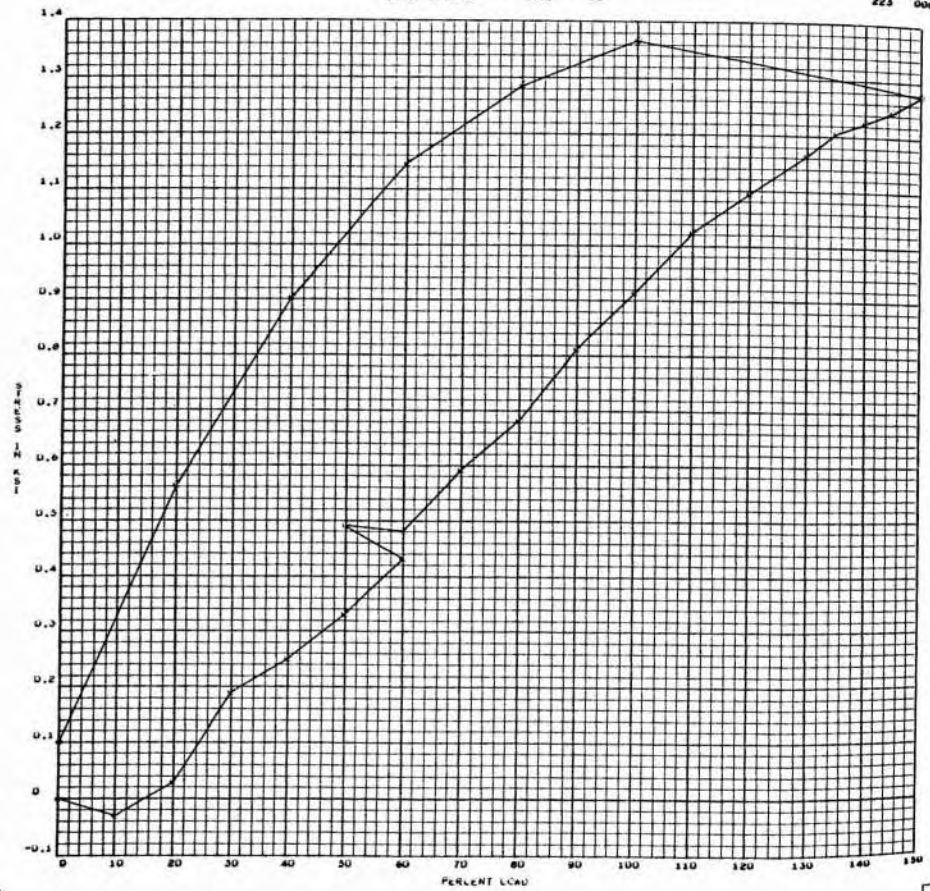


A-288

SID 67-317

AXIAL STRESS GAGE Z2

2625-01  
Z23 000



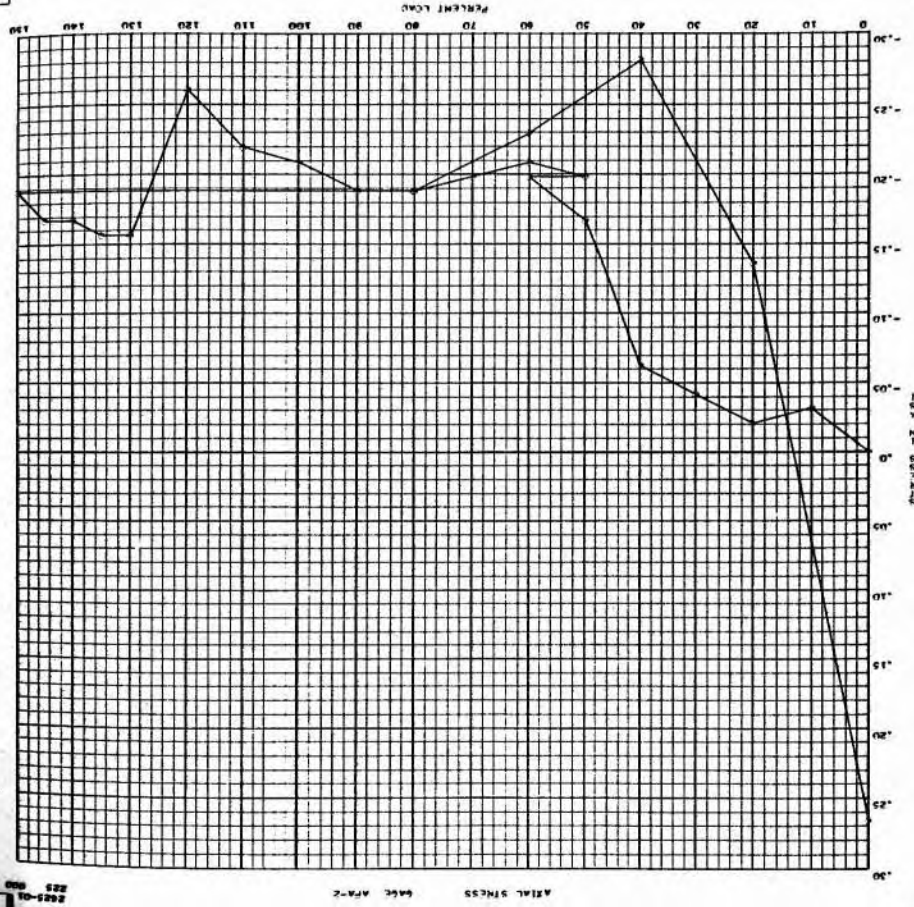
A-289

SID 67-317



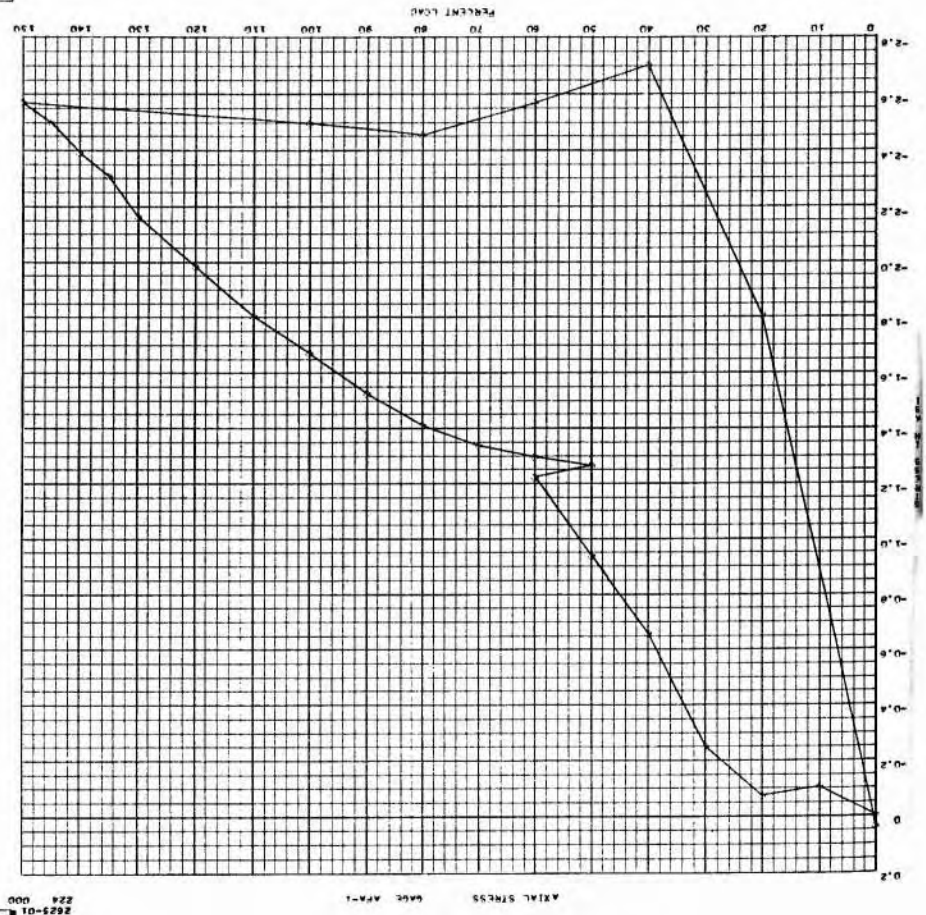
SID 67-317

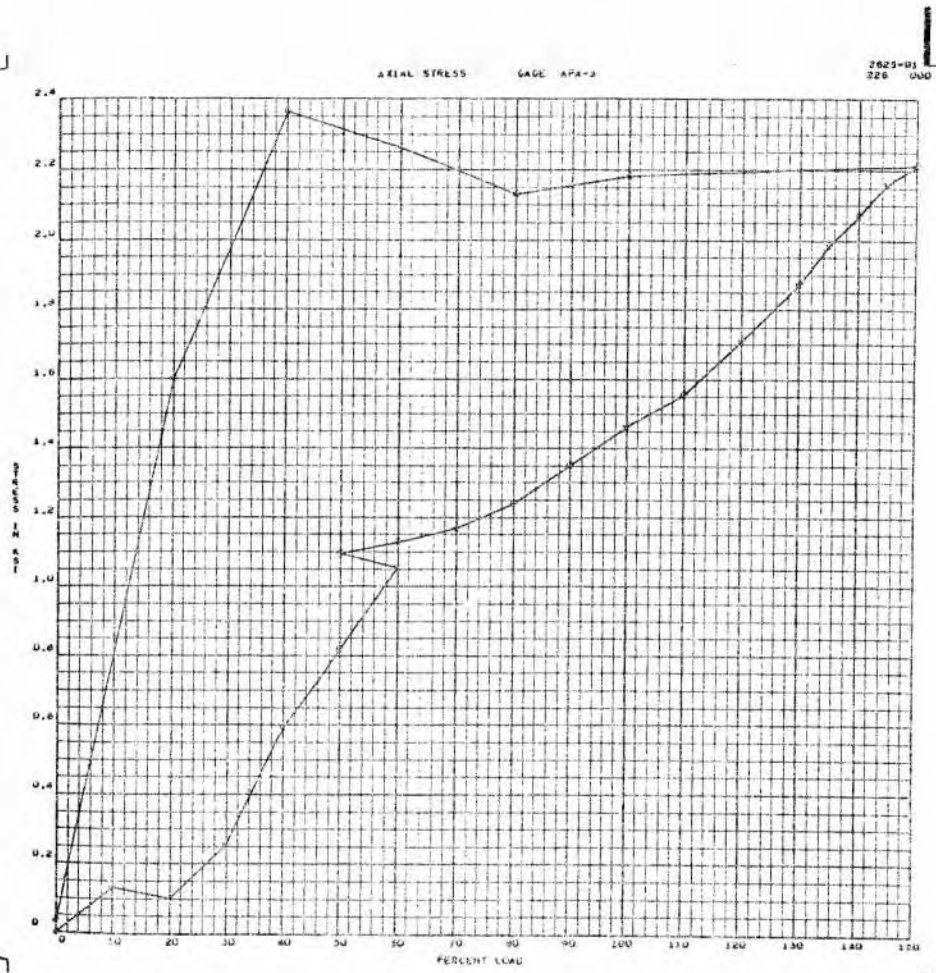
A-291



SID 67-317

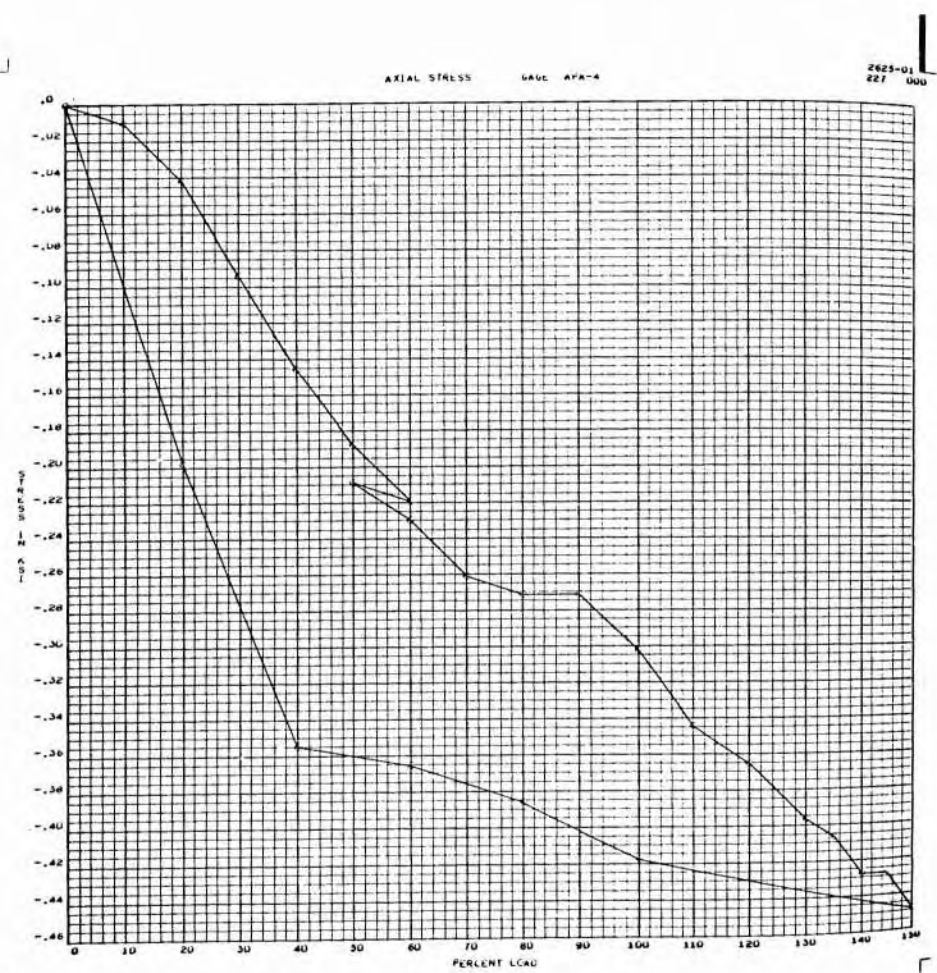
A-290





A-292

SID 67-317

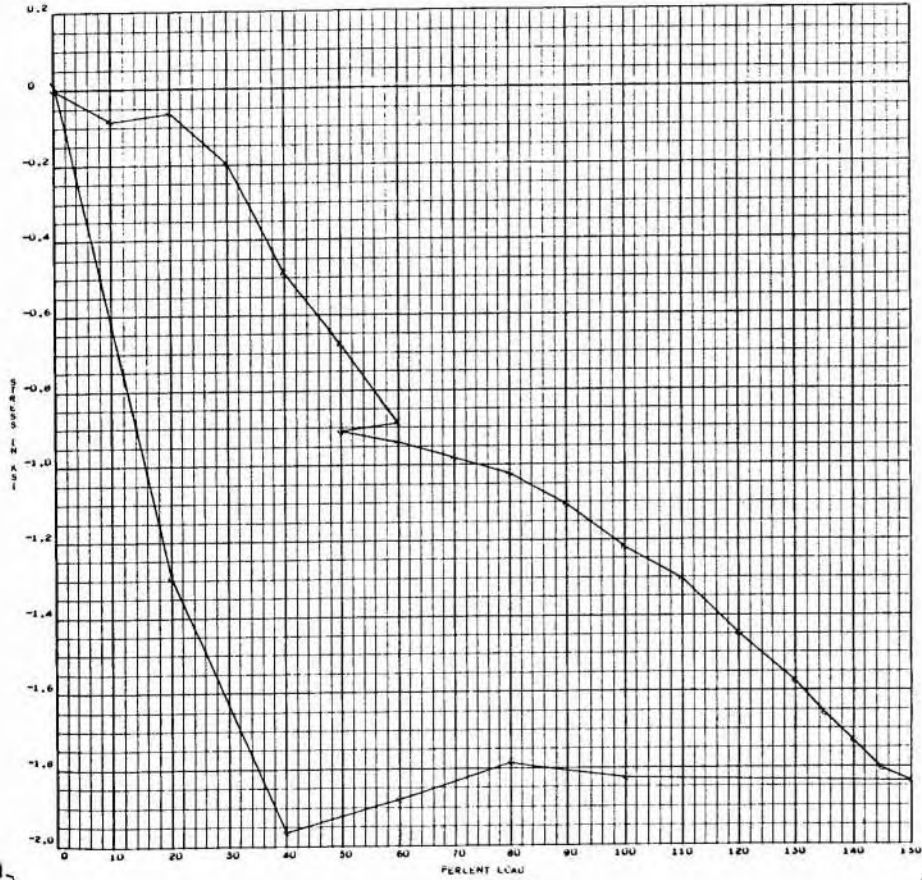


A-293

SID 67-317

AXIAL STRESS WAGE AFAPD

2625-01  
228 000

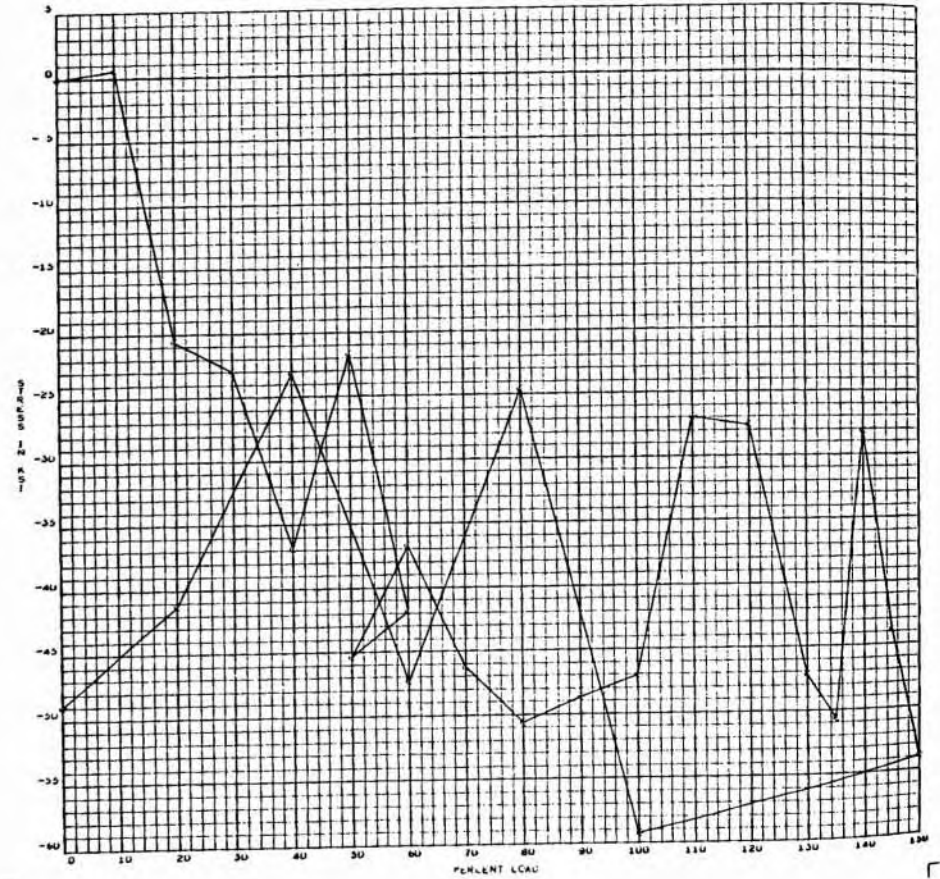


A-294

SID 67-317

AXIAL STRESS WAGE LUMMY

2625-01  
229 000



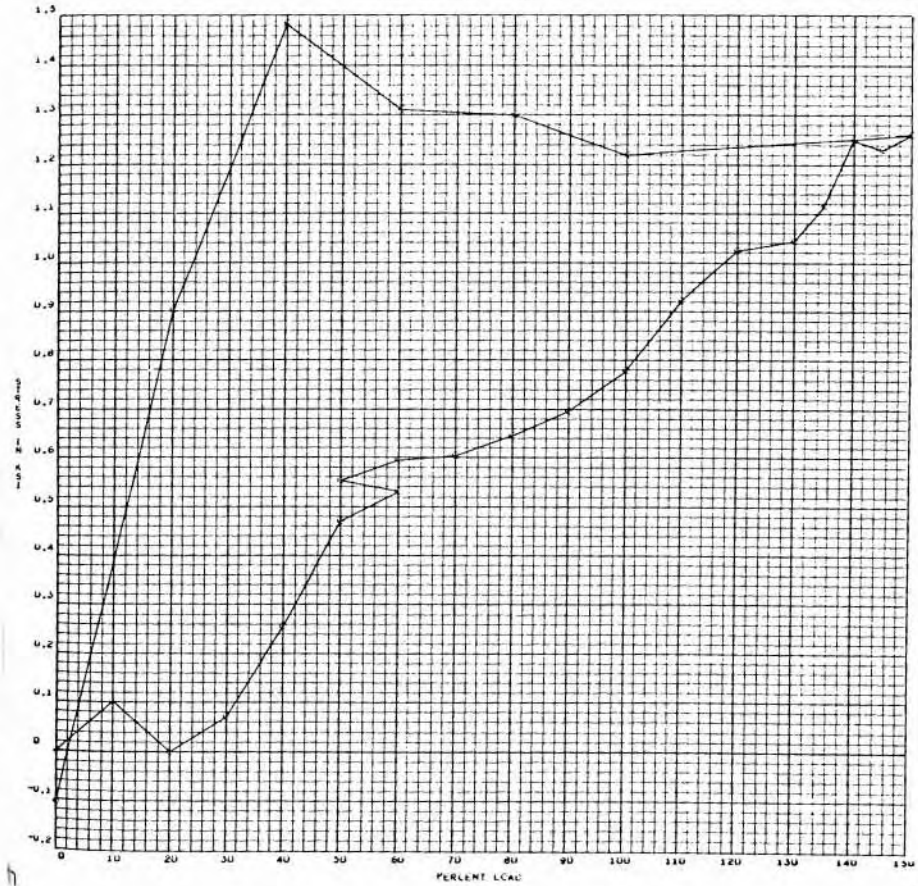
A-295

SID 67-317



AXIAL STRESS GAGE AFA-7

2623-01  
230 000

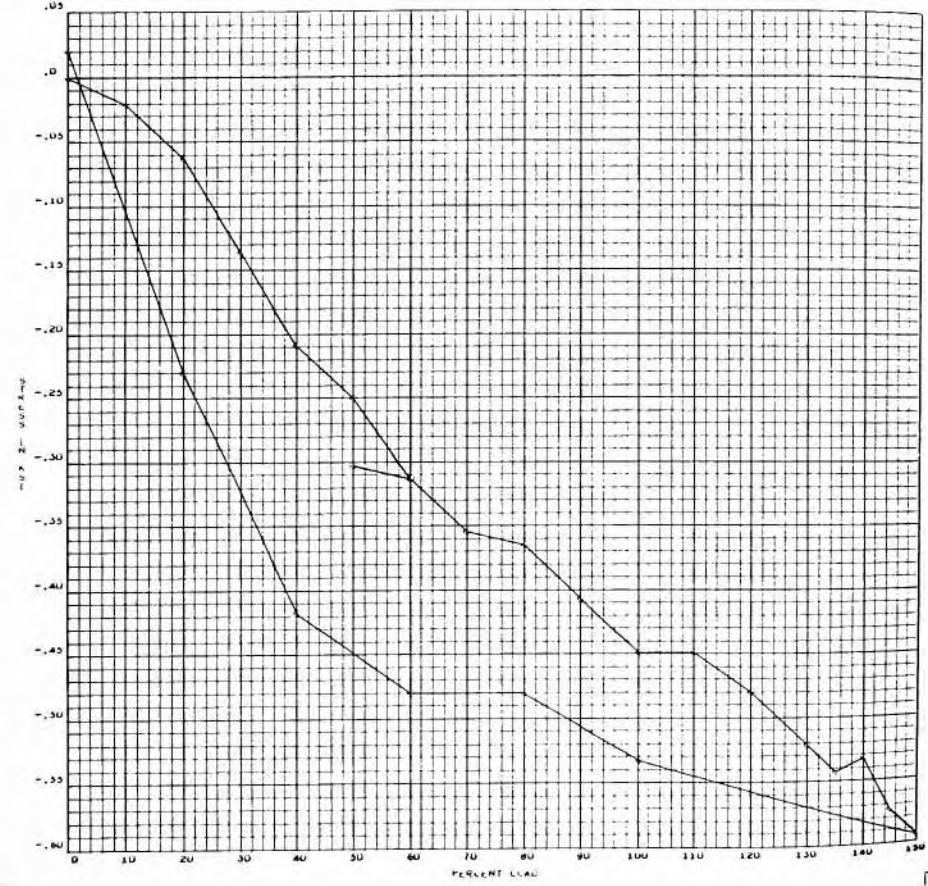


A-296

SID 67-317

AXIAL STRESS GAGE AFA-8

2623-01  
231 000



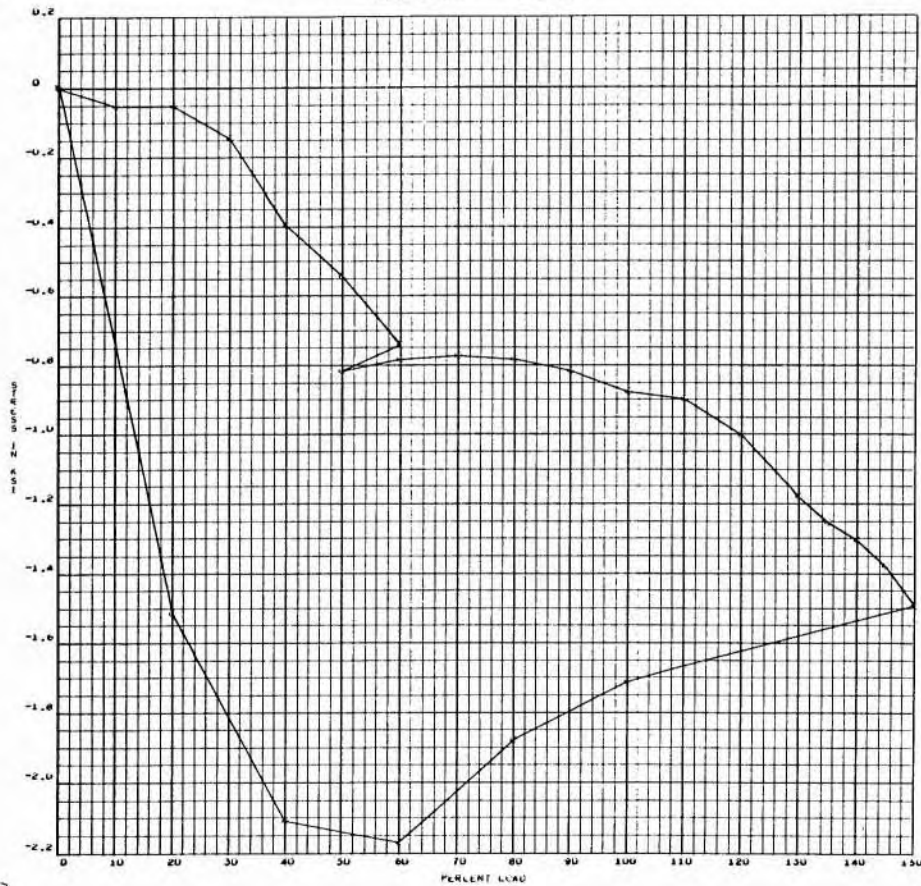
A-297

SID 67-317



AXIAL STRESS WAVE GPA<sup>-1</sup>

2625-01  
232 000

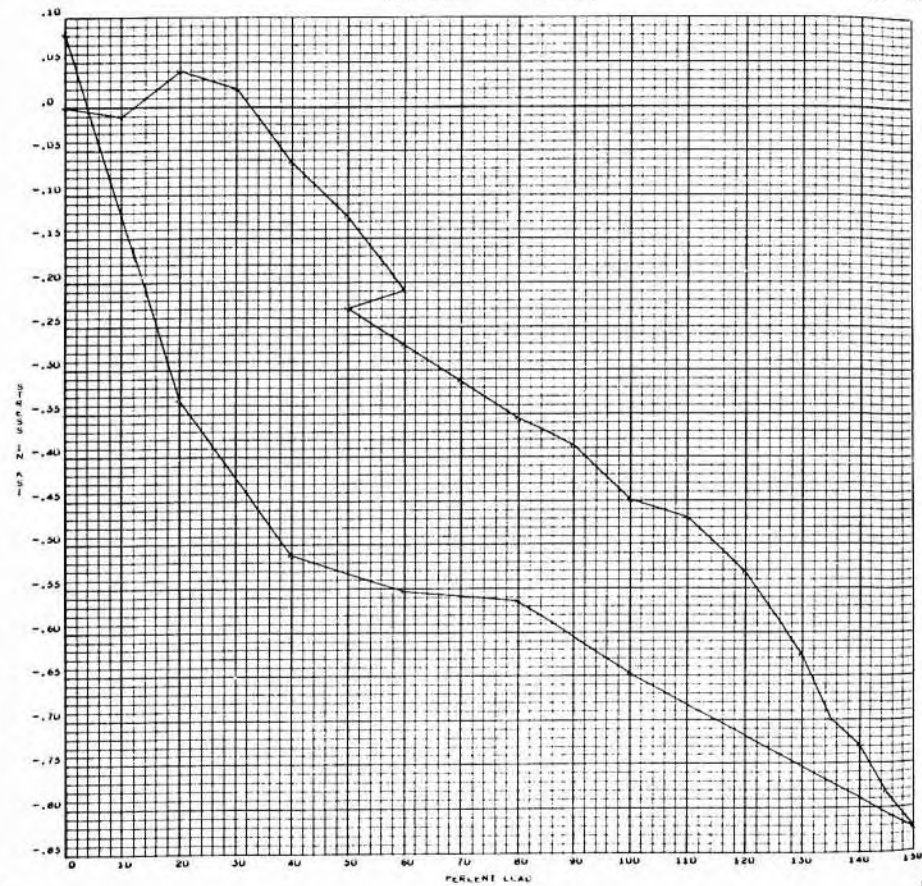


A-298

SID 67-317

AXIAL STRESS WAVE GPA<sup>-1</sup>

2625-01  
232 000

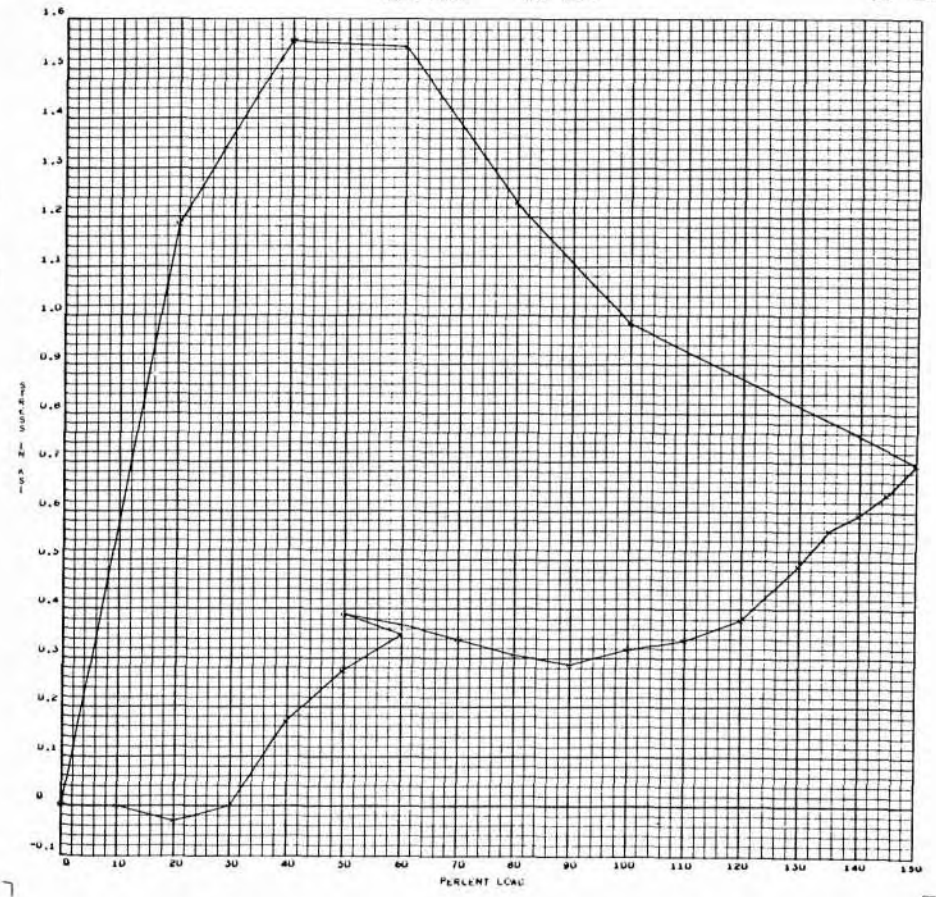


A-299

SID 67-317

AXIAL STRESS GAGE GFA-3

2623-01  
234 000

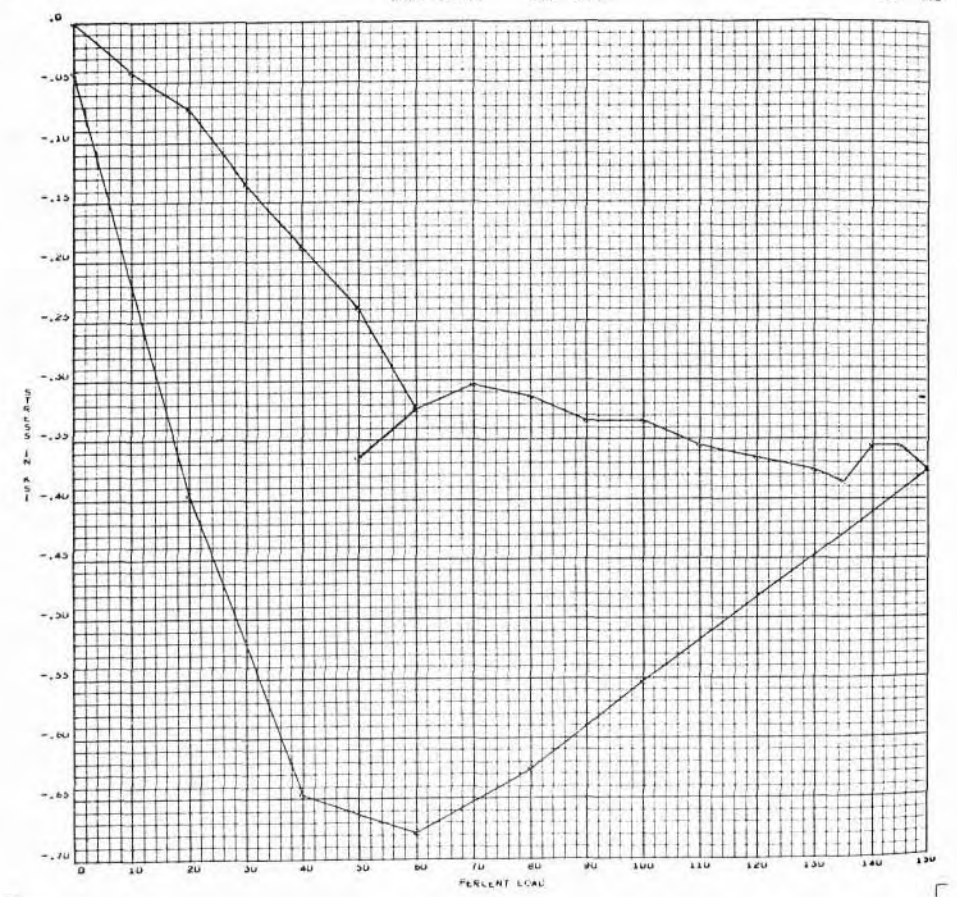


A-300

SID 67-317

AXIAL STRESS GAGE GFA-4

2623-01  
235 000

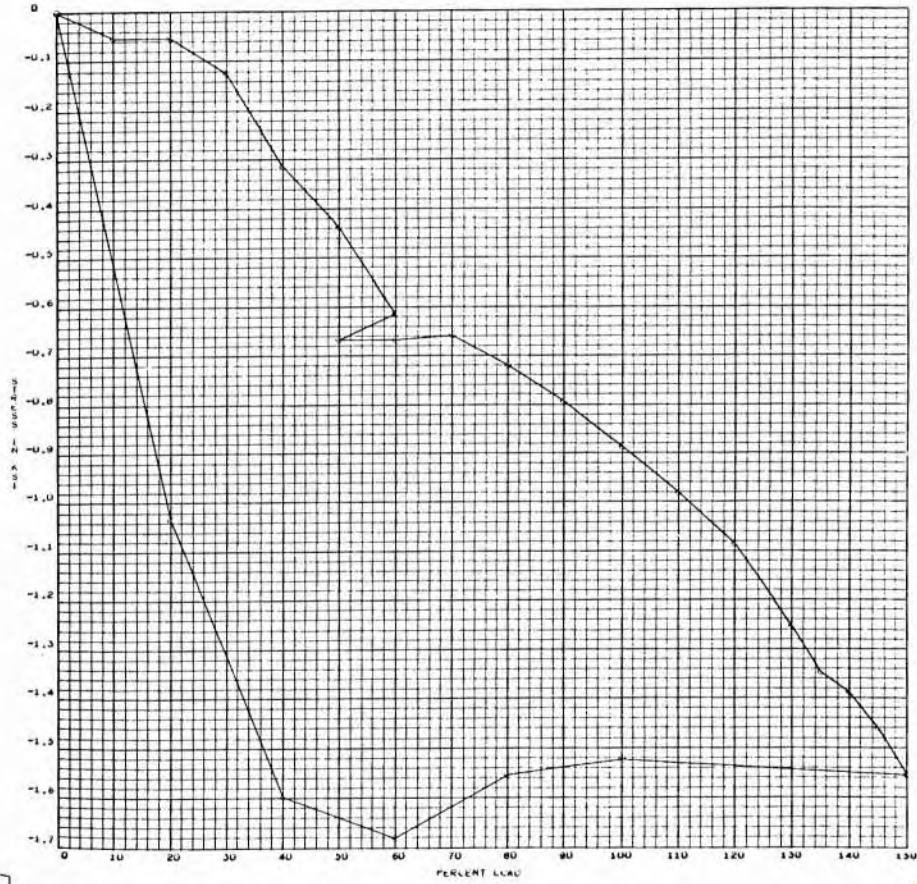


A-301

SID 67-317

AXIAL STRESS GAGE GFA-2

2625-01  
236 000

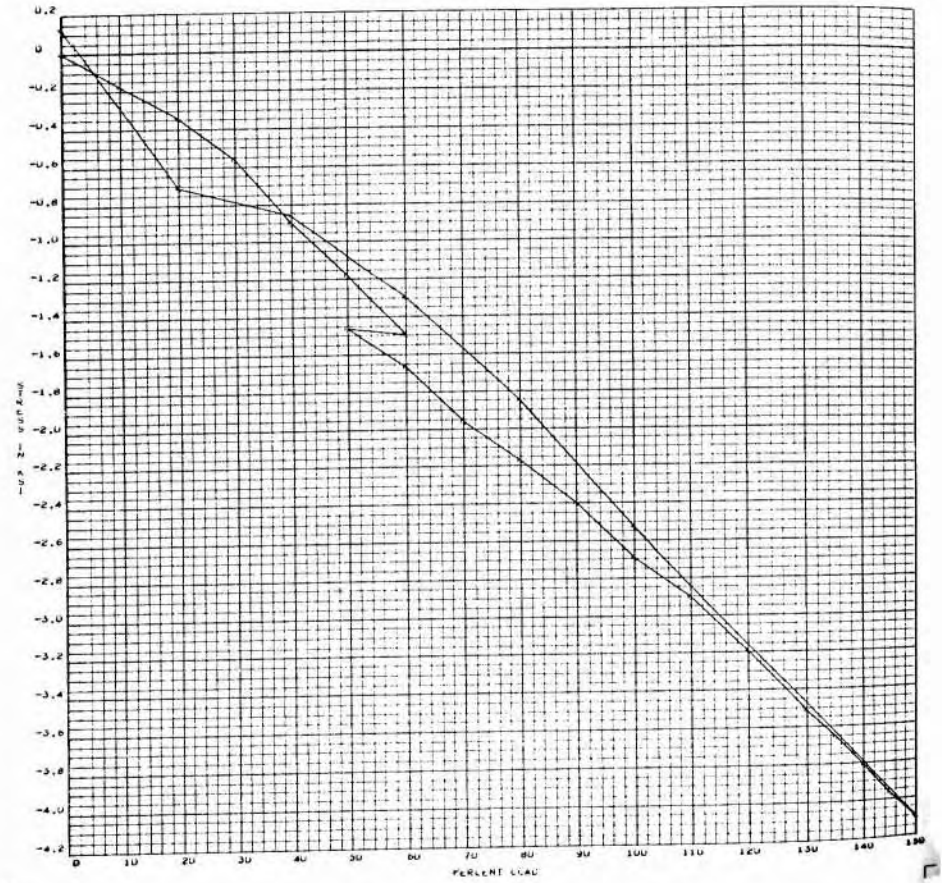


A-302

SID 67-317

AXIAL STRESS GAGE GFA-10

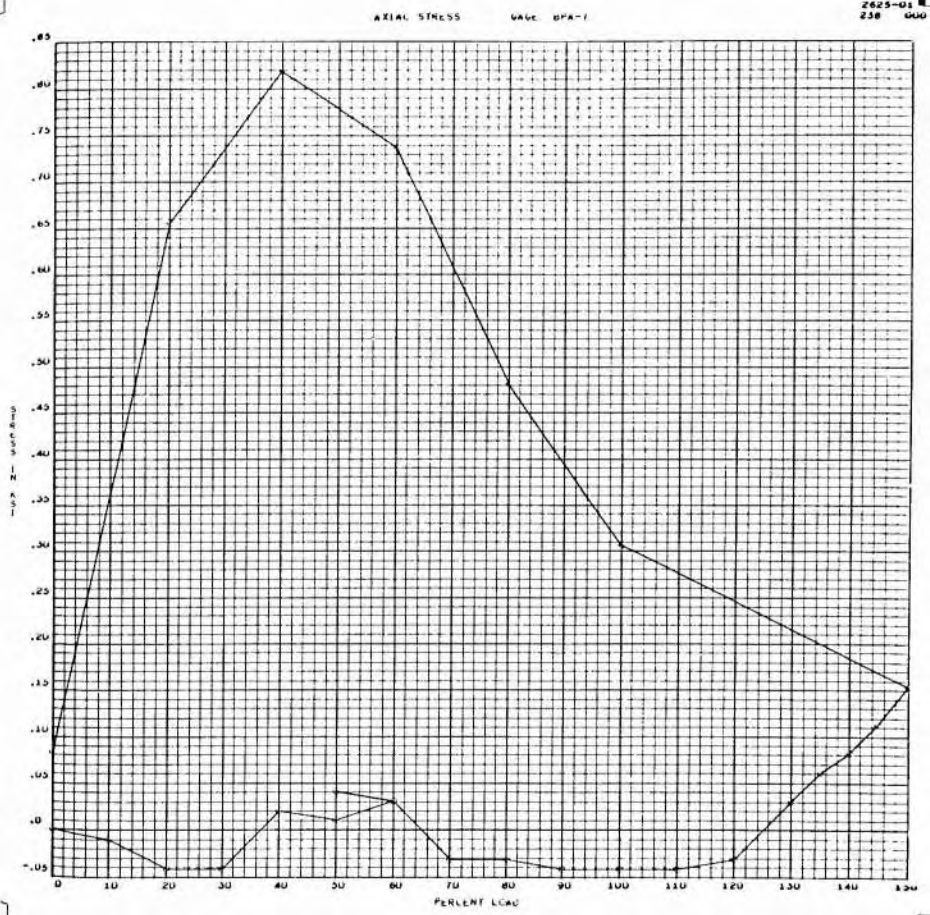
2625-01  
237 000



A-303

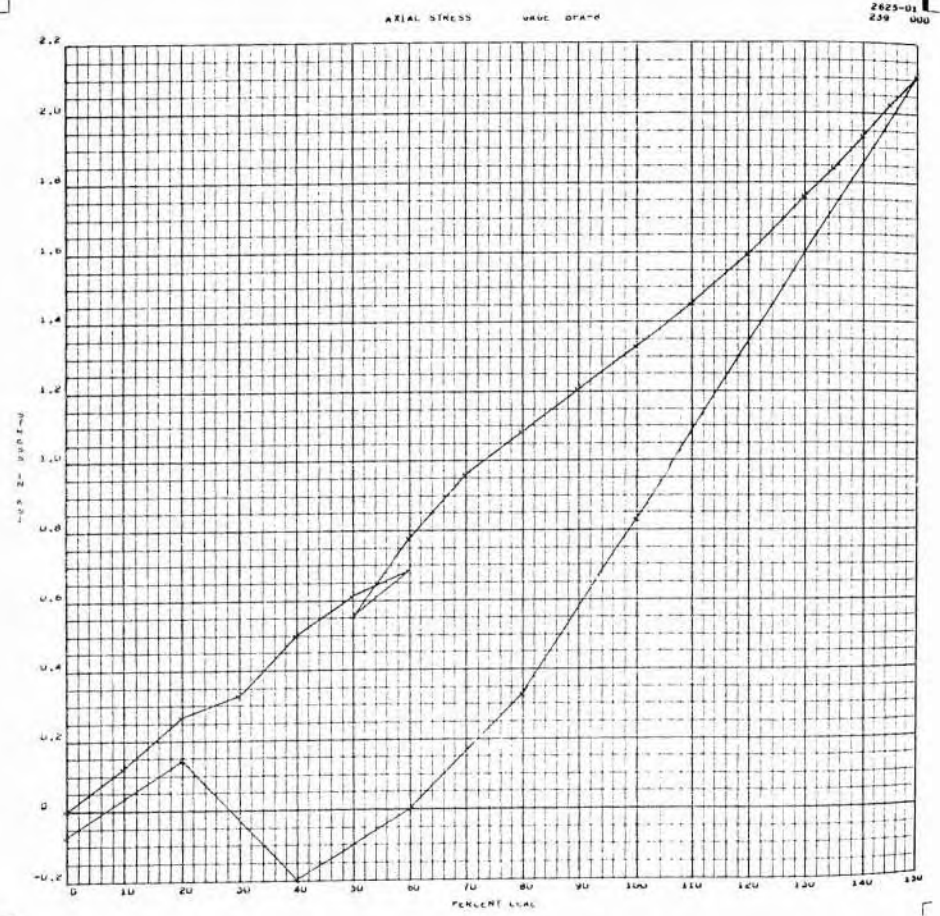
SID 67-317





A-304

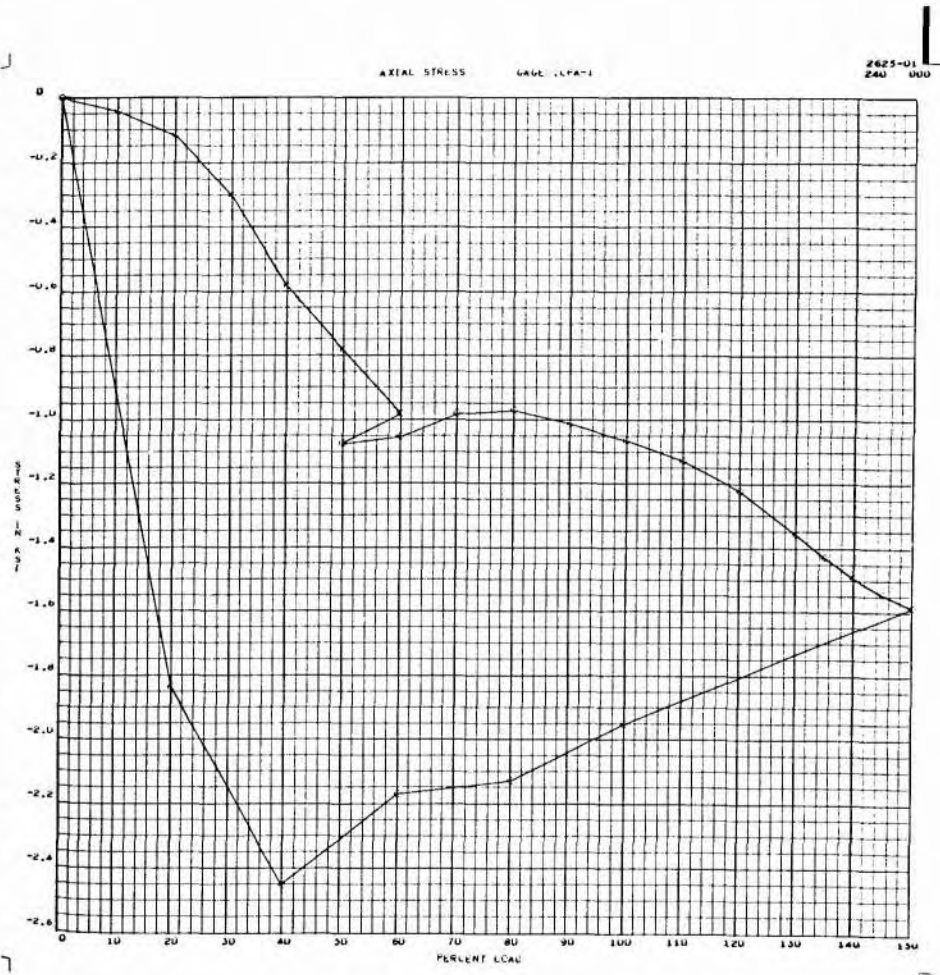
SID 67-317



A-305

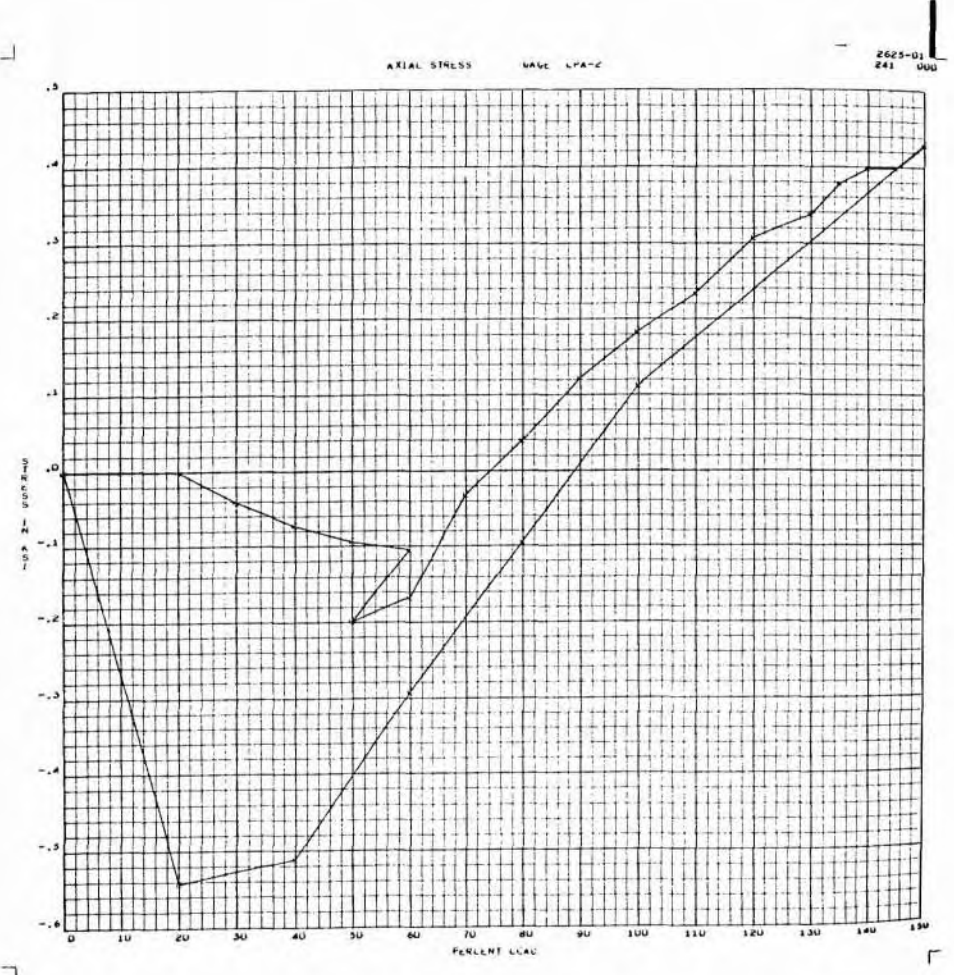
SID 67-317





A-306

SID 67-317

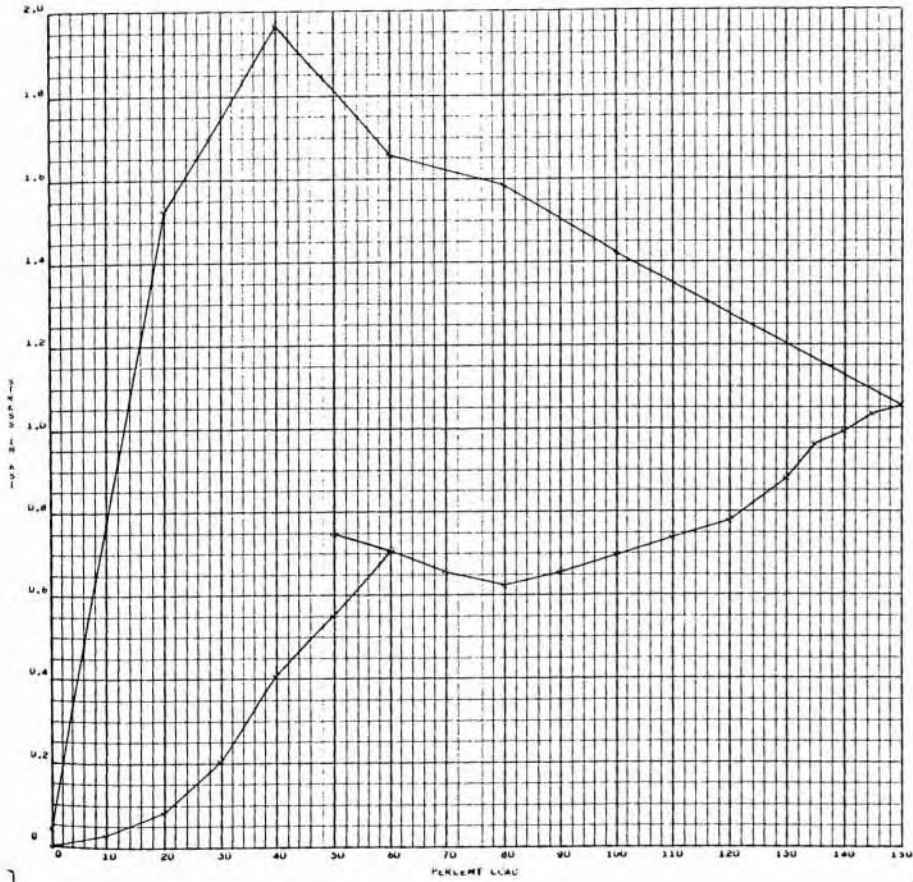


A-307

SID 67-317

AXIAL STRESS GAGE LPA-2

2625-01  
242 000

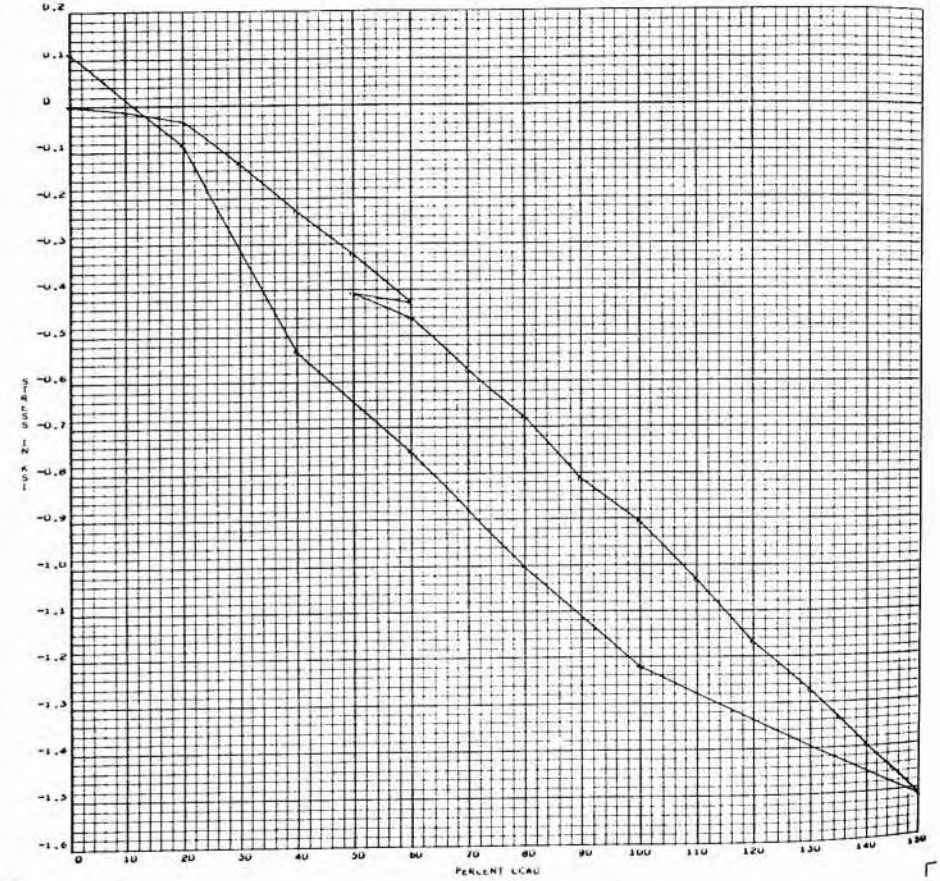


A-308

SID 67-317

AXIAL STRESS GAGE LPA-4

2625-01  
243 000

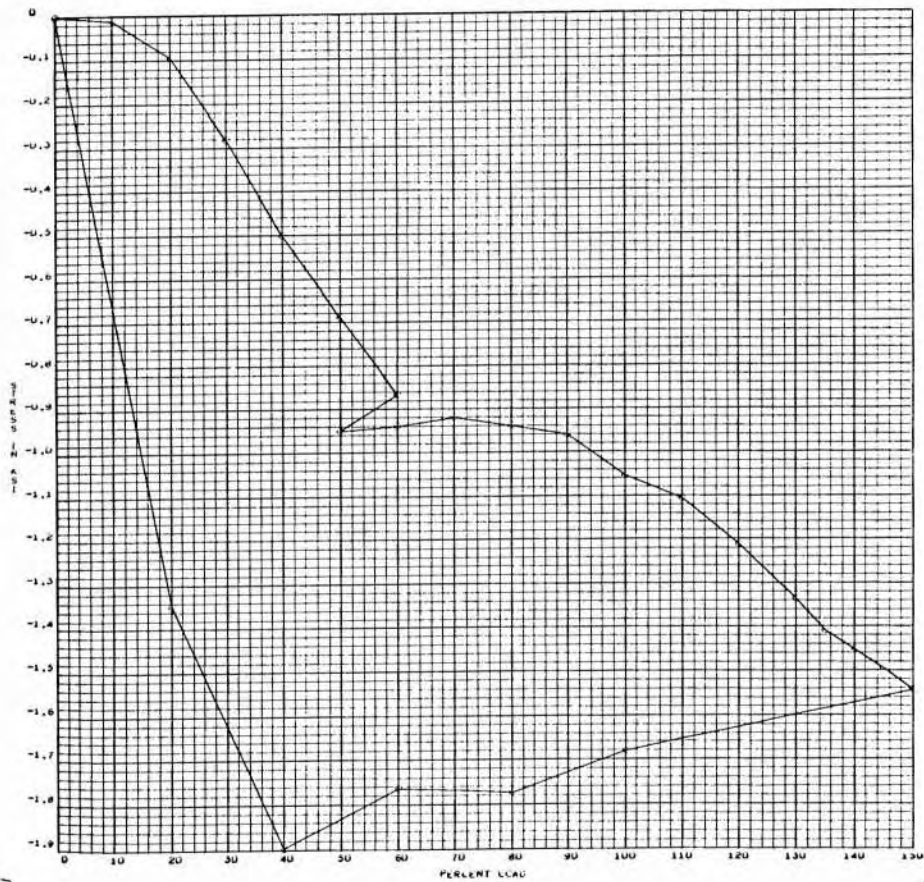


A-309

SID 67-317

AXIAL STRESS WAVE LPA-2

2625-01  
244 000

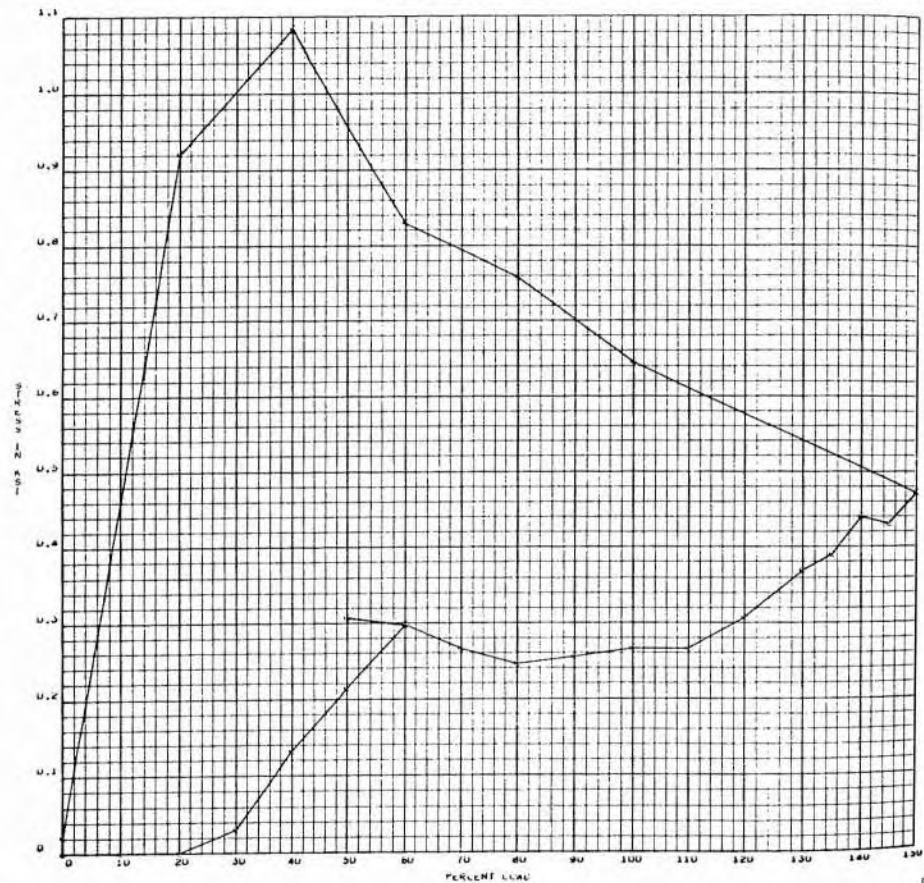


A-310

SID 67-317

AXIAL STRESS WAVE LPA-1

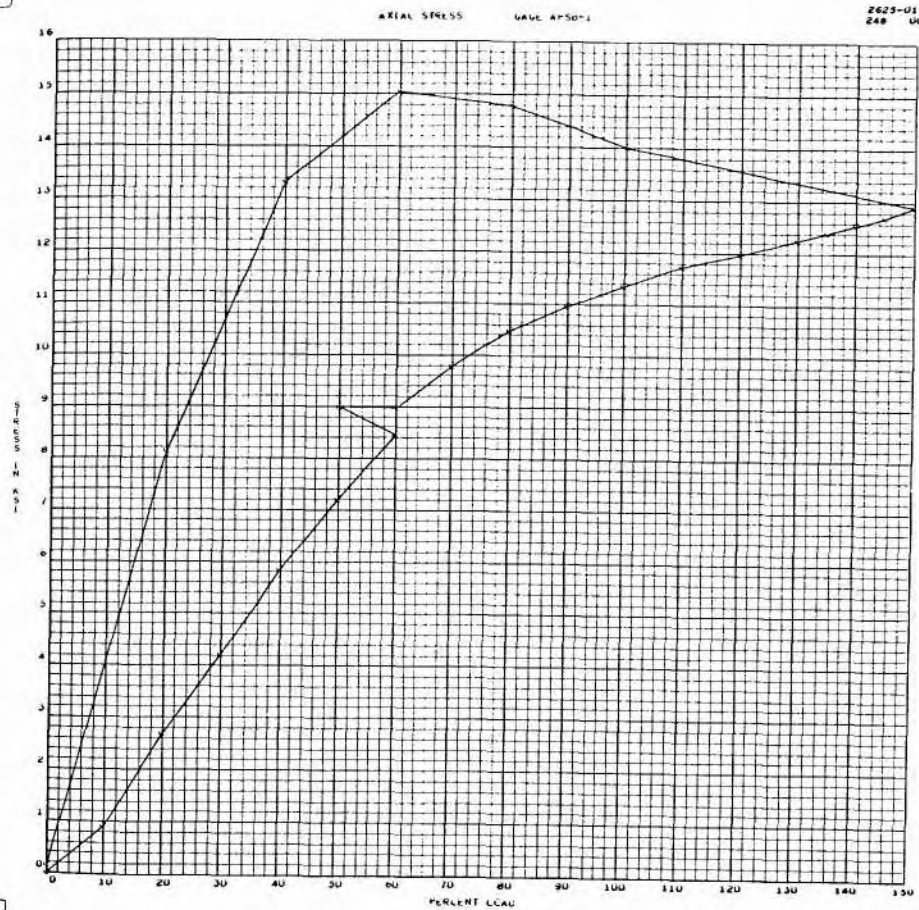
2625-01  
246 000



A-311

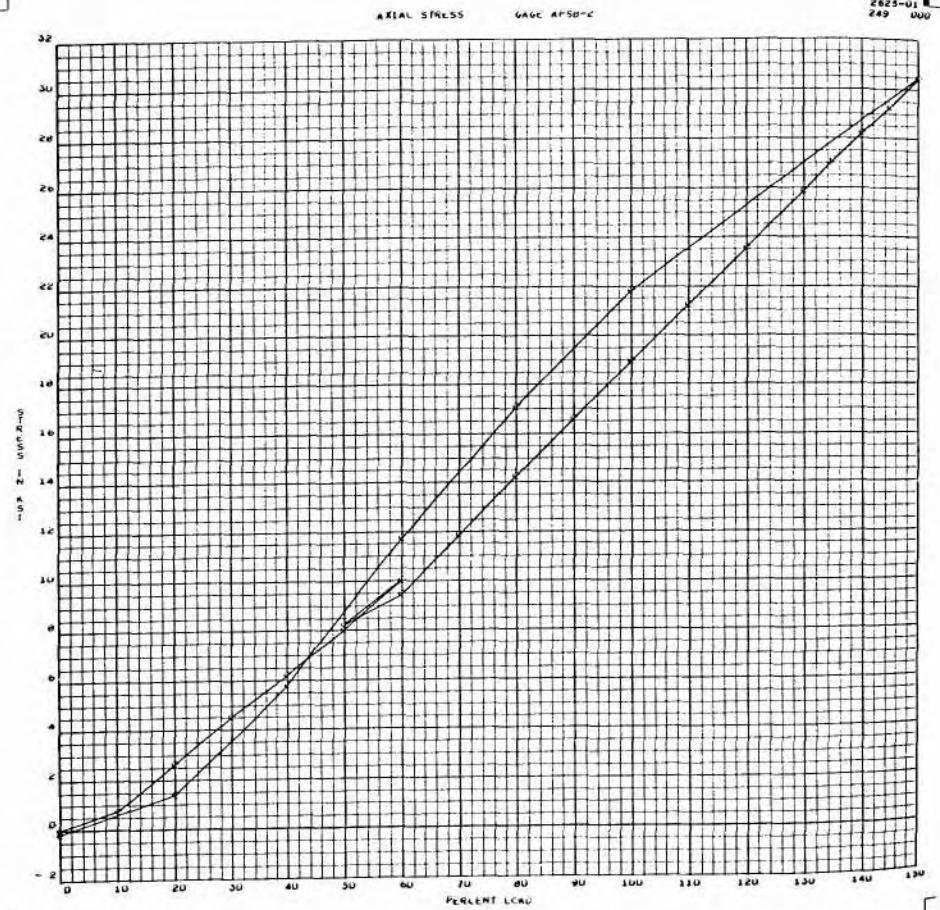
SID 67-317





A-312

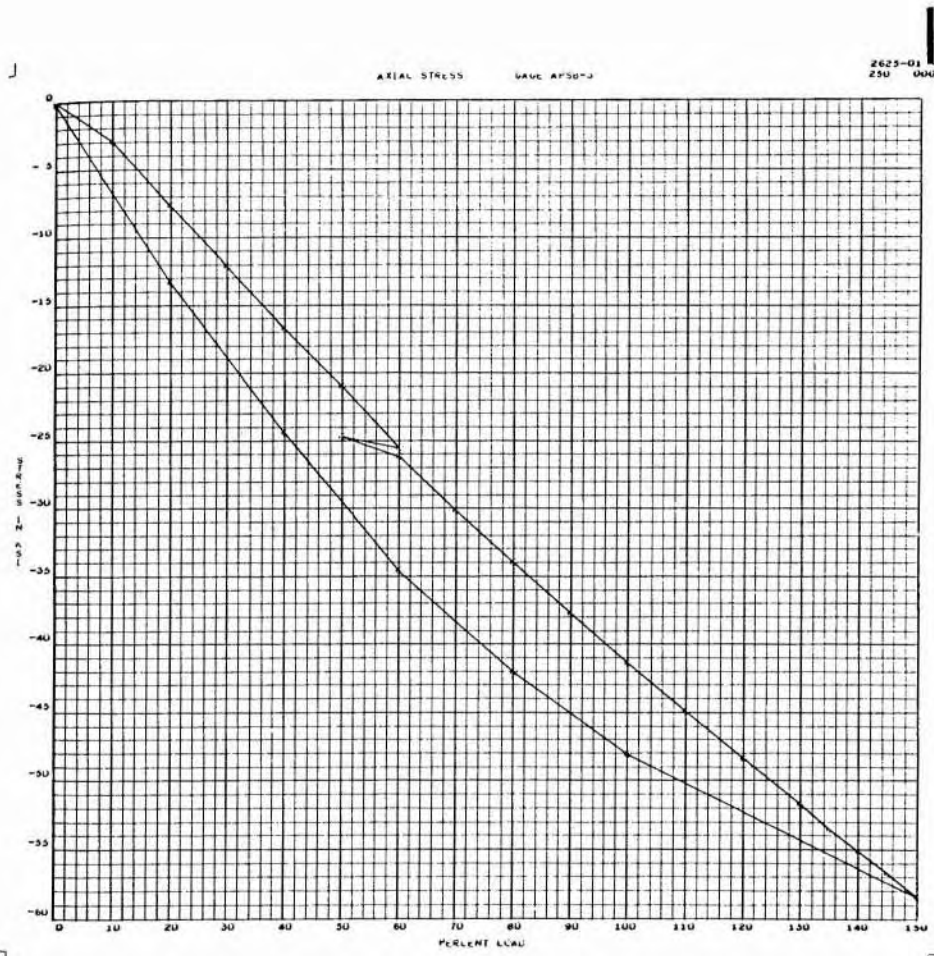
SID 67-317



A-313

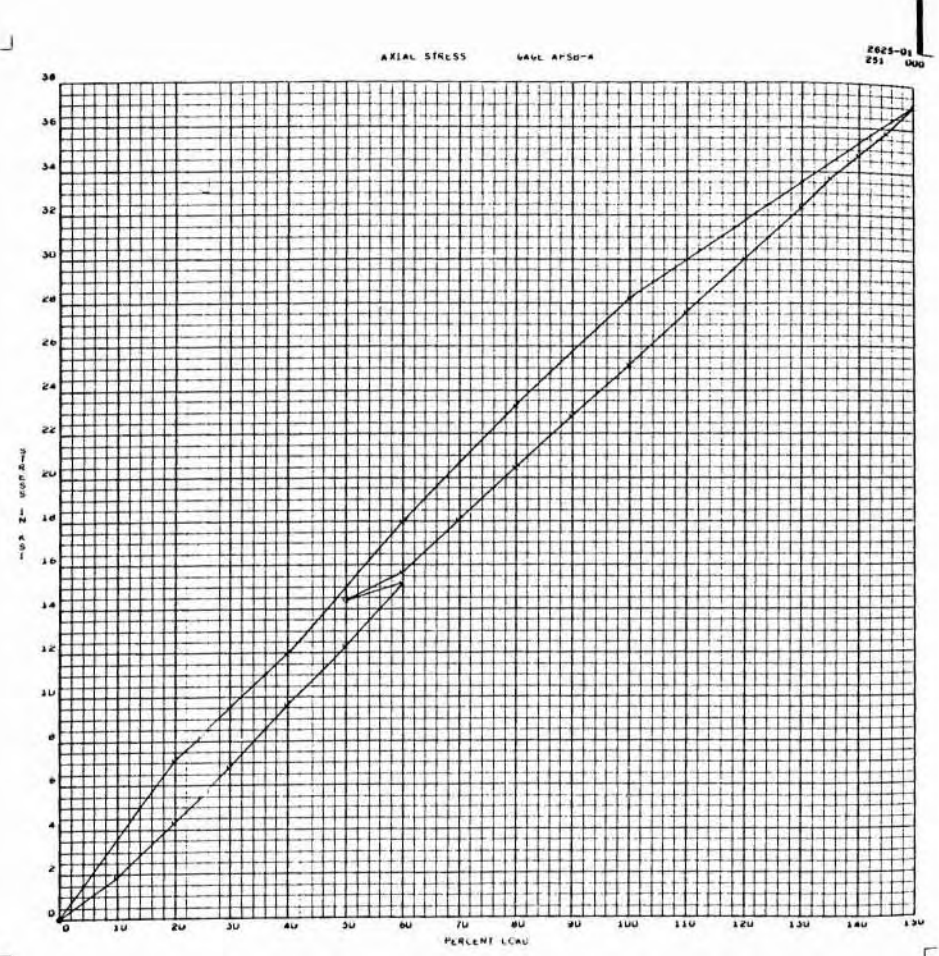
SID 67-317





A-314

SID 67-317

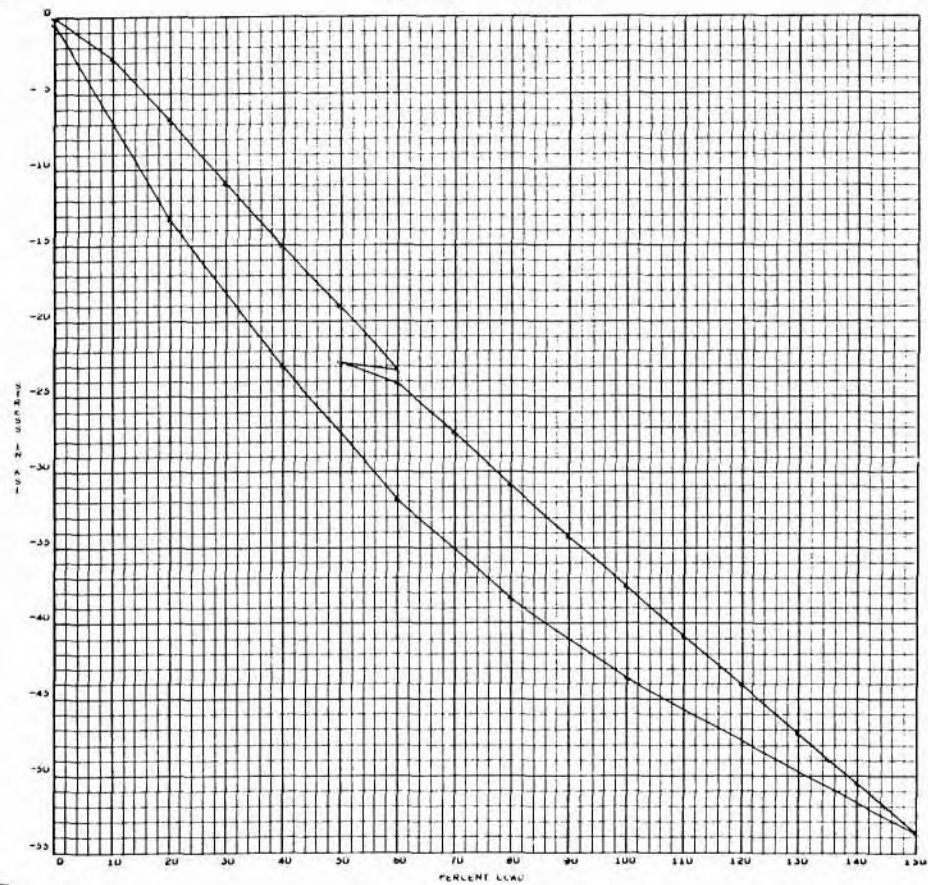


A-315

SID 67-317

AXIAL STRESS WAVE 0P50-1

2625-01  
252 000

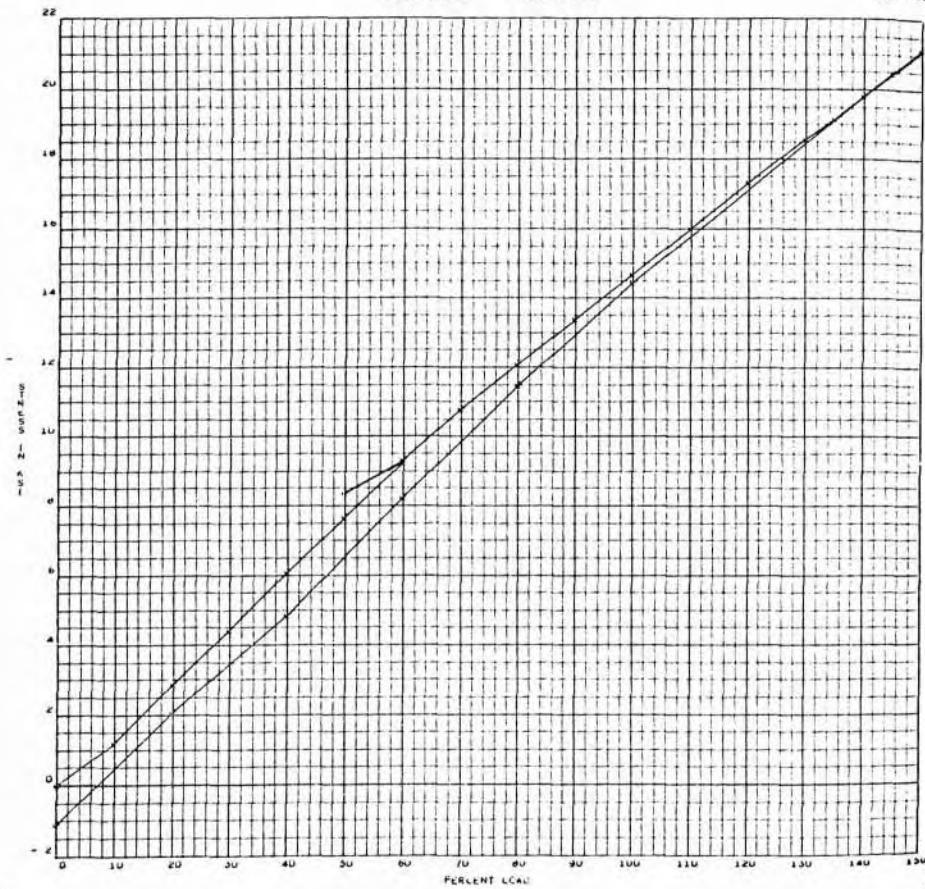


A-316

SID 67-317

AXIAL STRESS WAVE 0P50-2

2625-01  
253 000

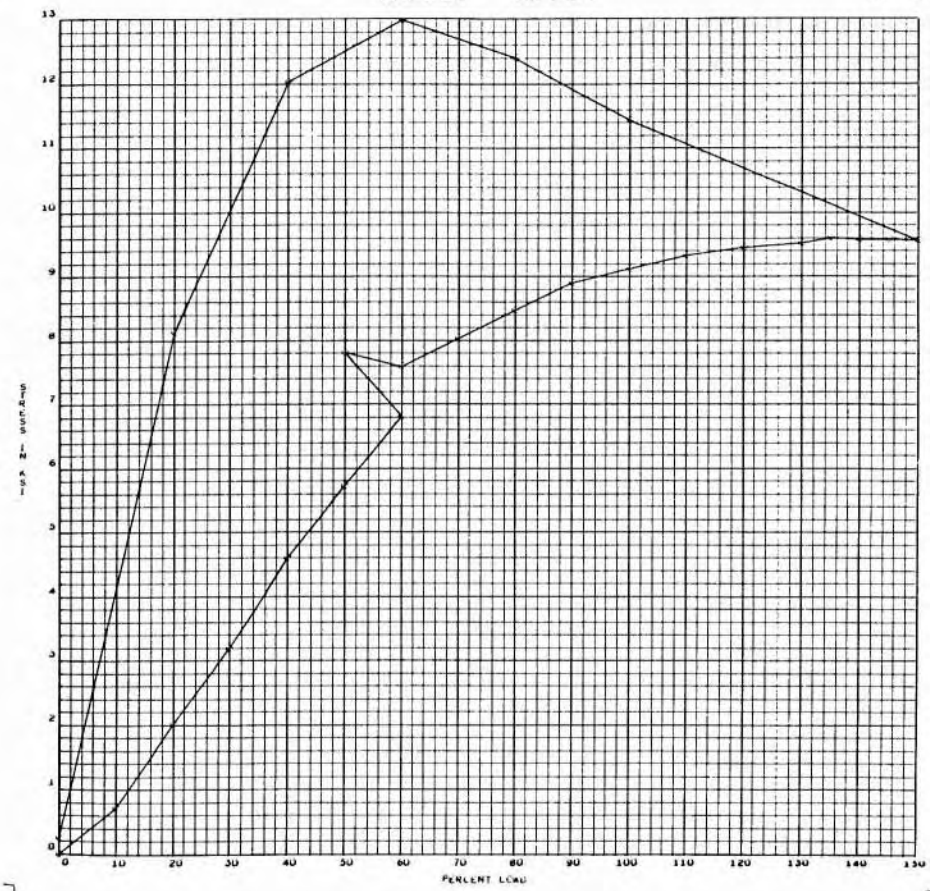


A-317

SID 67-317

AXIAL STRESS GAGE D750-3

2623-01  
254 000

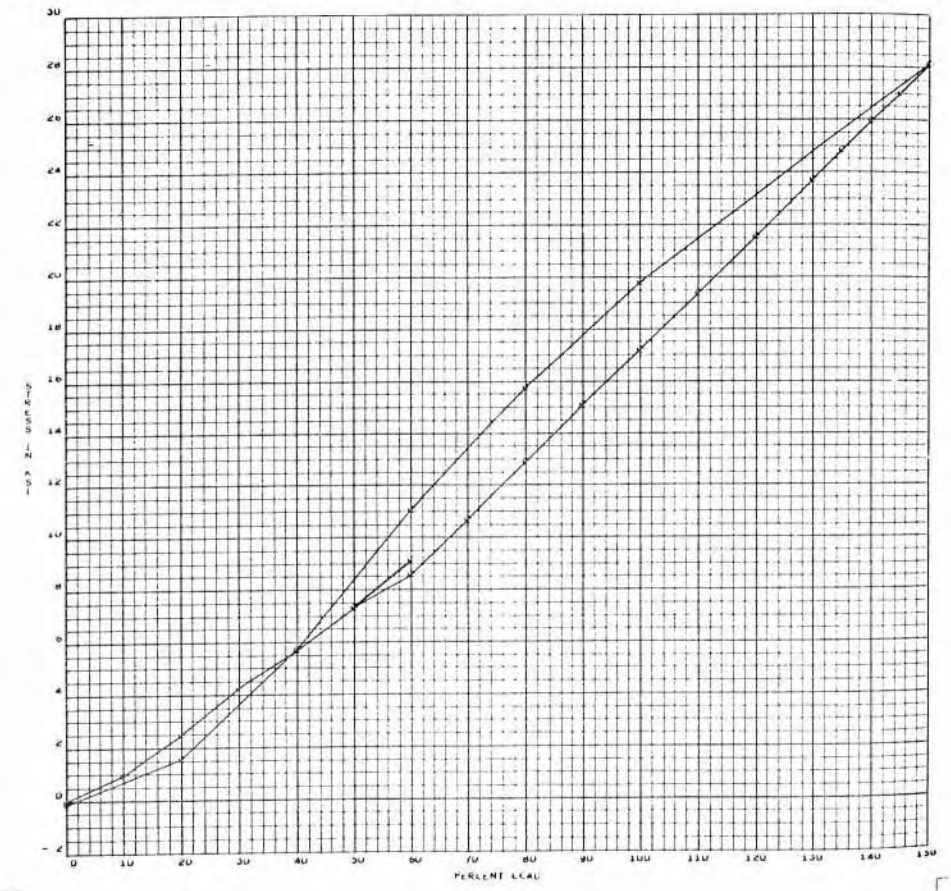


A-318

SID 67-317

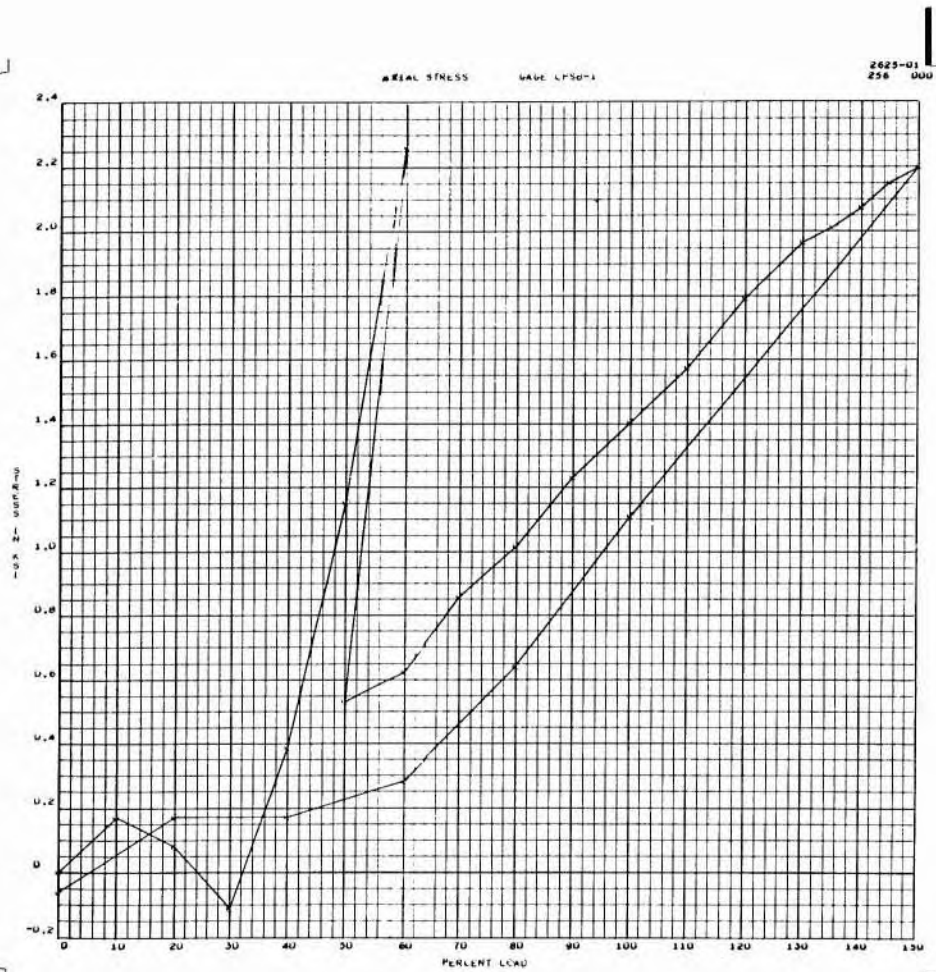
AXIAL STRESS GAGE D750-4

2623-01  
255 000



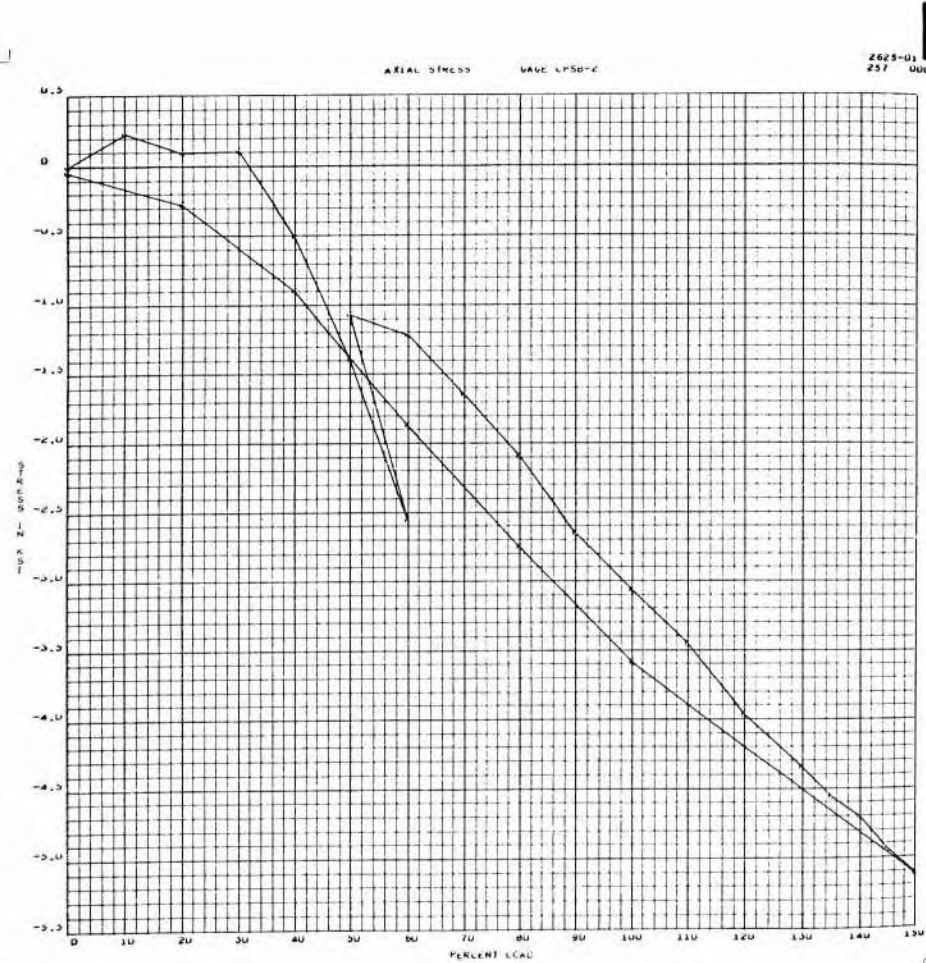
A-319

SID 67-317



A-320

SID 67-317



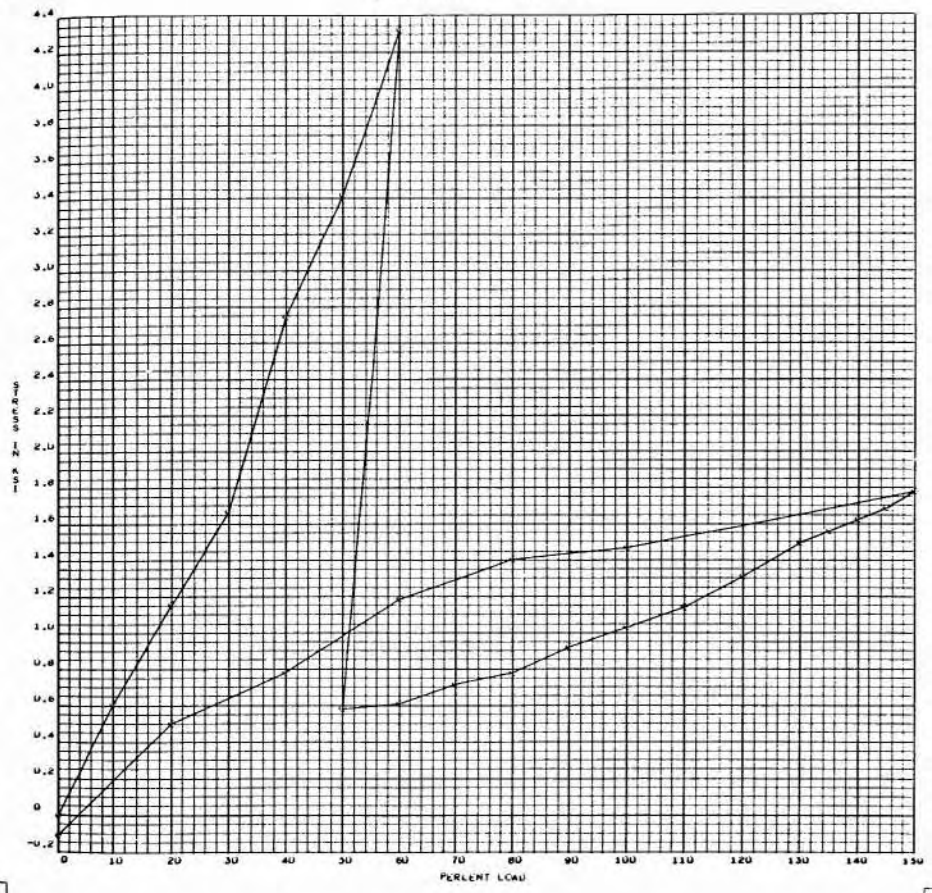
A-321

SID 67-317



AXIAL STRESS GAGE LP50-3

2625-01  
Z58 000

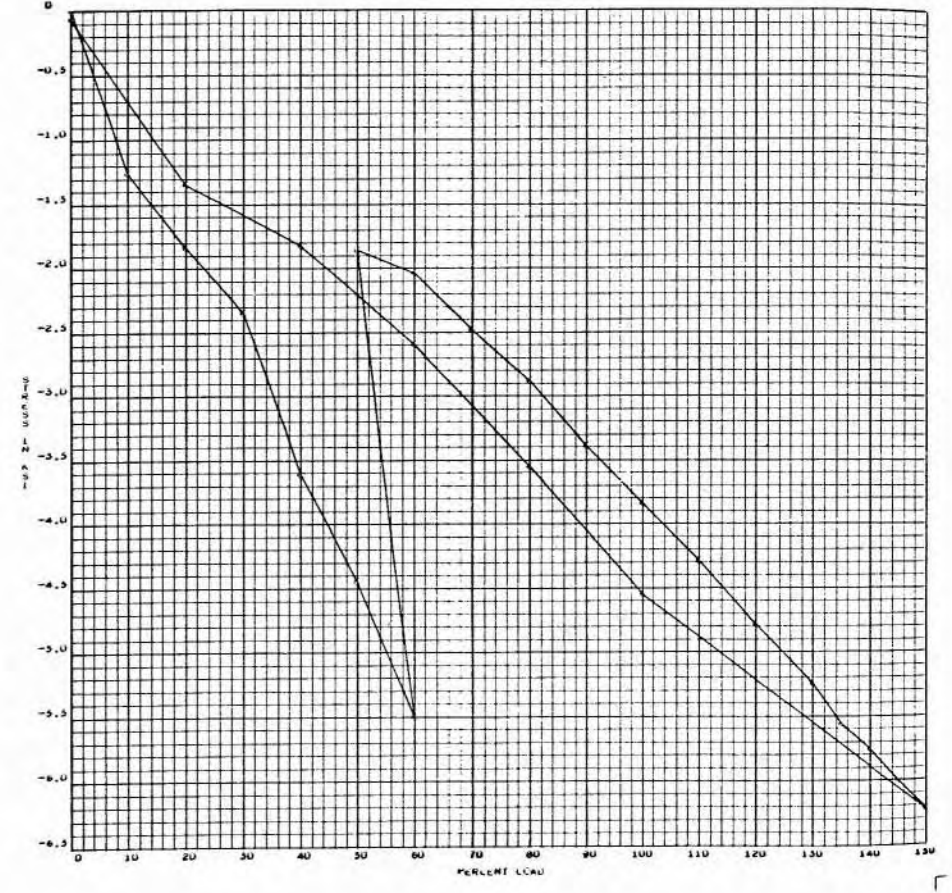


A-322

SID 67-317

AXIAL STRESS GAGE LP50-4

2625-01  
Z59 000

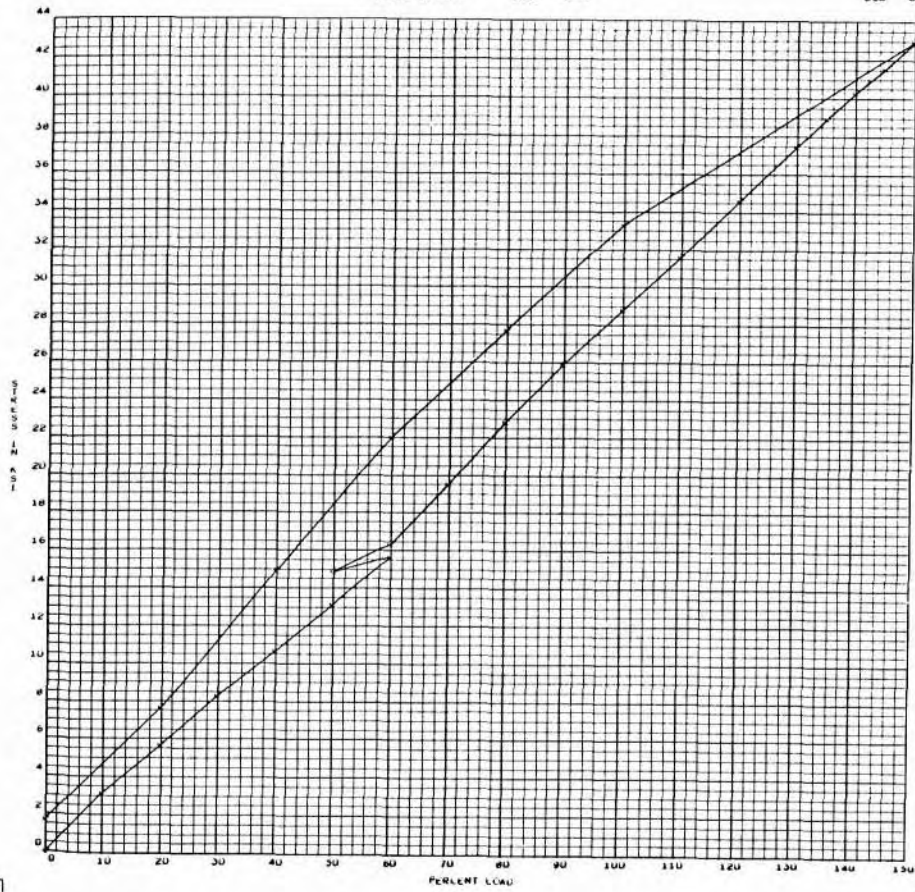


A-323

SID 67-317

AXIAL STRESS WAGE LF-1

2625-01  
260 000

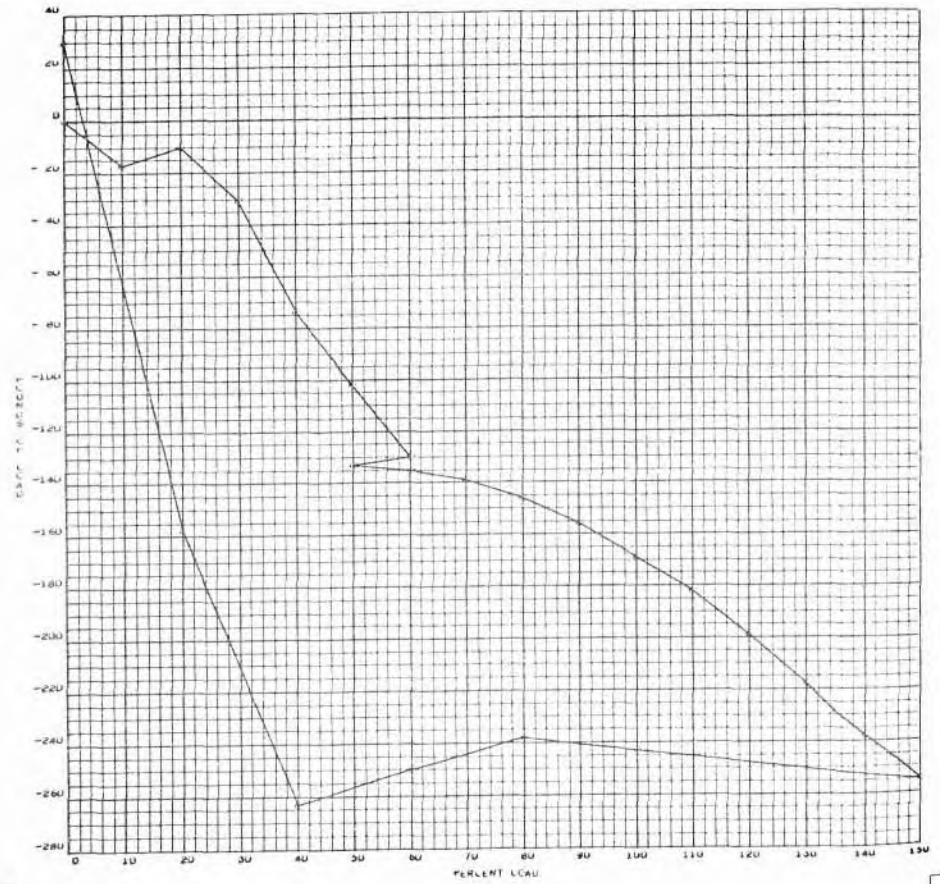


A-324

SID 67-317

LOAD NUMBER DA-1

2625-01  
265 000

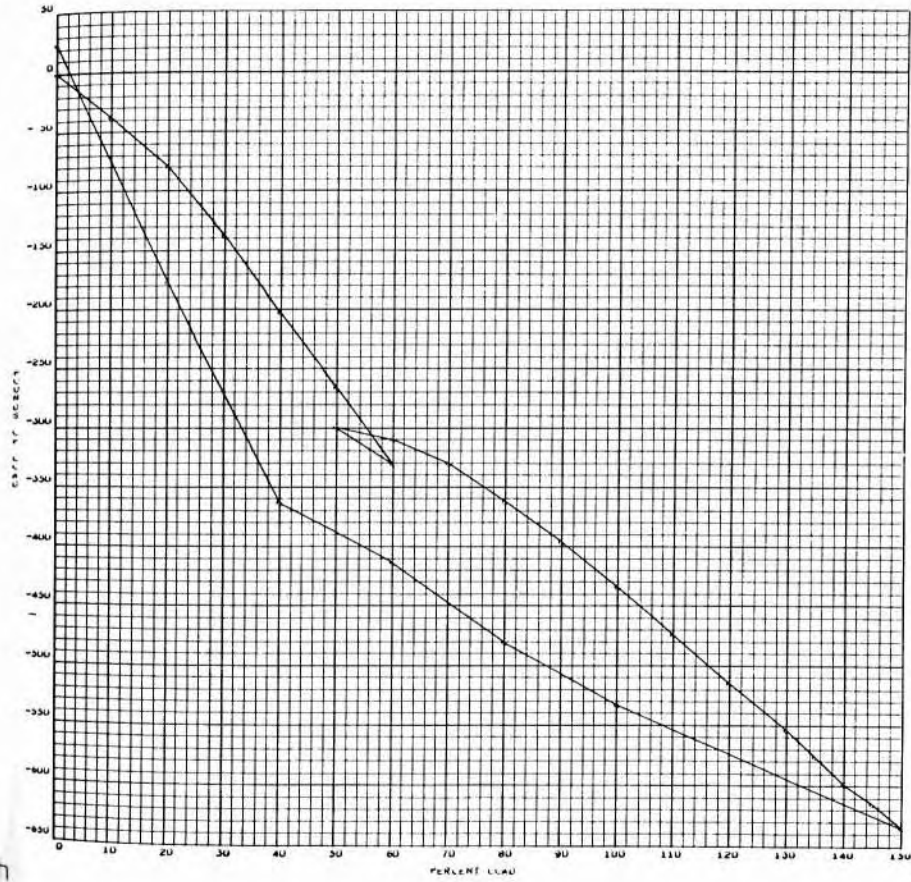


A-325

SID 67-317

LOAD NUMBER UA-2

2625-01  
266 000

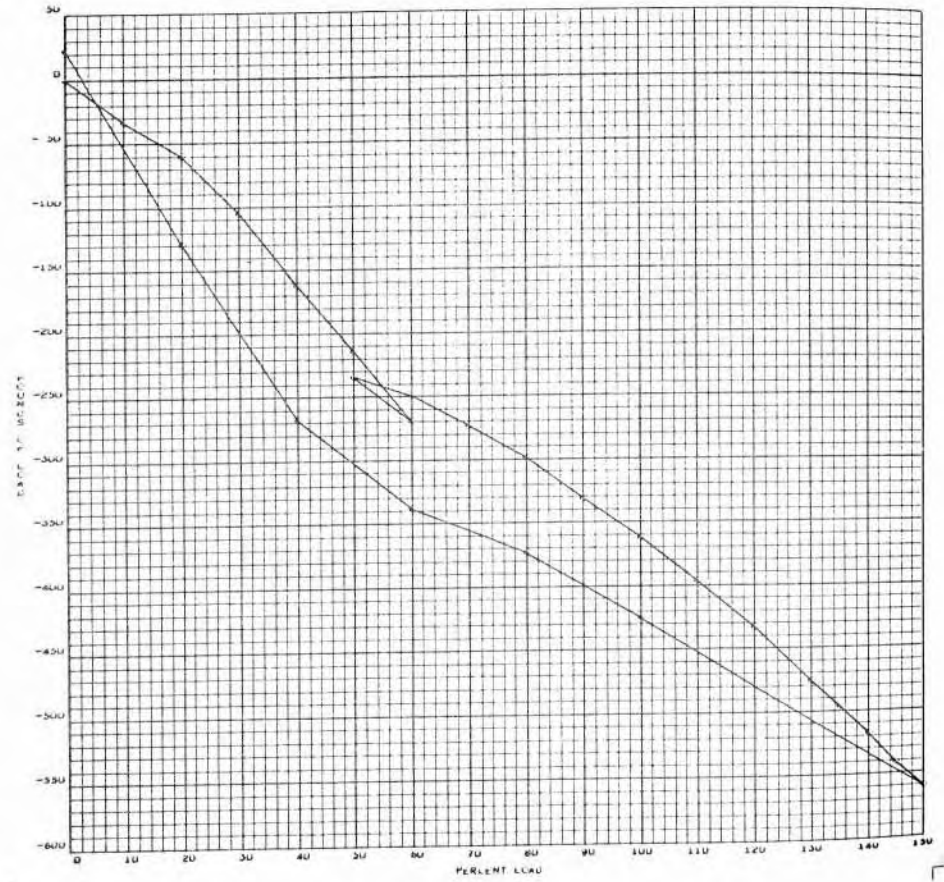


A-326

SID 67-317

LOAD NUMBER UA-3

2625-01  
267 000



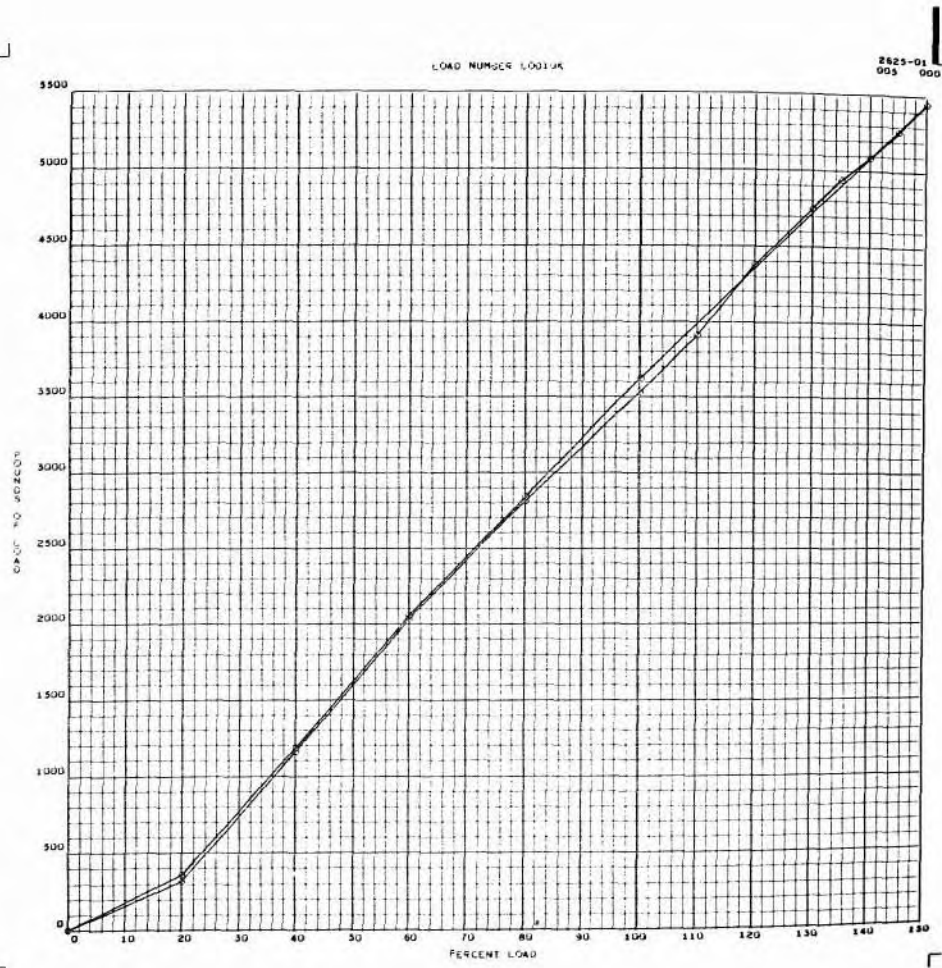
A-327

SID 67-317

TEST CONDITION V

SIP 67-317



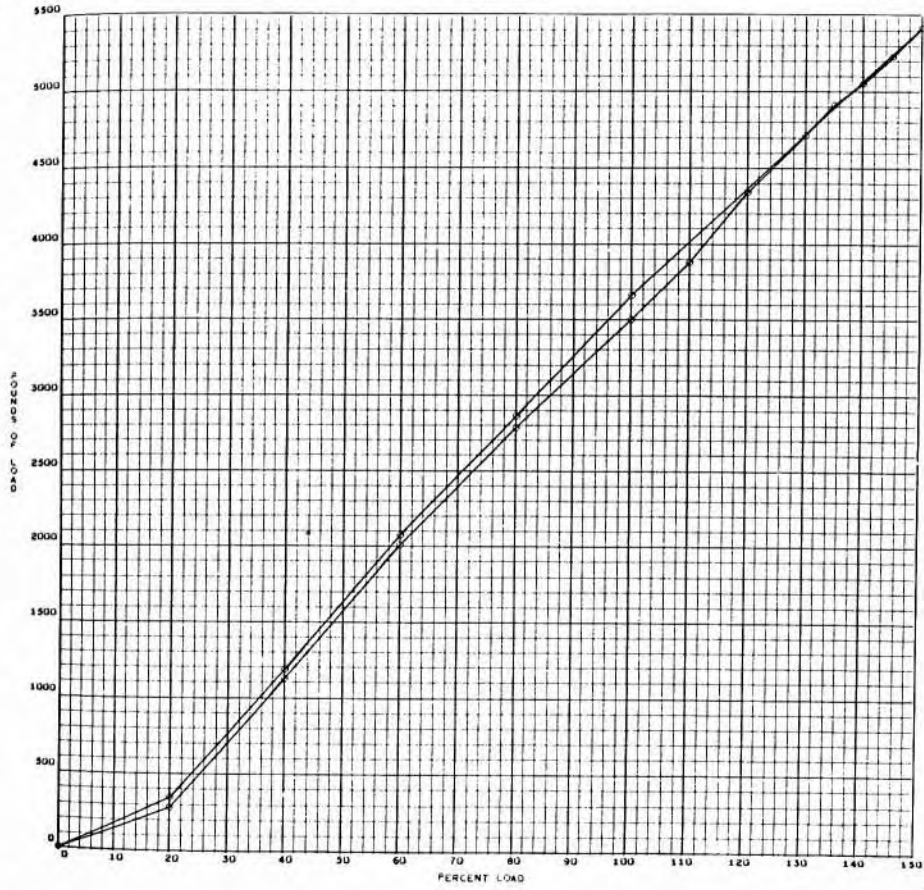


A-328

SID 67-317

LOAD NUMBER LOGSUK

Z625-01  
006 000

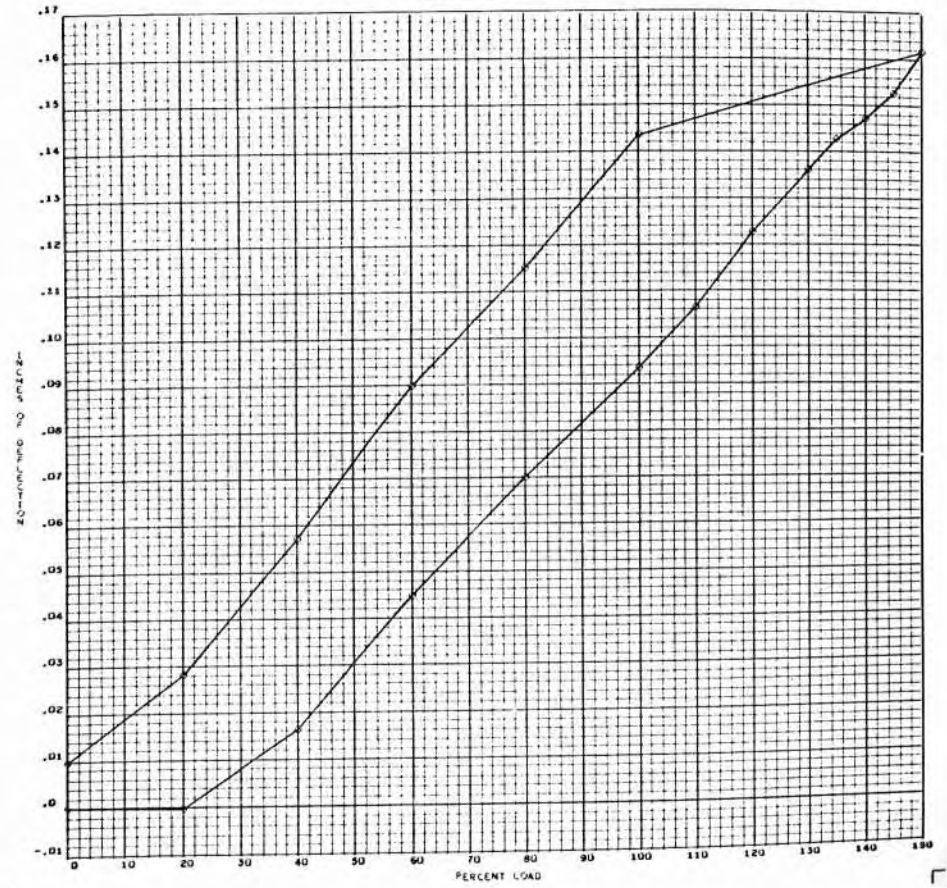


A-329

SID 67-317

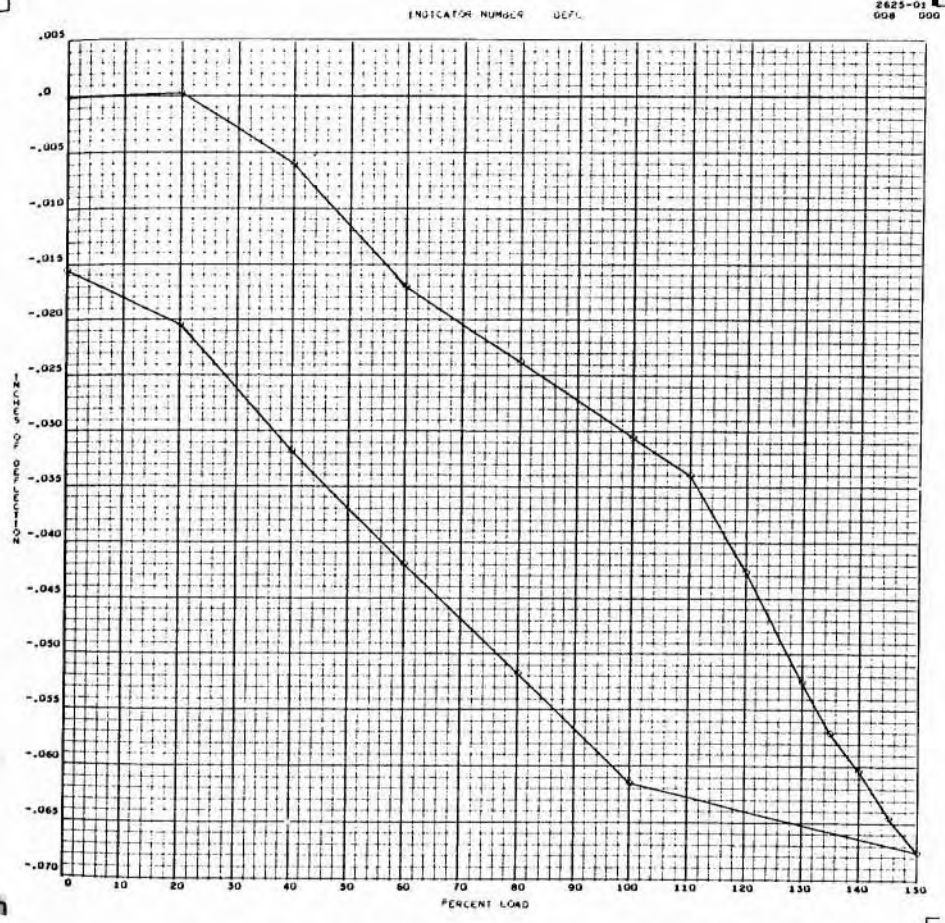
INDICATOR NUMBER DEFU

Z625-01  
007 000

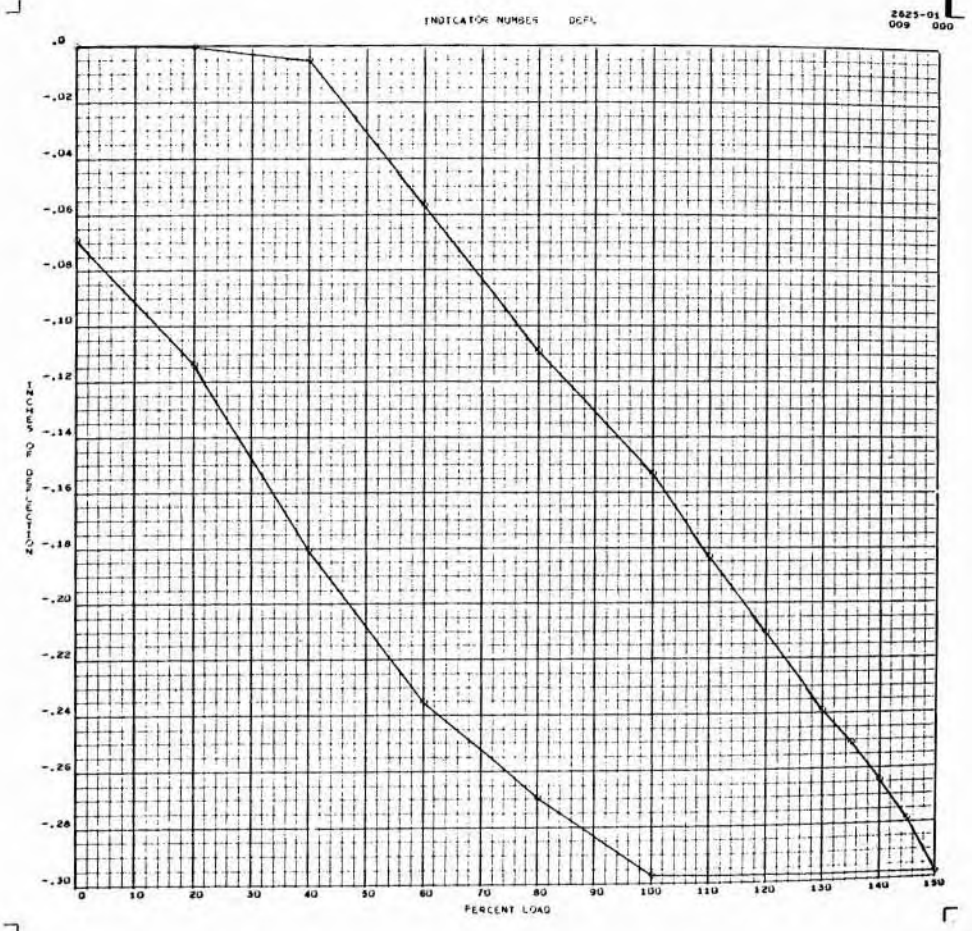


A-330

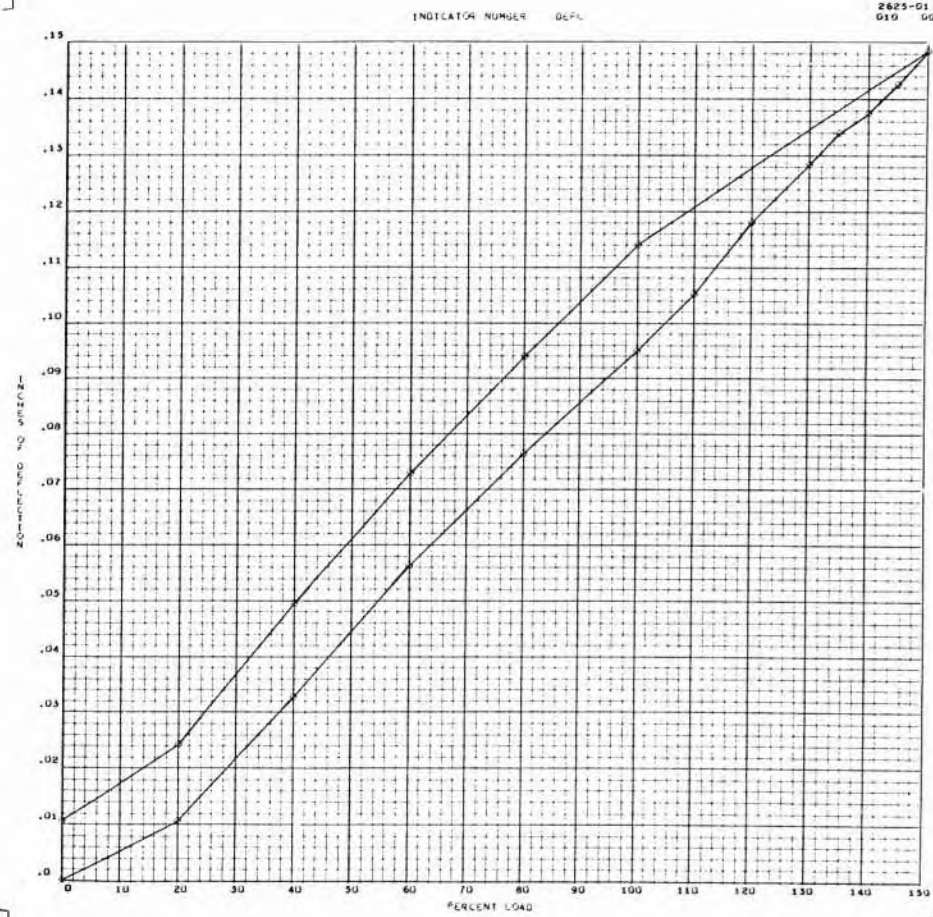
SID 67-317



A-331      SID 67-317

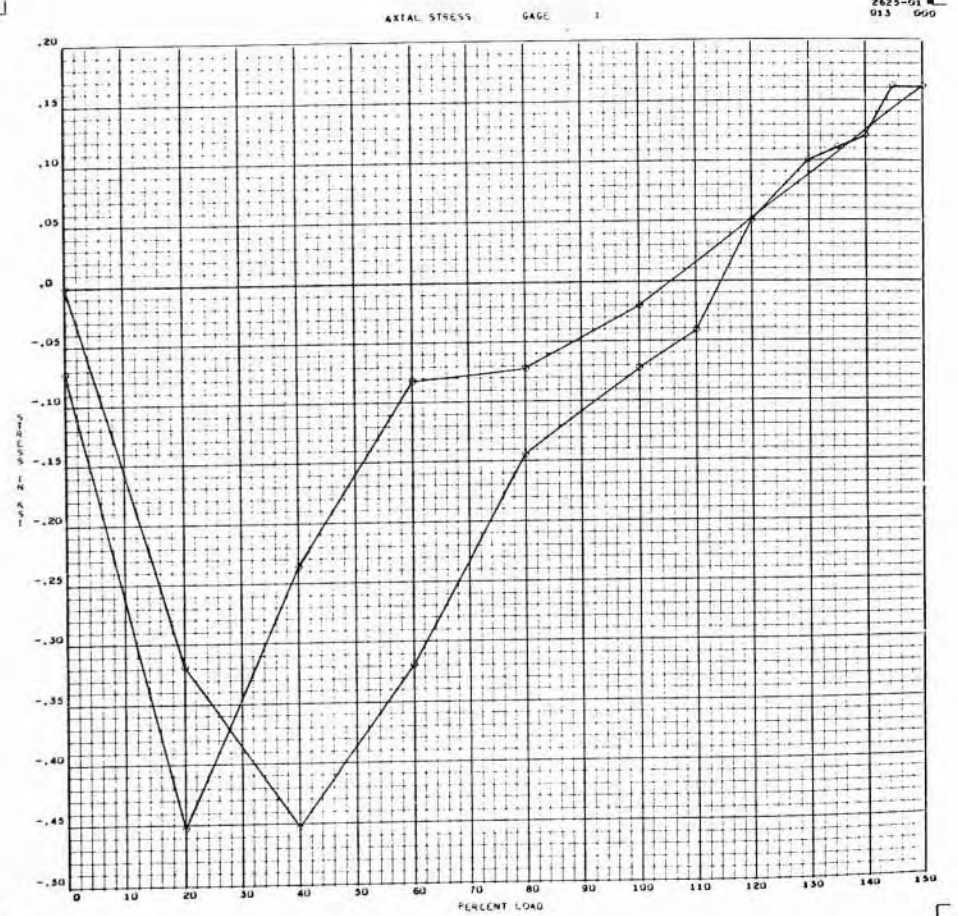


A-332      SID 67-317



A-333

SID 67-317



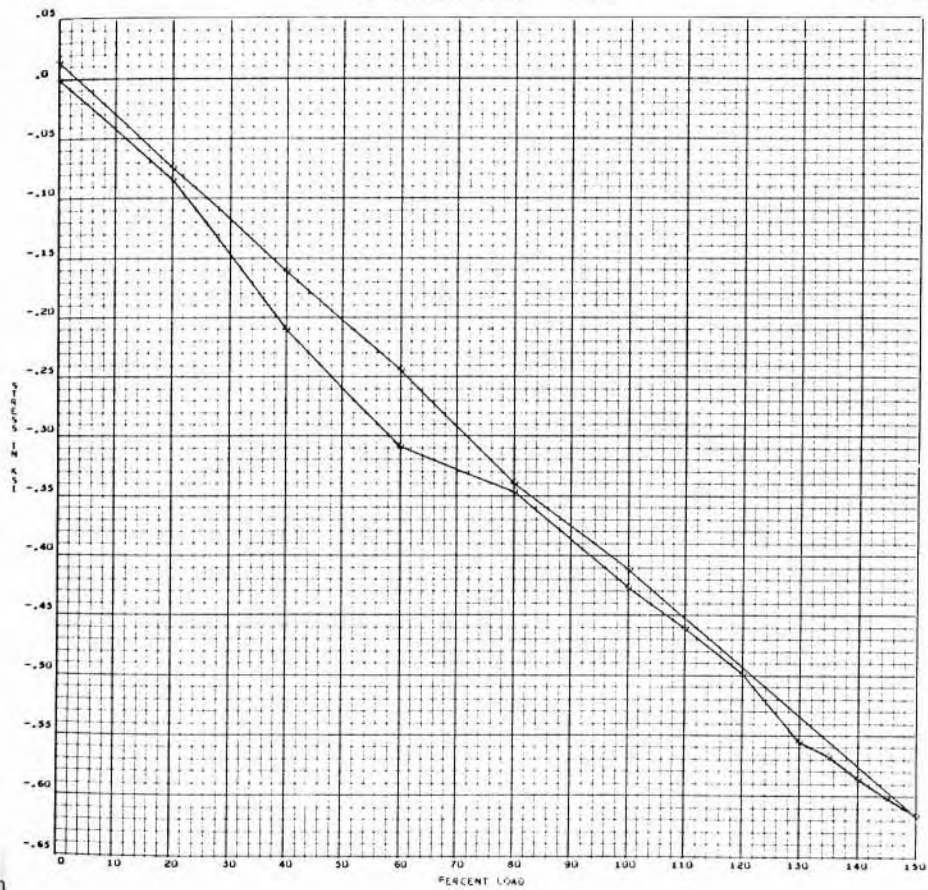
A-334

SID 67-317



AXIAL STRESS ALONG GAGE 2 AXIS

2623-01  
014 000

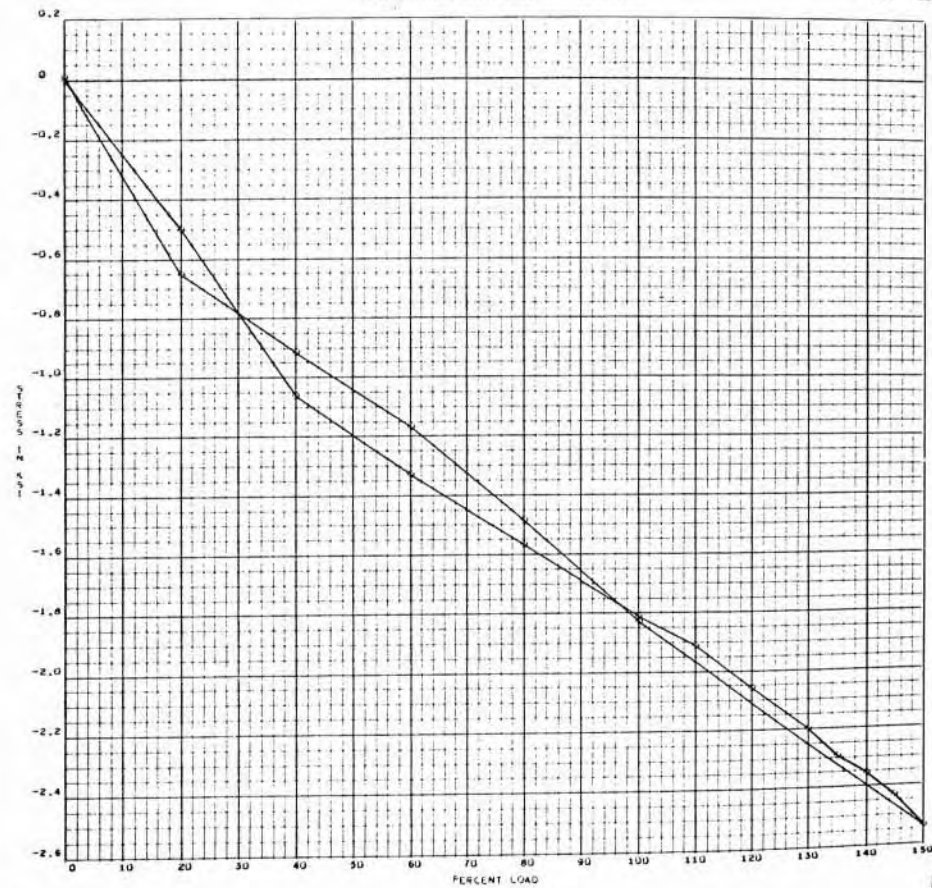


A-335

SID 67-317

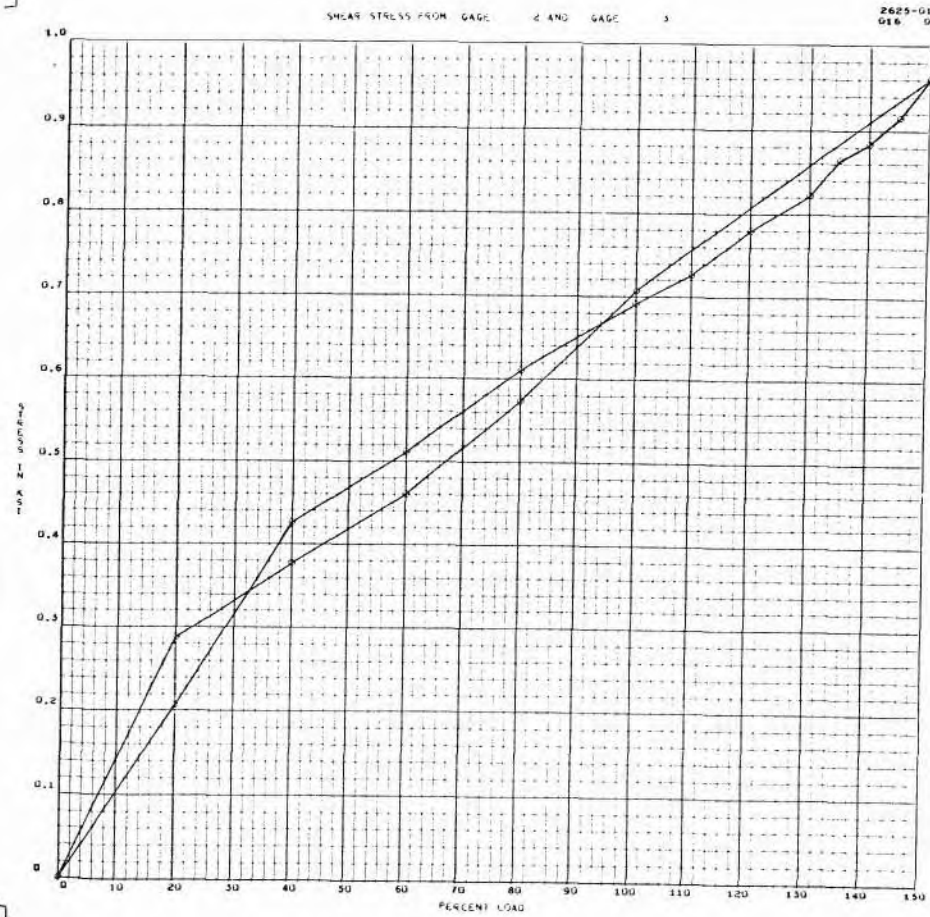
AXIAL STRESS ALONG GAGE 3 AXIS

2623-01  
015 000



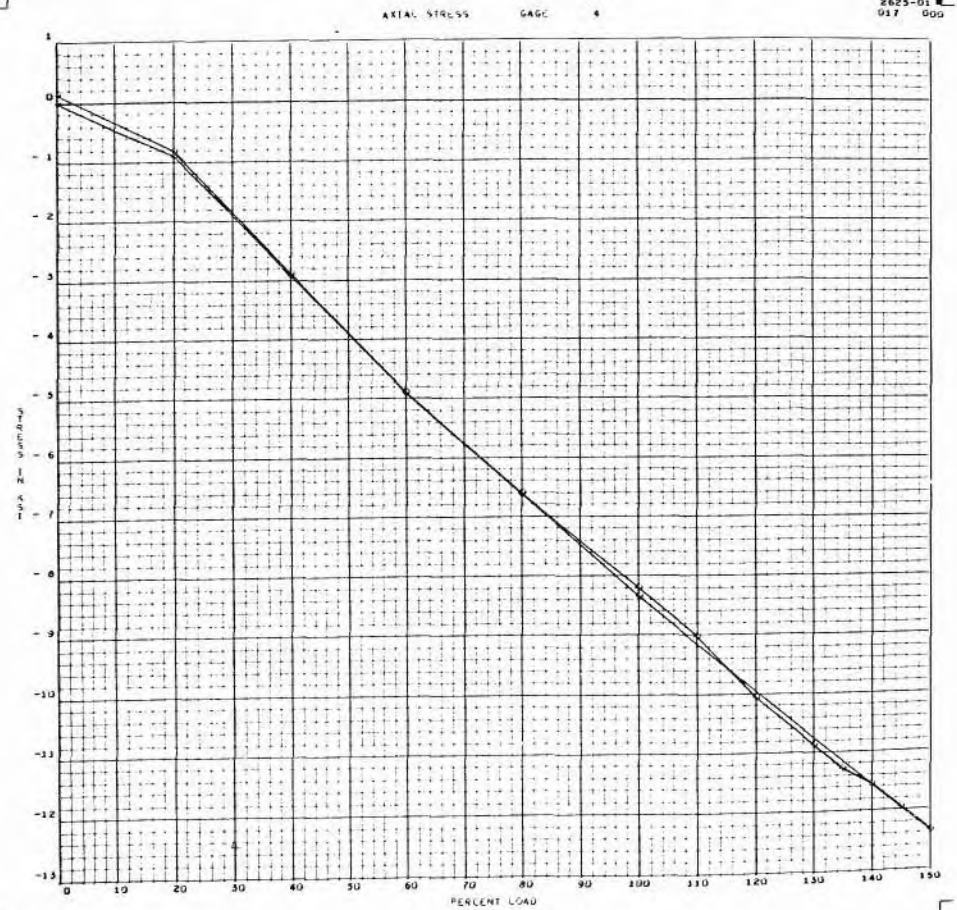
A-336

SID 67-317



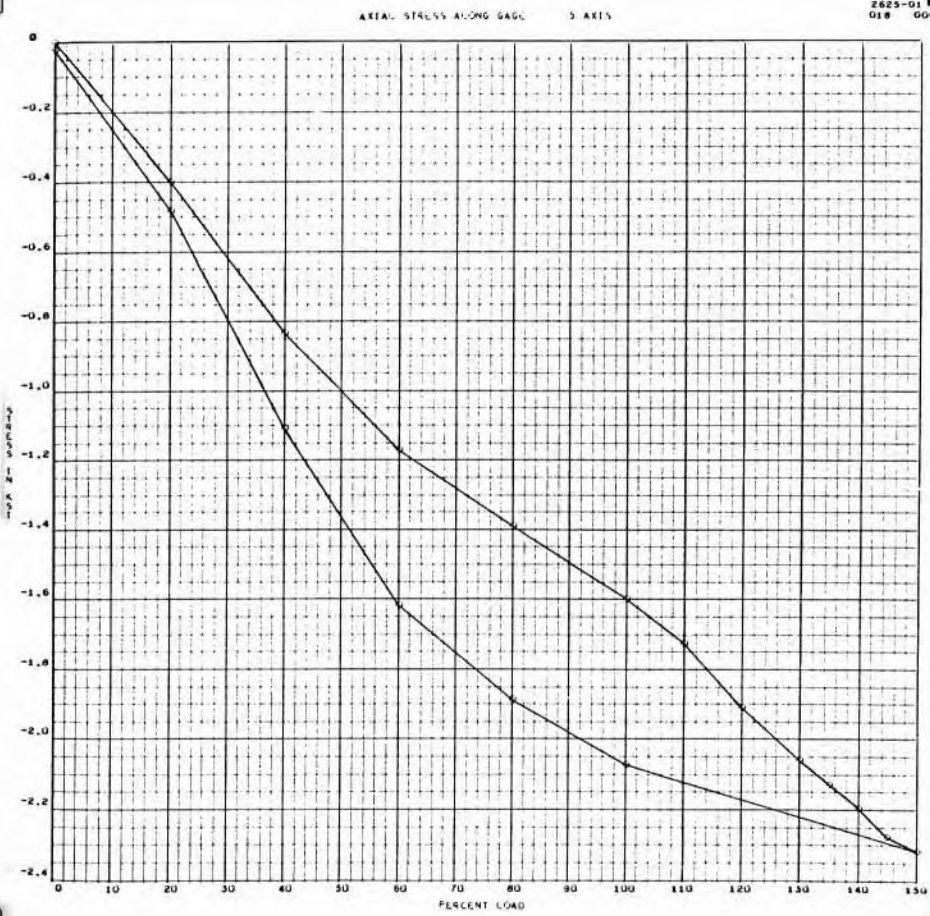
A-337

SID 67-317



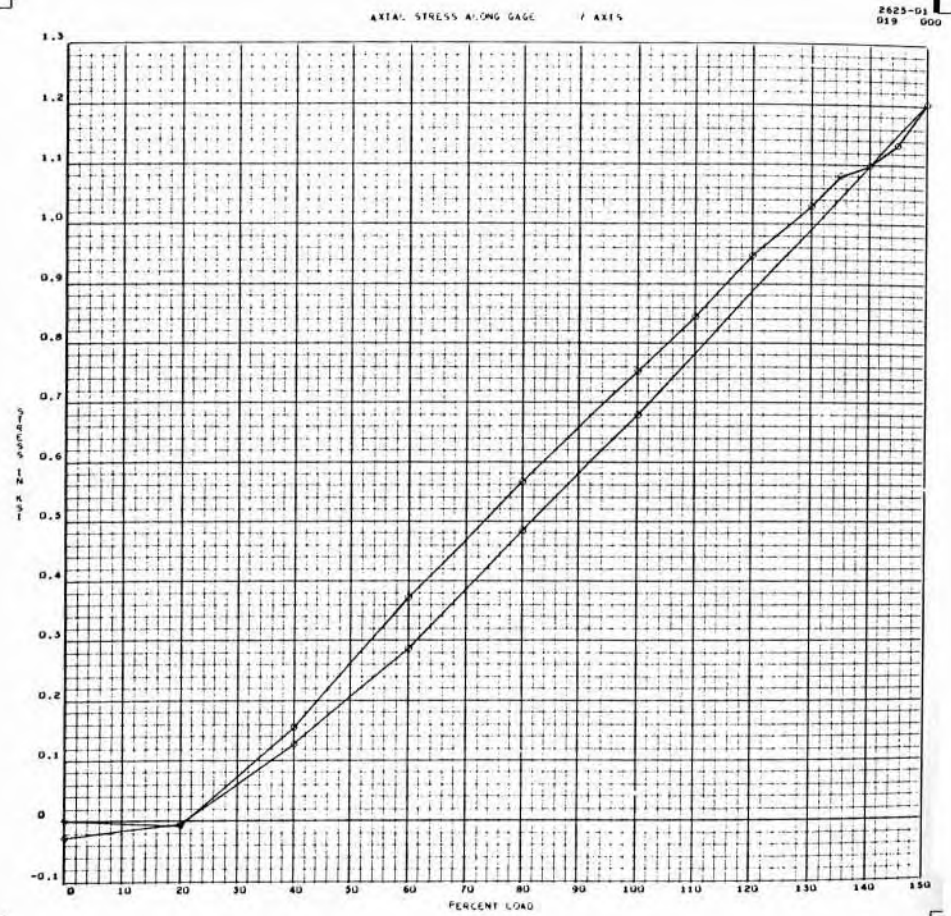
A-338

SID 67-317



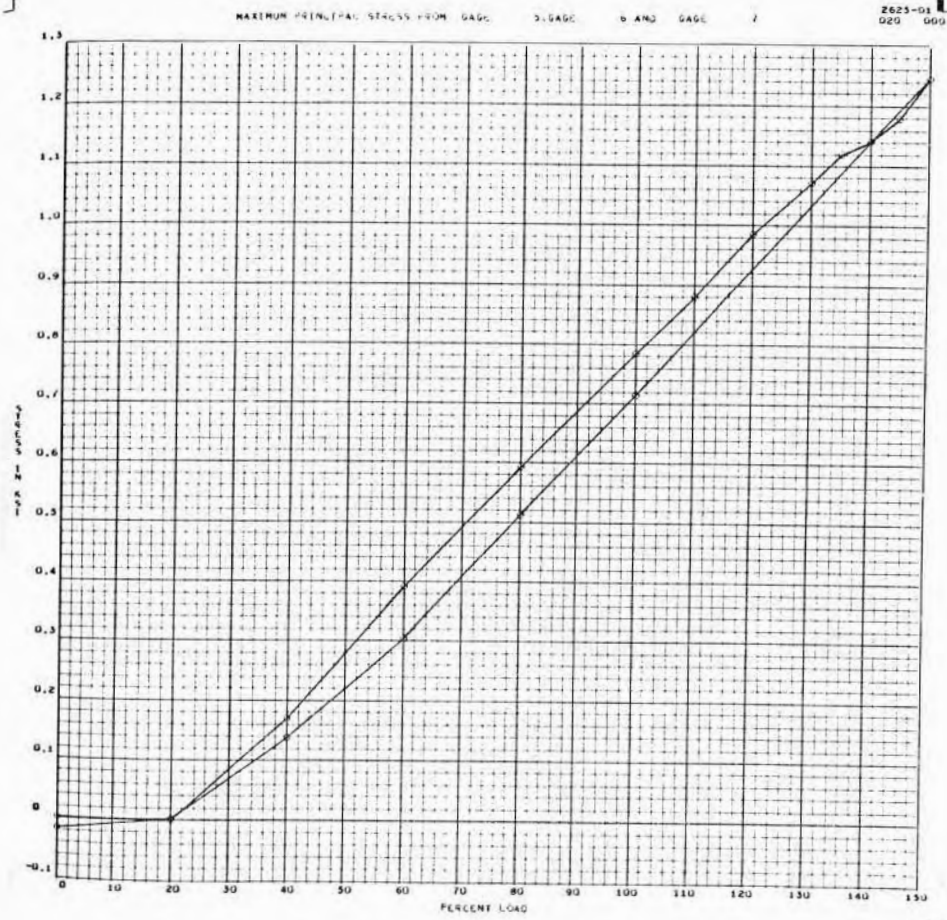
A-339

SID 67-317



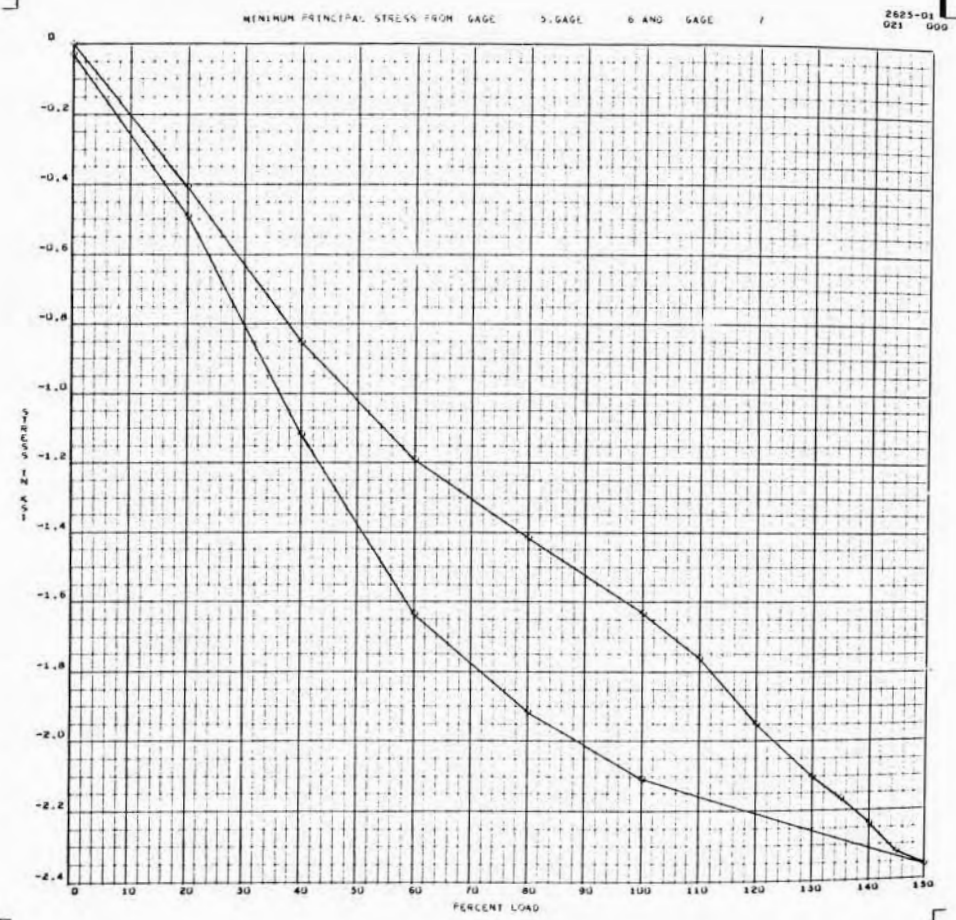
A-340

SID 67-317



A-341

SID 67-317



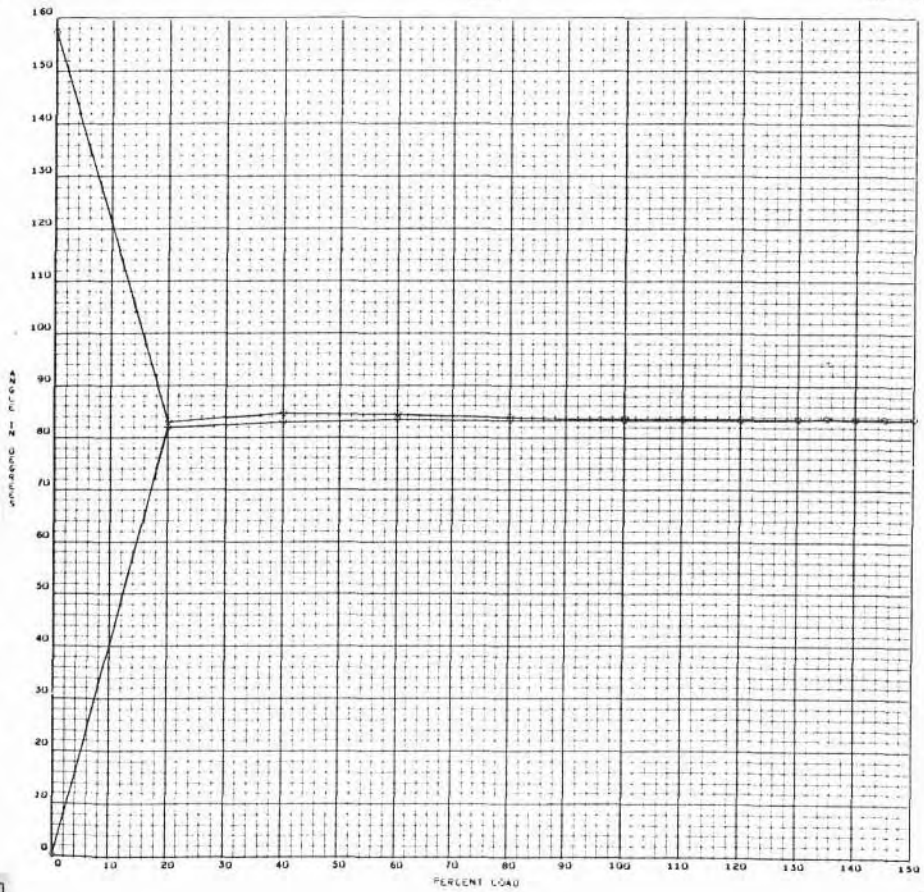
A-342

SID 67-317



THETA

2625-01  
022 000

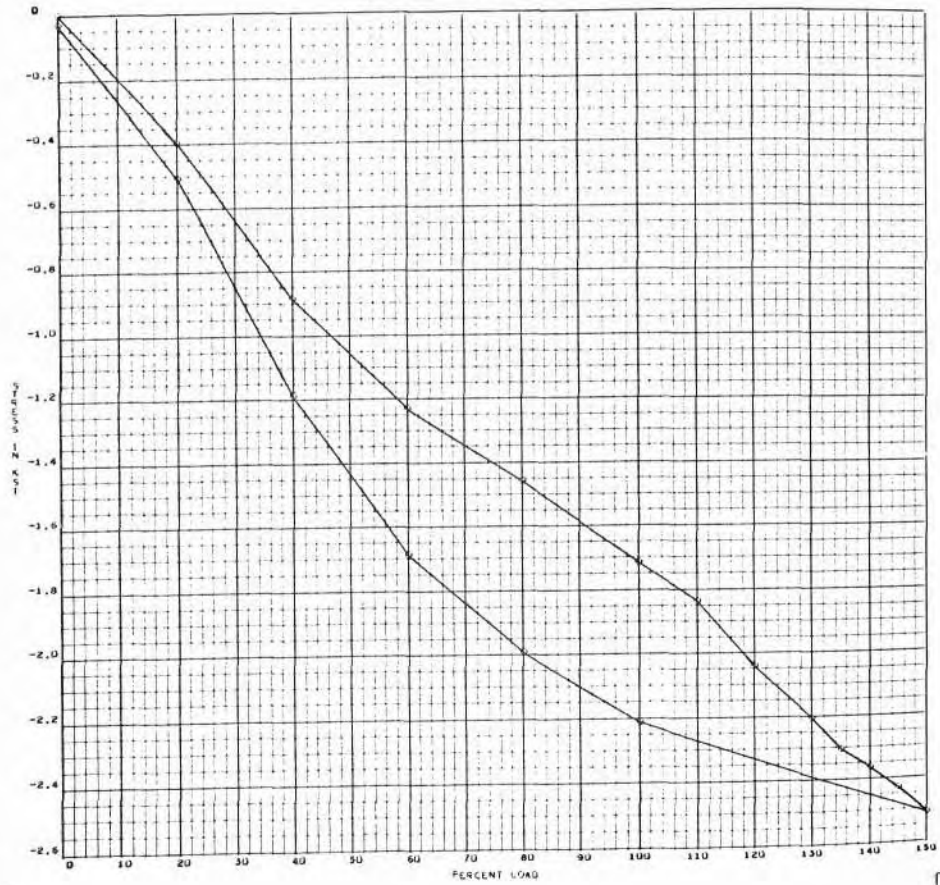


A-343

SID 67-317

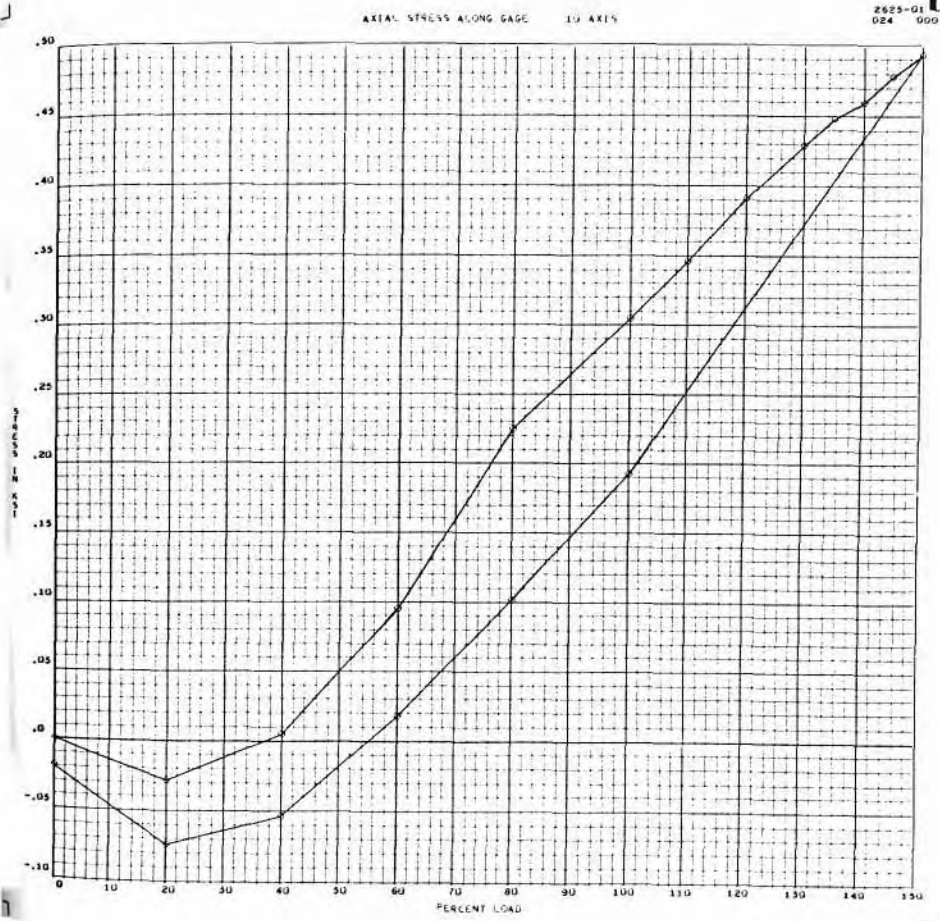
AXIAL STRESS ALONG GAGE + AXIS

2625-01  
023 000



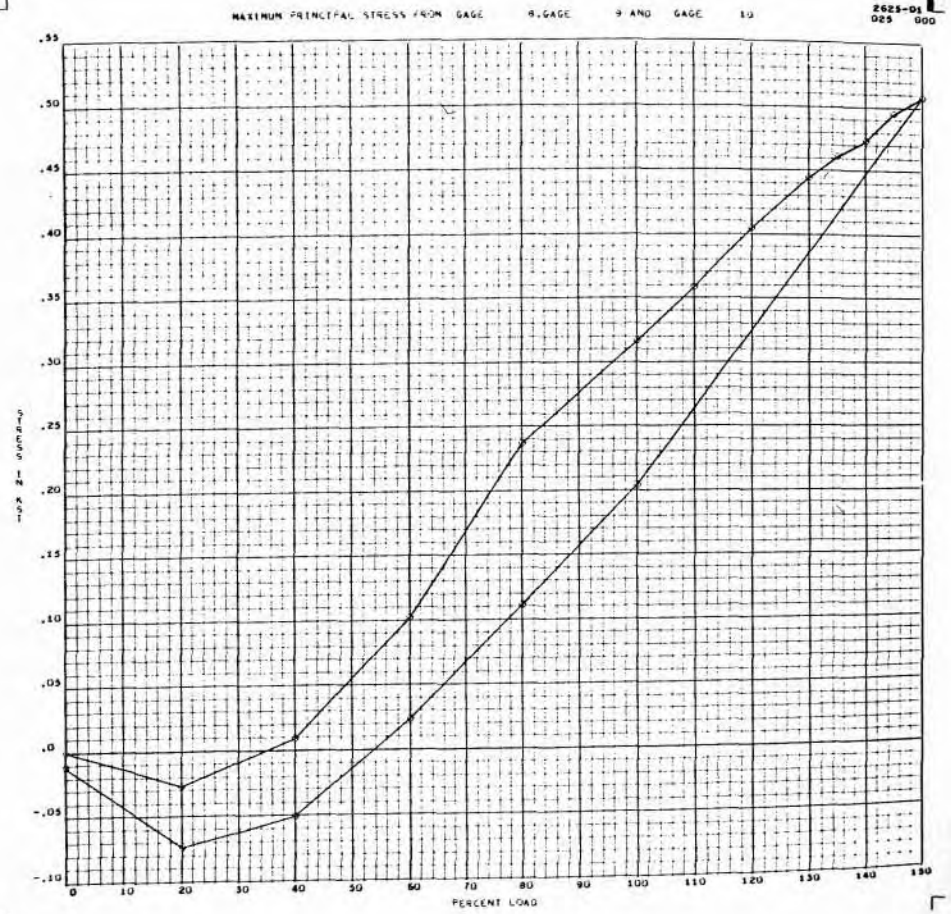
A-344

SID 67-317



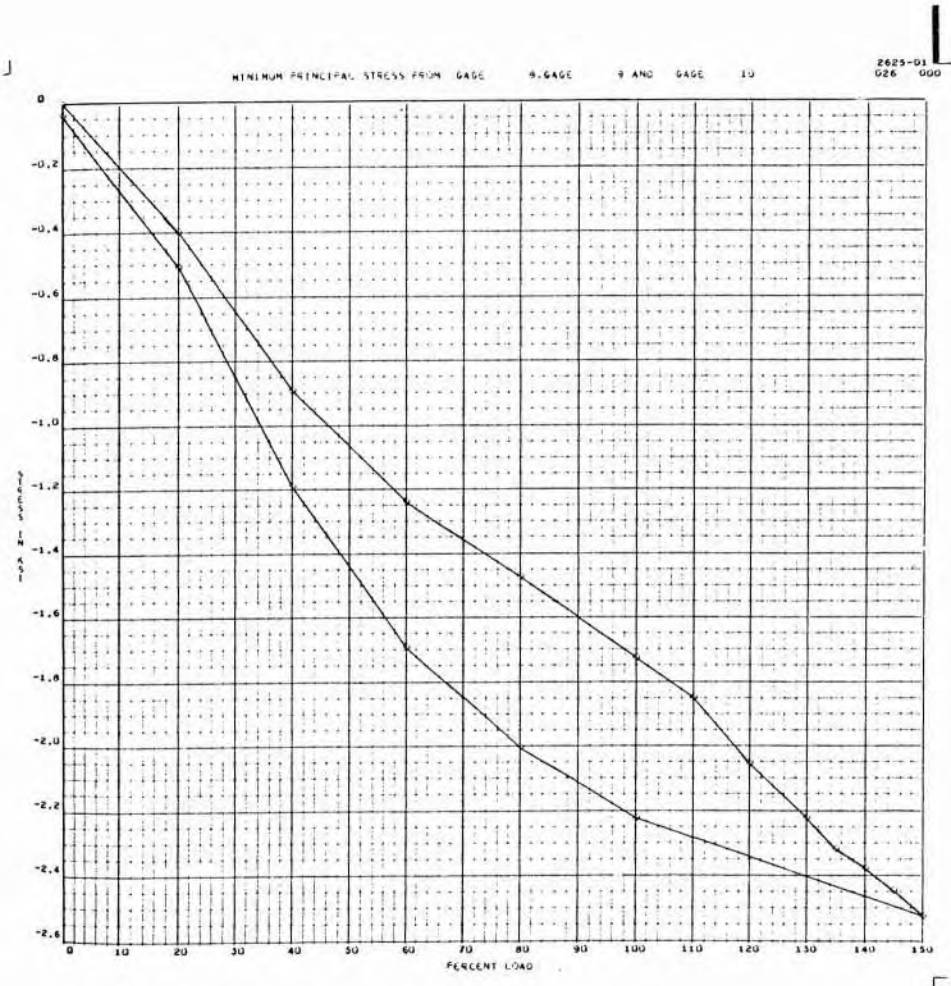
A-345

SID 67-317

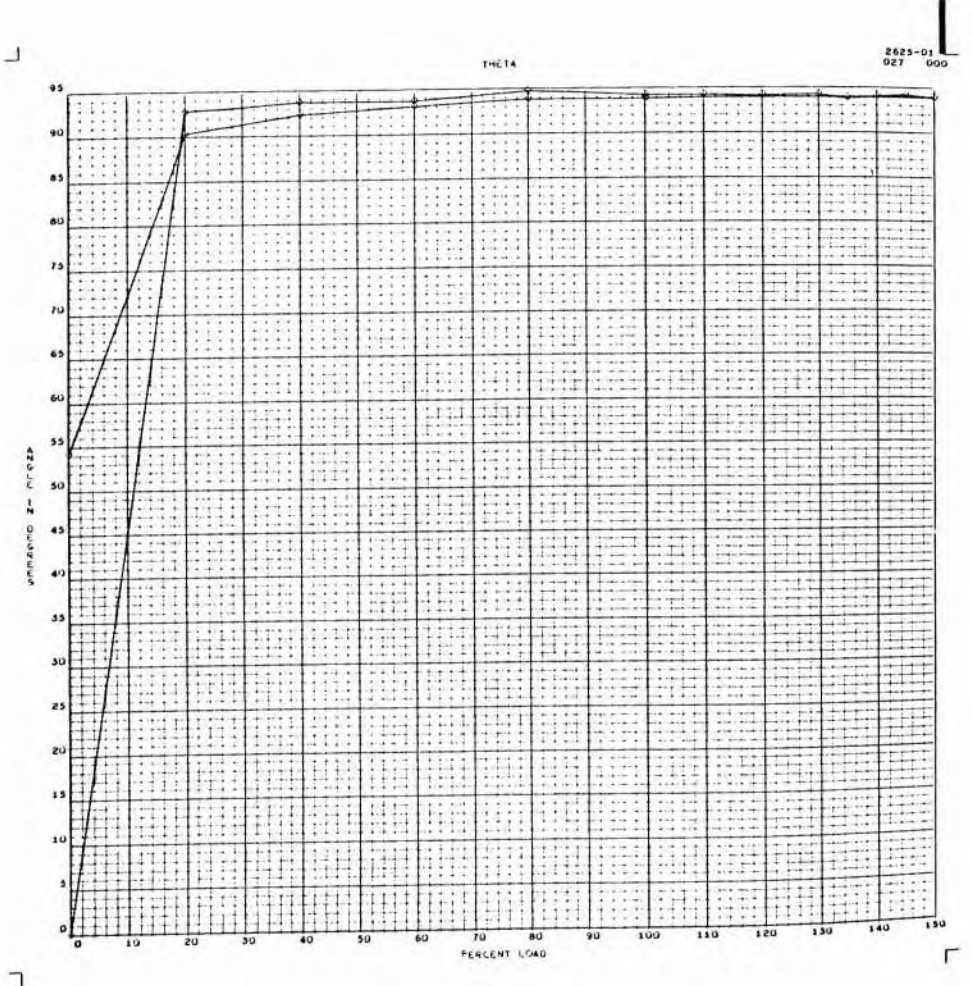


A-346

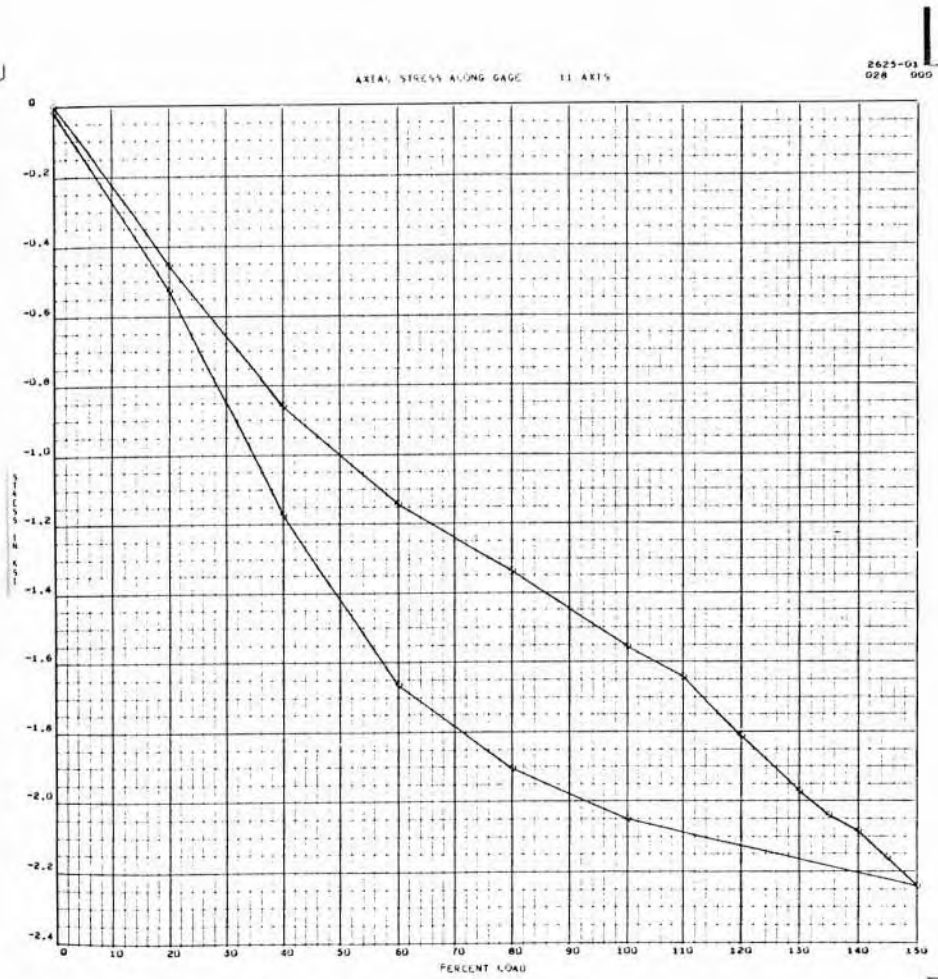
SID 67-317



A-347      SID 67-317

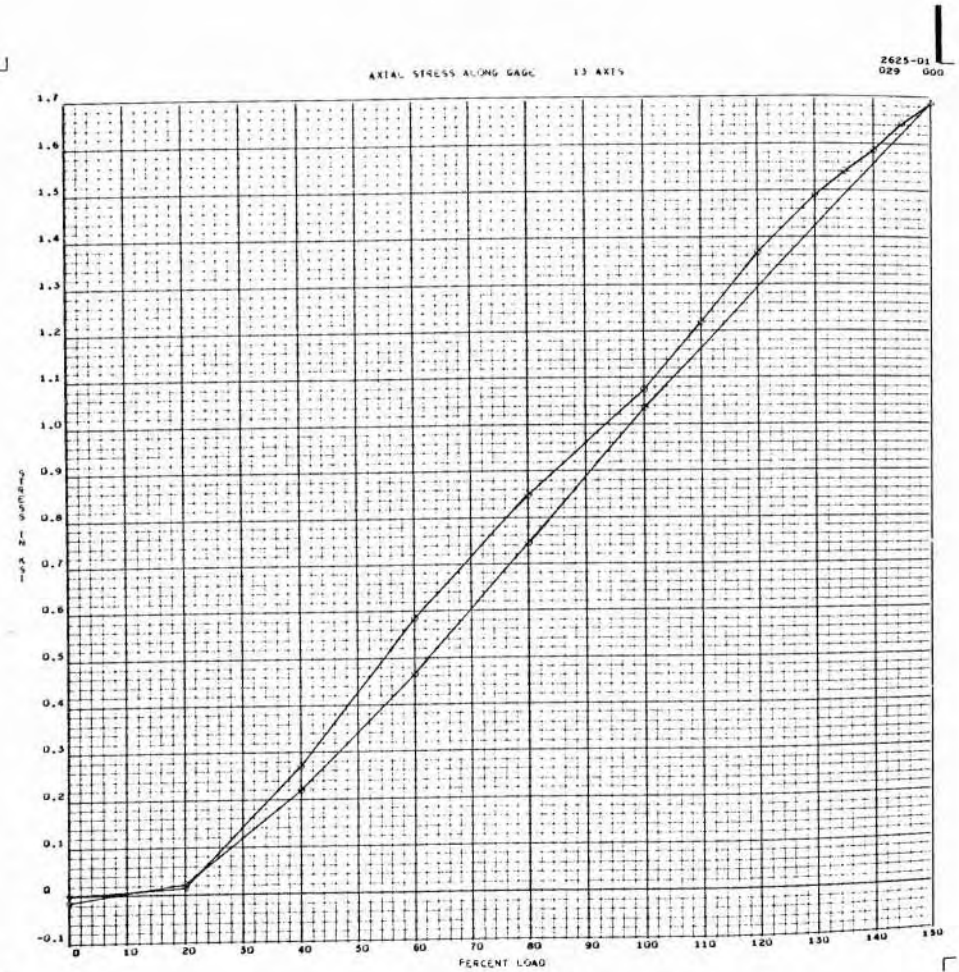


A-348      SID 67-317



A-349

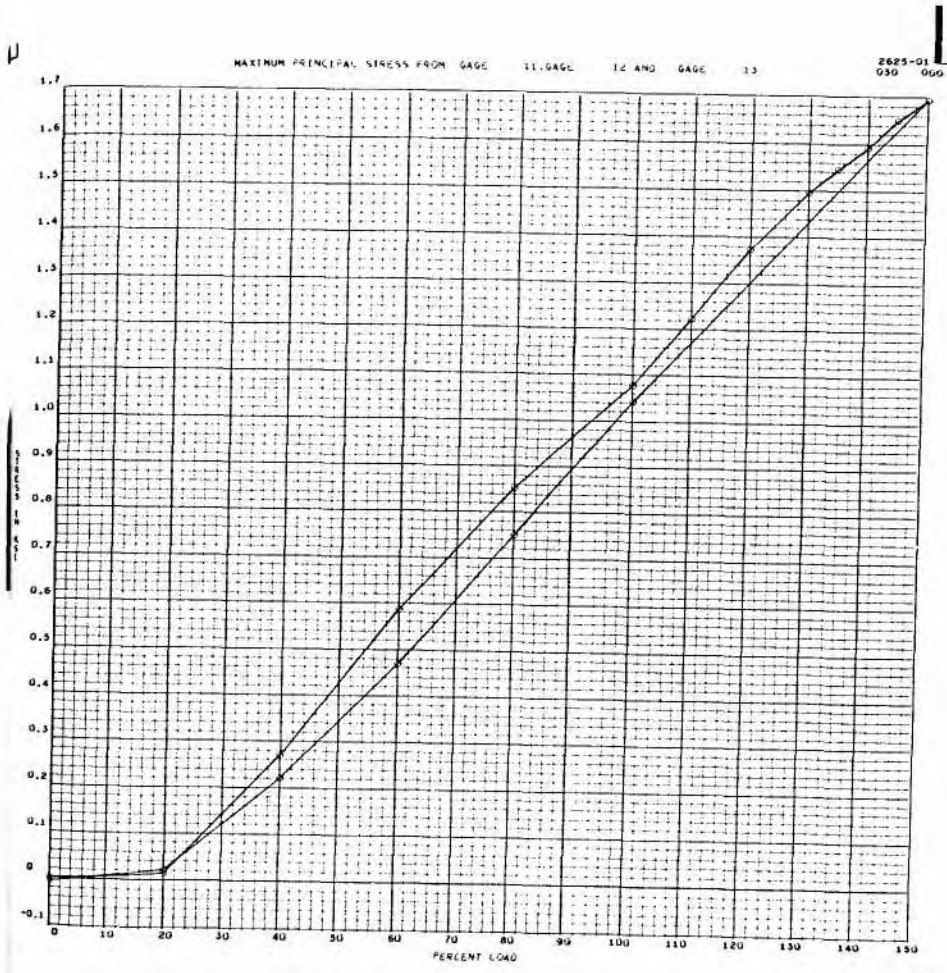
SID 67-317



A-350

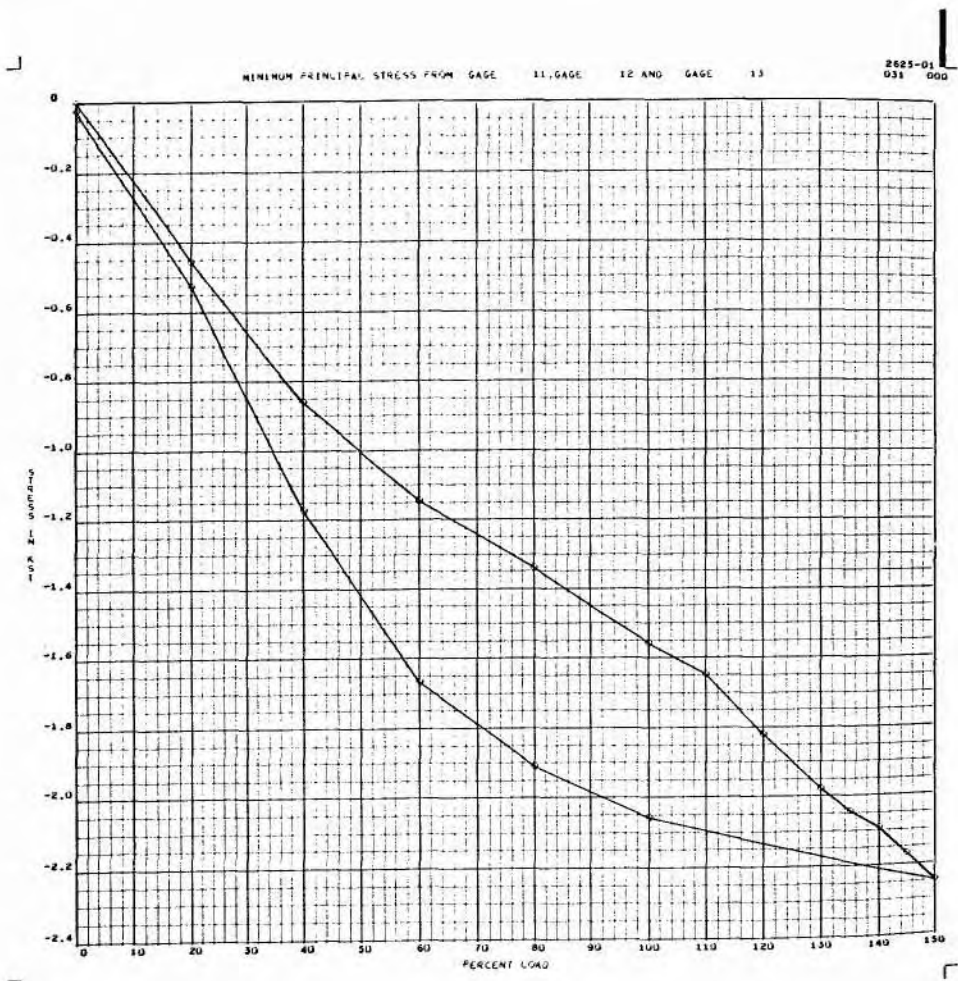
SID 67-317





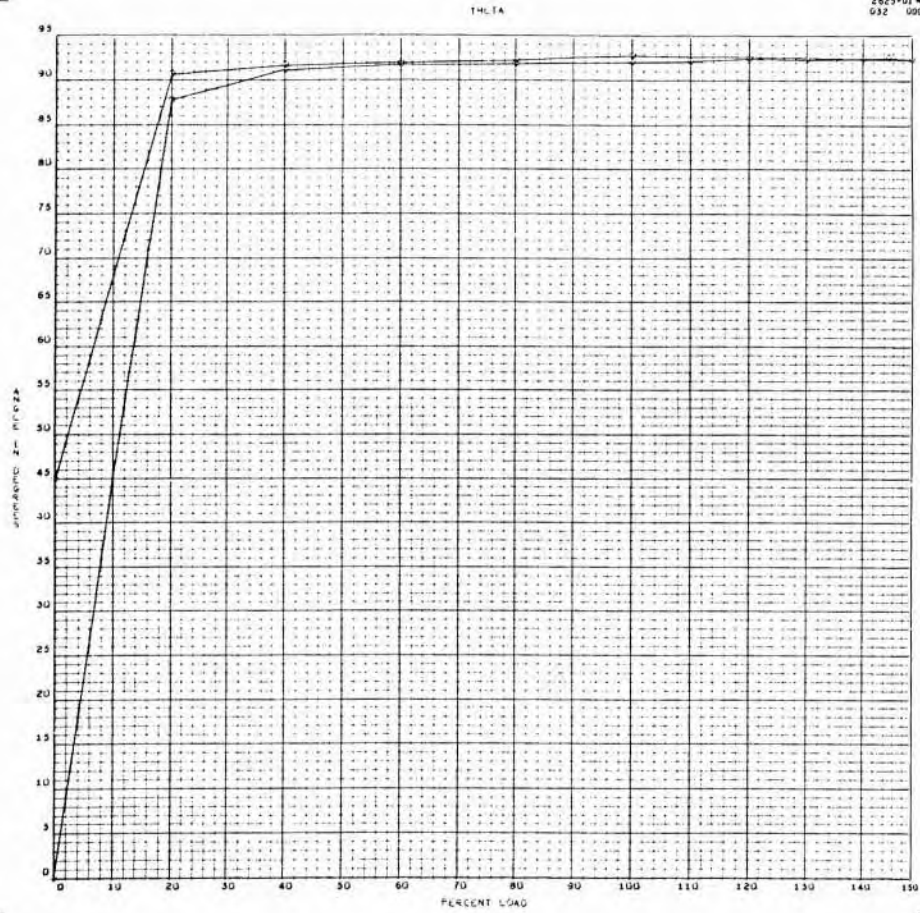
A-351

SID 67-317



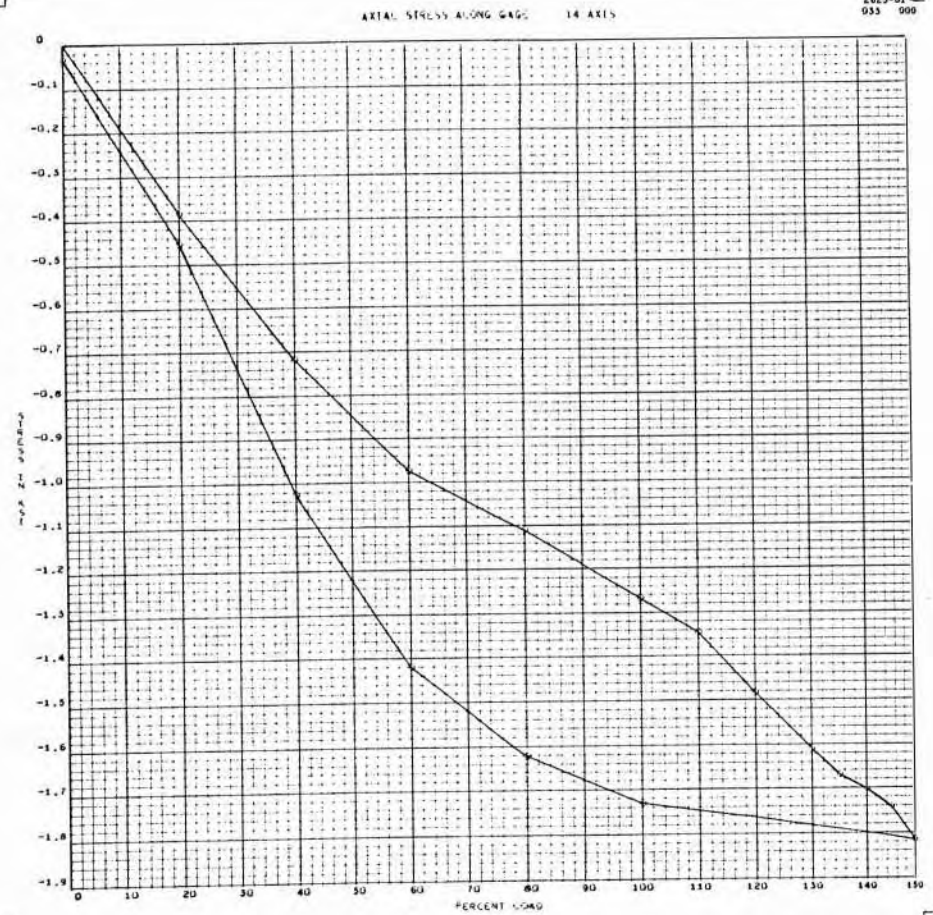
A-352

SID 67-317



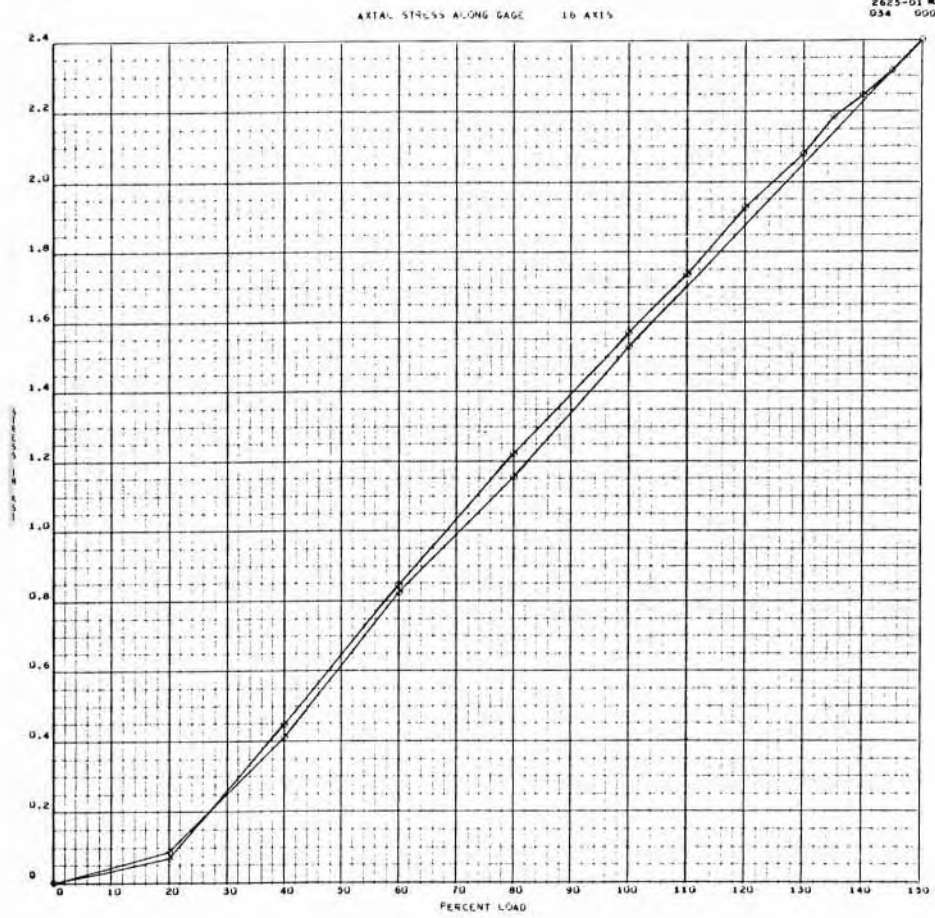
A-353

SID 67-317



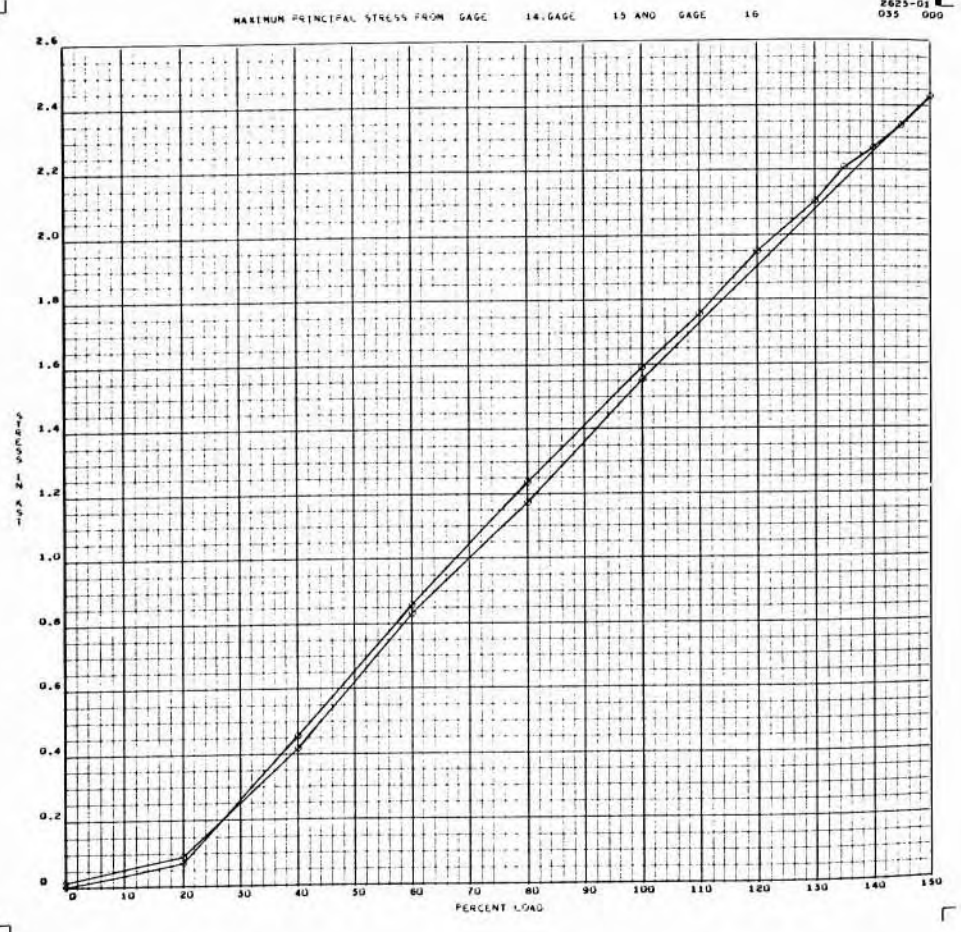
A-354

SID 67-317



A-355

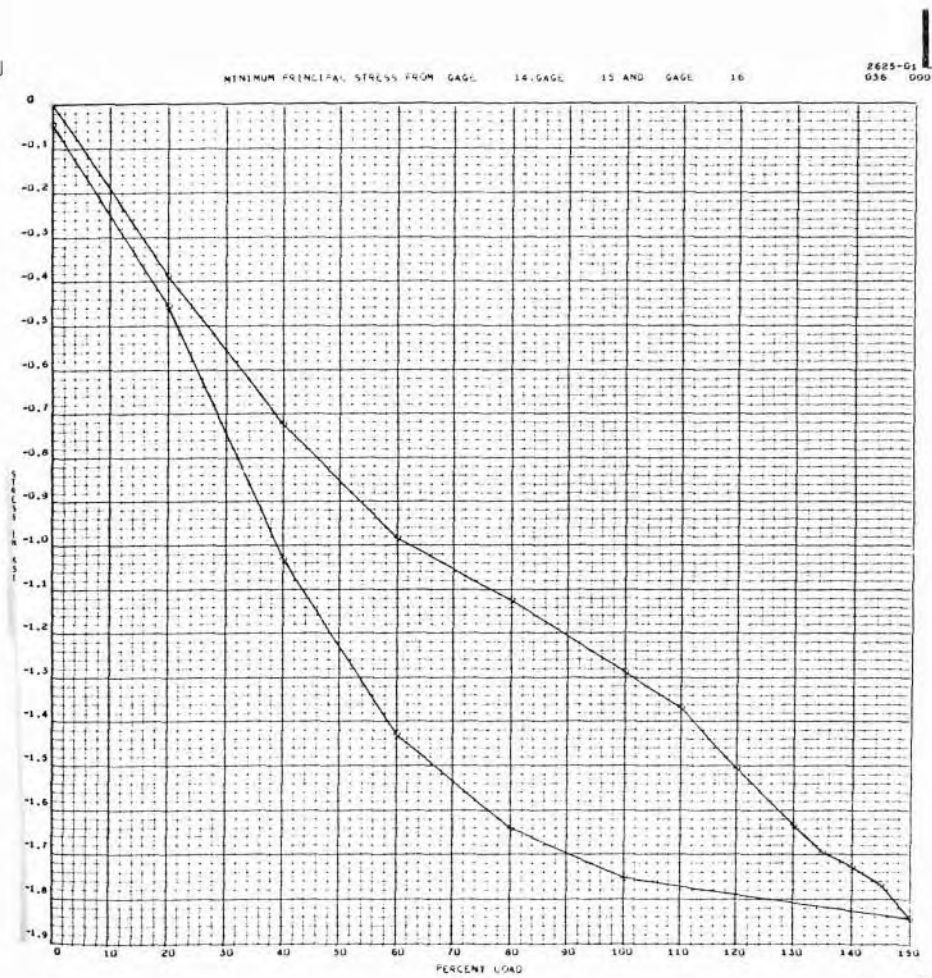
SID 67-317



A-356

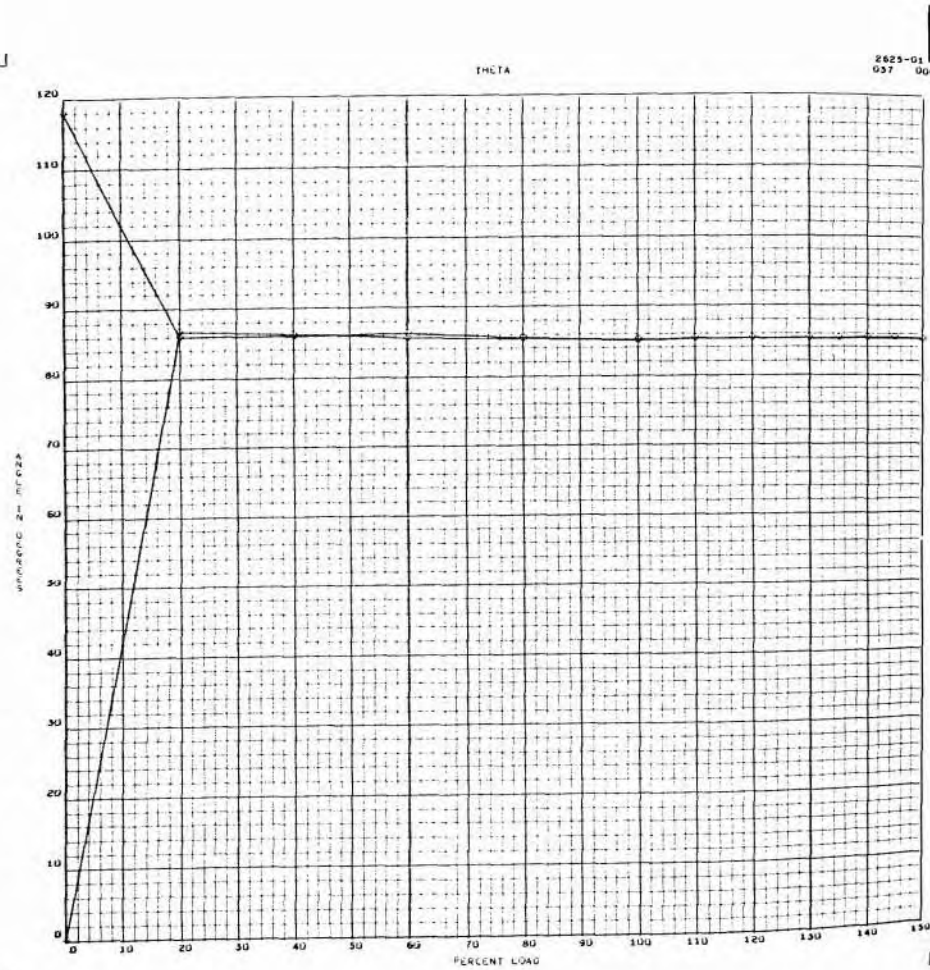
SID 67-317





A-357

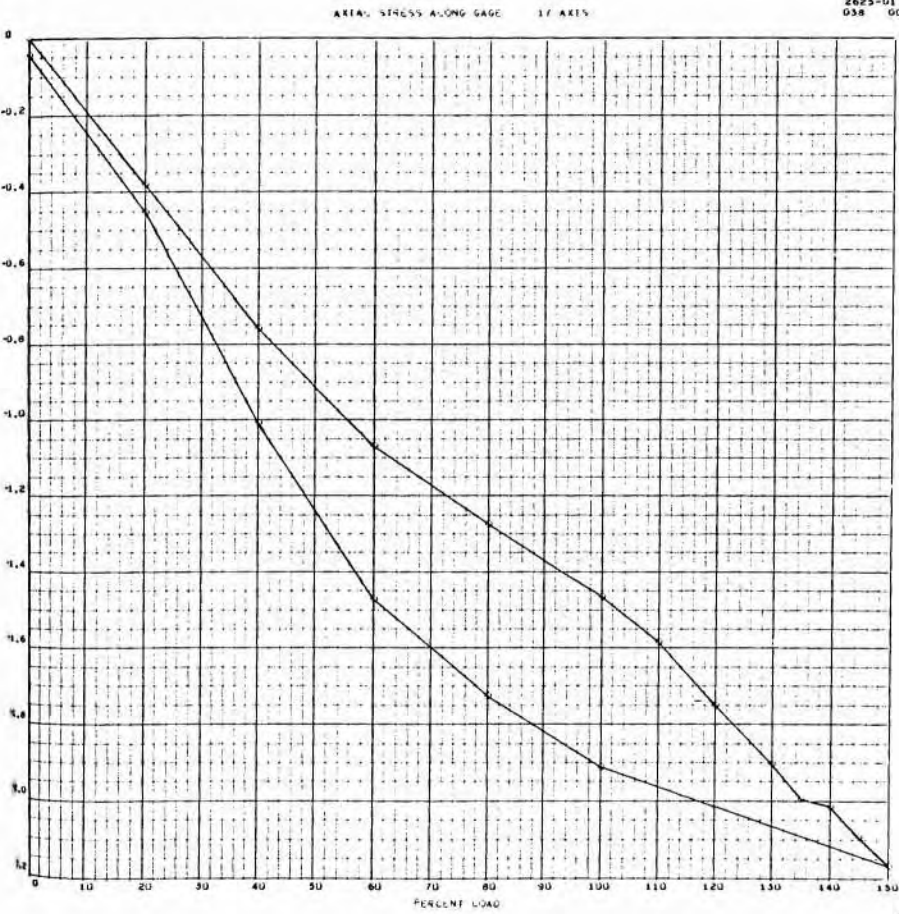
SID 67-317



A-358

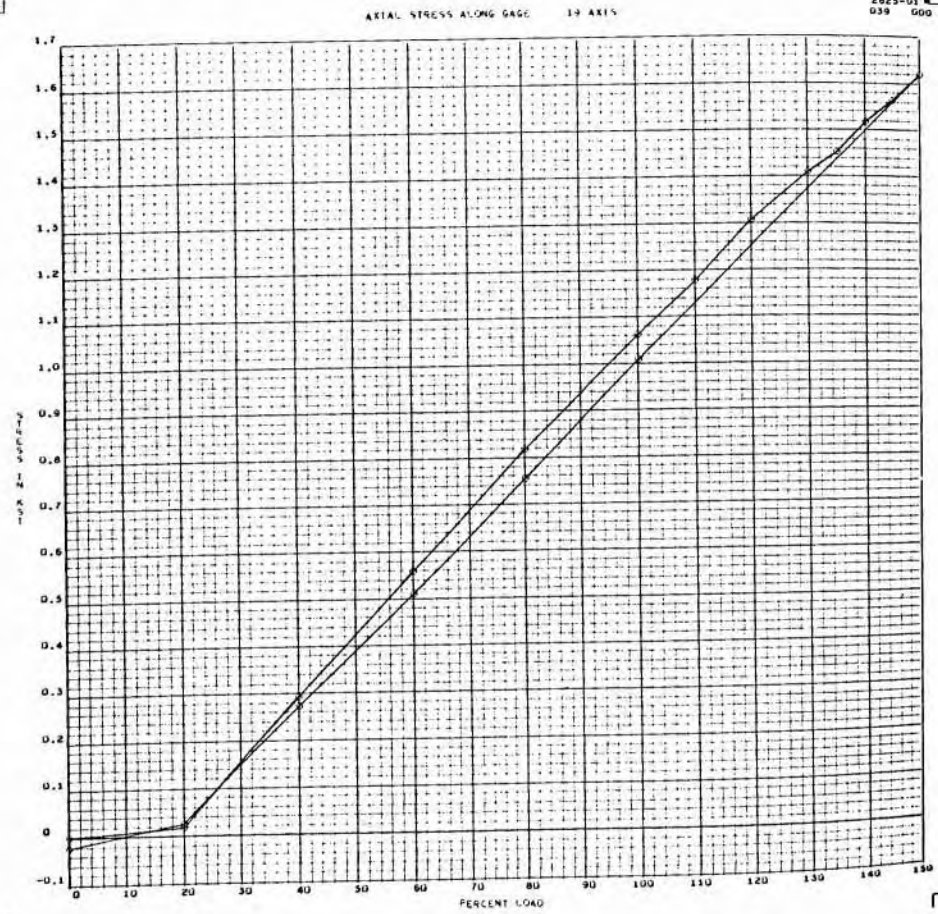
SID 67-317





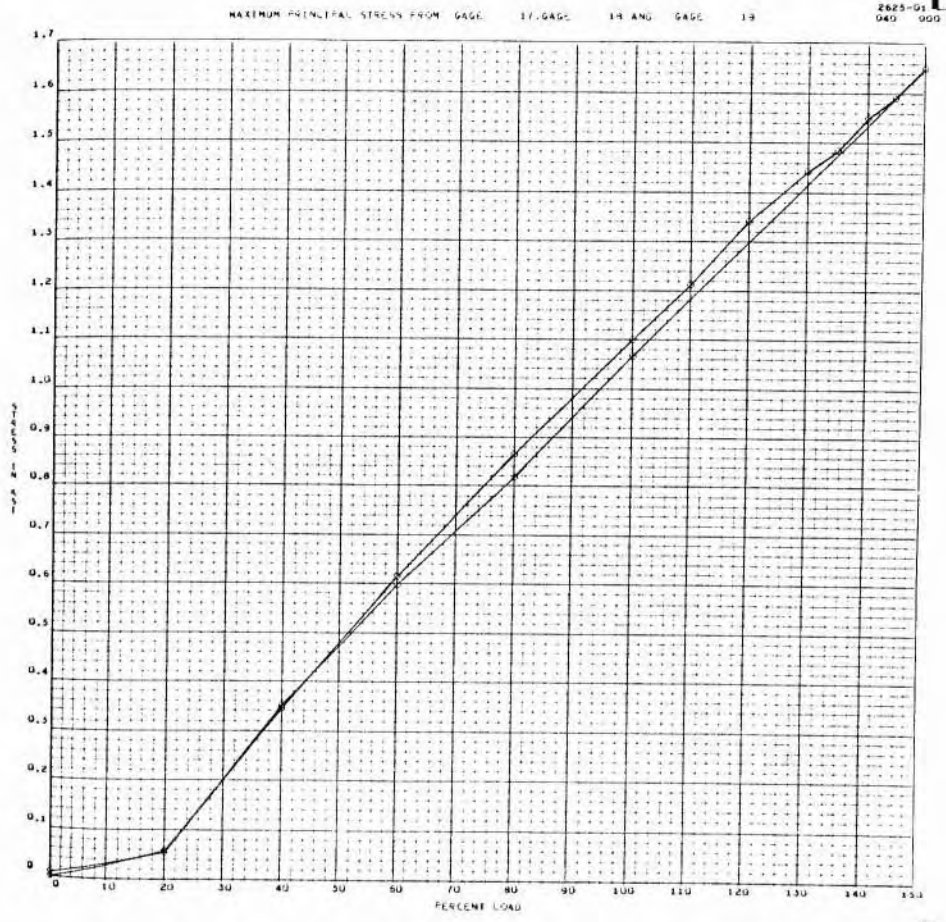
A-359

SID 67-317



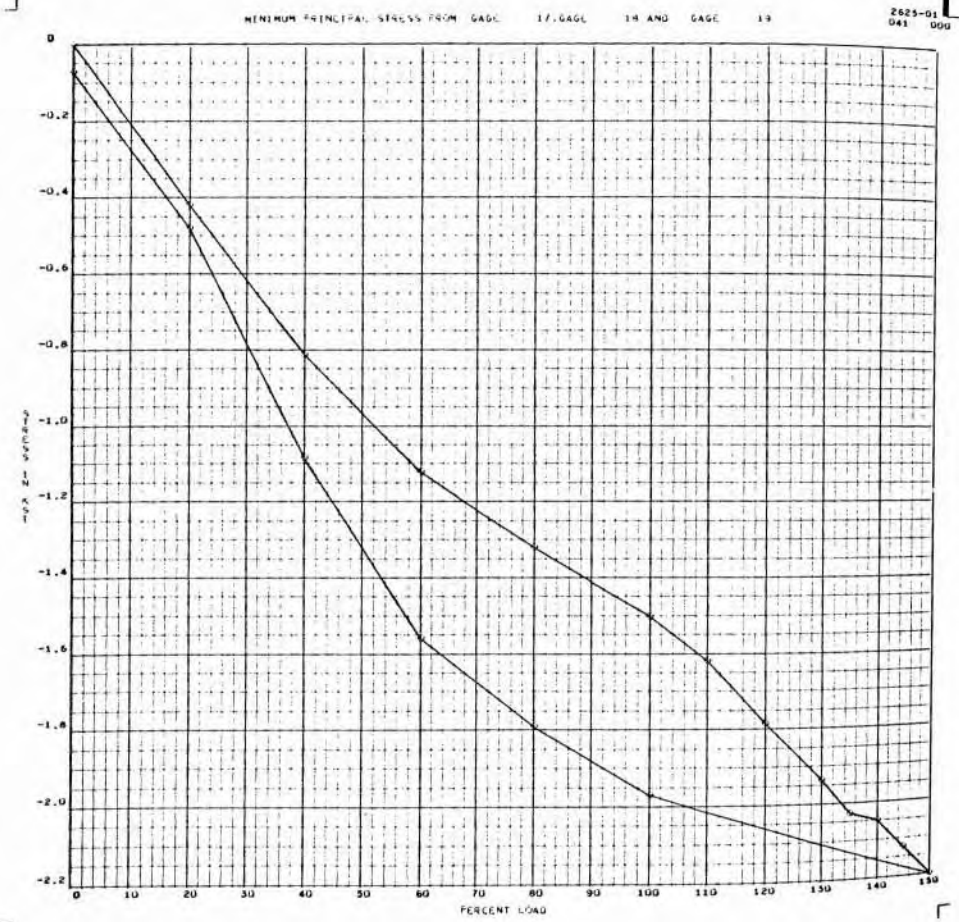
A-360

SID 67-317



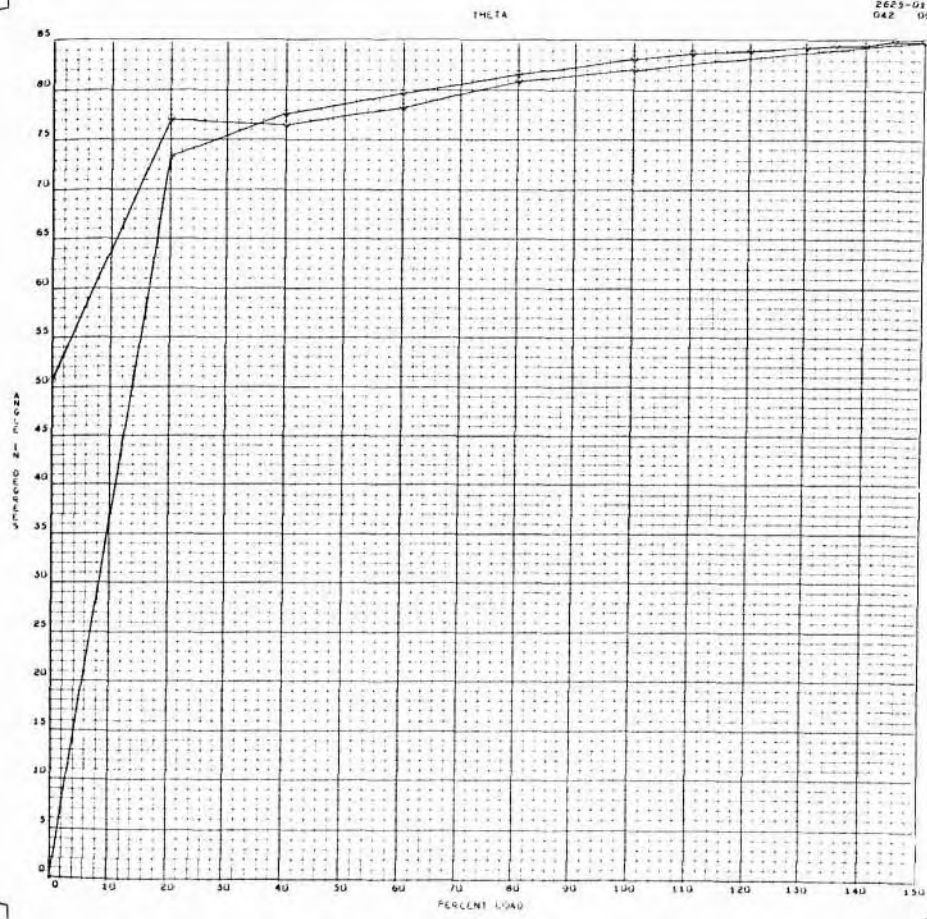
A-361

SID 67-317



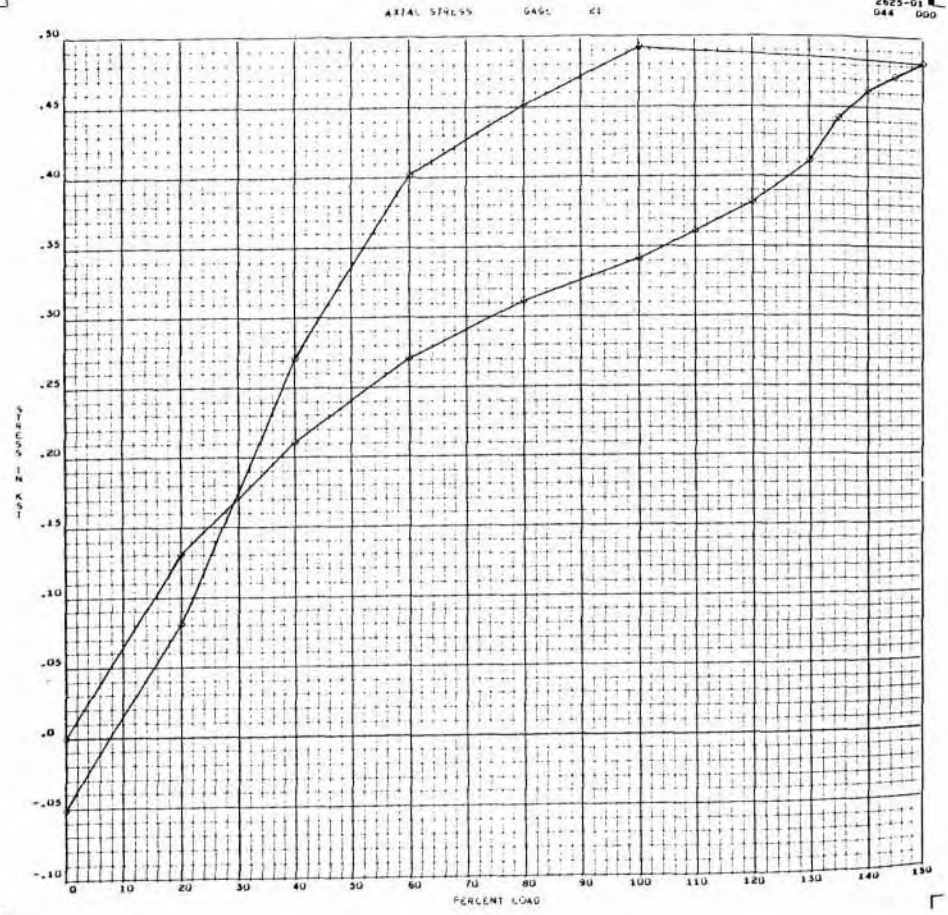
A-362

SID 67-317



A-363

SID 67-317

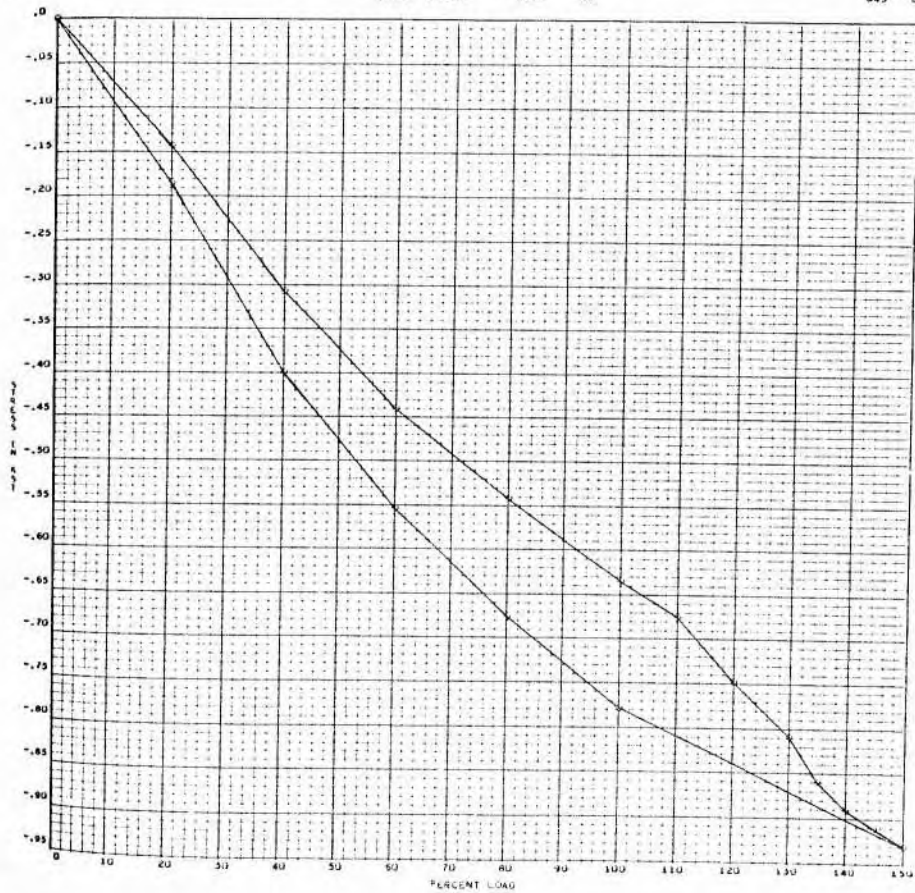


A-364

SID 67-317

AXIAL STRESS GAGE CC

2625-01  
045 999

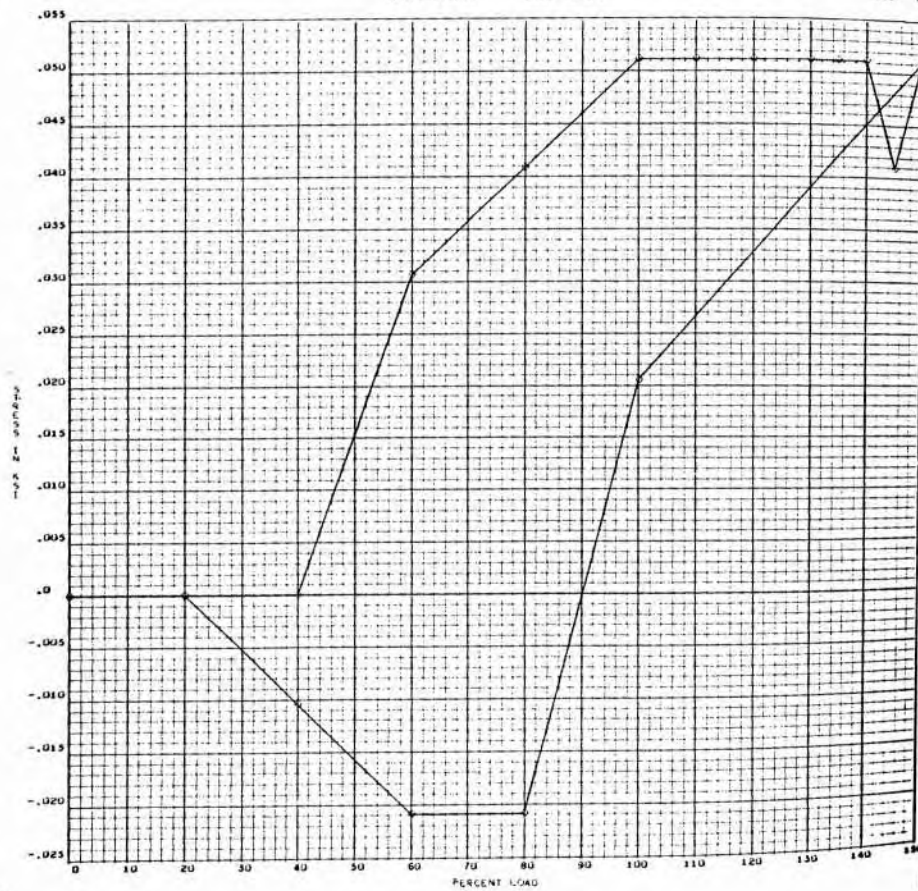


A-365

SID 67-317

AXIAL STRESS GAGE AFA-1

2625-01  
046 000



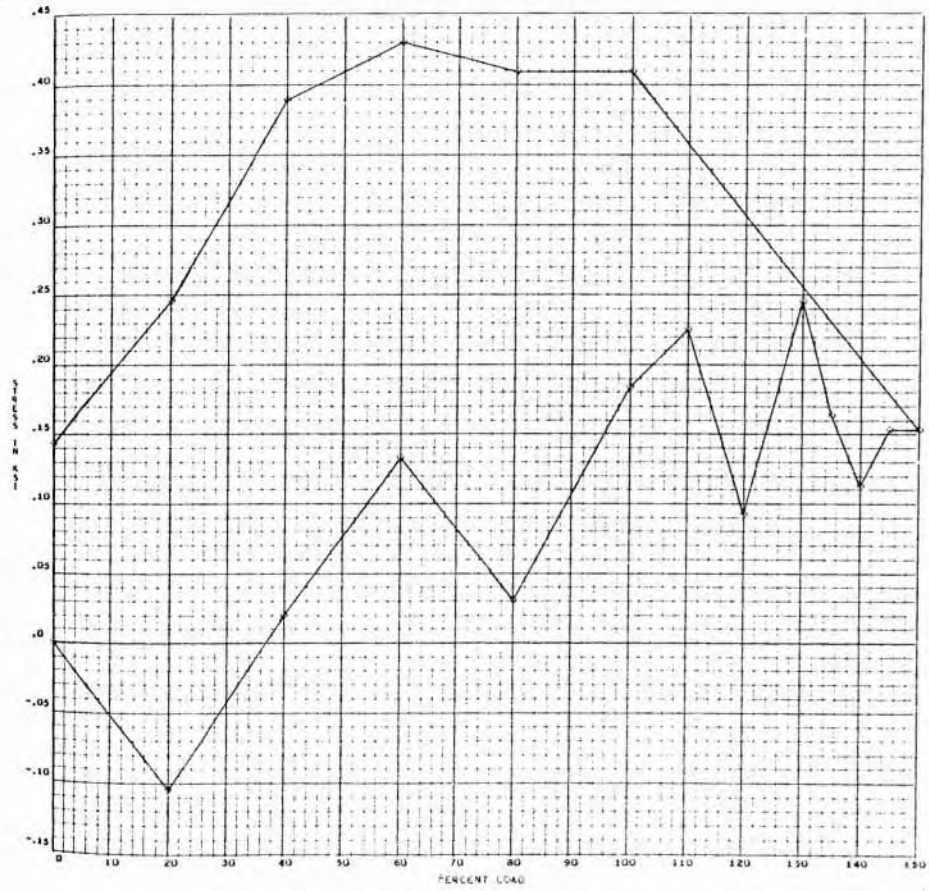
A-366

SID 67-317



AXIAL STRESS GAGE AFA-2

2625-01  
047 050

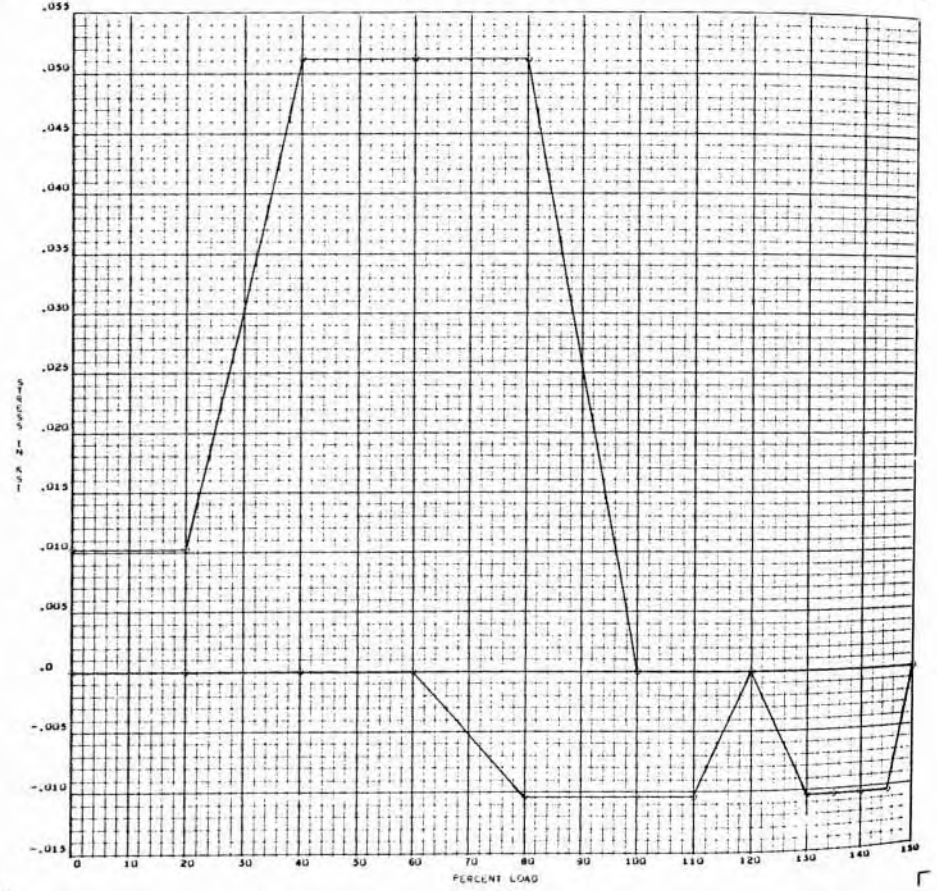


A-367

SID 67-317

AXIAL STRESS GAGE AFA-3

2625-01  
048 050

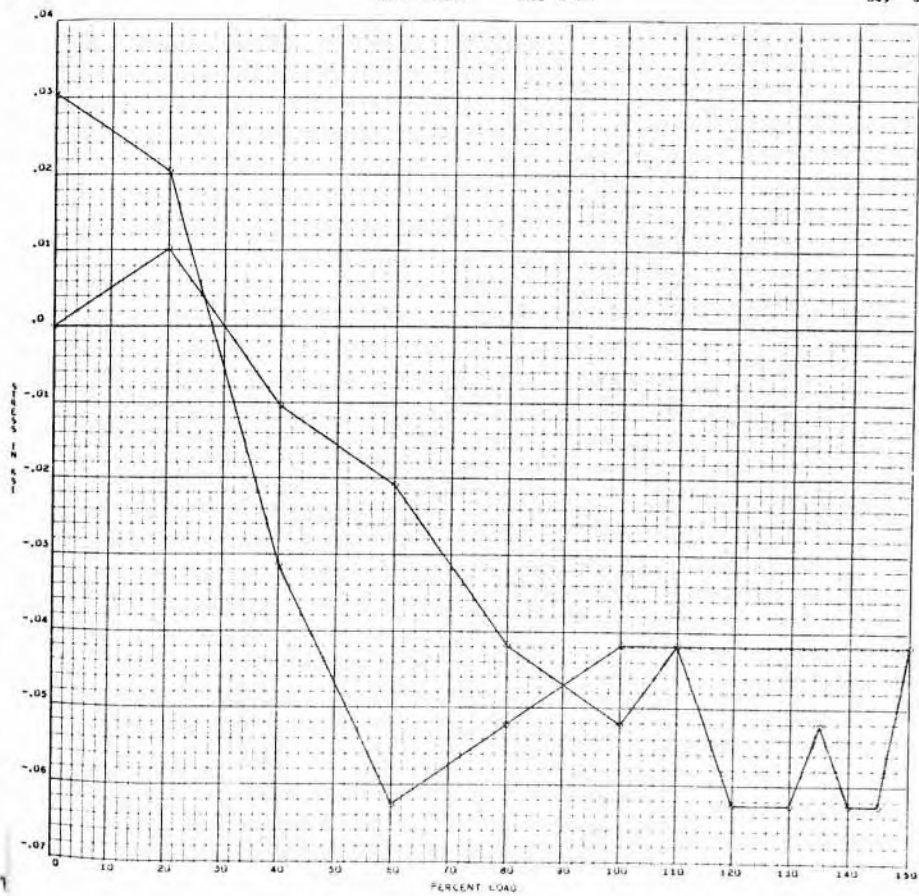


A-368

SID 67-317

AXIAL STRESS GAGE AFA-4

2625-01  
049 000

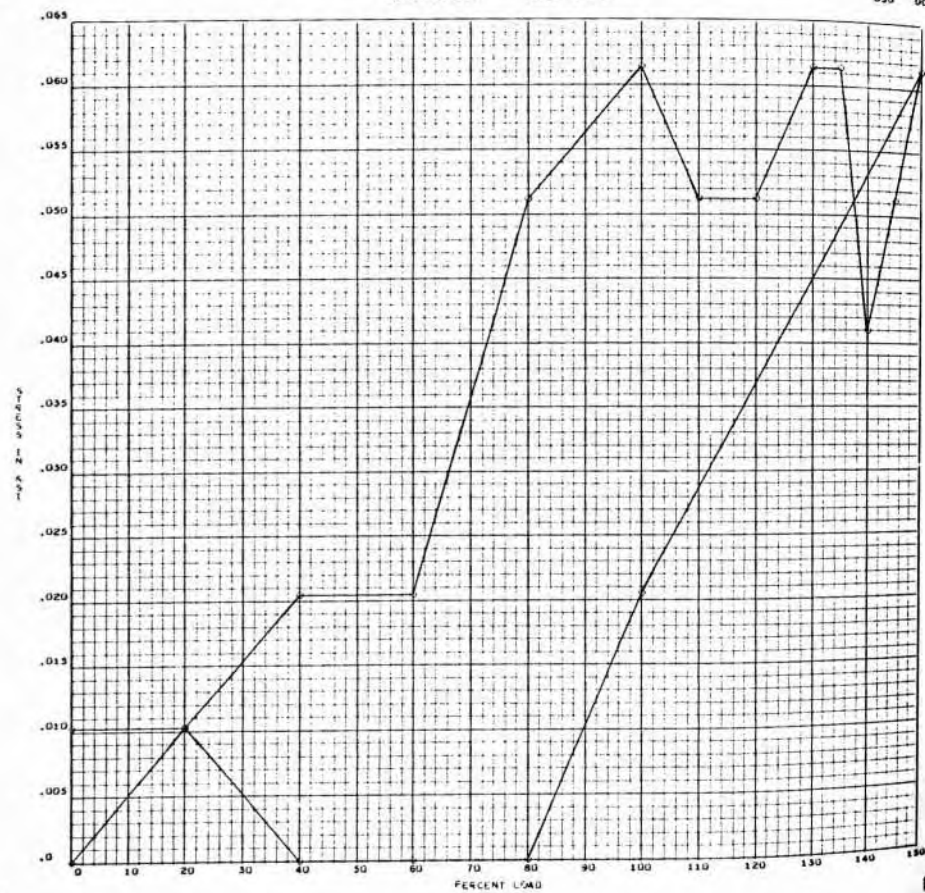


A-300

SID 67-317

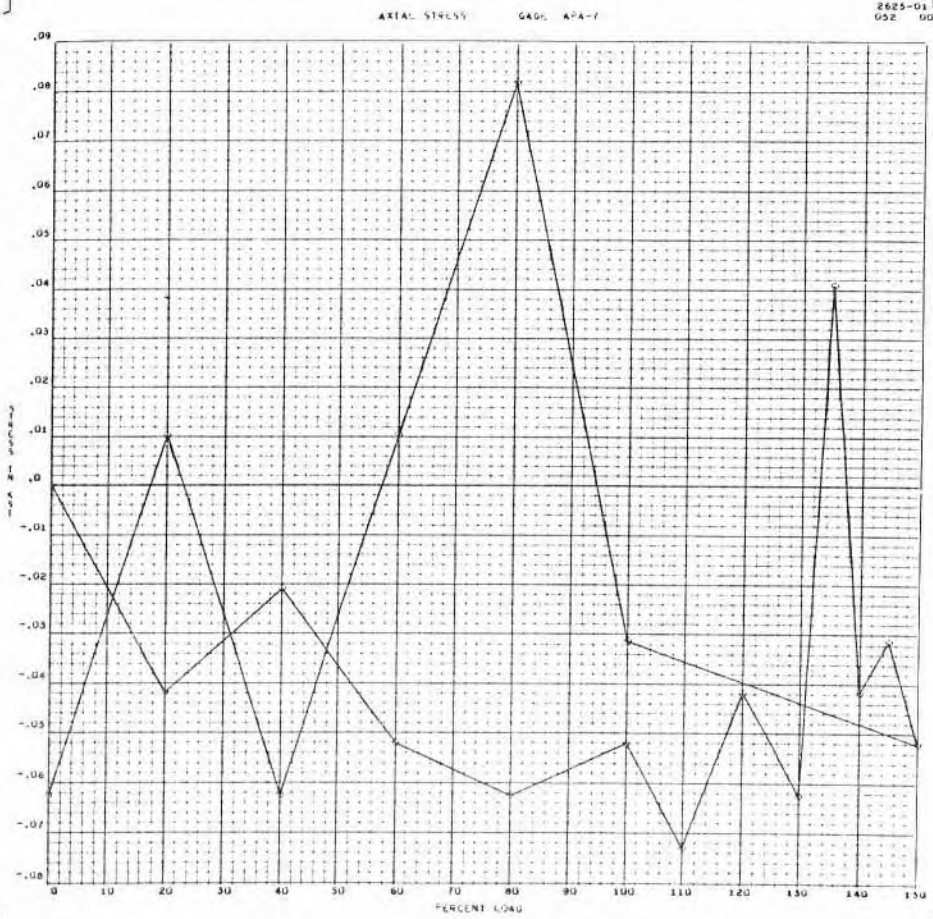
AXIAL STRESS GAGE AFA-3

2625-01  
050 000



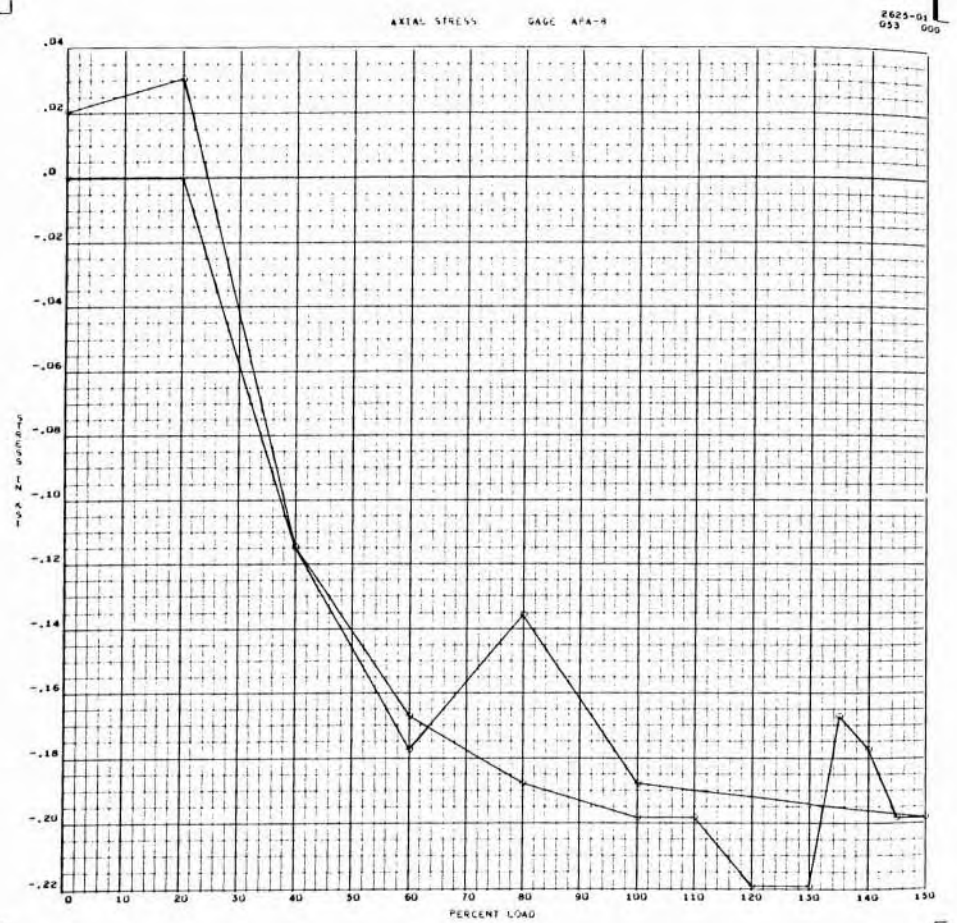
A-370

SID 67-317



A-371

SID 67-317

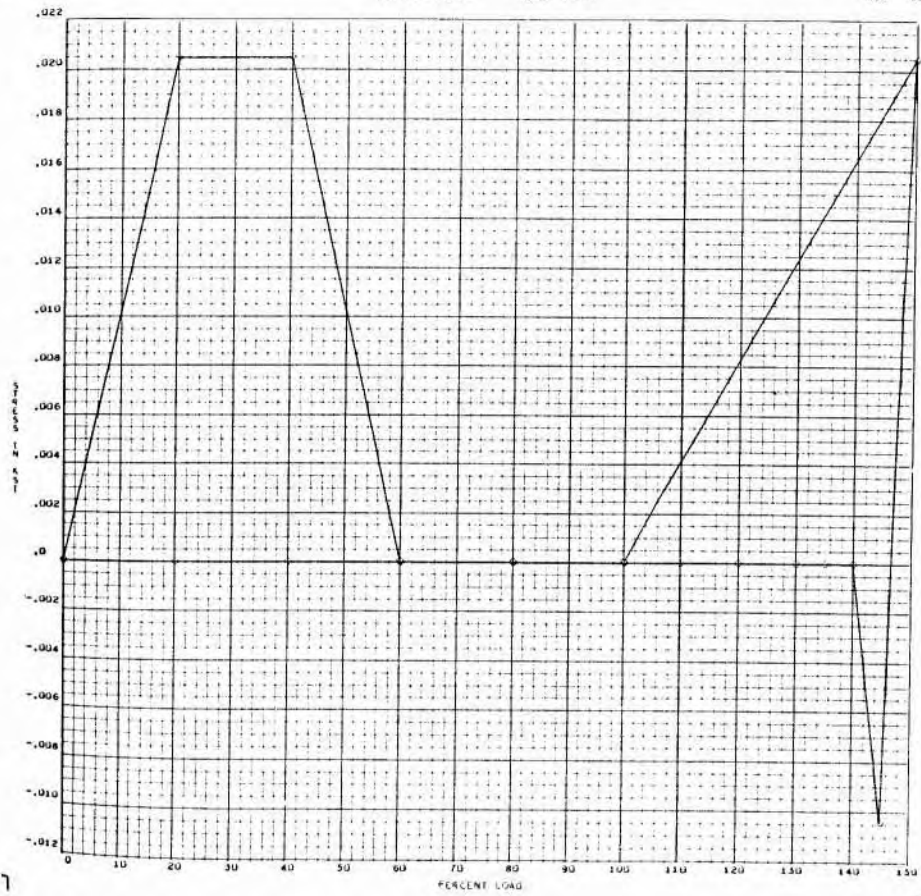


A-372

SID 67-317

AXIAL STRESS GAGE GFA-1

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054 000

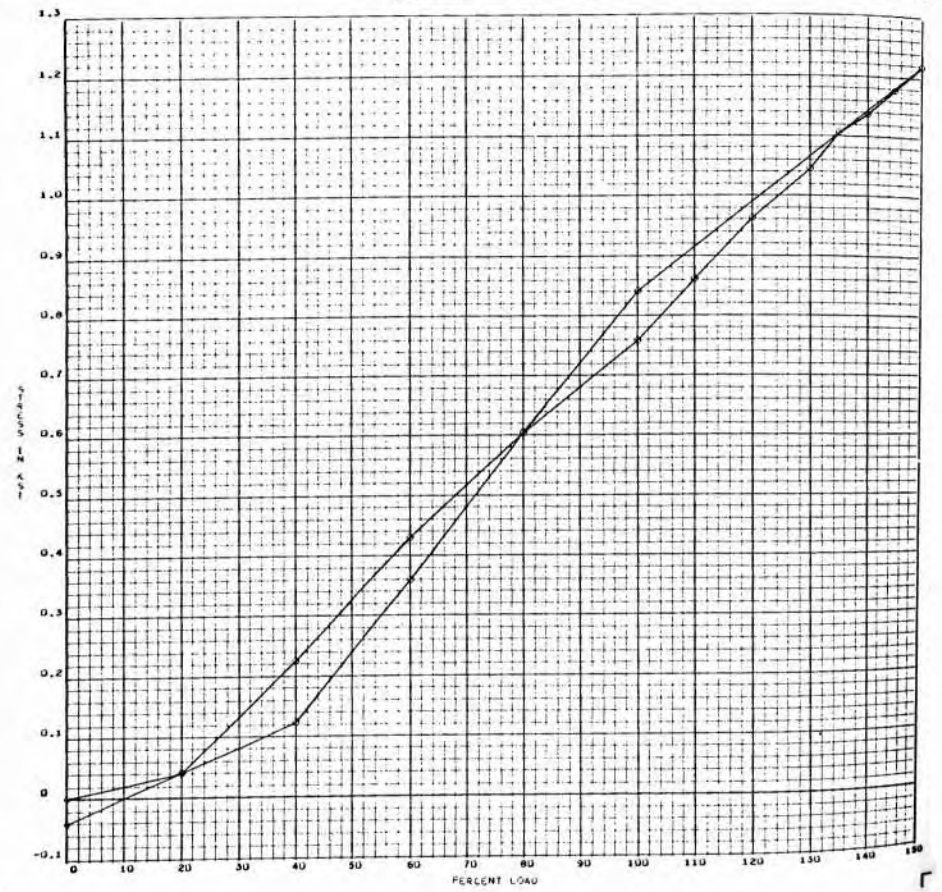


A-373

SID 67-317

AXIAL STRESS GAGE GFA-2

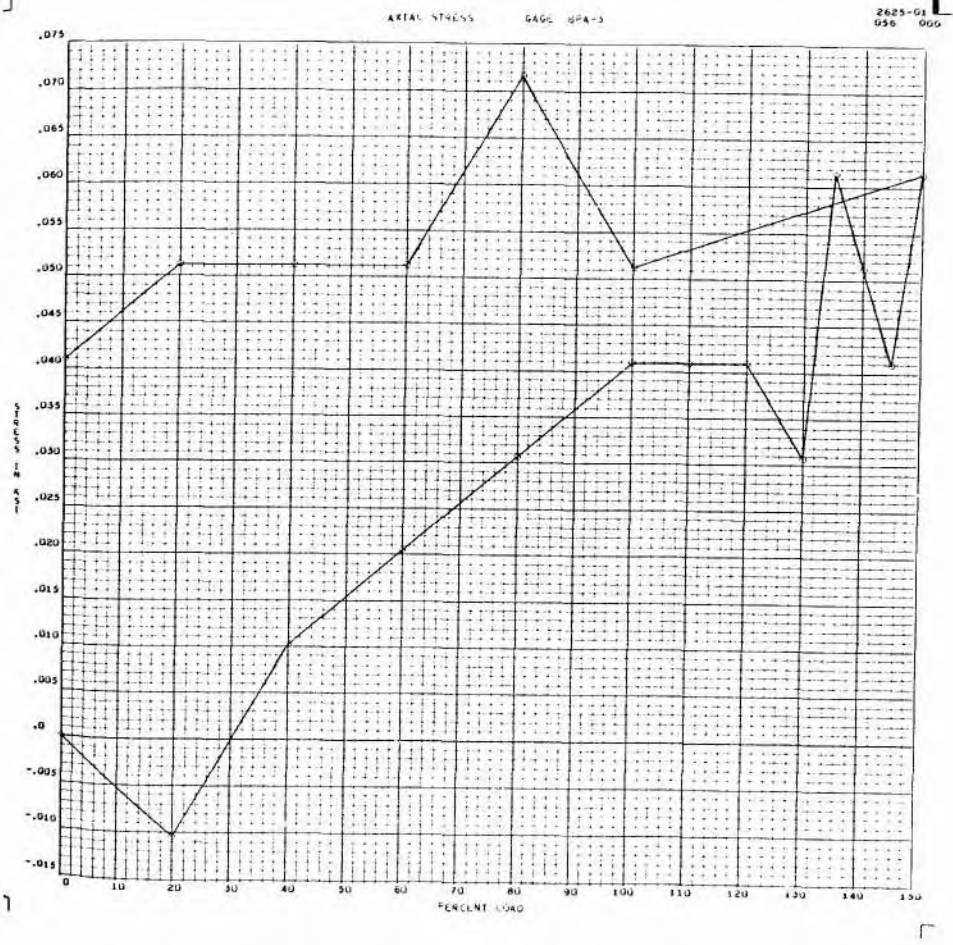
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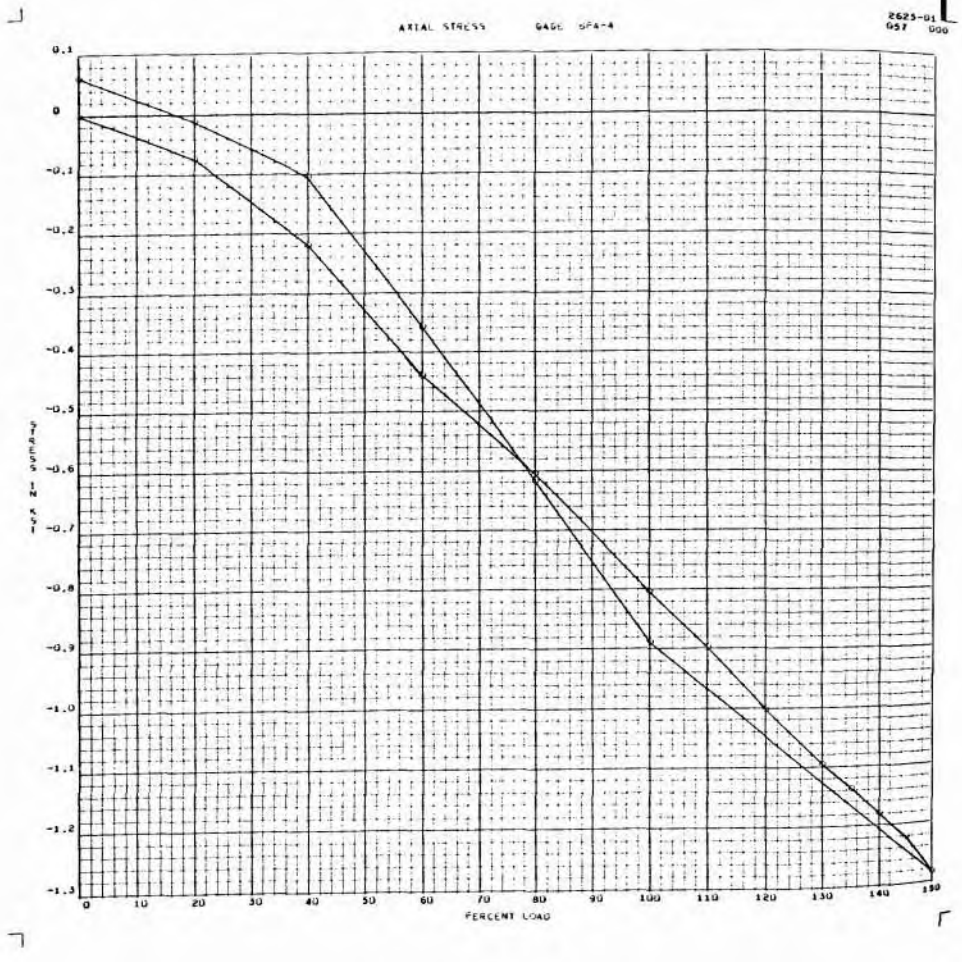
A-374

SID 67-317





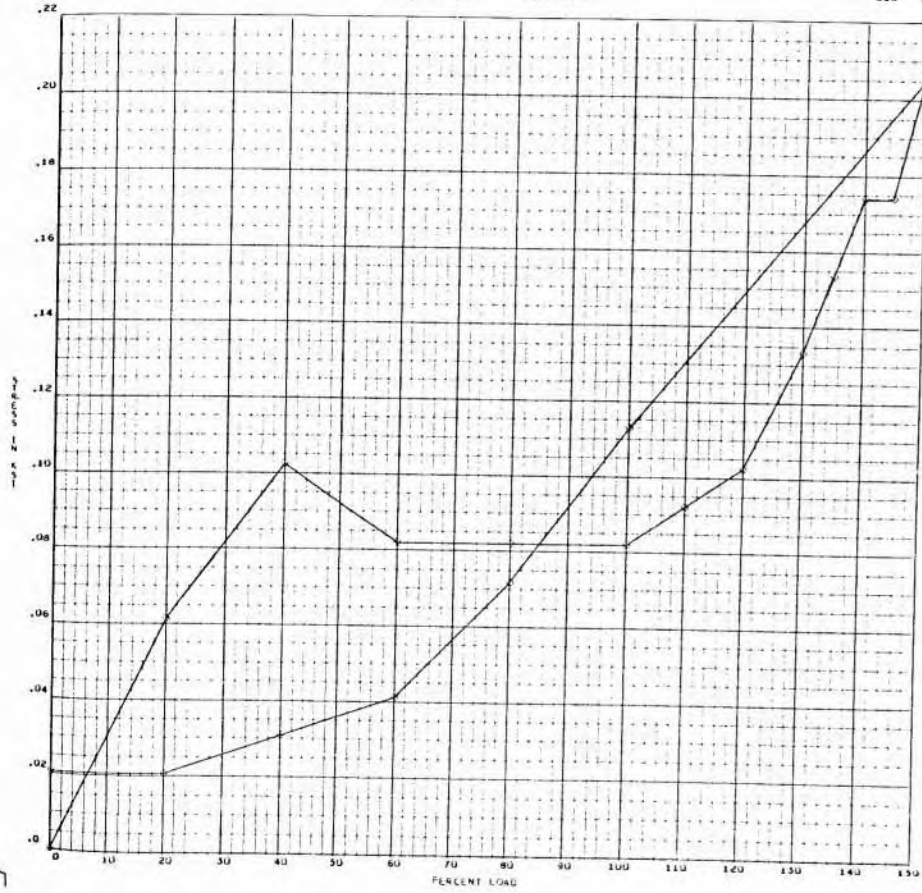
A-375      SID 67-317



A-376      SID 67-317

AXIAL STRESS GAGE GFA-3

2625-01  
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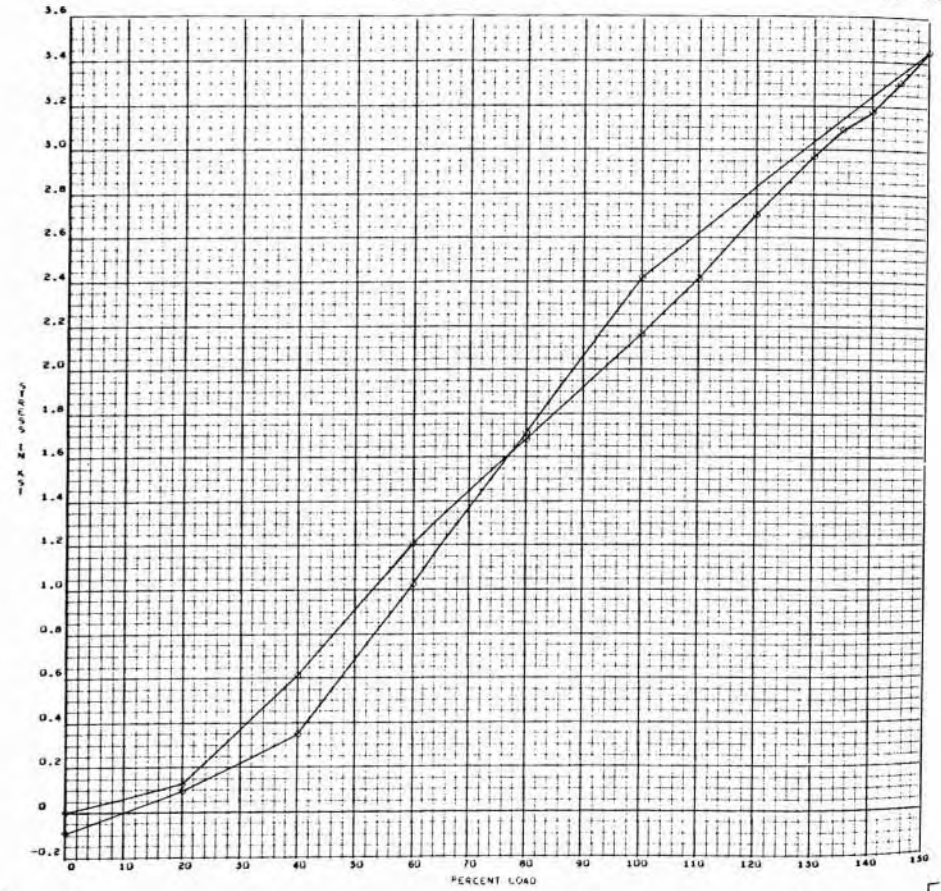


A-377

SID 67-317

AXIAL STRESS GAGE GFA-6

2625-01  
059 000

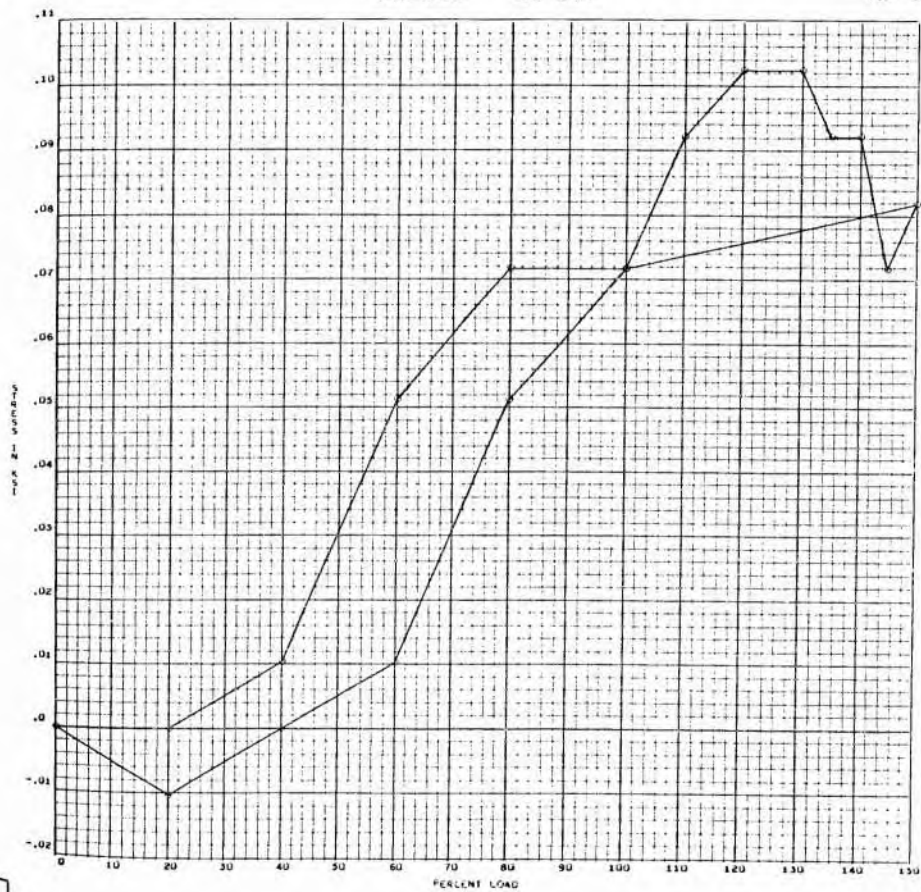


A-378

SID 67-317

AXIAL STRESS GAGE SPA-7

2625-01  
060 000

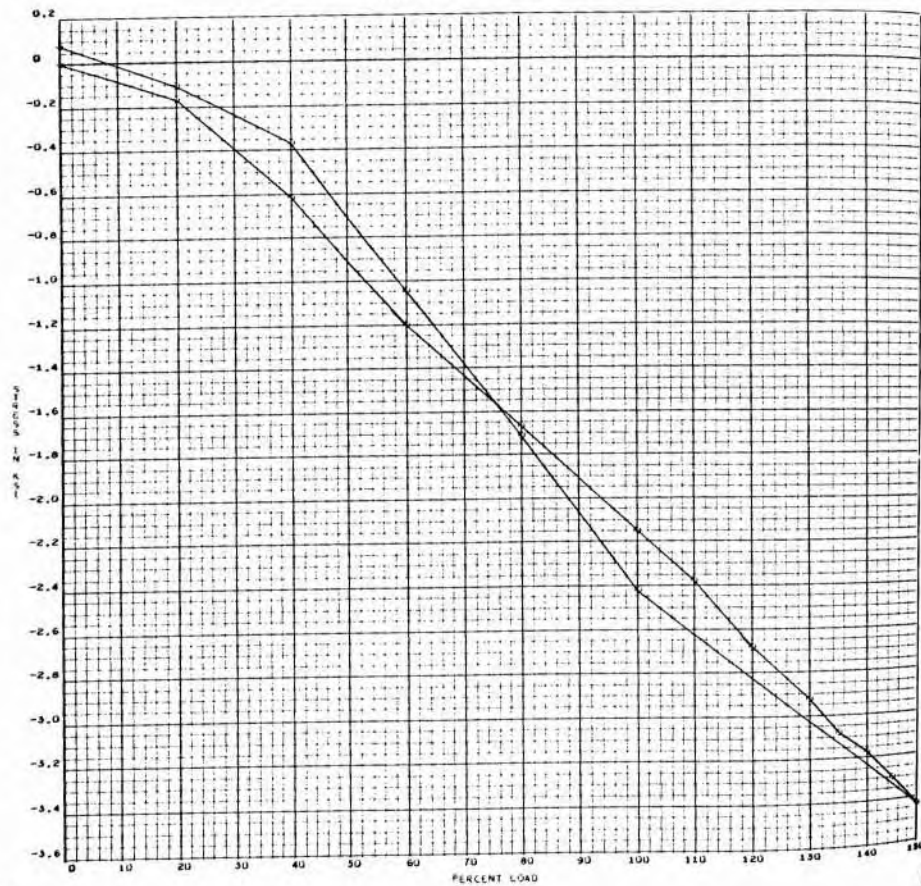


A-379

SID 67-317

AXIAL STRESS GAGE SPA-7

2625-01  
061 000

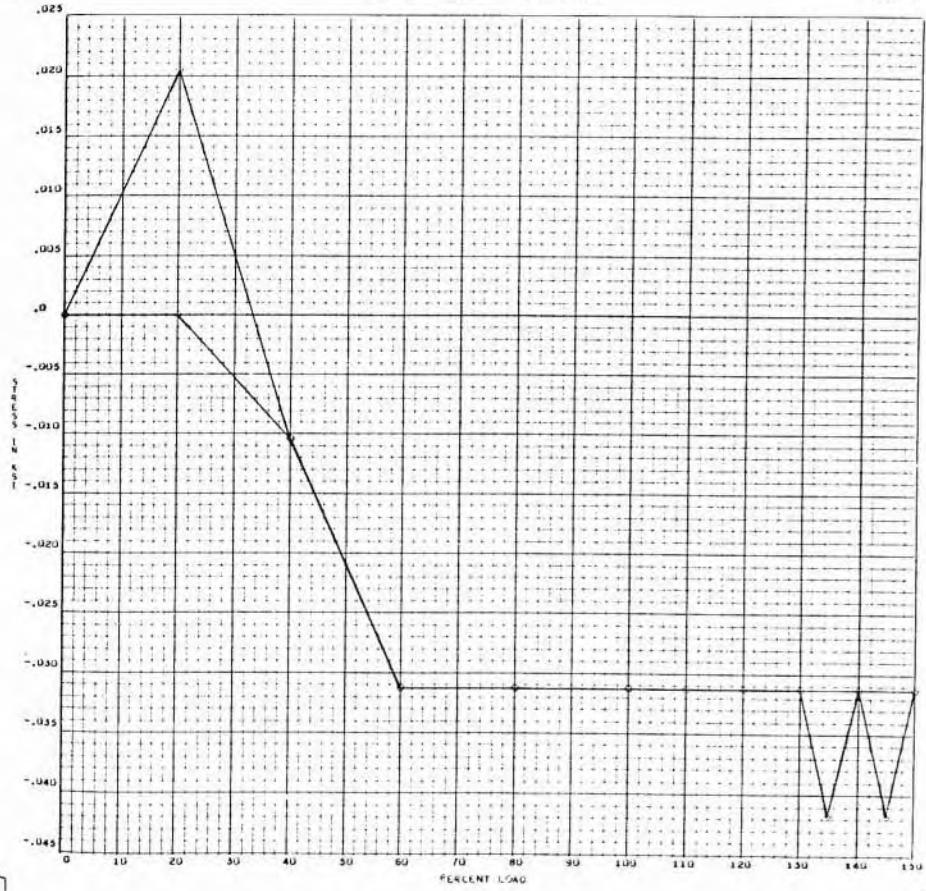


A-380

SID 67-317

AXIAL STRESS GAGE LCPA-1

2625-01  
062 000

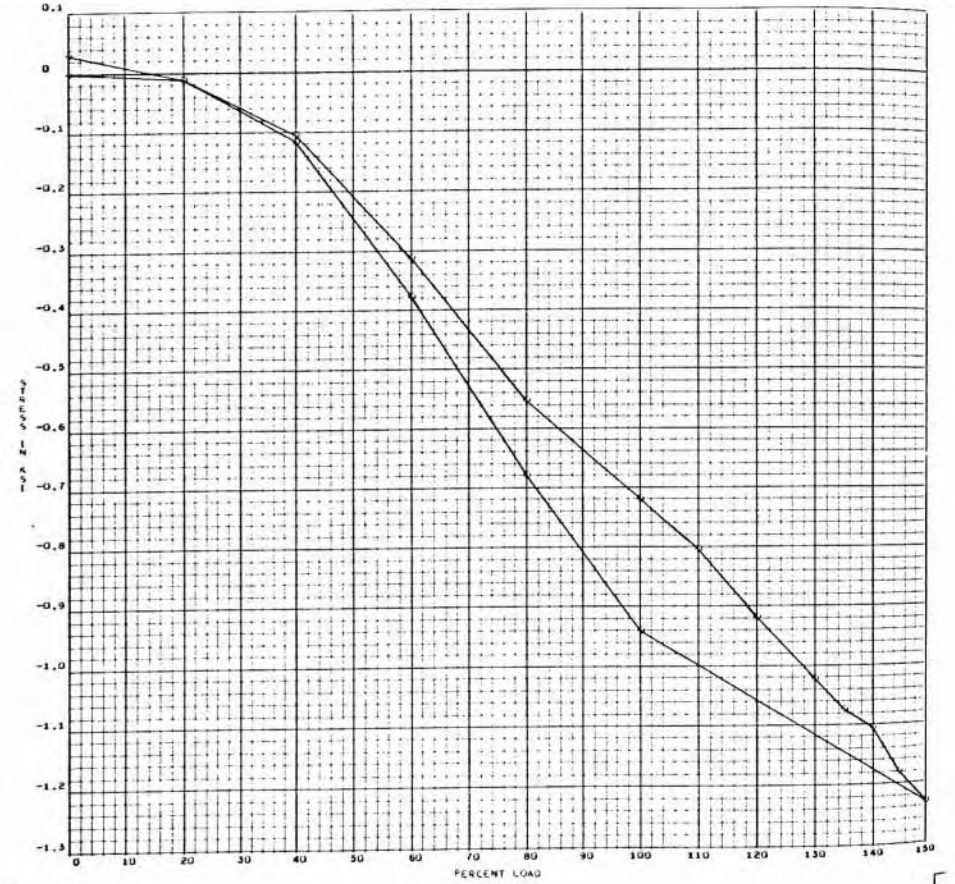


A-381

SID 67-317

AXIAL STRESS GAGE LCPA-2

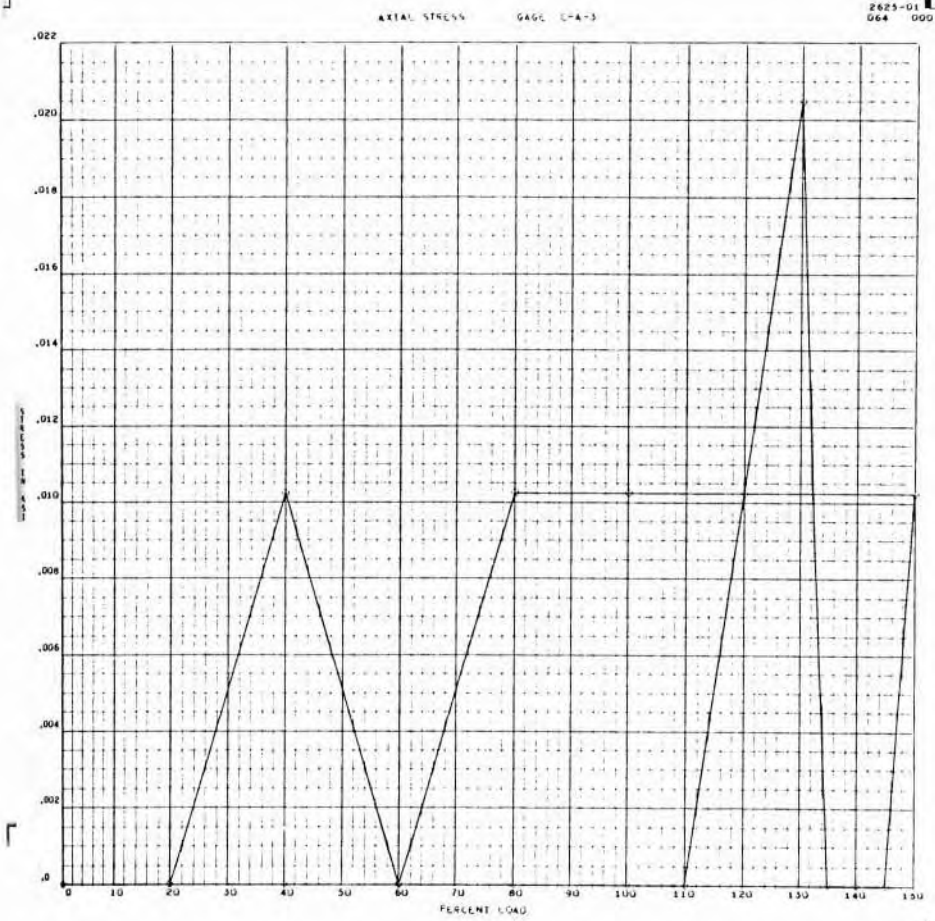
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063 000



A-382

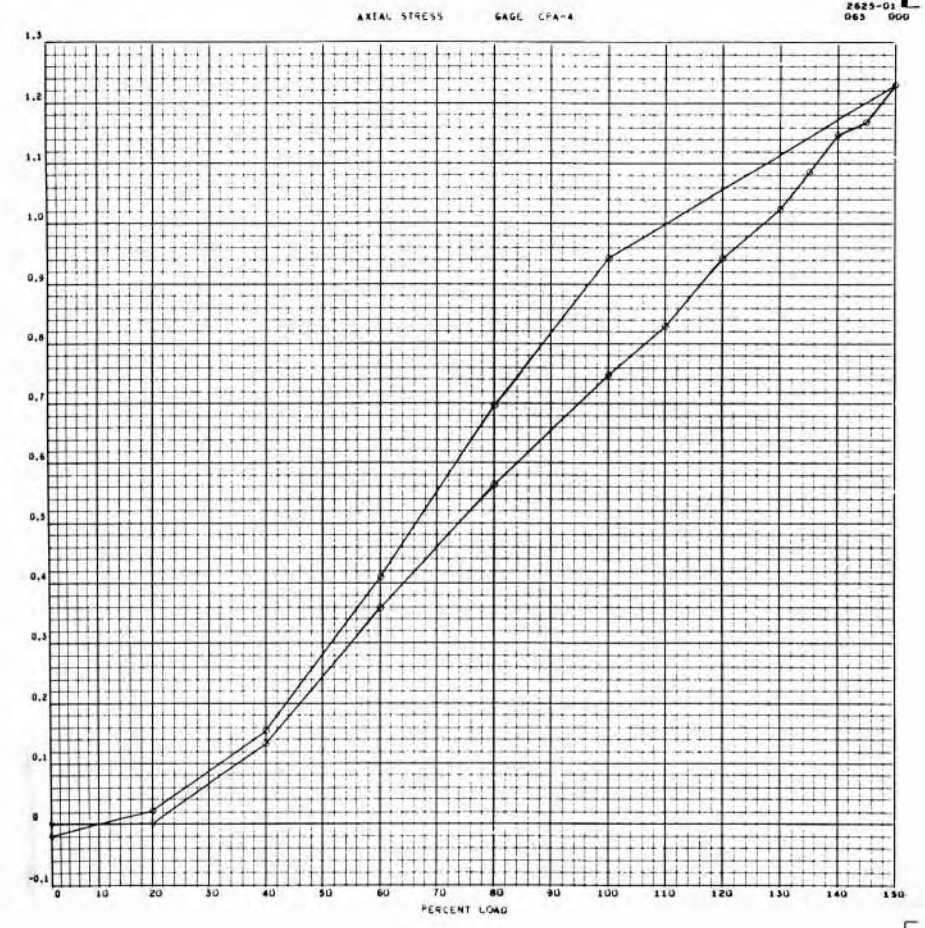
SID 67-317





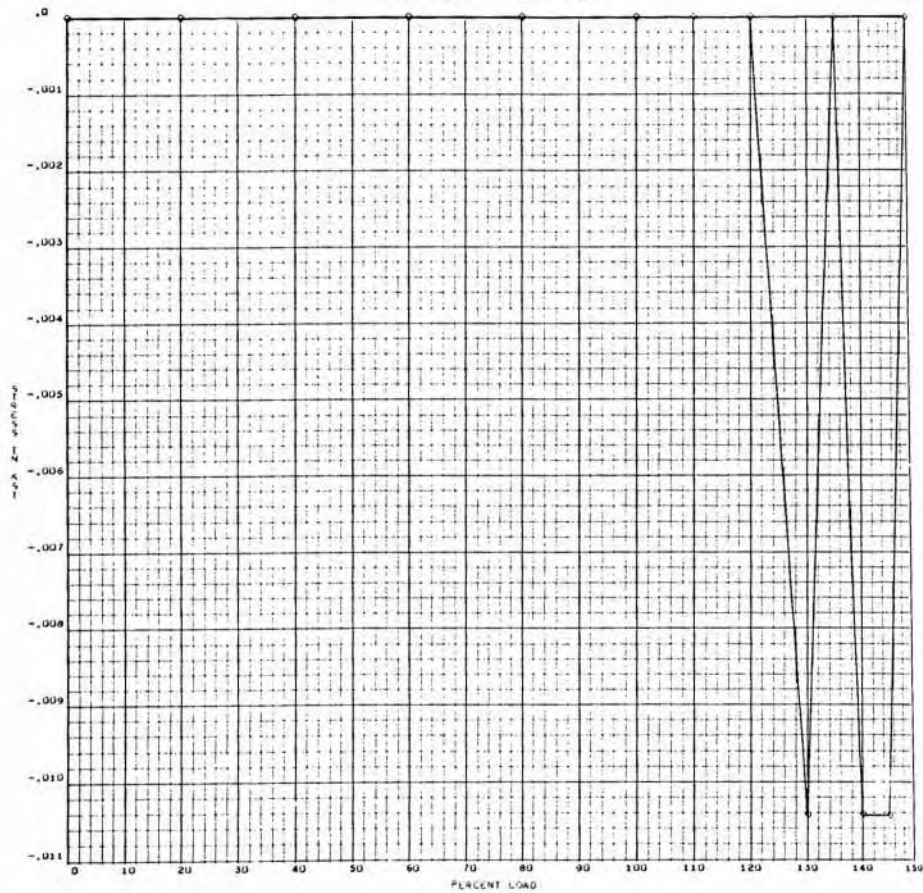
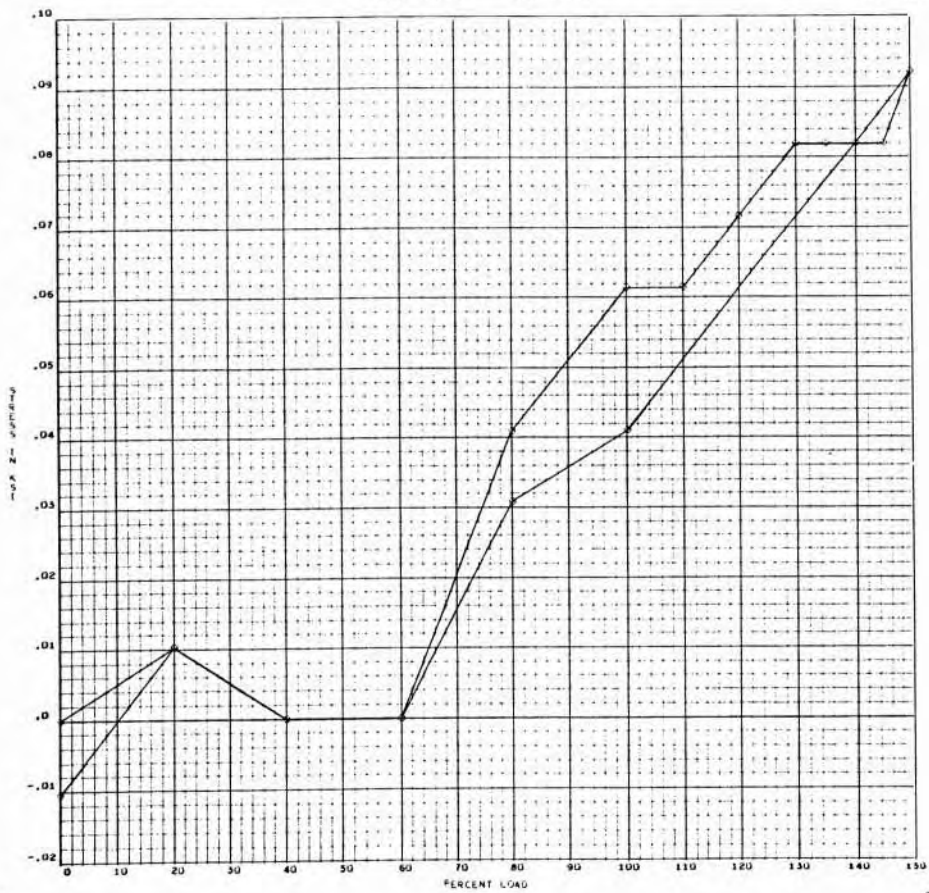
A-383

SID 67-317



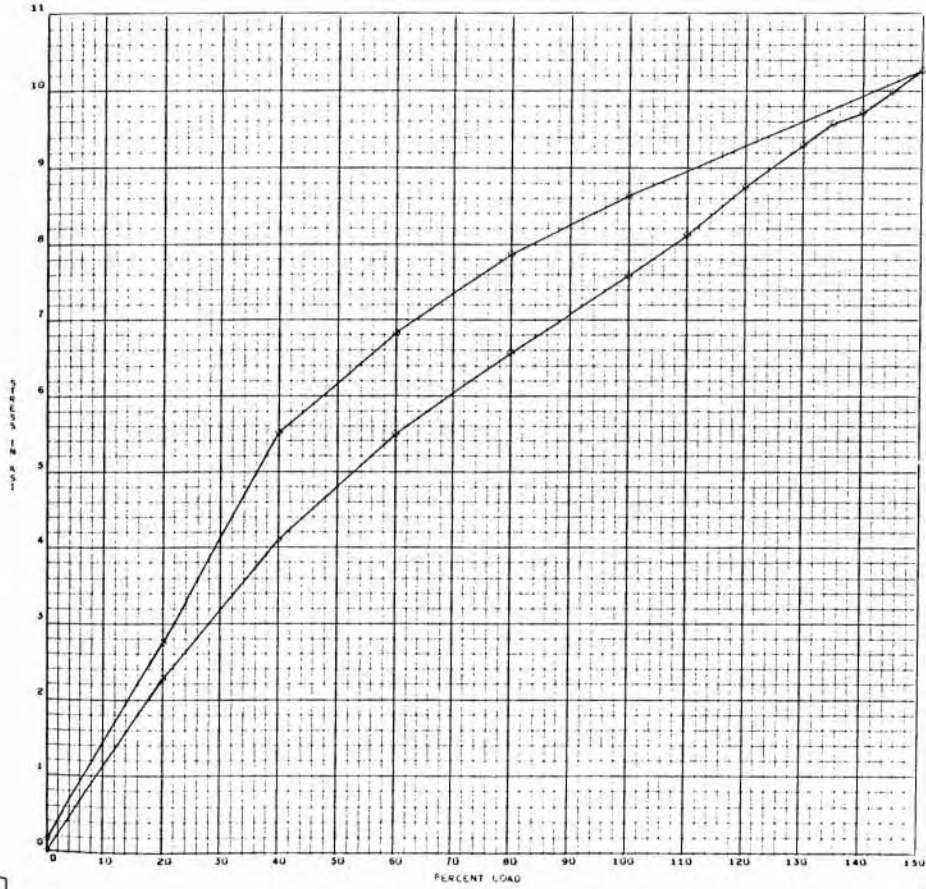
A-384

SID 67-317



AXIAL STRESS GAGE AP58-1

2625-01  
070 000

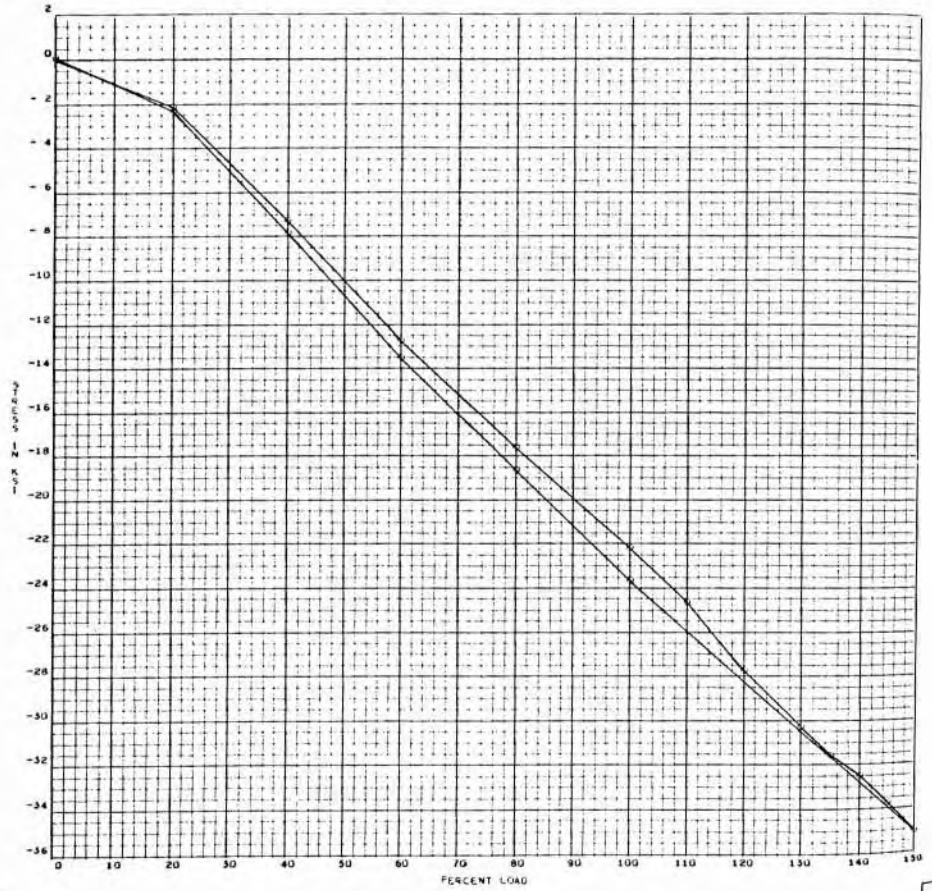


A-387

SID 67-317

AXIAL STRESS GAGE AP58-2

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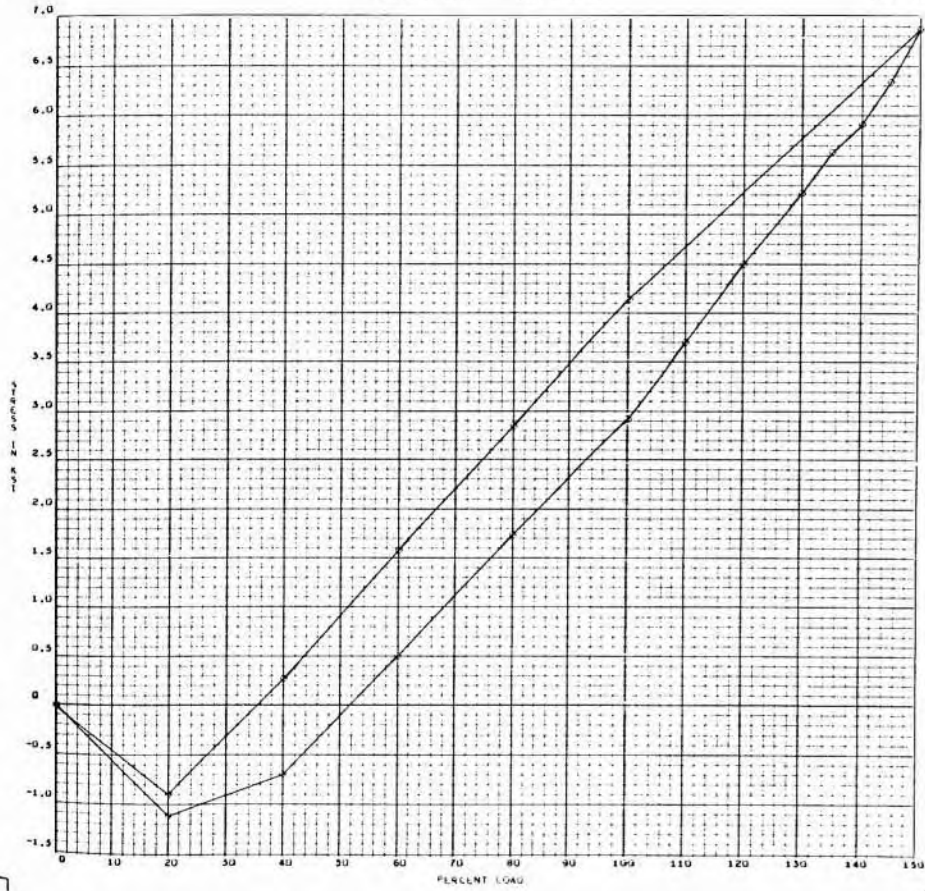


A-388

SID 67-317

AXIAL STRESS GAGE AP50-3

2625-01  
072 090

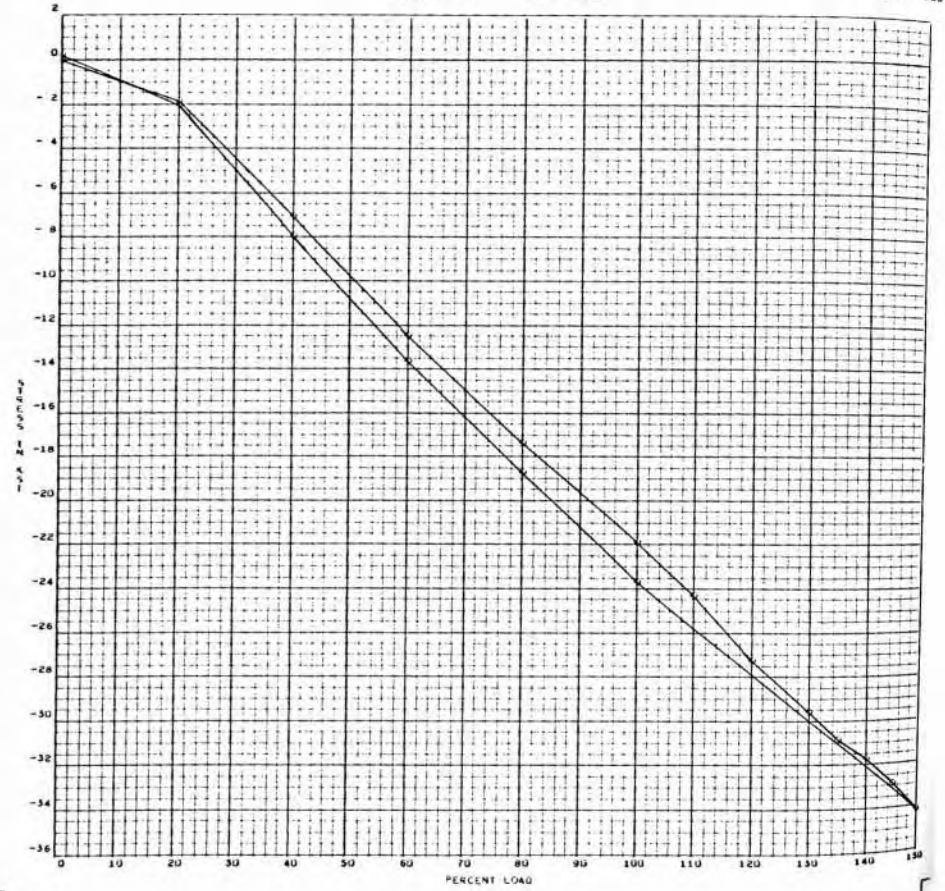


A-389

SID 67-317

AXIAL STRESS GAGE AP50-4

2625-01  
073 090



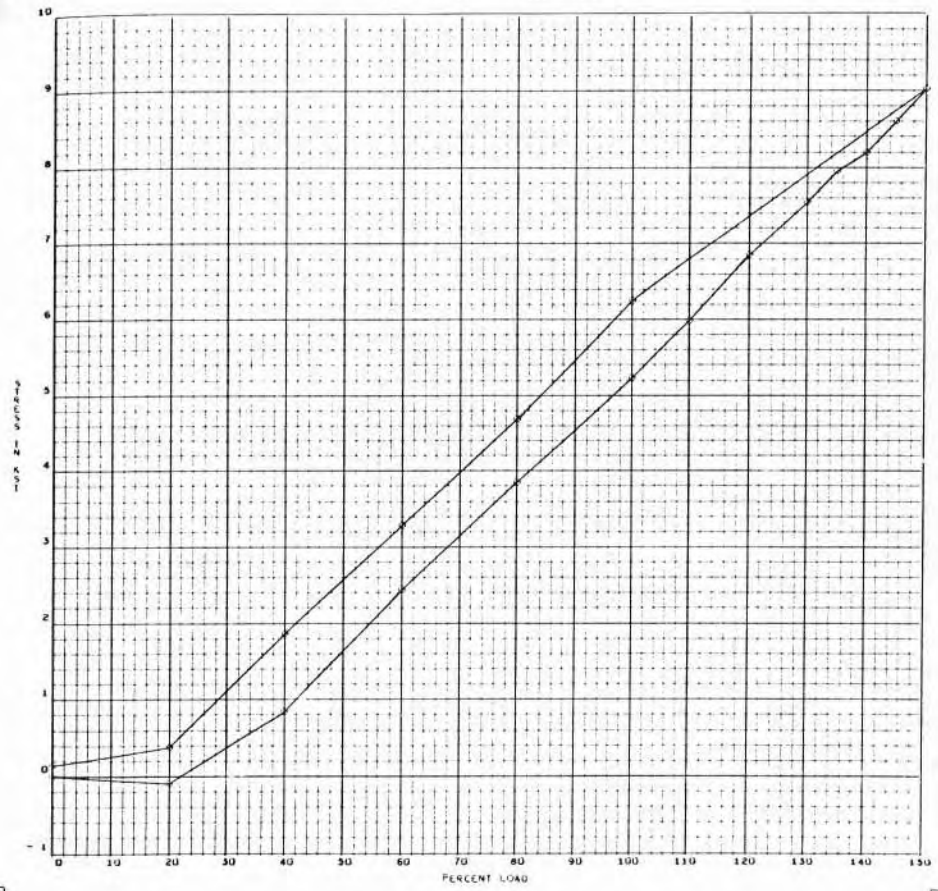
A-390

SID 67-317



AXIAL STRESS GAGE 0F50-1

2625-01  
074 000

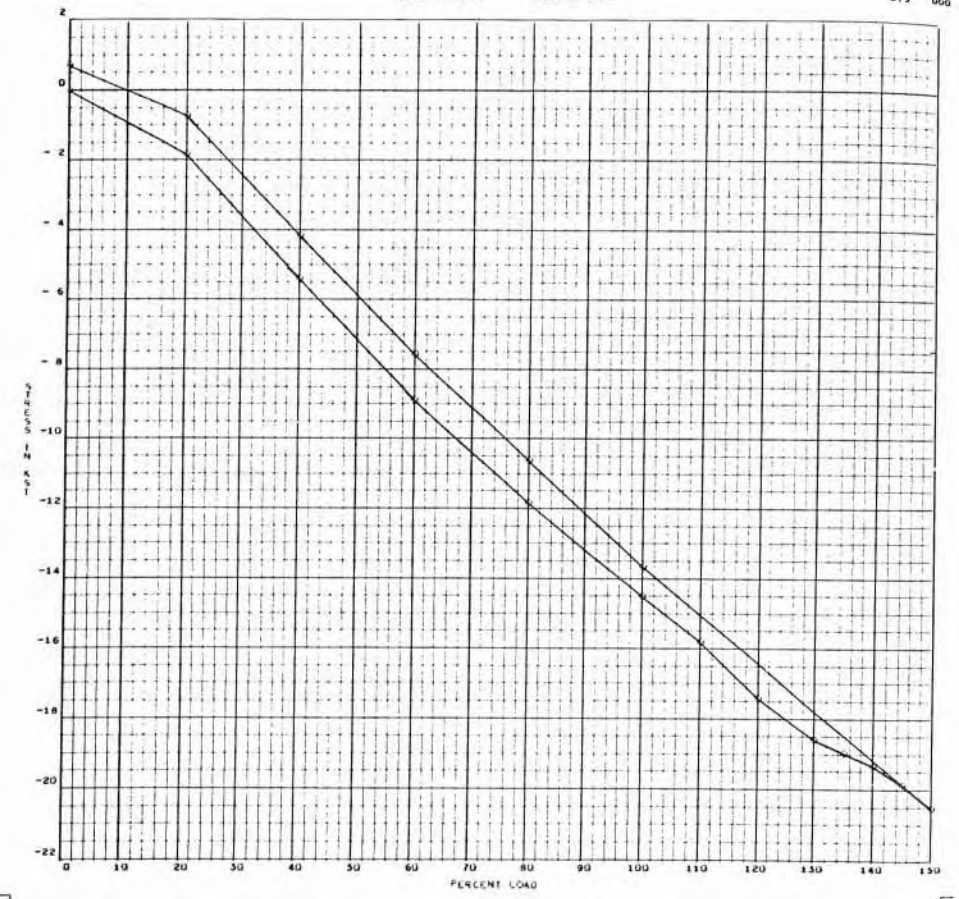


A-391

SID 67-317

AXIAL STRESS GAGE 0F50-2

2625-01  
073 000

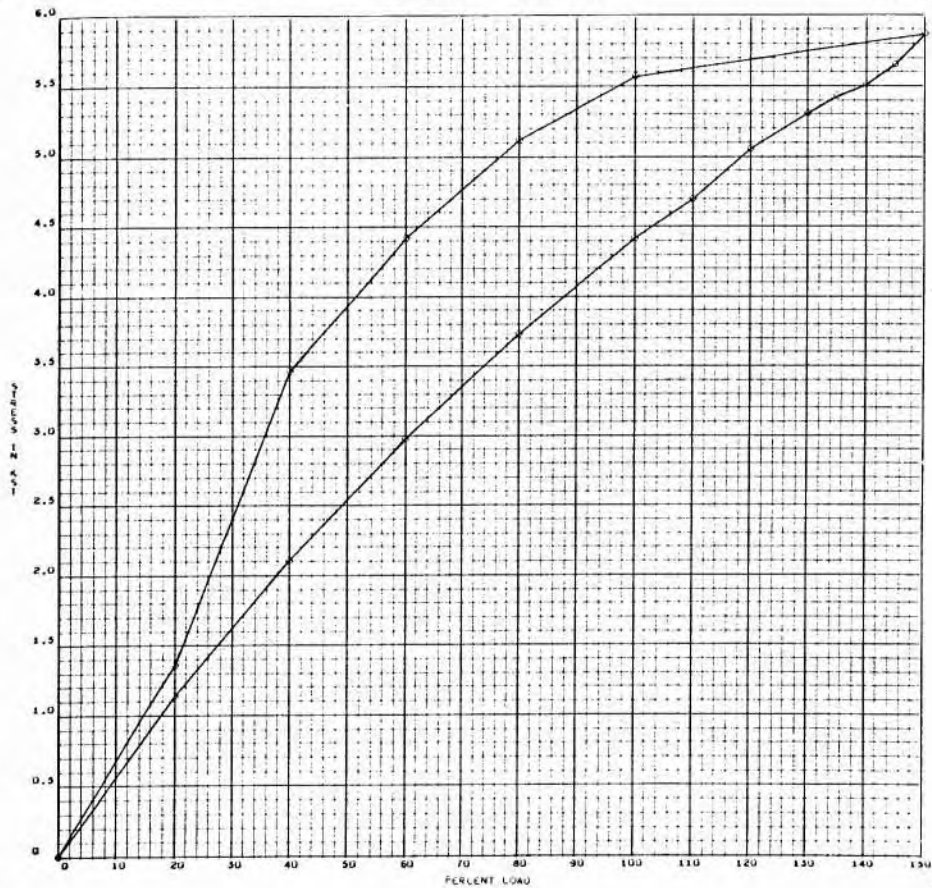


A-392

SID 67-317

AXIAL STRESS GAGE SF50-3

2625-01  
076 000

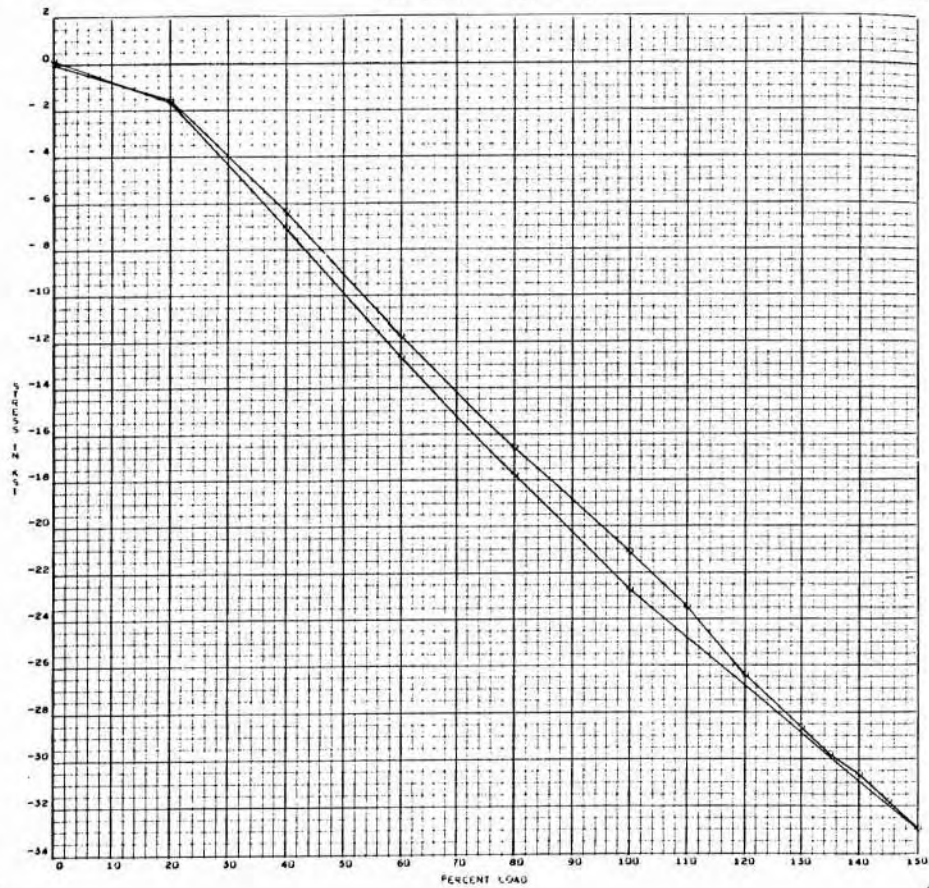


A-393

SID 67-317

AXIAL STRESS GAGE SF50-4

2625-01  
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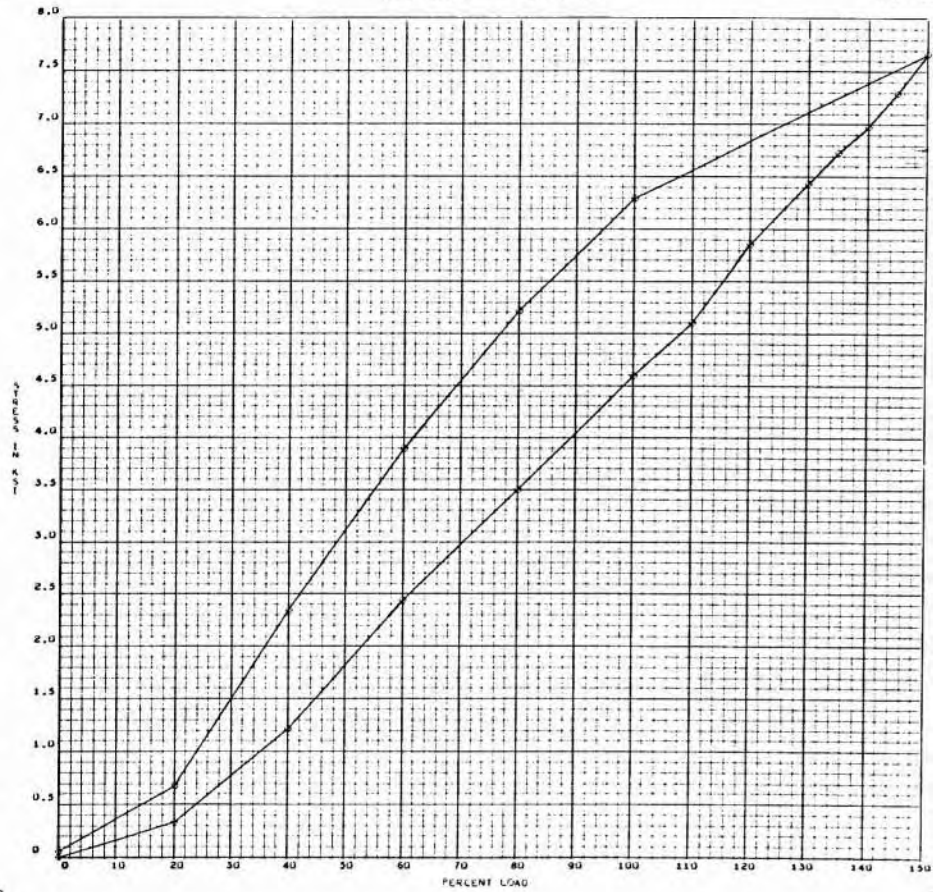


A-394

SID 67-317

AXIAL STRESS GAGE CP50-1

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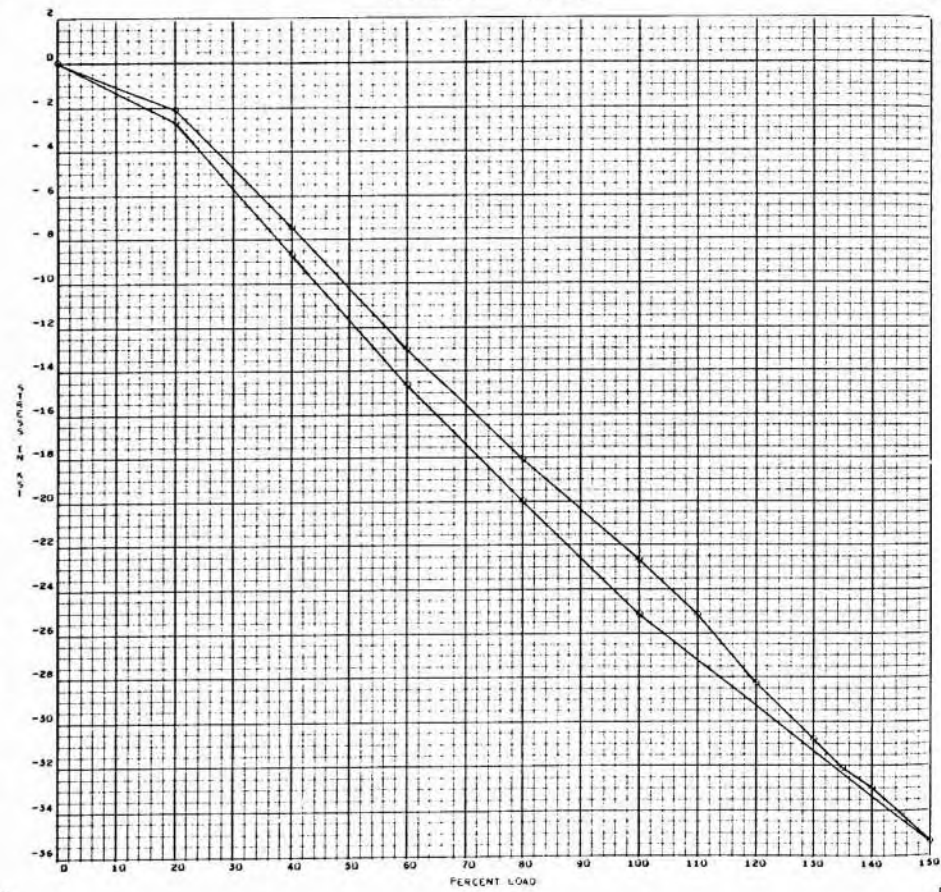


A-395

SID 67-317

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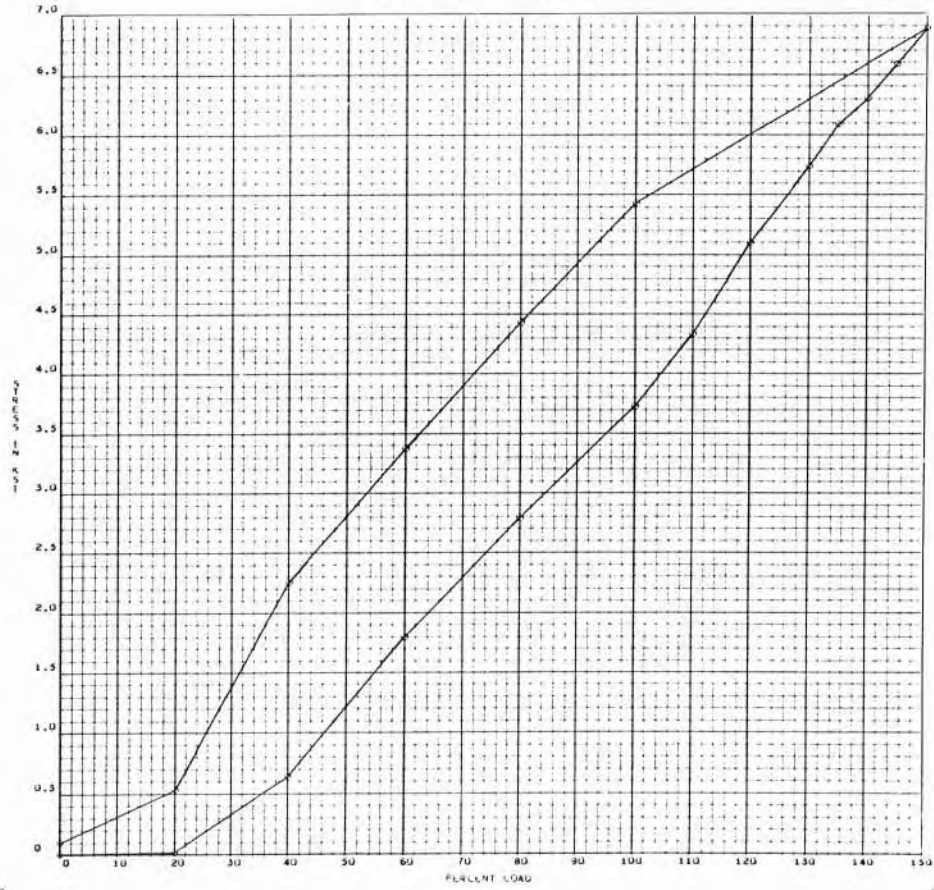


A-396

SID 67-317

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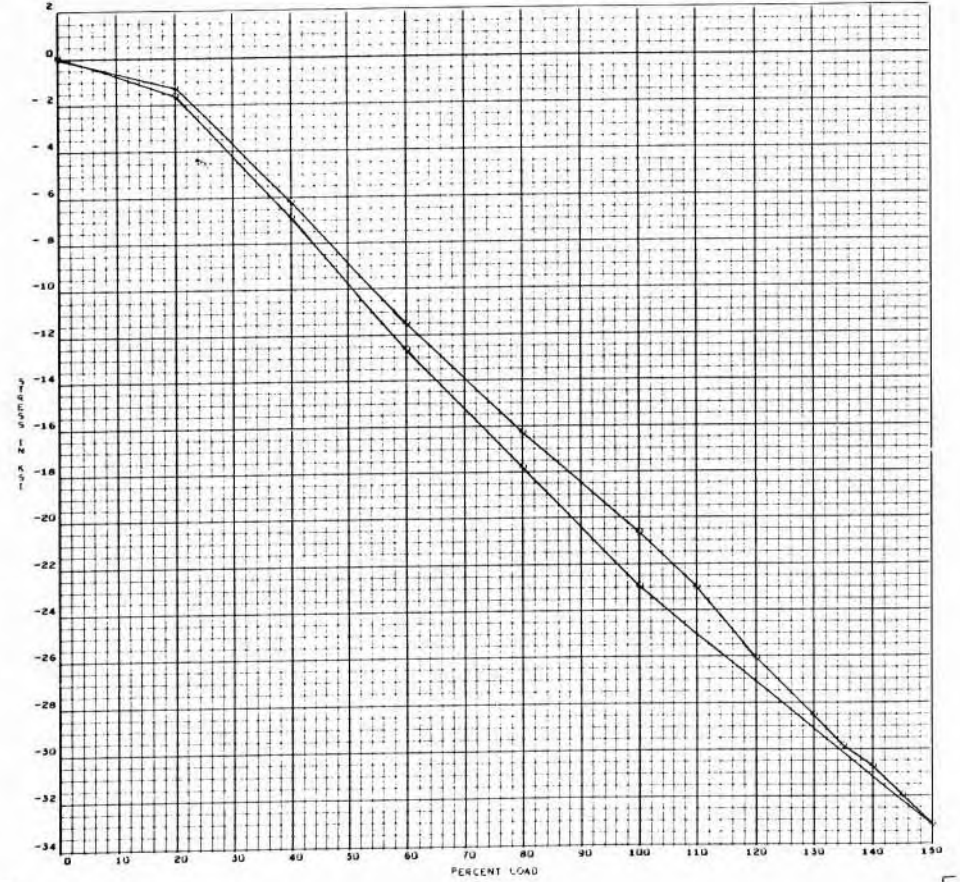


A-397

SID 67-317

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081 000



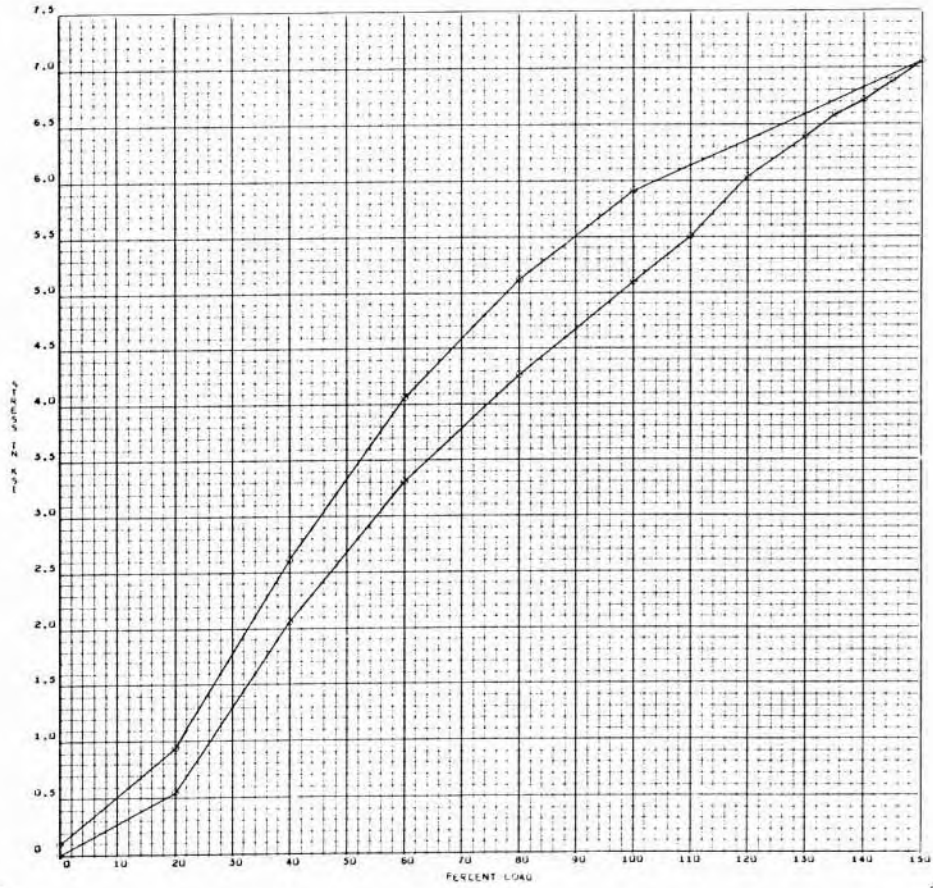
A-398

SID 67-317



AXIAL STRESS GAGE CP-1

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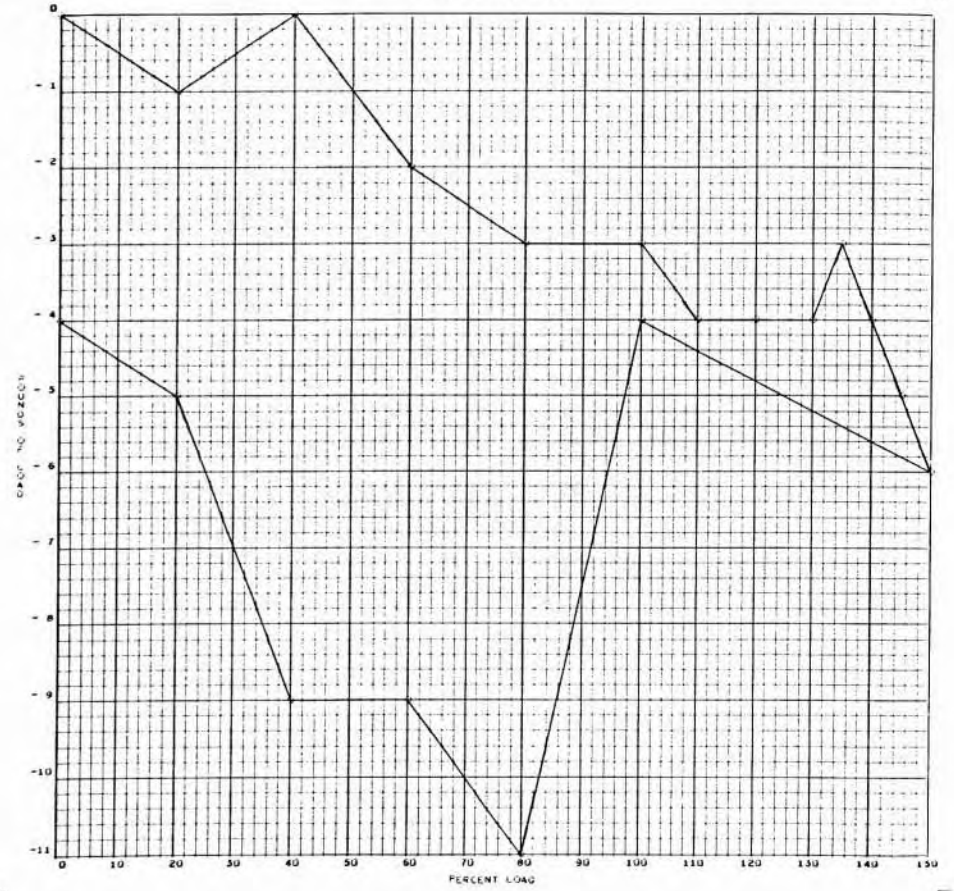


A-399

SID 67-317

LOAD NUMBER GA-1

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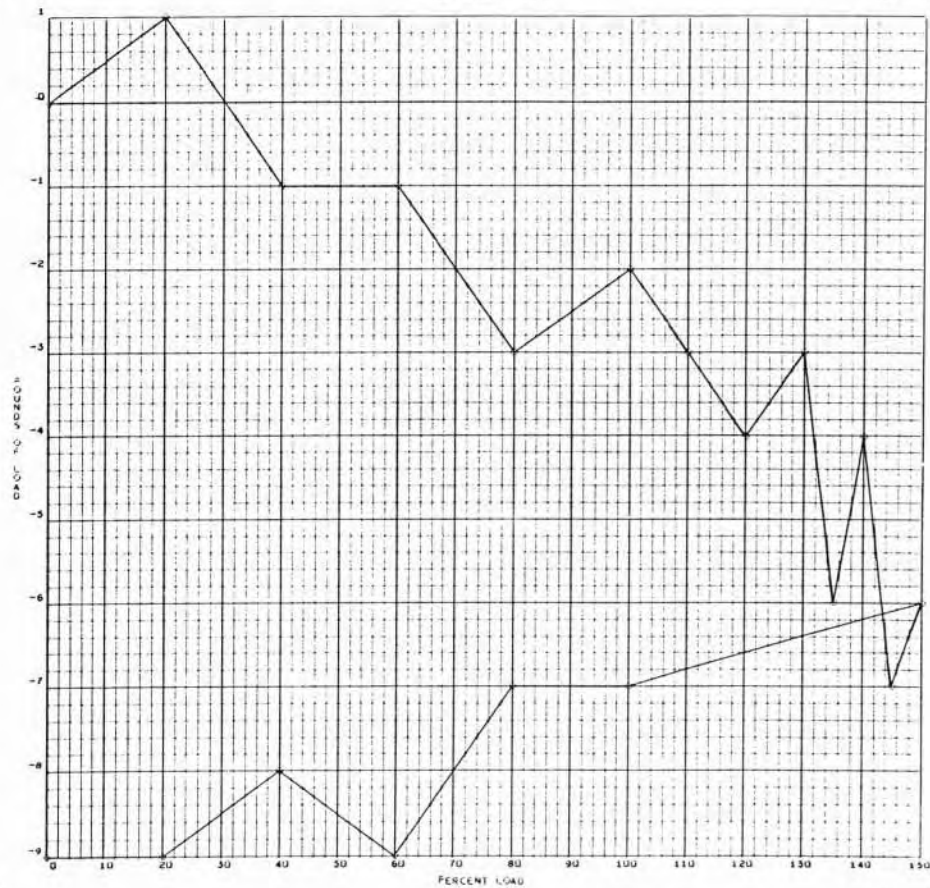


A-400

SID 67-317

LOAD NUMBER 0A-2

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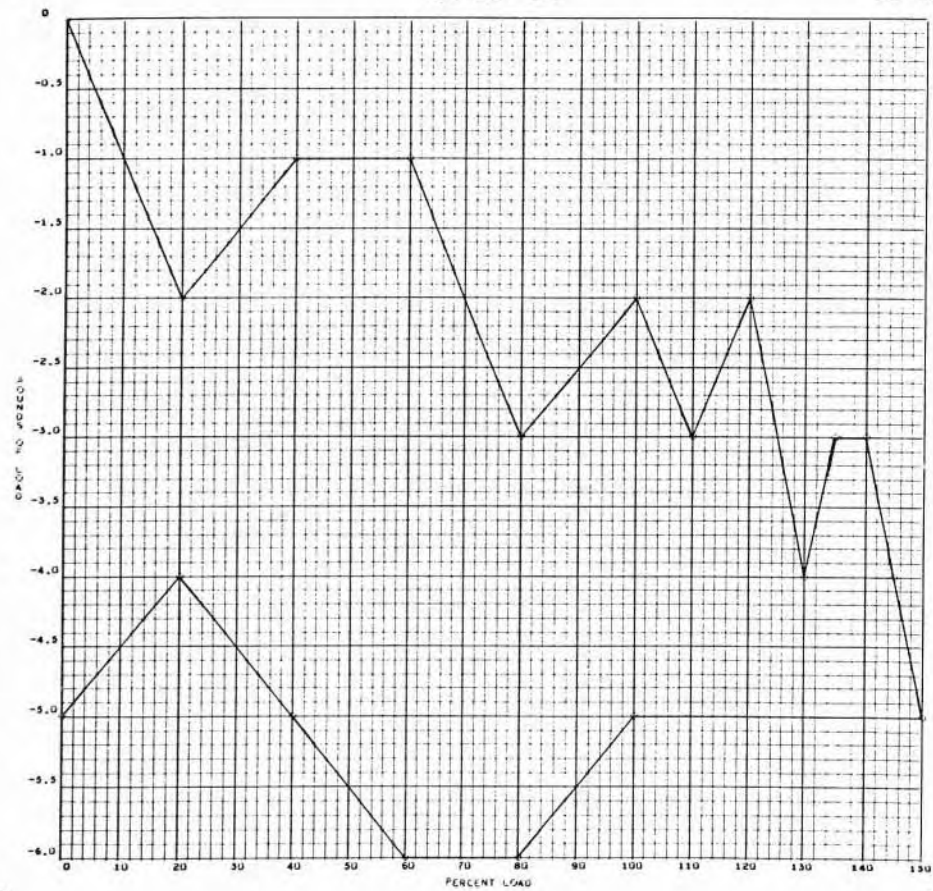


A-401

SID 67-317

LOAD NUMBER 0A-3

2625-01  
089 000



A-402

SID 67-317

1. What is the stability & performance of the suspension system for each fuel loading condition?

2. ~~Are~~ Is there any data from the Vibration test ~~that~~ that may indicate the model frequencies to be expected?

Tam  
Madden

3. What's status of NASA Langley Suspension system?

4. Who's going to write the Test Report?

$$a_1 = 1965$$

$$b_1 = -7150$$

$$ab_1 = \frac{-164}{.035} = -4690$$

$$a_1 = \frac{834 + 4690}{469} = 11.1$$

$$1303$$

b.

*[Handwritten scribbles and a large arrow pointing downwards]*

*[Handwritten scribbles]*



Note: Missing Page No. A-139.