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1 st Review Date 2/15/98 Authority: ADD Name: <i>W. C. Payne</i>	2 nd Review Date 7/20/98 Authority: ADD Name: <i>W. C. Payne</i>	Determination (UCR) Number: 1. Classification Retained to <i>UNCL</i> 2. Classification Changed to 3. Contains No DOE Classified Information 4. Coordinates With 5. Contains UCAI? 6. Comments: <i>Deletable</i>
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NOV 9 1966
 Case No. 706.00
 Ref. Sym: 1612 (375)
 Project No. TM-441
 File: XW-27, 3-2

RECEIVED

NOV 13 1966

R & D FILES

MR. W. J. DENISON - 1216

Attn: Mr. T. P. Krein - 1216-1

Re: Centrifuge Test of the XW-27/Regulus

CRI No. PROJECT NUMBER FILE NO. <i>16-27 Reg</i> <i>3-2</i>	<i>Bm</i>
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Summary of Results

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A centrifuge test has been conducted to subject an XW-27/Regulus warhead section, with a dummy warhead, to loads of 115 per cent and 150 per cent of its design limit load with the loads applied in one direction longitudinally and in two directions vertically.

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The maximum stress measured during the longitudinal loading to 150 per cent design limit load was 20,800 psi tension, measured on the aft surface of the right longeron adaptor. The maximum stress measured during the vertical loading to 140 per cent design limit load in which the load was applied upward with respect to the weapon in its normal flight orientation was 7,180 psi tension, measured on the aft surface of the top longeron adaptor. The maximum stress measured during the vertical loading to 143 per cent design limit load in which the load was applied downward with respect to the weapon in its normal flight orientation was 9,230 psi compression, measured on the aft surface of the top longeron adaptor.

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The acceleration switch and timer operation was monitored and found to operate satisfactorily.

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The XW-27/Regulus fusing system was checked and found to operate satisfactorily after the longitudinal loading and again after the vertical loadings.

No structural failures were noted during the test.

Object of Test

The object of this test was to subject a dummy XW-27/Regulus warhead section to loads of 115 per cent and 150 per cent of its design limit load with the loads applied in one direction longitudinally and in two directions vertically. It was also the object of this test to measure strains on the structural members of the warhead and during the longitudinal loading to monitor the operation of the acceleration switches and timers.

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CLASSIFICATION CHANGED TO: <i>U</i> <i>Emilda, Search 7/20/98</i> PERSON CHANGING MARKING & DATE <i>W. C. Payne 7/22/98</i> PERSON VERIFYING MARKING & DATE	AUTHORITY: <i>W. C. Payne</i> RECORD ID: <i>98SN3052</i> DATED: <i>7/20/98</i>

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NOV 8 1956

Ref. Sym: 1612 (375)
Project No. TM-441

Mr. W. J. Denison - 1216

-2-

Reason for Test

This test was requested in a Work Order Authorization from J. W. Jones, 1214 to P. H. Adams, 1612, dated February 20, 1956.

Summary of Past Tests

A previous static test of the XW-27/Regulus has been conducted by Department 1610. The results of the test are reported in a memorandum entitled, Static Test of XW-27/Regulus, Ref. Sym: 1612 (324), TM-390, dated November 2, 1956. During the static test the XW-27/Regulus and its centrifuge jig were tested under the following three different loading conditions; longitudinal (aft), vertical (+) and vertical (-). The vertical (+) up and vertical (-) down load is relative to the weapon orientation in normal flight.

The maximum principal stress as computed from observed strain data and at 200 per cent design limit load on the warhead only for the longitudinal loading condition was 24,500 psi tension and was near a bolt connecting the longeron adaptor assembly to the warhead mounting assembly.

The maximum principal stress at 200 per cent design limit load on the warhead only for the vertical up and down (relative to the normal flight orientation of the weapon) loading conditions was 11,442 psi tension and 12,322 psi compression, respectively. These stresses were also near bolts connecting the longeron adaptors to the warhead mounting assembly.

There was no apparent yielding or failure of the warhead at any of the loading conditions.

Setup for Test

The test setup for the longitudinal loading is as shown in Fig. 1. The test setup for loading the warhead section in the positive vertical direction (accelerated downward with respect to the normal flight orientation of the weapon) is as shown in Fig. 2. The test setup for loading the warhead section in the negative vertical direction (accelerated upward with respect to the normal flight orientation of the weapon) is as shown in Fig. 3.

A tabulation of the components tested is as given in Table I.

The equipment used to perform the test was as follows:

Hydraulic centrifuge
Miller oscillograph, Model J, Serial No. 99
Miller oscillograph, Model H, Serial No. 159

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UNCLASSIFIED

UNCLASSIFIED

NOV 8 1958
Ref. Sym: 1612 (375)
Project No. TM-441

Mr. W. J. Denison - 1216 -3-

- Miller amplifiers, Type C-3, Serial Nos. 3 and 7
- Hathaway amplifiers, Type MRC-21, Serial No. 5492-1
- Hathaway amplifiers, Type MHC-21, Serial No. 5492-2

The test unit was instrumented with biaxial and uniaxial strain gages. The biaxial strain gages were type AX-7, gage factor $1.81 \pm .2$ per cent, gage resistance $120.1 \pm .2$ ohm, Lot No. 175. The two types of uniaxial strain gages used are as follows: Type A-7, gage factor $1.90 \pm .2$ per cent, gage resistance $120.3 \pm .2$ ohm, Lot No. 211 and Type A-18, gage factor $1.61 \pm .2$ per cent, gage resistance $119.8 \pm .2$ ohm, Lot No. 132. The biaxial, AX-7, strain gages used and their number and location are as shown in Figs. 4, 5, and 6. The uniaxial, A-7, strain gages used and their number and location are as shown in Figs. 4, 5, 7, and 8. One type A-18 strain gage was used which was strain gage No. 25, located on the warhead support flange at the keel. A tabulation of the strain gages used is as given in Table II. The strain gage types and their locations were determined on the basis of a Stresscoat test run prior to the static test. The strain gage types, and their locations, used during the centrifuge test were chosen from those strain gages placed on the test unit for the static test.

An accelerometer was mounted on the centrifuge boom, for the longitudinal loading, as shown in Fig. 1 and on the centrifuge adaptor jig, for the vertical loading, as shown in Figs. 2 and 3. The accelerometer used was a Statham, Model A5A-50-240, range ± 50 g, Serial No. 274.

Procedure

The XW-27/Regulus warhead section was attached to the centrifuge as shown in Fig. 1 to apply the load along the longitudinal axis of the warhead section. The centrifuge was then rotated at sufficient angular velocity to apply 115 per cent and 150 per cent design limit load, 59 inches aft of the nose of the test unit. In the longitudinal direction the design limit load is 10.5 g aft.

To apply vertical loads in two directions to the XW-27/Regulus warhead section the test unit was attached to the centrifuge as shown in Figs. 2 and 3. The centrifuge, in both cases, was rotated at sufficient angular velocity to apply 115 per cent and 150 per cent design limit load at the vertical CG of the test unit. In the vertical direction the design limit load is ± 3.5 g.

The operation of the acceleration switches and timers was monitored during the longitudinal loading.

UNCLASSIFIED

NOV 8 1966

Mr. W. J. Denison - 1216

-4-

Ref. Sym: 1612 (375)
Project No. TM-441Results

The maximum strains measured during the longitudinal loading are as given in Table III. The maximum strains measured during loading in the positive and negative vertical directions are as tabulated in Table IV and V, respectively.

The time sequence of operation of the acceleration switches and timers is as shown in Table VI.

No structural failures were noted during the test.

After the longitudinal loading and again after the vertical loadings the XW-27/Regulus fusing system was checked and found to operate satisfactorily.

W. H. Cross
W. H. CROSS - 1612-1

B. W. Duggin
B. W. DUGGIN - 1612-1

Approved by:

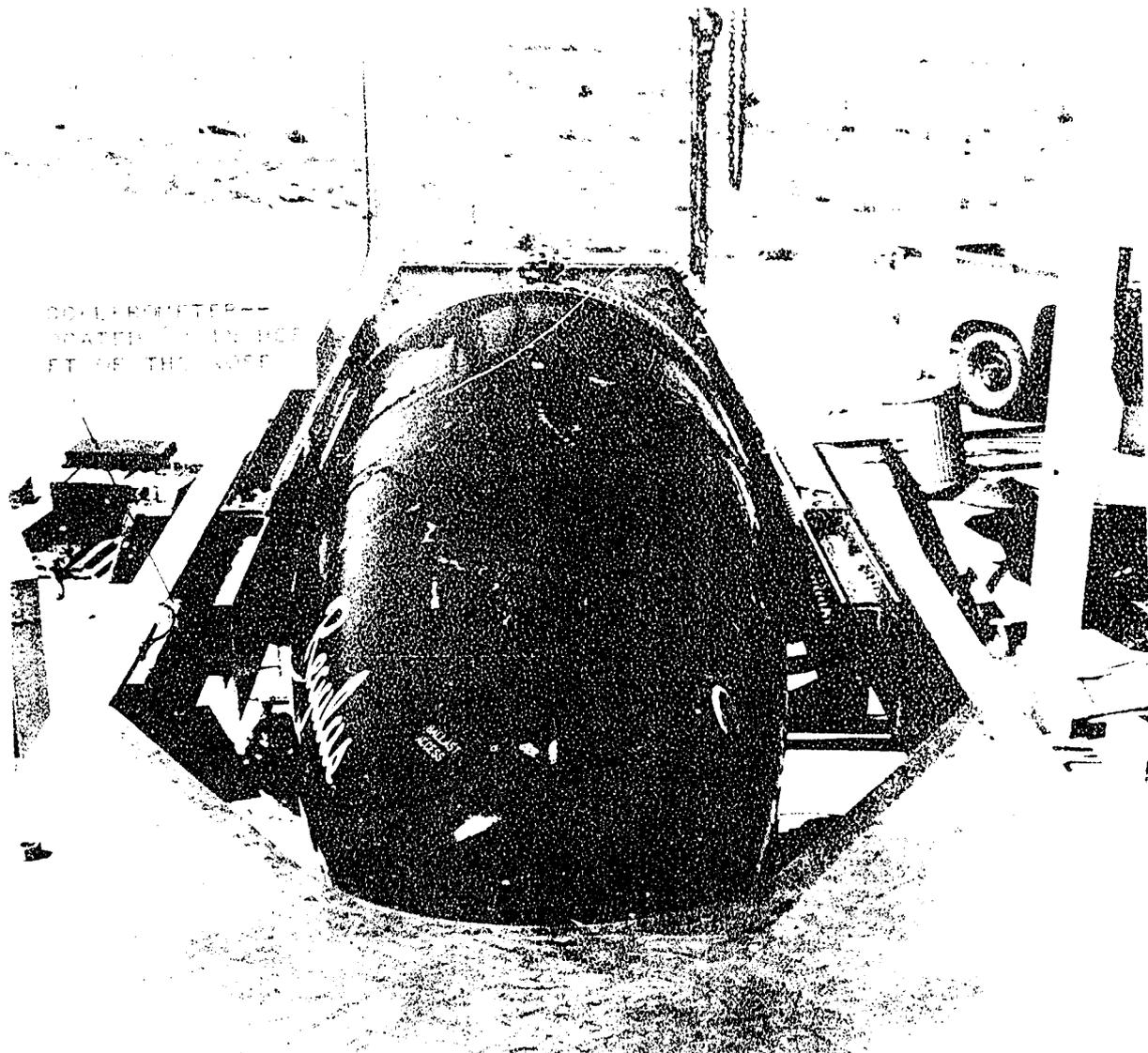
P. H. Adams
P. H. ADAMS - 1612

WHC:1612-1:as

- 1,2/7A - W. J. Denison, 1216
- 3/7A - W. A. Gardner, 1610
- 4/7A - D. M. Bruce, 1282
- 5/7A - C. L. Gomel, 5523
- 6/7A - R. K. Smeltzer, 7222-2
- 7/7A - Tech. Ref. File, Bldg. 880, 7222-2

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COULFBOMETER --
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FIG. 1 -- TEST SET UP FOR LONGITUDINAL LOADING -- CENTRIFUGAL TEST OF THE XW-02-01-01-01

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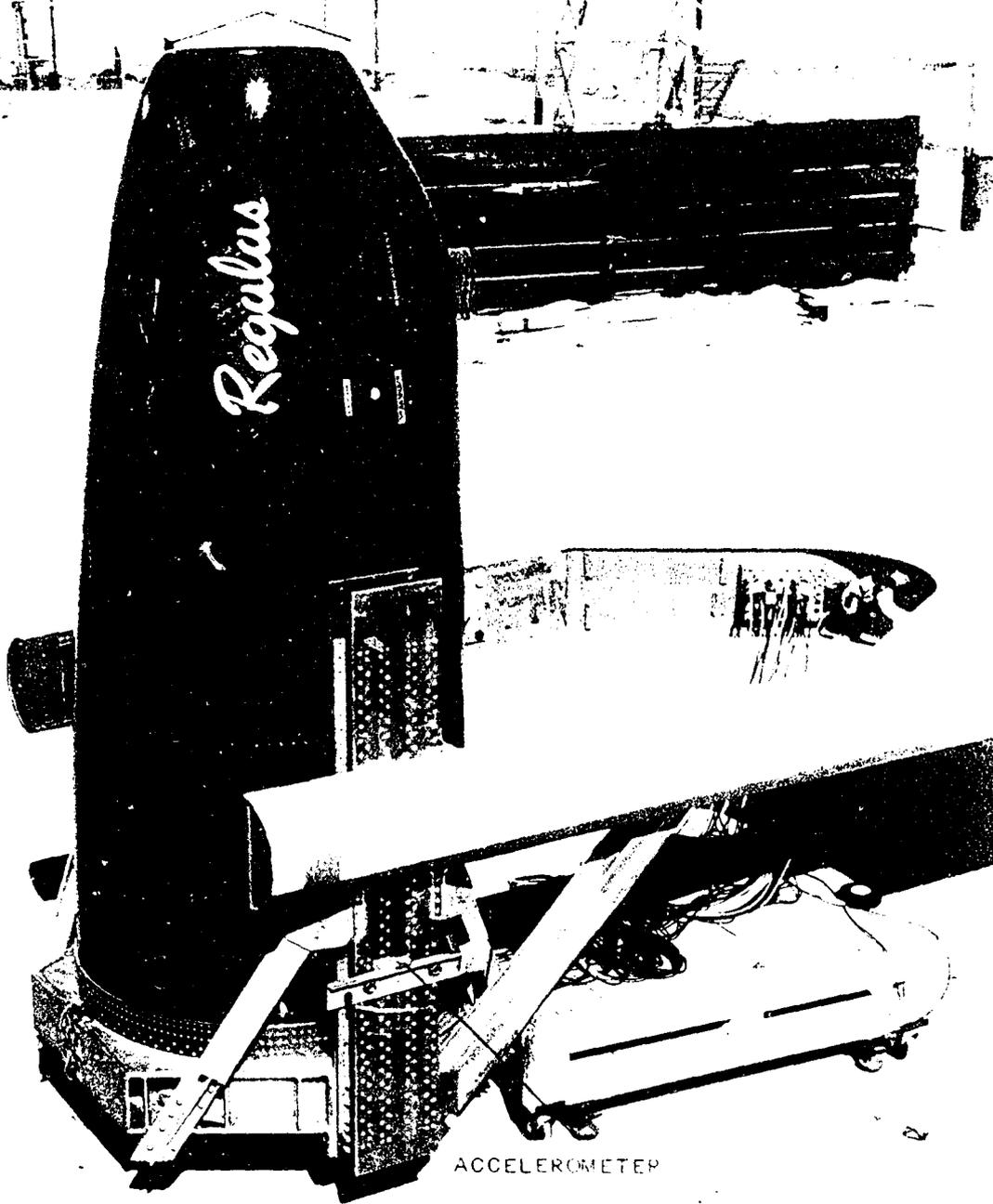


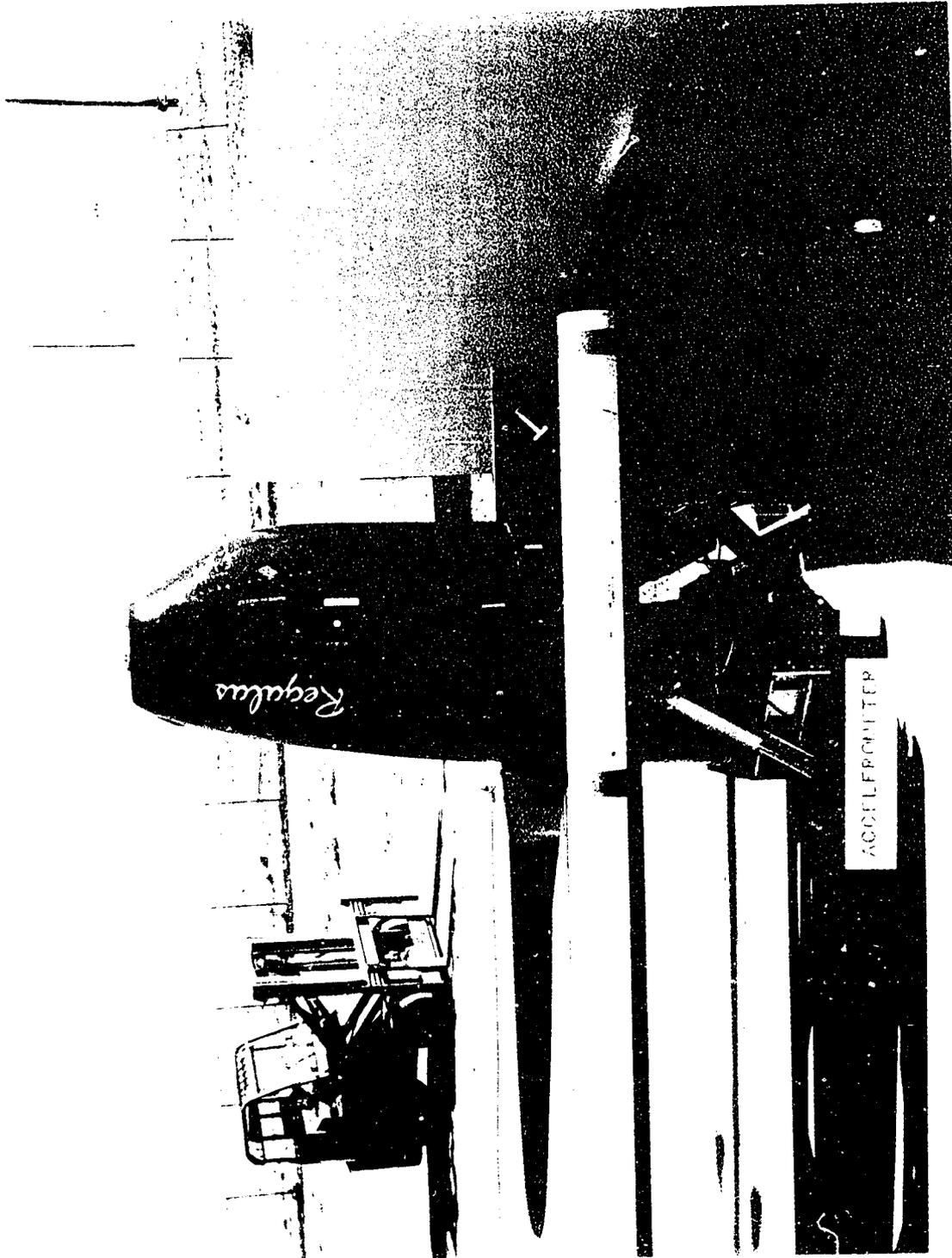
FIG. 2 -- TEST SUPPORT AND ACCELEROMETER MOUNTING FOR THE REGULUS MISSILE. (SEE FIG. 1 FOR LOCATION OF ACCELEROMETER)

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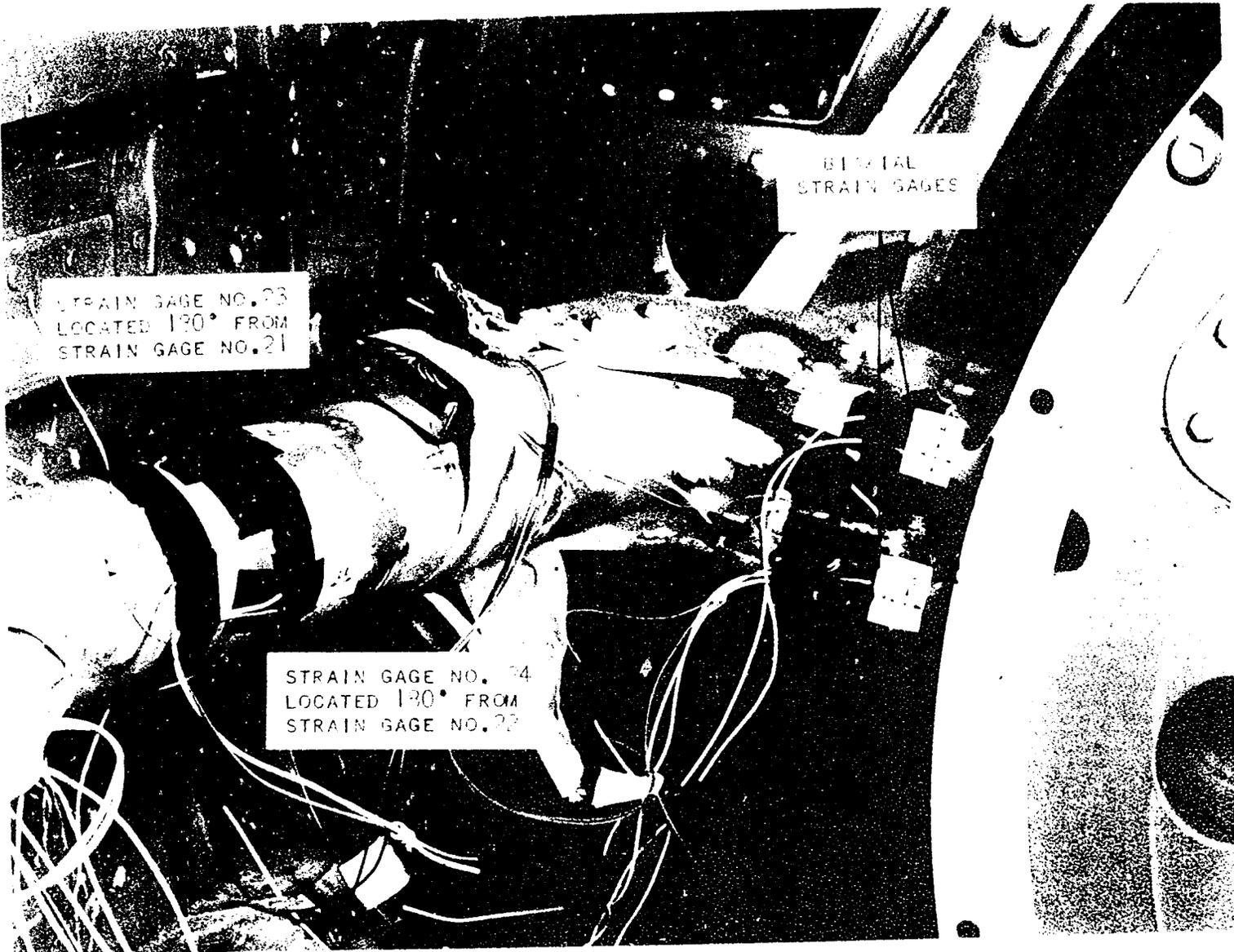
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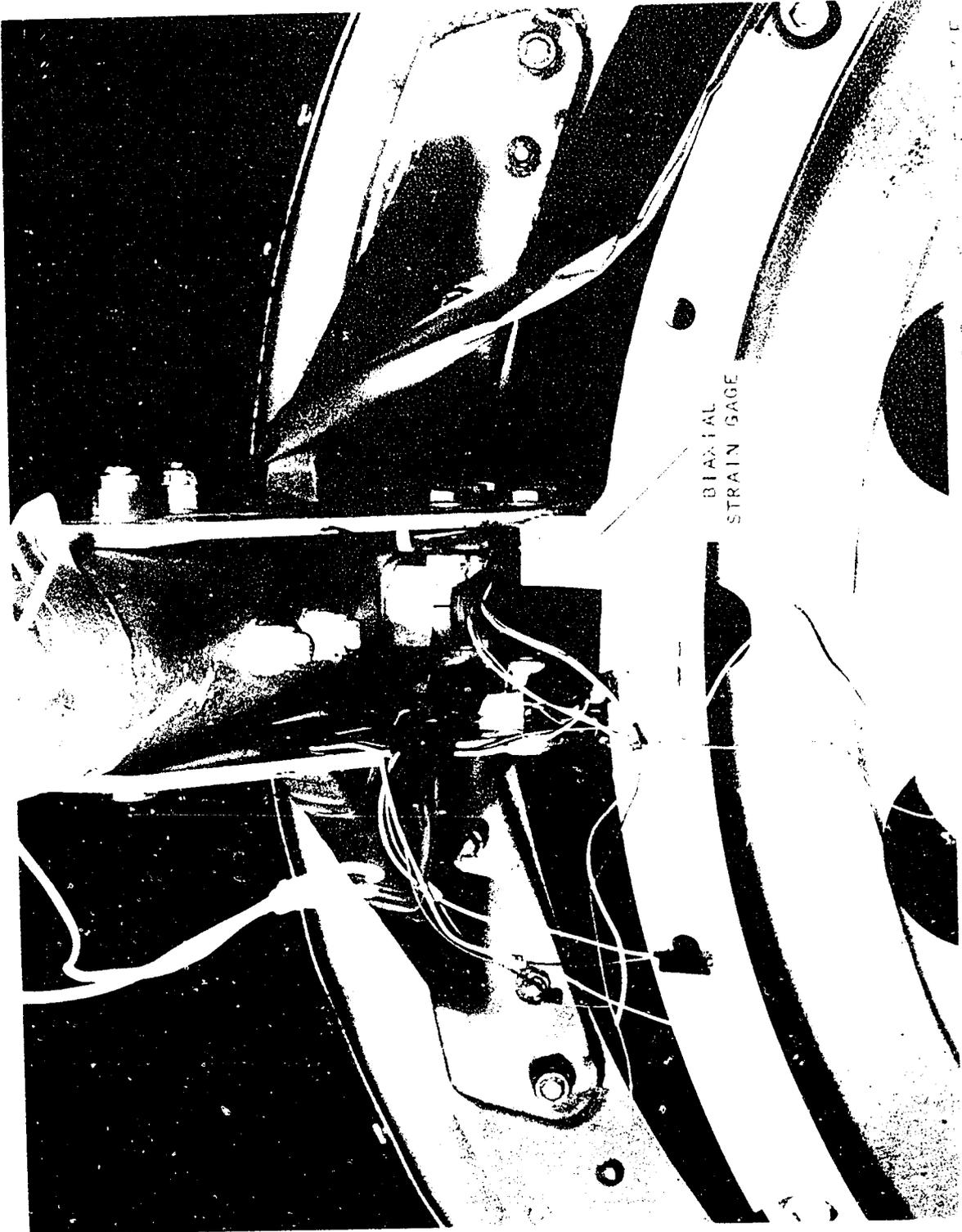
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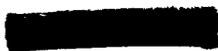
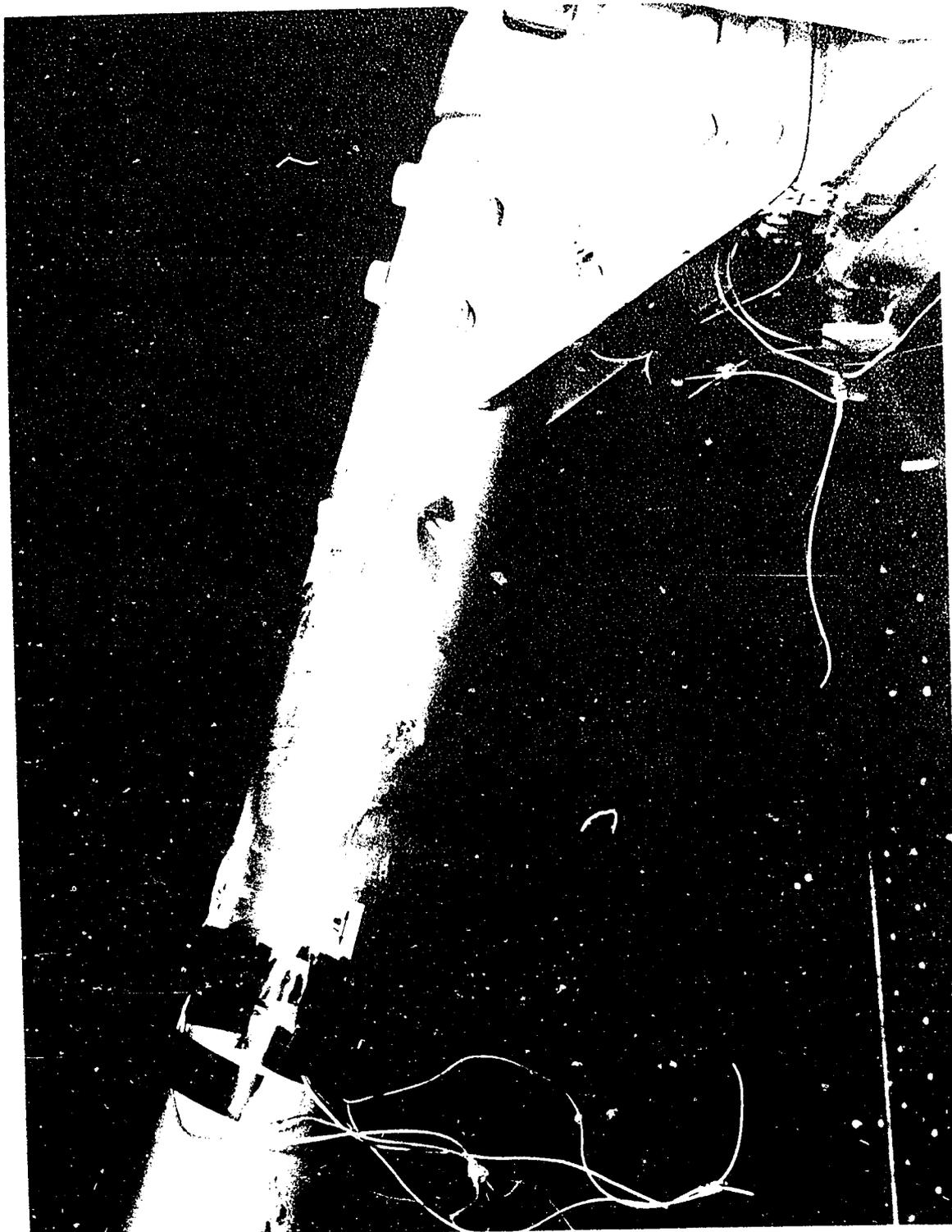
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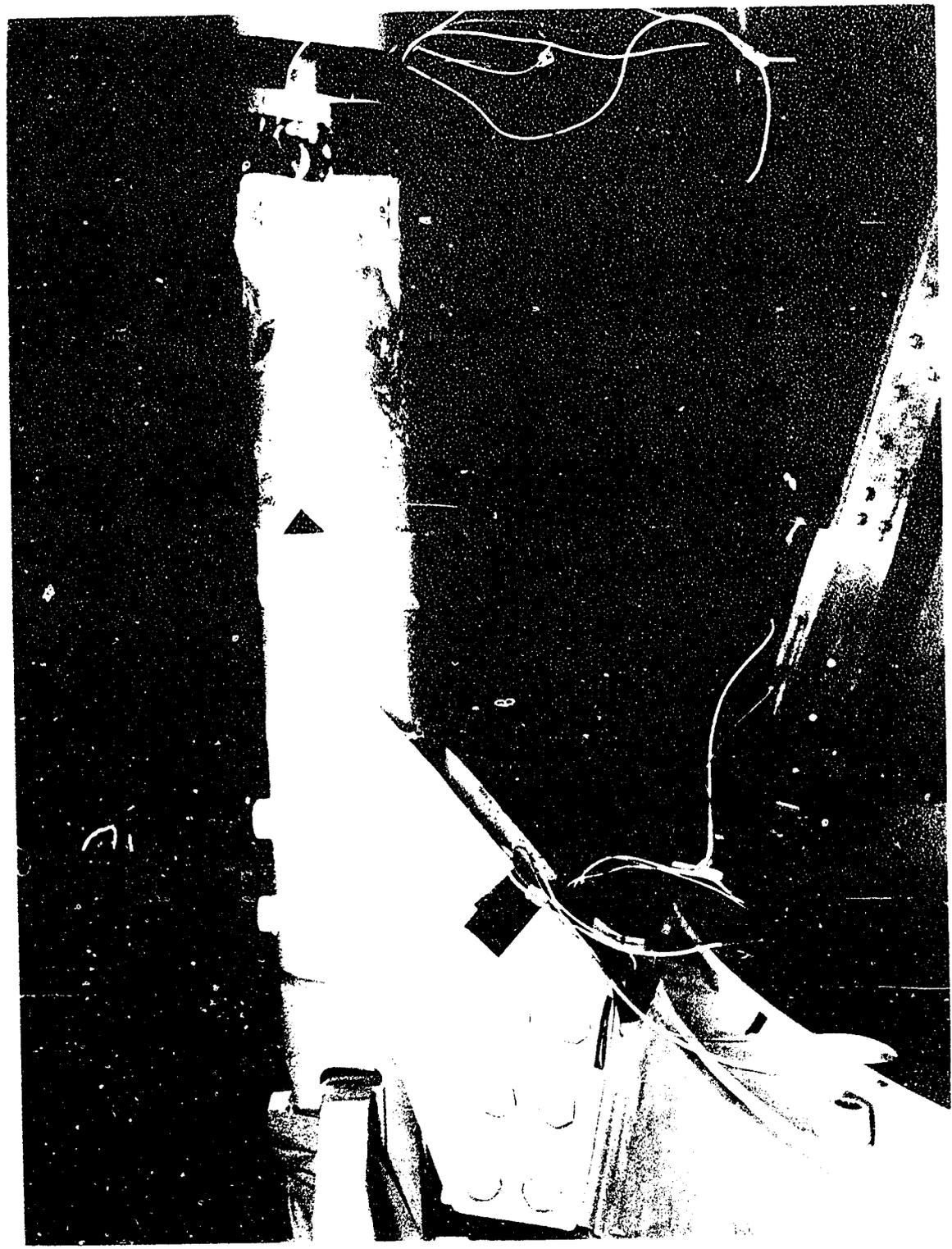
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Ref. Sym: 1612 (375)
Project No. TM-441

-13-

TABLE I

COMPONENTS TESTED DURING CENTRIFUGE TEST OF THE XW-27/REGULUS

<u>MC No.</u>	<u>Item</u>	<u>Drawing No.</u>	<u>Serial No.</u>
436	Acceleration Switch	120971	Prototype No. 6
665	Baro Switch	310229	BLX018F6
752	Timer	310352	GBO011F6
753	Interconnecting Box	310353	AAK006G6
783	Preflight Selector Set	310385	AAK001F6
784	Warhead to Missile Adaptor	310386	2
785	Cartridge Support	310387	X007
786	Cartridge to Missile Adaptor	310388	X008
	Dummy Warhead System		011

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Ref. Sym: 1612 (375)

-14-

Project No. TM-441

TABLE II

STRAIN GAGES USED DURING CENTRIFUGE TEST OF THE XW-27/REGULUS

Strain Gage No.	Strain Gage Location	Figure Reference	Active Gage Res. - Ohms	Gage Type	Remarks
1	Right Longeron Adaptor	4	119.5	AX-7	
2	Right Longeron Adaptor	4	120.7	AX-7	
3	Right Longeron Adaptor	4	119.9	AX-7	
4	Right Longeron Adaptor	4	121.2	AX-7	
5	Right Longeron Adaptor	4	120.8	AX-7	
6	Right Longeron Adaptor	4	119.4	AX-7	
7	Left Longeron Adaptor	5	120.1	AX-7	
8	Left Longeron Adaptor	5	121.2	AX-7	
9	Left Longeron Adaptor	5	119.8	AX-7	
10	Left Longeron Adaptor	5	120.6	AX-7	
11	Top Longeron Adaptor	6	121.5	AX-7	
12	Top Longeron Adaptor	6	119.1	AX-7	
13	Right Longeron - Top	4	120.1	A-7	
14	Right Longeron - Right	4	120.0	A-7	Located 180° from Strain Gage No. 16
15	Right Longeron - Bottom	4	120.1	A-7	Located 180° from Strain Gage No. 13
16	Right Longeron - Left	4	120.5	A-7	
17	Top Longeron - Top Right	7	120.2	A-7	
18	Top Longeron - Bottom Right	7	120.3	A-7	
19	Top Longeron - Bottom Left	8	120.5	A-7	
20	Top Longeron - Top Left	8	120.5	A-7	
21	Left Longeron - Top	5	120.4	A-7	
22	Left Longeron - Right	5	120.6	A-7	
23	Left Longeron - Bottom	5	119.2	A-7	Located 180° from Strain Gage No. 21
24	Left Longeron - Left	5	120.6	A-7	Located 180° from Strain Gage No. 22
25	Warhead Support Flange at the Keel	--	120.6	A-18	

UNCLASSIFIED

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UNCLASSIFIED

-15-

Ref. Sym: 1612 (375)
Project No. TM-441

TABLE III

MAXIMUM STRAINS, AND THEIR COMPUTED STRESSES*, MEASURED DURING
LONGITUDINAL** LOADING -- CENTRIFUGE TEST OF THE XW-27/REGULUS

Strain Gage No.	Strain Gage Location	11.9 g--113% Design Limit Load		15.7 g--150% Design Limit Load	
		Maximum Strain u in./in.	Computed Stress psi	Maximum Strain u in./in.	Computed Stress psi
1	Right Longeron Adaptor	+890	+8,200	+1020	+8,840
2	Right Longeron Adaptor	-550	-3,030	-780	-5,200
3	Right Longeron Adaptor	+1540	+16,750	+1910	+20,410
4	Right Longeron Adaptor	-260	+2,710	-420	+2,240
5	Right Longeron Adaptor	+1480	+16,540	+1870	+20,800
6	Right Longeron Adaptor	-130	+3,990	-190	+4,740
7	Left Longeron Adaptor	+1030	+11,210	+1400	+15,140
8	Left Longeron Adaptor	-170	+1,860	-260	+2,190
9	Left Longeron Adaptor	+1230	+15,100	+1670	+20,310
10	Left Longeron Adaptor	+260	+7,540	+300	+9,630
11	Top Longeron Adaptor	-140	+1,830	-130	+3,130
12	Top Longeron Adaptor	+930	+10,170	+1250	+13,890
13	Right Longeron - Top	-410	-4,220	-320	-3,300
14	Right Longeron - Right	-210	-2,160	-280	-2,880
15	Right Longeron - Bottom	-340	-3,500	-420	-4,330
16	Right Longeron - Left	-680	-7,000	-870	-8,960
17	Top Longeron - Top Right	-130	-1,340	-170	-1,750
18	Top Longeron - Bottom Right	-280	-2,880	-310	-3,190
19	Top Longeron - Bottom Left	-280	-2,880	-370	-3,810
20	Top Longeron - Top Left	-180	-1,850	-220	-2,270
21	Left Longeron - Top	-360	-3,710	-480	-4,940
22	Left Longeron - Right	-540	-5,560	-730	-7,520
23	Left Longeron - Bottom	-340	-3,500	-410	-4,220
24	Left Longeron - Left	-150	-1,540	-170	-1,750
25	Warhead Support Flange at the Keel	+280	+2,880	+230	+2,370

* True stresses computed for biaxial gages (gages 1 through 12) correcting for the cross sensitivity of the gage and Poisson's effect.

** Longitudinal with respect to the normal flight orientation of the warhead.

UNCLASSIFIED

UNCLASSIFIED

-16-

Ref. Sym: 1612 (375)

Project No. TM-441

TABLE IV

MAXIMUM STRAINS AND THEIR COMPUTED STRESSES* MEASURED DURING
POSITIVE VERTICAL** LOADING — CENTRIFUGE TEST OF THE XW-27/REGULUS

Strain Gage No.	Strain Gage Location	4.4g -- 125% Design		4.9g -- 140% Design	
		Limit Load	Computed	Limit Load	Computed
		Maximum Strain μ in./in.	Stress psi	Maximum Strain μ in./in.	Stress psi
1	Right Longeron Adapter	+560	+6,330	+600	+6,790
2	Right Longeron Adapter	-30	+1,730	-30	+1,820
3	Right Longeron Adapter	+80	+960	+80	+960
4	Right Longeron Adapter	+10	+415	+10	+415
5	Right Longeron Adapter	+140	+1,610	+150	+1,760
6	Right Longeron Adapter	0	+520	+10	+660
7	Left Longeron Adapter	+110	+1,260	+130	+1,490
8	Left Longeron Adapter	0	+410	0	+420
9	Left Longeron Adapter	+130	+1,530	+150	+1,760
10	Left Longeron Adapter	+10	+590	+10	+660
11	Top Longeron Adapter	-130	+800	-140	+870
12	Top Longeron Adapter	+620	+6,650	+670	+7,120
13	Right Longeron - Top	+30	+310	+40	+410
14	Right Longeron - Right	-20	-210	-20	-210
15	Right Longeron - Bottom	-70	-720	-70	-720
16	Right Longeron - Left	-50	-510	-40	-410
17	Top Longeron - Top Right	+120	+1,240	+140	+1,440
18	Top Longeron - Bottom Right	-350	-3,600	-380	-3,910
19	Top Longeron - Bottom Left	-460	-4,740	-500	-5,150
20	Top Longeron - Top Left	-10	-100	0	0
21	Left Longeron - Top	+30	+310	+30	+310
22	Left Longeron - Right	-30	-310	-50	-510
23	Left Longeron - Bottom	-70	-720	-80	-820
24	Left Longeron - Left	-30	-310	-30	-310
25	Warhead Support Flange at the Keel	-100	-1,030	-110	-1,130

* True stresses computed for biaxial gages (gages 1 through 12) correcting for the cross sensitivity of the gage and Poisson's effect.

** Accelerated downward with respect to the normal flight orientation of the warhead.

UNCLASSIFIED

UNCLASSIFIED

-17-

Ref. Sym: 1612 (375)

Project No. TM-441

TABLE V

MAXIMUM STRAINS, AND THEIR COMPUTED STRESSES,* MEASURED DURING NEGATIVE
VERTICAL** LOADING -- CENTRIFUGE TEST OF THE XW-27/REGULUS

Strain Gage No.	Strain Gage Location	3.9g -- 111% Design		5.0g -- 143% Design	
		Limit Load		Limit Load	
		Maximum Strain μ in./in.	Computed Stress psi	Maximum Strain μ in./in.	Computed Stress psi
1	Right Longeron Adaptor	-510	-5,710	-580	-6,490
2	Right Longeron Adaptor	+40	-1,430	+50	-1,580
3	Right Longeron Adaptor	-170	-1,880	-180	-2,000
4	Right Longeron Adaptor	+20	-400	+20	-440
5	Right Longeron Adaptor	-280	-3,110	-310	-3,410
6	Right Longeron Adaptor	+30	-700	+40	-690
7	Left Longeron Adaptor	-260	-2,840	-300	-3,230
8	Left Longeron Adaptor	+40	-500	+60	-420
9	Left Longeron Adaptor	-240	-2,940	-270	-3,320
10	Left Longeron Adaptor	-50	-1,460	-60	-1,690
11	Top Longeron Adaptor	+210	-990	+240	-500
12	Top Longeron Adaptor	-920	-9,800	-880	-9,230
13	Right Longeron - Top	0	0	0	0
14	Right Longeron - Right	+30	+310	+30	+310
15	Right Longeron - Bottom	+100	+1,030	+120	+1,240
16	Right Longeron - Left	+100	+1,030	+120	+1,240
17	Top Longeron - Top Right	-60	-620	-90	-930
18	Top Longeron - Bottom Right	+390	+4,020	+440	+4,530
19	Top Longeron - Bottom Left	+500	+5,150	+560	+5,770
20	Top Longeron - Top Left	+60	+620	+70	+720
21	Left Longeron - Top	+50	+510	+60	+620
22	Left Longeron - Right	+150	+1,540	+180	+1,850
23	Left Longeron - Bottom	+110	+1,130	+130	+1,340
24	Left Longeron - Left	+10	+100	+10	+100
25	Warhead Support Flange at the Keel	+180	+1,850	+200	+2,060

* True stresses computed for biaxial gages (gages 1 through 12) correcting for the cross sensitivity of the gage and Poisson's effect.

** Accelerated upward with respect to the normal flight orientation of the warhead.

UNCLASSIFIED

UNCLASSIFIED

-18-

Ref. Sym: 1612 (375)
Project No. TM-441

TABLE VI

ACCELERATION SWITCH AND TIMER OPERATION
CENTRIFUGE TEST OF THE XW-27/REGULUS

<u>Time</u>	<u>Operation</u>	<u>Acceleration (g)</u>
* To	Acceleration switch No. 1 operated, Timer Motors 1 and 2 start.	3.3g
To + 4.300 sec.	Acceleration Switch No. 2 operated.	3.9g
To + 1 min. 58.783 sec.	Timer Motor No. 2 stops and voltage applied to timer net.	---
To + 2 min. 0.974 sec.	Timer Motor No. 1 stops.	---

* Time zero.

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