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Thermal Cycle, Shock, Acceleration and Vibration Testing of
a BeO Reflector Specimen, Part No. EX-N69626085

AUTHOR

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ABSTRACT Summary of test results and recommendations. A BeO block representing a section of the 4 Pi reflector was thermal cycled to 1300°F, and then subjected to a series of shock, vibration and acceleration tests which simulated the prelaunch thermal cycles and launch shock and vibration condition. Examination of the block revealed no damage to have occurred after vibration tests up to 85 g's. The tests demonstrated that the BeO block and its mountings are adequate for the design loads.

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I. TEST OBJECTIVES

A. Objectives

The objectives of this test were (1) to determine the ability of the BeO block and the Ta-10W band, which represent a typical section of the 4 Pi Reflector, to withstand prelaunch thermal cycles and anticipated launch loads, and (2) to provide data for the design of the complete reflector component.

B. Test Procedure and Work Plan

This test report describes one of the activities outlined in the Work Plan for the 4 Pi Reflector⁽¹⁾ and described in detail in the Development Test Procedure⁽²⁾ for this specific test.

C. Description of Test Item

The reactivity of the ZrH reactor will be controlled by ten cylindrical shaped poison backed control drums which reflect or absorb the reactor neutrons according to the angular orientation of the drums about their longitudinal axis with respect to the reactor core. The reflector material is BeO, and the absorber (poison) and structural material is a Ta-10W alloy. Each drum is composed of semi-cylindrical segments of BeO banded to a rigid absorber plate. A cladding of Ta-10W alloy is considered as one of the materials to cover the BeO segments.

The BeO segment and Ta-10W band used in this test were representative of a section of the proposed control drum.

The BeO block was procured (Purchase Order No. N8410430) from the Brush Beryllium Co. as Thermalox 995 prepared by cold pressing and sintering. The density was specified on the drawing (EX-N69622007) to be 2.84 to 2.96 g/cm³, and the grain size to be 10 to 20 microns (See Appendix 1-3)

This segment used in this test (Figures 1 and 2) was machined from the EX-N69622007 block as per Drawing No. EX-N69626085 (See Appendix 4).

The Ta-10W alloy was obtained from Fansteel, Inc., (Purchase Order No. 9620029) as 0.010-inch thick sheet (See Appendix 5) which was machined into the band as per Drawing No. EX-69626084 (See Appendix 6).

A second order of the same material also was procured from Fansteel, Inc., (Purchase Order No. 9260262), because of the increased requirements in the overall program (See Appendix 7 for Material Certification). Two tensile specimens were cut from this sheet. One specimen was cut parallel to the direction of rolling and the other was cut perpendicular to the direction of rolling. Table 1 shows the mechanical properties obtained from the two specimens.

TABLE 1

MECHANICAL PROPERTIES OF Ta-10W ALLOY
AT ROOM TEMPERATURE
(0.010 Inch Thick Sheet)

Grain Direction Relation to Specimen	Tensile Strength Kpsi	0.2% Yield Strength Kpsi	Percent Elongation
Parallel	97.0	87.0	18.0
Perpendicular	102.6	97.3	22.5

Hardness of Ta-10W RB 84 or DPH 170

The test fixture, used during the shock and vibration test, consisting of an aluminum base plate, BeO block and Ta-10W band was assembled as per Drawing No. EX-N69626004 (Appendix 8).

D. Description of the Tests

The Test Procedure outlined two types of tests to be performed on the BeO block:

1. A thermal cycle to 1300°F (4 cycles) in a vacuum not to exceed 1×10^{-5} torr pressure.
2. A shock, vibration and acceleration test sequence with the BeO block banded to a fixture using Ta-10W bands tensioned to simulate future assembly loads.

E. Test Condition Limits

1. Thermal Cycle Test

The thermal cycle test will be shut down for the following reasons:

- a. Inability to limit the test pressure to the 10^{-4} torr range for short lengths of time or 10^{-5} torr for long lengths of time.
- b. Inability to reach $1300 \pm 20^\circ\text{F}$.
- c. Impending damage to the test setup.
- d. Inability to meet Health and Safety requirements.

2. Shock, Vibrational and Acceleration Test

The shock, vibration and acceleration test will be stopped for the following reasons:

- a. Failure or impending failure of the BeO block.
- b. Failure or impending failure of the Ta-10W band assembly.
- c. Failure of test equipment.
- d. Inability to meet Health and Safety requirements.

II. TEST RESULTS AND RECOMMENDATIONS

A. Test Results

1. Thermal Cycle Tests

The BeO block was given one stress relief thermal cycle to 1500°F and four test thermal cycles to 1300°F between February 3, 1969 and February 7, 1969. Figure 3 shows the heating and cooling cycles for the stress relief cycle and a typical thermal cycle.

The maximum heating rate during the 1500°F stress relief cycle was about 10°F/minute, whereas the average heating rate was about 5°F/minute. During the 1300°F thermal cycle tests, the maximum heating rate was about 13°F/minute and the average heating rate was about 8°F/minute. The heating rate specified in the Test Procedure was about 50°F/minute.

The BeO specimen temperature was stabilized at the end of each heating cycle. Table 2 shows the specified and the actual conditions.

TABLE 2
STABILIZATION TIME AND TEMPERATURE
FOR BeO BLOCK

Thermal Cycle No.	Time, minutes	Temperature, °F	
		Maximum	Minimum
Specified	45 $\pm$ 15	1300 $\pm$ 20	
1	250	1390	1290
2	105	1320	1300
3	215	1320	1300
4	70	1380	1300

During the stabilization period, the temperature recorder was checked against a Model 8686 I. & N. potentiometer and found to agree within $\pm$ 5°F.

Cooling of the BeO specimen was accomplished by turning off the power to the heater and permitting the specimen to radiate to the surroundings. A maximum cooling rate of about 21°F/minute, in all cases occurred immediately

after shutting off heater power.

Visual examination of the block revealed that no damage had occurred. Chipped areas, on the edge of the block and around the hole drilled into the flat face of the block, observed during pre-test examination, had not enlarged. Figures 1 and 2 show the block after thermal cycling.

2. Shock, Vibration, and Acceleration Tests (3)

After assembly* of the Shock and Vibration Test Component (Figures 4-7) in the laboratory, the component was shipped on March 18, 1969 to the Environmental Test Laboratory for Shock, Vibration and Acceleration testing.

Vibration, shock, and acceleration testing was completed on the BeO reflector test specimen (Figure 8) with no damage evident to the support band. After the first vibration test (Y axis resonance search and 22-1/2 g dwell), it was noted that chips were missing from the BeO block, however, it was confirmed that these chips had been missing before testing. After the next vibration test (X axis resonance search and 22-1/2 g dwell), it was noted that the BeO segment was rotated slightly with respect to the bearing plate. This condition had been noted before testing. Neither condition appeared to get worse as testing progressed.

One of the three strain gages (#3) on the band failed ten minutes into the very last vibration test (Y axis, 85 g 1.4 hours dwell). It is suspected that the gage wire failed in fatigue. This failure was not accompanied by a failure in the strap.**

a. Shock Test Results

No significant stresses were evident in the band during the 20 g shock tests. Table 3 lists the range of varying stresses observed during both the plus and minus shocks in each direction.

*See III.B for Assembly of Shock and Vibration Test Component
**See final examination

TABLE 3

OBSERVED STRESSES DURING SHOCK TESTING

X Axis

707 to 1180 psi (gage 1)

negligible (gage 2)

negligible (gage 3)

Y Axis

negligible stresses (all gages)

Z Axis

940 to 1510 psi (gage 1)

negligible (gage 2)

720 to 1000 psi (gage 3)

b. Acceleration Tests

Strain gages were not monitored during the acceleration tests (Figures 9-12). Band stresses under the steady-state static loading would be so small under the required 6 g and 2 g acceleration levels as to be hidden in the noise level of the recording instrumentation. Consequently, visual examination after test was used to evaluate specimen performance.

c. Vibration Tests

A summary of the vibration test results is tabulated in Table 4. Of particular interest are the varying stress values (psi) observed in the band during testing. These values coupled with the mean stress and any potential stress concentration values can be used by the designer/analyst to predict fatigue life of the band.

A discussion of the testing sequence is presented in the next section of this report, Description of Methods Used and Test Equipment." Laboratory Notebook pages B3614, 19-26 document the various laboratory test activities. Oscillograph records, polaroid pictures, and X-Y- plots taken or made during the test are on file for reference in the Environmental Test Laboratory. Figures 13-15 show various views and orientations of the component during the test sequence.

TABLE 4
VIBRATION RESULTS

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Test qu	Axis	Input (G)	Time Min.	Response (G)	Freq. (HZ)	Gauge #	Varying Stress + psi	Total Cycles Applied
3	X Run #2 survey	2	--	X 24 Y 29 30 Z 8 18	1400 1450 1700 1100 1600	1 2 3		
4	X Dwell	22.5	10	X 22.5 Y negl Z negl	200	1 2 3	250 --- ---	1.2×10^5
8	X Dwell	50	10	X 56 Y negl Z negl	200	1 2 3	250 --- 200	1.2×10^5
11	X Dwell	55	84	X 60.7 Y negl Z negl	200	1 2 3	500 --- 300	10^6
1	Y Run #1 survey	2	--	X 3.2 Y 4.5 Z 2.4	1600 1450 1750	1 2 3		
2	Y Dwell	22.5	10	X negl Y 22.5 Z negl	200	1 2 3	1000 --- ---	1.2×10^5
7	Y Dwell	50	44	X negl Y 54 Z negl	200	1 2 3	1750 --- ---	5.3×10^5
12	Y Dwell	85	84	X negl Y 85 Z negl	200	1 2 3	9100 --- noisy	10^6
5	Z Run #3 survey	2	--	X 16 10.5 Y 9.5 16.5 Z 5.5 24	1300 1400 1100 1300 700 1600	1 2 3		
6	Z Dwell	22.5	10	X negl Y negl Z 22.5	200	1 2 3	1400 --- 1100	1.2×10^5
9	Z Dwell	50	10	X negl Y negl Z 54	200	1 2 3	2450 --- 1800	1.2×10^5
10	Z Dwell	55	84	X negl Y negl Z 57	200	1 2 3	2600 --- 2100	10^6

3. Final Examination

The BeO block was returned from the Environmental Test Laboratory on March 28, 1969 for final examination (Figures 16-19). The strain gages were connected and read, in the same manner as described in III.B. Table 5 shows the microinches of strain recorded on the gages before and after shock and vibration testing.

TABLE 5

MICROINCHES OF STRAIN INDICATED BY GAGES

<u>Gage No.</u>	<u>Pretest</u> (75 lb load)	<u>Post-Test</u>
1	32767	32800
2	34800	34820
3	33488	33587

It was concluded from these readings that the preload in the Ta-10W band had not changed appreciably during test. A lower post-test value would indicate a yielding and permanent set and a loosening of the band.

The nut on the band assembly was loosed to produce "no-load," and the strain recorded. Table 6 shows the pre- and post-test "no load strain."

TABLE 6

MICROINCHES OF STRAIN IN UNLOADED BAND

<u>Gage No.</u>	<u>Pretest</u>	<u>Post-Test</u>
1	31390	31725
2	32647	33144
3	31990	32016

The band was removed from the block, and the block (Figure 20) and aluminum base plate separated. Examination of the band revealed that the cement, holding the strain gage and a portion of the lead wires, had cracked leaving the strain gage stuck to the band, but freeing the lead wires to vibrate. This situation had been noted during shock and vibration testing by the erratic behavior of the strain gage.

Examination of the contact surface of the BeO and the aluminum block revealed that rubbing had occurred depositing aluminum on the BeO block (Figure 21). From the appearance of the rubbed area, it was concluded that the two pieces had been in close contact only near the center.

Examination of the surface of the BeO (Figure 22) revealed the chipped areas to be about the same as before the test (Figure 2).

All information relating to this test, with the exception of the shock and vibration data, are recorded in Laboratory Notebooks N4421 and N4442.

B. Conclusions and Recommendations

It was concluded from this series of tests that a band arrangement for holding the BeO segment could be used for assembly of the control drum component.

The BeO block was found to have suffered no damage during thermal cycling, or the series of shock, vibration, and acceleration tests.

The Ta-10W band was demonstrated to be capable of holding the BeO block during shock, vibration, and acceleration testing without suffering yielding and permanent set. Fatigue failure of the band was not found to occur even after three 84 minutes vibration tests - each test consisting of one million cycles each.

III. DESCRIPTION OF METHODS USED AND TEST EQUIPMENT

A. Thermal Cycle Tests

A Health and Safety approval-to-handle was obtained on the BeO block before work was begun. Visual inspection of the block revealed that several small chips were missing from the bottom edge of the block, and that the edge of the hole in the bottom surface was slightly chipped.

The BeO block then was placed on a tantalum plate in the center of a tantalum heater installed in a CVC Vacuum system (AEC No. 173560). Two Type K thermocouples, tantalum sheathed, were strapped to the BeO block. These thermocouples were connected to a temperature recorder, (AEC No. 164885).

A metal bell jar was installed and the system prepared for evacuation. Prior to the start of the first heat cycle, the system was evacuated to $\sim 10^{-7}$ torr. The power to the tantalum heater was regulated using a manually operated Powerstat to produce the heating cycles.

Throughout the series of thermal cycles, the system pressure was no greater than 1×10^{-6} torr (10^{-5} torr was permitted by the Test Procedure). The total time for the four cycles was 102 hours.

At the end of the thermal testing, Health and Safety approval was given to proceed with further testing.

B. Assembly of Shock and Vibration Test Component

The BeO block was shipped to the Mechanical Components Unit (Dept. 737-752) for installation of the strain gages as per the Test Procedure instructions:

"Secure one strain gage at each end and the middle of band EX-N69626084. The gages shall be on the band near the end fittings and on the side of the band opposite the BeO (See Drawing EX-N69626004). The gage will be oriented on the narrow part of the band to indicate band tension loads in the narrow part of the band. Secure a third strain gage on a separate sample of 0.010 inch thick Ta-10W (simulating the band) to serve as a temperature compensator. Waterproof the gages. Record the resistance and gage factor for each strain gage.* The gages must be suitable for use with a Baldwin-Lima-Hamilton Strain Indicator Model 120 and a B-L-H Balancing and

* Gage factor $2.02 \pm 1/2\%$, Resistance 120 ± 0.2 ohms

Switching Unit Model 225."

A dead weight assembly was prepared on March 13, 1969 to stress cycle the band assembly. The band was placed in the assembly and the strain gages connected to the strain indicator and a balancing and switching unit. The strain indicator was balanced with no load on the band. A 110 lb. 14 oz. tension load (See Appendix 9) was slowly applied to the band. The strain indicator was balanced and read. The load was then removed, the strain indicator balanced and re-read. Ten stress cycles were applied to each band. Table 7 shows the data from the stress cycling test.

TABLE 7MICROINCHES OF STRAIN ON GAGES DURINGSTRESS CYCLING

(110 lb. 14 oz. load)

	Strain Gage No.	Cycle No.										Average
		1	2	3	4	5	6	7	8	9	10	
Load	1	31953	32011	31975	32039	32041	32000	32017	31900	32055	32050	32004
No Load		30154	30075	30077	30115	30136	30125	30108	30110	30075	30107	30108
Load	2	31152	31162	31162	31168	31175	31175	31173	31167	31167	31162	31166
No Load		30028	30040	30039	30048	30048	30048	30047	30047	30046	30038	30043
Load	3	32054	32050	32057	32087	32083	32085	32093	32090	32112	32022	32073
No Load		30055	30132	30126	30105	30108	30110	30122	30117	30117	30092	30108

The test was repeated with a 74 lb 14 oz tension load (See Appendix 9) for five stress cycles. Table 8 shows the test data.

TABLE 8

MICROINCHES OF STRAIN DURING STRESS CYCLING
(74 lb. 14 oz. load)

	Strain Gage No.	1	2	3	4	5	Average
Load	1	31350	31409	31390	31312	31406	31373
No Load		30000	29987	29987	29968	30011	29990
Load	2	30638	30649	30649	30649	30640	30645
No Load		30000	30002	30000	30004	30000	30001
Load	3	31495	31500	31500	31495	31502	31498
No Load		30000	30019	30000	30000	30013	30006

The band was placed on the BeO block and formed with finger pressure to the contour of the block. The band end fittings were placed in the base plate holes normal to the base plate surface. The strain indicator was balanced and the strain recorded for no load, except for the band deformation (Table 9).

TABLE 9

MICROINCHES OF STRAIN RECORDED DURING ASSEMBLY
WITH "J" LOAD

<u>Gage No.</u>	<u>Microinches</u>	<u>Location</u>
1	31390	Side of BeO block
2	32647	Top of BeO block
3	31990	Side of Beo block

A tension pre-load was applied to the band by tightening the nuts on the end of the band assembly until the strain indicator indicated the strain

for a 75 ± 1 lb. tension load greater than the readings shown in Table 9. The band and BeO block were tapped lightly while tightening the band. Table 10 shows the recorded strain values.

TABLE 10

MICROINCHES OF STRAIN RECORDED DURING ASSEMBLY
TO APPLY 75 LB. LOAD TO BAND

Gage No.	Microinches Strain	Desired Strain
		(1) (2)
1	32767	$31390 + 1373 = 32763$
2	34800	$32647 + 645 = 33292$
3	33488	$31990 + 1498 = 33488$

(1) Deformation Load

(2) 75 lb. load

It was observed during the assembly that the correct load could be placed on strain gages Nos. 1 and 3 at the ends of the band, but the load on the center (#2) strain gage exceeded the desired value, since its load was dependent upon the adjustment of the remaining two gages.

C. Shock, Vibration and Acceleration Testing

Upon receipt in the Environmental Test Laboratory, on March 19, 1969, the BeO test specimen was mounted on the MB 6000 lb shaker table in preparation for shock testing in the Y axis. Accelerometers were installed on the test article and calibrated. Strain gages already in place on the band were fed into an oscillograph and calibrated. Figure 8 shows a sketch of the specimen, instrumentation locations, and assigned axis orientation.

Testing on the BeO reflector assembly was guided by the procedures noted in DTP-696-26-004. However, some deviations were required, particularly in the magnitude of test levels required. Existing shaker equipment is incapable of directly applying the high levels requested, and so test inputs were limited to the available output of the shaker equipment. These maximum values are noted in the discussion which follows.

1. Shock Testing

Three 20 g, 1/2 sine, 10 millisec duration shocks were applied in each direction to the specimen assembly in the Y axis. After reorienting the specimen on the shaker table, the same number and type of shocks were applied in the X and Z directions, respectively. During all tests, recordings of shock input, shock response on the specimen, and stress readings on the band were made.

2. Vibration Resonance Surveys and Dwells

Upon completion of shock testing, the specimen was returned to the shaker position required for Y axis testing. A 2 g resonance search was run from 10-2000 Hz. This was followed by a 22-1/2 g dwell for ten minutes at 200 Hz. The same procedure was followed first in the X axis and then the Z axis. Continuous recordings were made during all resonance surveys. Sample records were made during the dwells.

3. Acceleration Testing

Acceleration was the next programmed environment. With the specimen oriented in the centrifuge for + X axis testing, the unit was subjected to 6 g's for 5 minutes. The test was repeated in the -X direction for 5 minutes and 6 g's. The Z and Y also were similarly covered in both $\pm$ directions for 5-minute tests except that the test level was reduced to 2 g's. No data were recorded during the acceleration tests.

4. Vibration Dwells - High Level

The test specimen was returned to the shaker in preparation for the high level dwell tests which were run as noted in Table 11.

TABLE 11**CONDITIONS FOR HIGH LEVEL DWELL TESTS**

<u>Axis</u>	<u>g Level Input</u> <u>g</u>	<u>Frequency</u> <u>Hz</u>	<u>Duration</u> <u>Minutes</u>
Y	30	200	44
X	50	200	10
Z	50	200	10
Z	55	200	84 (1,000,000 cycles)
X	55	200	84 (1,000,000 cycles)
Y	85	200	84 (1,000,000 cycles)

Samplings of the accelerometer and strain gage outputs were made during each of the above dwell tests.

D. Instrumentation and Equipment

A tabulation of the instrumentation and test equipment used in conducting the test is given in Table 12.

TABLE 12**INSTRUMENTATION AND EQUIPMENT USED**

<u>Item</u>	<u>AEC No.</u>	<u>Date</u> <u>Calibrated</u>	<u>Date</u> <u>Due</u>
Strain Indicator Model 120 BLH	173667	2-25-69	5-25-69
Switching and Balancing Unit, Type 525	173668	Not needed	
CVC Mech. Diffusion Pump Vacuum System	173519	-	4-20-69
Powerstat, Superior Electric Type 1256	None	Not needed	
Temp. Recorder, Barber-Coleman, 0-2000°F	164883	12-30-68	6-27-69
Potentiometer, Leeds & Northrup No. 8686	170073	10-29-68	4-29-68
Vibration Exciter Control	199839	12-20-68	6-20-69
True RMS Meter	174290	3-14-69	4-18-69
Tape Recorder	172808	1-2-69	7-3-69
Dynamic Analyzer	172062	11-8-68	5-9-69

<u>Item</u>	<u>AEC No.</u>	<u>Date Calibrated</u>	<u>Date Due</u>
Dynamic Analyzer	172061	12-27-68	6-27-69
X-Y Plotter	109501	1-17-69	5-2-69
Amplifier Log Converter	2310012	1-17-69	5-2-69
Amplifier Time Base	176051	1-17-69	5-2-69
X-Y Plotter	167634	3-6-69	9-9-69
Log Frequency Converter	172749	2-11-69	8-15-69
Change Amplifier Ch 1-4	177106	12-4-69	6-4-69
Accelerometer 2217	GA 84	12-27-68	3-27-69
Accelerometer 2229	NA 79	8-13-68	11-12-68
Accelerometer 2229	NA 98	8-13-68	11-14-68
Accelerometer 2229	NB 09	8-13-68	11-14-68
Visicorder	168240	7-3-68	1-1-69
Carrier Amplifier	163653	9-3-68	4-4-69
Power AMP	172809	1-25-68	5-9-68
Shaker	172811	11-6-67	5-6-68
Exact Wave Form Synth.	169623	8-16-68	2-14-69
Oscilloscope	171346	2-25-68	7-18-69
Band Pass Filter	109846	3-15-68	3-13-69
Dynamic Analyzer	170591	11-8-68	5-9-68
Centrifuge	169690	--	--

Calibration of some of the instrumentation utilized was not in date at time of test and so a deviation from the noted DTP was required. Project agreed to proceeding with the test using out of date equipment providing:

1. Calibration of data readout systems would use calibrated instruments.
2. Input levels would be established using readings from calibrated instruments.
3. Calibration or service stickers would be obtained for out-of-date equipment as soon as possible consistent with available funds and manpower.

4. Any deviations concerning the use of out-of-date equipment would be noted in the final test report.
(See Appendix 10).

IV. DISPOSITION OF TEST SPECIMENS

After completion of the tests, the BeO was sealed in a plastic bag, labelled, and marked with a one year storage expiration date, and stored as approved by Health and Safety. If after one year, there is no need for the sample, it may be disposed of according to Health and Safety procedures.

V. REFERENCES

1. WPL-696-26-001, "4 Pi Reflector Work Plan for FY 1969 (Subaccount 7759-4-620)," G. F. Queener, November 6, 1968
2. DTP-696-26-004, "Development Test Procedure, 4 Pi Reflector Drum BeO Components Test Outlined in Work Plan WPL-696-26-001," G. F. Queener, December 26, 1968
3. IL, R. M. Oliva to G. F. Queener, "Vibration, Shock and Accelerator Testing of BeO Reflector Specimen," March 31, 1969

FIGURE 1
TOP VIEW OF BEO REFLECTOR SEGMENT
(EX-N69626085) AFTER THERMAL
CYCLING

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PRODUCTION OF: SANCOAST, INC.

7759-4089

CHIPS

CHIP

FIGURE 2
BOTTOM VIEW OF BEO REFLECTOR SEGMENT
(EX-N69626085) AFTER THERMAL CYCLING

2-10-69

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FIGURE 4
END VIEW

EX-N69626004
BeO Shock & Vibration Fixt.
Pre Test

FIGURE 5
OPPOSITE END VIEW

EX-N69626004
BeO Shock & Vibration Fixt.
Pre Test

FIGURE 6
SIDE VIEW

FIGURE 7
OPPOSITE SIDE VIEW

EX-M/626004
BeO Shock & Vibration Fixt.
Pre Test

FIGURE 8

TEST SPECIMEN AND AXIS ORIENTATION

FIGURE 9
BEO SPECIMEN MOUNTED IN CENTRIFUGE

3-25-69

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North American Division
P.O. Box 1000, Santa Barbara, CA 93101

759-40146

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FIGURE 10
BEO SPECIMEN MOUNTED IN CENTRIFUGE
TOP VIEW

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UNCLASSIFIED Atomic & International
Energy Agency (IAEA)

7759-40143

FIGURE 11
BEQ SPECIMEN MOUNTED IN CENTRIFUGE
CLOSEUP VIEW

3-25-69

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Nuclear Research Products
P.O. Box 1000, Oak Ridge, TN 37831

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FIGURE 12
BEO SPECIMEN MOUNTED IN CENTRIFUGE
CLOSEUP VIEW

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FIGURE 13
BEO SPECIMEN MOUNTED ON SHAKER FOR
Y-AXIS TESTING

3-21-69

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7759-40153

FIGURE 15
BEC SPECIMEN MOUNTED ON SHAKER FOR
Z-AXIS TESTING

27-69

7769-40151

EX-N69626004
BeO Shock & Vibration Fixt.
Post Test

FIGURE 16

END VIEW AFTER SHOCK AND VIBRATION TEST-
ING - SAME VIEW AS FIGURE 4

EX-N69626004
BeO Shock & Vibration Fixt.
Post Test

FIGURE 17
OPPOSITE END VIEW AFTER SHOCK AND VIBRA-
TION TESTING - SAME VIEW AS FIGURE 5

FIGURE 18
SIDE VIEW AFTER SHOCK AND VIBRATION TEST-
ING - SAME VIEW AS FIGURE 6

FIGURE 19
OPPOSITE SIDE VIEW AFTER SHOCK AND VIBRA-
TION TESTING - SAME VIEW AS FIGURE 7

FIGURE 20
BEO BLOCK REMOVED FROM FIXTURE AFTER
SHOCK AND VIBRATION TESTING

4-2-69

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Do Not Release

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FIGURE 22
CLOSE-UP OF SURFACE OF BEO BLOCK SHOWING
CHIPPED AREAS

WICH NO	L' DIM
-1	1.500
-2	2.000
-3	4.500
-4	6.000

• ULTRASONIC CLEAN ALL COMPLETED PARTS IN FACILITY AND
CLEANER & NEUTRALIZER SOLUTIONS. LIMITED IN A HAN
HEIN USE.

3 USE JUSTICE WATER JAWNS GRINDING STATION
 OWNED BY JUSTICE PRODUCTS, 1125 MCKINLEY AVE,
 CLEVELAND, OHIO FOR THE GRINDING JUSTICE
 OVER THE 1 MONTH PERIOD.

①2 MATERIAL: ERUCH BERYLLIUM CO T-GLASS 993

FILE PROCESS: COOL DRIES & SINTER
DENSITY: 2.84 TO 2.90 GR/CM³
AVERAGE GRAIN SIZE: 10 TO 20 MICRON
BREAK ALL SHAFF CUTS .020

NOTES UNLESS OTHERWISE SPECIFIED

<div style="text-align: center;"> <div>100-368615</div> <div>SEARCHED</div> </div>		<div> <div>INDEXED</div> <div>SERIALIZED</div> </div>
FILED	<div> <div>APR 11 1968</div> <div>FBI - NEW YORK</div> </div>	FILED
<div> <div>APR 11 1968</div> <div>FBI - NEW YORK</div> </div>		<div> <div>APR 11 1968</div> <div>FBI - NEW YORK</div> </div>

APPENDIX 1

[illegible]

REDUCED DRAWING

THE BRUSH BERYLLIUM COMPANY
ELMORE, OHIO

CERTIFICATE OF COMPLIANCE

To: ATOMICS INTERNATIONAL
DIVISION OF NORTH AMERICAN ROCKWELL
P.O. BOX 302
ACCOUNTS PAYABLE 9/9
CANOGA PARK, CALIFORNIA 91304

Date 10/11/68
Your PO N-8410430
Our SO V-787
Item No. 1 2 3 4
Quantity 2 PCS. 4 PCS. 1 PC. 1 PC.

It is hereby certified that all articles herewith furnished in the quantities as called for in the above purchase order are in conformance with the requirements, specifications, and drawings applicable to that order.

All physical, chemical or other tests applicable to your order are on file, and copies of such reports will be furnished upon request.

Chemical Analysis:

	PPM		PPM
Al	25	Zn	-20
Fe	35	Mg	880
Mn	-2	Si	2000
Ca	50	Cr	10
Ni	12	Cd	ND
Li	-1	Mo	-3
Ti	-2	Pb	2
B	-1	Na	40
Ce	-1	Ag	-1
Cu	-2		

(ND) Not detected
(-) Less than

THE BRUSH BERYLLIUM COMPANY

Don E. Yambert
Don E. Yambert
Quality Control Supervisor
Ceramic Department

SPECIFICATION

THE BRUSH-BEVERLY COMPANY
CERAMICS AND NON-METALLIC PRODUCTS DEPARTMENT
ELMORE, OHIO 43021
Telephone 419-852-2715 FAX 419-853-0960

APPENDIX 3

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ATOMICS INTERNATIONAL
CUSTOMER ORDER NO. N-8410430
BRUSH ORDER NO. V-787

1. These plates were fabricated from pressing powder lot 995 C-30. Records pertaining to actual preparation of this lot will be on file for 3-5 years.
2. All blocks were fired in Kiln No. 3, Run 155. The actual firing curve will also be maintained for 3-5 years and can be recalled by specifying kiln and run number.
3. Machining was accomplished by grinding the outside contour on fixture GF-6484 (D-7111). Balance of grinding utilized standard machine shop practices.
4. All inspection reports are available by specifying the Brush order number. Record storage will be 3-5 years.

In addition to the basic data provided above, the actual routings, print copies, and inspection reports used to produce this order will be maintained under the designation "BBRCP-4360-1500". These will be available as reference for processing any new order for five years.

PJK/elm

10-7-68

UNLESS OTHERWISE SPECIFIED

[illegible]

FANSTEEL CERTIFICATION

FANSTEEL INC.

Metals Division

5101 TANTALUM PLACE

BALTIMORE, MARYLAND 21226

Phone 301/355-3500 TWX: 710/234-2456

RYERSON

Atomic International, NAA Rockwell
8900 DeSoto Avenue, Conoga Park, Calif 91305
(J. P. Ryerson & Son, Inc)

12AD505221

CUSTOMER

PURCHASE ORDER NO.

PRODUCTION NO.

77161

QUANTITY

1 pc

237 Y

MATERIAL

.010" x 2 sq. ft. Fansteel 60 Metal sheet

Spec. No. 562401-R-0

LOT NO.

60 B 2310

CHEMICAL REPORT (All values in PPM unless otherwise shown)

C	10
O	25
N	10
H	5
Ti	10
Fe	10
Ni	10
Si	10
Mn	10
Ca	10
Al	10
Cu	10
Zn	10
Cr	10
V	10
Co	10
Zr	10
Cb	90
P	9.75%
S	Bal

DOT 1-1008

10/10/63

QUALITY CONTROL REPRESENTATIVE

-02 END FITTING ASSY

-01 BAND

EX-N69626084 BAND ASSEMBLY
(SCALE 2/1)

BREAK ALL SHARP EDGES .005 MIN R.

2. FORM -01 BAND ENDS AROUND -02 PLATE AS SHOWN BEFORE LIVE DRILLING. INSTALL RIVETS PER A.I. SPEC LA0101-001
3. 5 DIAS IN LIVE WITHIN .010 TOTAL.
1. 2. CRIZE WITH EASY FLO #45 PER NA007-001

NOTES: UNLESS OTHERWISE SPECIFIED

QTY REQD	QTY	PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION	CODE IDENT	MATERIAL	DATA: SPECIFICATIONS SIZES, NOTES, VENDORS	LINE NO.
	4		RIVET		ST. STL. RD HD	3/16 DIA X 1/2 LONG. CONE.	
1		-04	PLATE		ST. STL. PLATE	1/2 THK	003
1		-03	RUD		ST STL RD BAR	1/2 DIA	004
2		-02	END FITTING ASSY				003
1		-01	BAND		7610W SHEET	.010 THK 1745STL ALLOY 60	002
-02		EX-N69626084	BAND ASSY				001

LIST OF MATERIALS OR PARTS LIST

UNLESS OTHERWISE SPECIFIED: DIMENSIONS ARE IN INCHES. TOLERANCES ON: DECIMALS ANGLES FRACTIONS				OR BY V. K. MURSON		ATOMICS INTERNATIONAL	
XX = ± .03 XXX = ± .010 ± 30° ± 32				CHK BY		A Division of North American Aviation, Inc. CANOGA PARK, CALIFORNIA	
HOLES NOTED "DRILL"				APPROVED BY		BAND ASSY-Z.H. DRUM	
.013 THRU .040: +.001-.001				EX-N69626084		COMPONENTS SHALL F	
.041 THRU .130: +.002-.001						VIBRATION TEST	
.131 THRU .229: +.003-.001							
.230 THRU .500: +.004-.001							
.501 THRU .750: +.005-.001							
.751 THRU 1.000: +.007-.001							
1.001 THRU 2.000: +.010-.001							
DO NOT SCALE PRINT							
APPLICATION (USAGE) DATA							

FANSTEEL CERTIFICATION

North American Rockwell Corp
Atomic International Div. - 5900 Le Soto Ave
Canoga Park, Calif TAG N-9260262
(J.T. Eyerson & Son, Inc)

CUSTOMER _____ PURCHASE ORDER NO. 12AD505321
PRODUCTION NO. 777641 QUANTITY 3 pcz .825K
MATERIAL .010" x Random Width x Random Length Fansteel 60 Metal

LOT NO. 60 B 1921

CHEMICAL REPORT (All values in PPM unless otherwise shown)

C	13
O	100
H	10
Ti	10
Fe	10
Ni	10
Si	10
Mn	10
Cr	10
Al	10
Cu	10
Sn	10
Cr	10
V	10
Co	10
Mo	10
W	10
Cb	600
Nb	9.90%
Ta	10

11/20/68

QUALITY CONTROL REPRESENTATIVE

(1) 3 POINTS AS REQD TO ATTAIN 75 LBS AND PUNED
 (2) 2 SURFACE FLAT WITHIN .001 TOL
 & DRAWING INTERPRETATION FOR SPECIFICATIONS
 * NOTES UNLESS OTHERWISE SPECIFIED

[illegible][illegible]

APPENDIX 8

APPENDIX 9

BAND TENSION LOAD CALCULATIONS

Pre-tension in-flight band to be 131.25 lb with a load stress of 28,846 psi (based on holding BeO block to absorber up to 75 g's).
See TI-696-26-021.

Estimated weight of test BeO block (EX-N69626085) = 2.0 lb

Block weight times 75 g's = 150 lb

Desired preload in each end of band = $\frac{150}{2} = 75$ lbs

Let tensile preload in band be 28,850 psi

Area of band = $\frac{P}{\sigma} = \frac{75}{28,850} = 0.0026 \text{ in}^2$

Thickness of band = 0.010 inch, $\therefore$ width of band = 0.260 inch

Stress cycle strain gages to $\sim 45,000$ psi

$P = \sigma A = 45,000 (.0026) = 117 \text{ lb } (\sim 110 \pm 5 \text{ lb})$

Actual stress in band during stress cycling = $\sigma = \frac{110}{.0026} = 42,300$ psi

Yield tensile strength of Ta-10W per AI test = 87,000 psi
(.010 sheet recrystallized)

INTERNAL LETTER
NORTH AMERICAN ROCKWELL CORPORATION
AEROSPACE AND SYSTEMS GROUP

TR-696-26-003

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APPENDIX 10

Date March 24, 1969

TO L. M. Maki
Address 715
BB03

FROM L. A. Garber
Address 737-752
S027

Phone 6463

Subject Test Plan Deviation - Use of Uncalibrated
Test Instrumentation and Equipment;
Environmental Test Laboratory - Bldg. 027

Ref: DTP-696-26-004, "Development Test Procedure,
1 pi Reflector Drum EEO Components Tests
Outlined in Work Plan WPL-696-25-001."
G. P. Quezner, 12/26/68

This IL documents our telephone conversation of 3-21-69 during which you agreed to a deviation from the referenced DTP. The deviation recognizes the utilization of some instruments and equipment which do not have current calibration or service stickers. It was agreed that the test should be started observing the following criteria:

1. Calibration of data readout systems will use calibrated instruments.
2. Input levels will be established using readings from calibrated instruments.
3. Calibration or service stickers will be obtained for out-of-date equipment as soon as possible consistent with available funds and manpower.
4. Any deviations concerning the use of out-of-date equipment will be noted in the final test report.

L. A. Garber
Rockwell Components Unit

cc: P. M. Forster
G. P. Steele III
L. H. Hill
G. P. Quezner
L. M. Maki
BB03
M. D. Nagel 737-4705
J. E. Spreen 737-4705