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SNAP 19 PROGRAM

GENERATOR SUPPORT STRUCTURE

TRANSMISSIBILITY TEST REPORT

MND-3169-61

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There is no objection from the patent
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ABSTRACT

This report describes and presents the results of transmissibility tests conducted on the generator and support structure assembly of the SNAP 19 Radioisotope Thermoelectric Generator power supply system for the Nimbus B Satellite application. Transmissibility data is presented in the form of response vs. frequency plots for various locations and vibration conditions.

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I. INTRODUCTION

A. Purpose

The SNAP 19 generator and support structure assembly was vibrated in three axes, at varying frequencies and vibration levels, for the purpose of obtaining frequency response data at a number of points of interest on the assembly. This information was required for the overall analysis of the Nimbus B Spacecraft.

B. Applicable Documents

MNSP-MN-4186	Martin-Nuclear IDC: SNAP 19 Meeting at Martin, 10 February 1965, on Transmissibility Tests, dated February 15, 1965
452A1000000	Generator Assembly, SNAP 19, Nimbus (Change C)
452A1050010	Support Structure Assembly

II. DISCUSSION

A. Description of Specimen

The transmissibility tests described herein were conducted on an assembly consisting of SNAP 19 generators S/N 001 and 002, and the associated support structure and standoff support. The ejection mechanism was not operative. Mounting of the assembly to vibration fixtures geometrically simulated the normal spacecraft mounting, utilizing the design attachment points and standard size fasteners.

The generators themselves were complete prototypes, with the exception that no electrical heater leads were installed, and the units were inoperative during the test.

B. Test Conditions

1. Instrumentation

The test assembly was instrumented with Endevco Model 2235 crystal accelerometers at nine positions, as shown in the diagram. Accelerometers numbered 2 through 9 were permanently mounted to sense acceleration in the axes indicated, throughout the complete range of tests. Number 1 was oriented parallel to the vibration axis for each test, to provide the input acceleration reference.

2. Data Recording

Signals from Number 1 reference accelerometer and from each of the remaining accelerometers were fed to the automatic transmissibility plotter. Within this system, the voltage sensitivity of each individual accelerometer was normalized against that of accelerometer number 1. The normalized signals were then sent into two identical narrow band, constant bandwidth type analyzers. The filtered analyzer outputs were fed into identical log converters, and in turn into a differential amplifier. This conditioned signal was recorded by an X-Y plotter, the Y-axis being driven by the output of the differential amplifier, and the X-axis by a potentiometer attached to the variable frequency oscillator which regulated the shaker vibration frequency.

The transmissibility plotter has provisions for recording three channels simultaneously, by the above process. Thus, the response at three accelerometer locations could be recorded during any one frequency sweep. The resulting plots show transmissibility in decibels (DB.), or voltage ratio, versus frequency. The DB. values are converted to the ratio of output to input acceleration (Q) by the following relation:

$$Q = \text{Antilog } \frac{\text{DB.}}{20}$$

C. Method of Test

In order to adequately record the desired response data, 36 vibration frequency sweeps were made, as detailed in Table 1. In each case, the frequency range was swept at a linear rate, controlled by the variable frequency oscillator of the transmissibility plotter.

Vibration in the thrust axis was performed at peak accelerations of 5g, 3g, and 1g. In addition to the 50 to 2000 cps frequency sweeps at 5g, sweeps were made from 16 to 200 cps, to expand the frequency scale of the plots in the region of the primary resonance. At the 3g and 1g levels, only the frequency range from 12 to 400 cps was swept. In all cases except for the 200 cps range, the frequency scales were swept both upward and downward to detect any peculiarities in resonant peak shape.

In the radial and tangential axis, the frequency surveys were made at 3g and at 1g, to avoid the large amplitudes at resonance which would result from higher input loads. Frequency sweeps were again made from 12 to 200 cps and from 50 to 2000 cps, sweeping in both directions.

Two complete sets of runs were made at each g - loading in the thrust and radial axes, since information was desired at six accelerometer locations, only three of which could be recorded simultaneously.

D. Test Results

Results of all tests are presented in the form of transmissibility plots which are numbered according to run (Table 1), and accelerometer number.

Several runs were repeated where original runs were in question, due to temperature changes which affected the crystal frequency control of the analyzer, or to analyzer drift, etc. In each case, the spurious data was discarded and replaced by valid plots.

In general, comparable results were obtained between upward and downward frequency sweeps under the same conditions. A notable exception is seen in Runs 23 and 24. A peak at 31 cps during the downsweep of Run 24 is higher in amplitude than a corresponding peak developed at 28 cps during the upsweep of Run 23. This case was further investigated by manually sweeping slowly back and forth through the resonant range. The resonance was shown to have a very narrow peak which sometimes appeared and sometimes did not build up, apparently due to non-linearity of the structure rather than to the recording equipment. This may be due to a "hardening spring" effect.

SNAP 19 TRANSMISSIBILITY TEST
SINUSOIDAL VIBRATION
LINEAR FREQUENCY SWEEPS

RUN NO.	INPUT AXIS	FREQUENCY RANGE (CPS)	INPUT g LEVEL	CHANNELS PLOTTED	DURATION (MIN:SEC)
1	Thrust	16 - 200	5 g	2, 5, 7	8:41
2	Thrust	50 - 2000	5	2, 5, 7	9:00
3	Thrust	50 - 2000	5	3, 8, 9	9:36
4	Thrust	16 - 200	5	3, 8, 9	9:55
5	Thrust	12 - 400	3	3, 8, 9	3:45
6	Thrust	400 - 12	3	3, 8, 9	3:53
7	Thrust	12 - 400	3	2, 5, 7	3:43
8	Thrust	400 - 12	3	2, 5, 7	3:49
9	Thrust	12 - 400	1	2, 5, 7	3:52
10	Thrust	400 - 12	1	2, 5, 7	4:48
11	Thrust	12 - 400	1	3, 8, 9	3:57
12	Thrust	400 - 12	1	3, 8, 9	3:52
13	Radial	12 - 200	3	3, 6, 8	8:32
14	Radial	200 - 12	3	3, 6, 8	8:35
15	Radial	50 - 2000	3	3, 6, 8	17:49
16	Radial	2000 - 50	3	3, 6, 8	17:42
17	Radial	50 - 2000	3	2, 5, 9	17:46
18	Radial	2000 - 50	3	2, 5, 9	17:46
19	Radial	50 - 2000	1	2, 5, 9	17:49
20	Radial	2000 - 50	1	2, 5, 9	18:02
21	Radial	50 - 2000	1	3, 6, 8	18:26
22	Radial	2000 - 50	1	3, 6, 8	17:43
23	Radial	12 - 200	1	3, 6, 8	8:53
24	Radial	200 - 12	1	3, 6, 8	9:00
25	Radial	12 - 200	1	2, 5, 9	8:36
26	Radial	200 - 12	1	2, 5, 9	9:22
27	Radial	12 - 200	3	2, 5, 9	8:46
28	Radial	200 - 12	3	2, 5, 9	9:14
29	Tangential	12 - 200	1	2, 3, 4	8:36
30	Tangential	200 - 12	1	2, 3, 4	8:52
31	Tangential	12 - 200	3	2, 3, 4	9:02
32	Tangential	200 - 12	3	2, 3, 4	8:50
33	Tangential	50 - 2000	3	2, 3, 4	17:10
34	Tangential	2000 - 50	3	2, 3, 4	17:49
35	Tangential	50 - 2000	1	2, 3, 4	17:46
36	Tangential	2000 - 50	1	2, 3, 4	17:48

TRANSMISSIBILITY TEST
 SNAP 19 ASSEMBLY SHOWING ACCELEROMETER LOCATION
 AND ORIENTATION

9.

32.

FREDERICK POST COMPANY
301TR10 CROSS SECTION 10X10 PER INCH

FREDERICK POST COMPANY
301TR10 CROSS SECTION 10X10 PER INCH

FREDERICK POST COMPANY
301TR10 CROSS SECTION 10X10 PER INCH

FREDERICK POST COMPANY
301TR10 CROSS SECTION 10X10 PER INCH

FREDERICK POST COMPANY
301TR10 CROSS SECTION 10X10 PER INCH

38.

FREDERICK POST COMPANY
301TR10 CROSS SECTION 10X10 PER INCH

RUN 13 3/2/65
RADIAL AXIS
12-200 CPS @ 3g
ACCEL. #6

10 DB/IN
~
Q
0
DB.
(1:1)

24 CPS
Q = 5.0

84 CPS
Q = 1.6

12

40

80

120

160

200

FREQUENCY ~ CPS

FREDERICK POST COMPANY
301TR10 CROSS SECTION 10X10 PER INCH

RUN 13 3/2/65
RADIAL AXIS
12-200 CPS @ 3g
ACCEL. #8

FREDERICK POST COMPANY
301TR10 CROSS SECTION 10X10 PER INCH

FREDERICK POST COMPANY
301TR10 CROSS SECTION 10X10 PER INCH

FREDERICK POST COMPANY
301TR10 CROSS SECTION 10X10 PER INCH

FREDERICK POST COMPANY
301TR10 CROSS SECTION 10X10 PER INCH

RUN 15 3/3/65
RADIAL AXIS
50-2000 CPS @ 3g

ACCEL. #3

FREDERICK POST COMPANY
301R10 CROSS SECTION 10X10 PER INCH

45.

FREDERICK POST COMPANY
CENTRIC CROSS SECTION 10 X 10 PER INCH

RUN 15 3/3/65
RADIAL AXIS
50-2000 CPS @ 3 g

ACCEL. # 8

46.

FREDERICK POST COMPANY
301 TRIO CROSS SECTION 10 X 10 PER INCH

FREDERICK POST COMPANY
301 TRIO CROSS SECTION 10 X 10 PER INCH

RUN 16 3/3/65
RADIAL AXIS
2000-50 CPS @ 3g

ACCEL. #6

FELF-CO TO COMPANY
3011 CROSS SECTION K ERINCH

FREDERICK POST COMPANY
301 TR19 CROSS SECTION 10 X 10 PER INCH

RUN 17 3/3/65
RADIAL AXIS
50-2000 CPS @ 3g
ACCEL. #2

FRITZCK 10% COMPANY
1" H. CROSS SECTION 10 X 1 PER INCH

FREDERICK POST COMPANY
301TR10 CROSS SECTION 10 X 10 PER INCH

RUN 17 3/3/65
RADIAL AXIS
50-2000 CPS @ 3g

ACCEL. #9

10 DB/IN.
0
0 DB
(1:1)

FREDERICK POST COMPANY
3011610 CROSS SECTION 10 X 10 PER INCH

FREDERICK POST COMPANY
SUTRIC CROSS SECTION 10 X 12 PER INCH

FREDERICK POST COMPANY
301 TRIP CROSS SECTION 10 X 10 PER INCH

FREDERICK POST COMPANY
301 TR10 CROSS SECTION 10 X 10 PER INCH

FREDERICK POST COMPANY
30 TRI6 CROSS SECTION 10 X 10 PER INCH

FREDERICK POST COMPANY
361TR16 CROSS SECTION 10 X 16 PER INCH

RUN 19 3/4/65
RADIAL AXIS
50-2000 CPS @ 1g
ACCEL. #9

10 DB / IN.
2
Q
0 DB.
(1:1)

245 CPS
Q=3.7

270 CPS
Q=2.8

520 CPS
Q=3.15

1190 CPS
Q=2.0

50

400

800

1200

1600

2000

FREQUENCY ~ CPS

FREDERICK POST COMPANY
301 TR10 CROSS SECTION 10 X 10 PER INCH

RUN 20 3/4/65
RADIAL AXIS
2000-50 CPS @ 1g

ACCEL. #2

FREDERICK POST COMPANY
301 BR 10 CROSS SECTION 10 X 10 PER INCH

RUN 20 3/4/65
RADIAL AXIS
2000 - 50 CPS
ACCEL. #5

FREDERICK POST COMPANY
301 FRI0 CROSS SECTION 10 X 10 PER INCH

FREDERICK FOST COMPANY
301TR10 CRO SECTION 1 X 1 FLR INCH

RUN 21 3/4/65
RADIAL AXIS
50-2000 CPS @ 1g

ACCEL. #3

FREDERICK POST COMPANY
301 TR10 CROSS SECTION 10 X 10 PER INCH

FREDERICK FORT COMPANY
301TR 0 CROSS SECTION 10 X 1 PER INCH

FREDERICK POST COMPANY
301 TRIG. GRAPH SECTION 10 X 10 PER INCH

RUN 22 3/4/65
RADIAL AXIS
2000-50 CPS @ 1g

ACCEL. # 3

65.

FREDERICK POST COMPANY
301 TRIO CROSS SECTION 10 X 10 PER INCH

RUN 22 3/4/65
RADIAL AXIS
2000-50 CPS @ 1g

ACCEL #6

66.

FREDERICK POST COMPANY
301TR10 CROSS SECTION 10 X 10 PER INCH

RUN 22 3/4/65
RADIAL AXIS
2000-50CPS @ 1g
ACCEL. # 8

FREDERICK POST COMPANY
301TR10 CROSS SECTION 10 X 10 PER INCH

FREDERICK POST COMPANY
301TR10 CROSS SECTION 10 X 10 PER INCH

FREDERICK POST COMPANY
301 TRIO CROSS SECTION 10 X 10 PER INCH

FREDERICK POST COMPANY
301TR10 CROSS SECTION 10 X 10 PER INCH

FREDERICK POST COMPANY
301TR10 CROSS SECTION 10 X 10 PER NCH

FREDERICK POST COMPANY
J01TR10 CROSS SECTION 10 X 10 PER INCH

RUN 25 3/5/65
RADIAL AXIS
112-200 CPS @ 1g
ACCEL. #2

FREDERICK POST COMPANY
301TR10 CROSS SECTION 10 X 10 PER INCH

FREDERICK POST COMPANY
301 TRIO CROSS SECTION 10 X 11 PER INCH

FREDERICK POST COMPANY
301TR10 CROSS SECTION 10 X 10 PER INCH

FREDERICK POST COMPANY
9511R10 CROSS SECTION 10 X 10 PER INCH

78.

FREDERICK POST COMPANY
301TR10 CROSS SECTION 10 X 10 PER INCH

RUN 20 3/5/65
RADIAL AXIS
200-12 CPS @ 1g
ACCEL. #9

DB
(1:1)

79.

FREDERICK POST COMPANY
301TR10 CROSS SECTION 10 X 10 PER INCHRUN 27 3/5/65
RADIAL AXIS
12-200 CPS @ 3g

ACCEL. #2

FREDERICK POST COMPANY
301 TR10 CROSS SECTION 10 X 10 PER INCH

FREderick POST COMPANY
301TH10 CROSS SECTION X 1 FLR INCH

82.

FREDERICK POST COMPANY
301 TR10 CROSS SECTION 10 X 10 PER INCH

RUN 28 3/5/65
RADIAL AXIS
200-12 CPS @ 3g

ACCEL. #2

FREDERICK POST COMPANY
301 TR10 CROSS SECTION 10 X 10 PER INCH

84.

FREDERICK POST COMPANY
301 TRIO CROSS SECTION 10 X 10 PER INCH

RUN 28 3/5/65
RADIAL AXIS
200-12 CPS @ 3g

ACCEL. # 9

FREDERICK POST COMPANY
301TR10 CROSS SECTION 10 X 10 PER INCH

FREDERICK POST COMPANY
301TR16 CROSS SECTION 10 X 10 PER INCH

RUN 29 3/5/65
TANGENTIAL AXIS
12-200 CPS @ 19
ACCEL. #3

FREDEF CK POST COMPANY
3011R10 CROSS SECTION 10 X 10 INCH

FREDERICK POST COMPANY
301 TR10 CROSS SECTION 10 X 10 PER INCH

RUN 30 3/5/65
TANGENTIAL AXIS
200-12 CPS @ 19
ACCEL. #2

dB/W
10
0
dB
(1:1)

FREDERICK POST COMPANY
301 TR10 CROSS SECTION 10 X 16 PER INCH

RUN 30 3/5/65
TANGENTIAL AXIS
200-12 CPS @ 19
ACCEL. #3

Q ~ 10 DB/IN.
(80
9:1)

35 CPS
Q = 1.18

TRANSIENTS
(DISREGARD)

12

40

80

120

160

200

FREQUENCY ~ CPS

FREDERICK POST COMPANY
301TR10 CROSS SECTION 10 X 10 PER INCH

RUN 30 3/5/65
TANGENTIAL AXIS
200-12 CPS @ 19

ACCEL. #4

FREDERICK POST COMPANY
301TR16 CROSS SECTION 10 X 10 PER INCH

RUN 31 3/5/65
TANGENTIAL AXIS
12-200 CPS @ 39
ACCEL. #2

10 dB/in.
~
Q
0
dB
(1:1)

FREDERICK POST COMPANY
301 TR10 CROSS SECTION 10 X 10 PLR INCH

RUN 31 3/5/65
TANGENTIAL AXIS
12-200 CPS @ 3g

ACCEL. #3

FREDERICK POST COMPANY
301TR10 CROSS SECTION 10 X 10 PER INCH

FREDERICK POST COMPANY
J01YR10 CROSS SECTION 10 X 10 PER INCH

RUN 32 3/5/65
TANGENTIAL AXIS
200-12 CPS @ 39
ACCEL. #2

FREDERICK POST COMPANY
301 ERIC CROSS SECTION 10 X 10 PER INCH

RUN 32 3/5/65
TANGENTIAL AXIS
200-12 CPS @ 39
ACCEL. #3

FREDERICK POST COMPANY
301TR10 CROSS SECTION 10 X 10 PER INCH

RUN 32 3/5/65
TANGENTIAL AXIS
200-12 CPS @ 39
ACCEL. #4

FREDERICK POST COMPANY
301TR10 CROSS SECTION 10 X 10 PER INCH

RUN 33 3/5/65
TANGENTIAL AXIS
50-2000 CPS @ 3g
ACCEL. #2

10 dB/m.
a ~
0 dB
(1:1)

FREDERICK POST COMPANY
301TR10 CROSS SECTION 10 X 10 PER INCH

RUN 33 3/5/65
TANGENTIAL AXIS
50-2000 CPS @ 3g

ACCEL. #3

dB/N
Q ~ 10

0
dB
(1:1)

FREDERICK POST COMPANY
301TR10 CROSS SECTION 10 X 10 PER INCH

RUN 33 3/5/65
TANGENTIAL AXIS
50-2000 CPS @ 3g

ACCEL. #4

FREDERICK POST COMPANY
301TR10 CROSS SECTION 10 X 10 PER INCH

RUN 34 3/5/65
TANGENTIAL AXIS
2000-50 CPS @ 39

ACCEL. #2

10 DB/N.
~
Q
0
DB
(1:1)

FREDERICK POST COMPANY
301 TR10 CROSS SECTION 10 X 10 PER INCH

RUN 34 3/5/65
TANGENTIAL AXIS
2000-50 CPS @ 39

ACCEL. #3

10 DB/N.

0
DB
(1:1)

FREDERICK POST COMPANY
301 TR10 CROSS SECTION 10 X 10 PER INCH

RUN 34 3/5/65
TANGENTIAL AXIS
2000 - 50 CPS @ 3g

ACCEL. #4

FREDERICK POST COMPANY
301TR10 CROSS SECTION 10 X 10 PER INCH

RUN 35 3/6/65
TANGENTIAL AXIS
50-2000 CPS @ 1g
ACCEL. #2

DB/N.
10
~
Q
0
DB
(1:1)

FREDERICK POST COMPANY
30" TRI0 CROSS SECTION 10 X 10 PER INCH

RUN 35 3/6/65
TANGENTIAL AXIS
50-2000 CPS @ 1g

ACCEL. #3

DB
(1:1)

FREDERICK POST COMPANY
301TR10 CROSS SECTION 10 X 10 PER INCH

RUN 35 3/6/65
TANGENTIAL AXIS
50-2000 CPS @ 1g

ACCEL #4

10 dB/IN.
Q
0
dB
(1:1)

RUN 36 3/6/65
TANGENTIAL AXIS
2000-50 CPS @ 1g
ACCEL. #2

0
DB
(1:1)

10
DB/IN.

FREDERICK POST COMPANY
01111 CRO 5 SECTO 0 / 1 FLR INCH

RUN 36 3/6/65
TANGENTIAL AXIS
2000-50 CPS @ 19

ACCEL. #3

Q ~ 10 DB/N.

(-50)

RUN 36 3/6/65
TANGENTIAL AXIS
2000-50 CPS @ 19

ACCEL. #4