PRESENTATION OF ADAPTING THE SNAP-50 SPACE POWERPLANT TO A LUNAR BASE

AEC RESEARCH AND DEVELOPMENT REPORT

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PRATT & WHITNEY AIRCRAFT DIVISION OF UNITED AIRCRAFT CORPORATION

MIDDLETOWN, CONNECTICUT

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This report contains the illustrations which were used in the Pratt & Whitney Aircraft-CANEL presentation of adapting the SNAP-50 space powerplant to a lunar base. The presentation was to Colonel E.M. Douthett, Manager of the SNAP-50/SPUR Office, AEC Division of Reactor Development, Colonel T. C. Evans of NASA and Captain C.S. Gates of the U.S. Army Corps of Engineers in Washington, D.C., on October 8, 1963.

Part I of this report contains the illustrations which were used for the basic presentation and Part II contains those illustrations which were used as supplemental information for additional elaboration.

The 300 Kwe SNAP-50 space powerplant is depicted in Fig 2. An adaptation of this powerplant to a 50 Kwe lunar base power supply suitable for early lunar applications is shown in Fig 3. This reduction in power output is accomplished by incorporating only one of the four main radiator-condenser circuits of the basic SNAP-50 powerplant and operating the other components at derated conditions. The specific weight of this 50 Kwe lunar powerplant is approximately 80 lbs/Kwe without shielding. Higher power outputs are achieved with this basic powerplant by employing additional main radiator-condenser circuits. The specific weight of a unshielded 300 Kwe powerplant of this type is approximately 20 lb/Kwe.
I. BASIC PRESENTATION
# DESIGN OBJECTIVES

## SNAP - 50

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<th>SPACE SYSTEM</th>
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<td>10-20 LB/KWE</td>
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<td><strong>AVAILABILITY</strong></td>
<td>EARLY 1970'S</td>
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SNAP-50 LUNAR POWERPLANT
300 KWE SNAP - 50 FLOW SCHEMATIC

2000F 46 PSIA
18.8 LB/SEC
55 PSIA

1900F 30 PSIA

1850F 94.2 PSIA
100% QUALITY

1260F 6.9 PSIA
84.8 QUALITY
1.9 LB/SEC

1227F 28 PSIA

1077F 34 PSIA

1077F 18 PSIA
12 LB/SEC

1138F 140 PSIA
6.6 LB/SEC

1127F 5.7 PSIA
37 PSIA

RAD
CONSIDERATIONS IN ADAPTING SNAP-50 TO LUNAR BASE

HEAT REJECTION

SHIELDING

REACTOR SIDE REFLECTOR COOLING

DECAY HEAT REMOVAL AND POWERPLANT DISPOSAL
HEAT REJECTION

DIFFERS FROM SPACE OPERATION

IN ADDITION TO DIRECT SUNLIGHT THE EFFECTS OF LUNAR REFLECTION AND RADIATION MUST BE CONSIDERED

MAIN RADIATOR - NOT EFFECTED

AUXILIARY RADIATOR - SOME CHANGE

SOLID STATE DEVICE COOLING - MAJOR CONSIDERATION FOR DAY OPERATION

ALTERNATIVES:

DIRECT RADIATION - NOT FEASIBLE
HEAT STORAGE - VERY HEAVY
REFRIGERATION - PROBABLE METHOD
SHIEL DING FOR 500 KWT REACTOR POWER

OPERATING SHIELDS:

NEUTRON - 48 INCHES LiH
1 MREM/HR AT 500 FT
10^{12} NVT AT 10 FEET FOR 10,000 HOURS OPERATION

GAMMA - 3.5 INCHES U^{238}
1 MREM/HR AT 500 FEET
3 \times 10^4 RADS AT 10 FEET FOR 10,000 HOURS OPERATION

SHUTDOWN SHIELD:

GAMMA - 3.5 INCHES U^{238}
0.1 REM/HR AT 10 FEET ONE MONTH AFTER SHUTDOWN
SNAP - 50 REACTOR
SIDE REFLECTOR COOLING

SPACECRAFT APPLICATION:
REFLECTOR COOLED BY DIRECT THERMAL RADIATION TO SPACE

LUNAR BASE APPLICATION:
NO OBSTRUCTIONS - REFLECTOR AT 1500F
RADIATES TO SPACE OR LUNAR SURFACE

SHIELDED OR UNDERGROUND SITE - COLD WALL ABOUT 500F WITH AUXILIARY COOLING SYSTEM

SPACING TO MINIMIZE REACTIVITY EFFECTS
DECAY HEAT REMOVAL AND POWERPLANT DISPOSAL

NATURAL CIRCULATION FEASIBLE AT LUNAR GRAVITY

CONSIDERATIONS:

DIRECT PIPING FROM REACTOR CIRCUIT TO RADIATOR CIRCUIT

RADIATOR PANELS ADEQUATE TO REJECT DECAY HEAT

FREEZING OF RADIATOR PANELS MAY OCCUR AFTER LONG DECAY TIME

DIRECT RADIATION FROM REACTOR VESSEL AFTER LONG DECAY TIME
150 KWE POWERPLANT ARRANGEMENT USING SIV B PAYLOAD ENVELOPE WITH MIDCOURSE REORIENTATION

- MAIN RADIATOR PANELS
- POWER CONVERSION UNIT
- SECONDARY RADIATOR PANELS
- FUEL TANK SECTION
- REACTOR
- LUNAR LANDING ENGINE
- LUNAR SURFACE
300 KWE POWERPLANT ARRANGEMENT USING LEM VEHICLE

LUNAR CRATER APPROX. 140 FT. DIA.
1200 KWE LUNAR BASE
POWERPLANT ARRANGEMENT

MAIN RADIATOR PANELS
SECONDARY RADIATOR PANELS

LUNAR SURFACE
REACTOR
POWER CONVERSION UNIT
PIPING CONDUIT

92'
20'
30'
II. ADDITIONAL INFORMATION
# POWERPLANT WEIGHT SUMMARY

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<th>50 KWE</th>
<th>300 KWE</th>
<th>1200 KWE</th>
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<tr>
<td></td>
<td>750</td>
<td>1000</td>
<td>2000</td>
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<td><strong>TOTAL WEIGHT (LBS)</strong></td>
<td>3910</td>
<td>5670</td>
<td>15570</td>
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RADIATOR EFFICIENCY VERSUS RADIATOR TEMPERATURE

PARAMETER = SINK TEMPERATURE

RADIATOR EFFICIENCY (%)}

RADIATOR TEMPERATURE (F)

-260F

-60F

140F

340F

540F
THICKNESS OF NEUTRON OPERATING SHIELD VERSUS DISTANCE FROM REACTOR

REACTOR POWER - 500 KWT
SHIELD - LITHIUM HYDRIDE

DISTANCE - FT.

THICKNESS INCHES

100 300 1000

1.0 MREM/HR
0.1 REM/HR
10.0 REM/HR
THICKNESS OF GAMMA OPERATING SHIELD VERSUS DISTANCE FROM REACTOR

- Reactor Power: 500 KWT
- Shield: Depleted U^{238}

Distance in ft: 10, 30, 100, 300, 1000, 3000, 10,000

Thicknes in inches: 6.0, 5.0, 4.0, 3.0, 2.0, 1.0, 0.0

Dosages: 1 MREM/HR, 100 MREM/HR
THICKNESS OF GAMMA SHUTDOWN SHIELD VERSUS DISTANCE FROM REACTOR

DOSE = 0.1 REM/HR.

DOSE = 1.0 REM/HR.

REACTOR POWER = 500 KWT

SHIELD - DEPLETED U\(^{238}\)

OPERATING TIME - 10,000 HRS.
LAUNCH VEHICLE PAYLOAD ENVELOPE

DELIVERED PAYLOAD - 25,000 LBS

250 IN.

DIA.

250 IN.

100 IN.

250 IN.
LEM VEHICLE - SEQUENCE

1

300 KWE SNAP-50
SPACE POWERPLANT

2

EXPLODED VIEW OF ASSEMBLIES
LEM VEHICLE - SEQUENCE
(CONTINUED)

3

LANDING ON LUNAR SURFACE

4

NESTED ASSEMBLY IN LEM "TRUCK" VEHICLE
LEM VEHICLE - SEQUENCE

CONTINUED

5

DEPLOYMENT OF VEHICLE SHROUD

6

UNLOADING OF ASSEMBLIES
LEM VEHICLE - SEQUENCE

(continued)

7

ASSEMBLY OF STRUCTURAL FRAME

8

FINAL INSTALLATION