Westinghouse Astronuclear Laboratory

FPMS LIFE TEST

FINAL REPORT

AEC Contract AT (11-1)-3559

Prepared for:

U. S. ATOMIC ENERGY COMMISSION

January 1975

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SUMMARY

The SNAP-23A Fueled Prototype Mockup System has been on system thermal and life test since February 1970. It has accumulated 36,200 hours of testing through June 30, 1974 of which 34,600 have been accumulated on life test with the Prototype Mockup Converter PMC-3. On June 30 the system was producing 56 watts at an overall efficiency of 5.7 percent. The fuel power level was 978 watts corresponding to 7.7 years from the nominal fuel design loading of 1180 watts. During the life test period the system has performed as predicted without any significant degradation of system components and interfaces. The changes in performance have been consistent with that expected due to fuel decay.

This report marks the termination of the accumulation of life test data under Contract No. AT(11-1)-3559.

1.0 INTRODUCTION

At the end of Phase I, the Fueled Prototype Mockup System, FPMS, was assembled and testing was initiated on February 4, 1970. Initially testing was conducted with the PMC-2 converter for the purpose of evaluating the thermal performance of the system; results were documented in the Phase I Final Report - WANL 3800-46. The PMC-2 converter was removed on April 13, 1970 after 1634 hours of testing.

Testing of FPMS was resumed on May 12, 1970 with the PMC-3 converter and has continued on life test to date. The first 1170 hours of testing through June 30, 1970 was reported in the Phase II Final Report, WANL 4182-3.

The system was run on life tests at normal load conditions to produce 60 watts at 24 volts. During the first year from June 30, 1970 to June 30, 1971, a series of data points were taken quarterly with the system in thermal steady state at off load electrical conditions. WANL 4219-1 documents the results of life testing through that time period. Included in that report was a description of the testing procedure and method of data collection and analysis. Life test results collected through June 30, 1972 were reported in an annual report, WANL-3559-1. During that period off load testing was discontinued. This report documents the remaining life test data collected through June 30, 1974. Although the system remains in operation, life testing has been discontinued since this point in time.

2.0 RESULTS

The FPMS with the PMC-3 converter has been on test since May 12, 1970, and has accumulated 36,200 hours of testing through June 30, 1974. During this period 72 data points were taken at normal and off load operating conditions. Figures 2-1 to 2-3 show the thermal and thermoelectric performance of the system at normal loads. The predicted performance projected from the 1000 hour data based on the fuel decay rate is represented by the solid lines in the time dependent curves.

The initial period of FPMS/PMC-3 testing was performed with the converter operating near open circuit conditions such that the average hot cap temperature was held at 1070°F. This was performed to accelerate reseating of the elements to reduce the increased internal resistance that was experienced during converter shipping prior to assembly. Initial life test data at normal load conditions was not reported until after 700 hours of testing.

Figure 2-1 shows the projected fuel power decay and system efficiency versus time. The system power level has decayed from about 1088 watts to 980 watts during the life test period. System efficiency has dropped from 6.4 percent to 5.6 percent during this period. The experimental data has indicated essentially the same rate of decay as that projected for the effects of fuel decay with possibly some additional decay occurring over the last two years.

Figure 2-2 presents the open circuit voltage and converter power out versus time. The open circuit voltage has decayed from 46 to 39 volts and has remained close to the predicted curve. Similarly, the converter power output has decayed from 69 watts to 56 watts over the time span with good agreement to the predicted decay. Figure 2-3 is a plot of the converter temperature drop and internal resistance. The converter temperatures have shown good agreement with the projected values. The internal resistance dropped at a slightly faster

Figure 2-1. System Efficiency and Fuel Loading

Figure 2-2. Converter Power Output and Open Circuit Voltage

Figure 2-3. Converter Internal Resistance and Temperature Drop

rate in the 700 to 2000 hour range and then remained parallel to the predicted rate due to decay. The initial drop was attributed to the continued seating of the elements into the hot caps during the 700 - 2000 hour range. Figure 2-4 is a plot of the converter hot cap temperature and stud temperature versus time showing good agreement. Figure 2-5 plots the stud to hot cap temperature drop and the temperature of the base assembly at the inner ring of the hermetic seal. The temperature drop across the interface from the stud to the converter has remained stable with a total drop decaying with fuel decay from 110 to 105°F. Figure 2-6 contained plots of the drop across the interface from the converter outer case to the radiator base and the drop from the radiator base to the ambient 3 feet away. The interface has remained stable with a 10°F drop decaying to 9°F. The radiator to ambient drop has decayed from 63°F to 60°F.

Comparison of individual thermocouple readings of the latest data points with the earliest data points have indicated good stability with only a few thermocouple readings that has become erratic. Because of the small krypton leak in an inaccessible weld, the base assembly was initially filled with krypton and periodically serviced to maintain the base assembly pressure between 1 and 2 psig during the early period of the life test. During the last 18 months no backfilling has taken place. As a result the base assembly insulation probably contains an appreciable amount of air which would reduce the effectiveness of the insulation slightly.

Figure 2-4. Stud and Converter Hot Cap Temperature

Figure 2-5. Converter-Stud Interface and Base Assembly Temperatures

Figure 2-6. Converter-Ambient Interface Temperatures

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