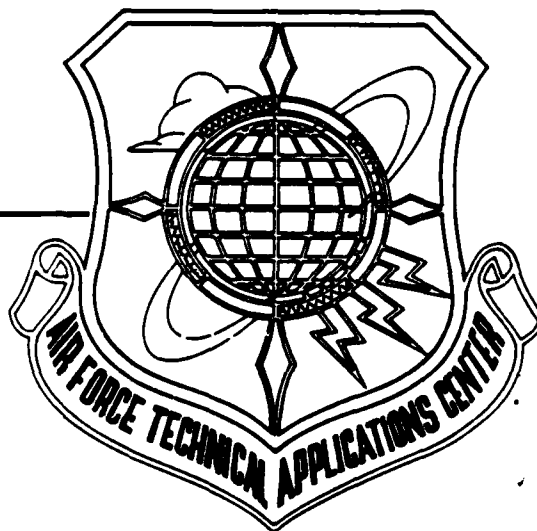


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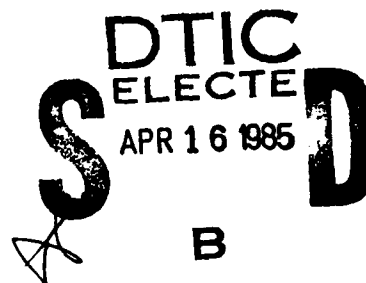
RESULTS FROM RADIATION MONITORING
EQUIPMENT EXPERIMENT ON STS-11



RICHARD G. MADONNA, VIRGIL L. BROWN, AND
STEVEN E. CASH

14 MARCH 1985

FINAL REPORT.



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The results from the Radiation Monitoring Equipment (RME) experiment, flown onboard STS-11 are presented and discussed. The RME consists of the HRM-III gamma ray counter and PRM neutron/proton dosimeter. The gamma ray data agree with data from previous flights. Increases in count rates are observed when the Orbiter is in the Southeast Asian Anomaly. Neutron/proton dosage is consistent with NASA predictions for STS-11.				
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SUMMARY

The Radiation Monitoring Equipment (RME) was flown on STS-11 Space Shuttle Mission for the purpose of testing a concept for in-cabin, real-time crew dosimetry, and for the purpose of obtaining time resolved gamma-ray background data and neutron/proton background data. The RME consists of two instruments, EG&G HRM-III gamma-ray counter and EG&G Pocket REM Meter (PRM) neutron/proton dosimeter. The HRM-III was operated by the astronaut crew four times during the mission, with each operation lasting 52.5 minutes. The PRM was operated twice during the mission with each operation lasting a minimum of 15 hours.

The results from the HRM-III operations were plotted as a function of time and as a function of ground position. The data show large increases in count rate during the periods when the Orbiter was in the East Asian Anomaly. These data are consistent with data obtained from other missions.

The PRM results are displayed in tabular form. The average dose rate from these operations is .359mrem/hr ($(2.84) \times 10^{-5}$ rad/hr). The total mission neutron/proton dosage predicted by these readings is approximately 60.30mrem (4.77mrads).

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SECTION I

INTRODUCTION

This report presents the results of the Radiation Monitoring Equipment (RME) experiment flown on STS-11. The objectives of the RME experiment are two-fold. The first objective was to exercise our ability to fly small quick reaction payloads on the Space Shuttle. The RME tested the feasibility of using state-of-the-art dosimetry equipment that was not originally designed for orbital application for in-cabin, real-time crew dosimetry. The second objective of the experiment is to obtain time resolved gamma-ray background data and neutron/proton background data.

The first objective was partially met during the flights of STS-6 and STS-8 (ref 1, ref 2). The RME was flown for the first time on STS-6 and a limited amount of data were taken. The quality of the data was sufficient to convince us that the instruments will work in space, and, more importantly, that the crew can operate them and obtain meaningful data. Longer operations were required to fully meet the first objective since the instruments were not utilized to their fullest extent during the STS-6 mission. STS-8 provided the first opportunity for long periods of operation.

The second objective was also achieved, in part, during the STS-6 and STS-8 missions. The neutron/proton dosimeter, EG&G's Pocket REM Meter (PRM), was operated for sufficiently long periods of time and gathered meaningful background data. During STS-6, the gamma-ray counter, EG&G's HRM III, was operated for only 10 seconds each time it was activated and did not yield enough background data to meet the second objective. During STS-8, the HRM-III was operated seven times for 52.5 minutes per operation. This yielded significant results.

STS-11 provided another opportunity to further both objectives of the RME experiment. The HRM III was operated four times with each operation lasting 52.5 minutes. The PRM was operated twice with each operation lasting a minimum of 15 hours.

SECTION II

EQUIPMENT

HRM-III.

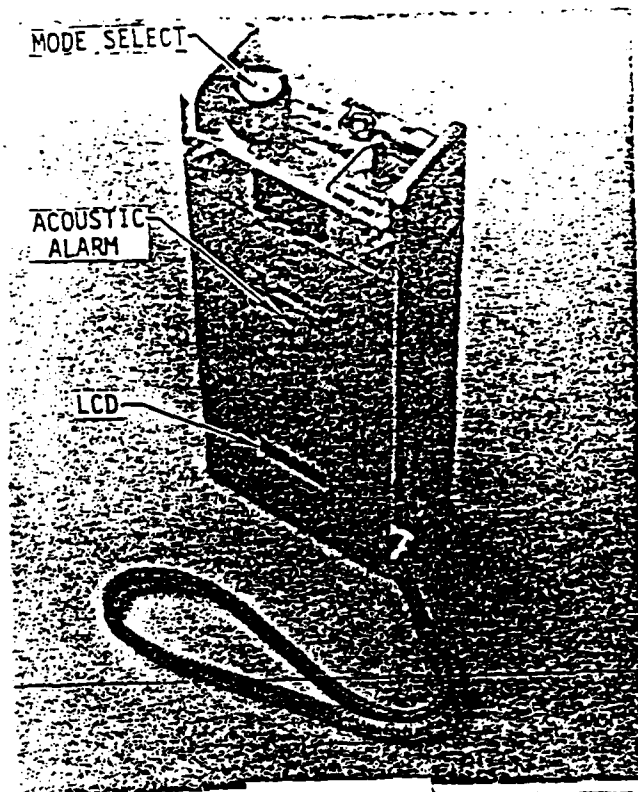
The HRM-III (Figure 1a) (ref 2) is a hand-held gamma-ray counter. It weighs approximately one kilogram (2.2 pounds) and is about the size of a small cassette recorder. The circuitry is all solid state and microprocessor controlled. The detector is a mercuric iodide (HgI_2) crystal with a detection threshold of 100keV.

The HRM-III has 105 internal memories that can store counting data for playback at a later time. These memories are filled with the average counts obtained during a user determined time interval. The interval can vary from 1/3 of a second to 33 seconds. Playback of the stored data is accomplished through a liquid crystal display (LCD) on the HRM-III. This record-playback feature allows for a time-history of the gamma-ray counts without having a user continually monitoring the instrument. (For a more complete description of the HRM-III, see references 1 and 2).

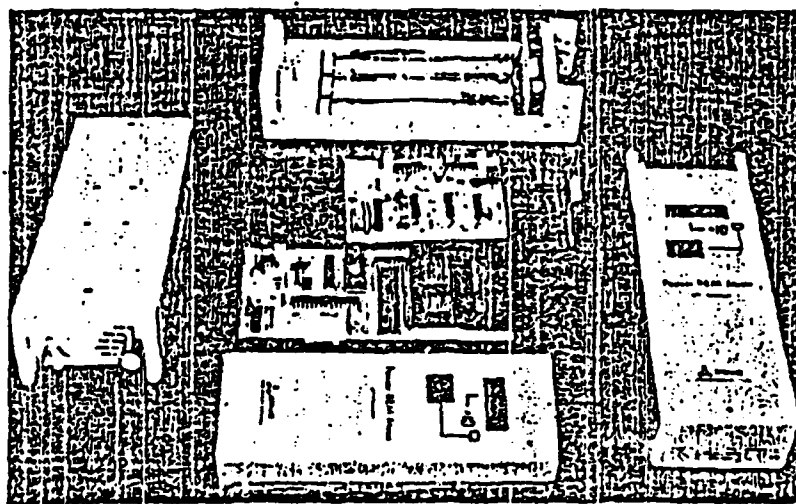
PRM.

The PRM (Figure 1b) (ref 3) is a hand-held neutron/proton dosimeter. It weighs approximately one kilogram (2.2 pounds) and is somewhat larger than the HRM-III. The PRM has microprocessor controlled solid state circuitry. It uses three ionization tubes as detectors. These tubes are surrounded by a tissue equivalent plastic. The associated electronics then produces data in the form of counts, dose (rad) and dose equivalent (rem) in real time.

Data are obtained via an LCD. The PRM will read out either hours (elapsed time since turn-on), counts, rads or rems just by changing the position of a rotary switch. The LCD displays the current value of the function (hours, counts, RADs, REMs) chosen and the LCD readout is updated as the value changes. Thus, the PRM is a real time dosimeter (For a more complete description, see references 1 and 3).



HRM-III
FIGURE 1A



PRM
FIGURE 1B

SECTION III

RESULTS

HRM-III.

The HRM-III was operated four times during the mission. Each operation lasted for 52.5 minutes. The HRM-III was setup to fill one memory every 30 seconds. In this configuration, the HRM-III took data over approximately 58% of a 165 nautical mile (nm) (305.6 km) orbit.

The data obtained from the four runs have been plotted two different ways. The first set of plots (Figures 2, 4, 6, and 8) shows average counts per second plotted against time elapsed since instruments turn on. The second set of plots (Figures 3, 5, 7, and 9) shows the average counts per second super-imposed on a map of the world with respect to the Orbiter's ground track (i.e., subpoint).

The data plotted in Figures 2 through 9 show the background counts/second for gamma-rays. The data can clearly be divided into two categories: one for count rate in the Southeast Asian Anomaly; and the other for count rates outside of the Southeast Asian Anomaly. For data taken outside the Southeast Asian Anomaly, the background average count rate is 30 counts/second. For data taken in the Anomaly the average count rate goes as high as 64 counts/second.

There is unfortunately, no easy way to convert these HRM-III counts into a "pure" gamma-ray dose. We are, however, currently exploring the possibility of modifying the PRM to include gamma-ray dosage with neutron/proton dosage.

No calibration is required for the HRM-III since it uses solid state components and detector. The HRM-III that was flown had been checked by EG&G ten months prior to STS-11.

In general, the data exhibit no technical surprises and appear consistent with previous measurements and expectations. Future flights will provide data from different altitudes and orbital inclinations thereby adding to the data base of background data.

PRM.

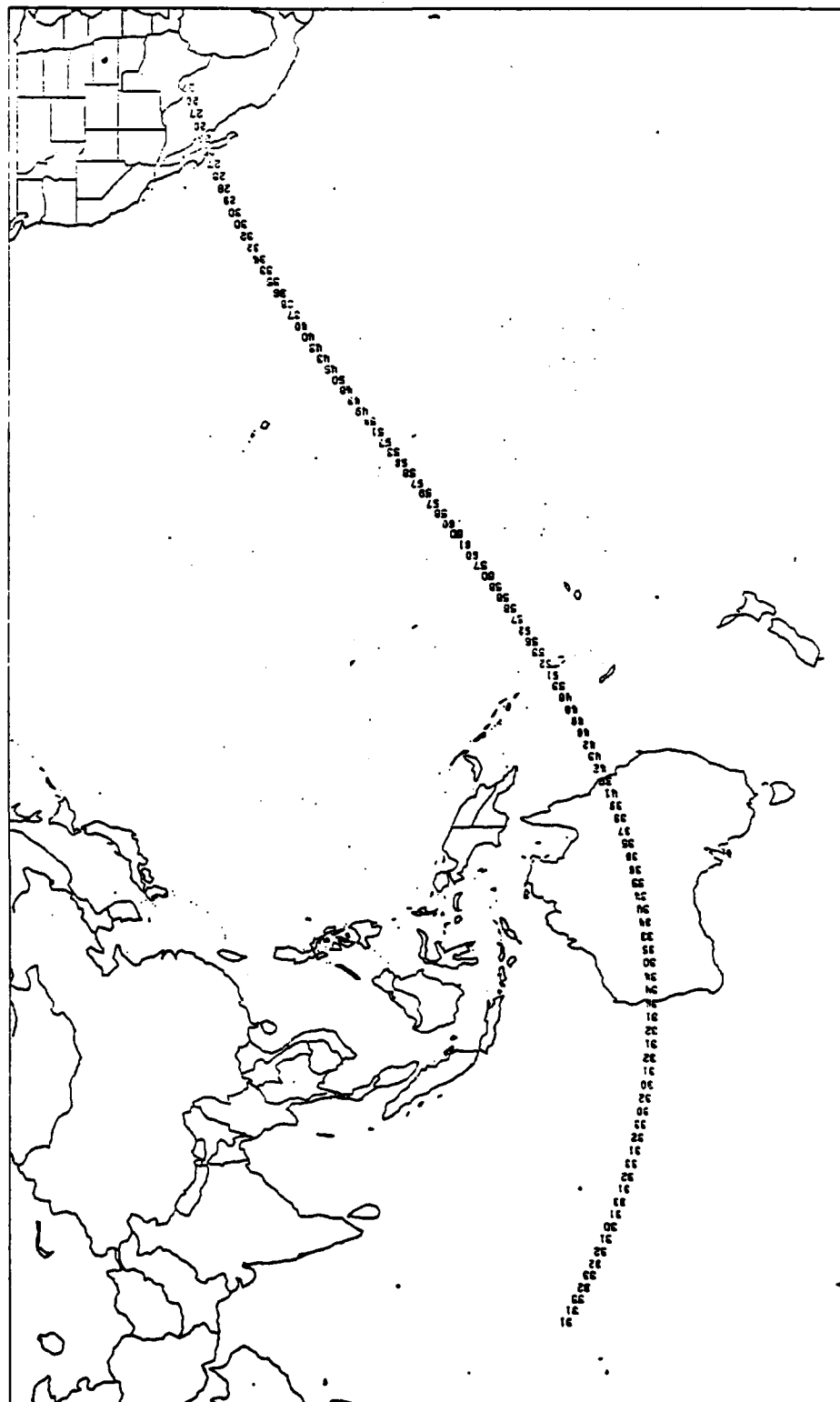
The PRM was operated twice during the STS-11 mission. The first operation occurred at MET 1/07:32:30 and lasted 15.00 hours. The second operation took place at MET 5/03:45:18 and lasted for 15.37 hours. The PRM had no anomalous behavior during either operation.

PRM data is presented in Table 1. The count rate is approximately the same for both operations. Table 2 shows the average dose rate for each operation and the average dose rate for both operations combined. For a seven day mission (more exactly, 7 days, 1 hour, 39 minutes), this would predict a dosage from neutrons and protons to be 60.3m REM or 4.77m RAD.

PRM calibration (ref 1) was performed by EG&G in May of 1983. The PRM was found to be accurate to within 3% during this calibration.

HRM-III

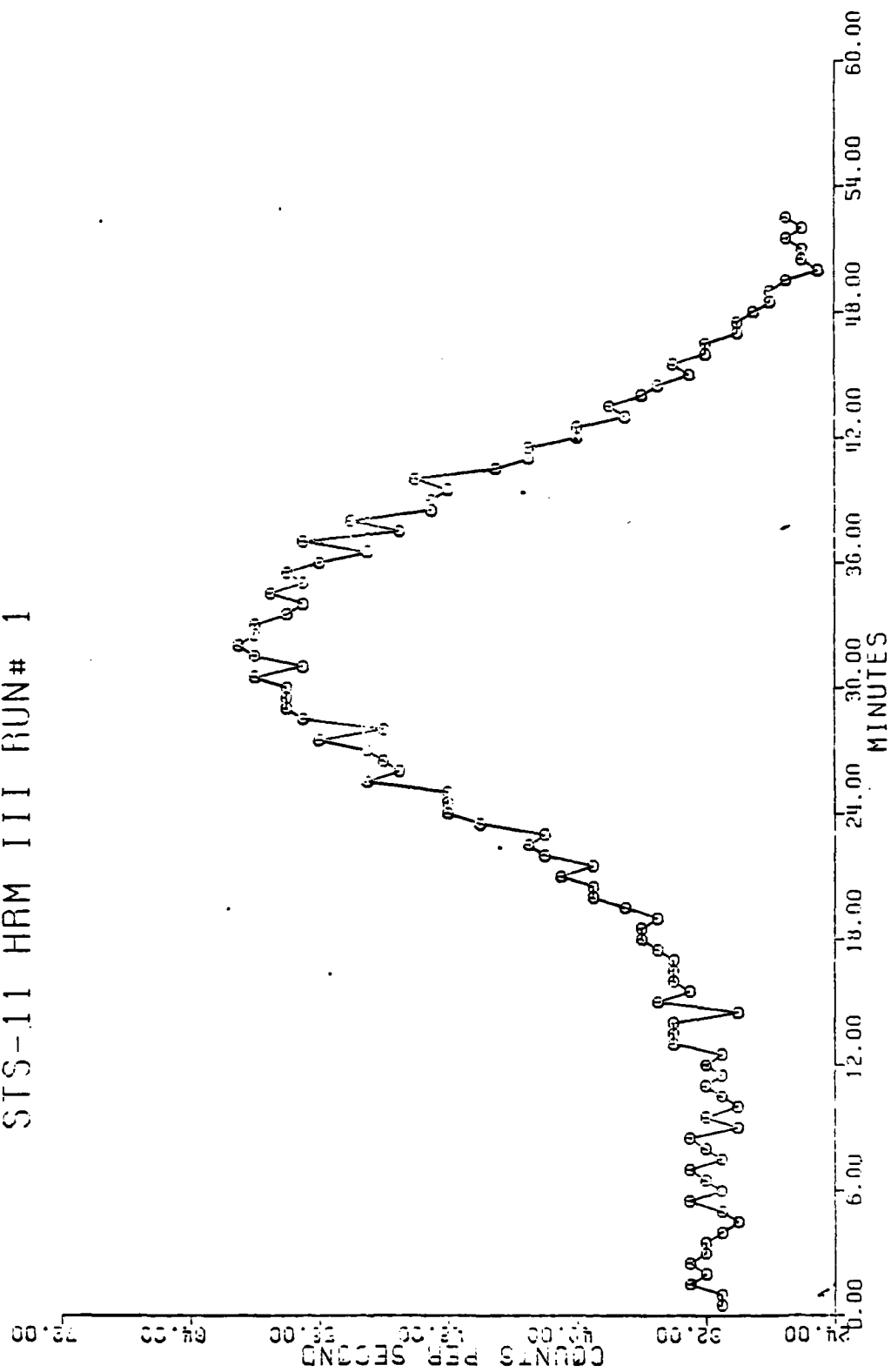
OPERATION NO. 1



STS-11

HRM-III GROUNDTRACK
OPERATION #1
FIGURE 2

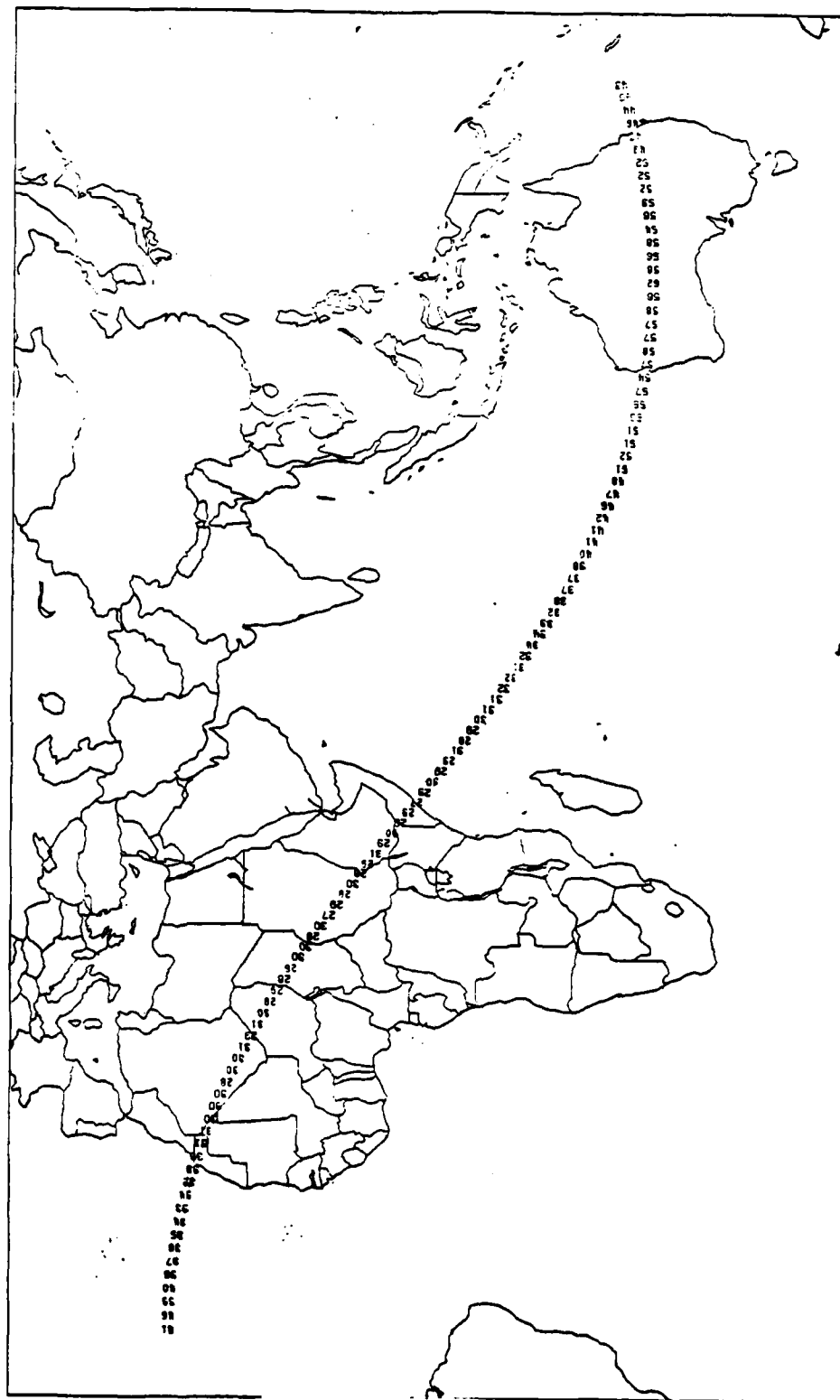
STS-11 HRM III RUN# 1



HRM-III
COUNTS VS TIME
OPERATION #1
FIGURE 3

HRM-III

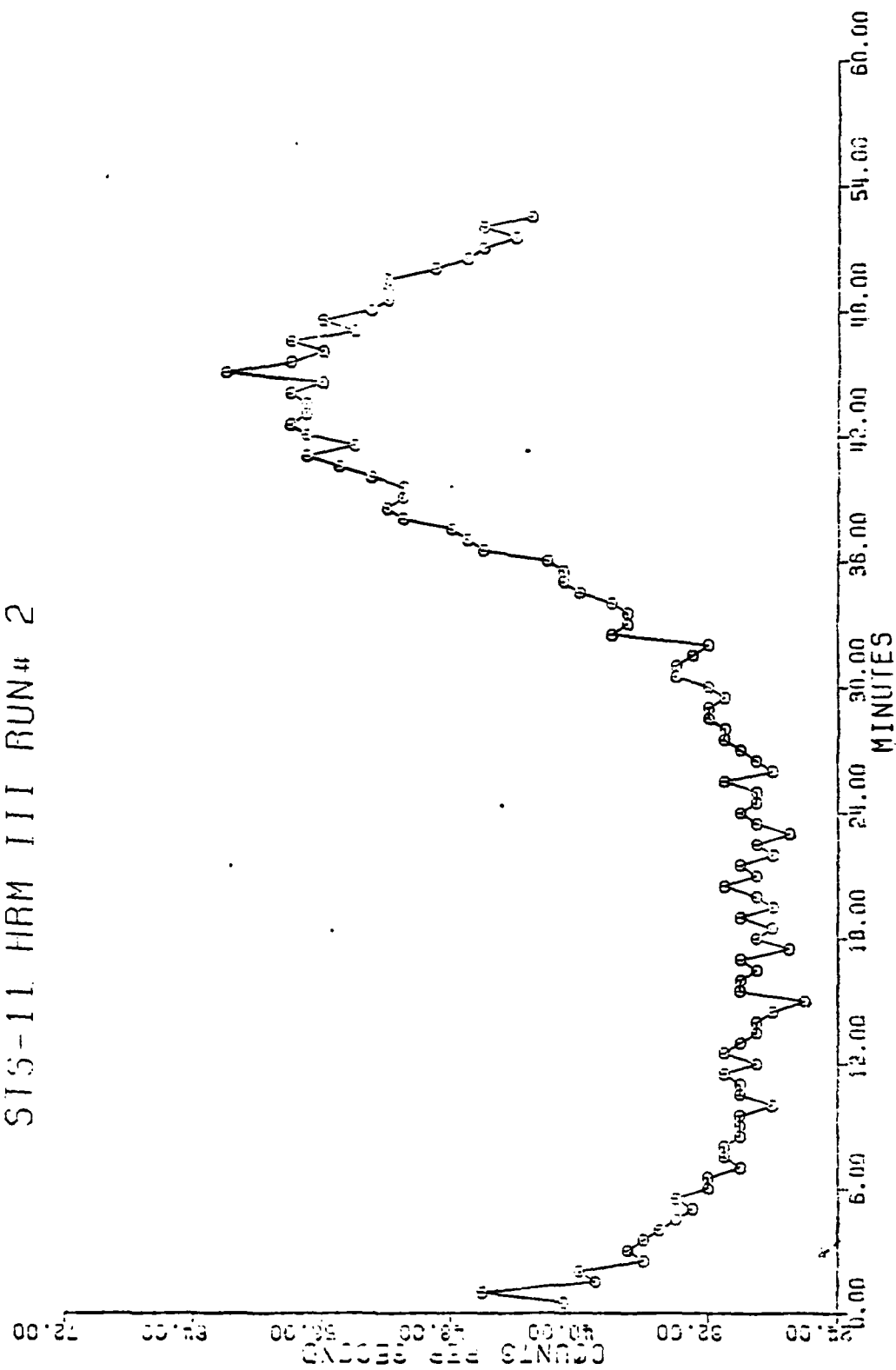
OPERATION NO. 2



STS-11

HRM-III GROUNDTRACK
OPERATION #2
FIGURE 4

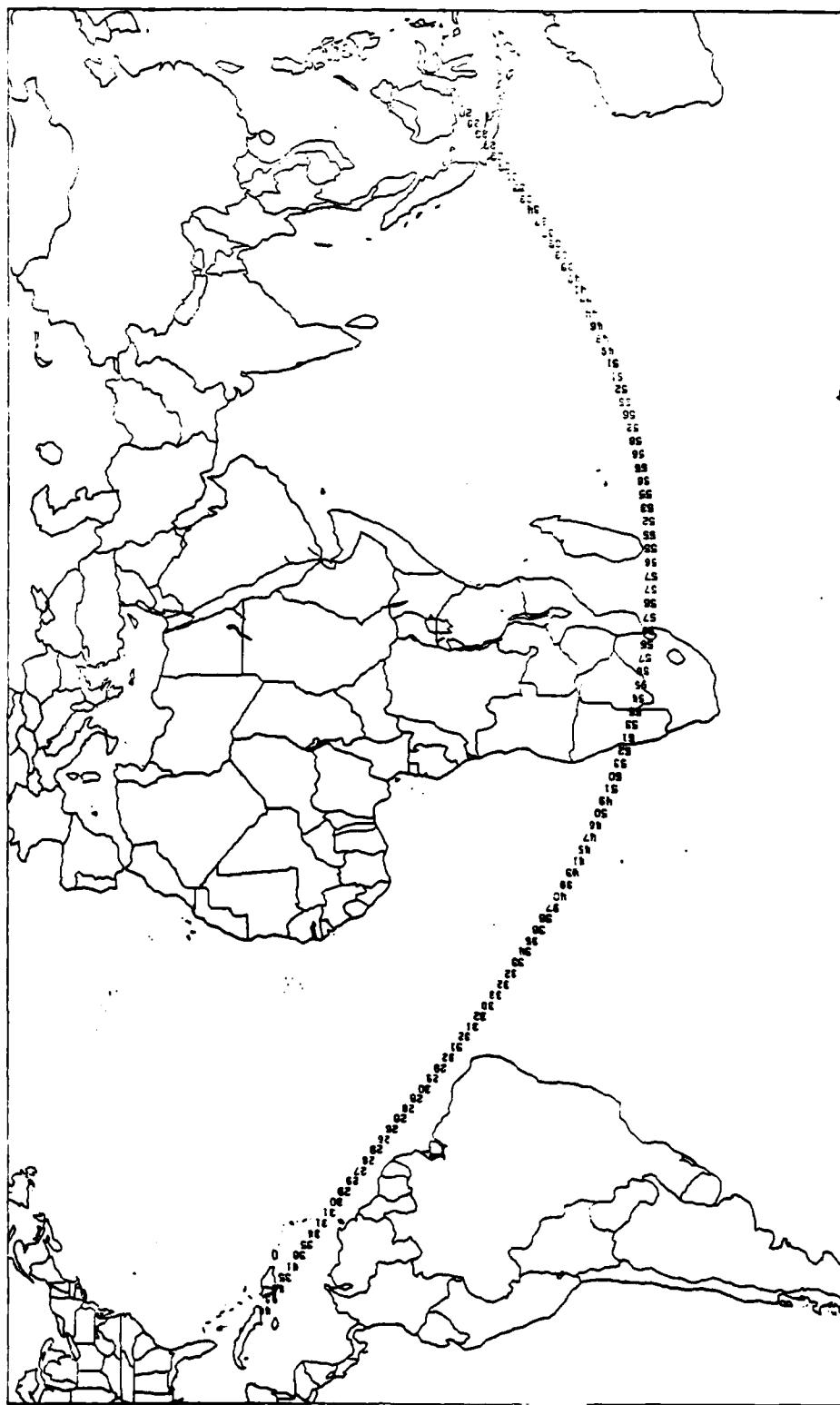
STS-11 HRM III RUN# 2



HRM-III
COUNTS VS TIME
OPERATION #2
FIGURE 5

HRM-III

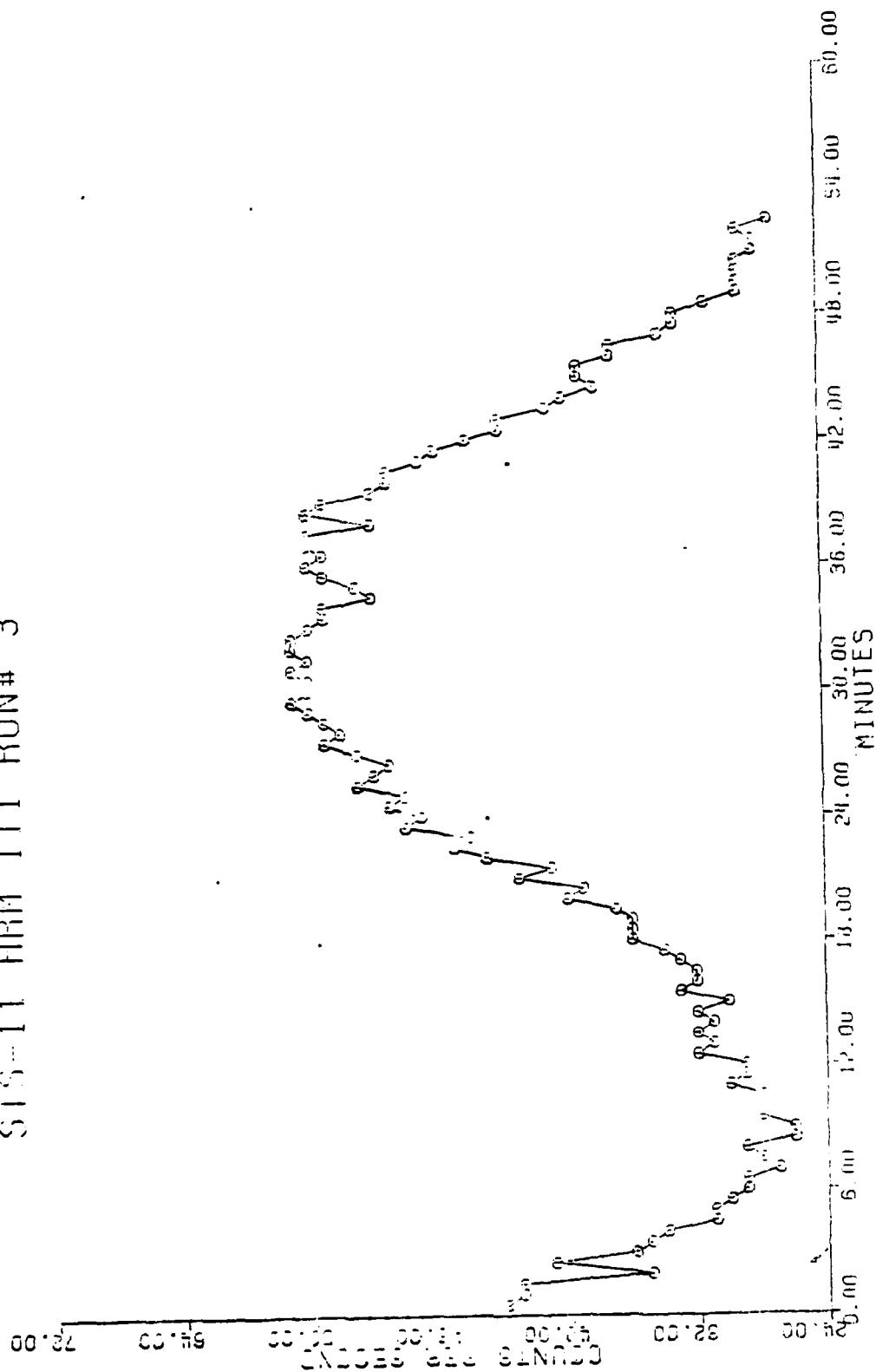
OPERATION NO. 3



STS-11

HRM-III GROUNDTRACK
OPERATION #3
FIGURE 6

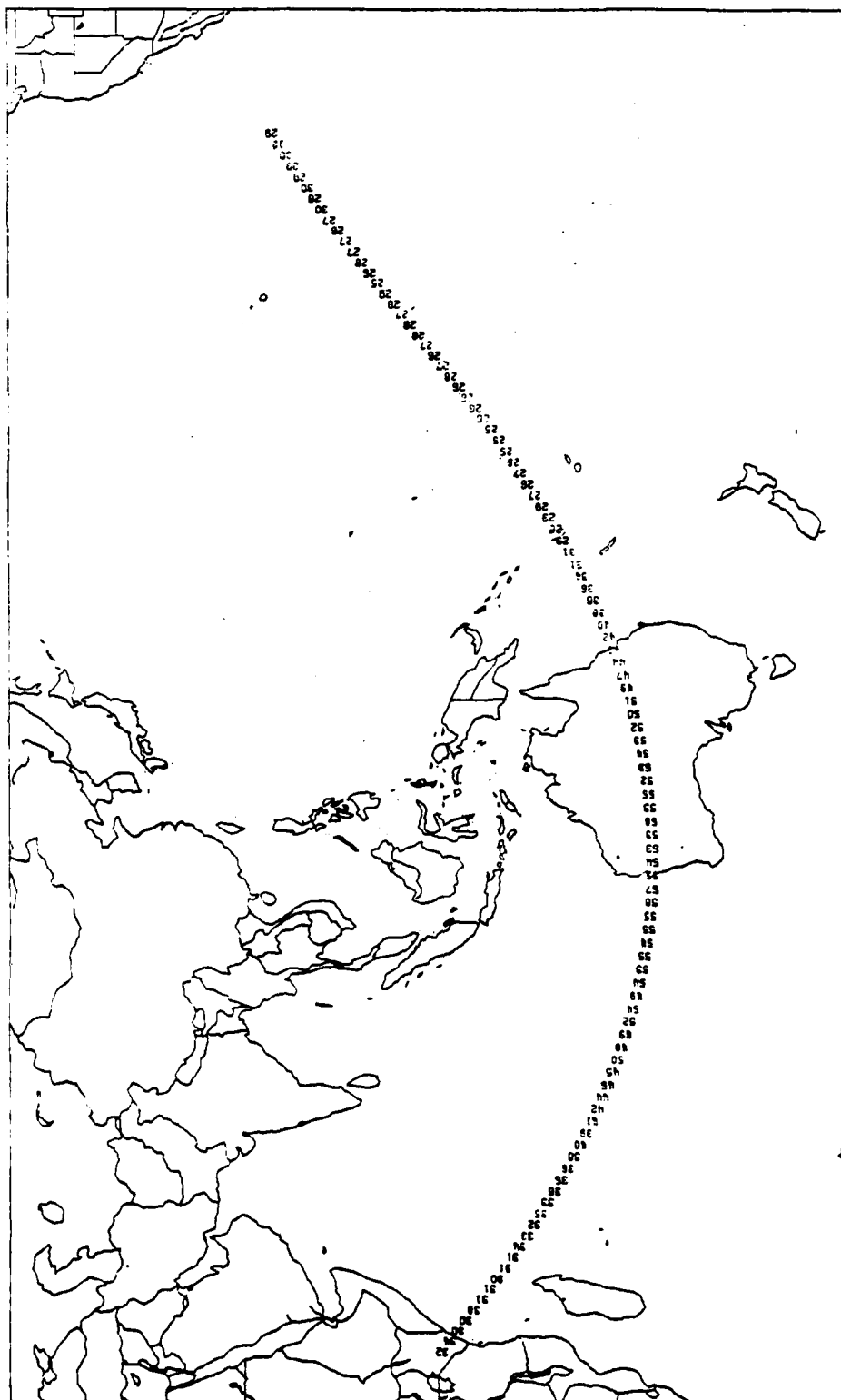
STS-11 HRM III RUN# 3



HRM-III
COUNTS VS TIME
OPERATION #3
FIGURE 7

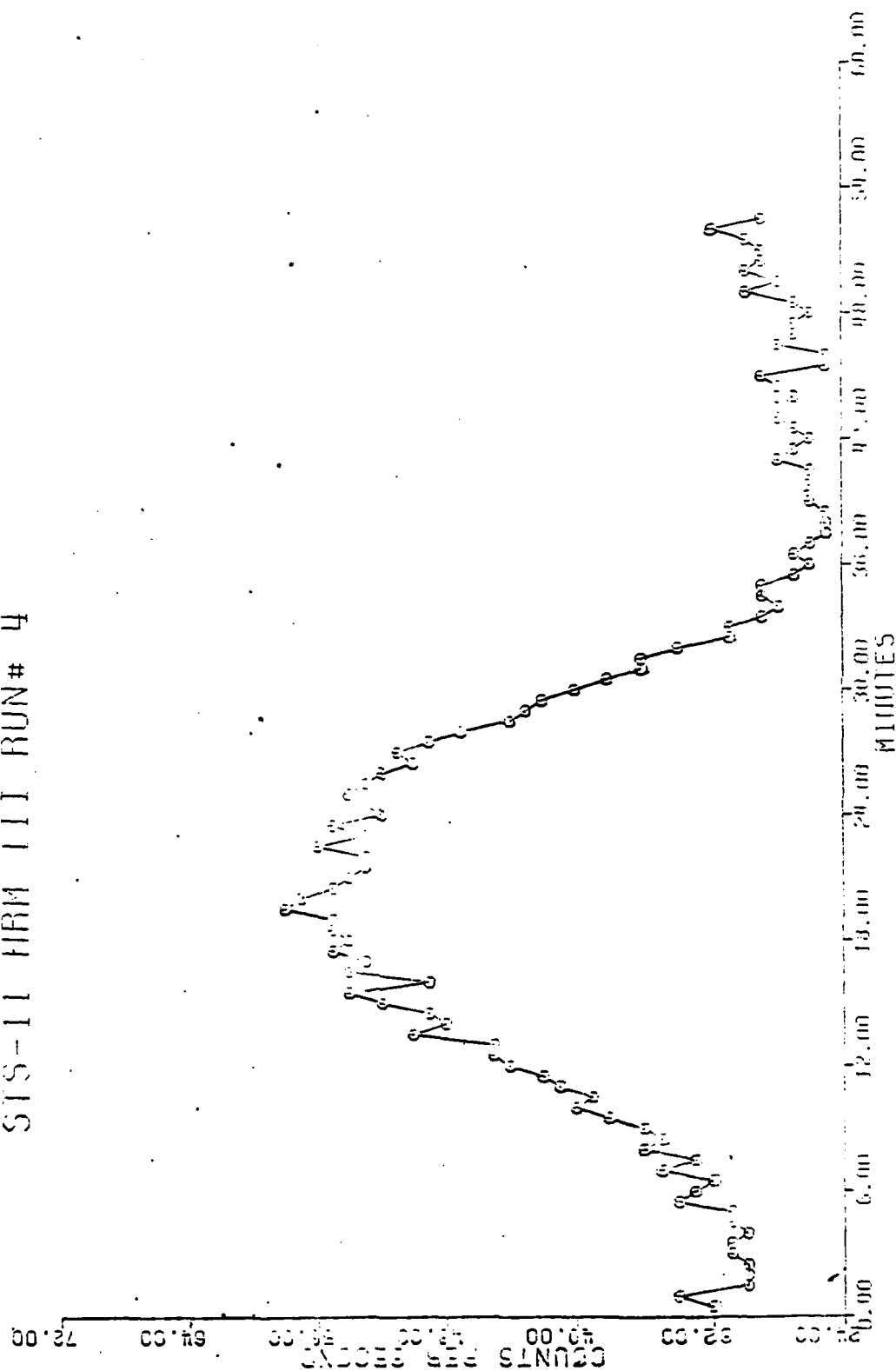
OPERATION NO. 4

STS-11



HRM-III GROUNDTRACK
OPERATION #4
FIGURE 8

STS-11 HRM III RUN# 4



HRM-III
COUNTS VS TIME
OPERATION #4
FIGURE 9

TABLE 1

PRM DATA FROM STS-11

RAW DATA

MET	1/07:32:30	5/03:45:19
Counts	1367	1493
Average Count Rate	91.13/hr	97.14/hr
Stdr Dev	$\pm 9.55/\text{hr}$	$\pm 9.86/\text{hr}$
rem	5.24 mrem	5.67 mrem
rad	.411 mrad	.451 mrad
Hours	15.00 hrs	15.37 hrs

TABLE 2

PRM DATA FROM STS-11

AVERAGE DOSE RATES

MET	1/07:32:30	5/03:45:19
Dose Rate (mrem/hr)	.35	.37
Dose Rate (mrads/hr)	.027	.029

Average dose rate for both operations:

(mrem/hr) $.36 \pm .008$ (mrads/hr) $.028 \pm .003$

SECTION IV

CONCLUSIONS

The data collected from the RME are consistent with data taken on previous missions. There were no surprises in the data and any variations in the data correspond to natural external sources of radiation (e.g., the Southeast Asian Anomaly).

The procedures used for the RME on STS-11 allowed the crew to employ the full capability of both instruments. Thus, the objective of testing the feasibility of using non-space specific hardware in space in a quick reaction mode was adequately demonstrated. An important point to note here is that the instruments were easily operated and read by the crew and meaningful data were obtained. These instruments are also easily serviced by the crew. The second objective of obtaining radiation background data was also satisfied by this mission.

Future flights of the RME will contribute to the data base on background radiation. Different mission profiles will yield data from different altitudes and orbital inclination. Such a data base will prove useful for planning future space systems, including crew health and safety requirements as may exist in permanently inhabited stations and platforms.

REFERENCES

1. STS-6 Report, (in publishing), AFTAC, Caplan, et al.
2. HRM-III Handheld Radiation Monitor User's Handbook; EG&G Report No. EGGH83-2424 S-347-MN
3. Pocket Neutron REM Meter; W. Quam, T. DelDuca, et al, preprint.
4. STS-8 Report, AFTAC, (in publishing) Madonna, et al.

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PRM

1 Activation & Checkout

Unstow PRM

If second operation, replace, mark and stow used battery

Set Rotary sw - HRS

ON/OFF sw - ON

✓ Display counts down from 9999 and record MET on PRM DATA PAD when Display = 0.00

- * If displays show a color, is *
- * blank, set ON/OFF sw - OFF; *
- * replace, mark, and stow used *
- * battery and repeat step 1 *

Report MET to VOD

Re-lock PRM (lock ON)

2 Data Recording

8-18 hrs after step 1, unstow PRM

Set rotary switch to appropriate positions and record display outputs on PRM DATA PAD

Set ON/OFF sw - OFF

Stow PRM

PRM DATA PAD

0.00 MET	<u>1107:32:30</u>	<u>5103:45:19</u>
	<u>1122:32:30</u>	<u>5106:19:10</u>
HRS	<u>15.00</u>	<u>15.37</u>
CNTS	<u>1.367 E (+) 03</u>	<u>1.493 E (+) 03</u>
PAD	<u>04.11 E (-) 04</u>	<u>4.51 E (-) 04</u>
REM	<u>05.24 E (-) 03</u>	<u>5.67 E (-) 03</u>

11-11

STS-11/FIN

DATA PAD FOR
PRM
OPERATIONS

HRM A PADS

CHANNEL	COUNTS/SEC	CHANNEL	COUNTS/SEC	CHANNEL	COUNTS/SEC	CHANNEL	COUNTS/SEC	CHANNEL	COUNTS/SEC	CHANNEL	COUNTS/SEC	CHANNEL	COUNTS/SEC
0-1	31	0-22	32	0-43	39	0-64	61	0-85	40				
0-2	31	0-23	31	0-44	42	0-65	60	0-86	37				
0-3	33	0-24	32	0-45	43	0-66	60	0-87	38				
0-4	32	0-25	31	0-46	42	0-67	58	0-88	36				
0-5	33	0-26	34	0-47	46	0-68	57	0-89	35				
0-6	32	0-27	34	0-48	46	0-69	59	0-90	33				
0-7	32	0-28	24	0-49	48	0-70	57	0-91	34				
0-8	31	0-29	30	0-50	48	0-71	58	0-92	32				
0-9	30	0-30	35	0-51	55	0-72	56	0-93	32				
0-10	31	0-31	33	0-52	51	0-73	53	0-94	30				
0-11	33	0-32	34	0-53	51	0-74	57	0-95	30				
0-12	31	0-33	34	0-54	51	0-75	51	0-96	29				
0-13	32	0-34	34	0-55	56	0-76	54	0-97	28				
0-14	33	0-35	35	0-56	51	0-77	49	0-98	28				
0-15	31	0-36	36	0-57	51	0-78	49	0-99	27				
0-16	32	0-37	36	0-58	52	0-79	48	0-100	25				
0-17	33	0-38	35	0-59	52	0-80	50	0-101	26				
0-18	30	0-39	31	0-60	53	0-81	45	0-102	26				
0-19	31	0-40	31	0-61	60	0-82	43	0-103	27				
0-20	30	0-41	39	0-62	39	0-83	43	0-104	26				
0-21	31	0-42	41	0-63	63	0-84	41	0-105	27				

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STS-11/F14

DATA PAD FOR
HRM-III
OPERATION 1

GAS

1941-1942

CHANEL	COUNTS/SEC	CHANEL	COUNTS/SEC	CHANEL	COUNTS/SEC	CHANEL	COUNTS/SEC	CHANEL	COUNTS/SEC
0-1	33	0-22	41	0-43	34	0-54	27	0-85	27
0-2	34	0-23	42	0-44	31	0-65	28	0-86	28
0-3	30	0-24	44	0-45	31	0-66	28	0-87	28
0-4	30	0-25	45	0-46	29	0-67	27	0-88	27
0-5	30	0-26	45	0-47	28	0-68	28	0-89	28
0-6	31	0-27	50	0-48	29	0-69	29	0-90	29
0-7	31	0-28	48	0-49	29	0-70	25	0-91	25
0-8	30	0-29	47	0-50	27	0-71	25	0-92	25
0-9	31	0-30	52	0-51	26	0-72	28	0-93	28
0-10	31	0-31	54	0-52	27	0-73	27	0-94	27
0-11	34	0-32	49	0-53	26	0-74	27	0-95	27
0-12	33	0-33	54	0-54	25	0-75	26	0-96	26
0-13	32	0-34	53	0-55	25	0-76	27	0-97	27
0-14	35	0-35	55	0-56	25	0-77	30	0-98	30
0-15	33	0-36	54	0-57	26	0-78	28	0-99	28
0-16	36	0-37	55	0-58	26	0-79	30	0100	30
0-17	35	0-38	55	0-59	26	0-80	29	0101	29
0-18	35	0-39	58	0-60	26	0-81	29	0102	29
0-19	34	0-40	57	0-61	26	0-82	30	0103	30
0-20	40	0-41	56	0-62	27	0-83	32	0104	32
0-21	39	0-42	54	0-63	26	0-84	29	0105	29

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DATA PAD FOR
HRM-III
OPERATION 4

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