50-607

DEPARTMENT OF THE AIR FORCE
HEADQUARTERS SACRAMENTO AIR LOGISTICS CENTER (AFMC)
McCLELLAN AIR FORCE BASE, CALIFORNIA

15 Sep 98

SM-ALC/TI-1
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Ref: License #R-130

Subject: Reportable Occurrence: Failed Fuel Element Final 30-Day Report

Dear Sir

The following reportable occurrence is being documented in accordance with the McClellan Nuclear Radiation Center's (MNRC) Technical Specifications 6.6.2(a, b and c) and 6.7.2(a.8.2).

Executive Summary

On 19 Aug 98, the McClellan Nuclear Radiation Center (MNRC) experienced a failed fuel element while increasing power to 2 megawatts. The reactor was immediately shutdown and all exhaust to the outside was stopped, and notification of appropriate agencies was accomplished.

The operations and health physics personnel were able to confirm that a fuel element had failed within the first hour.

All radiation exposures and concentrations were measured and evaluated as part of the recovery plan. The maximum airborne release of radioactive Xe-133 was 149 mCi. This was done on 24 Aug 98, five days after the shutdown to ventilate the reactor room.

Inspection of the reactor core began on 25 Aug 98. All fuel elements in the core were visually inspected. The visual inspection resulted in identifying three suspect elements as possibly leaking.

ltr encl
Add. LA 1 1
NRR/DRPM 1 1
RGN IV 1 1
OGC 1 1
IE22 1

These elements were located as follows:

a. Element 10730 in core position E-9.
b. Element 5279 in core position F-12.
c. Element 5304 in core position M-05.

Two of these elements, 5279 and 5304, are located in the outermost hex ring. It was determined that neither of these elements was leaking. Element 10730 is a 20 wt % TRIGA type element manufactured by General Atomics. The element arrived at the MNRC in 1995 and has been in core position E-9 since 1997. The average power density for this position is 24 kW (this corresponds to approximately 430°C). This is well below the safety analysis maximum of 32 kW.

While performing the visual fuel inspection, element 10730 could not be removed from the grid plate. Special fixturing was fabricated to remove the element. Upon removal of the element it was observed that the element appeared to have a very slight bulge on the upper end area. It was noted that as the element was brought closer to the surface, bubbles began to form and a fine stream of bubbles began to rise to the surface. This confirms that element 10730 is leaking.

All three elements have been removed from the core. A surveillance program to inspect 25% of all 8.5 wt % elements every six months will be initiated immediately. This should ensure that any problem with this fuel type will be identified early.

All lead elements are inspected annually in accordance with the MNRC Technical Specifications. This should ensure that any fuel degradation will be identified at an early stage.

Chronology of Events

19 Aug 98, at 1835 hours, the senior reactor operator granted permission to start reactor run #3072. The reactor was taken to the critical power of 50 kW at 1841 hours. At this time all "at critical" readings were taken, all readings (i.e., operational and radiation) were normal at this time. The senior reactor operator authorized power to be increased to 2 MW. The reactor operator continued to raise power and at approximately 1849 hours the reactor was at 1.6 MW. At this time, the reactor room CAM alerted and alarmed. The reactor was shutdown immediately.

Health physics staff were immediately notified and began an investigation. the reactor room ventilation system automatically went into the recirculation mode upon receiving the alarm, thereby closing the stack damper. The reactor room stack CAM reading never indicated a release of any kind (Atch 1).

As per the MNRC Technical Specifications 6.6.2(a and b), the operations supervisor and MNRC facility director were notified immediately.

Health physics personnel obtained a reactor room portable air sample (PAS), primary water samples, and pulled the reactor room CAM particulate filter. Gamma spectroscopy analysis revealed the presence of fission product daughters in all three samples. The stack CAM particulate filter was analyzed and no fission product daughters were found. Therefore, no inadvertent release of fission products to the environment resulted as a consequence of this failed fuel element.

A portable air sample in the room adjacent to the reactor room (Atch 2) was taken. The PAS revealed no abnormal radionuclides, in addition contamination surveys performed outside the reactor room were also negative. Direct radiation surveys performed outside the reactor room door indicated a dose rate of 0.25 mR/hr on contact with the door. The highest contact dose rate on the air recirculation system was 0.8 mR/hr. The condensation from the dehumidifier was analyzed and fission products were observed confirming a failed fuel element source.

Entry into the reactor room was restricted. Periodic reactor room air samples, primary water samples and dehumidifier condensation water samples were taken and analyzed.

20 Aug 98, the facility director notified the following individuals and agencies in accordance with the MNRC Technical Specifications paragraph 6.6.2(a, b and c).

0620 Brigadier General Michael Wiedemer (licensee)
0653 Lt Col Catherine Zeringue (AFSC)
0705 Dr. Warren Eresian (USNRC Project Manager)
0754 USNRC Operations Center
1000 McClellan Nuclear Safety Committee Members
A preliminary status report was sent to the NRC Operations Center at 1000 (Atch 3)

The facility director called a meeting at 0930 to put together a plan to recover from the failed fuel event.

The recovery planning was accomplished by the following McClellan Air Force Base organizations:

77 MedGrp/SGPB	Patrick Pierce (Bioenvironmental)
77 MedGrp/SGPB	Dale Gillespie (Bioenvironmental)
SM-ALC/SEG	John O'Brien (Safety Office)
SM-ALC/TIMR	Charles Heidel (MNRC Operations Supervisor)
SM-ALC/TIMH	Jeffrey Ching (MNRC Health Physics Supervisor)
SM-ALC/TI-1	Wade Richards (MNRC Facility Director)

The consensus of the recovery planning group was to follow the radiation work permit (Atch 4). to make an entry into the reactor room.

The operations and health physics personnel developed the fuel inspection and entry procedures. The procedures were sent to AFSC, Kirtland AFB NM, for review and approval. AFSC approved both procedures.

An entry was made into the reactor room to perform radiological surveys. Radiation levels were normal, no loose contamination was found, and Xe-133 was the primary airborne contaminate (Atch 5).

21 Aug 98

Based on the reactor room radiation levels and air monitoring data (Atch 5), it was decided to vent the reactor room to the environment through the HEPA and charcoal filters. The reactor room was vented for the day. The major release was in the first hour of venting, when 4.1 mCi of Xenon-133 was released. The reactor room stack ventilation system was left on over the weekend.

24 Aug 98

Continued monitoring the air in the reactor room. The radiation levels in the reactor room are normal. The reactor room ventilation system has been returned to its normal configuration (Atch 1). Reactor room ventilation to remove Xenon-133 continued from 24-25 Aug. A total of 149 mCi of Xenon-133 was released (Atch 6). The reactor operations and health physics personnel prepared the reactor room and tank for visually inspecting all fuel elements in the reactor grid plate to find the leaking element.

25 Aug 98

Reactor operations and health physics started the visual inspection of each fuel element in the grid plate (Atch 7).

26 Aug 98

The visual inspection resulted in the following:

a. Element 10730 in position E-9 could not be removed from the upper grid plate. Element 10730 is a 20 wt % element and had been in the reactor since Mar 97. The element had been in the E-9 position since Jun 97 (Atch 8). The power generated in position E-9 is 24.6 kW.

b. Element 5279 in position F-12 appeared to have a crack in the bottom graphite section of the element (Atch 9). Element 5279 was inspected on 6 Feb 97. There were no indications of any cladding problems at that time. Element 5279 was then loaded into position F-04. On 16 Jun 97 element 5279 was moved to position F-12 (Atch 10). The power generated in position F-04 and F-12 are 9.8 and 10.6 kW respectively.

c. Element 5304 in position M-05 appeared to have a crack in the bottom fuel meat area. This crack appeared to be approximately 4-5 inches long and showed signs of having released fission gasses (i.e., white patchy areas in the right side of crack) (Atch 11). Element 5304 was inspected on 6 Feb 97. There were no indications of any cladding problems at that time. Element 5304 was then loaded into position K-06. On 16 Jun 97 element 5304 was moved to position M-05 (Atch 12). The power generated in position K-06 and M-05 are 11.34 kW and 8.2 kW respectively.

27-28 Aug 98

A complete visual inspection of all fuel elements in the core was accomplished. All elements were found to be satisfactory with no apparent damage. The elements around element 10730 have been removed. A fixturing device was made to remove element 10730 from the core areas.

31 Aug 98

The core central facility was removed to facilitate the removal of element 10730. The procedure to remove element 10730 (Atch 13) was followed.

1-10 Sep 98

Attempts to remove the element from position E-9 using SOP-98-14 (Atch 13) were unsuccessful. It is not possible to get enough of an angle from position E-9 to the central facility position, to lower the element into the central facility cup. Therefore, a new plan to remove the element was formulated as SOP-98-16 (Atch 14), "Removing the TRI-FLUTE on Element 10730." This SOP will effectively remove a portion of one TRI-FLUTE from the element, thereby allowing the element to be removed from position E-9.

Fixturing to accomplish SOP-98-16 is being fabricated.

11 Sep 98

The fixturing to accomplish SOP-98-16 was installed into the reactor grid plate. One section of the TRI-FLUTE was removed and the element was removed from position E-9 to the central facility.

Element 10730 was removed from the central facility to within six feet of the top surface to expel a fine stream of bubbles indicating that the element has a pin hole leak in the top weld area. The element was immediately placed in the element storage area. The element will be visually inspected in detail later in the week.

The reactor core was reloaded and preparations for returning to power in accordance with SOP-98-15 (Atch 15), "Starting the Reactor After Locating Failed Fuel Element."

12 Sep 98

The reactor was returned to power in accordance with SOP-98-15. No further indications of failed fuel were observed during the approach to power. The reactor is back to full power (2 MW) operation.

A detailed visual inspection of elements 10730, 5279, and 5304 was performed on this date. The results are as follows:

Element 10730

Element 10730 was in position E-9. The visual inspection revealed a very slight bulge at the interface between the top graphite and fuel section. This bulge is in excess of .050 inches. The element has a definite PINHOLE LEAK about two inches above the bottom interface between the graphite and fuel section. The pinhole leak was very evident, in that a fine stream of bubbles escaped from the pinhole as the element was moved toward the surface of the water (see Atch 16).

Element 5279

As reported earlier, element 5279 has a dark black line running from the bottom of the graphite section to approximately one inch into the bottom of the fuel section. A whitish powder seems to be located in the fuel area at the one-inch location. This is probably the effect of lighting or AL_2O_3 (see Atch 17).

A feeler gauge was moved over the dark line and no crack was detected. THIS ELEMENT IS NOT LEAKING OR CRACKED.

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Element 5279

As reported earlier, element 5279 has a dark black line running from the bottom of the graphite section to approximately one inch into the bottom of the fuel section. A whitish powder seems to be located in the fuel area at the one-inch location. This is probably the effect of lighting or AL_2O_3 (see Atch 17).

A feeler gauge was moved over the dark line and no crack was detected. THIS ELEMENT IS NOT LEAKING OR CRACKED.

Element 5304

As reported earlier, element 5304 has a wide (approximately 1/8 inch) dark line running from one inch below the bottom graphite/fuel interface, to five inches into the bottom fuel section. It was reported earlier that this element was cracked and was probably leaking.

A feeler gauge was moved over the dark line and no crack was detected. THIS ELEMENT IS NOT LEAKING OR CRACKED (see Atch 18).

Conclusion As Of 16 Sep 98

All suspect elements have been removed from the reactor core grid plate (i.e., elements 10730, 5279 and 5304). Upon detailed visual inspection only, element 10730 appears to be leaking.

Elements 5279 and 5304 have long dark lines at the bottom of the graphite section and running into the fuel sections. Neither of these elements is cracked or leaking.

The only correlation that can be made between elements 5279 and 5304 is that they both are in the outer most hex ring and both are at the corner positions of the hex. Both are 8.5 wt % fuel elements. Based on this information, 8.5 wt % fuel elements with the old style fuel adapters will not be placed at the corner hex positions of the outermost ring.

10730 is a 20 wt % fuel element. It was fabricated by General Atomics and arrived at the MNRC in 1995. The element has been in position E-9 since Jun 97 (Atch 8). As can be seen from the power history (Atch 8) for element 10730, position E-9 is one of the higher power density locations. Element 10730 has an average power density of 23.9 kW (this corresponds to approximately 430°C) for core configurations 97 core 2 through 98 core 2 (Atch 8). This is well below the safety analysis maximum value of 32 kW. A surveillance program to inspect 25 % of all 8.5 wt % elements every six months will be initiated immediately. All lead elements (i.e., hex row C and part of D) are inspected annually in accordance with the MNRC Technical Specifications.

Wade J. Richards

WADE J. RICHARDS, Ph.D.
Facility Director
McClellan Nuclear Radiation Center

ATTACHMENT 1

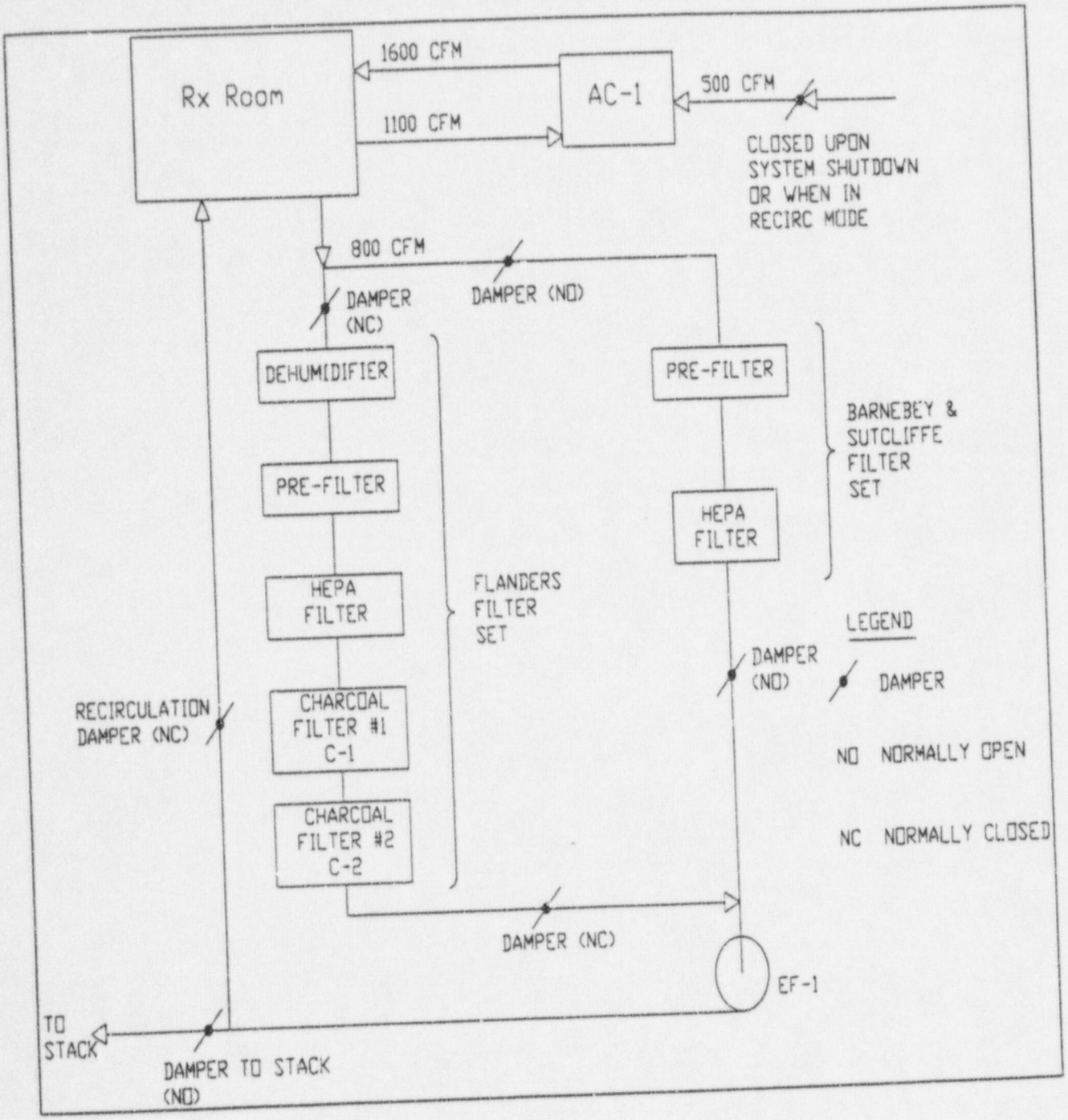
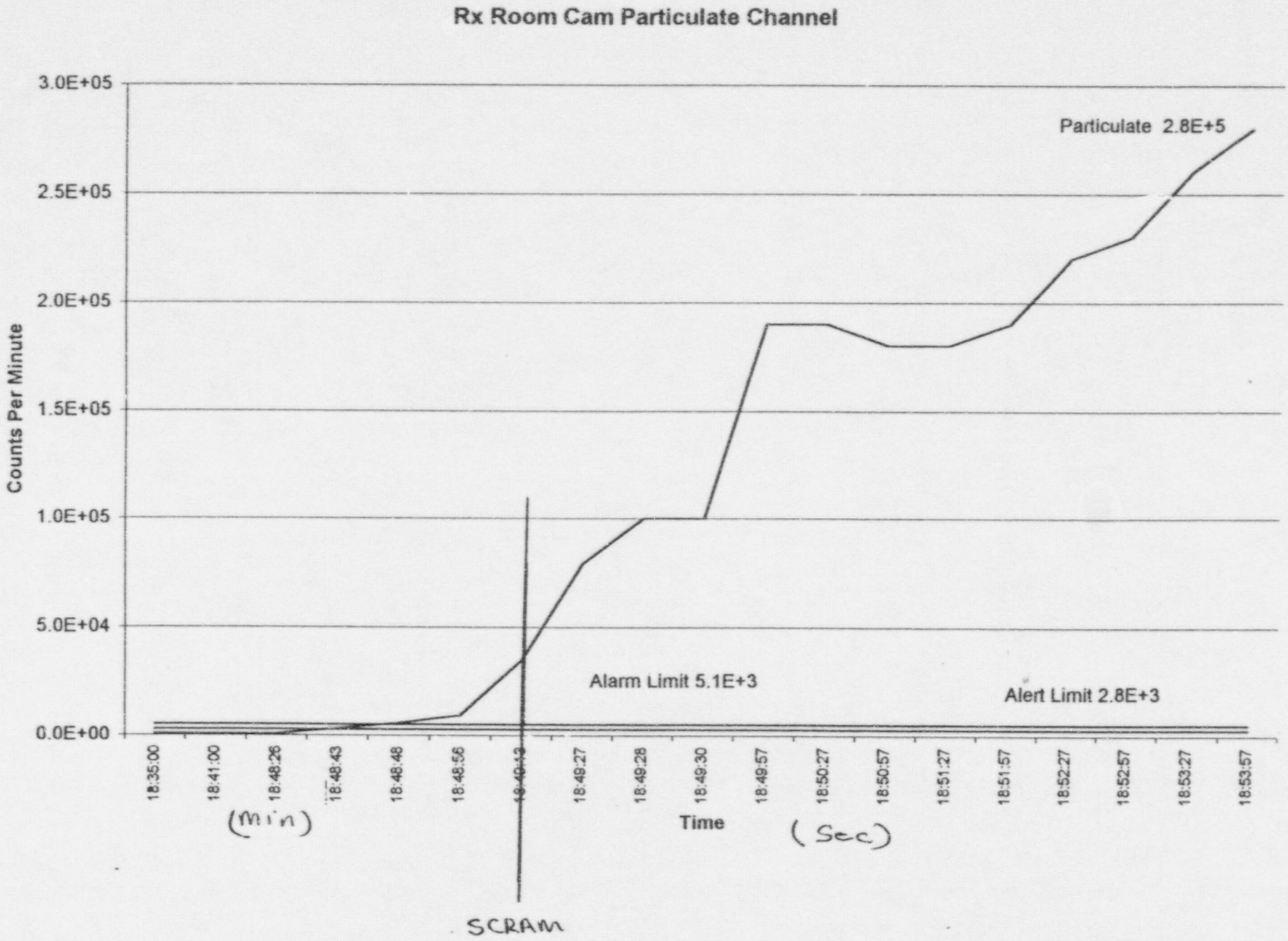


FIGURE 1 -- REACTOR ROOM VENTILATION SYSTEM


Rx Room Cam Particulate Channel
3.0E+05
2.5E+05
2.0E+05
1.5E+05
1.0E+05
5.0E+04
0.0E+00
Counts Per Minute
Particulate 2.8E+5
Alarm Limit 5.1E+3
Alert Limit 2.8E+3
18:35:00
18:41:00
18:48:26
18:48:43
18:48:48
18:48:56
18:49:13
18:49:27
18:49:28
18:49:30
18:49:57
18:50:27
18:50:57
18:51:27
18:51:57
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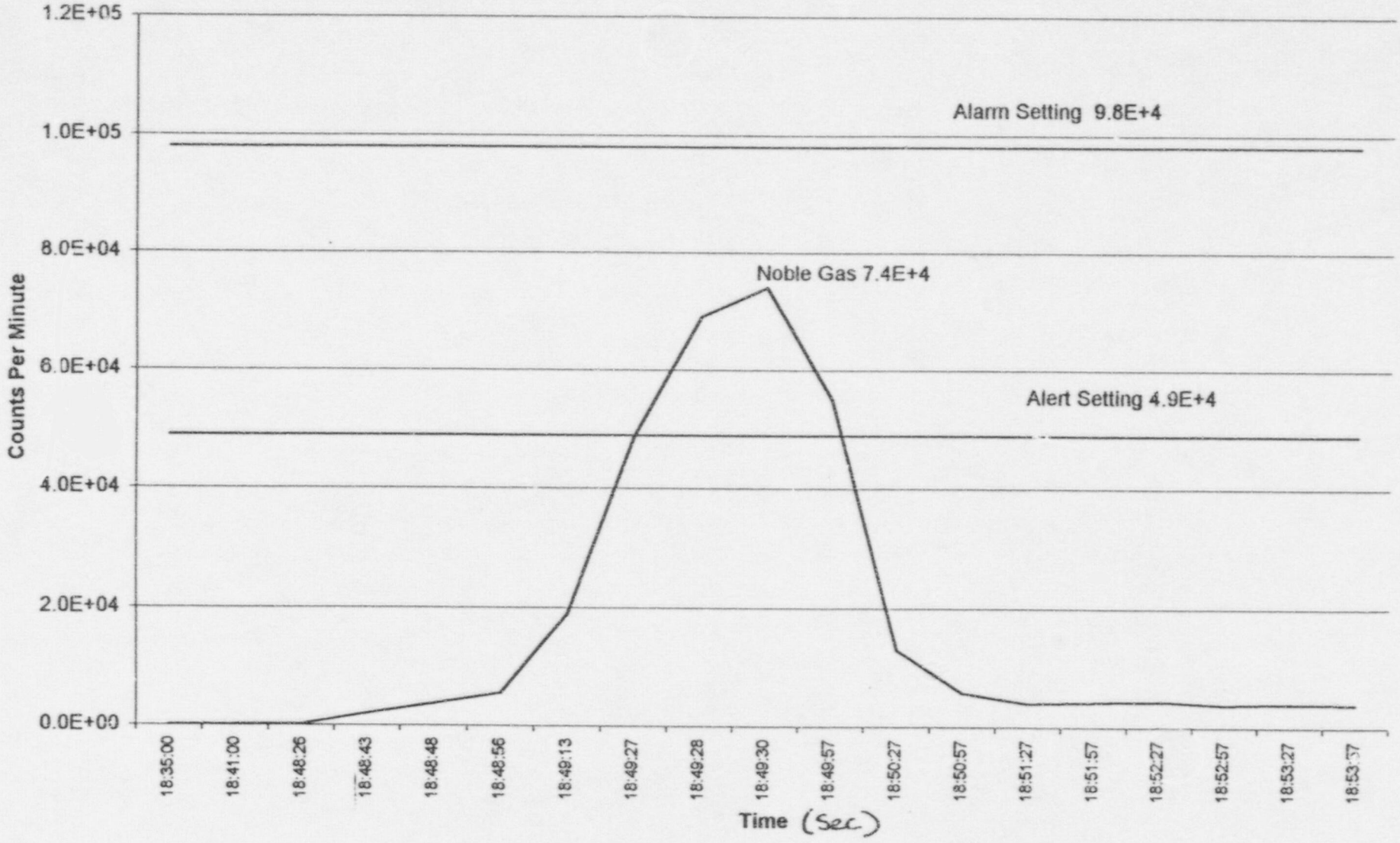
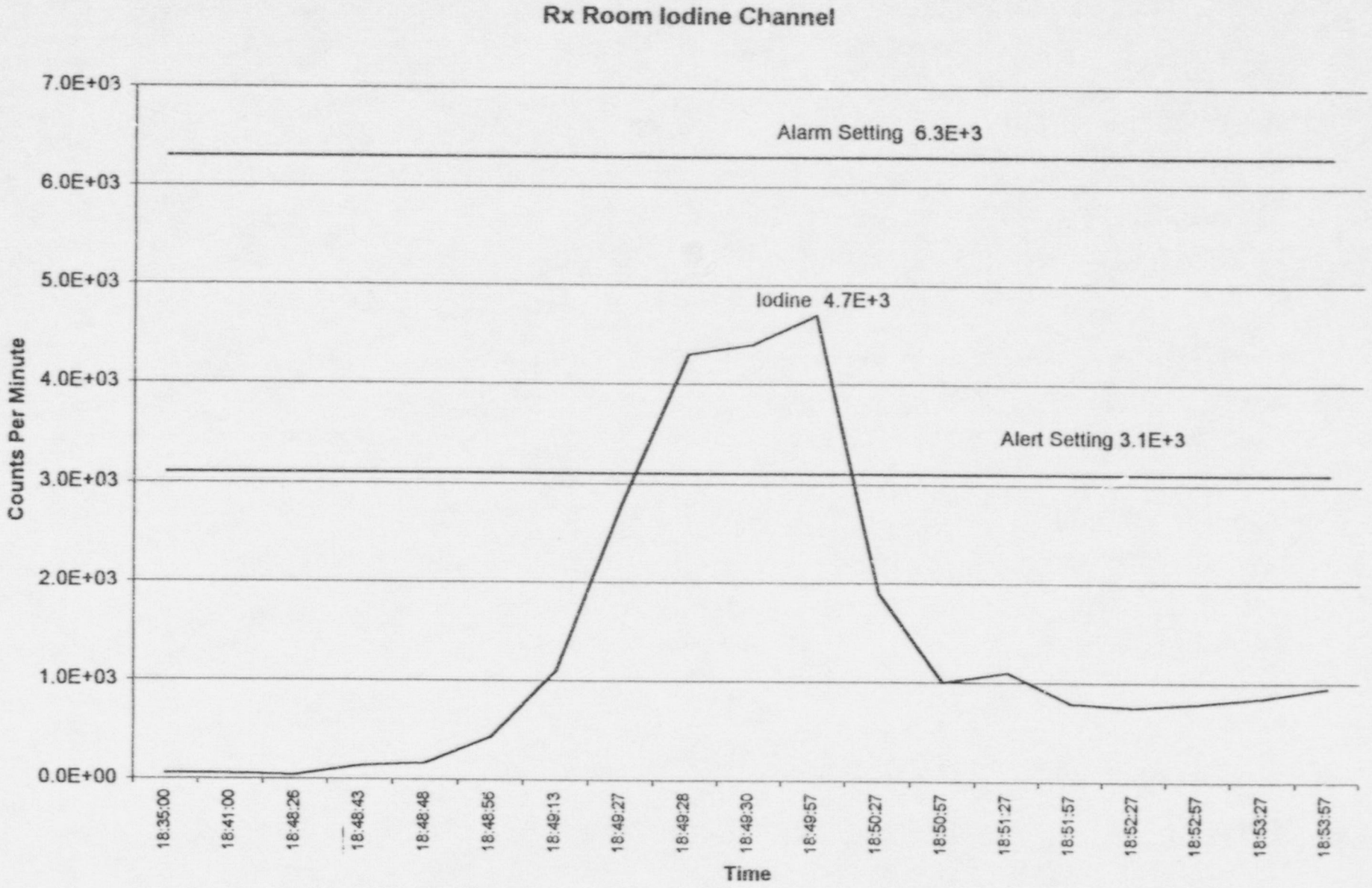
(min)
Time
(Sec)
SCRAM

Rx Room Noble Gas Channel




Rx Room Iodine Channel
7.0E+03
6.0E+03
5.0E+03
4.0E+03
3.0E+03
2.0E+03
1.0E+03
0.0E+00
Counts Per Minute
Alarm Setting 6.3E+3
Iodine 4.7E+3
Alert Setting 3.1E+3
18:35:00
18:41:00
18:48:26
18:48:43
18:48:48
18:48:56
18:49:13
18:49:27
18:49:28
18:49:30
18:49:57
18:50:27
18:50:57
18:51:27
18:51:57
18:52:27
18:52:57
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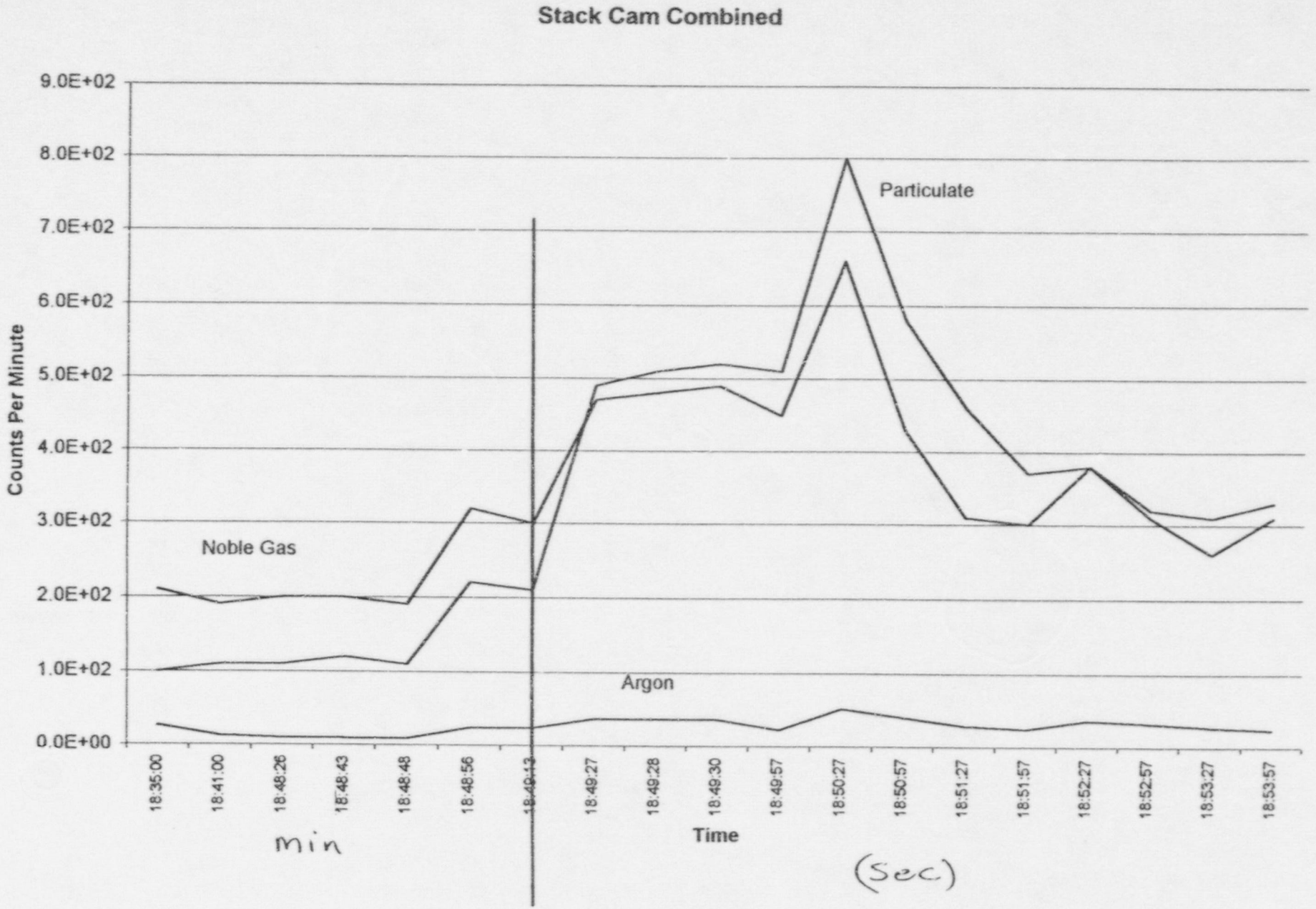
18:53:57
Time

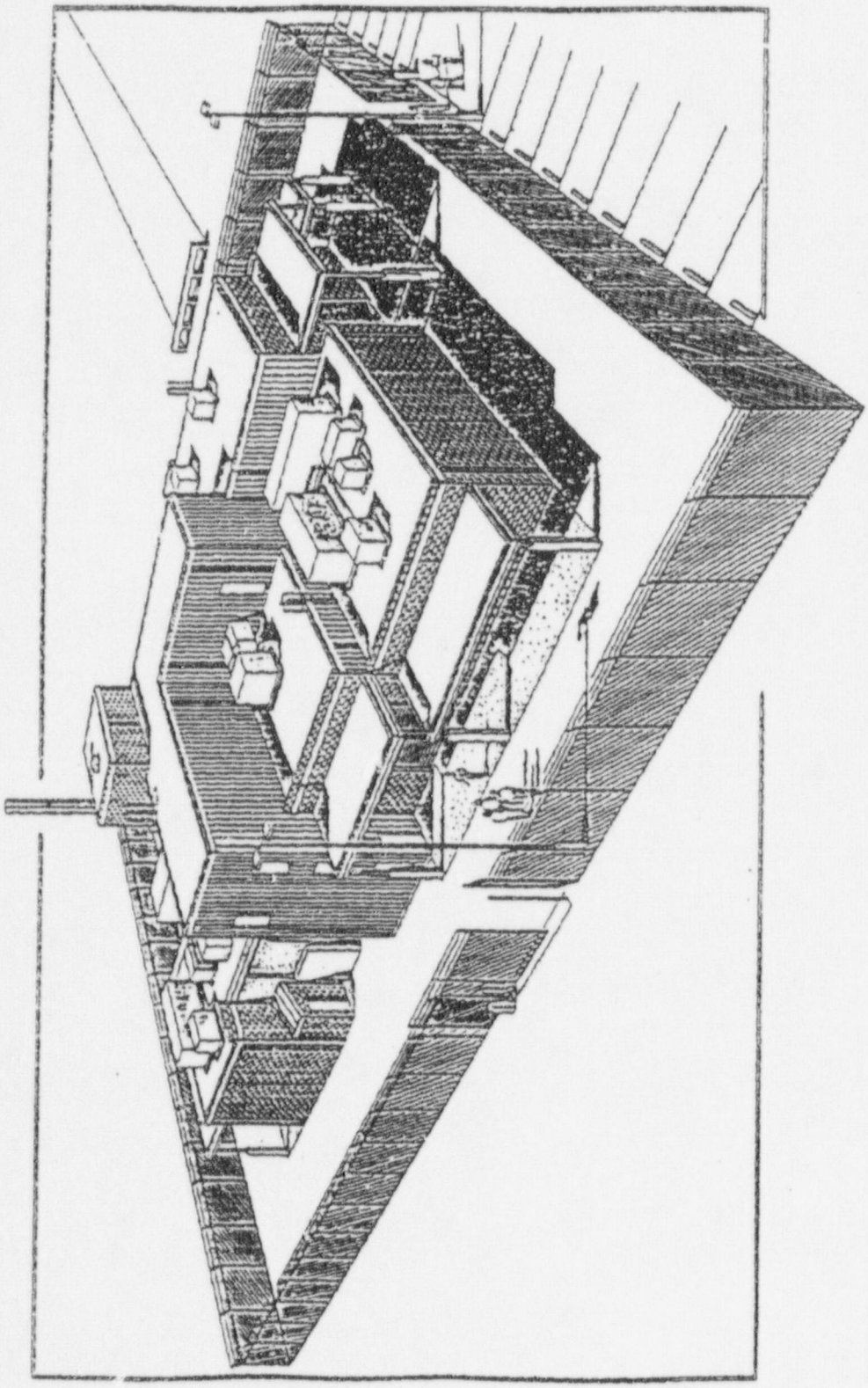
3.8×10^3 PART
1.0×10^4 Nobe
1.6×10^2 Argo



MNRC Fuel Element Failure Chronology 19 Aug 98

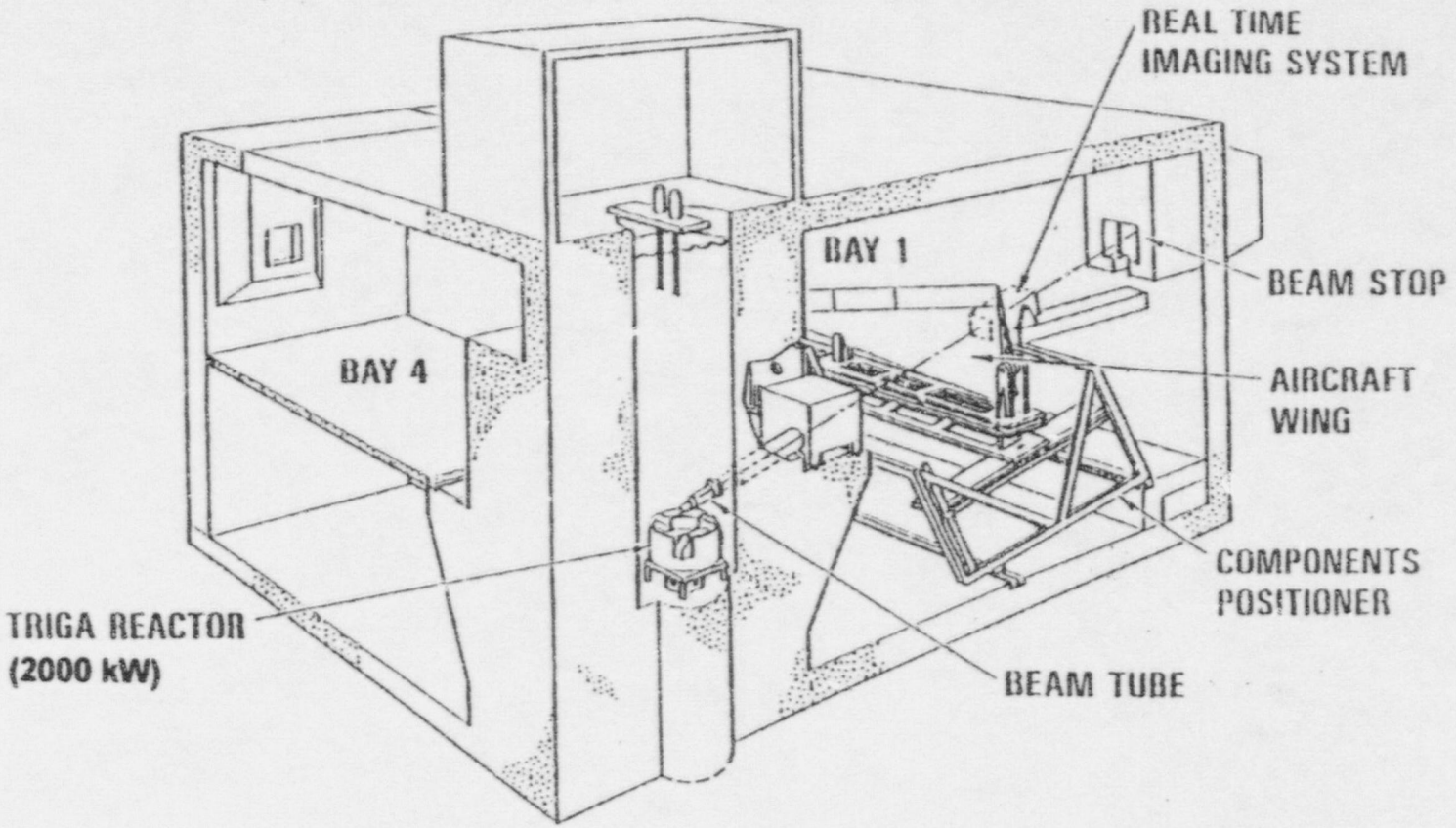
			RX RM CAM			STACK CAM		
TIME	EVENT	POWER	Part.	N.G.	I	Part.	N.G.	Ar
	8/19 Alert Settings		2.8E+03	4.9E+04	3.1E+03	2.0E+03	5.0E+03	1.2E+02
	8/19 Alarm Settings		5.1E+03	9.8E+04	6.3E+03	3.8E+03	1.0E+04	1.6E+02
18:00:00		2.0E+06	8.3E+02	3.5E+02	9.9E+01	1.2E+02	2.4E+02	4.8E+02
18:29:00	CSC Watchdog scram	2.0E+06						
18:35:00	startup		6.1E+02	8.5E+01	5.7E+01	1.0E+02	2.1E+02	2.7E+01
18:41:00		5.0E+01	5.7E+02	1.3E+02	5.2E+01	1.1E+02	1.9E+02	1.3E+01
18:48:26		1.6E+06	6.1E+02	1.4E+02	4.2E+01	1.1E+02	2.0E+02	9.4E+00
18:48:43	Rx Rm CAM Alert	1.7E+06	3.1E+03	2.0E+03	1.4E+02	1.2E+02	2.0E+02	9.6E+00
18:48:48	Rx Rm CAM Alarm	1.7E+06	5.8E+03	3.7E+03	1.7E+02	1.1E+02	1.9E+02	9.1E+00
18:48:56		1.7E+06	9.3E+03	5.6E+03	4.3E+02	2.2E+02	3.2E+02	2.4E+01
18:49:13	Console pushbutton scram	1.7E+06	3.5E+04	1.9E+04	1.1E+03	2.1E+02	3.0E+02	2.4E+01
18:49:27			7.9E+04	4.9E+04	2.8E+03	4.9E+02	4.7E+02	3.7E+01
18:49:28			1.0E+05	6.9E+04	4.3E+03	5.1E+02	4.8E+02	3.7E+01
18:49:30			1.0E+05	7.4E+04	4.4E+03	5.2E+02	4.9E+02	3.7E+01
18:49:57			1.9E+05	5.5E+04	4.7E+03	5.1E+02	4.5E+02	2.3E+01
18:50:27			1.9E+05	1.3E+04	1.90E+03	8.0E+02	6.6E+02	5.2E+01
18:50:57			1.8E+05	5.8E+03	1.0E+03	5.8E+02	4.3E+02	4.1E+01
18:51:27			1.8E+05	4.0E+03	1.1E+03	4.6E+02	3.1E+02	2.9E+01
18:51:57			1.9E+05	4.2E+03	7.9E+02	3.7E+02	3.0E+02	2.5E+01
18:52:27			2.2E+05	4.4E+03	7.5E+02	3.8E+02	3.8E+02	3.7E+01
18:52:57			2.3E+05	3.8E+03	7.9E+02	3.2E+02	3.1E+02	3.3E+01
18:53:27			2.6E+05	4.1E+03	8.5E+02	3.1E+02	2.6E+02	2.8E+01
18:53:57			2.8E+05	3.9E+03	9.5E+02	3.3E+02	3.1E+02	2.4E+01

ATTACHMENT 2



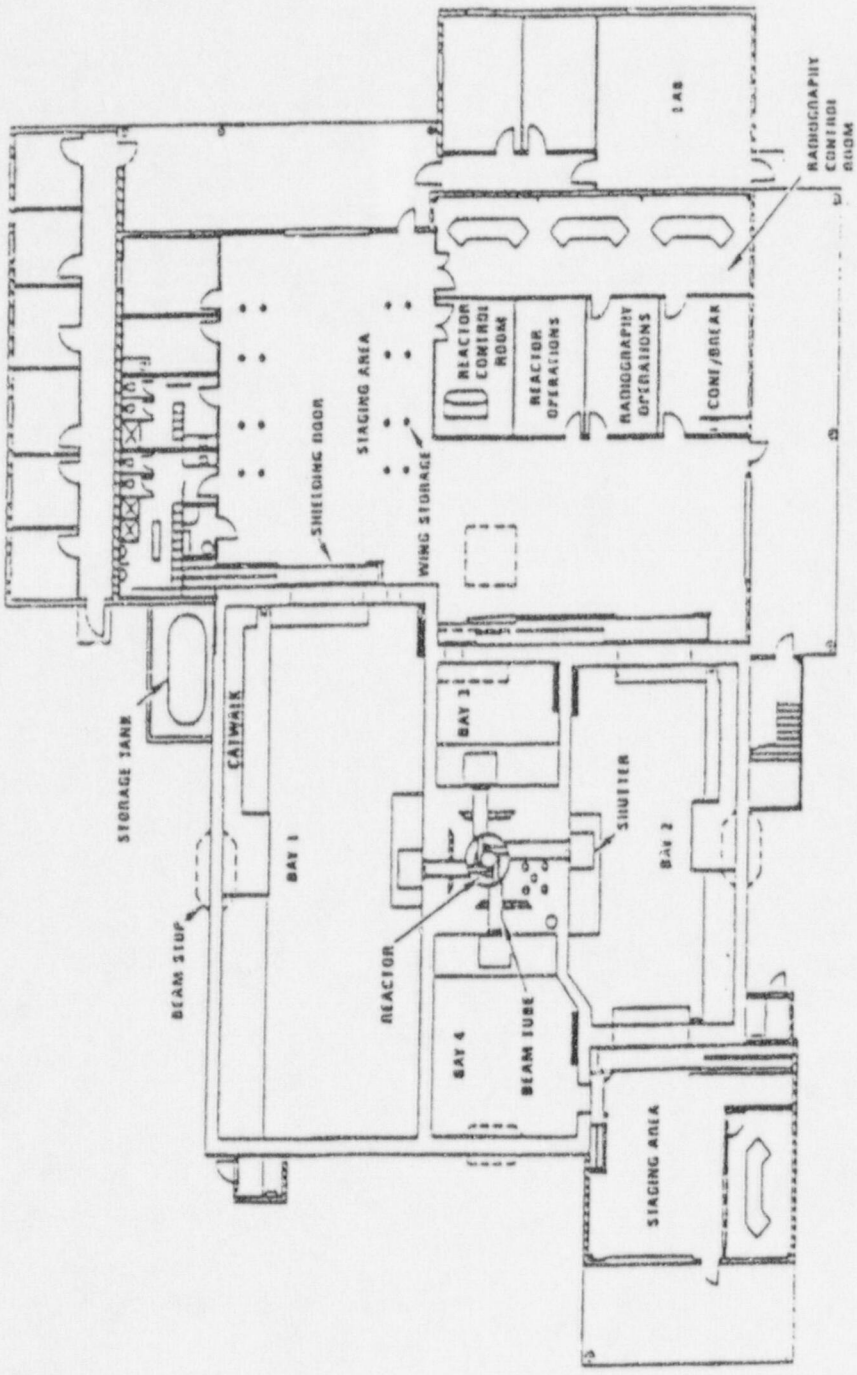
MNRC AXONOMETRIC VIEW

FIGURE 1.1



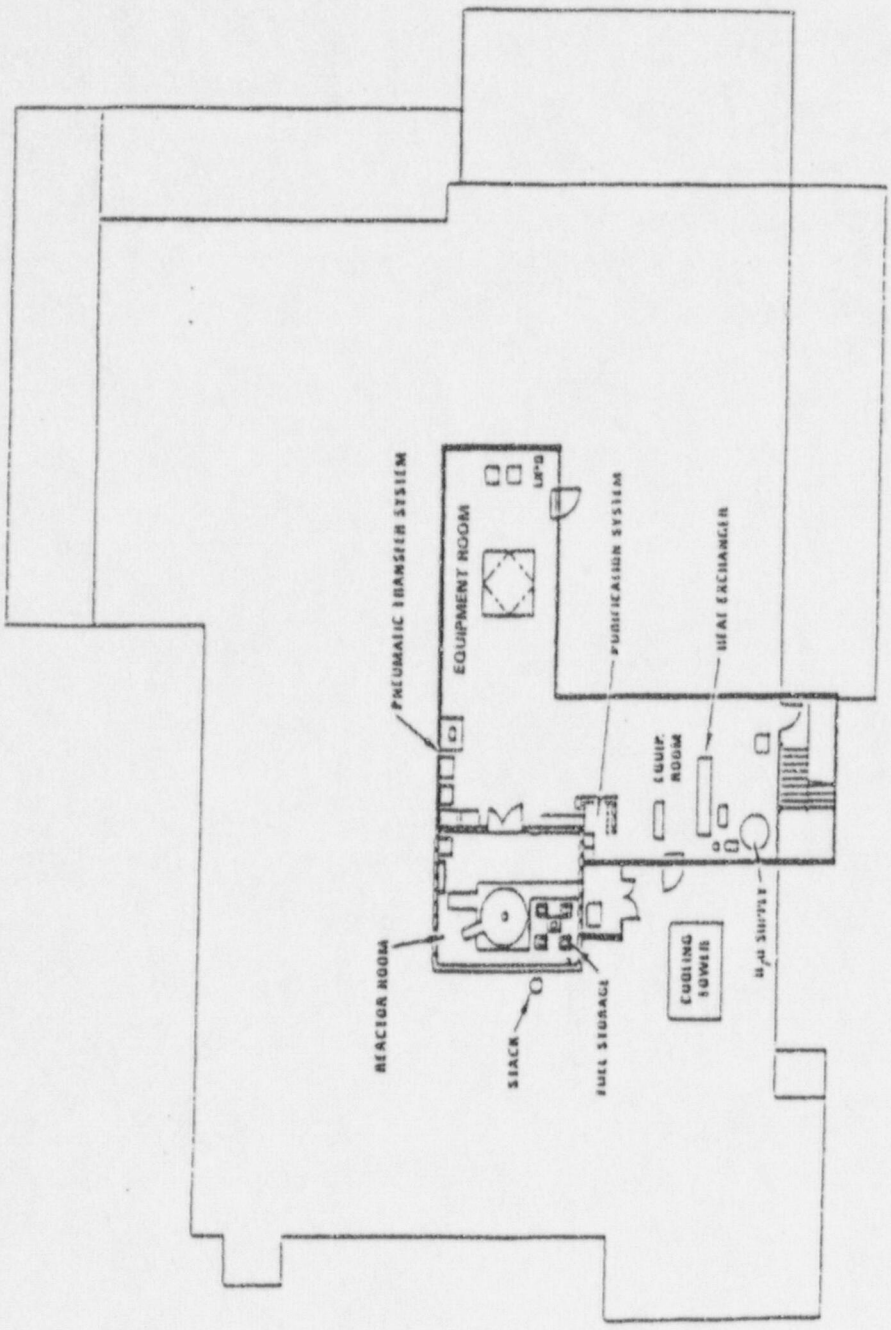
MCCLELLAN NUCLEAR RADIATION CENTER

FIGURE 1.2



MNRC PLAN VIEW - MAIN FLOOR

FIGURE 1.3



MNRC PLAN VIEW - SECOND FLOOR

FIGURE 1.4

ATTACHMENT 3