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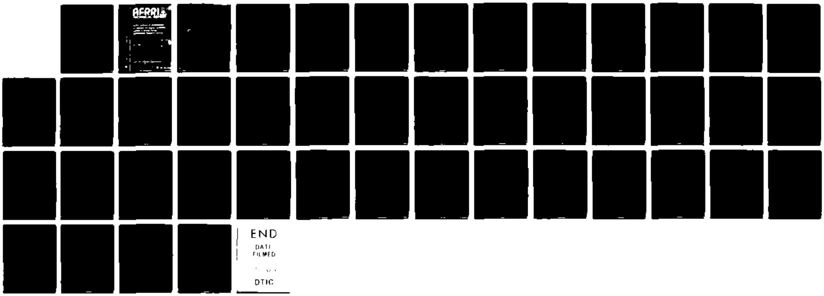

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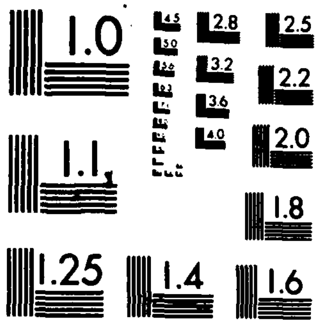

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AFRRI TR83-1

AFRRI TECHNICAL REPORT

Safety analysis of modifications to upgrade the reactor ventilation system at Armed Forces Radiobiology Research Institute

M. L. Moore

[illegible]

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This report describes the proposed changes to the ventilation system of the reactor building at the Armed Forces Radiobiology Research Institute (AFRRI) in Bethesda, Maryland. Classified as a Safety Analysis Report that meets the requirements of the Code of Federal Regulations (Title 10, Part 50.59), this document provides the basis for the author's conclusion that the changes to the system involve no unreviewed safety questions and, in fact, are improvements in the radiological safety at AFRRI. In order to

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20. ABSTRACT (continued)

accomplish these changes, certain other changes must be made to AFRRI administrative documents. Included here are excerpts from the administrative documents and the changes to be made to them.

Minutes of a meeting of the Reactor and Radiation Facility Safety Committee (of AFRRI) confirm the fact that the Committee has reviewed this report and has concurred with it.

CONTENTS

Present conditions at the Armed Forces Radiobiology Research Institute (AFRRI) require that certain modifications be made to upgrade the ventilation system. The original ventilation system of the reactor building was described in the 1962 Final Safety Analysis Report (FSAR). The system was upgraded in 1967 with accompanying documentation.

The Code of Federal Regulations (Title 10, Part 50.59) requires that modification of a portion(s) of a licensed facility as described in the facility Safety Analysis Report (SAR) be documented with a written safety analysis. Such documentation provides the basis for determining that the change does not involve an unreviewed safety question. Based on the analysis in this Technical Report, the author has determined that the proposed changes to the AFRRI ventilation system will fully accomplish the objectives of the original FSAR (as modified in 1967), and will actually improve the radiological safety at AFRRI where possible airborne hazards are of concern.

The proposed modifications require minor administrative changes in the Technical Specifications of the current reactor license (R-84) as well as in the SAR and Technical Specifications pending before the U.S. Nuclear Regulatory Commission (NRC) as part of the AFRRI relicensing. These administrative changes are specified in Appendix C. They will form the principal part of a request for an amendment to the current reactor license, to incorporate the proposed modification of the ventilation system.

This Technical Report has been submitted to the AFRRI Reactor Radiation Facility Safety Committee for determination of unreviewed safety questions before submission to NRC as required under 10 CFR 50.59.

The ventilation system for the AFRRI reactor building was installed before operation of the reactor began in 1962. The Final Safety Analysis Report gives several requirements of the building and air systems to be used in the reactor area. These requirements ensure that the reactor air system will control and restrict any airborne radioactive material and will prevent its uncontrolled release to the unrestricted environment. These primary requirements that ensure the integrity of the system are as follows:

1. The reactor building will be designed to operate at atmospheric pressures.

2. An excellent degree of air confinement, with minimum air exfiltration if confinement is necessary, will be available for the reactor room.

3. Air exhausted from areas with a potential for developing airborne contamination will pass thru absolute filters before exhausting from the building.

4. These potential problem areas will be held at a slightly negative pressure relative to the rest of the reactor building.

5. The reactor building will be provided with an independent ventilation system.

In 1967, the ventilation system for the AFRRI reactor building was upgraded. This improvement was necessary because of the growth of the AFRRI complex. The changes made to the system did not change the intent of providing a radiologically safe ventilation system. The upgrade consisted basically of converting certain areas of the reactor building from the reactor-building air system to the Phase-III-building air system, and combining the exhaust from the two separate systems into one exhaust stack (from which releases to the unrestricted environment are made). The system is diagrammed in Figure 1.

At present, AFRRI consists of five phases, or separate building units; each phase has its own ventilation system, which is independent of the reactor's ventilation system. Complications associated with the growth of the AFRRI complex require certain changes to be made in the AFRRI ventilation systems. It has been proposed that a centralized system designed to serve the entire AFRRI complex will replace the separate systems, which require constant adjustment and maintenance. The system servicing the reactor areas would become a separate branch of the AFRRI system; along with other branches having radiological significance, the reactor branch would receive special air treatment. Several improvements in the air system and in the manner in which it performs its intended functions would increase the safety relating to possible airborne radioactive contaminants from the reactor and reactor operations. The proposed air system is shown in Figure 2.

The proposed modifications of the air system will fulfill the requirements cited in items 1 through 4 above. The proposed system will differ from item 5 in that the system will no longer be totally independent, but will be a separately treated branch of the system. The purpose of an independent air

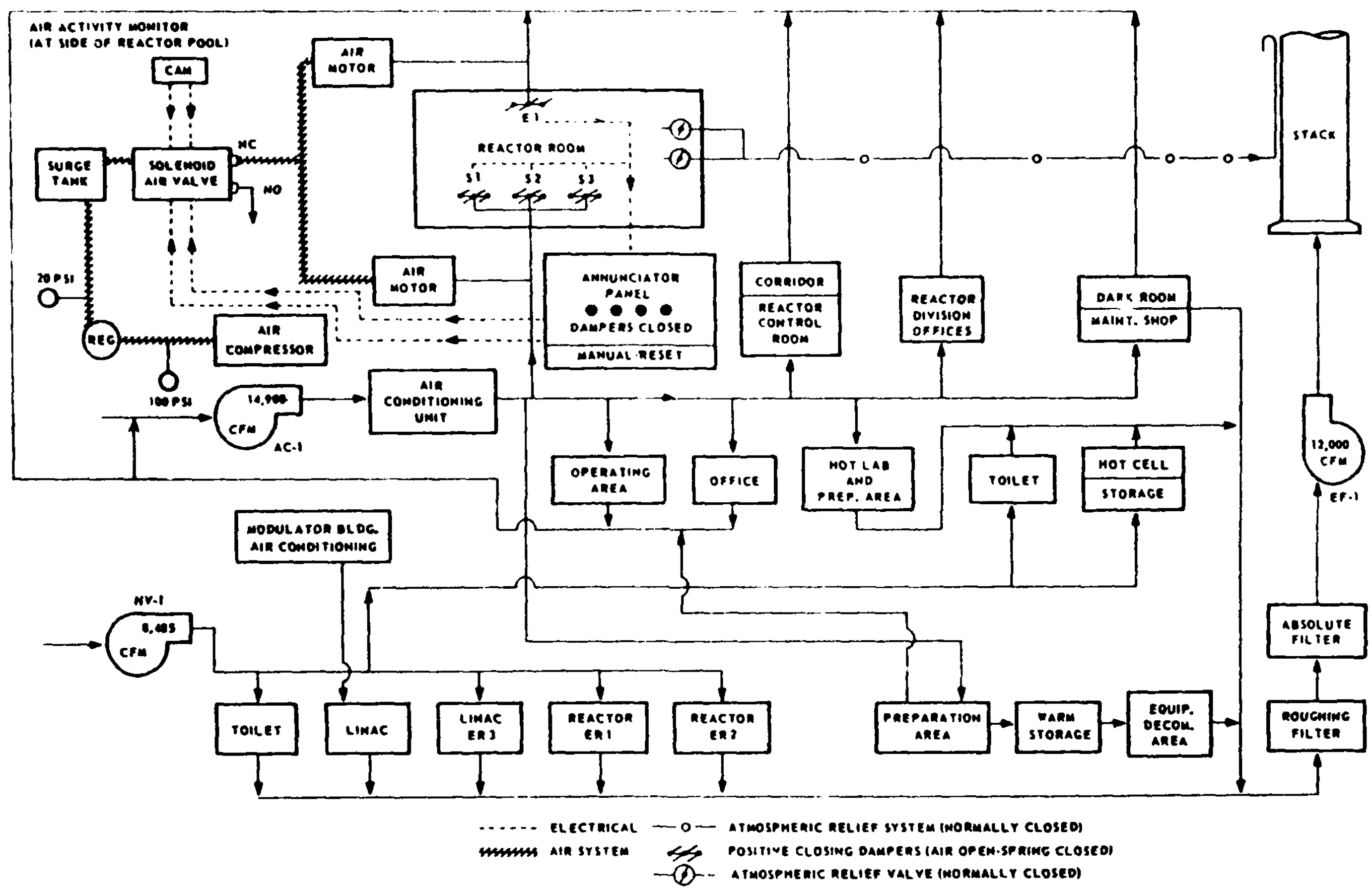

Figure 1. Air-handling system for reactor building. (This diagram appears as Figure 3-5 in the Safety Analysis Report and as Figure 4-1 in the Reactor Operations Manual.)

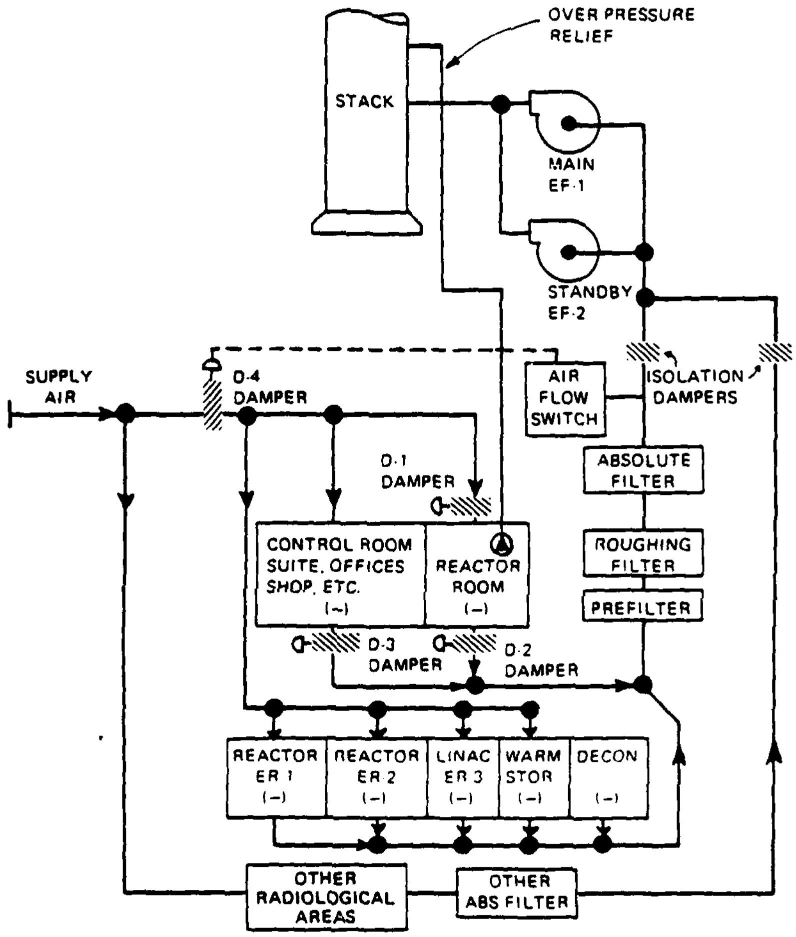

Figure 2. Diagram of ventilation system. (This figure will replace Figure 3-5 in the Safety Analysis Report and Figure 4-1 in the Reactor Operations Manual.)

system in the reactor building is to ensure the control of air movement and to provide the ability to isolate areas of possible airborne hazards. The proposed system upgrade not only upholds the SAR intent but also provides a safer and more reliable operational system.

Comparison of the present and the proposed air systems shows that major improvements to the system will be made without major changes in either design or function of the system components described in AFRRI administrative documents.

The relative differences between the two systems are explained below, as well as the advantages of the proposed air system over the present one:

1. 100% Exhaust Air Versus Recirculation Air: The current air system uses recirculated air mixed with outside air in most of the reactor building, except in the exposure rooms (ER's), the restroom on the lower level, and the hot cell. These areas exhaust 100% of their air. The reactor room air ducts use dampers to provide isolation in case of an airborne problem. The upgraded system is more safe radiologically because all air in the reactor-related areas is 100% exhausted. In addition, the air in the reactor room is held at a negative pressure in relation to the control room suite, which is in turn held negative in relation to the rest of the AFRRI complex. This is shown as change 1 on Figure 3.

2. Areas Excluded From the System: When the current system was installed, certain areas were included in the reactor air system because they were located in the reactor building. However, these areas are not of direct concern to the reactor-related operations, and have been excluded from our realm of consideration. Areas having radiological significance not related to the reactor are considered as other branches having special radiological treatment. The changes are shown in Figure 4.

3. Supply Air: In the existing system, air is supplied to the reactor building from two air-handling units. A heating and ventilation unit supplies 100% outside air to the exposure rooms, the hot cell, and a restroom on the lower level. Air from these areas is exhausted thru the radiation stack. The other air-handling unit mixes outside air with recirculated building air, and supplies it to the rest of the reactor building. In the proposed system, the reactor branch will receive supply air that is filtered and conditioned to standard laboratory quality. See change 1A on Figure 3.

4. Exhaust System: The present system uses a single fan to exhaust all single-pass air from the reactor building and a "drawn off" portion of the air that is recirculating in the building. This exhaust air is passed thru a bank of filters and pushed by the fan into the AFRRI stack; then, after mixing with other air, it is discharged to the environment thru the stack. The proposed system performs the same function, but the fan will be moved to another point within the system so that filtered air pulled from the reactor branch and other parallel branches is mixed before being passed thru the fan and discharged out the AFRRI stack.

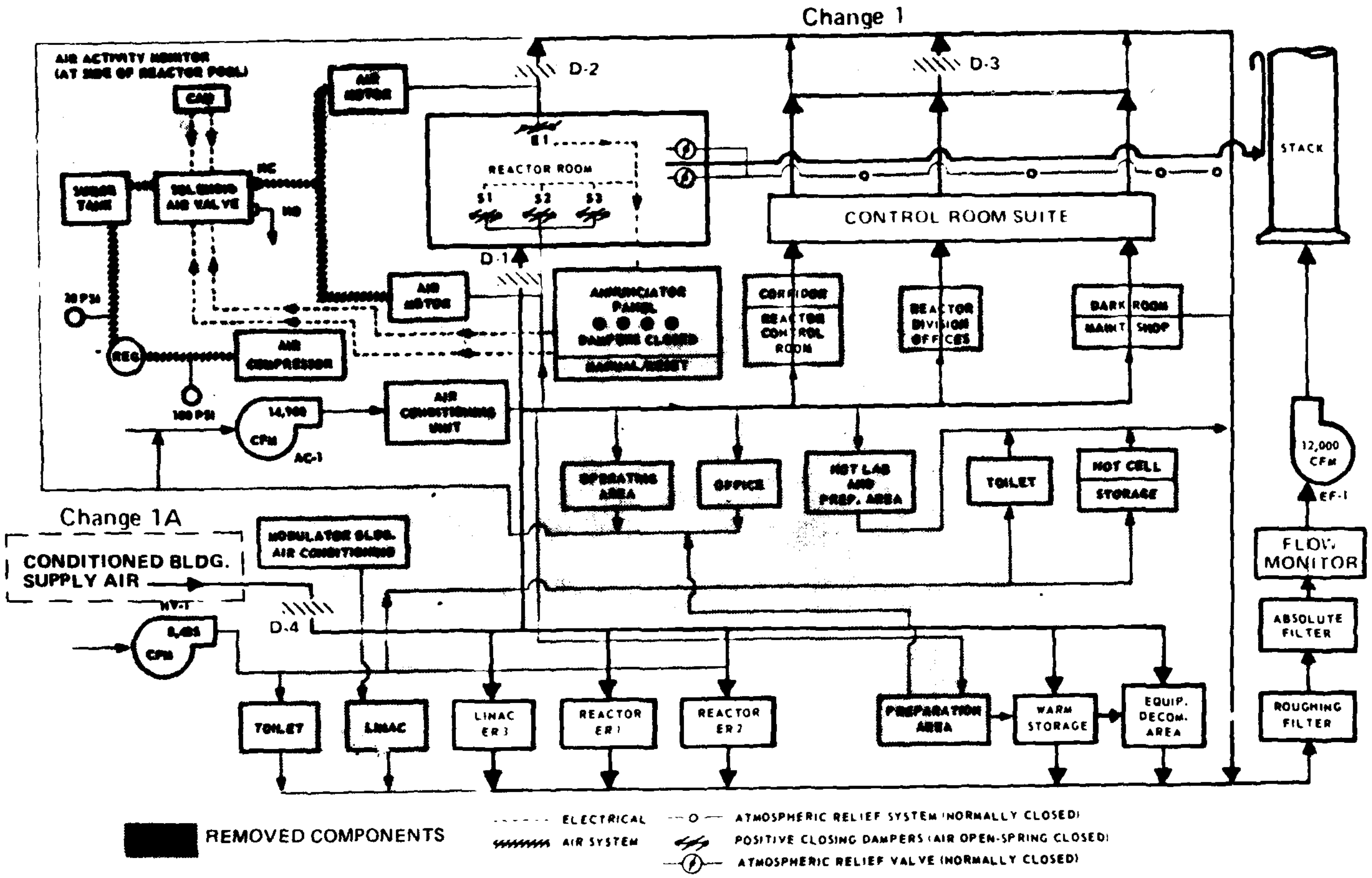

Figure 3. Changes to Figure 3-5 in the Safety Analysis Report. Change 1: Single-pass air system for reactor area. Change 1A: Air supply for reactor area building.

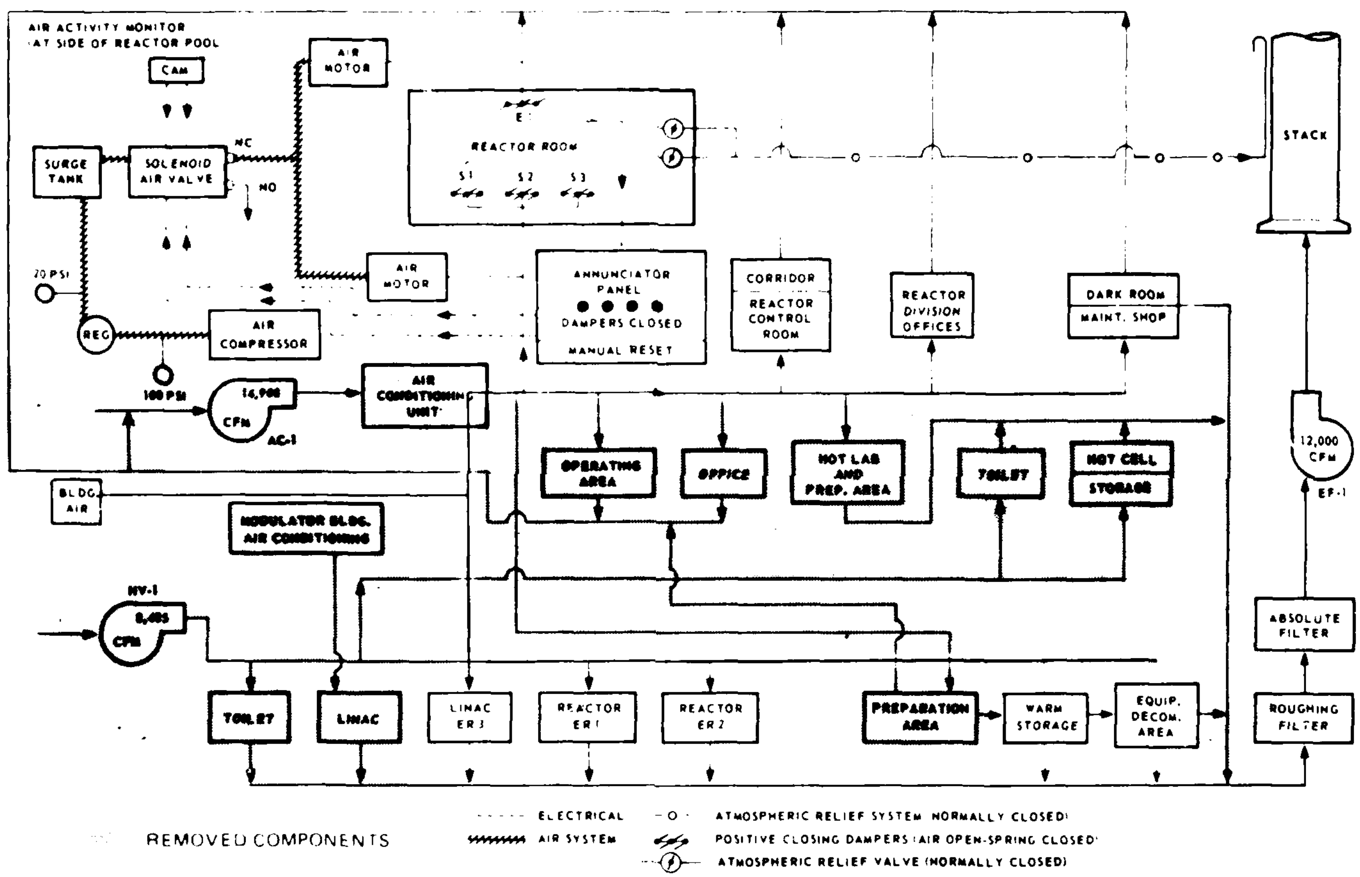

Figure 4. Change 2 to Figure 3-5 in the Safety Analysis Report: Reactor building areas removed from system

Isolation dampers in the reactor room will continue to operate with either an air particulate monitor or a manual button command. They may also be opened or closed manually from outside the contained areas. (See damper location in Figure 2.) Requirements not specified in this change will remain as currently described.

The proposed system has additional features that, although not required under the proposed amendment to the SAR, are nonetheless worthy of mention because they will improve the system's overall safety, reliability, and performance. A few of these features are as follows:

1. All exhaust-system duct work inside the building will be under negative air pressure.

2. A standby fan will automatically start if the main exhaust fan fails.

3. The air-moving system will have standby emergency power.

4. Airflow will be provided for each area of the system as described in Table 1.

5. Each room will have a thermostat and a reheat coil for its own temperature control.

6. Airflow sensors will adjust airflow to compensate for system changes resulting from actions such as loading of filters.

7. The proposed system allows radiological hoods and vented areas outside the reactor area to have independent absolute filtering as well as isolation if necessary, and yet it allows all sources of possible airborne radioactive material to exhaust thru the same stack.

In summary, the changes proposed for the air system of the AFRRI reactor building will provide an improved radiologically safe system that will

- Exhaust 100% of the air in all reactor areas where possible airborne radioactive material could be generated.
- Position the exhaust fan so that the reactor branch and other branches (such as radiological hoods, the LINAC area, and possible decontamination areas that need air control) will be supplied and exhausted in parallel. Air from each branch will pass thru its own absolute filters and isolation dampers.
- Use conditioned air from the main building supply as supply air.
- Hold negative the air pressure of all designated reactor areas (see Figure 2) in relation to other building areas for 100% of operational time with 100% exhausted air.

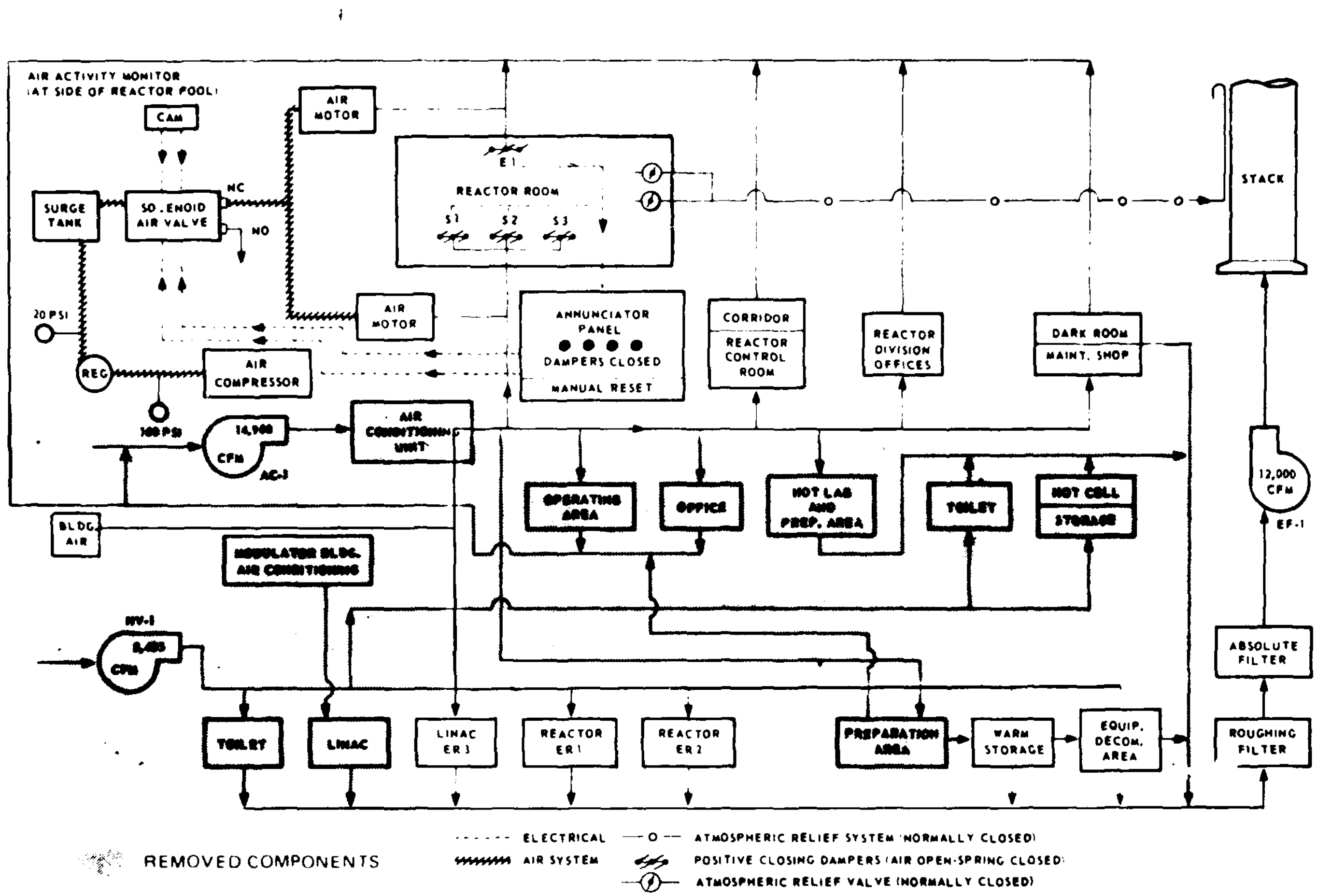

Figure 4. Change 2 to Figure 3-5 in the Safety Analysis Report: Reactor building areas removed from system

Table 1. Reactor Branch Air System Design Flow Rates*

Rm No.	Area Name	Area (sq ft)	Volume (cu ft)	Supply Air (CFM)	Exhaust Air (CFM)	Air Changes Per Hour	Relationship[+] (CFM)
1122	ER2	210	2,100	200	400	11.4	-200
1123	ER1	400	4,000	450	650	9.75	-200
1127	ER3	660	7,920	800	1,000	7.5	-200
1121	Decon						
	Wm Stor	718	7,180	2,000	2,540	21.2	-540
1128	LINAC						
	Cave	676	8,112	4,500	5,000	37.0	-500
							-1640
3106	Corridor	285	2,280	150	200	5.3	-50
3155	Office	112	1,120	105	105	5.6	0
3156	Office	126	1,260	105	105	5	0
3157	Office	104	1,030	125	125	7.3	0
3158	Office	126	1,260	120	120	5.7	0
3159	Shop	192	1,920	270	270	8.4	0
3160	Control	238	2,380	540	540	13.6	0
3161	Reactor	1,708	47,160	3,130	3,430	4.4	-300
							-350

Total air output from reactor branch: 14,285 CFM

Total output of other air branches: 20,715 CFM

Total exhaust thru radiation stack: 35,000 CFM

* All airflow rates in this Table are approximate; however, all areas designated with a positive or negative relation shall remain positive or negative as indicated.

+ Drawn from surrounding areas

A complete description of the proposed system is given in Appendix A. Excerpts from existing documents that require the changes appear in Appendix B.

Appendix D contains the minutes of the meeting on 31 March 1983 of the Reactor and Radiation Facility Safety Committee of AFRRI. Included is a signature page indicating that the Committee members reviewed the proposed changes and concurred with them.

APPENDIX A.

DESCRIPTION OF PROPOSED REACTOR VENTILATION SYSTEM

The AFRRI ventilation system supplies filtered and conditioned air to the laboratories and offices of the Institute. The ventilation system is a standard industrial type that mixes outside (new) air with recirculating building air, which is then conditioned to meet recognized standards for air quality. The air supplied to laboratories is approximately 85% outside air; air supplied to offices is approximately 25% outside air. The supply air is filtered thru a 25% roughing filter and an 85% final filter. The cleaned air is then heated or cooled to approximately 55°F. Then it is passed by air handlers thru supply ducts to terminal devices, which are capable of changing the air to the temperature set by a thermostat in the area to be serviced. The entire system consists of several branches that supply and exhaust the different sections of AFRRI.

One branch is of special interest in the control of possible airborne radiation hazards that may arise from actions or operations involving the TRIGA reactor. That branch services select areas within the reactor building. Several smaller branches serve fume hoods and other sources of possible airborne radioactive contamination. The reactor branch and other branches are installed in a parallel manner, using the same supply and exhaust. However, the reactor related area is held negative with respect to other areas within the complex. The area of interest is shown in the block diagram (Figure 3-5).

The select portions of the reactor building included in the branch are the reactor room; the Exposure Rooms 1, 2, and 3; the warm storage and decontamination room; and the reactor control room suite. The branch is subdivided into three parallel legs that service these areas. These areas are supplied air from the building supply air. Air is then single-passed thru each parallel leg, exhausted thru a set of absolute filters, monitored, and then released via the AFRRI stack.

Air from the building system is supplied to the legs of the reactor branch thru a single supply damper. This damper (which allows air movement) is held open only as long as there is airflow in the exhaust ducts beyond the absolute filters. A flow-sensitive switch that senses a loss of exhaust flow would send a signal to close the supply damper, thus stopping the supply of air to the entire branch.

To provide isolation capabilities in the event of airborne contamination, the reactor room air ducts (both supply and exhaust) are provided with sealing dampers. When closed, these dampers prevent air movement into or out of the reactor room via the ventilation system.

These dampers may be opened or closed from three points: a radiation-sensing device to sample air from the reactor room; a manual operate button in the control room; and each damper manually. The dampers are located so that access to them can be achieved without entering the reactor room. The dampers will be a "close on fail" type to insure a safe configuration in the event of system failure.

The location of the control room suite and its proximity to the reactor room requires air control primarily in the event of an airborne release. Since entry into the reactor room would be thru this area and since action stations would be established in this area, the area is held negative with respect to the rest of AFRRI, but positive to the reactor room. During normal conditions, air is circulated parallel to the reactor room; however, during airborne radiation conditions, the exhaust damper closes with the reactor room dampers. This causes a buildup of pressure relative to the reactor room, causing leakage into that room either thru the installed conduits or thru the entrance door if entry becomes necessary. To allow any small overpressures from the reactor room to vent in a controlled manner after long-term shutdown of the system, small vent lines with atmospheric relief dampers communicate from the reactor room to the stack.

Another leg of this branch supplies air to the Exposure Rooms (ER 1, 2, and 3) and the warm storage-decontamination area. The conditioned supply air is carried thru ducts to these areas. The exhaust air is drawn through the filter bank and, along with the other legs, is exhausted thru an exhaust stack.

After being pulled from the various serviced areas by fan EF 1, the exhaust air is pulled thru a set of absolute filters that insure stoppage of particulate material 0.3 microns or larger with a 99.97% efficiency. The filter bank will nominally consist of prefilters, roughing filters, and absolute filters. Filters are tested upon installation to insure that no leakage occurs. The filter buildup is measured by a differential pressure method. They are replaced when pressure reaches manufacturer's recommended levels. Isokinetic sampling is done on all air exiting the stack, and radiological monitoring is then performed. Readouts and alarms for both flow and radiological levels are in the control room, and are set according to the current limits given in appropriate instructions. Normal airflow rate thru the exhaust stack is about 35,000 CFM.

APPENDIX B.

EXCERPTS FROM EXISTING ADMINISTRATIVE DOCUMENTS

Excerpts from CURRENT TECHNICAL SPECIFICATIONS CONTAINED IN REACTOR LICENSE (R-84)

SECTION I: FACILITY DESCRIPTION

A. Reactor Building

1. **The reactor building, as a structurally independent building in the AFRRI complex, shall have its own ventilating system.*** The effluent from the reactor building ventilating system shall exhaust through absolute filters to a stack having a minimum elevation that is 18' above the roof level of the highest building in the AFRRI complex.

Excerpts from PROPOSED TECHNICAL SPECIFICATIONS ON FILE WITH NRC

5.0 REACTOR BUILDING AND VENTILATION SYSTEM

Applicability

This specification applies to the building which houses the reactor.

Objective

The objective is to restrict the amount of radioactivity released into the environment.

Specifications

a. **The reactor building, as a structurally independent building in the AFRRI complex, shall have its own ventilation.** The effluent from the reactor building ventilating system shall exhaust through absolute filters to a stack having a minimum elevation that is 18' above the roof level of the highest building in the AFRRI complex.

*Note: Sections to be changed are in bold type.

Excerpts from pending SAFETY ANALYSIS REPORT, contained in Docket 50-170

3.2.2 Reactor Building Ventilation

The reactor building ventilation system, shown schematically in Figure 3-5, is independent of the ventilation systems servicing the rest of the AFRRI complex. Thus, only the reactor building ventilation system is significant in the discussion of airborne radiation resulting from reactor operations.

Air enters the reactor building primarily through two air supply fans, AC-1 (√15,000 cfm) and HV-1 (√8,500 cfm). The air then circulates through the reactor building as shown on Figure 3-5. The reactor building ventilation system utilizes very slight negative differential pressures so that the air flow within the building will always be from clean areas (i.e., offices, etc.) into potentially contaminated areas (i.e., reactor exposure rooms, hot cell, etc.). Air exhausted by the reactor ventilation system to the AFRRI exhaust stack is passed through a roughing filter and an absolute filter. These filters remove particulate matter greater than 0.3 microns in diameter, and are maintained at a minimum efficiency of 99.9 percent. The differential pressure across each filter is measured to determine when the filters should be changed according to manufacturer's specifications. The air is then discharged through air exhaust fan EF-1 (√12,000 cfm) to the AFRRI stack. Failure of air exhaust fan EF-1 actuates an audible and visual alarm in the reactor control room.

3.2.4 Reactor Room Confinement

The reactor room contains approximately 1,800 square feet of floor space, has a ceiling height of approximately 18 feet, and a volume of about 32,400 cubic feet. The reactor building construction and ventilation system design allow confinement of the reactor room air volume. The external walls of the reactor room are constructed of reinforced ordinary (Portland) concrete. The roof of the reactor room is made of ordinary concrete poured over a corrugated steel form supported by steel roof trusses. The roof is sealed and waterproofed by the application of roofing compound. The contact surfaces between the concrete roof and the reinforced concrete external walls are further sealed by flashing, expansion joint material, and roofing compound. The interior walls of the reactor room are formed from ordinary concrete blocks in Portland cement mortar and most of the walls are plastered and painted on one side. The doors and hatches leading to the reactor room are kept closed and locked and are sealed with compressible rubber garlute. The windows between the reactor room and the reactor control room and adjacent offices are sealed and cannot be opened. All penetrations in the walls and floor for conduits and piping are also sealed.

The reactor building ventilation system contains three air supply dampers (S1, S2, and S3) and one exhaust damper (E1) in the reactor room and the reactor equipment room. These fail-safe dampers are pneumatically operated and require pressurized air to remain open. When the pressurized air, provided by one of the pressurized air supply systems, is removed, the dampers automatically close. The pressurized air is supplied to each damper through a solenoid valve.

In the event of the release of airborne radioactivity within the reactor room, radioactivity will be detected by the reactor room primary continuous air monitor (CAM). The high radiation alarm set point of the CAM will initiate a signal that causes the solenoid valves to vent and release the pressurized air from the dampers, causing them to close automatically. The reactor room is then confined. The four dampers, upon closing, actuate microswitches which complete light circuits for four indicator lights in the reactor control room. The dampers may also be closed or reset (opened) manually from the reactor control room.

APPENDIX C.

REQUESTED ADMINISTRATIVE CHANGES

The following administrative changes are requested as amendment number 18 to the AFRRI reactor license R-84. These changes have been reviewed and do not represent an unreviewed safety question. The technical specifications changes requested reflect minor administrative and wording changes and are not changes in reactor safety systems. It is requested that these proposed changes become effective upon installation and testing of the modified reactor ventilation system.

CURRENT TECHNICAL SPECIFICATIONS

Change 1:

Section 1:A.1, first sentence, replace the sentence with the following, "Areas of the reactor building including the reactor room, the control room suite, ER rooms 1, 2, and 3, and the warm storage-decontamination area shall have a separate branch of the AFRRI ventilating system."

PROPOSED TECHNICAL SPECIFICATIONS (on file with NRC as part of relicensing request Docket #50-170)

Change 1:

IV Section 5, specification a, first sentence, replace the sentence with the following, "Areas of the reactor building including the reactor room, the control room suite, ER rooms 1, 2, and 3, and the warm storage-decontamination area shall have a separate branch of the AFRRI ventilation system."

PROPOSED SAFETY ANALYSIS REPORT (on file with NRC as part of relicensing request Docket 50-170)

Change 1:

Replace section 3.2.2 (page 3-7) with new pages 3-7, 3-7a, and 3-7b.

Change 2:

Remove section 3.2.4, paragraph 2 (page 3-10). (This paragraph is included in Change 1 above.) Replace with new page 3-10.

Change 3:

Section 3.2.4 paragraph three sentence two (page 3-11), replace with: "The high radiation alarm set point of the reactor room primary CAM will initiate automatic closure of the reactor room dampers." Replace with new page 3-11.

Change 4:

Replace figure 3-5 with inclosed figure 3-5A.

Copies of the new pages follow, as Enclosures 1-9.

CURRENT TECHNICAL SPECIFICATIONS

Change: Remove pages 2 and 3; insert new pages 2 and 3 (Enclosures 1 and 2).

b. Pulse Mode - Operation in the pulse mode shall mean that the reactor is intentionally placed on a power excursion by making a step insertion of reactivity above critical with the transient rod, utilizing the scrams in Table I and the interlocks in Table II.

5. Cold Critical

Cold critical shall mean the critical condition when temperatures of the reactor fuel and bulk reactor water are equal (less than 40 degrees C).

6. Operable

A system or device shall be considered operable when it is capable of performing its intended functions in a normal manner.

7. Experiment

Experiment shall mean:

a. Any apparatus, device, or material placed in the reactor core region, in an exposure facility, or in-line with a beam of radiation originating from the reactor core.

b. Any operation designed to measure reactor parameters or characteristics.

8. Exposure Facilities

The exposure facilities associated with the AFRRI-TRIGA reactor shall be:

a. Exposure Room #1

b. Exposure Room #2

c. Pneumatic Transfer System

d. Reactor Pool

e. Portable Beam Tube

9. Channel Check

A channel check is a qualitative verificatón of acceptable performance by observation of channel behavior. This verification shall include comparison of the channel with other independent channels or methods measuring the same variable.

SECTION I: FACILITY DESCRIPTION

A. Reactor Building

1. Areas of the reactor building including: the reactor room, the control room suite, ER rooms 1, 2, and 3, and the warm storage-decontamination area shall have a

separate branch of the AFRRI ventilating system. The effluent from the reactor building ventilating system shall exhaust through absolute filters to a stack having a minimum elevation that is 18' above the roof level of the highest building in the AFRRI complex.

2. The reactor room shall contain a minimum free volume of 22,000 cubic feet.

3. The ventilating system air ducts to the reactor room shall be equipped with positive sealing dampers activated by fail-safe controls that will close off the ventilation to the reactor room automatically upon an alarm of the reactor room continuous air monitor.

4. The reactor room shall be designed to restrict air leakage when the positive sealing dampers are closed.

B. Reactor Core

1. The reactor core shall consist of standard TRIGA Mark F reactor fuel elements and a minimum of two (2) thermocouple instrumented TRIGA Mark F reactor fuel elements; Zr/H ratio of 1:1.7 (nominal), with stainless steel cladding; as described in Amendment No. 7 to the AFRRI Facility License No. R-64. The fuel elements shall be placed in a close packed array.

2. There shall be: four single core positions occupied by the three standard control rods and the transient rod; a neutron start-up source with holder; and positions for possible in-core experiments.

3. The core shall be cooled by natural convective water flow.

4. In-core experiments shall not be placed in adjacent fuel positions of the B-ring and/or C-ring.

5. Any burnable poison used for the specific purpose of compensating for fuel burnup or long term reactivity adjustments shall be an integral part of the manufactured fuel elements.

6. All fuel elements not in the reactor core shall be stored and handled in accordance with the provisions of 10 CFR 70. Irradiated fuel elements and fueled devices shall be stored in an array which will permit sufficient natural convective cooling by water or air such that the fuel element or fueled device temperature will not exceed design values.

SECTION II: OPERATIONAL LIMITATIONS AND RESTRICTIONS

A. Basic Safety Parameters

1. The maximum steady state power level shall be one megawatt.

PROPOSED TECHNICAL SPECIFICATIONS

Change: Remove page 39; insert new page 39 (Enclosure 3).

Objective

The objective is to assure that fuel which is stored will not become critical and will not reach an unsafe temperature.

Specification

All fuel elements not in the reactor core shall be stored and handled in accordance with the provisions of 10 CFR 70. Irradiated fuel elements and fueled devices shall be stored in an array which will permit sufficient natural convective cooling by water or air such that the fuel element or fueled device temperature will not exceed design values. Such an array will contain not more than 12 fuel elements in a single storage rack.

Basis

The limits imposed by this specification are conservative and assure safe storage and handling. Experience shows it requires approximately 67 fuel elements, of the design used at AFRRI, in a close packed array to achieve criticality. Calculations show that in the event of a storage rack failure with all 12 elements falling in a contact configuration the mass would be less than that required for critcality.

5.0 REACTOR BUILDING AND VENTILATION SYSTEM

Applicability

This specification applies to the building which houses the reactor.

Objective

The objective is to restrict the amount of radioactivity released into the environment.

Specifications

a. Areas of the reactor building including: the reactor room, the control room suite, ER rooms 1, 2, and 3, and the warm storage-decontamination area shall have a separate branch of the AFRRI ventilating system. The effluent from the reactor building ventilating system shall exhaust through absolute filters to a stack having a minimum elevation that is 18' above the roof level of the highest building in the AFRRI complex.

PROPOSED SAFETY ANALYSIS REPORT

Change 1: Remove page 3-7; insert new pages 3-7, 3-7a, 3-7b (Enclosures 4, 5, and 6).

Change 2: Remove page 3-10; insert new page 3-10 (Enclosure 7).

Change 3: Remove page 3-11; insert new page 3-11 (Enclosure 8).

Change 4: Remove Figure 3-5; insert new Figure 3-5 (Enclosure 9).

The lines of contact between the poured light concrete roof and the reinforced concrete walls are further sealed by flashing, expansion joint material, and roofing compound.

All reactor building exterior doors are well fitted and weatherstripped with good-quality, commercial, interlocking-type stripping at the top and sides. The bottoms of the doors are provided with interlocking thresholds.

3.2.2 Reactor Building Ventilation

The AFRRI ventilation system supplies filtered and conditioned air to the laboratories and offices of the Institute. The ventilation system is a standard industrial type that mixes outside (new) air with recirculating building air, which is then conditioned to meet recognized standards for air quality. The air supplied to laboratories is approximately 85% outside air; air supplied to offices is approximately 25% outside air. The supply air is filtered thru a 25% roughing filter and an 85% final filter. The cleaned air is then heated or cooled to approximately 55°F. Then it is passed by air handlers thru supply ducts to terminal devices, which are capable of changing the air to the temperature set by a thermostat in the area to be serviced. The entire system consists of several branches that supply and exhaust the different sections of AFRRI.

One branch is of special interest in the control of possible airborne radiation hazards that may arise from actions or operations involving the TRIGA reactor. That branch services select areas within the reactor building. Several smaller branches serve fume hoods and other sources of possible airborne radioactive contamination. The reactor branch and other branches are installed in a parallel manner, using the same supply and exhaust. However, the reactor related area is held negative with respect to other areas within the complex. The area of interest is shown in the block diagram (Figure 3-5).

The select portions of the reactor building included in the branch are the reactor room; the Exposure Rooms 1, 2, and 3; the warm storage and decontamination room; and the reactor control room suite. The branch is subdivided into three parallel legs that service these areas. These areas are supplied air from the building supply air. Air is then single-passed thru each parallel leg, exhausted thru a set of absolute filters, monitored, and then released via the AFRRI stack.

Air from the building system is supplied to the legs of the reactor branch thru a single supply damper. This damper (which allows air movement) is held open only as long as there is airflow in the exhaust ducts beyond the absolute filters. A flow-sensitive switch that senses a loss of exhaust flow would send a signal to close the supply damper, thus stopping the supply of air to the entire branch.

To provide isolation capabilities in the event of airborne contamination, the reactor room air ducts (both supply and exhaust) are provided with sealing dampers. When closed, these dampers prevent air movement into or out of the reactor room via the ventilation system.

These dampers may be opened or closed from three points: a radiation-sensing device to sample air from the reactor room; a manual operate button in the control room; and each damper manually. The dampers are located so that access to them can be achieved without entering the reactor room. The dampers will be a "close on fail" type to insure a safe configuration in the event of system failure.

The location of the control room suite and its proximity to the reactor room requires air control primarily in the event of an airborne release. Since entry into the reactor room would be thru this area and since action stations would be established in this area, the area is held negative with respect to the rest of AFRRI, but positive to the reactor room. During normal conditions, air is circulated parallel to the reactor room; however, during airborne radiation conditions, the exhaust damper closes with the reactor room dampers. This causes a buildup of pressure relative to the reactor room, causing leakage into that room either thru the installed conduits or thru the entrance door if entry becomes necessary. To allow any small overpressures from the reactor room to vent in a controlled manner after long-term shutdown of the system, small vent lines with atmospheric relief dampers communicate from the reactor room to the stack.

Another leg of this branch supplies air to the Exposure Rooms (ER1, 2, and 3) and the warm storage-decontamination area. The conditioned supply air is carried thru ducts to these areas. The exhaust air is drawn through the filter bank and, along with the other legs, is exhausted thru an exhaust stack.

After being pulled from the various serviced areas by fan EF1, the exhaust air is pulled thru a set of absolute filters that insure stoppage of particulate material 0.3 microns or larger with a 99.97% efficiency. The filter bank will nominally consist of prefilters, roughing filters, and absolute filters. Filters are tested upon installation to insure that no leakage occurs. The filter buildup is measured by a differential pressure method. They are replaced when pressure reaches manufacturer's recommended levels. Isokinetic sampling is done on all air exiting the stack, and radiological monitoring is then performed. Readouts and alarms for both flow and radiological levels are in the control room, and are set according to the current limits given in appropriate instructions. Normal airflow rate thru the exhaust stack is about 35,000 CFM.

3.2.3 Reactor Room

The reactor room (Room 3161) contains approximately 1,800 square feet of floor space and has a ceiling height of approximately 18 feet and contains the open surface of the TRIGA Mark-F reactor pool. Adjacent to the reactor room is the reactor administration/control room (Room 3160), five offices (Rooms 3155 through 3159), and Hall 3106. The only access to these rooms is from Hall 3106 in the reactor administration/control area. Large, sealed windows provide visual observaprotection in confining the reactor room air in the event that the other double doors are inadvertently opened. These doors are automatically locked by a local security system mounted near the doors. Additionally, during nonduty hours they are key-locked. The local security system will unlock the doors when operated by special ID badges or when the system is momentarily bypassed by a Reactor Operator. Special badges are issued only to reactor branch personnel, their superiors, and other personnel designated by the Director of AFRRI. The security system limits access to the reactor administration/control area to those personnel essential to reactor operations. The local security system does not prohibit personnel from leaving the reactor administration/control area during normal duty hours when not secured by the key lock.

3.2.4 Reactor Room Confinement

The reactor room contains approximately 1,800 square feet of floor space, has a ceiling height of approximately 18 feet, and a volume of about 32,400 cubic feet. The reactor building construction and ventilation system design allow confinement of the reactor room air volume. The external walls of the reactor room are constructed of reinforced ordinary (Portland) concrete. The roof of the reactor room is made of ordinary concrete poured over a corrugated steel form supported by steel roof trusses. The roof is sealed and waterproofed by the application of roofing compound. The contact surfaces between the concrete roof and the reinforced concrete external walls are further sealed by flashing, expansion joint material, and roofing compound. The interior walls of the reactor room are formed from ordinary concrete blocks in Portland cement mortar and most of the walls are plastered and painted on one side. The doors and hatches leading to the reactor room are kept closed and locked and are sealed with compressible rubber garlute. The windows between the reactor room and the reactor control room and adjacent offices are sealed and cannot be opened. All penetrations in the walls and floor for conduits and piping are also sealed.

In the event of the release of airborne radioactivity within the reactor room, radioactivity will be detected by the reactor room primary continuous air monitor (CAM). The high radiation alarm set point of the reactor room primary CAM will initiate automatic closure of the reactor room dampers. The reactor room is then confined. The four dampers, upon closing, actuate microswitches which complete light circuits for four indicator lights in the reactor room control room. The dampers may also be closed or reset (opened) manually from the reactor control room.

In order to accommodate significant changes in barometric pressure or a change in the reactor room air temperature that could appreciably alter the pressure in the reactor room, a special normally-closed atmospheric relief valve connects the reactor room directly to the atmosphere. A rise or fall in pressure sufficient to cause structural damage to the reactor room would open the atmospheric relief valve, allowing air to be expelled from the room to the atmosphere through a pipe attached to the stack.

3.3 REACTOR WATER PURIFICATION AND COOLANT SYSTEMS

The systems of the AFRRI-TRIGA Mark-F reactor associated with the reactor coolant are the primary cooling system, the secondary cooling system, the primary water purification system, the makeup water system for the primary coolant, and the reactor pool Nitrogen-16 (N^{16}) diffuser.

The open, nonpressurized reactor pool contains approximately 15,000 gallons of light, demineralized water. Natural convection of the water in the reactor pool disperses the heat generated by the reactor core. The reactor tank water level is monitored by a float-activated switch. A drop in the reactor tank water level of ~6 inches causes an immediate reactor scram, and activates several alarms.

3.3.1 Primary Cooling System

The primary cooling system consists of the reactor tank, the primary pump, the tube side of the shell-and-tube heat exchanger, and associated piping, valves, and fittings, all situated at elevations above the top of the core. The primary pump draws water from the reactor pool through the suction line, located in the reactor pool approximately 4 feet beneath the pool surface. The primary pump passes the water through the tube side of the heat exchanger at a rate of approximately 350 gallons per minute (gpm). The water is then returned to the reactor pool through the return line, located in the reactor pool approximately

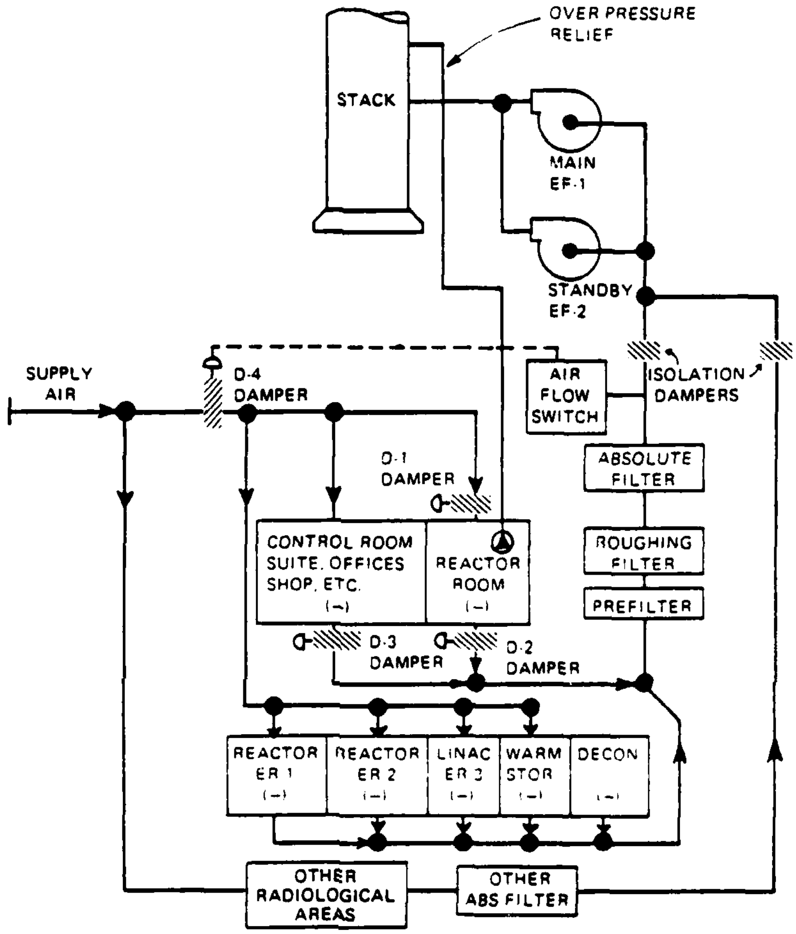

Fig. 3-5A Schematic Air Flow Diagram

APPENDIX D.

MINUTES OF MEETING OF RRFSC

Appendix D contains the minutes of the 31 March 1983 meeting of the Reactor and Radiation Facility Safety Committee (RRFSC) of AFRRI.

This appendix also contains a signature page on which the Committee members indicated that they had reviewed the proposed changes and concurred with them.

Minutes of the Reactor and Radiation Facility
Safety Committee Meeting, 31 March 1983

A special meeting was held at 0900, 31 March 83 in the AFRRI Board Room.

The following members were present:

L. S. Myers, Jr.	Scientific Director, AFRRI
R. Devine, CDR, USN	Radiation Sciences Department, AFRRI
R. R. Smoker, MAJ, USA	Administrative Department, AFRRI
J. A. Sholtis, Maj, USAF	Radiation Sources Division, AFRRI
N. K. Chawla	Radiation Safety Department, AFRRI
J. N. Stone	Naval Research Laboratory
T. G. Hobbs	National Bureau of Standards
C. B. Galley, CDR, USN	Naval Medical Command, National Capital Region
F. J. Munno	University of Maryland
B. S. Markovich	Non-voting Recorder

Ad-hoc member present:

M. L. Moore	Radiation Sources Division, AFRRI

Invited non-members present:

R. Florance	Logistics Department, AFRRI
D. Reynor	Henry Adams, Inc.

The meeting was called to order by Dr. Myers who served as Acting Committee Chairman since Dr. Conklin was not in attendance. Dr. Myers asked Major Sholtis to briefly summarize the purpose and planned agenda for this special committee meeting. The meeting was called to present the findings of the Safety Analysis for Upgrade Modification of the AFRRI Reactor Ventilation System to the Committee for review and concurrence. If the Committee concurs that no unreviewed safety questions are involved, an administrative change to the Reactor License will be requested, upon the Director's approval, that will permit these proposed modifications in the Reactor ventilation system. Mr. Moore, who performed the safety analysis, will brief the committee on the proposed ventilation system modifications, will present his findings for the committee's review and concurrence, and will also identify the associated administrative changes to the Reactor License which are required.

Mr. Donald Raynor of Henry Adams, Inc., who did the architectural and engineering work on the proposed ventilation system was introduced to the committee members and the meeting was turned over to Mr. Moore.

Mr. Moore first explained that the planned MILCON project at AFRRI involves modifications to upgrade the ventilation system. He went on to point out that 10 CFR 50.59 requires that modifications made to portions of a licensed facility that are described in the facility Safety Analysis Report be documented with a written safety analysis that provides the basis for the determination that such a change does not involve an unreviewed safety question. Based on his Safety Analysis of the proposed upgrade modification of the AFRRI reactor ventilation system, Mr. Moore has determined that the proposed changes to the AFRRI ventilation system will accomplish the full intent of the original Final Safety Analysis Report, FSAR (as modified in 1967), that these proposed changes in fact represent an improvement in radiological safety where possible airborne hazards are of concern, and that there are no unreviewed safety questions concerning this modification.

If, as a result of this review, the Committee concurs with these findings, the system modifications will require minor administrative changes to the current Reactor License R-84 in the form of word changes to the Technical Specifications and the facility Safety Analysis Report (SAR), as well as word changes to the proposed SAR and Technical Specifications already submitted and now pending before the USNRC as part of the AFRRI reactor relicensing. These administrative changes are specified in Attachment D and they will form the primary part of a request for amendment to the current Reactor License (R-84), incorporating the proposed modification.

Mr. Moore began his substantive presentation by first explaining to the Committee that the existing ventilation system for the AFRRI reactor building was installed prior to the original reactor startup in 1962. He pointed out that the FSAR gives several qualifications of the building and air systems to be used in the reactor area. These qualifications insure that the reactor air system will control and restrict any airborne radioactive material and will prevent its release in an uncontrolled manner to the unrestricted environment. Mr Moore identified and discussed the primary qualifications to insure the integrity of the system. A lengthy discussion followed with Mr. Moore using viewgraphs of Figure 3.5 showing Change 1: Reactor Area Single Pass Air System, and Change 1A: Reactor Area Building Air Supply.

A recommendation was made that all committee members go on a tour of the areas involved in the changes; this was accomplished. A lengthy discussion followed the committee's return from the tour. Mr. Moore explained the diagram again and said the proposed ventilation system servicing the reactor area would simply become a separate branch of the overall AFRRI ventilation system which, along with other branches having radiological significance, would receive special air handling treatment.

Mr. Moore said the purpose of an independent air system in the reactor building is to insure the control of air movement and to provide the capability to isolate areas of possible airborne hazards. The proposed system upgrade not only upholds the SAR intent, but also provides a safer and more reliable system.

Using viewgraphs, Mr. Moore compared the current system with the proposed air system. He showed how the proposed changes will be improvements to the existing system and how they will be accomplished without major changes in either the design or function of the system components.

He went on to explain the relevant differences between, and the advantages of, the proposed air system with respect to the current system. He discussed the 100% exhaust versus recirculation air, areas excluded from the system, supply air and the exhaust system. Also the additional features the proposed system will have were mentioned and how they will improve the system's overall safety, reliability and performance. Mr. Moore went on to explain in detail all of the features of the proposed system.

A lengthy discussion followed on all the proposed changes contained in the analysis. Several recommendations were made; they included: (1) The Safety Analysis for the Upgrade Modification of the AFRRI Reactor Ventilation System will be made a Tech Note. (2) Since three paragraphs of the SAR are due to be replaced, and these will describe the new system, it was recommended that the entire pages be replaced so there is no error in replacement of paragraphs. (3) Minor word changes to the analysis were recommended to clarify certain areas.

A question about the chart showing air flow rates was raised. Mr. Raynor explained the Reactor Branch Air System Flow Rates chart and how it was developed. After a short discussion it was recommended by the committee that several clarifications be made to the chart. These included: The relation column should have an asterisk added with a note at the bottom of the page explaining the imbalance since this chart will remain part of the analysis. (NOTE: The air difference as related will be drawn from surrounding areas not in the Reactor Branch Area.) Other recommendations were that the chart be titled "Design Reactor Branch Air System Flow Rates" that Input Air (CFM) be changed to Supply Air (CFM) and that Output Air (CFM) be changed to Exhaust Air (CFM); that Relation be changed to CFM* with an explanatory note at the bottom of the page. All of these changes were approved by the committee and the final version along with the minutes of this meeting were recommended to be included in the Tech Note.

Mr. Moore discussed what would be sent to the NRC in the form of a license change request. They include Attachment C, Attachment D (this will be incorporated into a letter asking that these changes be made). It was recommended that this not be called a specific amendment number since the last time (i.e., in the case of the new Tech Specs which were identified as amendment number 17), it was numbered incorrectly and amendment numbers are assigned by the NRC not AFRRI. Mr. Moore explained that it had to be an amendment and we would accept what ever number we are given. The letter will ask that the administrative changes requested be granted as an amendment to the AFRRI Reactor License. Attachment E will also be included. Dr. Munno recommended that page changes be made instead of requesting NRC to change paragraphs or sentences. That is, send these page changes as attachments with the letter. Maj Sholtis recommended that Attachment E should be changed from "Extracts from CURRENT TECHNICAL SPECIFICATIONS - R-84" to "Extracts taken from CURRENT TECHNICAL SPECIFICATIONS - R-84". Dr. Munno made a motion and it was seconded by Mr. Stone that all of these changes be made and incorporated in the final Tech Note and this was approved by the remaining committee members.

The committee reviewed Mr. Moore's analysis and by unanimous vote they concurred that no unreviewed safety questions are involved and that the changes proposed to the Technical Specifications are administrative in nature. The changes as incorporated in the final safety analysis (TECH NOTE 83-1) were likewise found to have no unreviewed safety questions and the package was unanimously approved as requested. It was noted that the analysis may require simple editing corrections for publication as a the Tech Note; upon completion a copy will be forwarded to all committee members.

It was pointed out that the NRC typically requests a point of contact on all correspondence other than the Director preferably someone familiar with the letter and subject. The committee saw no problem. A point of contact will be identified in the last paragraph of the letter along with a telephone number.

With no further business the meeting adjourned at 1110.

PREPARED: B. S. MARKOVICH
Recorder

SUBMITTED: LAWRENCE S. MYERS, Jr., Ph.D.
Scientific Director
Acting Chairman, Reactor and Radiation Facility Safety Committee

THROUGH: JAMES J. CONKLIN, M.D.
LtCol, USAF, MC
Deputy Director
Chairman, Reactor and Radiation Facility Safety Committee

APPROVED: BOBBY R. ADCOCK
COL, MSC, USA
Director

We have reviewed the proposed modification to the AFRRI reactor ventilation system and find there to be no unreviewed safety questions. We find this modification will enhance reliability as well as the intent of the Safety Analysis Report and that the proposed system is more conservative than that currently in use. This committee recommends that this requested modification and the minor administrative changes to required documentation be approved.

Reactor and Radiation Facility Safety Committee

J. J. CONKLIN, Chairman	1 Apr 83 Date		
Z. Z. CHURCH	31 MAR 83 Date	L. MYERS	31 Mar 83 Date
R. T. DEVINE	31 March 83 Date	J. N. STONE	3/31/83 Date
R. R. SMOKER	31 MAR 83 Date	T. G. HOBBS	3/31/83 Date
J. A. SHOLTIS, Jr.	31 Mar 83 Date	F. MUNNO	31 MAR 83 Date
N. CHAWLA	31 MAR 83 Date	C. B. GALLEY	31 Mar 83 Date