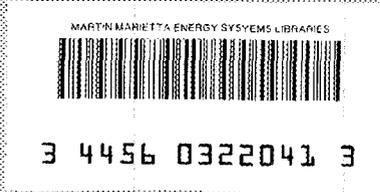


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DESCRIPTION OF FACILITY RADIATION AND CONTAMINATION ALARM SYSTEMS INSTALLED IN RADIOCHEMICAL PROCESSING PILOT PLANT BUILDING 3019

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1. ABSTRACT

Facility Radiation and Contamination Systems were installed in the Radiochemical Processing Pilot Plant Building 3019 to continuously and automatically monitor gamma radiation (by sixteen gamma monitrons), neutron radiation (by three neutron dose-rate--burst detectors), and air contamination (by seven beta-gamma and four alpha constant air monitors) in the entire facility. These instruments and other components in the network provide health physics monitoring information, sound local alarms when abnormal conditions occur, and indicate the abnormal conditions on a central panel board.

Operating personnel are first given warning when a "caution level" of 7.5 mr/hr or 1000 counts/min is detected by a monitron or beta-gamma air monitor, respectively. A second warning is given when a "high level" is detected, i.e., 23 mr/hr by a monitron, 4000 counts/min by a beta-gamma air monitor, or 800 counts/min by an alpha air monitor. The neutron detectors operate "rate" alarms when a level of 23 mrem/hr is detected or operate "burst" alarms when a current pulse of 3×10^{-6} amp with a rise time of 100 μ sec is exceeded.

The building is automatically "contained" when two or more monitrons or two or more air monitors detect a "caution level" of radiation or air contamination. The building evacuation system operates automatically when two or more monitrons or two or more air monitors detect a "high level" of radiation or air contamination, or when two or more neutron monitors detect a neutron burst or a "high-rate" level.

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2. INTRODUCTION

The Radiochemical Processing Pilot Plant (Building 3019) is one of 17 facilities at Oak Ridge National Laboratory being equipped with networks of radiation and air monitoring instruments connected to a central control room within the building and to the Laboratory Emergency Control Center.¹ Facility Radiation and Contamination Systems were installed in Building 3019 to continuously and automatically determine the radiation condition of the entire facility and to report this information to a central control panel within the building. Should the radiation level or the air activity in a large portion of the building exceed preset values, an audible alarm in the building will be actuated, the building containment system will be actuated, warning lights outside the building will flash, and an alarm signal will be transmitted to the Emergency Control Center, Building 2500.

3. DESCRIPTION

3.1 System

The gamma radiation level is monitored by 16 monitrons located throughout the Pilot Plant and High Radiation Level Analytical Facility (HRLAF) located in the building (Table 1). The neutron radiation level is monitored by three neutron dose rate and burst detectors located throughout the building. Air is monitored for beta-gamma emitting particles by seven constant air monitors and for alpha emitting particles by four constant alpha air monitors located throughout the building.

Since none of the health physics functions originally designed into the monitrons and air monitors were altered, each instrument is an independent unit that retains all of its local alarm features. Each instrument, however, is connected to an individual indicator module on the monitoring panel near the Volatility Pilot Plant control room. By means of three colored lamps, which normally give a dim light, an indicator module indicates the condition of the instrument to which it is connected; that is, a white lamp burns at full intensity if the instrument becomes inoperative, an amber lamp burns at full intensity if the "caution alarm level" (7.5 mr/hr for a monitron and 1000 counts/min² for a beta-gamma air monitor) is reached, and a red lamp burns at full intensity if the "high alarm level" (23 mr/hr for a monitron and 4000 counts/min² for a beta-gamma air monitor and 800 counts/min for an alpha air monitor) is reached (Table 2).

The neutron detectors cause an amber lamp to burn at full intensity if the dose rate exceeds 23 mrem/hr, and a red lamp to burn at full intensity if the neutron burst level alarm is tripped (Table 3). This instrument is designed to alarm at a neutron burst level that would be observed if a criticality occurred at a distance of 200 ft. For these instruments there

¹D. J. Knowles et al., Instrumentation and Controls Div. Ann. Progr. Rept. Sept. 1, 1963, ORNL-3578, pp. 37-40.

²The count/min values are for Model Q-2240B air monitors only. The equivalent values for the Model Q-1740A are 2000 and 10,000 counts/min.

Table 1. Radiation, Contamination, and Neutron Monitors Installed in Building 3019

Location	Monitor Number
1. Facility Radiation Monitors (arranged in evacuation alarm groups)^{a, b}	
<u>West Group</u>	
Pipe tunnel west	1
Basement	4
Plenum area west	5
Sample gallery west	12
<u>East Group</u>	
Pipe tunnel east	3
Cell 2 inside	6
VPP makeup area	8
Penthouse east	11
<u>Central Group</u>	
Pipe tunnel center	2
PRFR makeup area	7
Penthouse west	9
Penthouse center	10
2. Radiation Monitors with Control Room Alarm Only^a	
Cell 4, 2nd level north	13
Cell 4, 2nd level south	14
Cell 4, 1st level	15
Room 211	16
3. Facility Contamination Monitors (arranged in evacuation alarm groups)^b	
<u>West Group (Beta-Gamma)</u>	
Corridor outside room 210 ^c	B-28
East bay of HRLAF ^d	B-29
West bay of HRLAF ^c	B-30
<u>East Group (Beta-Gamma)</u>	
East Penthouse ^c	B-6
West control room ^c	B-14
East control room ^d	B-15
Penthouse west ^c	B-20
<u>Alpha Monitor Group^e</u>	
Penthouse east	A-6
East control room	A-15
Penthouse west	A-20
HRLAF	A-29
4. Facility Neutron Monitors^{f, g}	
Penthouse	1
HRLAF	2
East control room	3

^aAll monitors are Q-1154B-13.

^bCoincidence of any two high level alarms in the group causes automatic evacuation.

^cORNL Model Q-2240B-4 Constant Air Monitor.

^dORNL Model Q-1740B Continuous Air Monitor.

^eAll monitors are ORNL Model Q-2340 Constant Alpha Air Monitor.

^fAll monitors are ORNL Model Q-2562 Neutron Rate and Burst Detectors.

^gCoincidence of any two burst alarms in the group causes automatic evacuation.

Table 2. Central Control Panel Alarm Indications
for Monitrons and Air Monitors

Instrument Condition	Lamp Intensities		
	Red	Amber	White
Normal Operation	Dim	Dim	Dim
Caution Level ^{a,d}	Dim	Bright	Dim
High Level ^{b,d}	Bright	Bright	Dim
Instrument Inoperative	Dim	Dim	Bright
Instrument Removed ^c	Bright	Bright	Bright

^aCaution level for a beta-gamma air monitor is 1000 counts/min and for monitron is 7.5 mr/hr. No caution level alarms are available on constant alpha air monitors.

^bHigh level for a beta-gamma air monitor is 4000 counts/min, for an alpha air monitor is 800 counts/min, and for a monitron is 23 mr/hr.

^cLamp intensities remain until a maintenance connection is made, giving "inoperative" indication.

^dThe count/min values are for Model Q-2240B air monitors only. The equivalent values for the Model Q-1740A are 2000 and 10,000 counts/min.

Table 3. Central Control Panel Alarm Indications for Neutron Detectors

Instrument Condition	Lamp Intensities	
	Red	Amber
Normal Operation	Dim	Dim
Burst Level ^a	Bright	Dim
Rate Level ^b	Dim	Bright
Burst and Rate Level	Bright	Bright
Instrument Removed ^c	Bright	Bright

^aBurst level is fixed in the instrument to that level whose current magnitude and rate of rise would be attained if a criticality should occur at a distance of 200 feet from the instrument.

^bRate level is 23 mrem/hr.

^cLamp intensities exist until a maintenance connection is made giving "Normal" indication.

is no indication when an instrument becomes inoperative. Any change in the intensity of any lamp, that is, from dim to bright, is announced by a buzzer module.

The high-level alarm outputs of twelve selected monitron indicator modules are connected in three groups of four to coincidence modules; the high-level alarm outputs of the constant air monitor indicator modules are connected in two groups of four and one group of three to coincidence modules. If a coincidence module receives a high-level alarm signal from any two or more constant air monitors or monitrons in a group, the building evacuation system is actuated (see Table 1).

The burst- and rate-alarm outputs of the three neutron dose-rate-burst detectors are connected to a coincidence module. If the coincidence module receives alarm signals from two or more instruments (burst, rate, or mixed), the building evacuation system is actuated.

The caution-level alarm outputs of the twelve selected monitrons and the seven beta-gamma constant air monitors are connected in the same grouping as the high level alarm modules and are connected to "containment" (modified coincidence) modules. Caution-level alarm output signals from two or more instruments in one of the groups will cause the building to be contained. Containment criteria for the Radiochemical Pilot Plant are described in ORNL CF-60-5-20, CF-60-3-74, and CF-61-12-13.

3.2 Components

3.2.1 Panel Board

The central panel board for the entire system, located on the containment panel near the VPP control panel, consists of five 12-module racks, one central control chassis, and one dc power supply. Four of the 12-module racks contain one indicating module for each instrument, coincidence modules for the beta-gamma and neutron radiation alarm system, coincidence modules for the contamination alarm system, coincidence modules for the containment system, a buzzer module, and a manual evacuation module. One 12-module rack contains modules which operate indicator lamps on a remotely located panel. The racks and modules are made of anodized aluminum. The modules have anodized Metalphoto front panels. A Metalphoto text strip is provided at the top of each rack for instrument identification. The central control chassis contains manual switches, timers, relays, and monitoring equipment which are parts of the system but not located in modules.

3.2.2 Monitron

The Remote Monitron (ORNL Model Q-1154B) is an ac powered, null-type radiation detection instrument for monitoring gamma radiation. The monitron consists of two basic units: (1) a control chassis, which contains the power supply, the main amplifier, a radiation-level indicating meter, and the

controls; and (2) a preamplifier and ion-chamber detector assembly. The detector assembly can be located remotely 50 ft or more from the control chassis. A 0- to 10-mv recorder or a 0- to 1-ma meter can be connected to the monitron.

The range of the meter is 0 to 25 mr/hr, and the calibrated accuracy of the meter is within 3% for gamma radiation. The zero setting may be checked by means of a pushbutton.

When the set point of an alarm circuit in the main chassis is exceeded, a bell is rung and a red lamp on the instrument is lighted. A connection on the instrument for an external alarm is used to operate the caution-level alarm for the system. In addition to these standard features, the monitrons installed in Building 3019 have two other features: (1) warm-up time delay relays installed on the main chassis, and (2) a high-level alarm meter-relay installed on an accessory chassis.

The instrument and alarms operate as follows:

1. A power failure or a disconnected power cord will cause the white lamp on the central control panel to burn brightly. After power is restored and a 1-min delay for warm-up, the white lamp resets itself. During this 1-min delay, caution and high-level alarms at the instrument might sound, but the same alarms on the central panel are locked out and will not sound.
2. If the caution level of 7.5 mr/hr is exceeded, an electronic alarm circuit causes the yellow lamp on the central panel to burn brightly and the bell at the instrument to ring. The alarms are automatically reset at the instrument when the radiation level decreases below 7.5 mr/hr, but they must be reset manually at the central panel.
3. The 0- to 1-ma meter output terminals are connected to the accessory meter-relay, which is set to operate when the 23 mr/hr (high-level alarm) set-point is exceeded. At 23 mr/hr, the bell at the instrument will be ringing, since it started at 7.5 mr/hr, and the red lamp on the central panel will burn brightly. When the radiation level decreases to less than 23 mr/hr, the high-level alarm at the instrument is automatically reset by a signal interrupter (allows a reset every 30 sec) from the central panel. The central panel alarm is reset manually.

3.2.3 Air Monitors

Two types of beta-gamma air monitors were installed: an older model, the Mobile Air Monitor (ORNL model Q-1740B); and its successor, the Beta-Gamma Constant Air Monitor (ORNL model Q-2240B). The alpha air monitors are ORNL model Q-2340.

Mobile Air Monitor. -- This monitor consists of an aspirating system, a paper filter, a halogen-type Geiger-Mueller tube detector, a logarithmic count-rate meter, and visible and audible alarms. Any background radiation

level within the range of the instrument can be suppressed, and from one to five decades may be selected for display on a strip-chart recorder. This scale arrangement allows the instrument to accumulate air-contamination data while operating in areas where the background count is high.

A Model H, Leeds & Northrup Speedomax recorder with upscale, downscale, and set-point alarms indicates high radiation, instrument failure, and above tolerance radiation, respectively. The local alarm circuit is so arranged that, if the air contamination increases to a point above the set point, an amber local annunciator light, indicating tolerance level, is actuated. At very high radiation conditions, an alarm bell and a red annunciator light are actuated simultaneously. The local annunciator lights are mounted on top of the instrument cabinet so that operation of the monitor can be observed from any position in the immediate area.

Beta-Gamma Constant Air Monitor. -- This monitor consists of an aspirating system, a paper-tape filter, a halogen-type Geiger-Mueller tube detector, a linear count-rate meter, a recorder, and visible and audible alarms. Air is drawn through the filter at 3 cfm (controlled manually) by a Roots blower. A sample containing beta-gamma emitting particles is collected on the paper-tape filter (collected sample size of 1 x 2-1/2 in.). The sample tape is advanced automatically every 24 hr. The tape may be advanced manually at any time by the operator. The detector counts the sample as it is being collected. The count-rate meter is a linear duty-cycle type utilizing a single range and having a high-voltage supply as an integral part. The normal range is 0 to 5,000 counts per minute, and ranges of 0 to 250, 0 to 1000, 0 to 10,000 and 0 to 25,000 counts/min at full scale may be obtained by relocating two jumper wires under the chassis. The input voltage sensitivity of the rate meter is 200 mv. The over-all accuracy of the rate meter, including the effect of long-term drift, is within 5%. The corona-regulated high-voltage supply is nominally 900 v with ± 150 -v adjustment. The maximum load current is 20 μ a.

The rate meter has adjustable high-level and caution alarms and puts out a 1-ma full-scale signal to drive an integrally mounted Rustrack recorder. The caution alarm is adjustable over the range of approximately 2 to 58%, and the high-level alarm is adjustable from the caution-alarm set point to full scale. The caution alarm is an electronic circuit which employs a dual triode and plate relay with potentiometer adjustment. The relay is energized below the trip point and is de-energized by current transfer from one triode to the other by a diode that couples the cathode circuits. Hysteresis is approximately 4% of full scale. The high-level trip is accomplished by the high contact on a contact-making meter. The associated high-level relay is de-energized below the set point. Upon reaching the set point, the meter contacts and relay are locked in and are released by depressing the reset pushbutton. A low-level pointer on the panel meter has no contacts and is used only as a visual indicator. The pointer should be set at the level corresponding to the caution-alarm set point.

The instrument has an alarm panel with four lights, a bell, and a buzzer. When the caution set point is reached, an amber lamp is lighted

and the buzzer is energized. There is no switch to silence the buzzer, and the operator is expected to advance the tape when this point is reached. When the high-level trip point is reached, a red lamp is lighted and the bell rings. The bell can be silenced by a toggle switch and, when this is done, an amber neon indicator is lighted.

When the filter tape breaks, a red neon indicator is energized and the caution circuit is energized through a flasher. The amber neon bulb burns continuously, and the caution light and the buzzer come on intermittently. If a tape breaks and, at the same time, the caution alarm sounds, the tape-break neon light, the caution light, and the buzzer will be on continuously. A test pushbutton permits checking the alarm panel by simultaneously simulating tape break and high-level alarm signals.

Constant Alpha Air Monitor. -- This instrument consists of an aspirating system, a paper-tape filter, a scintillation detector, a linear count-rate meter, a recorder, and visible and audible alarms. Air is drawn through the filter at 3 cfm (controlled manually) by a Roots blower. A sample of dust particles in the air is collected on the paper-tape filter (collected sample diameter of 1-5/8 in.). The sample tape is automatically advanced once every 24 hr. The tape may be advanced manually at any time by the operator. The detector, which counts the sample as it is being collected, is a silver-activated zinc sulfide scintillator having an effective detector diameter of 1-7/8 in. The detector window (nominal thickness of 1 mg/cm²) is light-tight.

The count-rate meter is a linear duty-cycle type, utilizing a single range and having a high-voltage supply as an integral part. The normal range is 0 to 1000 counts/min, but ranges of 0 to 250, 0 to 2500, 0 to 5000, and 0 to 10,000 counts/min at full scale may be obtained by relocating two jumper wires under the chassis. The input voltage sensitivity of the rate meter is 200 mv. The over-all accuracy of the rate meter, including the effect of long-term drift, is within 5%. The corona-regulated high-voltage supply is nominally 900 v with ± 150 -v adjustment. The maximum load current is 20 μ a.

The rate meter has adjustable high-level and caution alarms and puts out a 1-ma full-scale signal to drive an integrally mounted Rustrack recorder. The caution alarm is adjustable over the range of approximately 2 to 58% of full scale, and the high-level alarm is adjustable from the caution-alarm set point to full scale. The caution alarm is an electronic circuit employing a dual triode and plate relay with potentiometer adjustment. The relay is energized below the trip point and is de-energized by current transfer from one triode to the other by diode coupling the cathode circuits. Hysteresis is approximately 4% of full scale. The high-level trip is accomplished by the high contact on a contact-making meter. The associated high-level relay is de-energized below the set point. Upon reaching the set point, the meter contacts and relay are locked in and can be released only by the depression of the release pushbutton. There is a low-level pointer on the panel meter, but it has no contacts and is to be used only as a visual indicator. The pointer should be set at the level corresponding to the caution-alarm set point.

The instrument has an alarm panel with four lights, a bell, and a buzzer. When the caution set point is reached, an amber lamp is lighted and the buzzer is energized for 15 sec. The filter tape will advance after a 10-min delay. There is no switch to silence the buzzer. When the high-level trip point is reached, a red lamp is lighted and the bell rings. The bell can be silenced by a toggle switch and, when this is done, an amber neon indicator is lighted.

Filter-tape breakage is also indicated. When a tape breaks, a red neon indicator is energized and the caution circuit is energized through a flasher. The amber neon bulb burns continuously, and the caution light and the buzzer come on intermittently. If a tape breaks and, at the same time, the caution alarm sounds, the tape-break neon light, the caution light, and the buzzer will be on continuously. A test pushbutton permits checking the alarm panel by simultaneously simulating tape break and high-level alarm signals.

Accessory Chassis. -- In addition to these standard features, all air monitors at Building 3019 have an accessory "instrument-inoperative" chassis containing a meter-relay.

The instrument and alarms operate as follows:

1. An accessory meter-relay connected to the 0- to 1-ma output of the count-rate meter will cause the white "inoperative" light on the central panel to burn brightly whenever the meter pointer drops to zero, indicating no signal from the instrument. After power is restored and a 60-sec delay, this alarm clears itself. During the 60-sec delay, local caution and high-level alarms do not sound since they are locked out.

2. At the caution level of 1000 counts/min, an electronic alarm circuit will cause the yellow lamp in the control room to burn brightly. With an ORNL model Q-2240 or Q-2340 air monitor, a buzzer will sound at the instrument; with an ORNL model Q-1740 air monitor, a bell will ring intermittently at the instrument. Both models are reset automatically when the filter is changed. On a model Q-2340 Constant Alpha Air Monitor, the caution-level alarm is set at 600 counts/min. When the caution-alarm level is reached, a buzzer in the instrument sounds for 15 sec. At the end of 10 min, the filter tape is automatically advanced. Central alarm panel indication is not provided, since no external caution-level alarm contact is available in the instrument.

3. At the high level of 4000 counts/min, the panel meter relay on the instrument causes the red lamp in the control room to burn brightly. The buzzer on the ORNL model Q-2240 or Q-2340 instrument sounds. The bell on the Model Q-1740 instrument changes from an intermittent to a steady ringing. These alarms are reset by advancing or changing the filter and by pressing the manual reset button on the monitor.

4. The high-level alarm of the model Q-2340 Constant Alpha Air Monitor operates at 800 counts/min, causing the red lamp in the control room to burn brightly. The bell on the instrument rings. The filter tape is automatically on a high-level alarm. The alarm bell remains operating after a high-level until manually silenced.

3.2.4 Neutron Monitor³

The Neutron Monitor (ORNL model Q-2562) is a transistorized, ac-powered instrument for the continuous measurement of dose rate from fast and thermal neutrons and for the immediate warning of the occurrence of a critical incident. A polyethylene moderator which surrounds the BF₃ detector thermalizes the fast neutrons. The polyethylene is covered with 0.025-in. thick cadmium sheet, which affords a lower cut-off limit to the thermal neutrons. The compression of the neutron energies results in an RBE (relative biological effectiveness) factor for the detector which is approximately the same as for the original admixture of fast and thermal neutrons.

The monitor has a single range of 0 to 25 mrem/hr (milliroentgens equivalent man per hour), which is indicated by a calibrated panel meter. A high-level alarm with manual reset can be adjusted to alarm at any value within 0-25 mrem/hr. The output from the monitor can be fed to a strip-chart recorder to record the dose rate. A burst alarm operates independently of the dose-rate circuitry, which would be paralyzed by a fast excursion in neutron level before it could indicate an alarm condition. The response of the burst detector is sufficiently fast to sound an alarm when neutron bursts of only 20- μ sec duration originate from critical incidents up to 200 ft from the detector.

When the burst alarm is tripped, a red lamp burns brightly on the indicator module at the central alarm panel; when the dose-rate alarm level is exceeded, an amber lamp burns brightly on the indicator module at the central alarm panel.

3.2.5 Indicator Module

The indicator module (ORNL model Q-2563-1) consists of three independent transistorized channels, each operating an indicator lamp and providing a dc-voltage shift signal for alarm or control purposes and a voltage pulse signal for operating the buzzer module. The three lamps and a pushbutton are on the front panel. Each module is 35.8 mm wide, 120 mm high, and 125.8 mm deep. All connections are made on printed strip connections at the rear edge of the plug-in module.

When the instrument connected to an indicator module is operating normally, all lamps on that module are dim (Table 2). When the module receives a signal that the instrument is operating abnormally or that the caution level or the high-level alarm values have been exceeded, the lamps burn at full intensity: white for inoperative instrument, yellow for caution level, and red for high level. A signal is also generated by the module which causes a buzzer to sound. The white lamp indication will remain until the condition causing the alarm is cleared, at which time the lamp will return to the dim condition. The red and amber lights will remain bright until they are manually reset by means of a pushbutton on the indicator module. If the indicator module is reset when the alarm or abnormal condition still exists, the lamps will momentarily become dim when the reset

³F.M. Glass, E.D. Gupton, and E.E. Waugh, Instrumentation and Controls Div. Ann. Progr. Rept. Sept. 1, 1962, ORNL-3378, pp. 32-33.

button is depressed, and then will become bright and the buzzer will sound again when the reset button is released.

All indicator modules are identical and can be interchanged or replaced without alteration.

3.2.6 Coincidence Module

The coincidence module (ORNL model Q-2563-2) consists of one transistorized circuit which accepts a dc shift alarm signal from as many as six indicator modules. The circuit can be adjusted by internal jumper connections to operate a relay for alarm or control purposes on any combination of one to six input signals. All coincidence modules at Building 3019 are arranged to operate the relay when there is a coincidence of any two alarms. Each module is 35.8 mm wide, 120 mm high, and 125.8 mm deep. All connections are made on printed strip connections at the rear edge of the plug-in module.

Twelve monitrons are connected in groups of four to coincidence modules (ORNL model Q-2563-2), and eleven air monitors are connected in two groups of four and one group of three to coincidence modules, and three neutron dose-rate--burst detectors are connected to a coincidence module. When two or more monitron indicator modules, two or more air-monitor indicator modules, or two neutron radiation indicator modules in a group receive high-level alarm signals, the associated coincidence module will actuate the building warning and evacuation equipment and will transmit a signal to the Emergency Control Center, Building 2500. A red lamp on the affected coincidence module will indicate which set of instruments has detected an abnormal condition.

When the indicator modules showing an abnormal condition are reset manually, the coincidence module will also be reset.

All coincidence modules are identical and can be interchanged or replaced without alteration, except for an internal jumper connection which determines the number of coincidental input signals required for an output signal.

3.2.7 Containment Module

The containment module is identical to the coincidence module except for labeling on the module face.

3.2.8 Remote Indicator Module

The remote indicator module (ORNL model Q-2563-3 modified) consists of three independent transistorized circuits which operate three indicator lamps when a dc voltage shift signal is received from an indicator module. The remote indicator lamps on the panel at the north entrance repeat the lamp intensities on the indicator modules to which they are connected and reset automatically when the indicator module is reset. The remote indicator module front panel is blank.

3.2.9 Buzzer Module

The buzzer module (ORNL model Q-2563-4) consists of a transistorized trigger circuit that operates a silicon controlled rectifier to actuate a buzzer when a voltage shift pulse is received from an indicator module. The buzzer module is the same size as all other modules and is interchangeable with other buzzer modules.

The buzzer module gives audible notice that an indicator module has received any one of three input signals. The buzzer module, which serves all indicator modules, is reset by a pushbutton at the front of the module.

After being reset, the buzzer will sound again whenever an input signal is received by one of the indicator modules. For example, a change from a normal condition to a "caution alarm level" at some location will start the buzzer. After it is reset, a change to "high alarm level" or to "inoperative instrument" will start the buzzer again.

3.2.10 Air Whistle and Beacon Lights

Air Whistle. -- When a coincidence module has been energized by two or more monitrons or air monitors, two air whistles are activated by nitrogen gas bottles (one for each whistle) to notify the building occupants to leave the building. The air whistle, a "Clarion Whistle" by Westinghouse Air Brake Company, will sound about 4 min on one filled gas bottle. A control box for each whistle contains a pressure valve, pressure switches which monitor tank and regulated pressures, and a solenoid valve that is opened by an electrical signal from the coincidence module. A momentary signal will open the solenoid valve, and the valve will remain open until it is closed manually by pressing the mushroom head of the valve stem inward.

The normal gas pressures for proper operation of the whistles are not less than 1500 psig tank pressure and 80 to 120 psig line pressure to the solenoid valve. Abnormal pressures are indicated by red lamps (labeled "horn trouble") on the central control panel board, one lamp for each whistle. The dim lamp indicates normal pressures, and a bright lamp indicates abnormal pressures. Inspection of the gages will indicate whether the tank pressure or the line pressure is abnormal.

Beacon Lights. -- Four Federal Sign and Signal Corp., model 27S, 110-v beacons with magenta colored lens are installed on the corners of the building to warn personnel outside that the building has been evacuated. These beacons are actuated by a signal from a coincidence module, and they are automatically stopped when the coincidence module has returned to a normal condition.

Control Switches. -- A key-operated switch, labeled "normal-disable," on the central control panel board may be used to disconnect the air whistles and beacons during maintenance or abnormal operation periods. Since the Emergency Control Center receives an alarm signal when the switch

is moved to the "disable" position, the Control Center should be notified before the switch is set at this position.

A large red pushbutton on the central control panel, labeled "manual evacuate," actuates the air whistles and beacons and transmits an alarm signal to the Emergency Control Center (if the Center has not already received an alarm), regardless of the position of the "normal-disable" switch. If the manual evacuation pushbutton has been used, it must be reset by pressing the "reset" pushbutton on the module to restore the system to the normal conditions.

3.2.11 Power Supplies

The main power for the system is 120-v, 60 cycle, and is supplied from the emergency power bus in Building 3019 to the 24-v dc power supply and the monitoring instruments.

The 24-v dc transistorized power supply is a regulated voltage and current unit. A green "power on" lamp on the control chassis and a neon lamp on the power supply panel will be brightly lighted to indicate that the power supplies are operating.

3.3 Drawings

The Building 3019 Facility Radiation and Contamination System is described in the following ORNL Instrumentation and Controls Division drawings:

1. Q-2360-1 through -5, -6A, and -6B, Instrumentation location and wiring diagrams.
2. Q-2563-1 through -4, Plug-in modules.
3. Q-2358-7, Horn control box.
4. Q-1154B-1 through -14, Monitron.
5. Q-2359-12, Monitron high-level alarm.
6. Q-2240-1 through -23, Constant Air Monitor.
7. Q-2311B-4, Constant Air Monitor instrument failure box.
8. Q-2562-1 through -9, Neutron Monitor with Optional Burst Detector.
9. Q-2340-1 through -15, Constant Alpha Air Monitor.

4. CHECKOUT AND OPERATING PROCEDURES

Although the central alarm panel board serves as an aid in operating the facilities in the building, its primary purpose is to provide automatic radiation and contamination alarms required by Radiation Safety and Control regulations. An "inoperative instrument" alarm and two levels of radiation alarms from each of the 30 fixed-installation monitoring instruments in the facility are indicated on the central alarm panel. High-level alarm signals from 22 instruments actuate the evacuation alarm when the alarm limit is reached on two or more monitrons, two or more air monitors, or two or more neutron burst detectors.

To utilize the indications efficiently, the instruments should be reset, the alarm signals should be cleared, and burned out lamps, horn pressure alarms, and other abnormalities should be corrected promptly. An alarm signal can be cleared by performing the following steps:

1. Press the reset button on the buzzer module. This permits the audible alarm to be sounded again if another alarm is actuated before the first alarm can be cleared.
2. Check conditions at the instrument and reset the instrument if required (air monitor filter change or air monitor high-level alarm). The air monitor "caution" and "instrument inoperative" alarms and all monitron alarms are self-resetting when the radiation level or trouble causing the alarm is removed. The neutron monitors must be manually reset, if the alarm has operated.
3. Reset the module on the central alarm panel by pressing the button at the bottom of the module.

Whenever the local evacuation alarm is sounded in the facility, an alarm signal is indicated and sounded in the Emergency Control Center, Building 2500.

A key-operated "normal-disable" switch located on the central alarm panel may be used to prevent the system from causing unnecessary evacuation of the building or from sending false signals to the Emergency Control Center during maintenance or abnormal operating conditions. Since an alarm indication will show at the Emergency Control Center when the key-operated switch is in the "disable" position, the Emergency Control Center must be notified before the switch is operated.

A procedure for checking the instruments and their indicators for proper operation and a sheet for recording the test results are given on the following pages.

FACILITY RADIATION AND CONTAMINATION SYSTEM
CHECK-OUT PROCEDURE

DATE _____

BUILDING _____

Test	Purpose and Procedure	Correct Operation
1. Preliminary	Prepare to test system.	
a. Disable evacuation portion of system	<ol style="list-style-type: none"> 1. Contact Emergency Control Center (phone 3-6646) and notify dispatcher of coming alarm. 2. Obtain clearance from the operator and have test announced on public address system. 3. Turn key switch to "Disable" and close valves on N₂ tanks for whistles. 	Disconnects evacuation whistles and beacon lights. Gives evacuation alarm signal at Emergency Control Center.
b. Check panel lamps	Examine all panel lamps.	All lamps are dim.
2. Facility Beta-Gamma Contamination System	Test all monitors individually (see checkout sheets for locations).	
a. "Inoperative" alarm	<ol style="list-style-type: none"> 1. Unplug instrument. 2. Plug in instrument. 	<p>Buzzer sounds and white lamp glows brightly. Buzzer can be reset, but lamp cannot be reset. After 1-min delay, white lamp will reset.</p>
b. "Caution" alarm	<ol style="list-style-type: none"> 1. Increase gamma count rate with source to caution-alarm level. 2. Remove source until the count rate is below caution level. 	Buzzer sounds and yellow lamp glows brightly. Buzzer can be reset, but lamp cannot be reset. Yellow lamp can be reset.
c. "High-Level" alarm	<ol style="list-style-type: none"> 1. Increase count rate with source to high-alarm level. 2. Remove source; reset instrument. 	<p>Buzzer sounds and yellow and red lamps glow brightly. Buzzer can be reset, but neither lamp can be reset.</p> <p>Yellow and red lamps can be reset.</p>
3. Facility Alpha Contamination System	Test all monitors individually (see checkout sheets for locations).	
a. "Inoperative" alarm	<ol style="list-style-type: none"> 1. Unplug instrument. 2. Plug in instrument. 	<p>Buzzer sounds and white lamp glows brightly. Buzzer can be reset, but lamp cannot be reset. After 1-min delay, white lamp will reset.</p>
b. "Caution" alarm	<ol style="list-style-type: none"> 1. Increase alpha count rate with source to 600 counts/min. 2. Remove source until the count rate is less than 600 counts/min. 	Buzzer in instrument sounds for 15 sec. Tape will advance in 10 min. No central panel indication is provided.
c. "High-Level" alarm	<ol style="list-style-type: none"> 1. Increase count rate with source to 800 counts/min. 2. Remove source. 	<p>Buzzer sounds and red lamp glows brightly. Buzzer can be reset, but lamp cannot be reset.</p> <p>Red lamp can be reset.</p>
4. Facility Radiation System	Test all monitors individually (see checkout sheets for locations).	
a. "Inoperative" alarm	<ol style="list-style-type: none"> 1. Unplug instrument. 2. Plug in instrument. 	<p>Buzzer sounds and white lamp glows brightly. Buzzer can be reset, but lamp cannot be reset. After 1-min delay, white lamp will reset.</p>
b. "Caution" alarm	<ol style="list-style-type: none"> 1. Increase radiation level with source to 7.5 mr/hr. 2. Remove source until radiation level is less than 7.5 mr/hr. 	<p>Buzzer sounds and yellow lamp glows brightly. Buzzer can be reset, but lamp cannot be reset.</p> <p>Yellow lamp can be reset.</p>
c. "High Level" alarm	<ol style="list-style-type: none"> 1. Increase radiation level with source to 23 mr/hr. 2. Remove source until radiation level is less than 7.5 mr/hr. 	<p>Buzzer sounds and red and yellow lamps glow brightly. Buzzer can be reset, but neither lamp can be reset.</p> <p>Red and yellow lamps can be reset.</p>
d. Return system to normal	Turn key switch to "Normal."	Permits beacon lights and Emergency Control Center indicators to operate on alarm condition. Emergency Control Center alarms will reset.
5. Evacuation System	Check all features of evacuation system for correct operation.	A coincidence of two high-level alarms from Facility Contamination System or Facility Radiation System should operate the evacuation horn, magenta lights outside building should flash, and Building 2500 should receive correct alarm light. Key-switch lockout of horn and lights, and gas tank pressure switch should also be tested.
a. Check for control output from coincidence alarm	<ol style="list-style-type: none"> 1. Turn key switch to "Disable" after contacting Emergency Control Center. 	Check Emergency Control Center. A radiation and contamination alarm should be noted there.

Facility Radiation and Contamination System Check-Out Procedure (Continued)

Test	Purpose and Procedure	Correct Operation
	2. Check evacuation modules for radiation and contamination alarm systems.	A coincidence of two high-level alarms from Facility Contamination System or Facility Radiation System should operate the appropriate "Evacuation" module. Red lamps on appropriate module should be bright.
	a. Increase radiation at one air monitor to high-alarm level.	Red and yellow lamps on this module become bright and buzzer sounds. Reset buzzer.
	b. Increase radiation at second air monitor in same system to high-alarm level.	Red and yellow lamps become bright on second module and buzzer sounds. Red lamp on evacuation module becomes bright. Reset buzzer.
	c. Remove radiation sources.	Alarm lamps and buzzer may be reset. Evacuation alarm should reset automatically when either alarm is cleared.
	d. Different pairs of instruments should be used each time this test is made.	
	e. Repeat procedure with pairs of monitors in the Facility Radiation System.	Same results as above except Radiation Evacuation module is tested.
b. Check evacuation alarm equipment	1. Close valve on all horn N ₂ supply tanks (if not previously done in Part 1).	
	2. Plug horn trouble test boxes at horn control box.	
	3. Move key switch from "Disable" to "Normal."	Alarm lights at Emergency Control Center clear.
	4. Set two coincident "High-Level" alarms on the Facility Contamination System.	Buzzer, channel alarms, and coincidence alarm noted on central panel. Horns sound a short blast, alarm should indicate at Emergency Control Center, and flashing lights outside building should start. Horn trouble lights at central panel become bright. Low-line pressure and low-tank pressure lights show on test box.
	5. Reduce radiation levels to normal and reset alarm modules.	All modules clear, Emergency Control Center alarms clear, and flashing beacons stop.
	6. Reset horn solenoid valves manually; open tank valves until low-pressure alarms on test box clear.	Horn trouble alarms clear.
	7. Test high-pressure alarm by raising pressure regulator setting in horn box to more than 110 psi.	Horn trouble light should be on. High-pressure alarm is indicated by test box.
	8. Close tank valves. Set two coincidence alarms on Facility Radiation System.	Buzzer, channel alarms, and coincidence alarm noted on central panel. Horns sound a short blast, alarm should indicate at Emergency Control Center, and flashing lights outside building should start. Horn trouble lights at central panel become bright. Low pressure alarm lights on test box are lighted.
	9. Reduce radiation levels to normal and reset alarm modules.	All modules clear, Emergency Control Center alarms clear, and flashing beacons stop.
	10. Reset horn solenoid valves manually, open tank valves, and readjust regulators to 90 psi output pressure.	Gas cylinder pressure gauges should show 1800 psi on tank side of regulator and between 80 and 100 psi on horn side. Neither high-pressure nor low-pressure alarms should show on test box. Horn trouble light becomes dim. All alarms in all locations should be clear.
	11. If building has manual evacuation button, close valves on tanks and push button.	Same as Step 4, except no buzzer, no channel alarms, and only a radiation (red) light appears at the central panel and at the Emergency Control Center.
	12. Reset manual evacuation button and repeat Step 6.	End of test.
c. Conclude test	Return all controls and instruments normal condition.	<p style="text-align: center;"><u>Check List</u></p> 1. No alarm lights on central panel of Emergency Control Center. 2. Horn gas tank valves open and regulators adjusted. 3. Key switch in "Normal" position. 4. Notify Emergency Control Center and building personnel of end of test period.

FACILITY CONTAMINATION AND RADIATION SYSTEM CHECK SHEET

Bldg. 3019 Date _____

FACILITY CONTAMINATION SYSTEM

Monitor No.	Location	Inoperative	Caution	High	
CAM B-15	*East Control Room	_____	_____	_____	Evacuation Tested Using Stations
CAM B-14	*West Control Room	_____	_____	_____	and
CAM B-6	*East Penthouse	_____	_____	_____	OK _____ Inoperative _____
CAM B-20	*West Penthouse	_____	_____	_____	
CAM B-29	*HRLAF East Bay	_____	_____	_____	Evacuation Tested Using Stations
CAM B-30	*HRLAF West Bay	_____	_____	_____	and
CAM B-26	*Hall Outside Room 209	_____	_____	_____	OK _____ Inoperative _____
CAAM A-29	HRLAF	_____	_____	_____	Evacuation Tested Using Stations
CAAM A-15	East Control Room	_____	_____	_____	and
CAAM A-20	Penthouse, West	_____	_____	_____	OK _____ Inoperative _____
CAAM A-6	Penthouse, East	_____	_____	_____	

FACILITY RADIATION SYSTEM

Detector No.		Inoperative	Caution	High	
M-1**	*Pipe Tunnel, West	_____	_____	_____	Evacuation Tested Using Stations
M-4	*Basement	_____	_____	_____	and
M-5	*Plenum Area, West	_____	_____	_____	OK _____ Inoperative _____
M-12	*Sample Gallery, West	_____	_____	_____	
M-3	*Pipe Tunnel, East	_____	_____	_____	Evacuation Tested Using Stations
M-6	*Cell 2	_____	_____	_____	and
M-8	*VFP Makeup Area	_____	_____	_____	OK _____ Inoperative _____
M-11	*Penthouse, East	_____	_____	_____	
M-2	*Pipe Tunnel Center	_____	_____	_____	Evacuation Tested Using Stations
M-7	*PRFR Makeup Area	_____	_____	_____	and
M-9	*Penthouse, West	_____	_____	_____	OK _____ Inoperative _____
M-10	*Penthouse, Center	_____	_____	_____	
M-13	Cell 4, 2nd Level, N.	_____	_____	_____	Evac. Test Using Manual Stations
M-14	Cell 4, 2nd Level, S.	_____	_____	_____	Local OK _____ Inoperative _____
M-15	Cell 4, 1st Level	_____	_____	_____	Console OK _____ Inoperative _____
M-16	Room 211	_____	_____	_____	Remote OK _____ Inoperative _____
N-1***	*Penthouse	_____	_____	_____	Evacuation Tested Using Stations
N-2	*HRLAF	_____	_____	_____	and
N-3	*East Control Room	_____	_____	_____	OK _____ Inoperative _____

EVACUATION SYSTEM				EMERGENCY CONTROL CENTER				
Tank Pressure Alarm	High Pressure Alarm	Low Pressure Alarm		Radiation Alarm	Contamination Alarm	Neutron Alarm	Key Switch "Normal"	Key Switch "Disabled"
HRLAF Horn	_____	_____	_____	Red Bright	Yellow Bright	White Bright	Red Dim	Red Bright
Room 100 Horn	_____	_____	_____	Yellow Dim	Red Dim	Red Dim	Yellow Dim	Yellow Bright
	On	Rotating	_____	White Dim	White Dim	Yellow Dim	White Dim	White Bright
External Beacon 1	_____	_____	_____					
2	_____	_____	_____					
3	_____	_____	_____					
4	_____	_____	_____					

* Instrument Part of Evacuation System ** Indicates Monitrons *** Indicates Neutron Detectors

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