PHYSICS DIVISION

RADIATION SAFETY MANUAL

March 1, 1999

General Policy about Radioactive Materials in the Division

In the Physics Division, most of the experiments are carried out at ATLAS for which a separate radiation safety manual is written. The Radiation Safety Policy which is applied to ATLAS is also applicable for the whole Physics Division. For this reason the Division Radiation Safety Manual consists of this page and the ATLAS Radiation Safety Manual.

Radioactive materials are used and stored in those laboratories which have a **"Controlled Area"** sign. This sign is placed and removed only by the Health Physics personnel. Entry requirements are written on the posted sign. Persons working in Controlled Areas which contain only **sealed gamma** ray sources generally do not require **TLD badges**. **Eating, drinking and smoking are never allowed in Controlled areas**. The use and storage of radioactive sources is not allowed in non-controlled areas.

The whole Physics Division is classified as a single material balance area **(MBA)**. Hence, within the Physics Division radioactive materials can be moved around by trained personnel. Strong sources (as defined later) are moved and handled only in the presence of Health Physics personnel. Transfer of radioactive materials to other divisions and off-site locations can only be carried out by the **Special Materials Representative.**

Radioactive materials can be procured only by those Division staff members who are designated as custodians. The Health Physics personnel keep a record of all materials coming into and leaving the Division. It is the responsibility of the staff members to keep control of the radioactive materials they procure.

All radioactive sources in the Division are kept in locked safes. Sources being checked out should be logged in the book placed near the safe. The person checking out a source is responsible for that source. Checked out sources should be kept locked when not in use.

Neutron sources, which are special nuclear materials, are kept under lock. These can be checked out from the custodian and can be moved to the experimental location. The experimenter shall inform the ATLAS CSO about the location of the neutron source when in use. It is required that at least one person be present in the area when the neutron source is used. The source shall be kept locked when not in use.

Sealed sources can be used by properly trained students and staff members. **Open sources** can be used only by persons who have attended Radiation Worker I training and the Divisional Open Source Training course. Students and outside users are not allowed to use open sources.

Any person who plans to work with radioactivity or radiation must first contact T. Mullen, the Physics Division Safety Coordinator who will then arrange for proper training and also the issuance of the TLD badge.

Experiments at Dynamitron are covered by the Division Radiation Safety Policy. The Dynamitron has an interlock system to control access of personnel during the time the accelerator is running.

TLD badges are required for entry into ATLAS areas, Dynamitron and most Controlled laboratories.

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1. INTRODUCTION

It is the policy of the Physics Division to operate ATLAS and the associated experimental facilities so that radiation exposures to its staff, experimenters and outside visitors are within the limits approved by Federal Agencies as summarized in DOE order 10CFR835 and in the DOE Radiological Control Manual DOE/EH-0256T. It is furthermore the goal of the Physics Division to keep the exposures as far below the limits of this order as reasonably achievable.

This manual contains a summary of policies and practices for radiation safety as they apply to operations and experiments at the ATLAS accelerator. For answers to questions not covered in this manual (such as handling of hazardous materials, etc.), the ANL ESH manual should be consulted. In these cases it is further advisable to consult with either a member of the Physics Division Radiation Safety Committee or the Physics Division Safety Committee. The present members of these committees are listed in ***Appendix 1***.

2. THE PHYSICS DIVISION ALARA PROGRAM - GUIDELINES

The concept of maintaining radiation exposures **as low as reasonably achievable (ALARA)** is an essential guideline of the Physics Division's radiation safety policy. The objective is to maintain personnel exposures to the lowest possible levels commensurate with sound operating practice and economic considerations. This document provides the guideline for the Division's ALARA program.

There are two accelerator facilities that are capable of producing radiation that need consideration, ATLAS and the Dynamitron; some of the associated equipment may also produce radiation in amounts that need consideration. These are the major factors in determining the ALARA program of the Physics Division. There are activities dealing with radioactive sources or with devices not connected to the accelerator facilities that also cause radiation and the ALARA policy fully applies to these as well. The Division's ALARA policy is subject to periodic revision by the Director of the Physics Division to accommodate changes in the type of work carried out in the Division.

The ALARA Program and goals for the Physics Division are outlined in ***Appendix 2***.

3. RADIATION SAFETY ORGANIZATION AND RESPONSIBILITIES

The structure of the safety organization for ATLAS is shown in **Fig. 3.1**.

The **Director of the Physics Division** has overall line management responsibility for the oversight of Safety, Environment and Health issues in the Division.

The **Director of ATLAS** is responsible for assuring that all activities at the ATLAS facility comply with the objectives and Governmental ESH policies and requirements. This responsibility is shared with the Radiation Safety Committee which reports directly to the Division Director.

Fig. 3.1. Physics Division Safety Organization

The **Operations Manager** of ATLAS is responsible for implementing the ESH policies and directives as required by Governmental agencies. The formulation of the safety procedures and regulations are done in consultation with the Physics Division Safety and Radiation Safety Committees, the Physics Division Safety Coordinator, and with the Building 203 Health Physicist.

The **Chief Shift Operator's (CSO)** responsibility is to implement the radiation procedures and regulations. The CSO has primary responsibility for the safe operation of ATLAS for the shift duration. His duties regarding radiation safety include:

(a) to supervise the setting of the **interlocks**
(b) control of all keys and interlocks for beam areas in the **no access** or **locked** mode
(c) to perform the **sweeps** of the beam areas when access to the experimental stations is not allowed.
(d) to investigate and document all **interlock trips**
(e) to install **Low-Level Monitors** in the respective experimental area at the start of a new experiment, remove the monitors after the run, and replace defective units when necessary.

The **spokesperson** of the experiment or his delegate is responsible for compliance with the rules governing radiation safety matters by all people involved in the experiment.

All problems with radiation safety at ATLAS should be reported to the CSO who will forward the information to the Health Physics Technicians or other appropriate personnel.

HP Technician coverage is available during the hours of **8:00 a.m. to 4:30 p.m.** Monday through Friday in the building 203 HP office (phone extension **2-4138** and **2-6062**; pageboys **4-1947 or 4-1943**). Arrangements can be made for HP coverage during off-hours and weekends.

3.1 RECORD KEEPING

Records Relating to Radiation Surveys:

Results from the routine radiation surveys will be recorded on the form ESH-39. These records are kept in the building 203 HP office and will be archived by the ESH division.

Records of Radioactive Sources and Radioactive Waste:

Records of radioactive sources are kept in log books placed next to each radioactive safe. Records of radioactive waste are kept in Room H174, where the solid radioactive waste cans are located.

Records of materials to be disposed of are provided to the **Environmental Management Operations (EMO).**

Records of Experiment Proposal Fact Sheets:

Proposal fact sheets of ATLAS experiments are kept along with the proposals for the experiments in the ATLAS Control Room and copies of the proposed fact sheets are kept in the local HP office.

Records of Safe Work Permits and Radiation Work Permits:

Radiation Work Permits are kept in the Building 203 HP office. Safe work permits are kept in the Division Safety Coordinator's office and the Operations Manager's office.

Records of Radiation Training:

Records for the participation of each individual and his performance in the qualification program and retraining program are kept by the Physics Division Safety Coordinator.

3.2 TRAINING

All persons who work at ATLAS, including outside users, are required to have some level of radiation safety training. The training depends on the nature of the person's work. Some training is required for all ANL personnel, additional training is needed for radiation workers, and training on special topics for the accelerator personnel. The Physics Division Safety Coordinator is responsible for the coordination of the training program in the Division.

This section describes the necessary training courses which are relevant to Radiation Safety.

1. All members of the Physics Division working at ATLAS and ATLAS tour guides have to attend a **General Radiation Safety Training** course and an **ATLAS Site-specific Radiation Safety Training** which includes training on the ATLAS Radiation Interlock System.

2. **Outside Users** have to attend **a general safety lecture** and an **ATLAS Site-specific Radiation Safety Training** administered by the User Liaison Physicist, before they can participate in an ATLAS experiment.

3. **Non-scientific ANL employees and outside contractors** have to attend the basic session of the ATLAS Radiation Interlock System if they need to work at ATLAS without an escort.

4. **Radiation Worker I** training is required for the use of sealed and open sources and to work in controlled areas at ATLAS. The use of open sources also requires **Open Source Training** given by the Physics Division.

5. **The ATLAS operators** have to attend, in addition, the ATLAS Radiation Interlock Training Program Session 2.

3.3 TLD BADGES ARE REQUIRED FOR ENTRY IN THE ATLAS AREAS

4. REVIEW OF EXPERIMENTS FOR RADIATION SAFETY

The Physics Division has a Radiation Safety Committee whose members are appointed by the Division Director. The current membership of this committee is listed in ***Appendix 1*****.**

Experiments at ATLAS which are recommended for scheduling by the Program Advisory Committee (**PAC**) are forwarded to the Radiation Safety Committee for review. The chairperson of the Committee evaluates all the proposals and approves the routine ones. Proposals which require special precautions are reviewed by the Committee for approval. After review and approval by the Radiation Safety Committee, the Proposal Fact Sheet is signed by the appropriate Committee Representatives. No experiment can be scheduled at ATLAS unless approved by the Radiation Safety Committee.

5. RADIATION MONITORING

5.1 INSTRUMENTS USED FOR MONITORING AND SURVEY

Twenty-seven sets of neutron and gamma monitor detectors are located throughout the facility as shown in **Fig. 5.1**. All have local readouts near each detector and main readout is in the control room. Some have additional readouts in approach corridors. Additionally, **twelve X-ray monitors** are located near the linac cryostats and the ECR source areas, as shown in **Fig. 5.2**. Additional monitors will be added as deemed necessary.

All area monitors have an alert level setpoint at **2 mrem/h** (visible warning only) and an alarm level setpoint of **5 mrem/h** (visible and audible alarm).

Radiation surveys are performed by Health Physics personnel with portable Neutron Remmeter, an air ionization chamber survey meter, and an End-Window Geiger-Mueller (GM) survey meter.

5.2. CALIBRATION OF RADIATION DETECTORS

The detectors used for monitoring and survey are calibrated annually and records are kept by ESH.

6. THE ATLAS RADIATION INTERLOCK SYSTEM (ARIS)

6.1 PURPOSE

The purpose of the ATLAS Radiation Interlock System (ARIS) is two-fold:

Fig. 5.1. Low Level Neutron and Gamma Ray Monitors

Fig. 5.2. ATLAS X-Ray Monitors

- To offer protection against the possibility of a **Maximum Credible Incident (MCI)** in which a high radiation field could be produced through a combination of malfunctions in the operation of the facility.

- To keep the radiation exposure of personnel working at ATLAS to a minimum in accordance with the ALARA policy of ANL and the Physics Division.

To achieve these goals a Radiation Interlock System has been installed at ATLAS which has the following features:

- A uniquely defined beam path

- High-Radiation-Level Monitors (HRM) along the entire beam path

- Interlocked access gates for beam areas

- Low-Radiation-level monitors (LLM) near work areas

- Continuously measured integrated-dose limits when access to beam areas is possible

- Locked access gates under specified conditions

Additional protection against radiation hazards is provided by an independent beam current interlock system. A complete description of the Interlock System can be found in the document **The ATLAS Radiation Interlock System.**

6.2 SYSTEM OVERVIEW

The ATLAS facility is divided into ten beam areas (exclusion areas) for radiation exposure control. These areas are separately shielded and access to them can be controlled by access gates. The present beam areas are:

Area 1 ECR-II
Area 2 Tandem Vault
Area 3 Booster Linac Area
Area 4 ATLAS Tunnel
Area 5 BGO Area
Area 6 ATSCAT/Atomic Physics Area
Area 7 General Purpose Area
Area 8 Split Pole Spectrograph Area III
Area 9 FMA/APEX/Gammasphere Area
Area 10 Area II Split Pole Spectrograph

The exclusion areas and access gates are shown in **Fig. 6.1** and other exit gates are shown in **Fig. 6.2**.

The beam can be delivered to **only** one experimental station at a time.

Fig. 6.1. Exclusion Areas and Access Gates

Fig. 6.2. Exclusion Areas and Other Exit Gates

The functions of the radiation interlock system as outlined in **Section 6.1** are satisfied by:

1) **Beam valves**, whose **open** or **closed** status is part of the interlock system, which requires that the beam valves be open only along one path.

2) **Gates** (and doors) that limit personnel access to beam areas and whose status is part of the interlock system. For an area to be registered as **not occupied**, a sweep of the area and the activation of the interlock system is required. If the radiation-producing potential of the beam is above **100 mrem/h at 1 m**, no access is permitted, the access gates are locked by the operator and the key is controlled by the chief shift operator.

3) **High-Level Radiation Monitors** consisting of neutron detectors whose function is to inhibit the beam in front of the accelerator if the radiation field anywhere along the accelerator exceeds that corresponding to **5 rem/h at a distance of 1 m** (for normal operation).

4) If access to beam areas is needed, several **Low-Level Radiation Monitors** (each consisting of a neutron and a gamma-ray detector) become part of the interlock system. These are placed in the area in order to ensure that the radiation fields are below a certain level **(5 mrem/h at 1 m** for experimental areas) and that the integrated dose during access to the area remain under **10 mrem in any 8 hour period**.

5) An **Interlock Computer System** that monitors all the parameters and whose **live** state is necessary for the operation of the accelerator.

If the beam valve for a given beam area is **closed**, no beam can enter the area and access is permitted, provided that the beam in any adjacent area has a radiation-producing potential of less than **100 mrem/h at 1 m**. If it is above that level in an adjacent area, the gates are locked until a radiation survey has been performed.

If the beam valve is **open** the area becomes a **monitored access area**, provided that the total radiation-producing capacity of the beam is below **100 mrem/h at 1 m** and at least two Low-Level Radiation Monitors in the area are connected to the interlock system. For beam to enter an experimental area for the **first time** during an experiment the following procedure must be followed before the beam valve is opened:

a) The radiation-producing potential of the beam must be determined by the operator at the high energy beam stop at the exit of the linac.

b) All gates to the area must be locked and their interlocks activated after a sweep procedure by the accelerator operator. If the radiation-producing potential of the beam is above **100 mrem/h at 1 m** all the gates must remain locked.

c) If the radiation-producing potential of the beam is below **100 mrem/h at 1 m**, one **access gate** may be unlocked though closed, provided the Low-Level Monitors are connected and functioning in the area.

d) All the High-Level Monitors must be functioning along the accelerator, their trip levels set such that at no place along the accelerator and its beam lines can have the radiation field in excess of **5 rem/h at 1 m**, or the beam stop at the low-energy end of the accelerator will be inserted, thereby inhibiting the beam.

6.3 PROCEDURES FOR GETTING ACCESS TO BEAM AREAS

Entry into a monitored access area where the radiation level is above the prescribed level results in an immediate interruption of the ion beam. This is accomplished by the insertion of an upstream beam stop. The beam may also be interrupted in an emergency by pressing a **Beam Stop** button (**Fig. 6.3**). Such a button is located in each area on the Radiation Interlock Control Panel.

Each Radiation Interlock Control Panel is located such that the entire area must be traversed before the access gate is closed. A loud alarm is sounded when the **RESET** button is pressed at the start of the sweep to alert other personnel in the beam area.

Initially, before beam is introduced into an area, the access interlock system has to be set by the operator, after measuring the radiation producing potential of the beam at the high energy cup (**cup 4 or 5 in Fig. 6.4**) at the exit of the accelerator. The interlock system is set by

i) ensuring that all other personnel have left the room,
ii) pressing the **reset** button on the Radiation Interlock Control Panel in the area,
iii) exiting the room,
iv) **locking** all interlock gates leading to the area,
v) pressing the **reset** button located **outside** the gate,
vi) setting the interlock at the ATLAS Interlock Control Panel in the Control Room.

The area is now recognized by the computer system as being in the **locked** mode. If access is desired (and the level is below **100 mrem/h**) at least two Low-Level Monitors must be installed in the area and connected into the interlock system -- the area now is a **Monitored Access Area** and an **access gate** may be unlocked.

Restricted access to a monitored access area is possible when levels are below the prescribed access level. Such entry, through the access gate, puts the area into the **occupied** mode and the radiation-dose integrating process resumes. At the end of an entry, the interlock has to be reset, as described in steps i, ii, iii, and v, putting the area into the not occupied state. However, the spokesperson may request the operator set the area to no access status, in which case entry will cause an immediate interruption of the beam as above.

Fig. 6.3. ARIS Control Panel

Fig. 6.3. ARIS Control Panel

Fig. 6.4. Beam Faraday Cups Controlled by ARIS

6.4 RADIATION MONITOR SYSTEM

The operation of the Radiation Monitor Interlock System is designed to prevent accidental radiation exposure of personnel by using Low-Level Radiation Monitors in the experimental areas where elevated radiation levels may be induced by the beam, by High-Level Monitors along the beam line, and by monitors adjacent to the linac, where bremsstrahlung radiation from the accelerating structures may be present. All of these monitors are ***fail/safe***, and their response to radiation is transmitted to the interlock control computer as individual counts. For the experimental areas, where **access with the beam** is required, **two or more** Low-Level Monitors, each consisting of a neutron and a gamma-ray detector, have to be placed at the appropriate locations (approximately 1 m from components of the experimental system where the highest radiation levels are expected e.g. beam stops, beam defining slits, and targets). The normal distance where a person would work is more than 1 m from such components. For experimental setups standard positions for the Low-Level Monitors are set and reviewed by the Physics Radiation Safety Committee. In special cases, an alternate position of a monitor may be proposed by the experimenter and reviewed by the Radiation Safety Committee before the experiment. Special extension cables for this purpose are in the custody of the user liaison physicist. The location of the Low-Level Monitors will be documented for each experiment and may not be changed without review and approval process. ESH will monitor the radiation levels in a monitored access area when it is in the **occupied state** at the time of their daily survey.

If the prescribed integrated dose in the area during occupancy is exceeded, this will constitute a trip and require intervention by the operator.

6.5 BEAM INHIBIT CONDITIONS

Certain actions will cause the beam to be inhibited **without constituting an interlock trip**.

1. An **access** gate into a beam area is opened when radiation levels are above the specified level (but less than 100 mrem/h at 1 m) or when the **no access** status is set. A beam-stop inhibits the beam from entering the area.

2. The radiation level is measured to be in excess of the maximum specified for a monitored access area when it is occupied. A beam-stop inhibits the beam from entering the area. This inhibit condition has a response time of less than 30 seconds. If the measured value is over 100 mrem/h this is a **trip** (see 4. below).

6.6 THE INTEGRATION SCHEME AND LIMITING VALUES

The levels at which specific conditions are met for Normal Operation (see SAR) are as follows:

Rules Governing the Radiation Interlock System at ATLAS in Normal Operation. (Operations Envelope)

Requirements For:	Radiation Field (in mrem/h at 1 m) ATLAS HE Cup	In Area	Species Mass	Beam Current (pnA)	Energy (MeV/u)
Operating Accelerator	<5000	<5000	3<A<11 A>12	20 <20	<20
Access to an Accelerator with Beam	<100	<75	11<A<22		<10
Access to an Experimental Area with Beam	< 100	<5*	A>23		<20
Access to an Experimental Area Adjacent to an Area with Beam	<100** in the adjoining beam area				

*And less than **10 mrem** accumulated in the previous **8 hour** period.

**For Radiation levels above 100 mrem/h adjoining areas must be locked until a survey confirms that no radiation level above 2 mrem/h exists in any accessible part of the area.

6.7 INTERLOCK TRIP CONDITIONS

An interlock trip can be caused by any of the seven conditions listed below. The beam is interrupted and operator intervention is required to clear the tripped condition.

Trip Conditions:

1. An interlocked beam valve that allows a second beam path is opened. The low-energy beam stop is inserted.

2. The **Beam Off** button is pressed on any **Radiation Interlock Control Panel**. The low-energy beam stop is inserted.

3. The integrated radiation dose (neutron+gamma) is measured to be in excess of **10 mrem** over the previous **8 hours** by any monitor in a monitored access area. A beam-stop inhibits the beam from entering the area. A warning will sound when 80% of the trip level has been reached.

4. The radiation level is measured to be over **100 mrem/h** while a monitored access area is not in the **locked** state.

5. A radiation level corresponding to 5 rem/h at 1 m is signaled by any monitor. The low-energy beam stop is inserted. Should such a trip ever occur because of a high radiation field, it will require **a documented study and a careful radiation survey to determine the circumstances**. The response time for such a trip is 2 seconds.

6. Any of the active monitors register the **failure** signal. The low-energy beam stop is inserted. This feature, ensures that each detector is functioning properly by counting a weak radioactive source. The response time for this failure mode will be 5 minutes.

7. An **interlock gate**, other than the **access gate** is opened to a beam area when beam could be in the area (i.e. a valve is open). A beam stop is inserted.

6.8 STATUS DISPLAYS

Status displays are located at the entrance to each beam area showing the state of the area. The possible states are:

a) open
b) restricted access/not occupied
c) restricted access/occupied
d) no access
e) locked
f) inhibit
g) tripped

6.9 TEST OF THE RADIATION SAFETY SYSTEM

To ensure the proper functioning of the ATLAS Radiation Interlock System, the monitoring of the system is done daily by the operations staff. The system is designed such that a failure of the programmable controller or a failure of the control logic power will result in a message at the interlock display in the control room. Failures of individual door switches will also be indicate on the control display.

A complete test of the Interlock System is conducted every six months jointly by the Health Physics and ATLAS personnel. A copy of this test is kept on file in the Operations Manager's office along with documentation of any necessary corrective actions.

7. PROCEDURES FOR HANDLING RADIOACTIVE MATERIALS

7.1 STORAGE AND INVENTORY OF RADIOACTIVE SOURCES AND RADIOACTIVE TARGETS

Various sealed γ-ray sources, and open solid deposit, α, β and fission sources are available for calibration of detectors at ATLAS. These sources range from 0.1 μCi to ~10 μCi in activity. The sources are stored in five locked, shielded safes (Rooms H174, F166, G118 and FMA/APEX areas at ATLAS). Each safe has a log book which contains a list of sources for sign out. Unless used in the immediate vicinity of the safes, these sources must be checked out in the log book for use. All sources are surveyed **every six months** by the Health Physics personnel for leaks. Sources showing leaks are discarded as dry radioactive waste. Special open sources which show slight leaks but are difficult to replace will be kept. Their use has to be monitored by HP personnel. Sources of Special Nuclear Materials are audited routinely by DOE. All safes must be kept locked.

Three ^{228}Th α-sources, ~1 microCurie each, are permanently mounted in the beamline at PII, booster, and ATLAS locations for the calibration of silicon detectors which measure the heavy-ion beam energy. These sources are placed there for long-term use and, when needed, will be replaced by fresh ^{228}Th ($T_{1/2}$ = 1.9 y) sources in the presence of a Health Physics technician.

Use of Radioactive Sources and Radioactive Targets

The use of radioactive sources or targets at ATLAS requires **approval by the Physics Division Radiation Safety Committee**. For ATLAS experiments, the starting point is the ATLAS Scheduling Information Sheet, that is completed for each experiment and requires approval of the Radiation Safety Committee. In addition, each experimental group using radioactive materials should complete and submit a **Safety Evaluation Form for Radioactive Materials**; this form shown in *Appendix 3* may be applicable to several similar experiments. Any changes in the requirements for radioactive materials will require a new form.

Once the use of certain radioactive sources or targets is approved by the Radiation Safety Committee, each trained and qualified collaborator in the experiment can handle the radioactive sources - it is the responsibility of the spokesperson to see that the prescribed guidelines are followed. The Radiation Safety Committee provides general guidelines given below, more specific guidelines may be provided as required. **It is recommended that persons handling any radioactive material check themselves with the hand and foot monitor installed in the ATLAS Data Room.**

Handling of γ-Sources

These calibration sealed sources may be used by the experimenter without consulting HP personnel as long as their use is approved by the Radiation Safety Committee and the signout requirements and sound practices as outlined in the ESH manual are followed. Sources like ^{90}Y which decay by high-energy β^- particles (end point = 2.3 MeV) need ~2 cm plastic to stop the β^--particles. For this reason, new experiments which require special radioactive sources shall be approved by the Radiation Safety Committee before they can be carried out.

Handling of α, β and Fission Sources

Open α, β and fission sources may be moved by the experimenter from the storage safes to the experimental areas within building 203. These sources are routinely checked for leaks by counting the cover of the Petry dish. If the α or β source strength is below **10 microCurie**, and fission sources less than **1 μCi** and the source does not show any loose material it may be installed into the setup and removed without the supervision of HP. Sources which are stronger than **10 μCi** or which are known to produce loose material should be installed and removed in the presence of HP personnel.

Handling of Neutron-Sources

Pu-Be neutron and Pu-^{13}C γ ray sources are kept under lock in **M057**. The Custodian of these sources is Jim Nelson (**2-4002**). The neutron sources in this room can be used without consulting HP personnel. It is required that at least one person be present in the area when the neutron sources are in use. A radiation sign should be placed at the source indicating the radiation level. When not in use, these sources must be kept locked. To obtain a neutron source contact John Greene (**2-5364**). In his absence Jim Nelson should be contacted.

7.2 RESIDUAL RADIOACTIVITY AND CONTAMINATION:

At the end of an experiment at ATLAS, the Faraday cup of the experimental station which had been in use should be **surveyed externally by Health Physics** personnel. Usually the radioactivities are short-lived. In that case the cup can be reused for the next experiment. If, however, considerable radioactivity persists, the front lead or tantalum discs of the Faraday cup shall be disposed of as dry radioactive waste. In cases, where the Faraday cups are special, they can be stored for longer periods for the decay of the radioactivities.

Chambers, where open radioactive sources are used, can sometimes be contaminated. For this reason, chambers in which an open radioactive source has been used shall be surveyed by Health Physics personnel before it is **moved to another location**. If any contamination is found, the chamber must be cleaned. In cases of serious contamination, Environmental Management Operations shall be contacted for proper cleaning of the chamber.

7.3 TRANSFER OF RADIOACTIVE OR CONTAMINATED MATERIALS

Parts of the beamline system that might have come into contact with the ion beam (collimators, slits, target frames, Faraday cups) have to be surveyed by HP before they are disassembled or taken out of the ATLAS area. Transfer of radioactive or contaminated materials to and from the Building 203 has to be carried out by the **Special Materials Representative** (call **2-7388**). All open sources shall be placed in double containers during transport.

7.4 DISPOSAL OF RADIOACTIVE MATERIAL

The Division has a chemistry lab (H174) with a glove box and two hoods for the handling of radioactive materials. This lab contains **Solid Radioactive Waste (SRW)** containers. In addition, SRW containers will be placed in other areas where radioactive wastes are routinely generated. Any solid radioactive waste (SRW) generated within the Division should be placed in these containers. The type and amount of material is documented in a log book which is located in H174 near the SRW containers. The radioactive wastes should be removed **twice a year** by **Environmental Management Operations** under the supervision of Health Physics personnel. Details for the removal of Solid Radioactive Waste are given in the document ANL Waste Handling Procedure. Any liquid radioactive waste is dried first and then disposed of as solid radioactive waste. If the liquid cannot be solidified, it is disposed of as Liquid Radioactive Waste by Environmental Management Operations.

APPENDIX 3: SAFETY EVALUATIONS FORM FOR RADIOACTIVE MATERIALS

PHYSICS DIVISION, D-203 Safety Review #

Safety Evaluation Form for Experiments Involving Radioactive Materials

Principal Investigator: Other Investigators:

1. Brief Description of the Experiment:

2. Starting Date and Duration of the Experiment:

3. Location of the Experimental Area:

4. Radioisotope, inventory number, quantity (in microCurie) and form:

_____ _____ _____ _____

_____ _____ _____ _____

_____ _____ _____ _____

5. Transfer of the Radioactive Material:

From: To: and back.

6. Where will the radioactive material be stored during interim period (if applicable):

7. Will Health Physics Technician survey the area at the end of the experiment:

Committee Approval Date

PHYSICS DIVISION

RADIATION SAFETY MANUAL

General Policy about Radioactive Materials in the Division

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Radioactive materials can be procured by the Division staff members only. Approval from the Radiation Safety Committee is not required for sealed sources up to 1 μCi and open sources up to 10 μCi. The Health Physics personnel keep a record of all materials coming in the Division and leaving the Division. It is the responsibility of the staff member to keep control of the radioactive materials he or she procures.

All radioactive sources in the Division are kept in a locked safe. Sources being checked out should be logged in the book placed near the safe. A person checking out a source is responsible for that source. Checked out sources should be kept locked during off hours.

Neutron sources, which are nuclear materials, are kept under lock. These can be checked out from the custodian and should be moved to the experimental location in the presence of Health Physics personnel. Neutron sources shall never be left unattended when in use and shall be kept locked when not in use.

Experiments at Dynamitron are covered by the same Radiation safety policy as the division policy. The Dynamitron has an interlock system to control access of personnel the time the accelerator is running.

In the Division most of the experiments are carried out at ATLAS for which a separate radiation safety manual is written. The Division radiation manual consists of this section and the ATLAS Radiation Safety Manual.