2007 edition

THE WSU ALARA PROGRAM

11.1) Introduction

11.1.1) As Low As Reasonably Achievable (ALARA)

All Authorized Users of sources of ionizing radiation are expected to conduct their work in such a manner that the collective exposure of all individuals is kept **As Low As Reasonably Achievable (ALARA)**. In general, this means making every reasonable effort to maintain exposures to radiation as far below the dose limits as is practical consistent with the purposes for which the licensed activity is undertaken. Clearly, any action which has no cost in time or money and which will decrease the collective exposure shall be adopted. To exceed ALARA is not to violate the regulations. ALARA is a professional standard of excellence.

Although protection against external radiation fields needs to be and is addressed, experience at the Wichita State University indicates that contamination control and control over radioactive materials are the areas requiring special procedures and/or ALARA guidelines.

This document constitutes the written **ALARA Program** approved by the Radiation Safety Committee (RSC) and mandated by state regulations. The ALARA Program commits all users of sources of ionizing radiation to the principle that all “unnecessary exposure” is to be avoided. Secondly, where potential or real exposures are unavoidable, every reasonable effort should be made to reduce the exposure. The Program applies to all Authorized Users of sources of ionizing radiation at Wichita State University unless an amendment to a specific permit grants alternative means of satisfying equivalent control.

ALARA goals and levels of exposures or contamination requiring specific "action" are defined in this program. The latter are called **action levels** because they trigger the need for some specific response to the situation. Because references are made to these action levels throughout this document, the action levels are defined or stated first in Section 11.2 below.

The word **shall** is used for a required procedure. Failure to observe procedures and conditions introduced with a "shall" is "noncompliance" with permit conditions.

The word **should** is used for highly recommended, but not absolutely required, procedures and conditions.

11.1.2) Regulatory Limits

The limits for the exposure of Authorized Users, members of the general public, minors, and declared pregnant women are those specified in Part 4 of the Kansas **Radiation Protection Regulations** (Title 10, Code of Federal Regulations Part 20). These regulations also apply to exposure limits in unrestricted areas. Authorized Users are by definition occupationally exposed. The RSC will determine which Authorized Occupants (laboratory personnel) are included in the "occupationally exposed" category.

11.1.3) ALARA Goals

The goal of the ALARA program is to keep all individual Total Effective Dose Equivalents (TEDE) below 1 mSv (100 mrem) per year. No annual Shallow Dose Equivalent (SDE) should exceed 10 mSv (1,000 mrem). No annual Lens of the Eye Dose Equivalent (LDE) should exceed 3 mSv (300 mrem). No Total Organ Dose Equivalent (TODE) should exceed 10 mSv (1,000 mrem).

11.1.4) Achievement of Dose Equivalent Limits

Authorized Users shall:

11.1.4.1) Plan and conduct all activities so that the ALARA exposure limits specified in this chapter are not exceeded unless a Radiation Safety Committee-approved request (amendment to the permit) for a higher ALARA limit has been obtained. All approved ALARA limits shall be below the dose equivalent limits specified in the regulations.

11.1.4.2) Report to the Radiation Safety Officer (RSO) any accidental exposure which potentially is greater than the Wichita State University ALARA limits and cooperate with the RSO in the investigation of such an incident.

11.1.4.3) Plan and conduct activities such that the average weekly exposure does not lead to an exposure in excess of the annual ALARA limit unless a documented analysis shows that a higher exposure in a given week will be compensated by lower exposures in prior (preferable) or succeeding weeks.

11.1.4.4) Plan and conduct work so that the exposure of a declared pregnant woman does not exceed 300 µSv (30 mrem) in any given month during the declared phase of the pregnancy.

11.2) Action Levels

11.2.1) Radiation Exposures

11.2.1.1) Action Levels for Exposure

a.) **Remedial Level (RL) for Exposure**

Any measurable skin contamination requires decontamination and documentation in the survey records of the laboratory.

Note: Causes should always be determined when feasible even at the lowest levels of contamination and corrective action implemented.

b.) **Investigation Level (IL) for Exposure**

Any whole body personnel dosimeter report in excess of 30 mrems for x or gamma radiation in any one month and/or of 50 mrem energetic beta in any one month, requires an investigation by the RSO. See Section 11.7.

11.2.2) Control of Contamination

11.2.2.1) Wichita State University ALARA Goals in Contamination Control

a.) The primary goal in contamination control is to have no measurable contamination on any external surfaces that have the potential of being contacted by personnel, such as outside surfaces of containers and equipment, floors, bench tops, secondary containers, etc.

b.) Minimize contamination when the primary goal is not feasible.

c.) Remove contamination, even at low levels, whenever feasible and at the earliest possible time after detecting the contamination.

11.2.2.2) Action Levels in Contamination Control

a.) **Remedial Levels (RL) of Contamination**

Any removable contamination which exceeds one of the levels specified in Table 1 below requires prompt and documented decontamination. Fixed contamination shall not exceed 5 times the Table 1 levels.

Table 1 not withstanding, decontamination shall always be attempted when a "wipe" is measured to exceed an activity of 220 dpm for a surface subject to the "unrestricted" ALARA limit. Contamination levels above those specified in Table 1 are not allowed unless special permission has been granted by the RSO.

Table 1 - Remedial Levels of Contamination
(Removable contamination)

	Type of Radioactive Material*					
	Alpha Emitters		Beta or X-Ray Emitters		Low Risk Beta or X-Ray Emitters	
Type of Surface	($\mu Ci/cm^2$)	($dpm/100cm^2$)	($\mu Ci/cm^2$)	($dpm/100cm^2$)	($\mu Ci/cm^2$)	($dpm/100cm^2$)
1. Unrestricted areas	10^{-7}	22	10^{-6}	220	10^{-5}	2,200
2. Restricted areas	10^{-6}	220	10^{-5}	2,200	10^{-4}	22,000
3. Personal clothing worn outside restricted areas	10^{-7}	22	10^{-6}	200	10^{-5}	2,200
4. Protective clothing worn only in restricted areas	10^{-6}	220	10^{-5}	2,220	10^{-4}	22,000
5. Skin	10^{-6}	220	10^{-6}	220	10^{-5}	2,000

* Beta or x-ray emitter values are applicable for all beta and x-ray emitters other than those considered low-risk. Low-risk nuclides include C-14, H-3, S-35, Tc-99m, and others whose beta energies are less than 0.2 MeV maximum, whose gamma- or x-ray emission is less than 0.1 R/h at 1 meter per curie, and whose permissible concentration in air (see 10 CFR Part 20, Appendix B, Table 1) is greater than 10^{-6} µCi/ml. (Regulatory Guide 8.23, Radiation Safety Surveys at Medical Institutions)

Note: A **remedial level** of contamination is defined by the Federal Regulatory Guide 8.23 for restricted and unrestricted areas, equipment, and/or clothes. When a "remedial level" is discovered, prompt and documented decontamination shall be performed. Table 1 specifies those levels. Notice that these levels are not in cpm but in dpm. Appropriate efficiency corrections must be applied. These levels are defined in terms of removable activity (activity on wipes). [For example, a thin window (1-2 mg/cm^2) GM meter typically might have an efficiency of 0.05 for C-14 and 0.2 for P-32. Liquid Scintillation Counters have higher efficiencies. The user needs to determine the efficiency.] The Safety Data Sheets provide nominal conversion factors from cpm to dpm for the most used instruments.

b.) **Investigation Level (IL) for Contamination**

Any contamination levels that exceed those specified in (I) or (II) below requires an immediate investigation in which causes are determined, corrective actions designed to

prevent recurrence are implemented, and reports are submitted to the RSO and the RSC.

Two different IL's are used. These levels are as follows:

I.) For clearly marked and labeled work areas covered with absorbent paper, contamination at more then 25 times the Table 1 "restricted" levels or 5 or more spots at 10 times the Table 1 levels requires implementation of an Investigation Level.

II.) For unmarked areas, including all floors, contamination at more than 10 times the Table 1 "unrestricted" levels requires implementation of an Investigation Level.

11.3) Control of Radiation Sources

11.3.1) Instruments Containing Radioactive Sources (Liquid Scintillation Counters and Gas Chromatographs with radioactive sources) and Radiation Generating Devices

The Authorized Laboratory Supervisor shall:

11.3.1.1) Ensure that the serial number(s) or some other unique identifying number has been registered with the RSO under the permit which governs the use of the instrument and/or radiation generating device.

11.3.1.2) Ensure that the permit specifies where the instrument and/or radiation generating device is located.

11.3.1.3) Ensure that a highly visible label with the following words shall remain attached to such an instrument and/or radiation generating device.

Notice: "Do not move without notifying the Radiation Safety Officer."

11.3.1.4) Do not transfer responsibility for the instrument and/or radiation generating device unless prior written authorization from RSO and the Committee has been obtained.
Note: These sources are covered together with all other sources of ionizing radiation under standard permit conditions.

11.3.1.5 Promptly notify the RSO when the instrument and/or radiation generating device is no longer needed.

Note: Authorized Laboratories, sources of ionizing radiation, and radiation generating devices **shall not be abandoned** by an Authorized Laboratory Supervisor.

11.3.1.6) Do not remove such instruments or radiation generating devices from the Equipment Inventory unless prior approval has been obtained from the RSO.

11.3.1.7) Specify the location of storage for instruments, spare radiation generating devices and/or X-ray tubes to be used in instruments in the permit application, and shall not change location without first notifying the RSO.

Authorized Users shall:

11.3.1.8) Use the radiation generating devices and/or sources of ionizing radiation only as specified in the applicable permit. This includes training requirements and procedures

11.3.1.9) Not move a radiation generating device or source of ionizing radiation to another location without prior approval from RSO. This is for the purpose of ensuring that the radiation generating device or source of ionizing radiation will never become an "orphan," or that its location becomes unknown to the RSO.

11.3.1.10) Not remove the label specified in Section 11.3.1.3 above and/or "Caution Radioactive Materials" labels. Only RSO staff members are authorized to remove such labels subject to the restrictions placed upon them by the License.

11.3.1.11) Maintain the storage of spare radiation generating devices and/or spare X-ray tubes, (etc) in a secured fashion so that unauthorized access is prevented.

Note: For Authorized Laboratory Supervisors who have only "sources" of the type addressed in this section (11.3.1), the only other applicable sections are 11.4 and 11.8 below.

11.3.2) Outdated Radioactive Sources

The Authorized Laboratory Supervisor shall:

11.3.2.1) Arrange for approved transfer and/or disposal of all radioactive sources in the inventory of the permit before leaving the university or terminating the permit.

11.3.2.2) Require an accounting by Authorized Users under their permit of all radioactive sources created by the users before such users leave the university (This includes identification and labeling of containers with levels of activity and isotope.)

11.3.2.3) Properly and promptly transfer to RSO for disposal any sources for which no use is anticipated.

11.3.2.4) Place unused stock sources which have been on the inventory for more than five years and for which potential use has been justified in a secondary container which shall be sealed by the RSO and shall bear a label with these words: "Notice: Do not break seal or change location of this container without notifying the RSO." Sources will be placed in such containers at the time of the physical inventory. See Section 11.3.2.5 below.

11.3.2.5) Perform an annual physical inventory of all sources that are listed under the permit in cooperation with the RSO. (Stocks in containers specified in Section 11.3.2.4 above with unbroken seals are inventoried upon identification of the containers.)

Note: The conditions of Section 11.3.2 are agreed upon by the Authorized Laboratory Supervisor when responsibility for a permit and its conditions are accepted by signature of the acceptance letter.

11.4) Control of External Radiation Fields

11.4.1) Restrictions on External Gamma/X-ray Fields and Action Levels

The Authorized Laboratory Supervisor shall:

11.4.1.1) Ensure that the dose rate at the nearest occupyable unrestricted area where radioactive sources are stored or where x-ray producing machines are used is no greater than 2.0 μGy (0.20 mrem) in any one hour unless analysis by the RSO indicates that achievement of this level is not practical and an exemption is granted explicitly in the permit.

Note: If x-ray units are placed in a room with interlocks and no occupancy during exposures is

possible, the nearest accessible surfaces are the exterior sides of the walls. However, for units which are operated inside occupied rooms, the above limit applies to the surface of the equipment itself.

11.4.1.2) Evaluate, plan and perform all activities under the permit with the intent of meeting the ALARA limits on exposure as specified in Section 11.2.

11.4.1.3) Notify the RSO immediately if there is any reason (measurement or calculation) to believe that the exposure of any individual exceeded the Investigation Level listed in 11.2.1 in any one month. Section 11.2.1.1.b establishes this as an Investigation Level, therefore:.

a.) Identify causes for the contamination

b.) Establish Standard Operating Procedures designed to prevent recurrence of the contamination.

c.) Cooperate with the RSO in assessing the level of exposure

d.) Submit a report to the RSO and the Committee within two weeks of the incident.

11.4.2) External Beta Fields and Shallow Dose Exposures from Contamination

Authorized Users/Authorized Laboratory Supervisors should:

11.4.2.1) Use clear beta shields whenever high energy beta fields may be present.

11.4.2.2) Perform operations involving microcurie amounts of a high energy beta emitter behind a beta shield.

11.4.2.3) Store beta emitting sources so that betas will not penetrate to accessible areas, if this is readily achievable. The dose rate should not be more than 2.0 µGy (0.20 mrem) in any one hour.

11.4.2.4) Implement decontamination when measurable skin contamination is detected, implement corrective actions if feasible, and document initial and final activities with estimates of the duration of the contamination together with corrective actions.

Note: Measurements are to be made with instruments specified in the Safety Data Sheet for the radioactive source involved and under the conditions specified by the Safety Data Sheet (SDS). Safety Data Sheets provide specific radionuclide data on predicted and measured dose and dose rates, estimates of internal dose, and biological limits. Unless an RSO notation of a more accurate calibration factor is entered into the SDS, the calibration factor or conversion factor suggested in the SDS is to be used. If instruments specified in the general SDS are not available in the laboratory, the Authorized Laboratory Supervisor shall request an RSO calibration for the instruments that are to be used and these shall be noted in the laboratory-specific SDS.

11.4.2.5) Notify the RSO immediately if the possibility exists that the exposure could exceed the Investigation Levels.

a.) Identify causes for the contamination

b.) Establish Standard Operating Procedures designed to prevent recurrence of the contamination.

c.) Cooperate with RSO in assessing the level of exposure

d.) Submit a report to the RSO and the Committee within two weeks of the incident.

11.5) Contamination Control

11.5.1) Guidelines and Requirements

Note: In this section, action levels defined in Section 11.2 are used. Section 11.2 should be reviewed as needed.

Authorized Users shall:

11.5.1.1). Plan for and use procedures designed to prevent contamination.

11.5.1.2) Make reasonable attempts to remove any contamination found in unrestricted areas. **The goal is no measurable contamination.**

11.5.1.3) Use judgment in determining when decontamination may be deferred for a limited period of time provided that the contamination levels do not exceed the "Remedial Level".

Note: It always preferable to keep contamination levels in restricted areas at the "not measurable" levels, Dirty (many areas of contamination) areas are not acceptable.

11.5.1.4) Maintain floors in all areas below "Remedial Levels" for unrestricted areas.

Note: The only and "last resort" exception would be to establish a Class IV Laboratory with the approval of the Radiation Safety Officer and declare the lab off limits for housekeeping and other personnel from facilities operations.

11.5.1.5) Maintain bench tops which are clearly marked and identified as restricted areas below "Remedial Levels" for restricted areas.

Note: Outside surfaces of equipment labeled and exclusively kept in such marked areas shall also be below "Remedial Levels" for restricted areas.

11.5.1.6) Maintain all unmarked and unreserved areas and equipment or clothes in such areas below "Remedial Levels" for unrestricted areas and/or equipment.

Note: However, every effort should be made to keep levels well below this - preferably non-measurable. Destructive decontamination shall be considered, if necessary.

11.5.1.7) Survey laboratory coats and other items to be laundered before release to commercial laundries. The lab coats shall not be released if there is measurable contamination.

Note: The use of two lab coats is encouraged but not required.

Authorized Users/Authorized Laboratory Supervisors shall:

11.5.1.8) Immediately decontaminate, with the assistance of the RSO, any areas/materials which exceed the Investigation Level of Contamination. (See Section 11.2.2.2.b above)

11.5.1.9) Identify the causes and/or reasons for the contamination.

11.5.1.10) Establish changes in laboratory-specific standard operating procedures designed to prevent recurrence of such incidents, and ensure that all appropriate personnel are trained in those

procedures.

11.5.1.11) Maintain written documentation as part of laboratory records.

The Authorized Laboratory Supervisor shall:

11.5.1.12) Report the incident to the RSO as soon as possible.

11.5.1.13) Provide a written report to the RSO and the Committee with review within two weeks of the incident.

11.6) Laboratory Surveys

11.6.1) Survey Frequency

Authorized Users should:

11.6.1.1) Survey floors and/or other areas that may have become contaminated at the end of the day or at the end of the experiment, whichever comes first.

Note: When surveys have been performed at the end of the experiment and no new experiments are performed, surveys do not need to be performed at the end of a day when new experiments were not performed.

11.6.1.2) Survey areas shortly after any high level operation, any stock has been opened, or any operation which is highly vulnerable with respect to inadvertent contamination (mixing, blending, centrifugation, etc).

Authorized Users shall:

11.6.1.3) Perform surveys as soon as possible whenever there is reason to believe that contamination has occurred.

11.6.1.4) Perform comprehensive documented surveys at the minimum frequency specified in this section as applicable.

a.) **In Class IV Laboratories** (High Level)

Comprehensive Surveys are required: 1) at the end of the day whenever a stock is handled; 2) before an area reserved for work with radioactive materials is returned to unrestricted (unmarked) status.

b.) **In Class III Laboratories** (Medium Level)

Comprehensive Surveys are required: 1) whenever a stock is handled so that a bioassay must be performed within a day or week; 2) before an area reserved for work with radioactive materials is returned to unrestricted (unmarked) status; 3) at least once a week of selected areas, including the floor, which could become contaminated.

c.) **In Class II Laboratories** (Low Level)

Comprehensive Surveys are required: 1) before an area reserved for work with radioactive materials is returned to unrestricted (unmarked) status; 2) at least biweekly of selected areas, including the floor, which could become contaminated.

d.) **In Class I Laboratories** (Very Low Level)

Comprehensive Surveys are required: 1) before an area reserved for work with radioactive materials is returned to unrestricted (unmarked) status; 2) at least monthly on selected areas, including the floor, which could become contaminated.

Note: **The following exception shall apply to all laboratory classes given above:**

During a period of time when radioactive materials are not being used and materials are in storage only, area surveys do not need to be performed **if and only if** an extensive "close out" survey has been performed and recorded as such at the time usage was discontinued. Surveys are required during such a period if any accidents occur in the storage areas.

11.7) Actions Prompted by RSO Surveys/Reviews

11.7.1) Actions based upon RSO surveys

The RSO shall

11.7.1.1) Initiate corrective procedures immediately. The RSO will provide the necessary assistance.

The Authorized User/Authorized Laboratory Supervisor shall:

11.7.1.2) Provide the necessary effort to achieve prompt corrective action. See Sections 11.5.1.8 to 11.5.11.

The RSO may:

11.7.1.3) Initiate the procedures described in Section 11.8 if a survey by the RSO finds contamination at Remedial Levels (Section 11.2.2.2.).

Note: Because the actual occurrence of contamination is assumed to be accidental it is not in itself deemed "noncompliance." However failure by the users to identify such contamination by appropriate surveying and/or to decontaminate to the extent required by this program could be noncompliance.

Therefore, if surveys performed by RSO were always after the completion of an experiment or after the end of a day's work, the discovery of contamination above the remedial level by them could indicate "noncompliance" in that laboratory. Because surveys by the RSO are performed during the day and may occur while experiments are still in progress, such findings will not automatically be deemed "noncompliance."

However, the frequency with which RSO finds such contamination should be low and the escalating actions specified in Section 11.8 below will be taken. Authorized Laboratory Supervisors should investigate causes for any contamination above remedial levels and should implement additional procedures designed to prevent recurrence if appropriate. High frequency of contamination will most likely result in mandatory changes in the procedures applicable under the relevant permit.

The RSO shall:

11.7.1.4) Implement the Noncompliance Procedures of Section 11.8 below when levels exceed

the Investigation Level (See Section 11.2.2.2.b)

11.7.2) Actions by the RSO when Investigation Levels are Exceeded (whether reported by the laboratory or found with their own surveys)

The Radiation Safety Officer shall:

11.7.2.1) Attempt to determine the reason for any exposure in excess of the levels specified in Section 11.2.1.2.b above and to help the laboratory institute procedural changes designed to prevent recurrence of such exposure if feasible under ALARA constraints.

Note: Exposures in excess of these levels are not "noncompliance" when reported by the laboratory but are action levels for triggering an analysis. They are "noncompliance" if found by the RSO.

11.7.2.2) Document their findings and include a summary in reports to the Committee.

11.8) Noncompliance Items and Undetected Remedial Level Contamination

A **violation** is a finding by the RSO of "noncompliance" with state and federal regulations, permit conditions, and/or required ALARA procedures and/or conditions. Regulations and conditions have varying degrees of safety, safeguards, or environmental significance.

Level A Noncompliance addresses violations that are more significant and are of considerable concern. Violations involving training, personnel protection, required surveys not performed or documented, and other procedures that would greatly affect the health and safety of individuals are examples of this level. Level A Noncompliance violations are more severe than Level B Noncompliance violations.

Level B Noncompliance addresses violations that are significant and are of concern. Examples are not correctly posting and labeling areas and/or equipment, eating or drinking in restricted areas, not performing the required surveys and/or inspections, leaving radioactive sources unsecured, working in unrestricted areas, not wearing personnel dosimeters, not preparing or maintaining the required record keeping, placing labeled equipment in unrestricted areas, etc. There may be incidents when these violations would be considered Level A Noncompliance depending upon the level of risk. Some violations are listed as Level A and Level B Noncompliance (for example, failure to perform and document surveys) to show that the severity of these violations depends upon the effects to health and safety.

Sanctioned actions for noncompliance could include immediate attention by the Authorized Laboratory, written corrections or written responses from the Authorized Supervisor, interview with RSO and/or Committee, increased RSO inspections, additional training requirements, increased assessments by the Authorized Users, suspended shipments of radioactive materials, established restrictions on Authorized User, decreased scope of permit, confiscated radioactive materials, or suspended or permanently terminated permit.

11.8.1) Level A Noncompliance Violations

The Radiation Safety Officer shall:

11.8.1.1) Require individuals working with radioactive materials to immediately cease working if training has not been certified at the proper level.

11.8.1.2) Require individuals working with radioactive materials to immediately cease working if gloves and lab coats are not being used in a procedure that requires personnel protection.

11.8.1.3) Place ordering radioactive materials on a contingent status if the required documentation for surveys has not been completed by the Authorized Laboratory and has a significant impact on health and safety.

Note: Normally this precaution would only be initiated following the action of Section 11.8.2.3. Contingent implies that radioactive materials may be ordered upon completing the required survey.

11.8.1.4) Require individuals working with radioactive materials to immediately cease working if Level B Noncompliance violations have a significant impact on health and safety.

11.8.2) Level B Noncompliance Violations

11.8.2.1) First Violation or Undetected Remedial Level of Contamination

The Radiation Safety Officer shall:

a.) Submit a letter to the Authorized Laboratory Supervisor identifying the details of the violation and explaining the required corrective action, and/or condition b. A verbal notice should also be given by the RSO.

b.) Note the violation on the RSO's survey sheet in the "noncompliance" section.

11.8.2.2) Second Violation or Undetected Remedial Level of Contamination

The Radiation Safety Officer shall:

a.) Send the Authorized Laboratory Supervisor a notice of violation.

b.) Send a copy to the Chair of the Committee.

11.8.2.3) Third Violation or Undetected Remedial Level of Contamination

The Radiation Safety Officer shall:

a.) Send a warning letter to the Authorized Laboratory Supervisor.

b.) Send copies to the Chair of the Department and to the Chair of the Committee.

11.8.2.4) Fourth Violation or Undetected Remedial Level of Contamination

The Radiation Safety Officer shall:

a.) Request the Chair of the Committee to arrange for an interview between the Authorized Laboratory Supervisor and the Committee for the purpose of determining steps that need to be taken to prevent recurrence of the noncompliance.

Note 1: In the event of serious, health-threatening violations, the Radiation Safety Officer may take appropriate action, including stopping work under a permit, until an interview with the Committee has been completed and it has made recommendations with respect to the safety issues.

Note 2: If the interval between violations is more than eighteen months, the sequence again begins with Section 11.8.1.

The Radiation Safety Committee shall:

11.8.2.5) Take necessary actions to address the problems and monitor the adequacy of those actions.

On Radiation #3:WSU ALARA