APPLICATION GUIDE FOR PARTICLE ACCELERATOR LICENSE
INDUSTRIAL APPLICATIONS

Item 1. Self-explanatory

Item 2. If the particle accelerator(s) will be used at address(es) other than that listed in Item 1, specify all such addresses. If the accelerator(s) are portable or mobile and will be used at temporary job sites throughout the State of Arkansas, so state. (It is not necessary to specify addresses for temporary job sites.)

Item 3. Self-explanatory

Item 4. Self-explanatory

Item 5. List the departments or similar divisions of the organization which will use the particle accelerator(s). If more than one accelerator is requested, specify which of the departments will use each accelerator. If not applicable, so state.

Item 6. Self-explanatory

Item 7. One person should be designated by, and responsible to, the organization's management for coordination and supervision of the radiation safety program associated with particle accelerator operations.

Provide a statement describing this individual's responsibilities and authority for implementing the radiation safety program. The scope of the Radiation Protection Officer's duties will vary according to the scope of the proposed particle accelerator operations, but at least the following should be considered:

(1) General surveillance over activities involving the operation of the particle accelerator(s), including routine monitoring and special surveys of the accelerator and or target rooms.

(2) Determining compliance with rules and regulations and license conditions.

(3) Monitoring and maintaining special filter systems associated with the operation of the particle accelerator, if applicable.

(4) Furnishing consultation services on all aspects of radiation safety to personnel at all levels of authority.

(5) Distributing and processing personnel monitoring equipment, keeping personnel exposure records, and notifying individuals and their supervisors of exposures approaching maximum permissible amounts and recommending appropriate remedial action.

(6) Conducting training programs or otherwise instructing personnel in the proper procedure for particle accelerator use prior to use, at periodic intervals thereafter (refresher training), and as required by changes in procedures, equipment, regulations, etc.

(7) The authority to immediately terminate a project that is found to be a threat to health or property of employees or the general public.

Item 8. a. Identify each particle accelerator according to the following criteria:

1. Name of the manufacturer

2. Manufacturer's model number (if there have been alterations in the accelerator which have changed the original design specifications, these alterations should be detailed under Item 11, Facilities and Equipment).

3. Type of accelerator (e.g. van der Graaff, Cockcroft-Walton, travelling wave, etc.).

4. The number available for use of each accelerator listed.

5. The proposed use of each accelerator. If the accelerator will be used for production of radioactive material, an application for a Radioactive Material Licesne must be filed with the Department.

b. Describe the following operating characteristics of each accelerator described in Item 8.a. Characteristics described in Item 8.b. should be keyed to the appropriate accelerator listed in 8.a. (i.e. characteristics on line 8.b. (1) should apply to the accelerator listed on line 8.a. (1)).

1. Operating modalities available on each accelerator (e.g. electron, neutron, x-ray, etc.).

2. Operating modalities of the accelerator which will actually be used in normal operation. For example, an individual accelerator may be capable of producing a neutron and a deuteron beam, but for the applicant's program, only the deuteron beam is used.

3. Maximum radiant energy of each modality listed.

4. If the target material is radioactive (such as Tritium), specify the isotope and activity of radioactive material, and the target's manufacturer and model number. An amendment must be made to the organization's Radioactive Material License if radioactive targets are used.

Item 9. a. Identify the radiation detection instruments which will be used in the program according to the following criteria:

1. Type of instrument (e.g. ionization chamber, G.M., proportional counter, etc.).

2. Manufacturer of each instrument

3. Model number of each instrument

4. Number available for use

5. Type radiation the instrument is designed to detect (e.g. alpha, beta, gamma, neutron, etc.).

6. Sensitivity range of each instrument. This range may be expressed in mR/hr, in counts per minute, or in other appropriate units. Specify the range of the least sensitive scale and the most sensitive scale if the instrument has more than one scale.

7. Describe the proposed purpose for which each instrument will be used.

b. Radiation detection equipment should include portable monitoring equipment for surveys and area monitors for continuous measurement of radiation levels in all high radiation areas. Area monitors must provide a remote and a local readout with visible and/or audible alarms at both the accelerator control panel and at the monitoring station. Area monitors should be set so that alarms are activated at a level of at least 100 mrem/hr.

c. If any accelerator listed is capable of producing neutrons, some method of monitoring the neutron radiation levels must be provided. If detection instruments listed under Item 9 are not capable of detecting neutrons, describe the method used to evaluate neutron radiation levels.

Item 10. Calibration of Instruments Listed in Item 9.

a. X and gamma radiation detectors

Appendix A to this guide contains an acceptable set of procedures for the calibration of x-and gamma-ray detection instruments. Use the form in Appendix A to provide information concerning calibration of these instruments, including both portable survey meters and area monitors. The Appendix A form can be used whether these instruments will be calibrated by the applicant or by an outside organization.

b. Other detection instruments (including neutron survey meters) for survey instruments or area monitors designed to detect radiation other than x- or gamma-ray (charged particles, neutrons), submit procedures for calibration of these instruments, addressing:

1. Calibration source isotope, activity, manufacturer and model number
2. Frequency of calibration
3. Name, address, and registration number of any outside agency which will perform calibrations, or
4. Procedures to be followed for in-house calibration including the name of the responsible individual.

Item 11. Facilities and Equipment

a. Permanent Installations

For facilities where a particle accelerator is permanently installed in a single location (not portable), the following information should be submitted:

(1) Drawing or sketch of the accelerator facility and the surrounding areas, including

(A) Dimensions of the area, particularly distances to uncontrolled areas. In lieu of specifying these distances and dimensions, drawings may be made to a specified scale.

(B) Thickness, type, and density of shielding material on all sides, above, and below the accelerator facility. All barriers separating the accelerator from other areas must be permanent barriers (i.e. temporary walls are unacceptable).

(C) Identification of entrances to the accelerator area

(D) Identification of all areas adjacent to the accelerator facility.

(2) Radiation levels in all adjacent areas should be calculated for the maximum radiant energy of each operating modality that will be used. Suficient shielding should be provided to show that the expected levels do not exceed the limits specified in Paragraphs RH-1200 through RH-1204 of the Arkansas State Board of Health's Rules and Regulations for Control of Sources of Ionizing Radiation. A copy of all such calculations should be submitted with the application. For more information concerning shielding calculations, refer to the National Council on Radiation Protection and Measurement (NCRP) Report Number 51. In many cases, it may be advisable to consult someone specializing in shielding calculations for assistance.

(3) In addition to the calculations addressed above, a radiation survey of the accelerator installation must be performed when the accelerator is first capable of producing radiation. This survey should be conducted to verify that calculated radiation levels are not exceeded and should be capable of detecting and locating possible deficiencies in the shielding.

(4) Control and Interlocks

(A) All entrances to the accelerator target room or other high radiation areas must be provided with interlocks. Submit a description of the interlocks on these entrances according to the following criteria:

(i) Interlocks should be designed so that they are fail safe. That is, any defect or component failure in the interlock system must prevent operation of the accelerator.

(ii) Each separate interlock should be on an independent single circuit, operating independently of all other safety interlocks.

(iii) The interlocks must be designed so that when an interlock is tripped, the accelerator cannot be restarted until the interlock has been reset, first at the position where the interlock was tripped, then at the control console.

(B) A "scram" button or an emergency power cut-off switch must be located and easily identifiable in all high radiation areas. The location of all scram buttons should be identified on the facility drawing. These emergency switches should be designed so that the accelerator cannot be restarted at the control console without first resetting the cut-off switch.

(C) All high radiation areas and the entrances to these areas must be equipped with flashing or rotating warning lights which operate only when the accelerator is producing radiation.

(D) Barriers and pathways leading to high radiation areas must be posted with warning signs which state, "Caution (or Danger) High Radiation Area" as described in Paragraph RH-1303 (c)(1).

b. Temporary Use Locations

If the particle accelerator is designed so as to be portable, and will be operated at more than one location, describe the radiation safety precautions at these temporary sites, including:

(1) Establishing and posting controlled areas

(2) Control of access to controlled areas

(3) Use of time, distance, and shielding to maintain exposures below regulatory limits

(4) Special tanks, enclosures, or other facilities to provide shielding and control access. Special facilities should be described as to size, type and quantity of shielding, and exposure rates at the perimeter.

c. Equipment

(1) If any changes or alterations have been made in the particle accelerator(s) which alter the performance characteristics of the manufacturer's original design, describe the changes made in each accelerator, including the name of the individual or organization making these alterations and the design specifications which were altered. Include explanatory drawings or diagrams, if appropriate.

(2) Describe any remote handling or manipulation devices used in conjunction with particle accelerator operations, including a description of the procedures in which such devices are used and explanatory drawings, if applicable.

Item 12. Management Controls

a. Describe the organizational structure, indicating the position of responsibility and authority over the particle accelerator safety program. Include an organizational chart, if available.

b. Describe the precautions taken to secure the particle accelerator from unauthorized use. Procedures may include such provisions as locking and securing the control console, the accelerator facility, and other precautions.

Item 13. Operating and Emergency Procedures

A written set of Operating and Emergency Procedures should be established for particle accelerator operations at the facility. Appendix B to this guide is a form which is to be completed which indicates where in the procedures each of the topics addressed in the Appendix can be found. Complete the Appendix B form and submit it and a copy of the Operating and Emergency Procedures as a part of the application.

Item 14. Training Program

a. Describe the training program for persons who will operate the particle accelerator(s). This program should include formal course work (classroom training) and actual experience (on-the-job training). If examinations are given to personnel in the training program, submit a sample of the examinations which will be given, indicating the correct answers. Specify where in the training program such examinations are administered and the form of the examination (written, oral, practical).

NOTE: Examinations should be changed periodically to ensure an adequate test of individual competence. Copies of examinations submitted should be examples only.

The following topics constitute the minimum to be covered in training programs:

(1) Fundamentals of Radiation Safety

(a) Characteristics of radiation

(b) Units of radiation dose and quantity of radioactivity

(c) Measurement of radiation

(d) Methods of controlling radiation dose

(e) Radiation safety procedures, interlocks, and warning system.

(2) Fundamentals of Radiation Detection

(a) Use of radiation survey instruments

(b) Survey technique

(c) Use of personnel monitoring equipment

(3) Equipment

(a) Remote handling equipment

(b) Handling of activated material

(c) Use of shielding

b. Describe the training program for ancillary personnel (e.g. maintenance, housekeeping, etc.) who will work in the vicinity of the particle accelerator(s). Training for these individuals should be adequate to cover the radiation safety program as it relates to their specific job functions.

c. Periodic refresher training may be required to keep personnel informed of changes in procedures, equipment, or regulations. Describe any refresher training conducted, including:

(1) Frequency (The frequency may vary according to the specific applicant program, but at least an annual refresher course should be conducted.)

(2) Form (lecture, discussion, etc.)

(3) Topics covered

(4) Personnel involved with refresher training (it may be necessary to include both particle accelerator operators and ancillary personnel.)

Item 15. Special Considerations for Particle Accelerator Licensees

Appendix C to this guide is a form which lists several regulatory requirements for Particle Accelerator Licensees which have not been addressed elsewhere in this application. Complete the Appendix C form and submit it as a part of the application, indicating that the requirements specified will be met.

Item 16. Personnel Monitoring Devices

Specific requirements for monitoring personnel for radiation exposure are contained in Paragraph RH-1301 of the Arkansas State Board of Health's Rules and Regulations for Control of Sources of Ionizing Radiation.

a. Personnel monitoring devices which are capable of separating component parts (i.e. gamma, x-ray, thermal neutron, fast neutron, etc.) of a mixed radiation field should be used. Indicate the type of monitor to be used (film, thermoluminescent dosimeter, or other); the supplier's name, address and registration number; and the frequency with which these devices are exchanged. Organizations providing personnel monitoring services must be registered with the Arkansas Department of Health under Paragraph RH-34 (c).

b. If pocket ionization chambers (pocket dosimeters) are used, provide the manufacturer's name and model number, the number of chambers available, and the range of scale readings. Pocket dosimeters with very high ranges, such as Civil Defense dosimeters with ranges of 1 R or higher, should not be used.

Describe the procedures for use of the pocket dosimeters, including calibration procedure and frequency of reading and recording when in use. A copy of any logs or forms used for maintaining these records should be submitted if available.

Item 17. Formal Training in Radiation Safety

Attach a resume for each individual named in Items 6 and 7. Describe individual's formal training in the following areas where applicable. Include the name of person or institution providing the training, when training was received, etc.

a. Principles and practices of radiation protection.

b. Radioactive measurement standardization and monitoring techniques and instruments.

c. Mathematics and calculations basic to the use and measurement of radioactivity.

d. Biological effects of radiation.

Item 18. Experience

Attach a resume for each individual named in Items 6 and 7. Describe individual's work experience with radiation, including where experience was obtained. Work experience or on-the-job training should be commensurate with the proposed use. The resume should include a list of actual experience using particle accelerators, specifying the type of accelerators used and the energy range of each.

Item 19. The application must be signed by an individual authorized to act in behalf of the organization. This item MUST be completed by the applicant before submission to the Department. All unsigned applications will be returned.

APPENDIX A

CALIBRATION OF INSTRUMENTS

METHODS FOR CALIBRATION OF (X- AND GAMMA-RAY) DETECTION INSTRUMENTS INCLUDING PROCEDURES, STANDARDS, AND FREQUENCY

A. Calibration of detection instruments will be performed with radionuclide sources.

1. The sources shall be approximate point sources.
2. The source activities or exposure rates at given distances shall be traceable by documented measurements to a standard source certified within 5 percent accuracy to the U.S. National Bureau of Standards (NBS) calibrations.
3. The frequency shall be at least annually and after servicing for survey meters.
4. Each scale of the instrument shall be calibrated at least at two points located at approximately 1/3 and 2/3 of full scale.
5. The exposure rate measured by the instrument shall differ from the true exposure rate by less than 10 percent at the two points on each scale (read appropriate section of the instruction manual to determine how to make necessary adjustments to bring instrument into calibration). Readings within ± 20 percent will be considered acceptable if a calibration chart, graph, or response factor is prepared, attached to the instrument, and used to interpret meter readings to within 10 percent for radiation protection purposes.

   NOTE: Sources of Cs-137, Ra-226, or Co-60* are appropriate for use in calibrations. The activity of the calibration standard should be sufficient to calibrate the survey meters on each scale to be used for radiation protection purposes. Scales up to 1 R/hr should be calibrated, but higher-range scales above 1 R/hr need not be calibrated when they will not be needed for radiation protection surveys. If there are higher ranges, they should at least be checked for operation and approximately correct response to radiation. Otherwise, a cautionary note that they have not been checked should be placed on the instrument.

B. A reference check source of long half-life, e.g., Cs-137 or Ra D and E, shall also be read at the time of the above calibration or as soon as the instrument is received from a calibration laboratory. The readings shall be taken with the check source placed in specific geometry relative to the detector. A reading of this reference check source should be taken:

1. Before each use and also after each survey to ensure that the instrument was operational during the survey.
2. After each maintenance and/or battery change.
3. At least quarterly.

If any reading with the same geometry is not with ± 20 percent of the reading measured immediately after calibration, the instrument should be recalibrated. (See Item A).

C. Records of the above Items A, B-2, and B-3 must be maintained.

---

*Minimum activities of typical sources are 85 mCi of Cs-137, 21 mCi of Co-60, and 34 mCi of Ra-226 (to give at least 700 mR/hr at 20 cm).

CALIBRATION OF INSTRUMENTS

Check appropriate items.

A. Survey Instruments

_____ 1. Survey instruments will be calibrated at least annually and following repair.

_____ 2. Calibration will be performed at two points on each scale used for radiation protection purposes, i.e., at least up to 1 R/hr.

The two points will be approximately 1/3 and 2/3 of full scale. A survey instrument may be considered properly calibrated when the instrument readings are within ± 10 percent of the calculated or known valures for each point checked. Readings within ± 20 percent are considered acceptable if a calibration chart, graph, or response factor is prepared, attached to the instrument, and used to interpret readings to within ± 10 percent. Also, when higher scales are not checked or calibrated, an appropriate precautionary note will be posted on the instrument.

3. Survey instruments will be calibrated

_____ a. By the manufacturer

_____ b. At the licensee's facility

(1) Calibration source

Isotope (element and mass number)_____

Manufacturer's name _____

Model No. _____

Activity in millicuries_____

or

Exposure rate at a specified distance_____

Accuracy_____

Traceability to primary standard_____

_____ (2) The calibration procedures in Appendix A will be used.

or

_____ (3) The step-by-step procedures, including radiation safety procedures, are attached.

_____ c. By a consultant or outside firm

(1) Name_____

(2) Location_____

(3) Registration number _____

CALIBRATION OF INSTRUMENTS
(Cont'd)

Persons providing calibration services to Arkansas Particle Accelerator Licensees must be registered with the Department under Paragraph RH-34 (b).

B. Area Monitors

_____ 1. Area monitors will be tested for proper response using radionuclide sources.

Frequency of testing_____

Check source: isotope (element and mass number)_____

activity_____

_____ 2. Procedures for testing area monitor attached.

3. Area monitor alarms will be set to activate when radiation levels are _____mR/hr. (This level must not be higher than 100 mR/hr.)

APPENDIX B

OPERATING AND EMERGENCY PROCEDURES

Complete the following form by indicating where in the particle accelerator operating and emergency procedures (page number, section number, or other appropriate notation) each of the topics is addressed. This list constitutes the minimum topics to be covered by these procedures.

1. Use of the particle accelerator, including maintaining exposures below the regulatory limits and prohibition against using the interlock system to routinely turn the accelerator beam on and off.

   Information found_____

2. Procedures for checking safety and warning devices, including interlocks, for proper operation. These checks should be done at intervals not to exceed three months and records must be maintained for these checks.

   Information found_____

3. Procedures to be followed if an interlock is intentionally bypassed. This action must have the authorization of the radiation safety officer, be recorded in a permanent log book, and have a notice posted at the accelerator control console.

   Information found_____

4. Methods and occasions for conducting radiation surveys, including:

   (a) Radiation survey by a qualified expert when changes have been made in shielding, operation, equipment, or occupancy of adjacent areas, and at specified periodic intervals to check for unknown changes and malfunctioning equipment.

   (b) Periodic surveys to detect and quantify the amount of airborne particulate radioactivity, if applicable.

   (c) Periodic smear surveys to detect and quantify the degree of contamination in target and scattering chamber areas, if applicable.

   (d) Procedures for maintaining records of surveys.

   Information found_____

5. Personnel monitoring and the use of personnel monitoring equipment.

   Information found_____

6. Emergency procedures, indlucing:

   (a) Minimizing exposures in the event of an accident

   (b) Notifying proper individuals in the event of an accident.

6. (Cont'd) Specific names and phone numbers should be given.

   Information found_____

7. Maintenance of records including utilization logs or other records.

   Information found_____

8. Ventilation systems in areas where airborne radioactivity exceeds the limits of Paragraph RH-2200, Appendix A, Table I for the specified radioisotope. Ventilation of these areas must be performed with sufficient dilution to maintain concentrations below the limits specified in RH-2200, Appendix A, Table II. (Concentrations may be averaged over a period of one year.)

   Information found_____

9. Procedures for disposal of solid and liquid radioactive wastes produced at the accelerator facility. The disposal of these wastes must follow the requirements of Paragraphs RH-1402 and RH-1403.

   Information found_____

APPENDIX C

SPECIAL CONSIDERATIONS FOR PARTICLE ACCELERATOR LICENSEE

The following requirements from the Arkansas Rules and Regulations for Control of Sources of Ionizing Radiation are administrative requirements for Particle Accelerator Licensees. Each paragraph referenced should be read and understood. Completion of this application implies agreement to abide by these requirements. Indicate that each of these requirements are understood and will be followed by checking the blank in front of each item.

_____ 1. Electrical circuit diagrams of the accelerator, and the associated interlock system, will be kept current and on file at each accelerator facility. (Refer to Paragraph RH-5405 (d))

_____ 2. A copy of the operating and emergency procedures will be maintained at the accelerator control panel. (Refer to Paragrah RH-5405 (f))

_____ 3. Paragraph RH-1305, Instruction of Personnel; Posting of Notice to Employees.

_____ 4. Section 3, Part F, Paragraphs RH-1500 through RH-1506, Records, Reports, and Notification.

_____ 5. Section 3, Part N, Paragraphs RH-2801 through RH-2808, Notices, Instructions and Reports to Workers; Inspections.