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NEBRASKA DEPARTMENT OF
HEALTH AND HUMAN SERVICES

180 NAC 19

TITLE 180 CONTROL OF RADIATION

CHAPTER 19 LICENSES AND RADIATION SAFETY REQUIREMENTS FOR
IRRADIATORS

001. SCOPE AND AUTHORITY. The regulations are authorized by and implement the Nebraska Radiation Control Act, Nebraska Revised Statute (Neb. Rev. Stat.) §§ 71-3501 to 71-3520. This chapter contains requirements for the issuance of a license authorizing the use of sealed sources containing radioactive materials in irradiators used to irradiate objects or materials using gamma radiation. 180 Nebraska Administrative Code (NAC) 19 also contains radiation safety requirements for operating irradiators. The requirements of this chapter are in addition to other requirements of Title 180. In particular, the provisions of 180 NAC 1, 3, 4, 10, 13 and 18 apply to applications and licenses subject to this chapter.

001.01 OTHER REQUIREMENTS. Nothing in this chapter relieves the licensee from complying with other applicable Federal, State and local regulations governing the siting, zoning, land use, and building code requirements for industrial facilities.

001.02 APPLICABILITY. This chapter applies to panoramic irradiators that have either dry or wet storage of the radioactive sealed sources and to underwater irradiators where both the source and product being irradiated are under water. Irradiators whose dose rates exceed 5 grays (500 rads) per hour at 1 meter from the radioactive sealed sources in air or in water, as applicable for the irradiator type, are covered by this chapter.

001.03 EXCEPTIONS. This chapter does not apply to self-contained dry-source-storage irradiators, those in which both the source and the area subject to irradiation are contained within a device and are not accessible by personnel, medical radiology or teletherapy, radiography, the irradiation of materials for nondestructive testing purposes, gauging, or open-field, agricultural irradiations.

001.04 CONCRETE STANDARD. American Concrete Institute Standard ACI 318-89 "Building Code Requirements for Reinforced Concrete," Chapter 21 "Special Provisions for Seismic Design" as referred to in this Chapter is incorporated by reference and available for viewing at the Nebraska Department of Health and Human Services, Office of Radiological Health, 301 Centennial Mall South, Lincoln, Nebraska 68509-5026.

002. DEFINITIONS. The following definitions apply:

002.01 ANNUALLY. Annually is either:

- (A) At intervals not to exceed one year; or
- (B) Once per year, at about the same time each year, plus or minus one month.

002.02 CONSTRUCTION. The construction of any portion of a permanent irradiator structure on a site. Construction does not include engineering and design work, site purchase, site surveys or soil testing, site preparation, site evacuation, construction of warehouse or auxiliary structures, and other similar tasks.

002.03 DOUBLY ENCAPSULATED SEALED SOURCE. A sealed source where the radioactive material is sealed within a capsule and that capsule is sealed within another capsule.

002.04 IRRADIATOR. A facility that uses radioactive sealed sources for irradiation of objects or materials and where radiation dose rates exceeding 5 grays (500 rads) per hour exist at 1 meter from sealed radioactive sources in air or water, as applicable for the irradiator type. The term does not include irradiators where both the sealed source and area subject to irradiation are contained within a device and not accessible to personnel.

002.05 IRRADIATOR OPERATOR. An individual who has successfully completed the training and testing described in 180 NAC 19-018 and is authorized by the terms of the license to operate the irradiator without a supervisor present.

002.06 PANORAMIC DRY-SOURCE-STORAGE IRRADIATOR. An irradiator where irradiations occur in air in areas potentially accessible to personnel and where sources are stored in shields made of solid materials. The term includes beam-type dry-source-storage irradiators where only a narrow beam of radiation is produced for performing irradiations.

002.07 PANORAMIC IRRADIATOR. An irradiator where the irradiations are done in air in areas potentially accessible to personnel. The term includes beam-type irradiators.

002.08 PANORAMIC WET-SOURCE STORAGE IRRADIATOR. An irradiator where irradiations occur in air in areas potentially accessible to personnel and where sources are stored under water in a storage pool.

002.09 POOL IRRADIATOR. Any irradiator where sources are stored or used in a pool of water including panoramic wet-source-storage irradiators and underwater irradiators.

002.10 PRODUCT CONVEYOR SYSTEM. A system for moving the product to be irradiated to, from, and within the area where irradiation takes place.

002.11 RADIATION ROOM. A shielded room where irradiations take place. Underwater irradiators do not have radiation rooms.

002.12 RADIATION SAFETY OFFICER. An individual with responsibility for the overall radiation safety program at the facility.

002.13 SEALED SOURCE. Any radioactive material used as a source of radiation and encased in a capsule designed to prevent leakage or escape of radioactive material.

002.14 SEISMIC AREA. Any area where the probability of a horizontal acceleration in rock of more than 0.3 times the acceleration of gravity in 250 years is greater than 10%, as designated by the U.S. Geological Survey.

002.15 UNDERWATER IRRADIATOR. An irradiator where the sources always remain shielded under water and humans do not have access to the sealed sources or the space subject to irradiation without entering the pool.

003. SPECIFIC LICENSE APPLICATION. Each application for a license, must be accompanied by the fee set in 180 NAC 18-005.

004. SPECIFIC LICENSES FOR IRRADIATORS. The applicant must satisfy the general requirements specified in 180 NAC 3-011, (A) through (D) and the requirements contained in this chapter.

004.01 TRAINING. The application must describe the training provided to irradiator operators including:

- (A) Classroom training;
- (B) On-the-job or simulator training;
- (C) Safety reviews;
- (D) Means employed by the applicant to test each operator's understanding of the Department's regulations and licensing requirements and irradiator operating and emergency procedures; and
- (E) Minimum training and experience of personnel who may provide training.

004.02 OPERATING AND EMERGENCY PROCEDURES. The application must include an outline of the written operating and emergency procedures listed in 180 NAC 19-019 that describes the radiation safety aspects of the procedures.

004.03 ORGANIZATIONAL STRUCTURE. The application must:

- (A) Describe the organizational structure for managing the irradiator, specifically, the radiation safety responsibilities and authorities of the radiation safety officer and those management personnel who have important radiation safety responsibilities or authorities;
- (B) Specify who, within the management structure, has authority to stop unsafe operations; and
- (C) Describe training and experience required for the position of radiation safety officer.

004.04 ACCESS CONTROL SYSTEMS. The application must include a description of the access control systems required by 180 NAC 19-008, radiation monitors required by 180 NAC 19-011, method of detecting leaking sources required by 180 NAC 19-022 including the sensitivity of the method, and a diagram of the facility showing the locations of all required interlocks and radiation monitors.

004.05 LEAK TEST PROCEDURES. If the applicant intends to perform leak testing of dry-source-storage sealed sources, the applicant must establish procedures for leak testing and submit a description of these procedures. The description must include the:

- (A) Instruments to be used;

- (B) Methods of performing the analysis; and
- (C) Pertinent experience of the individual who analyzes the samples.

004.06 LOADING AND UNLOADING. If licensee personnel are to load or unload sources, the applicant must describe the qualifications and training of the personnel and the procedures to be used. If the applicant intends to contract for source loading or unloading of its facility, loading or unloading must be done by an organization specifically authorized by the Department, U.S. Nuclear Regulatory Commission (NRC) or an Agreement State to load or unload irradiator sources.

004.07 INSPECTION AND MAINTENANCE CHECKING. The applicant must describe the inspection and maintenance checks including the frequency of the checks required by 180 NAC 19-023.

005. START OF CONSTRUCTION. The applicant may not begin construction of a new irradiator before the submission of both a license application for the irradiator and the fee required by 180 NAC 18-005 to the Department. Any activities undertaken before the issuance of a license are entirely at the risk of the applicant and have no bearing on the issuance of license with respect to any statutory requirements or rules, regulations, and orders issued under of the Nebraska Radiation Control Act, as amended.

006. EXEMPTION APPLICATION. In addition to the exemption in 180 NAC 1-003.01, any application for a license or license amendment authorizing use of teletherapy-type unit for irradiation of materials or objects may include proposed alternatives for the requirements of this chapter. The applicant must provide adequate rationale for the proposed alternatives and demonstrate they are likely to provide an adequate level of safety for workers and the public.

007. PERFORMANCE CRITERIA FOR SEALED SOURCES.

007.01 INSTALLATION DATE. Sealed sources installed after October 30, 1996 must:

- (A) Have a certificate of registration issued under the U. S. Nuclear Regulatory Commission (NRC) or an Agreement State for evaluation of radiation safety information about its product.
- (B) Be doubly encapsulated;
- (C) Use radioactive material that is as nondispersible as practical and as insoluble as practical if the source is used in a wet-source-storage or wet-source-change irradiator;
- (D) Be encapsulated in a material resistant to general corrosion and to localized corrosion, such as 316L stainless steel or other material with equivalent resistance if sources are for use in irradiator pools; and
- (E) Have been leak tested and found leak-free after each test described in 180 NAC 19-007.02 through 19-007.07 in prototype testing of the sealed source.

007.02 TEMPERATURE. The test source must be held at -40° celsius for 20 minutes, 600° celsius for one hour, and then be subjected to a thermal shock test with a temperature drop from 600° celsius to 20° celsius within 15 seconds.

007.03 PRESSURE. The test source must be twice subjected for at least five minutes to an external absolute pressure of two million newtons per square meter.

007.04 IMPACT. A 2-kilogram steel weight, 2.5 centimeters in diameter, must be dropped from a height of 1 meter onto the test source.

007.05 VIBRATION. The test source must be subjected three times for ten minutes each to vibrations sweeping from 25 hertz to 500 hertz with a peak amplitude of five times the acceleration of gravity. In addition, each test source must be vibrated for 30 minutes at each resonant frequency found.

007.06 PUNCTURE. A 50-gram weight and pin, 0.3-centimeter pin diameter, must be dropped from a height of one meter onto the test source.

007.07 BEND. If the length of the source is more than 15 times larger than the minimum cross-sectional dimension, the test source must be subjected to a force of two thousand newtons at its center equidistant from two support cylinders, the distance between which is ten times the minimum cross-sectional dimension of the source.

008. ACCESS CONTROL.

008.01 PHYSICAL BARRIER. Each entrance to a radiation room at a panoramic irradiator must have a door or other physical barrier to prevent inadvertent entry of personnel if the sources are not in the shielded position. Product conveyor systems may serve as barriers as long as they reliably and consistently function as a barrier. It must not be possible to move the sources out of their shielded position if the door or barrier is open. Opening the door or barrier while the sources are exposed must cause the sources to return promptly to their shielded position. The personnel entrance door or barrier must have a lock that is operated by the same key used to move the sources. The doors and barriers must not prevent any individual in the radiation room from leaving.

008.02 BACKUP ACCESS CONTROL. In addition, each entrance to a radiation room at a panoramic irradiator must have an independent backup access control to detect personnel entry while the sources are exposed. Detection of entry while the sources are exposed must cause the sources to return to their fully shielded position and activate a visible and audible alarm to make the individual entering the room aware of the hazard. The alarm must also alert at least one other individual who is onsite of the entry. That individual must be trained on how to respond to the alarm and prepared to promptly render or summon assistance.

008.03 RADIATION MONITOR. A radiation monitor must be provided to detect the presence of high radiation levels in the radiation room of a panoramic irradiator before personnel entry. The monitor must be integrated with personnel access door locks to prevent room access when radiation levels are high. Attempted personnel entry while the monitor measures high radiation levels must activate the alarm described in 180 NAC 19-008.02. The monitor may be located in the entrance, normally referred to as the maze, but not in the direct radiation beam.

008.04 ALARM. Before the sources move from their shielded position in a panoramic irradiator, the source control must automatically activate conspicuous visible and audible alarms to alert people in the radiation room the sources will be moved from their shielded position. The alarms must give individuals enough time to leave the room before the sources leave the shielded position.

008.05 IN-ROOM SOURCE CONTROL. Each radiation room at a panoramic irradiator must have a clearly visible and readily accessible control that would allow an individual in the room to make the sources return to their fully shielded position.

008.06 SOURCE MOVEMENT CONTROL. Each radiation room of a panoramic irradiator must contain a control that prevents the sources from moving from the shielded position unless the control has been activated and the door or barrier to the radiation room has been closed within a preset time after activation of the control.

008.07 SIGNAGE. Each entrance to the radiation room of a panoramic irradiator and each entrance to the area within the personnel access barrier of an underwater irradiator must be posted as required by 180 NAC 4-034.05. Panoramic irradiators must comply with the posting requirements of 180 NAC 4-034.03; however, the sign may be removed, covered, or otherwise made inoperative when the sources are fully shielded.

008.08 INTERLOCKS. If the radiation room of a panoramic irradiator has roof plugs or other movable shielding, it must not be possible to operate the irradiator unless the shielding is in its proper location. This requirement may be met by interlocks that prevent operation if shielding is not placed properly or by an operating procedure requiring inspection of shielding before operating.

008.09 PERSONNEL ACCESS BARRIER. Underwater irradiators must have a personnel access barrier around the pool which must be locked to prevent access when the irradiator is not attended. Only operators and facility management may have access to keys to the personnel access barrier. There must be an intrusion alarm to detect unauthorized entry when the personnel access barrier is locked. Activation of the intrusion alarm must alert an individual, not necessarily onsite, who is prepared to respond or summon assistance.

009. SHIELDING.

009.01 OCCUPIED AREAS. The radiation dose rate in areas normally occupied during operation of a panoramic irradiator may not exceed 0.02 millisievert (2 millirems) per hour at any location 30 centimeters or more from the wall of the room when the sources are exposed. The dose rate must be averaged over any area not to exceed 100 square centimeters having no linear dimension greater than 20 centimeters. Areas where the radiation dose rate exceeds 0.02 millisievert (2 millirems) per hour must be locked, roped off, or posted.

009.02 POOL DOSE RATE. The radiation dose at 30 centimeters over the edge of the pool of a pool irradiator may not exceed 0.02 millisievert (2 millirems) per hour when the sources are in the fully shielded position.

009.03 DRY-SOURCE SHIELD. The radiation dose rate at 1 meter from the shield of a dry-source storage panoramic irradiator when the source is shielded may not exceed 0.02 millisievert (2 millirems) per hour and at 5 centimeters from the shield may not exceed 0.2 millisievert (20 millirems) per hour.

010. FIRE PROTECTION. The radiation room at a panoramic irradiator must have heat and smoke detectors and be equipped with a fire extinguishing system.

010.01 HEAT AND SMOKE DETECTORS. The detectors must activate an audible alarm capable of alerting a person who is prepared to summon assistance promptly. The sources must automatically become fully shielded if a fire is detected.

010.02 FIRE EXTINGUISHING SYSTEM. The system must be capable of extinguishing a fire without the entry of personnel into the room and have a shut-off valve to control flooding into unrestricted areas.

011. RADIATION MONITORS.

011.01 PRODUCT EXIT. Irradiators with automatic product conveyor systems must have a radiation monitor with an audible alarm located to detect loose radioactive sources carried toward the product exit. If the monitor detects a source, an alarm must sound and product conveyors must stop automatically. The alarm must be capable of alerting an individual in the facility who is prepared to summon assistance. Underwater irradiators where the product moves within an enclosed stationary tube are exempt from the requirements of 180 NAC 19-011.01.

011.02 POOL. Underwater irradiators not in a shielded radiation room must have a radiation monitor over the pool to detect abnormal radiation levels. The monitor must have an audible alarm and a visible indicator at entrances to the personnel access barrier around the pool. The audible alarm may have a manual shut-off. The alarm must be capable of alerting an individual who is prepared to respond promptly.

012. CONTROL OF SOURCE MOVEMENT.

012.01 KEY. The mechanism that moves the sources of a panoramic irradiator must require a key to actuate. Actuation of the mechanism must cause an audible signal to indicate the sources are leaving the shielded position. Only one key may be in use at any time, and only operators or facility management may possess it. The key must be attached to a portable radiation survey meter by a chain or cable. The lock for source control must be designed so the key may not be removed if the sources are in an unshielded position. The door to the radiation room must require the same key.

012.02 POSITION DETECTOR. The console of a panoramic irradiator must have a source position indicator that indicates when the sources are in the fully shielded position, in transit, and exposed.

012.03 CONTROL CONSOLE. The control console of a panoramic irradiator must have a control that promptly returns the sources to the shielded position.

012.04 CONTROL MARKING. Each control for a panoramic irradiator must be clearly marked as to its function.

013. IRRADIATOR POOLS.

013.01 SPECIFICATIONS. For licenses initially issued after October 30, 1996, irradiator pools must either:

- (A) Have a water-tight stainless steel liner or a liner metallurgically compatible with other components in the pools; or
- (B) Be constructed so there is a low likelihood of substantial leakage and have a surface designed to facilitate decontamination. In either case, the licensee must have a method to safely store the sources during repairs of the pool.

013.02 WATER OUTLETS. For licenses initially issued after October 30, 1996, irradiator pools must have no outlets more than 0.5 meter below the normal low water level that could allow water to drain out of the pool. Pipes with intakes more than 0.5 meter below the normal low water level and could act as siphons must have siphon breakers to prevent the siphoning of pool water.

013.03 REPLENISHMENT. A means must be provided to replenish water losses from the pool.

013.04 VISIBLE INDICATOR. A visible indicator must be provided in a clearly visible location to indicate if the pool water level is below the normal low water level or above the normal high water level.

013.05 WATER PURITY. Irradiator pools must be equipped with a purification system designed to be capable of maintaining the water during normal operation at a conductivity of 20 microsiemens (ohms) per centimeter or less and with a clarity so the sources can be seen clearly.

013.06 PHYSICAL BARRIER. A physical barrier, such as a railing or cover, must be used around or over irradiator pools during normal operation to prevent personnel from accidentally falling into the pool. The barrier may be removed during maintenance, inspection, and service operations.

013.07 TOOLS. If long-handled tools or poles are used in irradiator pools, the radiation dose rate on the handling areas of the tools may not exceed 0.02 millisievert (2 millirems) per hour.

014. SOURCE RACK PROTECTION. If the product to be irradiated moves on a product conveyor system, the source rack and mechanism that moves the rack must be protected by a barrier or guides to prevent products and product carriers from hitting or touching the rack or mechanism.

015. POWER FAILURES. Systems must function properly in the event of a power failure.

015.01 POWER LOSS. If electrical power at a panoramic irradiator is lost for longer than ten seconds, the sources must automatically return to the shielded position.

015.02 LOCK. The lock on the door of the radiation room of a panoramic irradiator may not be deactivated by a power failure.

015.03 SURVEY METER. During a power failure, the area of any irradiator where sources are located may be entered only when using an operable and calibrated radiation survey meter.

016. DESIGN REQUIREMENTS. Irradiators whose construction begins after October 30, 1996, must meet the design requirements of this section.

016.01 SHIELDING. For panoramic irradiators, the licensee must design shielding walls to meet generally accepted building code requirements for reinforced concrete and design the walls, wall penetrations, and entranceways to meet the radiation shielding requirements of 180 NAC 19-009. If the irradiator will use more than 2×10^{17} becquerels (5 million curies) of activity, the licensee must evaluate the effects of heating of the shielding walls by the irradiator sources.

016.02 FOUNDATIONS. For panoramic irradiators, the licensee must design the foundation, with consideration given to soil characteristics, to ensure it is adequate to support the weight of the facility shield walls.

16.03 POOL INTEGRITY. For pool irradiators, the licensee must design the pool to assure it is leak resistant, strong enough to bear the weight of the pool water and shipping casks, a dropped cask would not fall on sealed sources, all outlets or pipes meet the requirements of 180 NAC 19-013.02, and metal components are metallurgically compatible with other components in the pool.

016.04 WATER HANDLING SYSTEM. For pool irradiators, the licensee must verify the design of the water purification system is adequate to meet the requirements of 180 NAC 19-013.05. The system must be designed so water leaking from the system does not drain to unrestricted areas without being monitored.

016.05 RADIATION MONITORS. For all irradiators, the licensee must evaluate the location and sensitivity of the monitor to detect sources carried by the product conveyor system as required by 180 NAC 19-011.01. The licensee must verify the product conveyor is designed to stop before a source on the product conveyor would cause a radiation overexposure to any person. For pool irradiators, if the licensee uses radiation monitors to detect contamination under 180 NAC 19-022.02, the licensee must verify the design of radiation monitoring systems to detect pool contamination includes sensitive detectors located close to where contamination is likely to concentrate.

016.06 SOURCE RACK. For pool irradiators, the licensee must verify there are no crevices on the source or between the source and source holder that would promote corrosion on a critical area of the source. For panoramic irradiators, the licensee must determine source rack drops due to loss of power will not damage the source rack and source rack drops due to failure of cables, or alternate means of support, will not cause loss of integrity of sealed sources. For panoramic irradiators, the licensee, must review the design of the mechanism

that moves the sources to assure the likelihood of a stuck source is low and that, if the rack sticks, a means exists to free it with minimal risk to personnel.

016.07 ACCESS CONTROL. For panoramic irradiators, the licensee must verify from the design and logic diagram that the access control system will meet the requirements of 180 NAC 19-008.

016.08 FIRE PROTECTION. For panoramic irradiators, the licensee must verify the number, location, and spacing of the smoke and heat detectors are appropriate to detect fires and the detectors are protected from mechanical and radiation damage. The licensee must verify the design of the fire extinguishing system provides the necessary discharge patterns, densities, and flow characteristics for complete coverage of the radiation room and the system is protected from mechanical and radiation damage.

016.09 SOURCE RETURN. For panoramic irradiators, the licensee must verify the source rack will automatically return to the fully shielded position if offsite power is lost for more than 10 seconds.

016.10 SEISMIC. For panoramic irradiators to be built in seismic areas, the licensee must design the reinforced concrete radiation shields to retain their integrity in the event of an earthquake by designing to the seismic requirements of an appropriate source such as American Concrete Institute Standard ACI 318-89, "Building Code Requirements for Reinforced Concrete," Chapter 21, "Special Provisions for Seismic Design," or local building codes, if current.

016.11 WIRING. For panoramic irradiators, the licensee must verify electrical wiring and electrical equipment in the radiation room are selected to minimize failures due to prolonged exposure to radiation.

017. CONSTRUCTION MONITORING AND ACCEPTANCE TESTING. The requirements of this section must be met for irradiators whose construction begins after October 30, 1996. The requirements must be met before loading sources.

017.01 SHIELDING. For panoramic irradiators, the licensee must monitor the construction of the shielding to verify the construction meets design specifications and generally accepted building code requirement for reinforced concrete.

017.02 FOUNDATIONS. For panoramic irradiators, the licensee must monitor the construction of the foundations to verify their construction meets design specifications.

017.03 POOL INTEGRITY. For pool irradiators, the licensee must verify the pool meets design specifications and must test the integrity of the pool. The licensee must verify outlets and pipes meet the requirements of 180 NAC 19-013.02.

017.04 WATER HANDLING SYSTEM. For pool irradiators, the licensee must verify the water purification system, conductivity meter, and water level indicators operate properly.

017.05 RADIATION MONITORS. For all irradiators, the licensee must verify the proper operation of the monitor to detect sources carried on the product conveyor system and the related alarms and interlocks required by 180 NAC 19-011.01. For pool irradiators, the licensee must verify the proper operation of the radiation monitors and the related alarm if used to meet 19-022.02. For underwater irradiators, the licensee must verify the proper operation of the over-the-pool monitors, alarms, and interlocks required by 19-011.02.

017.06 SOURCE RACK. For panoramic irradiators, the licensee must test the movement of the source racks for proper operation before source loading; testing must include source rack lowering due to simulated loss of power. For all irradiators with product conveyor systems, the licensee must observe and test the operation of the conveyor system to assure the requirements in 180 NAC 19-014 are met for protection of the source rack and the mechanism that moves the rack; testing must include tests of any limit switches and interlocks used to protect the source rack and mechanism that moves the rack from moving product carriers.

017.07 ACCESS CONTROL. For panoramic irradiators, the licensee must test the completed access control system to assure it functions as designed and all alarms, controls, and interlocks work properly.

017.08 FIRE PROTECTION. For panoramic irradiators, the licensee must test the ability of the heat and smoke detectors to detect a fire, to activate alarms, and to cause the source rack to automatically become fully shielded. The licensee must test the operability of the fire extinguishing systems.

017.09 SOURCE RETURN. For panoramic irradiators, the licensee must demonstrate the source racks can be returned to their fully shielded positions without offsite power.

017.10 COMPUTER SYSTEMS. For panoramic irradiators that use a computer system to control the access control system, the licensee must verify the access control system will operate properly if offsite power is lost and must verify the computer has security features that prevent an irradiator operator from commanding the computer to override the access control system when it is required to be operable.

017.11 WIRING. For panoramic irradiators, the licensee must verify the electrical wiring and electrical equipment that were installed meet the design specifications.

018. TRAINING.

018.01 INSTRUCTION AND TRAINING. Before an individual is permitted to operate an irradiator without a supervisor present, the individual must:

- (A) Receive instruction in:
 - (i) Fundamentals of radiation protection applied to irradiators including the differences between external radiation and radioactive contamination, units of radiation dose, Department dose limits, why large radiation doses must be avoided, how shielding and access controls prevent large doses, how a irradiator is designed to prevent contamination, the proper use of survey meters and personnel dosimeters, other radiation safety features of an irradiator, and the basic function of the irradiator;

- (ii) Requirements of 180 NAC 10 and this chapter that are relevant to the irradiator;
- (iii) Operation of the irradiator;
- (iv) Those operating and emergency procedures listed in 180 NAC 19-019 that the individual is responsible for performing; and
- (v) Case histories of accidents or problems involving irradiators;
- (B) Pass a written test on the instruction received consisting primarily of questions based on the licensee's operating and emergency procedures that the individual is responsible for performing and other operations necessary to safely operate the irradiator without supervision;
- (C) Have received on-the-job training or simulator training in the use of the irradiator as described in the license application; and
- (D) Demonstrate the ability to perform those portions of the operating and emergency procedures the individual is to perform.

018.02 SAFETY REVIEW. The licensee must conduct safety reviews for irradiator operators at least annually. The licensee must give each operator a brief written test on the information. Each safety review must include, to the extent appropriate, each of the following:

- (A) Changes in operating and emergency procedures since the last review, if any;
- (B) Changes in regulations and license conditions since the last review, if any;
- (C) Reports on recent accidents, mistakes, or problems that have occurred at irradiators, if any;
- (D) Relevant results of inspections of operator safety performance;
- (E) Relevant results of the facility's inspection and maintenance checks; and
- (F) A drill to practice an emergency or abnormal event procedure.

018.03 SAFETY PERFORMANCE. The licensee must evaluate the safety performance of each irradiator operator at least annually to ensure regulations, license conditions, and operating and emergency procedures are followed. The licensee must discuss the results of the evaluation with the operator and must instruct the operator on how to correct any mistakes or deficiencies observed.

018.04 UNESCORTED ACCESS. Individuals that will be permitted unescorted access to the radiation room of the irradiator or the area around the pool of an underwater irradiator, but who have not received the training required for operators and the radiation safety officer, must be instructed and tested in any precautions they should take to avoid radiation exposure, any procedures or parts of procedures listed in 180 NAC 19-019 that they are expected to perform or comply with, and their proper response to alarms required in this chapter. Tests may be oral.

018.05 ALARM RESPONSE. Individuals who must be prepared to respond to alarms required by 180 NAC 19-008.02, 19-008.09, 19-010.01, 19-011.01, 19-011.02 and 19-022.02 must be trained and tested on how to respond. Each individual must be retested at least once a year. Tests may be oral.

019. OPERATING AND EMERGENCY PROCEDURES.

019.01 OPERATING PROCEDURES. The licensee must have and follow written operating procedures for:

- (A) Irradiator operation, including entering and leaving the radiation room;
- (B) Personnel dosimeter use;
- (C) Surveying the shielding of panoramic irradiators;
- (D) Monitoring pool water for contamination while the water is in the pool and before release of pool water to unrestricted areas;
- (E) Leak testing of sources;
- (F) Inspection and maintenance checks required by 180 NAC 19-023;
- (G) Loading, unloading, and repositioning sources, if the operations will be performed by the licensee; and
- (H) Inspection of movable shielding required by 180 NAC 19-008.08, if applicable.

019.02 EMERGENCY PROCEDURES. The licensee must have and follow emergency or abnormal event procedures, appropriate for the irradiator type, for:

- (A) Sources stuck in the unshielded position;
- (B) Personnel overexposures;
- (C) A radiation alarm from the product exit portal monitor or pool monitor;
- (D) Detection of leaking sources, pool contamination, or alarm caused by contamination of pool water;
- (E) A low or high water level indicator, an abnormal water loss, or leakage from the source storage pool;
- (F) Prolonged loss of electrical power;
- (G) A fire alarm or explosion in the radiation room;
- (H) An alarm indicating unauthorized entry into the radiation room, area around pool, or another alarmed area;
- (I) Natural phenomena, including an earthquake, a tornado, flooding, or other phenomena as appropriate for the geographical location of the facility; and
- (J) Automatic conveyor system jams.

019.03 REVISIONS. The licensee may revise operating and emergency procedures without Department approval only if all of the following conditions are met:

- (A) Revisions do not reduce the safety of the facility;
- (B) Revisions are consistent with the outline or summary of procedures submitted with the license application;
- (C) Revisions have been reviewed and approved by the radiation safety officer; and
- (D) Users or operators are instructed and tested on the revised procedures before they are put into use.

020. PERSONNEL MONITORING.

020.01 IRRADIATOR OPERATORS. Irradiator operators must wear a personnel dosimeter while operating a panoramic irradiator or while in the area around the pool of an underwater irradiator. The personnel dosimeter must be capable of detecting high energy photons in the normal and accident dose ranges. Each personnel dosimeter must be assigned to and worn by only one individual. Film badges must be processed at least monthly and all other personnel dosimeters that require replacement must be replaced at least quarterly. All personnel dosimeters must be evaluated at least quarterly or promptly after replacement, whichever is more frequent.

020.02 OTHER INDIVIDUALS. Other individuals who enter the radiation room of a panoramic irradiator must wear a dosimeter, which may be a pocket dosimeter. For groups of visitors, only two people who enter the radiation room are required to wear dosimeters. If pocket dosimeters are used to meet the requirements of 180 NAC 9-020, a check of their response to radiation must be done at least annually. Acceptable dosimeters must read within $\pm 30\%$ of the true radiation dose.

021. RADIATION SURVEYS.

021.01 OUTSIDE OF SHIELDING. A radiation survey of the area outside the shielding of the radiation room of a panoramic irradiator must be conducted with the sources in the exposed position before the facility starts to operate. A radiation survey of the area above the pool of pool irradiators must be conducted after the sources are loaded but before the facility starts to operate. Additional radiation surveys of the shielding must be performed at intervals not to exceed three years and before resuming operation after addition of new sources or any modifications to the radiation room shielding or structure that might increase dose rates.

021.02 MODIFICATIONS. If the radiation levels specified in 180 NAC 19-009 are exceeded, the facility must be modified to comply with the requirements in this chapter.

021.03 CALIBRATION. Portable radiation survey meters must be calibrated at least annually to an accuracy of $\pm 20\%$ for the gamma energy of the sources in use. The calibration must be done at two points on each scale or, for digital instruments, at one point per decade over the range that will be used. Portable radiation survey meters must be of a type that does not saturate and read zero at high radiation dose rates.

021.04 WATER. Water from the irradiator pool, other potentially contaminated liquids, and sediments from pool vacuuming must be monitored for radioactive contamination before release to unrestricted areas. Radioactive concentrations must not exceed those specified in 180 NAC 4, Table 2, Column 2 or Table 3 of Appendix 4-B, "Annual Limits on Intake (ALIs) and Derived Air Concentrations (DACs) of Radionuclides for Occupational Exposure; Effluent Concentrations; Concentrations for Release to Sewerage."

021.05 RESINS. Before releasing resins for unrestricted use, they must be monitored before release in an area with a background level less than 0.5 microsievert (0.05 millirem) per hour. The resins may be released only if the survey does not detect radiation levels above background radiation levels. The survey meter used must be capable of detecting radiation levels of 0.5 microsievert (0.05 millirem) per hour.

022. DETECTION OF LEAKING SOURCES.

022.01 DRY-SOURCE STORAGE. Each dry-source-storage sealed source must be tested for leakage at intervals not to exceed six months using a leak test kit or method approved by the Department, NRC or an Agreement State. In the absence of a certificate from a transferor that a test has been made within the six months before the transfer, the sealed source may not be used until tested. The test must be capable of detecting the presence of 200 becquerels (0.005 microcurie) of radioactive material and must be performed by a person approved by the Department, NRC or an Agreement State to perform the test.

022.02 POOL IRRADIATORS. For pool irradiators, sources may not be put into the pool unless the licensee tests the sources for leaks or has a certificate from a transferor that a leak test has been done within the six months before the transfer. Water from the pool must be checked for contamination each day the irradiator operates. The check may be done either by using a radiation monitor on a pool water circulating system or by analysis of a sample of pool water. If a contamination check is done by analysis of a sample of pool water, the results of the analysis must be available within 24 hours. If the licensee uses a radiation monitor on a pool water circulating system, the detection of above normal radiation levels must activate an alarm. The alarm set-point must be set as low as practical, but high enough to avoid false alarms. The licensee may reset the alarm set-point to a higher level if necessary to operate the pool water purification system to clean up contamination in the pool if specifically provided for in written emergency procedures.

022.03 LEAKING SOURCE. If a leaking source is detected, the licensee must arrange to remove the leaking source from service and have it decontaminated, repaired, or disposed of by the Department, NRC or an Agreement State licensee authorized to perform these functions. The licensee must promptly check its personnel, equipment, facilities, and irradiated product for radioactive contamination. No product may be shipped until the product has been checked and found free of contamination. If a product has been shipped that may have been inadvertently contaminated, the licensee must arrange to locate and survey that product for contamination. If any personnel are found to be contaminated, decontamination must be performed promptly. If contaminated equipment, facilities, or product are found, the licensee must arrange to have them decontaminated or disposed of by the Department, NRC or an Agreement State licensee authorized to perform these functions. If a pool is contaminated, the licensee must arrange to clean the pool until the contamination levels do not exceed the appropriate concentration in 180 NAC 4, Table 2, Column 2. Appendix 4-B. See 180 NAC 3-026 for reporting requirements.

023. INSPECTION AND MAINTENANCE. Licensees must perform inspection and maintenance checks of the irradiator and components. Malfunctions and defects found must be repaired promptly.

023.01 CHECKS. Inspection and maintenance checks must include, as a minimum, each of the following at the frequency specified in the license or license application:

- (A) Operability of each aspect of the access control system required by 180 NAC 19-008.
- (B) Functioning of the source position indicator required by 180 NAC 19-012.02.
- (C) Operability of the radiation monitor for radioactive contamination in pool water required by 180 NAC 19-022.02 using a radiation check source, if applicable.
- (D) Operability of the over-pool radiation monitor at underwater irradiators as required by 180 NAC 19-011.02.
- (E) Operability of the product exit monitor required by 180 NAC 19-011.01.
- (F) Operability of the emergency source return control required by 180 NAC 19-012.03.
- (G) Leak-tightness of systems through which pool water circulates by visual inspection.
- (H) Operability of the heat and smoke detectors and extinguisher system required by 180 NAC 19-010, but without turning extinguishers on.
- (I) Operability of the means of pool water replenishment required by 180 NAC 19-013.03.

- (J) Operability of the indicators of high and low pool water levels required by 180 NAC 19-013.04.
- (K) Operability of the intrusion alarm required by 180 NAC 19-008.09, if applicable.
- (L) Functioning and wear of the systems, mechanisms, and cables used to raise and lower sources.
- (M) Condition of the barrier to prevent products from hitting the sources or source mechanism as required by 180 NAC 19-014.
- (N) Amount of water added to the pool to determine if the pool is leaking.
- (O) Electrical wiring on required safety systems for radiation damage.
- (P) Pool water conductivity measurements and analysis as required by 180 NAC 19-024.02.

024. POOL WATER PURITY.

024.01 PURIFICATION SYSTEM. Pool water purification system must be run sufficiently to maintain the conductivity of the pool water below 20 microsiemens per centimeter under normal circumstances. If pool water conductivity rises above 20 microsiemens per centimeter, the licensee must take prompt actions to lower the pool water conductivity and must take corrective actions to prevent future recurrences.

024.02 CONDUCTIVITY. The licensee must measure the pool water conductivity frequently enough, but no less than weekly, to assure that the conductivity remains below 20 microsiemens per centimeter. Conductivity meters must be calibrated at least annually.

025. ATTENDANCE DURING OPERATION. Irradiators must be attended during operation.

025.01 PRODUCT MOVEMENT. Both an irradiator operator and at least one other individual, who is trained on how to respond and prepared to promptly render or summon assistance if the access control alarm sounds, must be present onsite whenever:

- (A) The irradiator is operated using an automatic product conveyor system; and
- (B) The product is moved into or out of the radiation room when the irradiator is operated in a batch mode.

025.02 STATIC IRRADIATIONS. At a panoramic irradiator at which static irradiations involving no movement of the product are occurring, a person who has received the training on how to respond to alarms described in 180 NAC 19-018.07 must be onsite.

025.03 UNDERWATER IRRADIATOR. At an underwater irradiator, an irradiator operator must be present at the facility whenever the product is moved into or out of the pool. Individuals who move the product into or out of the pool of an underwater irradiator need not be qualified as irradiator operators; however, they must have received the training described in 180 NAC 19-018.04 and 19-018.05. Static irradiations may be performed without a person present at the facility.

026. ENTERING AND LEAVING THE IRRADIATOR ROOM.

026.01 ENTERING. Upon first entering the radiation room of a panoramic irradiator after an irradiation, the irradiator operator must use a survey meter to determine that the source has

returned to its fully shielded position. The operator must check the functioning of the survey meter with a radiation check source before entry.

026.02 EXITING. Before exiting from and locking the door to the radiation room of a panoramic irradiator before a planned irradiation, the irradiator operator must:

- (A) Visually inspect the entire radiation room to verify no one else is in it; and
- (B) Activate a control in the radiation room that permits the sources to be moved from the shielded position only if the door to the radiation room is locked within a preset time after setting the control.

026.03 ENTERING DURING POWER FAILURE. During a power failure, the area around the pool of an underwater irradiator may not be entered without using an operable and calibrated radiation survey meter unless the over-the-pool monitor required by 180 NAC 19-011.02 is operating with backup power.

027. IRRADIATION OF EXPLOSIVE OR FLAMMABLE MATERIALS.

027.01 EXPLOSIVE MATERIAL. Irradiation of explosive material is prohibited unless the licensee has received prior written authorization from the Department. Authorization will not be granted unless the licensee can demonstrate detonation of the explosive would not rupture the sealed sources, injure personnel, damage safety systems, or cause radiation overexposures of personnel.

027.02 FLAMMABLE MATERIAL. Irradiation of more than small quantities of flammable material, meaning a flash point below 140° Fahrenheit, is prohibited in panoramic irradiators unless the licensee has received prior written authorization from the Department. Authorization will not be granted unless the licensee can demonstrate that a fire in the radiation room could be controlled without damage to sealed sources or safety systems and without radiation overexposures of personnel.

028. RECORDS AND RETENTION OF RECORDS. The licensee must maintain the following records at the irradiator for the periods specified:

- (A) A copy of the license, license conditions, documents incorporated into a license by reference, and license amendments until superseded by new documents or until the Department terminates the license for documents that have not been superseded;
- (B) Each individual's training, tests, and safety reviews provided to meet the requirements of 180 NAC 19-018.01 through 19-018.02, 19-018.04 and 19-018.05 until three years after the individual terminates work;
- (C) Annual evaluations of the safety performance of irradiator operators required by 180 NAC 19-018.03 for three years after the evaluation;
- (D) A copy of the current operating and emergency procedures required by 180 NAC 19-019 until superseded or the Department terminates the license. Records of the radiation safety officer's review and approval of changes in procedures as required by 19-019.03 (C) retained for three years from the date of the change;
- (E) Personnel dosimeters evaluations required by 180 NAC 19-020 must be retained until the Department terminates the license;

- (F) Radiation surveys required by 180 NAC 19-021 for three years from the date of the survey;
- (G) Radiation survey meter calibrations required by 180 NAC 19-021 and pool water conductivity meter calibrations required by 19-024.02 until three years from the date of calibration;
- (H) Leak test results required by 180 NAC 19-022.01 and contamination check results required by 19-022.02 for three years from the date of each test; checks required by 180 NAC 19-023 for three years.
- (I) Major malfunctions, significant defects, operating difficulties or irregularities, and major operating problems that involve required radiation safety equipment for three years after repairs are completed;
- (J) Receipt, transfer and disposal, of all licensed sealed sources as required by 180 NAC 3-025 and 3-030;
- (K) Design checks required by 180 NAC 19-016 and construction control checks as required by 19-017 until the license is terminated. Records must be signed and dated. The title or qualification of the person signing must be included; and
- (L) Records related to decommissioning of the irradiator as required by 180 NAC 3-018.07.

029. REPORTS.

029.01 EVENTS. In addition to the reporting requirements in other parts of Department regulations, the licensee must report the following events if not reported under other parts of Department regulations:

- (A) Source stuck in an unshielded position.
- (B) Any fire or explosion in a radiation room.
- (C) Damage to the source racks.
- (D) Failure of the cable or drive mechanism used to move the source racks.
- (E) Inoperability of the access control system.
- (F) Detection of radiation source by the product exit monitor.
- (G) Detection of radioactive contamination attributable to licensed radioactive material.
- (H) Structural damage to the pool liner or walls.
- (I) Abnormal water loss or leakage from the source storage pool.
- (J) Pool water conductivity exceeding 100 microsiemens (ohms) per centimeter.

029.02 TELEPHONE REPORT. The report must include a telephone report within 24 hours as described in 180 NAC 3-026.03 (A) and a written report within 30 days as described in 180 NAC 3-026.03 (B).