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Radiation Safety Program	ACA Standards: 2-CO-2A-01		
Scott Crow, Director Oklahoma Department of Corrections			

Radiation Safety Program

The Oklahoma Department of Corrections (ODOC) is dedicated to all components of workplace safety. This written program establishes procedures to safeguard the health of correctional employees, volunteers, visitors, and inmates working around cabinet x-ray systems and to ensure compliance with the applicable federal and state regulations. (2-CO-2A-01)

I. Procedure

This procedure provides guidelines for the implementation of an effective Radiation Safety Program and is designed to reduce the risk of exposure related to the operation of cabinet x-ray systems. This procedure will apply to all affected ODOC facilities.

The facility will ensure that radiation safety procedures and guidelines are followed to ensure the safe operation of all cabinet x-ray systems.

II. Definitions

A. Access Panel

An access panel is any barrier or panel which is designed to be removed or opened for maintenance or service, requires tools to open, and permits access to the interior of the cabinet.

B. Cabinet X-ray System

A cabinet x-ray system is a system with an x-ray tube installed in an enclosure which, independently of existing architectural structures, except the floor on which it may be placed, is intended to contain at least that portion of a material being irradiated, provide radiation attenuation, and exclude personnel from its interior during generation of x-radiation (i.e., Autoclear 6040 System).

C. Door

A door is a barrier, which is designed to be movable or opened for routine operation purposes, does not generally require tools to open, and permits access to the interior of the cabinet.

D. Dose

A dose is the quantity of radiation or energy absorbed. Dose may refer to either of the following:

1. Absorbed Dose – The amount of energy deposited per unit mass.

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2. Equivalent Dose – The absorbed dose adjusted for the relative biological effect of the type of radiation being measured.

E. Emission Limit

The emission limit is the exposure limit of the radiation emitted from the cabinet x-ray system. The x-ray system will not exceed the set emission limit.

F. Exposure

Exposure is a term defining the amount of ionizing radiation that strikes living or inanimate material. The Federal Drug Administration (FDA) definition is found at 21 CFR 1020.40(b)(5).

G. Radiation

Radiation is the process in which energetic particles or waves travel through a medium or space. There are two distinct types of radiation; ionizing and non-ionizing.

H. Röntgen

Röntgen is a unit of exposure indicating the strength of ionizing radiation.

I. Röntgen Absorbed Dose (RAD)

Röntgen Absorbed Dose (RAD) is the basic unit of absorbed radiation dose.

J. Röntgen Equivalent Man (REM)

Röntgen Equivalent Man (REM) is the basic unit of equivalent dose. It relates to the absorbed dose in human tissue to the biological effect of the radiation.

K. Safety Interlock

The safety interlock is a device, which is intended to prevent the generation of x-rays when access by any part of the human body to the interior of the cabinet x-ray system through a door or access panel is possible.

L. X-ray

An x-ray, also called x-radiation or Röntgen radiation, is a form of electromagnetic radiation similar to light, but of shorter wavelength and capable of penetrating solids and of ionizing gases. X-rays have a

wavelength in the range of 0.01 to 10 nanometers and energies in the range 120 eV to 120 keV. The electron volt (eV) is the smallest energy unit.

M. X-ray System

An x-ray system is an assemblage of components for the controlled generation of x-rays.

III. Responsibilities

A. Agency

Staff designated by the administrator of Environmental Health and Safety will serve as the ODOC Radiation Safety Officer (RSO).

1. The RSO will maintain the Radiation Safety Program and coordinate the safe operation of the cabinet x-ray systems in compliance with the applicable regulations.
2. All radiation sourcing equipment must be reviewed for registering with the Oklahoma Department of Environmental Quality (ODEQ). (2-CO-2A-01)

B. Facility

The facility head, through oversight of the RSO, will ensure compliance within the guidelines established in this procedure.

1. The facility head, designated employees, and supervisors will be held accountable for enforcing these established work procedures to those persons whose activities are affected by this procedure.
2. All new x-ray emitting equipment must be reported to the RSO prior to its arrival at the facility to ensure proper permits for installation of the equipment are obtained.
3. Once installed and operational, x-ray cabinets shall not be moved in any way from the permitted location without prior approval from the RSO.
4. X-ray cabinets shall not be relocated or moved in any way by ODOC staff or inmates. Cabinet relocation shall be conducted only by licensed contracted vendors and will be approved and scheduled by the RSO.
5. All affected persons are obligated to comply with the requirements of this procedure and are to immediately report any related safety concerns.

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6. Equipment operators are required to use the cabinet x-ray systems in a responsible manner in accordance with this procedure.
7. Cabinet x-ray systems must be maintained according to the manufacturer's recommendations.

IV. Operation Procedures

System operation procedures supplied by the manufacturer of the equipment are acceptable. This procedure will be maintained within the operator's work area.

A. Equipment Safety Features

Numerous safety features are built into the cabinet x-ray system to ensure employees, volunteers, visitors, and inmates cannot be exposed to excessive radiation, providing the equipment is operated as intended. Safety features include:


1. Lead shielded cabinet and collimated beams are required, assuring minimum to no radiation exposure to the operator.
2. Shielded curtains are to be provided to allow continuous shielding for insertion and removal of items.
3. An "X-Ray On" warning light in order to notify personnel when the system is in operation.
4. Radiation warning labels, caution labels, and notes of interest are provided in the user manual.
5. Auto shut off capability and a lockable control panel are required.
6. Each door of a cabinet x-ray system will have a minimum of two safety interlock devices.
7. One, but not both, of the interlocks will be such that the door opening results in physical disconnection of the energy supply circuit to the high-voltage generator. Such disconnection shall not be dependent upon any moving part other than the door.

B. Failure of Safety Features/Vendor Repair


The above safety features are required to be functioning to operate the system. Should any of these features become inoperable, the operator must shut off the system, and an outside vendor will make repairs as necessary. Facility staff or inmates will not attempt repairs on such equipment.

V. Warning Signs

The facility must post radiation exposure warning signs on or near any switch that turns on the x-ray equipment and in each area or room containing an x-ray system. The signs may state:

 "WARNING!
CAUTION RADIATION AREA"

 "WARNING!
DANGER RADIATION AREA"

 "WARNING!
NEVER PLACE ANY PART OF THE
BODY INTO X-RAY TUNNEL WHEN
X-RAY IS ON"

VI. Calibration Requirements

Calibration of the x-ray system instruments will be performed using federal standards under 21 CFR 1020.4. The equipment will be calibrated at energy levels and over a range appropriate for use.

A. Generator

The generator must be seasoned according to the Autoclear Operator and Maintenance Manual and within the following requirements:

1. If the unit has not been operated for 30 days or more;
2. If staff are unsure when the system was last operated; or
3. If the generator is new.

B. Calibrations

1. Calibrations will be performed during the annual survey and/or after servicing.
2. The maximum allowable exposure reading is 0.5mr/hr at 5cm (2in.) from the external surface of the cabinet.
3. Instrument calibration records will be kept on file with the RSO during the lifetime of the x-ray cabinet.

VII. Annual Radiation Survey

A. Annual Radiation Survey Requirements

An annual radiation survey will be conducted by an outside qualified vendor to ensure no radiation exposure to the operators. Radiation surveys must be performed initially upon acquiring the equipment and thereafter at intervals not exceeding one year. Annual surveys will be scheduled by the RSO.

1. The survey will consist of a full cabinet, curtain survey and radiation level test.
2. The conveyor drive roller assembly is to be inspected for excessive vibration and noise. Shaft bearings will be inspected for wear.
3. All system components will be inspected for visible wear or damage and replace as required.
4. Certificates will be kept on file with the RSO for 40 years in accordance with [OP-020202](#) entitled "Management of Office Records" according to the ODOC Records Disposition Schedule and [OP-150310](#) entitled "Hazard Communication Program."

A survey is also required if any part of the cabinet, x-ray tube, or shielding is serviced or modified, as well as when the equipment is serviced in a way that would potentially increase the system output.

VIII. System Checks/Maintenance

Each facility will designate staff who will be trained in the safe operation/care of the x-ray systems. The facility head will maintain a list of all staff authorized to operate the system. Post orders will be established for those assigned to operate this equipment.

A. Daily System Checks

The assigned operator of each shift will complete the initial status equipment check prior to use/assuming the post. The initial startup safety check will be completed as followed and recorded in the post logbook.

1. The cabinet will be checked to see if there is any obvious damage.
2. The lead curtain will be inspected on both ends of the tunnel for missing or damaged pieces. The system may not to be operated if the lead curtain is damaged or if pieces are missing.
3. The conveyor belt edges will be checked for wear and fraying. If damage is noticed, the belt may need to be replaced or adjusted.

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4. All access panels must be securely in place.
5. All cable connections are to be secure.
6. With system power on, it will be verified that the "POWER" LED on the control panel is working. With the "X-RAY ON" button pressed, the LED lights on the control panel are verified to be working, as well as the two LED lights on the x-ray tunnel.
7. The equipment is to be wiped down as necessary in accordance with Section VIII. item C. of this procedure.

B. Repair or Replacement of Equipment

1. If any damage is found during the daily checks or annual inspection to a component critical to radiation safety or the function of the equipment, the component must be replaced or repaired prior to operation of the equipment.
2. The facility head will be contacted immediately and an outside vendor will be contacted.
3. If the damage compromises the safety of persons assigned and working around equipment, the emergency procedures outlined in this procedure will be followed.

C. General Maintenance

The following general cleaning instructions are required in order to keep the system clean and running properly. The system must always be turned OFF before cleaning.

1. Cleaning Conveyor Belt
 - a. To remove dirt from the conveyor belt, lukewarm water should be used to dampen a sponge.
 - b. If excessively dirty, a mild cleanser can be added to the water.
 - c. The sponge should only be dampened; excess water must be kept from entering any part of the system.
2. Cleaning Fan Filter

To cool the electronic modules, x-ray units are typically equipped with a fan. The filter mat on the front side of the fan cleans the air from dust particles. This mat should be checked and cleaned weekly.

 - a. It is sufficient to shake the filter mat if it is only slightly dirty.

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- b. If the filter is excessively dirty, it may be washed in warm water with a mild detergent.
 - c. The filter must be completely dry before reusing.
 - d. It is recommended that the filter be replaced if it is damaged or worn, or at regular intervals, typically every two three months.
- 3. Cleaning the Photo-Electric Eye and Reflectors Systems that are equipped with a photo-electric eye and reflectors are to be cleaned monthly with a cloth and isopropyl alcohol. A clean, dry cloth may be used to remove any film.
 - 4. Cleaning the Lead Curtain

When the lead curtain appears dirty, it can be cleaned with a mild spray cleanser and clean cloth.

D. Main Component Maintenance

All parts removal and installation of any main components of the system is to be completed by a trained and qualified x-ray technician only. The main components of an x-ray system are:

- 1. X-ray generator;
- 2. Conveyor belt;
- 3. Motor;
- 4. PC;
- 5. Idler roller;
- 6. High voltage power supply;
- 7. X-ray collimator;
- 8. Curtain; and
- 9. Detector board.

IX. Annual Permit

Affected facility heads will obtain a radiation permit from the ODEQ. Permits are valid for ten years, but permit fees are due each year on the last day of the month in which the permit was issued.

X. Emergency Procedures

A. Response

The provided safety features will significantly reduce the possibility of an emergency condition on the cabinet x-ray. However, should an emergency condition occur, such as possible radiation leakage, the system is to be immediately shut off and the shift supervisor contacted. If the control panel is not accessible or functioning, the main power breaker for the system must be shut off or the unit unplugged immediately.

B. Possible Exposure

If any situation occurs that the operator suspects possible exposure to radiation while operating the x-ray system, the operator must immediately notify the shift supervisor. The shift supervisor will assess the situation accurately and, if a risk is determined, immediate notification will be made to the facility head and the RSO.

1. If it is suspected that there was truly a potential for an exposure, x-ray operations will be immediately discontinued. The RSO will then have a radiation survey performed of the x-ray equipment in the condition it was when it became suspect.
2. If there is a leakage condition, the RSO will contact ODEQ for assistance in calculating the approximate exposure (radiation intensity) of the employee involved. The employee will be directed to seek immediate medical attention as required.

XI. Training of Personnel

Affected facilities will provide training to ensure that the procedures of this program are understood by employees. No employee will be allowed to operate any x-ray system without first receiving appropriate training and an annual refresher training. Training records will be maintained by the facility training officer in accordance with [OP-100101](#) entitled "Training and Staff Development."

A. Training Requirements

A representative from the manufacturer or a qualified instructor will provide training to employees prior to operating the system and, at a minimum, will consist of the following items:

1. Fundamentals of radiation;
2. Identification of radiation hazards with the x-ray system exposure limits;
3. Importance of radiation safety devices incorporated into the x-ray system;

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4. General operation procedures for the x-ray system;
5. Emergency procedures for the x-ray system; and
6. X-ray equipment inspection, maintenance, and survey requirements.

XII. References

OP-020202 entitled Management of Office Records”

OP-100101 entitled “Training and Staff Development”

Food and Drug Administration, Department of Health and Human Services, Federal Cabinet X-Ray System Performance Standard, 21 CFR 1020.40 and 21 CFR Part 1010

Oklahoma DEQ Land Protection Division/Radiation Management

U.S. Department of Health and Education Welfare Division of Compliance Bureau of Radiological Health

Radiation Control for Health and Safety Act of 1968 (now incorporated in the Federal Food, Drug, and Cosmetic Act; Chapter V, Subchapter C, Electronic Product Radiation Control)

Auto Clear Operator and Maintenance Manual

XIII. Action

Affected facility heads are responsible for the safe operation and appropriate maintenance of the x-ray systems and for the development of related post orders.

The administrator of Environmental Health and Safety is responsible for compliance with this procedure.

The chief of Operations is responsible for the annual review and revisions.

Any exceptions to this procedure will require prior written approval from the agency director.

This procedure is effective as indicated.

Replaced: OP-150340 entitled "Radiation Safety Program" dated November 30, 2020

Distribution: Policy and Operations Manual
Agency Website