REGULATIONS GOVERNING

THE USE OF

IONIZING RADIATION

JUNE, 1992

(Revision 9)

BETHLEHEM STEEL CORPORATION

AND

SUBSIDIARY COMPANIES

B/18

Radiation Coordinator at This Facility

_____

Plant Extension _____

DIRECT ALL QUESTIONS
AND INQUIRIES
THROUGH YOUR COORDINATOR

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1. INTRODUCTION

1.1 This revision reflects the latest changes in Federal and State regulations governing ionizing radiation. These Corporate Regulations can be obtained through the health physics consultant or Health, Safety & Corporate Services Division, Human Resources Department, 159 SGO Building, 701 E. Third Street, Bethlehem, PA 18016.

1.2 Purpose -- These regulations are for the purpose of promoting the safe use of ionizing radiation, the maintenance of personnel doses as low as reasonably achievable, and general compliance with applicable governmental regulations.

1.3 Scope -- These regulations shall apply to the acquisition, possession, utilization, storage and disposal of all ionizing radiation sources and their related operation by or on behalf of Bethlehem Steel Corporation and Subsidiary Companies (hereafter referred to as the Corporation).

1.4 Additional regulations relating to ionizing radiation protection may be issued regarding specific installations or radiation sources.

2. DEFINITIONS

Accelerator Produced Material -- Any material made radioactive by irradiating it in a particle accelerator.

Access Point -- Any location through which an individual could gain access to a radiation area or to radioactive materials.

Agreement State -- Any State with which the Nuclear Regulatory Commission (NRC) and/or the U.S. Department of Labor has entered into an effective agreement whereby the State has assumed certain licensing and regulatory responsibilities formerly vested in the Nuclear Regulatory Commission (NRC) and/or the U.S. Department of Labor relative to the possession and use of specified radiation sources. A list, current as of June 1, 1992 of Agreement States of importance to the corporation may be found in Appendix A.

Airborne Radioactivity Area -- Any room or area in which airborne radioactive materials exist in concentrations in excess of the derived air concentrations listed in Appendix B, to Title 10, Code of Federal Regulations, Part 20, **Standards for Protection Against Radiation.**

ALARA (As Low Reasonable Achievable) -- Making every effort to maintain exposures to radiation as far below the annual dose limits as is practical consistent with the use and taking into account the state of technology and the economics of dose reduction in relation to the benefits to be derived from such reductions.

Annual Limit of Intake (ALI) -- The derived limit for the amount of radioactive material taken into the body of an adult worker by inhalation which would result in a committed effective dose equivalent of 5 rems or a committed dose equivalent of 50 rems to any individual organ.

Becquerel (Bq) -- The unit of activity in the International System of units, equal to 1 disintegration per second (dps).

Bioassay -- The determination of the radionuclide, quantity, location and concentration in the body by either in-vivo counting or by the analysis of body materials.

By-product Material -- (1) Material made radioactive by irradiating it in a nuclear reactor or (2) radioactive material (except special nuclear material or source material) resulting from the fissioning of fuel in a nuclear reactor.

Collimator -- Any device used to restrict the size and direction of the radiation beam.

Committed Dose Equivalent -- Dose equivalent to organs that will be received from an intake of radioactive material by an individual during the 50 year period following the intake.

Committed Effective Dose Equivalent -- Sum of the products of the weighting factors applicable to each of the body organs that are irradiated and the committed dose equivalent to those organs.

Controlled Area -- An area outside of a restricted area but inside the facility, access to which can be limited by management for any reason.

Couloumb per Kilogram (C/kg) -- In the International System of units, the quantity of ionization produced in air by X and gamma rays. 2.58×10^{-4} coulombs per kilogram equals 1 roentgen.

Curie (Ci) -- A unit of measurement of radioactivity. One curie (Ci) is that quantity of radioactive material that decays at the rate of 3.7×10^{10} disintegrations per second (dps).

Dead-man Switch -- A switch of such design that continuous pressure is required to maintain a closed, energized circuit.

Declared Pregnant Woman -- A woman who has voluntarily informed management, in writing, that she is pregnant and the estimated date of conception.

Deep Dose Equivalent -- Whole body external dose equivalent at a depth in tissue of 1 cm (1000 mg/cm^2).

Derived Air Concentration (DAC) -- The concentration of a radionuclide in air which if breathed by the "reference man" for 2000 hours (one working year), under conditions of light work (1.2 m^3/hr inhalation rate), results in an intake of one annual limit of intake.

Dose -- The quantity of ionizing radiation energy absorbed per unit mass of a material. The unit of dose is the RAD. One RAD equals 100 ergs per gram or 0.01 joule per kilogram.

Dose Equivalent -- Expresses on a common scale for all ionizing radiations, a measure of the estimated biological effect on tissue relative to one RAD of X or Gamma rays. The unit of dose equivalent is the rem. For purposes of these regulations, dose equivalent will be referred to as simply "DOSE".

Effective Dose Equivalent -- Sum of the products of the dose equivalent to an organ and the weighting factors applicable to that organ.

Exempt Quantity -- The quantity of radioactive material that may be possessed and used without licensed authorization.

Exposure -- The quantity of ionization produced in air by X or gamma radiation. For radiation protection purposes, the exposure may be considered to be numerically equivalent to the dose. The special unit of exposure is the ROENTGEN. (See Radiation Exposure for the use of the word "exposure" in a manner normally encountered in industrial hygiene.)

External Radiation -- Ionizing radiation originating outside of the body.

Extremity -- Hand, elbow, arm below the elbow, foot, knee or leg below the knee.

Eye Dose Equivalent -- Dose equivalent to the lens of the eye at a depth of 0.3 cm (300 mg/cm^2) from external radiation.

Filtration -- The application of various thin materials, such as aluminum and copper, to reduce the radiation intensity of ineffective low energies in the useful beam.

Gray (Gy) -- The unit of dose in the International System of units. One Gy is equal to 1 joule per kilogram (J/kg).

Half-value Layer -- The thickness of a material which will reduce a given radiation intensity to one half the original intensity.

Health Physics Consultant -- A person retained by the Corporation who, by training and experience, is qualified to evaluate and control radiation exposure and contamination problems associated with the possession and use of radiation sources.

High Radiation Area -- Any area, accessible to personnel, in which radiation exists so that a major portion of the body could receive a dose, in any one hour, in excess of 100 millirem at 30 cm from the radiation source or from any surface that the radiation penetrates.

Human Use -- The deliberate internal or external administration of radiation or radioactive material to human beings for medical purposes.

Installation -- Any room, area or facility in which one or more radiation sources are present. Areas or rooms in which radiation machines are stored in such a manner that the devices are not connected to a power supply and are not capable of generating or liberating ionizing radiation do not constitute an installation.

Internal Radiation -- Ionizing radiation originating from radioactive materials present in the body.

Ionizing Radiation -- X and gamma rays, alpha and beta particles, high speed electrons, neutrons, protons and other nuclear particles capable of producing ion pairs, directly or indirectly, as the result of interaction with matter. For purposes of these regulations, ionizing radiation will be referred to as simply **"RADIATION"**. Examples of the use or occurrence of ionizing radiation in the steel industry are:

- Industrial radiography.
- Medical diagnostic x-rays.
- Sheet thickness and coating thickness gages.
- Devices to measure the liquid or solid levels in tanks, storage bins or other containment vessels or equipment.
- Density gages.
- Electrostatic eliminators.
- Tracer studies and quality control.
- X-ray and electron diffraction, electron microscope equipment and electron probe microanalyzers.
- Electronic tubes operating at voltages above 15 kV and those tubes which contain radioisotopes.
- Calibration sources.
- Control or indicator devices, such as dew pointers, alphatrons, smoke detectors and refractory wear indicators.
- Devices to measure the moisture or hydrogen content in materials.

Lead Equivalent -- The thickness of lead which affords the same radiation attenuation, under the conditions specified, as the material in question.

License -- A permit issued by the Nuclear Regulatory Commission or by an Agreement State authorizing the possession and use of by-product, accelerator-produced, special nuclear, source or naturally occurring radioactive material.

Licensee -- The person licensed. The licensee for all licenses issued to corporate facilities is Bethlehem Steel Corporation.

Maximum Permissible Accumulated Dose -- The maximum dose of ionizing radiation which is not expected to produce discernible biological effects, if accumulated during the working lifetime of an individual.

Maximum Permissible Dose -- The maximum dose of ionizing radiation that an individual may receive to his body or any specified part of his body during a stated period of time, usually one year.

NARM (Naturally Occurring and Accelerator Produced Radioactive Material) -- A naturally occurring or accelerator produced radioactive material. The term does not include by-product, source or special nuclear material. NARM is not regulated by the NRC.

Natural Radioactivity -- Radioactivity from nuclides which occur naturally in the environment or the body.

Non-Stochastic Effect -- Health effects where severity varies with the dose and for which a threshold is believed to exist. Radiation caused skin burns are an example of a non-stochastic effect.

NORM (Naturally Occurring Radioactive Material) -- A nuclide which is radioactive in its natural physical state (i.e., not man-made), but does not include source or special nuclear material.

NRC (U.S. Nuclear Regulatory Commission) -- The federal agency which has been given primary regulatory authority over radioactive materials other than that which is classified as NARM or NORM.

Occupationally Exposed (Occupational Radiation Exposure) -- Radiation exposure to an individual in a restricted or controlled area, or during such time in which the individual's assigned duties involve exposure to radiation or to radioactive materials. Exposure to background radiation or radiation resulting from medical practices is not included in occupational radiation exposure.

Particle accelerator -- A machine capable of accelerating electrons to an energy of 1 MeV or more, or heavier particles to an energy of 0.1 MeV or more.

Personnel Monitoring -- The estimation of radiation dose to an individual by means of dosimeters worn by the individual.

Protective Barrier -- Any material such as a shield which is placed or located in a radiation beam with the purpose of reducing the radiation intensity at a particular point to an acceptable level, or preventing access into a restricted area.

Quality Factor -- The modifying factor by which the dose equivalent in rems or sieverts is calculated from the exposure in roentgens or the dose in rads or grays. For the purpose of these regulations, quality factors are as follows.

X, gamma or beta radiation	1
Neutrons, high energy protons	10
Alpha particles	20

Rad -- Special unit of dose. See Dose.

Radiation Area -- Any area, accessible to personnel, in which radiation exists so that a major portion of the body could receive a dose in excess of 5 millirems in any one hour at 30 cm from the radiation source or from any surface that the source penetrates.

Radiation Coordinator -- A person named by management at a facility where radiation sources are used to (1) coordinate the communication between the local facility and the health physics consultant and (2) maintain the necessary files required to be kept at the facility.

Radiation Exposure -- The absorption of ionizing radiation by any part of the body as a result of the presence of an external field of ionizing radiation or the deposition of radioactive material within the body.

Radiation Machine -- Any device, not containing radioactive materials as the primary source of radiation, which produces ionizing radiation when energized.

Radiation Source -- Any radioactive material or any radiation machine which emits ionizing radiation when energized.

Radiation Worker -- Personnel receiving occupational radiation exposure who routinely work with radiation producing devices.

Radioactive Material -- Any material, solid, liquid or gas, that spontaneously emits ionizing radiation.

Radiographer -- A person who performs radiographic non-destructive testing involving the use of ionizing radiation sources for other than medical purposes or laboratory types of non-destructive testing, such as x-ray diffraction analysis.

Radiographer Assistant -- A person who, under the personal direct supervision of a radiographer, uses radiation sources, related handling equipment or survey instruments in industrial radiographic testing.

Radiographer-in-Charge -- The person having the primary supervisory responsibility for industrial radiography at any Corporation facility.

Rem -- The special unit of dose equivalent in the U.S. systems of units, from any type of ionizing radiation, which is equal to the dose in rads or exposure in roentgens multiplied by the quality factor for the radiation. For the purposes of these regulations, any of the following are considered to be equivalent to a dose of one rem:

1	roentgen of x or gamma radiation
1	rad of x, gamma or beta radiation
0.1	rad of neutron or high energy proton radiation
0.05	rad of alpha radiation

Restricted Area -- Any area to which access is limited by the Corporation for the purpose of protecting personnel from excessive radiation exposure.

Roentgen (R) -- The special unit of exposure in the U.S. system of units. A measure of x and gamma radiation in air. One roentgen equals 2.58×10^{-4} coulomb per kilogram of air.

Scattered Radiation -- Radiation which has been deviated in direction or reduced in energy as a result of interaction with matter.

Sealed Source -- A quantity of radioactive material encapsulated or otherwise enclosed in a matrix in such a manner as to prevent the release or dispersal of the material under normal conditions of use.

Shallow Dose Equivalent -- The dose to the skin or an extremity at a depth of .007 cm (7 mg/cm^2) averaged over an area of 1 cm^2.

Shielding -- Material used to reduce the intensity of a radiation beam.

SI -- The International System (Systeme Internationale) of measurement units.

Sievert (Sv) -- The unit of dose equivalent in the International System of units, equal to the dose in Gy multiplied by the quality factor for the radiation.

Source Material -- Any physical or chemical form of uranium or thorium or their ores which contain 0.05% or more of uranium or thorium, except Special Nuclear Material.

Special Nuclear Material (SNM) -- Quantities not sufficient to form a critical mass of uranium enriched in U-233, U-235 or plutonium of any mass number.

Stochastic Effect -- Health effects that occur randomly and for which the probability of the effect occurring rather than its severity is assumed to be a linear function of dose without a threshold. Cancer and leukemia induction and genetic effects from ionizing radiation exposure are examples of stochastic effects.

Survey -- Evaluation of radiation hazards incidental to the production, use or existence of radiation sources. These evaluations include, but are not limited to, tests, physical examination and measurement of radiation intensities or concentrations of radioactive materials, proximity of radiation sources to work stations and the degree of occupancy, determination of radiation source workloads, and determining if restrictions on the use of the radiation source is necessary.

Total Effective Dose Equivalent -- The sum of the deep dose equivalent for external radiation exposure and the committed effective dose equivalent for internal radiation exposure.

Weighting Factor -- The proportion of the risk of stochastic effects resulting from the irradiation of an organ to the total risk of stochastic effects when the whole body is irradiated uniformly. The values for various weighting factor for calculating the effective dose equivalent are as follows:

Organ	Weighting Factor
Gonads	0.25
Breast	0.15
Red Bone Marrow	0.12
Lung	0.12
Thyroid	0.03
Bone Surfaces	0.03
Remainder	0.3
Whole Body	1.0

Whole Body -- Deep exposure to the head, trunk, arms above the elbows, or legs above the knee.

3. RADIATION CONTROL RESPONSIBILITY

3.1 The immediate responsibility for maintaining radiation exposures as low as is reasonably achievable, compliance with applicable rules and regulations, and the safe use of radiation sources rests with the management of the facility possessing the radiation source. Such responsibility shall include, but not necessarily be limited to, the following items.

3.1.1 The promotion and maintenance of compliance with all applicable rules and regulations pertaining to radiation protection on the part of Corporation employees and outside contractor personnel.

3.1.2 Arranging for the adequate training of personnel in the safe and proper use of radiation sources and equipment, operating and emergency procedures, and related rules and regulations, as required.

3.1.3 Arranging for the adequate training in the meaning of informational and warning signs and signals, and how to maintain their doses as low as reasonably achievable, for personnel who have occasion to work around, but not directly with, sources of radiation.

3.1.4 Arranging through the Radiation Coordinator for the installation, removal, initial survey, and safe storage of all radiation sources.

3.1.5 Arranging through the Radiation Coordinator for periodic surveys or tests to assure that radiation intensities are within acceptable levels.

3.1.6 Preparing written, safe working or emergency procedures and assuring that personnel are instructed in the procedures and that personnel working with radiation sources are made aware of and understand the content of the procedures.

3.1.7 Defining and posting restricted areas, radiation areas or high radiation areas.

3.1.8 The judicious use of personnel radiation monitoring dosimeters as recommended by the health physics consultant or the local radiation coordinator.

3.1.9 The investigation of all accidental exposure incidents, damage to or loss of radiation sources, or the circumstances surrounding lost personnel radiation monitoring dosimeters.

3.1.10 The accountability and security of all radiation sources during storage or use.

3.1.11 The reporting of all existing or potential radiation control problems to the health physics consultant through the radiation coordinator.

3.1.12 The reporting of all anticipated applications and planned acquisitions of new radiation sources to the health physics consultant through the local radiation coordinator.

3.1.13 The scheduling of personnel for required medical examinations.

3.1.14 Assistance in achieving compliance with Sections 3.1.1 through 3.1.13 shall be provided by environmental health engineers at those facilities at which one is assigned. In the absence of in-house environmental health personnel, assistance shall be provided by the health physics consultant. The health physics consultant shall determine when assistance requires outside consultants.

3.2 The Health, Safety and Corporate Services Division of the Human Resources Department, (hereafter referred to as HSCS), acting on behalf of management, has the responsibility to: develop and promote the Corporate radiation control program, prepare corporate rules and regulations, review safe operating and emergency procedures prepared by the various operating departments, conduct audits of the local radiation control programs, make recommendations to promote compliance with these policies and governmental regulations, and to act in the capacity of consultant in matters relating to the safe use of radiation sources. These activities are carried out by or arranged through the health physics consultant.

3.3 HSCS has the responsibility of liaison between the Corporation and the Nuclear Regulatory Commission and other governmental agencies regulating radiation sources.

3.4 Liaison between the health physics consultant and the local facilities shall be through (1) the plant environmental health engineer where one is assigned, or (2) the radiation coordinator at those facilities not having an environmental health engineer.

3.5 All personnel working with radiation sources or frequenting restricted areas shall immediately consult their supervisor when there is a question regarding radiation control or protection, performance of radiation devices, radiation control procedures or other such situations.

3.6 In the event of an emergency, such as an accident involving radioactive materials, supervisory personnel shall be notified immediately and shall take prompt action to protect personnel and property, minimize the spread of contamination and restrict access to the area of concern. The health physics consultant through the plant environmental health engineer or, if none, the local radiation coordinator shall be apprised of the situation as soon as possible. Source recovery and decontamination, if necessary, shall be accomplished by or under the direct supervision of the health physics consultant.

3.7 A copy of the following shall be forwarded to the health physics consultant for his review and file.

3.7.1 All reports (including file memoranda) of initial surveys, device relocation surveys and radiation exposure incidents.

3.7.2 Internal facility procedures written to implement these regulations.

3.7.3 New or revised procedures written to instruct personnel in the safe methods of working with or around radiation sources.

3.8 The health physics consultant, acting through the General Manager, HSCS, shall have the authority to recommend to management the termination of use of any source of ionizing radiation, if such source poses an imminent threat to the health and safety of personnel or members of the general public.

4. RADIATION SOURCE PROCUREMENT

4.1 All proposed uses of ionizing radiation, including radioactive materials and industrial and medical x-ray machines, shall be reviewed with the health physics consultant and the local radiation coordinator during the initial planning stages. Such equipment is included in Purchasing Commodity Codes 05423 and 09636. This applies to:

- Radiation sources which are intended for outright purchase by the Corporation.
- Radiation sources purchased or leased under the manufacturer's general license.
- Instrumentation packages where the instrumentation supplier must buy a radiation source to incorporate into his package.
- Radiation sources involved in turnkey projects.
- Leased radiation sources.
- Radiation sources provided by a vendor to a Corporation facility for testing purposes.
- New applications of outside vendor radiography services and all other vendor services utilizing radiation sources in a Corporation facility.

4.2 The purpose of this early notification is to alert the local radiation coordinator and the health physics consultant of new locations of radiation usage and to permit sufficient time for input of necessary radiation control considerations. It will also allow adequate lead time to secure any necessary licenses and permit better coordination of delivery time.

4.3 A listing of coordinators is periodically updated and distributed by the health physics consultant. A list current as of June 1, 1992 is found in Appendix B.

4.4 In order to properly review a proposed application of radiation usage, the health physics consultant should be supplied through the radiation coordinator with the following information as early in the planning stage as possible:

4.4.1 A description of the device(s), including the name of the manufacturer or vendor, model number, type of radiation source and the source size in curies (or maximum kilovoltage and milliamperage for x-ray machines).

4.4.2 A description of the intended uses of the device(s).

4.4.3 A description of the area in which the device(s) will be located, including a sketch showing where the device(s) will be installed on equipment.

4.4.4 Environmental conditions in the immediate area which could have an impact on radiation safety, such as high temperatures, excessive dust, high moisture, corrosive atmospheres, etc.

4.4.5 The degree of occurrence of personnel in the immediate area of the device(s)--for routine, transient and maintenance purposes.

4.4.6 The name of a person at the local facility who can be contacted for further information and the phone number.

4.5 The acquisition of each radiation source (with the exception of blanket replacement purchase orders of iridium 192 radiography sources) is to be approved by the health physics consultant prior to the placing the order. This is to allow time for input as described in 4.1 and 4.2 above.

4.6 Manufacturers are prohibited by the US NRC from shipping a radioactive source or a device containing a radioactive source to a recipient until the manufacturer receives a copy of the recipient's license, authorizing the possession of the source. The health physics consultant will forward the necessary license copies to the manufacturers.

4.7 Persons submitting requisitions to the Purchasing Department are to include the words "Radioactive" or "x-ray" in a prominent place on the requisition. This is to provide Purchasing with a warning flag. The person initiating the requisition should also send a copy to the health physics consultant through the radiation coordinator. Any applicable specifications with respect to radiation protection should also be included at this time. The Corporation has specifications for gaging devices and other radiation equipment. These are found in Section 29 or they may be obtained from the health physics consultant.

4.8 The Purchasing Department buyer should send a copy of the **Invitation To Bid** to the local radiation coordinator and/or the health physics consultant as described in the Purchasing Department Manual. The health physics consultant will then notify the buyer, in writing, of the approval, disapproval or suggested changes to the desired item(s). The health physics consultant will also supply the names and phone extension (if needed) to be included in the special wording shown in Section 4.9.

4.14.7 All purchase orders for radioactive materials shall contain the clause:

> "The U.S. Nuclear Regulatory Commission Regulation 10 CFR 21 is applicable to the device, radioactive material or service included in this purchase order."

4.10 When a purchase order is written for a radioactive source, the buyer should include, as one of the purchase conditions, that the manufacturer is to mark the outside of the shipping container housing the radioactive source with the following standard wording:

CONTAINS RADIATION SOURCE

NOTIFY _____ **OF RECEIPT**

EXTENSION_____

4.11 Turnkey contractors are to be advised in the purchase contract that the Corporation will take physical possession of all isotope radiation sources upon delivery to the job site, and will provide storage until such time as they are to be installed. Possession will then be returned to the contractor at the time of installation, provided a person licensed to supervise the installation of sources is present. Purchasing should include the following clause as a part of the specifications on the invitation to bid and as a part of the purchase order.

> "Any radiation source shipped to our plant as part of this order (Turnkey job/contract/purchase order) must be received and stored by Bethlehem Steel Corporation under the jurisdiction of Bethlehem Steel Corporation's health physics consultant or the local radiation coordinator."

4.11.1 Should this not be acceptable to the turnkey contractor, he shall be advised that he will have to obtain a radioactive material license, and the applicable radioactive materials shall be stored and installed under his own specific radioactive material license.

4.12 An operating department anticipating the use of radiation sources by an outside contractor while working in a Corporation facility shall bring it to the attention of the radiation coordinator. Examples of such application are vendor radiography, internal pipe inspections and soil moisture and compaction tests. The purchase requisition shall specify that the contractor is to familiarize himself with these regulations and comply with all applicable provisions. This specification shall be made a condition of the purchase order and a copy of these regulations shall be sent to the contractor (a supply is available through the local radiation coordinator).

4.13 The local radiation coordinator shall forward a legible copy of the shipping papers and a copy of the manufacturer's leak test report for each radioactive material source to the health physics consultant for each x-ray or radioactive material radiation source received. These items are to be sent to:

A. LaMastra
Room 159, SGO
Bethlehem Steel Corporation
701 East Third Street
Bethlehem, PA 18016

4.14 The local radiation coordinator should also arrange with Receiving at his facility to obtain a legible copy of the vendor's shipping papers, and for the secure storage of the radiation source(s).

4.15 Packages containing radioactive material shall be examined using the following procedures.

4.15.1 Receiving shall be notified that such a package is expected and the person to contact upon arrival of the delivery vehicle.

4.15.2 The external security seal is to be inspected for integrity. The condition of the external package should be intact and not show signs of damage which could affect the safety or containment of the radioactive material.

4.15.2.1 If the security seal is not intact or the shipping package is physically damaged, extra care shall be exercised during unpacking, to assure that radiation safety is not compromised.

4.15.3 The external radiation levels shall be measured. Radiation levels exceeding those listed for the package shipping labels in 15.7.4 may indicate a failure of the internal shielding. This information shall be made immediately known to the health physics consultant.

4.15.4 If the package contains other than a sealed source, a contamination wipe shall be taken of the external package surface and checked with a thin end-window GM counter as described in Section 16.5. Removable contamination levels exceeding the limits in Section 15.4.8 shall require the package to wrapped in plastic and the health physics consultant to be immediately notified.

4.15.5 Should either the external radiation levels or, in the case of a non-sealed source, the surface wipes exceed the limits in 15.7.4 or 15.4.8, the device shall be secured in an area that can be locked and restricted, and the health physics consultant immediately notified.

4.15.6 Once the package is found to be acceptable, the radiation coordinator shall update the inventory and forward the surface wipes and a copy of the manufacturer's source and device information to the health physics consultant.

5. LICENSING AND REGISTRATION

5.1 The acquisition, possession and use of radioactive materials must be authorized by a license issued by the NRC, an Agreement State or other State having jurisdiction and authority. License applications or amendment applications to existing licenses for all radioactive materials shall be prepared and submitted by HSCS. A copy shall be sent to the local radiation coordinator for his file.

5.2 As required by State or local regulations, radiation sources shall be registered with the appropriate agency by the health physics consultant. A copy of the registration will be forwarded to the facility for local filing.

6. RESTRICTED AREAS

6.1 All fixed radiation sources shall be installed in such a way to physically prevent access by the head, trunk, arms above the elbows, or legs above the knees to doses exceeding 100 millirem in one hour within the primary measurement beam or 2 millirem in one hour at three feet (100 cm) from any accessible surface on the radiation source housing.

6.2 Personnel having access to the primary measurement beam or to radiation fields exceeding 2 millirem in one hour shall be provided training as described in Section 8.4.

6.3 All gage installations shall be posted with a sign warning that a radiation producing device is installed in the area, and such other radiation warning signs as may be required by Section 13.

7. PERSONNEL RADIATION EXPOSURE

7.1 The maximum permissible dose for an occupationally exposed individual shall be considered to include all occupational exposure from internal and external radiation sources, from all types and energies of ionizing radiation, whether delivered simultaneously or successively to the region of interest during the period of measurement. Every effort is to be made by management of the facility using the radiation sources to avoid all unnecessary radiation exposure of personnel, and to maintain personnel radiation exposure as far below the listed dose limits as is reasonably achievable through good radiation protection planning and practices.

7.2 As part of the Corporation's effort to maintain radiation exposures as low as reasonable achievable, the health physics consultant will perform an annual audit of the radiation control program at those facilities possessing radiation sources. These audits will review existing local radiation control programs, personnel radiation exposures, radiation source location and operating procedures. Recommendations will be made with respect to improving local radiation control policy, operating procedures and radiation source location so as to maintain personnel exposure as low as reasonably achievable.

7.3 Occupational radiation exposure, from both internal and external sources of radiation being used by or under the control of the corporation, of personnel engaged in operations involving the routine use or maintenance of radiation sources or from occupancy in restricted areas, shall be limited to not more than the quantities in 7.3.1.

7.3.1

AREA OF BODY	ANNUAL DOSE (REM)
Penetrating exposure of the head, trunk, arms above elbows, legs above knees	5 * +
Lens of the eye	15
Skin, each hand, each forearm, each foot, each leg below the knees	50

* A maximum of 3 rems to these areas during a single calendar quarter in a year is permitted provided that the total annual dose does not exceed 5 rems.

\+ The 5 rems per year limit is the sum of both external and internal exposure.

7.4 Internal occupational radiation exposure of personnel engaged in operations involving the routine use or maintenance of radiation sources or occupancy in restricted areas shall be controlled by limiting the average concentration of radioactive material in air to as low as is reasonably achievable and not more than the limits specified in Appendix B, Table I, Column 3, Title 10, Code of Federal Regulations, Part 20, Standards for Protection Against Radiation. In the case of exposure to non-radiation workers or members of the general public, the limits in Table 2, Column 1 apply. For the purposes of this regulation, concentrations may be averaged over an exposure period of 40 hours in any seven consecutive days.

7.5 All Corporation owned, controlled or contracted radiation sources shall be used or stored in such a manner as to maintain external radiation levels in unrestricted areas as low as reasonably achievable. In no case are they to exceed levels which will result in penetrating exposures to the head and trunk, arms above the elbows, and legs above the knees of personnel in unrestricted areas exceeding 0.1 rem in a calendar year and 2 millirems in any one hour.

7.6 No fetus is to receive a dose exceeding 0.5 rem during its term, due to the occupational radiation exposure of the mother who has declared that she is pregnant. The dose to the fetus shall be assumed to be equal to the deep dose of the mother.

8. TRAINING

8.1 The health physics consultant shall meet one of the training and experience combinations listed in Table 1 of the USNRC Regulatory Guide OP-722-4 (Section 8).

8.2 Personnel performing initial and relocation surveys or supervising the installation or removal of radiation devices at a local facility shall be (1) trained in industrial hygiene and have successfully completed at least a 20-hour course in radiation protection, or (2) have successfully completed at least a 20 hour course in radiation protection and have at least three years experience in making surveys under the direction of someone authorized to perform surveys, and approved by HSCS. This does not apply to supervisors of industrial radiography.

8.3 Class A users of radiation sources operating under the Corporation's Research and Development License shall successfully complete a minimum 20-hour corporate training course, or shall successfully complete a non-corporation course in radiation protection which provides a minimum of 20 hours of classroom training in topics comparable to the Corporation's "Short Course in Radiation Protection"; plus a minimum of 6 hours of instruction by the health physics consultant on emergency procedures, personnel monitoring, survey technique, applicable regulations and Bethlehem's policies and procedures. The applicant will be considered to have successfully completed an outside course if he has attended all sessions and has taken and scored at least a 75% final grade. If a formal test is not given as part of the course, the student will be required to pass a HSCS test similar to one given for the 20 hour corporation course.

8.4 Personnel maintaining or calibrating gaging devices, Class B users under the Corporation's Research and Development License, and those working in restricted areas, other than industrial radiographers, shall be given a minimum of three hours of training every three years covering the topics listed below. This training is available from the health physics consultant and consist of the following.

- The types of sources to be encountered and likely levels of radiation.
- Potential hazards and biological effects.
- Methods of protection.
- Applicable rules and regulations.
- Safe operating and emergency procedures.

8.5 Personnel responsible for the supervision of industrial radiographers shall have successfully completed the Corporation's course, "Radiation Protection for Industrial Radiographers", and should be Level II (ASNT, TC-1A) radiographers.

8.6 Personnel engaged in industrial radiography are to successfully complete the Corporation's course, "Radiation Protection for Industrial Radiographers," before being permitted to operate radiographic devices without direct supervision and shall attend an annual refresher session of a minimum of 4 hours.

8.7 Personnel operating soil moisture/density gages shall attend the manufacturer's training course and attend a 2 hour refresher presented by the health physics consultant every five years.

8.8 Personnel operating or performing maintenance on equipment on which radiation producing devices are installed shall be given a 3 hour biannual training course which describes the radiation levels likely to be encountered, the associated risks, methods of protection, safe operating procedures, applicable regulations, and what to do in the event of a suspected radiation over-exposure or emergency.

8.9 Other training requirements may be stipulated by conditions contained in a specific license granted to a facility or by special conditions of the installation.

9. PERSONNEL MONITORING AND EXPOSURE RECORDS

9.1 Personnel (employees or visitors) meeting one or more of the criteria listed below shall be required to wear a whole body radiation dosimeter of the film or TLD type.

- Enter a high radiation area or a restricted area in which radiation levels exceed 5 millirem per hour.
- Commonly works in areas in which there is a reasonable likelihood of receiving a dose to a major portion of the body in excess of 0.1 rem in a year.
- Engaged in industrial radiography.
- A declared pregnant employee who works within 5 feet of a radiation source.
- Personnel who install or handle unshielded, sealed sources. These personnel shall also wear finger radiation dosimeters when working with these sources.

9.2 All personnel using a radiation source for industrial radiography or entering a restricted radiography area shall wear a pocket dosimeter in addition to a whole body radiation dosimeter. The pocket dosimeter shall be capable of measuring from zero to at least 200, but not more that 500 milliroentgens, and be able to be directly read by the user. It shall be read frequently during the shift and the dose shall be recorded daily. Should the pocket dosimeter be discharged beyond its maximum range, the employee shall immediately notify his supervisor. He shall not resume working with radiation sources until approval is given by the radiographer-in-charge, with concurrence by the health physics consultant.

9.3 Bricklayers and other personnel who are required to be on the same level during the time in which refractory wear indicating sources are being installed, shall be required to wear a whole body radiation dosimeter at least until the scaffold is raised or until the exposure rate is reduced to below 2 mR/hr at 18 inches from the refractory.

9.4 Personnel whose work causes their hands to be in such proximity to radiation sources that (1) there is a reasonable likelihood of their hands receiving a dose of 0.3 rem in any calendar quarter or 0.5 rem in any calendar year, or (2) who routinely work with open beam x-ray diffraction, spectrographic or manually fed x-ray emission apparatus, or (3) who maintain x-ray diffraction or emission apparatus, and electron microscope or microprobe apparatus while the x-ray tube is energized, shall wear finger radiation dosimeters while working on energized x-ray equipment.

9.5 The health physics consultant may determine from time to time that certain individuals or classes of individuals should wear radiation dosimeters in order to determine the likelihood of radiation exposure for either a limited period or on a permanent basis.

9.6 Each person shall wear the radiation dosimeter that is specifically assigned to him during a wearing period. He shall not transfer the dosimeter to another person or wear another person's assigned dosimeter during a wearing period.

9.7 Each person shall wear his radiation dosimeter (and pocket, finger or wrist dosimeter if required) in such a manner as to accurately reflect his exposure. The loss of any personnel monitoring equipment shall be immediately reported to the supervisor and a proper replacement obtained before resuming work.

9.8 Radiation dosimeter and exposure evaluation services shall only be supplied by a vendor chosen by HSCS and monitoring periods shall be established by the health physics consultant.

9.9 The permanent record of the cumulative radiation exposure for all personnel monitored for external radiation exposure, or subject to internal exposure to radioactive materials, shall be maintained by HSCS. These records are available upon request by appropriate agencies for their inspection, or to supplement the files of a local facility.

9.10 The radiation coordinator at the local facility shall maintain on file, the periodic radiation monitoring results for his facility. These files should be kept from at least the time of the last inspection by a regulatory agency.

9.11 All employees issued radiation dosimeters may review their radiation exposure history by contacting the facility radiation coordinator. A written record of their accumulated dose may be obtained, through their supervisor, from HSCS.

9.12 Prior to beginning radiation work requiring the issuance of a radiation dosimeter, an employee shall complete the Corporation Form 48322 (Radiation Badge Issue). The form shall be forwarded to the health physics consultant through the radiation coordinator. The radiation coordinator shall notify the vendor supplying radiation monitoring dosimeters to add the employee to the routine monitoring list.

9.13 It is the responsibility of the department to which an employee is assigned to assure that all personnel monitoring employee information possessed by the vendor is accurate and current and that radiation dosimeters are being properly used.

9.14 A radiation dosimeter is not to be taken outside of Corporation property unless the employee is engaged in job-related radiation work off site. Each department where employees are issued radiation dosimeters shall establish procedures to assure that dosimeters are used only for Corporation-related radiation exposure.

10. RADIATION SOURCE INSTALLATION, REMOVAL, RELOCATION, PHYSICAL SURVEYS, ENVIRONMENTAL SAMPLING AND SURVEY EQUIPMENT

10.1 The health physics consultant or, as indicated in 10.2, an authorized delegate, must be present for the installation, removal or relocation of any fixed device containing a radioactive source. He is also required to make an initial survey of all such installations or relocations whether they contain isotope or x-ray sources, unless those functions have been specifically delegated to a person authorized by the license. Arrangements should be made through the radiation coordinator at least two weeks in advance.

10.2 This responsibility may be delegated by HSCS to local personnel who have successfully met the requirements of section 8.2. Environmental health engineers at the local plants generally meet this requirement. Outside courses may not be substituted without the prior approval of the health physics consultant.

10.3 The health physics consultant or the authorized delegate is to be notified as far in advance as possible of all such installations, removals, or relocations so that a review of the location can be made. The following information is to be provided:

- Identification of the device.
- A description of the area in which the device will be located, and preferably a sketch showing where it will be located on equipment.
- The occurrence of personnel in the immediate area of the device for routine, transient and maintenance purposes.

10.4 Radiation protection surveys include all surveys in which the radiation exposure or dose rate is determined for the purpose of: (1) protecting personnel; (2) informing personnel of the intensity of a radiation field or the quantity of radioactive material in a particular location; (3) assuring that a radiation source is "off" prior to entry into an area; (4) determining personnel radiation dose; or (5) surveys of packages containing radioactive material that are being received or shipped.

10.4.1 Radiation surveys made to determine the continued presence of refractory wear indicating sources in blast furnace refractory or to check the primary beam intensity of a gaging device in order to evaluate detector operation, are not considered radiation protection surveys.

10.4.2 Radiation protection surveys shall be performed by or under the supervision of the health physics consultant or someone meeting the requirements of Section 10.2 and approved by HSCS. If it is impractical for the health physics consultant or a local delegate to perform surveys to assure that a radiation source is "off" or to determine the intensity of an external radiation field, these surveys may be performed by personnel who meet the requirements of section 8.4 and who have been properly trained in the use of survey meters and have been approved by HSCS.

10.5 An initial survey shall be performed by or under the supervision of the health physics consultant or a local representative specifically designated by HSCS. An initial survey shall be performed prior to the use of all new radiation sources or after significant modification or relocation of existing equipment. The purpose of the initial survey is to evaluate radiation hazards and operating procedures associated with the subject radiation source. Records of all initial surveys shall be maintained by the radiation coordinator, with a copy forwarded to the health physics consultant.

10.5.1 The documentation of an initial survey shall include the following:

- Identity of the radiation source (manufacturer, model, serial number, radionuclide and activity or kVp and mA, and intended use.
- Workload (minutes per week, hours per month).
- Location of routine work stations and occupancy rate.
- Location of walkways with respect to the radiation source.
- Identity of the survey meter (mfg, model, sn, last calibration date).
- Exposure rates created by the radiation source at contact with the source housing, at one (1) and (3) feet from the source housing, in routinely occupied areas, and in walkways.
- Location of warning signs and the type of signs posted.
- Any operating restrictions imposed on the use of the radiation source.
- Recommendations made to maintain radiation doses ALARA.

10.6 Environmental sampling to evaluate the concentration of radioactive material in air and water shall be performed by or under the supervision of the health physics consultant. Records of such evaluations shall be maintained by the radiation coordinator.

10.7 A permanent record of initial surveys and survey meter calibrations shall be maintained by HSCS. Local copies of these records shall be maintained by the radiation coordinator from at least the time of the last inspection by a regulatory agency. If an inspection has not been made by a regulatory agency within five years, these local records may be discarded after five years.

10.8 Survey meters and equipment used for surveys described in 10.4 to 10.6 shall be approved by the health physics consultant prior to purchase to assure that the model selected is acceptable for the intended use.

10.9 Personnel who use survey meters shall attend a training course presented by the health physics consultant. Industrial radiography personnel shall not use survey instruments until they have received at least the initial indoctrination training as described in the facility's training program.

10.10 Survey meters used by corporation facilities shall be recalibrated on a frequency set in Section 26 of these regulations, or sooner if the meter is malfunctioning. Records of calibration and maintenance shall be maintained by the local department using the meter.

11. PHYSICAL EXAMINATIONS AND BIOASSAY

11.1 Employees assigned to departments where personnel monitoring is required under Sections 9.1 and 9.2 may be given a physical examination before starting such work, upon recommendation of the General Manager, HSCS and a locally assigned physician. Any examination so recommended shall include the usual history, physical examination, laboratory work including CBC, and at the discretion of the General Manager, HSCS and a locally assigned physician, other hematological tests as may be indicated. In taking the history, inquiry as to significant past radiation exposures, including diagnostic and therapeutic procedures shall be made and documented.

11.1.1 For purposes of these regulations, significant exposures shall include any therapeutic radiation treatment. Diagnostic exposures, particularly from diagnostic radioisotopes, fluoroscopic examinations, examinations of the gastrointestinal tract, genitourinary organs, spine, and blood-forming organs may be considered significant if the total dose in a year exceeds 10 rems. Routine chest x-rays and radiographic examinations of the extremities are not considered significant.

11.2 Persons receiving or suspected of having received a single acute radiation exposure in excess of 5 rems to the trunk or active blood forming organs, or in excess of 10 rems to an extremity may be examined at the discretion of the General Manager, HSCS and a locally assigned physician. The health physics consultant will notify the General Manager, HSCS and appropriate local medical personnel of all such exposures and their significance.

11.3 Persons receiving apparent low exposures from apparatus having highly collimated, high intensity, low energy radiation may be examined at the discretion of the General Manager, HSCS and a locally assigned physician. The health physics consultant will notify the General Manager, HSCS and appropriate local medical personnel of all such exposures and their significance.

11.4 Every person who is suspected of having ingested, inhaled or otherwise received radioactive materials into his body may also be examined as directed in Section 11.1. The health physics consultant shall notify the General Manager, HSCS and appropriate plant medical personnel of all such incidents. The health physics consultant shall also notify local personnel of the necessary precautions to be taken in the handling of such persons and determine the need for the biological specimens to be obtained and the analytical procedures to be used. He shall also notify medical and environmental health personnel of the results of the analyses and their significance.

11.5 Plant medical personnel, acting upon the advice of the General Manager, HSCS and the health physics consultant, shall recommend the temporary or permanent removal of any employee from a job which involves possible exposure to radiation or radioactive materials if, in their judgment, further radiation exposure may jeopardize the employee's health. Any person so removed shall not be reassigned to radiation work without written authorization from plant medical personnel.

11.6 Employees having an accumulative radiation exposure in excess of 5 rems, and for whom an intent to terminate employment is known, may be given a physical examination as outlined in Section 11.1 immediately prior to termination.

11.6.1 The employee's department should notify the health physics consultant through the local radiation coordinator of all planned terminations of monitored employees.

11.6.2 The health physics consultant shall notify the General Manager, HSCS and a locally assigned physician of (1) the identity of the employees, (2) the total exposure, and (3) the significance of the exposure.

11.6.3 The General Manager, HSCS and local medical personnel shall then determine if a termination examination is warranted and make the necessary arrangements.

12. ACCOUNTABILITY RECORDS

12.1 A semi-annual physical inventory shall be made of each radiation source. Records of such inventories shall be maintained by the radiation coordinator at each facility where radiation devices are possessed, stored or used. The record shall show the date of the inventory, the location of the device, the manufacturer, model, and serial number, the isotope and quantity for radioactive material sources or the maximum kilovoltage and milliamperage of the beam if an x-ray source. The inventory distributed by the health physics consultant can serve as the documentation of the semi-annual inventory, provided it is verified against the installed sources.

12.2 In addition to Section 12.1, up-to-date records shall be maintained which show the amount of each radioactive material received and from whom. These records shall also show the amount of each radioactive material transferred, decayed in storage or use, and released for disposal when such sources are transferred or disposed of.

12.3 In addition to the requirements of Sections 12.1 and 12.2, a quarterly inventory of all sealed radiation sources used in industrial radiography shall be performed. Documentation of such inventories shall include information as to the quantities, kinds, locations of sealed sources and the date of the inventory.

12.4 Up-to-date records shall be maintained which show the receipt, transfer or disposal of all x-ray equipment.

13. POSTING OF NOTICES, WARNING SIGNS AND LABELING

13.1 Required warning signs and labels, unless otherwise specified, shall bear the standard radiation symbol and appropriate wording in the conventional colors of magenta or purple on a yellow background.

13.2 All restricted and radiation areas shall be conspicuously posted with a sign or signs bearing the words, **CAUTION - RADIATION AREA.**

13.3 All high radiation areas shall be conspicuously posted with a sign or signs bearing the words, **CAUTION - HIGH RADIATION AREA.**

13.4 All areas, rooms or enclosures in which airborne radioactive materials exist in excess of the derived air concentrations listed in 10 CFR 20, Appendix B, Table 1, shall be conspicuously posted with a sign or signs bearing the words, **CAUTION - AIRBORNE RADIOACTIVITY AREA.**

13.5 All radiation-producing machines shall be posted with a label bearing the words, **CAUTION - THIS EQUIPMENT PRODUCES RADIATION WHEN ENERGIZED.** Such labels shall be affixed on the control panel near the

switch which energizes the tube. Caution or warning signs, in addition to the above label, shall be posted in the vicinity of the radiation producing tubes if such tubes are significantly remote from the control panel. Such signs may be worded in a manner appropriate to the installation and may be in colors other than those of the conventional radiation warning signs if such is permitted by applicable regulations.

13.6 All gaging devices in which it is possible to insert any part of the body shall be posted with a warning sign(s) alerting personnel of the potential presence of a radiation beam in the air gap. The sign or signs shall be visible from the normal avenues of approach to the gaging device.

13.7 All containers in which radioactive materials are stored, transferred or used shall be conspicuously posted with a label bearing the words, **CAUTION - RADIOACTIVE MATERIAL.** Additional information such as the kind and quantity of the material as well as the date of assay shall also be provided on the label.

13.8 All "Free Air" sources which are not fastened to or contained in a radiographic exposure device shall have a durable tag attached which is at least 1 inch square and bearing the words, **DANGER - DO NOT HANDLE. NOTIFY CIVIL AUTHORITIES IF FOUND.**

13.9 All x-ray diffraction and x-ray spectrographic devices shall be posted with a label bearing the words, **CAUTION - HIGH INTENSITY X-RAY BEAM.** Such labels shall be attached to the exposure chamber or apparatus enclosing the primary and secondary radiation beams.

13.9.1 All rooms in which x-ray machines are used shall be posted with a sign or signs bearing the words, **CAUTION - X-RAY EQUIPMENT.**

13.10 All areas or rooms in which radioactive materials are used or stored in amounts exceeding 10 times (100 times in the case of natural uranium and natural thorium) the quantities specified in **Appendix C, Title 10, Code of Federal Regulations, Part 20, Standards for Protection Against Radiation,** shall be conspicuously posted with a sign or signs bearing the words, **CAUTION - RADIOACTIVE MATERIALS.**

13.10.1 However, areas or rooms are not required to be posted as in 13.10 if the radioactive material is in the form of a sealed radioactive material source, and, if the radiation intensity at a distance of 12 inches from the surface of the source container does not exceed 5 millirems per hour and the container is adequately labeled as described in Section 13.7.

13.11 Copies of Form NRC-3, Notice to Employees, or a similar form as designated by a State agency having such jurisdiction, shall be posted, if required, in such a manner and in sufficient locations so that all employees who work in restricted areas may observe a copy.

13.12 The Corporation's Notice to Employees shall also be posted in such a manner and in sufficient locations so that all employees who work in restricted areas may observe a copy.

14. EMERGENCY PROCEDURES

14.1 The departments responsible for environmental health and plant protection at all facilities where radioactive materials are used or stored shall be informed of all use or storage locations, the kinds and quantities of such materials and the associated contamination and radiation exposure potentials. At those facilities where an environmental health engineer is not assigned, the radiation coordinator is to be advised.

14.2 An up-to-date list of the names, office and home telephone numbers of personnel qualified to cope with radiation emergencies shall be kept on file by the radiation coordinators and Plant Protection. The names and phone extension of the radiation coordinator may be found at the front of this booklet.

14.3 Fire Department personnel shall, in cooperation with facility radiation protection personnel and the health physics consultant, plan for combating fires in which radioactive materials are involved. Such planning shall include the evaluation of possible hazards.

14.4 Rooms or areas in which radioactive materials are stored should be inspected at least annually by the facility Fire Department. For those facilities not having an in-house fire department, the inspection should be made by a qualified fire patrolman.

14.5 It shall be the responsibility of all personnel to immediately report any emergency involving radioactive materials to the radiation coordinator or, if he is unavailable, to plant protection. In the absence of the radiation coordinator, Plant Protection shall notify the personnel listed under 14.2.

14.6 Should an emergency occur, radiation sources located in the affected area should be turned off if an x-ray machine, or returned to their shielded position if a radioactive material source, provided such action does not jeopardize the safety of personnel.

14.7 The immediate area in which the radioactive material is located shall be evacuated and roped off to a distance which will insure that dose rates beyond the restricted area do not exceed 2 millirem in any one hour.

14.8 Supervision has the responsibility of insuring that emergency plans are provided for all equipment under their control. This would include requesting restricted area distances for their particular sources from the local radiation coordinator or the health physics consultant. Only personnel trained to respond to radiation emergencies, meeting the requirements of Section 8.2, and in possession of a properly operating and calibrated survey meter and dosimeter badges shall be permitted to enter the restricted area.

14.9 Upon arrival of qualified personnel, appropriate steps shall be taken to confine the radioactive materials; warn other personnel who might be in the area; take immediate measures to decontaminate

personnel if such is required; and by the use of available survey instruments, redefine the boundaries of the area to be restricted. Further corrective action, unless otherwise dictated by the circumstances of the emergency, shall await the arrival or recommendations of the health physics consultant.

14.10 Personnel present in or frequenting the area in which the emergency occurred shall be surveyed for contamination, and decontaminated if such action is required prior to leaving the specific facility.

14.11 Where there is a likelihood of significant airborne radioactive materials, personnel entering such emergency areas shall wear respiratory protective equipment and anti-contamination clothing as appropriate. The health physics consultant and the environmental health engineer shall recommend the selection of all respiratory protection equipment prior to its use. Appropriate respiratory protective equipment shall be used in accordance with Corporate or facility procedures.

14.12 In the event of an accident involving radioactive materials while they are being transported outside of Corporation property, personnel referred to in Section 14.2 shall be notified immediately. Immediate measures shall be taken to contain the material and to prevent exposure of employees or the general public, whenever possible. Dependent on the type and quantity of material being transported and the contamination and exposure potential, appropriate State authorities and/or the Nuclear Regulatory Commission and the U.S. Department of Transportation shall be notified regarding the accident. Reporting shall be through HSCS.

15. TRANSPORTATION OF RADIOACTIVE MATERIALS

15.1 The following information reflects the October 1, 1991 Revision of the U.S. Department of Transportation regulations (49 CFR Parts 100-199) concerning the transportation of radioactive materials commonly encountered at Bethlehem facilities. For situations not covered in this Section, contact the health physics consultant.

15.2 The health physics consultant is to be notified of all proposed shipments of radioactive materials. This notification does not apply to the routine return shipments of depleted radiography sources to the manufacturer.

15.2.1 Bethlehem Steel Corporation no longer has authorization to transport or offer for shipment, quantities of radioactive material exceeding Type A. If larger than Type A quantities of radioactive material need to be shipped (see 15.3.3), the health physics consultant shall be contacted for guidance.

WHEN RADIOGRAPHY DEVICES ARE TRANSPORTED OVER PUBLIC ROADS, ALL APPLICABLE REGULATIONS MUST BE FOLLOWED.

15.2.2 Radioactive material may only be shipped in Department of Transportation approved specification containers. If assistance is needed in determining if a container is approved by the Department of Transportation, the health physics consultant is to be contacted.

15.3 Definitions

15.3.1 **A_1** means the maximum activity of special form radioactive material permitted in a Type A package.

15.3.2 **A_2** means the maximum activity of normal form radioactive material permitted in a Type A package.

15.3.3 **A_1 and A_2 Quantities for Specific Radionuclides in Curies**

Radionuclide	Special Form (A1)	Normal Form (A2)
Americium 241	8*	0.008
Cadmium 109	1000	70
Californium 252	2	0.009
Carbon 14	1000	60
Cesium 137	30	10
Cobalt 57	90	90
Cobalt 60	7	7
Cobalt 244	10	0.01
Iridium 192	20	10
Iron 55	1000	1000
Lanthanum 140	30	30
Lead 210	100	0.2
Nickel 63	1000	100
Plutonium 239	2 (32g)*	0.002 (32mg)
Polonium 210	200	0.2
Promethium 147	1000	25
Radium 226	10	0.05
Strontium 90	10	0.4
Tritium Gas (compressed/uncompressed)	1000	1000
Thorium (natural)	unlimited	
Uranium (natural)	unlimited	

* Except that americium and plutonium as americium-beryllium or plutonium-beryllium neutron sources can have a special form limit of 20 curies (7.4×10^{11} becquerels).

15.4.4 **Fissile Radioactive Materials** are: Pu 238, Pu 239, Pu 241, U 233, and U 235.

15.3.5 **Hazard class** is the system used by the U.S. Department of Transportation to didvide hazardous materials into one of 9 classes. Radioactive materials are Class 7.

15.3.6 **Limited Quantities** are those activities of radioactive material not exceeding the limits specified for special and normal form as found in the following table. Packaging requirements for limited quantity radioactive materials are described in 15.5.9. They are exempt from the other packaging and labelling requirements of this section.

	INSTRUMENTS AND ARTICLES		
Contents	Device Limit	Package Limit	Not In Devices
Solids			
Special Form	10^{-2} A_2	A_1	10^{-3} A_1
Normal Form	10^{-2} A_2	A_2	10^{-3} A_2
Tritium	20 Ci	200 Ci	20 Ci
Liquids (Other than tritium)	10^{-3} A_2	10^{-1} A_2	10^{-4} A_2
Gases			
Tritium	20 Ci	200 Ci	20 Ci
Other - Special Form	10^{-3} A_1	10^{-2} A_1	10^{-3} A_1
Other - Normal Form	10^{-3} A_2	10^{-2} A_2	10^{-3} A_2

15.3.7 **Normal Form** essentially means loose material. It is defined as not "special form" materials.

15.3.8 **Special Form** means a solid massive form, either by the physical makeup of the material or by encapsulation. The definition also requires that if released to the environment, the material would present a low radiotoxicity hazard. This could be due to the isotope involved or to the physical makeup of the material, such as by ceramic pelletization.

15.3.9 **Transport Index** is numerically equal to the maximum radiation dose rate in millirem/hr (**rounded upward to the next highest tenth**), measured at a distance of 1 meter (3.3 feet) from any surface of the shipping container.

15.3.10 **Type A Quantity** is any activity of radioactive material not exceeding the limit A_1 if special form, or A_2 if normal form. Type A quantities must be shipped in Type A packages which are described in Section 15.14.

15.3.11 **Type B Quantity** is any activity of radioactive material exceeding the limit A_1 if special form, or A_2 if normal form. Type B quantities must be shipped in Type B Packages. Type B packages must have their design approved by the USNRC; and a quality assurance program written and followed for the design, construction, repair, use and maintenance of the packages. The health physics consultant can provide the necessary assistance in obtaining approval.

15.4 The values in the table below are the maximum removable external radioactive contamination limits permitted on package surfaces. They may be averaged over any 300 cm^2 area of any part of the package's outer surface. The wipe location must be of those surfaces which will give a representative assessment of contamination levels.

Contaminant	Maximum Permissible uCi/cm^2	Contamination Levels dis/min/cm^2
Natural or depleted uranium, natural thorium, uranium-235 uranium-238, thorium-232, alpha emitting radionuclides with a half-life of less than 10 days and all beta and gamma emitters.....	0.00001	22
All other alpha emitting radionuclides.....	0.000001	2.2

15.5 **General Package Requirements:** There are general requirements for any packaging used to contain a hazardous material, of which radioactive materials are one type.

15.5.1 Under the normal conditions of transportation, the packaging should not be substantially damaged or the contents should not be released to the environment.

15.5.2 The device containing the radioactive material shall be securely closed to prevent accidental opening during transport.

15.5.3 The outer package shall have a security seal that is not easily breakable and is capable of showing that the package has not been opened. The health physics consultant can supply seals or guidance in sealing packages as required.

15.5.4 The outer shipping container shall be free of removable contamination in excess of the limits given in 15.4. To determine removable contamination, follow the instructions given in 17.10.3 to 17.10.7, except that the envelope should be marked **"Shipping Wipe -- Immediate Analysis Requested".** An area of at least 300 cm^2 (7" x 7") should be wiped.

15.5.5 Packages cannot have any dimension smaller than 4 inches, and internal bracing has to be provided to prevent the shifting of the device or inside container within the outer shipping package.

15.5.6 Radiation levels on the outside of the outer package are limited to the following, unless the shipment is to be made in a "sole-use" vehicle. Contact the health physics consultant for guidance on limits for "sole-use" shipments.

200 millirem/hr at the surface,
10 millirem/hr at 1 meter from surface
(transport index = 10 - see 15.7.4)

15.5.7 For liquid materials and Type B quantities additional requirements apply. The health physics consultant can supply this information.

15.5.8 Type A packages shall be used to transport Type A quantities and Type B packages shall be used to transport Type B quantities. The specifications for Type A packages are described in Section 15.13.1. Bethlehem Steel Corporation is not authorized to ship Type B quantities.

15.5.9 Packages which are exempt from marking and labeling requirements and can be sent via air, highway or water with no indication that a radioactive material is contained must meet the following conditions:

15.5.9.1 Limited quantity as defined in 15.3.6 and;

- Packaged in strong, tight packages that will not leak the contents during conditions normally incident to transportation and which have at least one dimension not less that 4 inches;
- Surface radiation intensity not exceeding 0.5 millirem per hour;
- No significant removable surface contamination (See 15.4);
- The outside of the *inner* container is marked **"Radioactive"**.

15.6 Postal shipments may be made through the mails *only if*:

- No alpha, beta or neutron radiation is detected on, or emitted through, the package surface.
- Gamma radiation levels must be below 0.05 milliroentgens per hour.
- The package does not contain special nuclear or source material, or more than 0.002 microcurie of other radioactive material.

15.7 **Package Shipping Labels:** Three types of shipping labels are used for radioactive material packages and are shown in 15.7.4. All information on the labels must be completed. The health physics consultant can supply needed labels.

15.7.5 **NO PACKAGE CAN BE SHIPPED WITH A SURFACE RADIATION LEVEL GREATER THAN 200 MILLIREM/HR OR A TRANSPORTATION INDEX GREATER THAN 10.**

15.7.6 **THE TOTAL OF THE TRANSPORT INDEXES OF ALL PACKAGES IN A SHIPMENT CANNOT EXCEED 50.**

15.7.7 Labels are to be placed on opposite sides of the outer package (excluding the bottom). One label must be next to the shipping name marked on the outer package.

15.8 The proper shipping name is to be marked on the outer package near one of the labels. A list of the proper shipping names is given below. The health physics consultant can determine the correct name to use if there is a question.

UN Number	Proper Shipping Name
UN 2974	Radioactive material, Special form, NOS (Most likely to be used)
UN 2982	Radioactive material, NOS
UN 2910	Radioactive material, limited quantity, NOS
UN 2911	Radioactive material, instruments and articles
UN 2912	Radioactive material, LSA, NOS
UN 2918	Radioactive material, Fissile, NOS
UN 2908	Radioactive material, empty package
UN 2976	Radioactive material, Thorium Nitrate
UN 2981	Radioactive material, Uranium Nitrate, Solid

15.9 A Shipper's Certification is to be completed for all shipments containing radioactive materials including the routine transport of radiography devices or soils gages over public roads, even when private or company vehicles are used. The health physics consultant can supply copies of the shipper's certification. In addition, a corporate Bill of Lading (Form 19500, latest revision) must be completed for all shipments made by common carrier. The shipper's certification shall contain the following information:

15.9.1 The proper shipping names and UN number listed in 15.8 above.

15.9.2 The name of each radionuclide and its mass number, even if the term, "MIXED" is used on the shipping label.

15.9.3 A description of the chemical and physical form if the material is not special form, or the description "special form".

15.9.4 The activity of each source. Either curies or millicuries may be used.

15.9.5 The type of shipping label. (Radioactive I, II or III)

15.9.6 The transport index.

15.9.7 A 24 hour emergency phone number.

15.9.8 Special Handling - If a placard is required, indicate; "PLACARD--RADIOACTIVE", or other special handling instructions as required.

15.9.9 The following statement:

> "This is to certify that the above named materials are properly classified, described, packaged, marked, and labeled, and are in proper condition for transportation according to applicable regulations of the Department of Transportation and the EPA."

15.9.10 The certification statement is to be signed unless the shipment is being made in Corporation or private vehicles.

15.9.11 If the material is being shipped via aircraft, an additional form is required and may be obtained from the health physics consultant. The following certification must be used instead of the one in 15.9.9. Additionally, the bill of lading or the shipper's certification form must be marked, **"FOR CARGO AIRCRAFT ONLY".** This restriction is usually noted in the section for "Special Handling Instructions".

> "This is to certify that the above named materials are properly classified, described, packaged, marked, and labeled, and are in proper condition for transportation by air according to the applicable international and national government regulations."

15.9.12 A copy of the shipper's certification and the Bill of Lading must be given to the driver of the vehicle, including drivers of company or private vehicles. One copy should be supplied for each driver, if multiple vehicles will be used to transport the shipment. A copy of the shipper's certification and Bill of Lading shall also be attached to the package.

15.10 The carrier is to be told that the shipment will contain radioactive materials and if vehicle placards are required. **(All packages having a Radioactive III label require placards.)** If placards are required, the shipper is to have placards available if needed by the carrier. These may be obtained from the health physics consultant.

15.10.1 Four placards are to be placed on a vehicle (both sides, front and back).

15.7.1 **Contents** - Insert the radionuclide name and mass number, i.e., Cobalt 60, Cesium 137, etc. Do not use abbreviations. If the package contains more than one radionuclide, use the word, **"MIXED".**

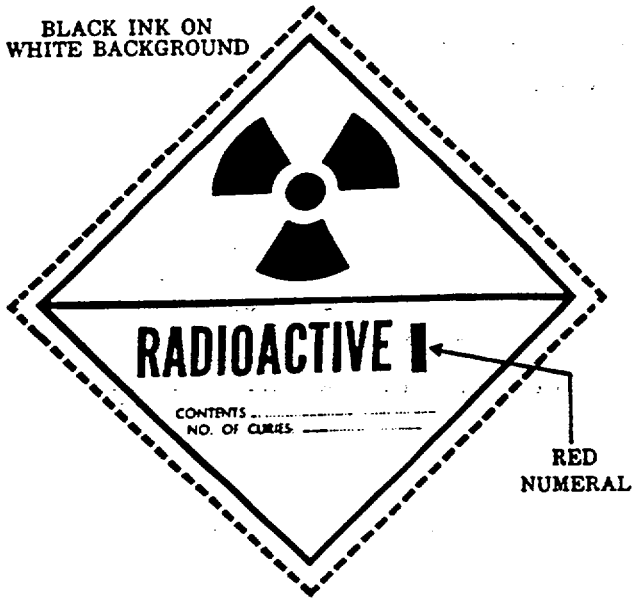
15.7.2 **Number of Curies** - Insert the number of curies or millicuries even if this number is very small. For example, a 100 microcurie source may be written: 0.0001 curie or 0.1 millicurie

1 microcurie (uCi) = 0.001 millicurie (mCi) = 0.000001 curie (Ci)

15.7.3 **Transport Index** (on Radioactive II and III labels only) - For all radioactive material except fissile material, the Transport Index is equal to the dose rate in millirem/hour at 1 meter (3.3 feet) from the surface of the outer package **rounded up** to the next highest tenth. The Transport Index is to be inserted in the space provided on Radioactive II or Radioactive III labels. Do not include the units "millirem/hr." **If neutron sources are being shipped, the contribution from the neutron radiation must be added into the total Transport Index.** The health physics consultant will supply the Transport Index if fissile material sources are being shipped.

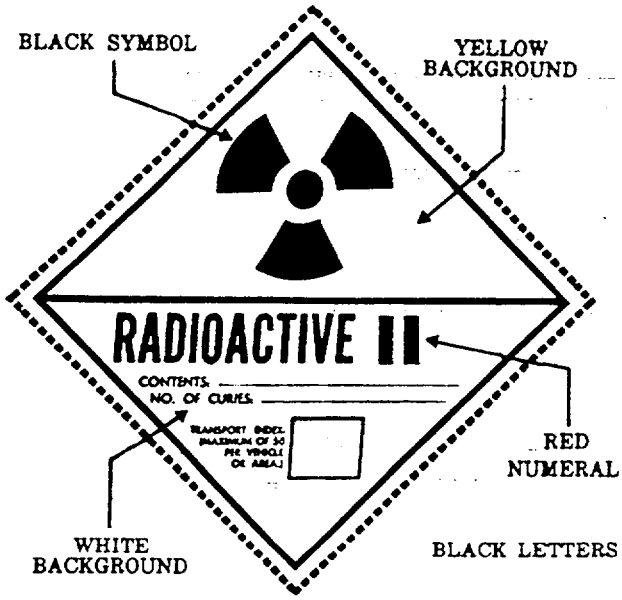
15.7.4 The three labels and their use are shown below:

15.7.4.1 **RADIOACTIVE I (WHITE)** - Any package having a detectable surface radiation level not exceeding 0.5 millirem/hr and no detectable radiation at 1 meter from the surface. **NO VEHICLE PLACARD REQUIRED.**



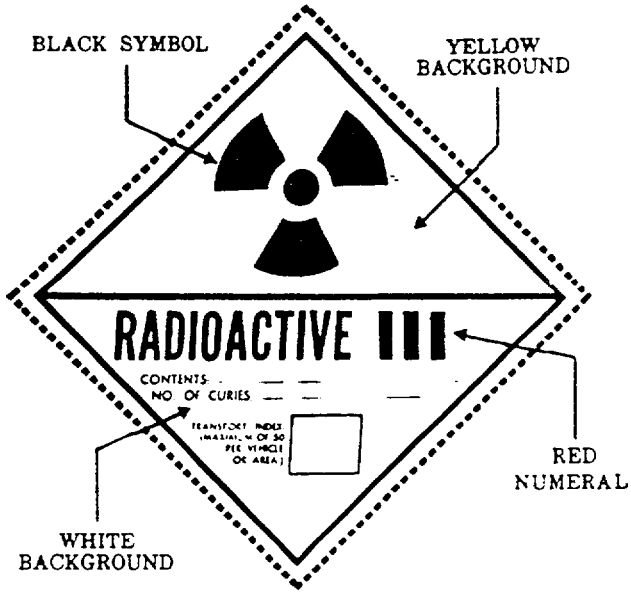
Actual Size 4" x 4"

15.7.4.2 **RADIOACTIVE II (YELLOW)** - Any package having a surface radiation level of greater than 0.5 millirem/hr but not greater than 50 millirem/hr. The Transport Index has to be 1.0 or less. **NO VEHICLE PLACARD REQUIRED.**



Actual Size 4" x 4"

15.7.4.3 **RADIOACTIVE III (YELLOW)** -- Any package having a surface radiation level of greater than 50 millirem/hr but not exceeding 200 millirem/hr . The Transport Index has to be 10 or less. **VEHICLES TRANSPORTING PACKAGES BEARING RADIOACTIVE III LABELS MUST BE PLACARDED.** The health physics consultant can supply required placards.



Actual Size 4" x 4"

15.10.2 Vehicle placards are diamond shaped, 10-3/4 inches on a side, as shown below.

15.11 Radioactive materials may not be shipped in the same vehicle with Class A explosives. They may be shipped with Class B and C explosives or other hazardous materials. In addition, they must be kept at a minimum separation distance from personnel or undeveloped film while in transport, as shown in the table below.

Mimimum Separation Destances - (Feet)

Total transport Index	Air and highway transportation: From undeveloped film for periods 0-2 hr.	2-4 hr.	4-8 hr.	8-12 hr.	Over 12 hr.	Air and highway transportation: From Personnel	Rail Transportation: From Undeveloped film	Rail Transportation: From Personnel
None	0	0	0	0	0	0	0	0
0.1 - 1	1	2	3	4	5	1	15	3
1.1 - 5	3	4	6	8	11	2	15	3
5.1 - 10	4	6	9	11	15	3	15	3
10.1 - 20	5	8	12	16	22	4	22	4
20.1 - 30	7	10	15	20	29	5	29	5
30.1 - 40	8	11	17	22	33	6	33	6
40.1 - 50	9	12	19	24	36	7	36	7

Note: The distances in the table must be measured from the nearest point on the package.

15.12 When radioactive materials are to be transported over public roadways by Corporation or private vehicles, the following conditions shall be observed in addition to those previously listed.

15.12.1 The container shall be secured in **a closed** transporting vehicle in such a manner that its position will be maintained under conditions normally incident to transportation.

15.12.2 The vehicle shall be surveyed after loading. External radiation levels on the outer surface of the vehicle shall not exceed 2 millirems per hour. The vehicle shall be placarded, if required, in accordance with Section 15.10.2.

15.12.3 A responsible person at the intended destination shall be notified of the departure of the shipment and the estimated time of arrival. Acknowledgement of receipt of the shipment shall be made to the shipper by telephone.

15.12.4 The driver of the vehicle shall be instructed to notify the responsible person at the shipment origin should unusual delays be encountered en-route.

15.12.5 The driver shall have a copy of the Shipper's Certification listing the contents.

15.12.6 In the event of an accident en-route, the responsible person at the shipment origin shall immediately initiate the appropriate measures of Section 14, EMERGENCY PROCEDURES, upon notification by the driver. The health physics consultant is to be notified.

15.12.7 Should the transporting vehicle be overdue at its destination and unreported for a period of two hours or more, an immediate search shall be initiated. The health physics consultant is to be notified.

15.12.8 In the case of radioactive materials being shipped for disposal at a licensed low level radioactive waste disposal site or those sources being returned to a manufacturer, the shipper shall request immediate notification of the receipt of the shipment by the receiving company. If notification of receipt is not received within 20 days, an investigation is to be initiated. The health physics consultant is to be notified.

15.12.9 All disposals of low level radioactive waste shall be coordinated through the health physics consultant who will assist in completing the required waste manifests.

15.13 If Type B quantities (Iridium or cobalt radiography sources) have to be shipped, contact the health physics consultant for guidance.

15.14 Only the following described shipping containers may be used to ship Type A quantities of radioactive materials as special form (sealed sources). For radioactive materials in any other form please call the health physics consultant for proper shipping instructions.

15.14.1 Type A Quantities shall be shipped in packages meeting the US DOT Specification 7A. A Specification 7A package is any container which meets the 7A test conditions. There are several metal drums and wooden boxes that have been tested at the listed maximum weights and shown to meet the test specifications. Some are listed below. (See 15.3.2 for quantity limits of specific isotopes.)

15.14.1.1 Metal Drums

Capacity	DOT Spec	Maximum Gross Wgt
5 gallon	6 C	80 lbs.
	17 C	100 lbs.
10 gallon	6 C	160 lbs.
30 gallon	17 C or H	500 lbs.
	6 B	600 lbs.
55 gallon	17 C or H	840 lbs.

15.14.1.2 Wooden Boxes

Maximum Gross Wgt	Outside Dimensions Inches
150 lbs.	12x12x12
250 lbs.	12x12x48
400 lbs.	24x24x24

15.14.1.2.1 General Box Specifications, See 15.14.5 for sketch of a typical box.

15.14.1.2.2 All corners shall be 3-way corners.

15.14.1.2.3 Top, bottom and sides shall be of 3/4" A/C exterior grade plywood with nailed seams.

15.14.1.2.4 Nails to be cement coated and sized according to the following table.

Max. Gross Wgt. (lbs)	Cleats Minimum Thickness	Cleats Minimum Width	Minimum Nail Size (Penny)	Nail Spacing (Inches)
150	11/16"	2 1/16"	7	2 1/4'
250	13/16"	2 7/16"	8	2 1/2"
400	7/8"	2 5/8"	10	2 3/4"

15.14.1.2.5 Cleats to be of pine, hemlock or fir; well seasoned and commercially dry; free from decay, loose knots or knots that would interfere with nailing. The grain of wood shall not cut across the cleat in less than one-half its length. Bottom cleats may be of 2" x 4" or 4" x 4" material to allow entry of lift forks.

15.14.1.2.6 Two cleats shall be required on each face at opposite edges plus others as necessary so that cleats are not more than 12 inches apart. Cleats shall extend the full length of the face.

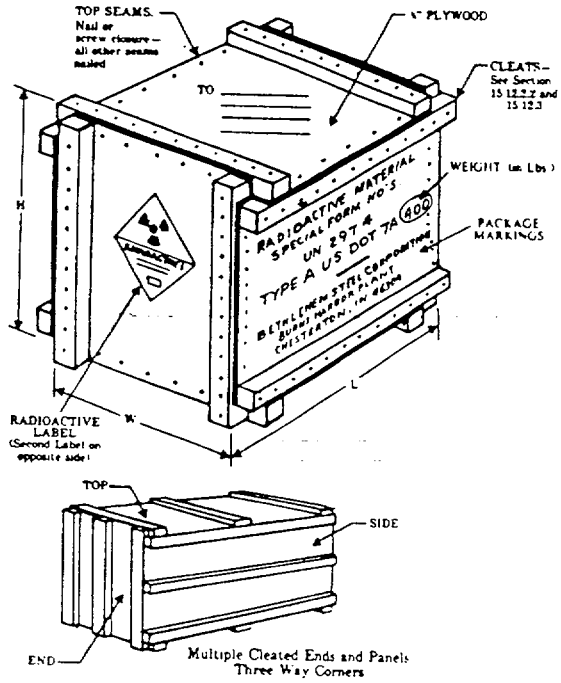
15.14.1.2.7 Each cleat shall form a 3-way corner. Each cleat shall be nailed to an adjoining cleat on an adjoining face.

15.15 **Package Markings** - The outside of the shipping container is to be marked with the following information. The markings are to be permanently attached, at least 1/2 inch high and contrasted to the container so as to be readily apparent and understood. The markings must be located near one of the required radioactive labels.

- The proper shipping name of the contents and the type (Type A).
- The USDOT container specification number (usually DOT 7A) and the gross weight in pounds.
- Shipper's name and address.
- An example of the markings is as follows:

Radioactive Material	Bethlehem Steel Corp.
Special Form, NOS, UN 2974	Burns Harbor Plant
Type A	US Route 12
USDOT 7A -- 400 lbs.	Burns Harbor, IN 46304

15.15.5 Below is a sketch of a wooden box which is commonly used as a Specification 7A container, showing labeling and marking.



15.16 **Quality Assurance Check of Shipments.**

15.16.1 Prior to any shipment each package shall be examined to determine that:

15.16.1.1 It meets the design specification and is labeled with the proper markings (See 15.15).

15.16.1.2 It is suitable for the contents to be shipped.

15.16.1.3 It is not physically damaged.

15.16.1.4 Each closure device (lid), including gaskets if required, are properly installed, secured and free of defects.

15.16.1.5 External radiation and contamination levels are within applicable limits specified in 15.4, 15.5.6, 15.5.9.1, or 15.6.

16. LEAK TESTING

16.1 Sealed radiation sources shall be leak tested prior to initial use and every six months thereafter or at intervals specified by applicable regulations or licenses. The testing is for the purpose of detecting faulty or damaged containment capsules which may permit the escape of radioactive material to the environment.

16.2 Leak test wipes shall be taken in accordance with the procedures in this Section. Wipes will be supplied by the health physics consultant.

16.3 Analyses of leak test samples shall be performed by the health physics consultant, unless otherwise authorized by a radioactive material license.

16.4 The sensitivity of analytical procedures shall be capable of detecting a minimum activity of 0.001 microcurie.

16.5 Immediately following sampling, the wipes shall be checked with a thin window Geiger survey meter as follows:

16.5.1 Move away from all sources of radiation, turn the meter to its lowest scale and make a background reading. It should not exceed 0.05 mR/hr. If it does, move farther away and reread.

16.5.2 Place the wipe near the probe window of the Geiger counter and measure. The reading should not exceed 0.05 mR/hr. If higher readings are obtained, or if you cannot obtain a reasonable background reading, call the health physics consultant.

16.5.3 If the wipe meets the above limits, place it in an envelope with the following information: (Examples are given in parentheses).

- Facility and intended use location.
  (Bethlehem Plant, West Coke Hopper, D Blast Furnace)
- Device. (Coke moisture gage)
- Manufacturer. (Texas Nuclear, Ohmart, KayRay, etc)
- Model and serial number
  (of the **source housing**--not the detector or other component)
- Source and quantity. (Americium 241, 1 curie)
- Test date.
- Tested by (initials of person making the wipe).

16.5.4 Should the radiation levels exceed .05 milliroentgen per hour at a point in close proximity to the sample, place wipe in a plastic bag, seal bag and place it in envelope and seal envelop. **DO NOT LICK ENVELOPE.** Radiation levels on the outer surfaces of the envelope **cannot exceed 0.05 mR/hr.** If they do, notify the health physics consultant.

16.5.5 Send the envelope(s) to:

A. LaMastra
Health Physics Associates, Inc.
RD 1 Box 796
Lenhartsville, PA 19534

16.5.6 Following completion of testing, wash your hands.

16.6 Should a leak test reveal the presence of transferable activity of 0.005 microcurie or more, the health physics consultant shall immediately inform the local facility and initiate steps to have the device immediately withdrawn from service, decontaminated, repaired or disposed of.

16.7 Leak testing shall be accomplished by one of the following methods depending on the type of device or source. In all cases the person making the wipe should wash his hands following testing. **DO NOT, UNDER ANY CIRCUMSTANCES, BRING YOUR HANDS WITHIN 6 INCHES OF AN UNSHIELDED SOURCE CAPSULE.**

16.7.1 **"Free Air" Sources** - "Free Air" sources are those which are not incorporated in remote handling devices or shielded source holders. These sources may be handled by the string and pole method, a threaded rod, tongs, or a magnet attached to the end of a rod.

16.7.1.1 The primary hazard associated with the leak testing of "free air" sources is that of external radiation exposure. The test should be performed as rapidly as possible in a manner which makes maximum use of available shielding, such as the source storage container or lead bricks.

16.7.1.2 The source shall be removed from the storage container using an approved handling tool and wiped with a cotton swab. **DO NOT PICK UP THE SOURCE CAPSULE WITH YOUR HANDS.** The wipe shall then be surveyed for excessive contamination as described in 16.5 and placed in the accompanying labeled envelope.

16.7.1.3 After wiping, the source shall be immediately returned to the storage container.

16.7.2 **Sources Used In Gaging Devices** - Gaging devices are constructed in such a manner that there are only a few areas where the radioactive material can escape to the environment if the source capsule should leak. Sealed radiation sources contained in devices for the measurement of liquid and solid level, density or thickness and other equipment in which the source is permanently mounted in a shielded position are included in this category.

16.7.2.1 The primary hazards associated with the leak testing of this type of sealed source is the possibility of radiation exposure from those gage systems having an accessible radiation beam between the source housing and detector.

16.7.2.2 At the time of the initial survey, the person performing the initial survey shall determine the areas where leak test wipes should be made on the gage housing.

16.7.2.3 The same gage housing areas shall be wiped during subsequent leak tests. The resulting wipe shall be surveyed for excessive contamination as described in Section 16.5 and placed in an envelope.

16.7.2.4 At the time the leak test is made, the person making the test shall operate, or have operated, the shutter mechanism on all gaging systems having a shutter. Any malfunction or difficulty in moving the shutter is to be noted on the leak test envelope, and also brought to the attention of the operating department responsible for the gage system. Operating departments shall be notified beforehand that the shutter will be temporarily closed for testing.

16.7.3 **Sources Used In Remote Handling Devices** - Radiographic exposure devices containing sealed radiation sources which are operated by remote means are included in this category. Normally, the high activity of the sources dictates against removing the source from the equipment so that the source itself can be leak tested directly. In lieu of such direct testing, surfaces of the device which make contact with the source capsule, such as exit ports on the shield container, shall be tested as an indication of the integrity of the capsule.

16.7.3.1 The primary hazard associated with the leak testing of this type of device is the potential for personnel exposure. A calibrated and operating survey meter is to be used as well as a personnel monitoring and pocket dosimeter. Entry is to be made on a Utilization Log of the testing.

16.7.3.2 Immediately prior to leak testing, a radiation survey shall be made to assure that the source is in the shielded position and that the projector is locked.

16.7.3.3 A surface (or surfaces) of the device which makes contact with the capsule shall be wiped with a cotton swab. The swab shall be surveyed as described in 16.5 and placed in the sample envelope.

16.7.4 **Soils Gages** - Some soils gages contain sources which, while they are attached to the gage mechanism, the source capsule is capable of being projected outside of the protective shielding of the housing. For those soils gages in which the source remains fully enclosed within the housing, the procedures in 16.7.2 shall be followed.

16.7.4.1 The primary hazard associated with the leak testing of soils gage sources is that of external radiation exposure. The test should be performed as rapidly as possible in a manner which makes maximum use of available shielding from the source storage container.

16.7.4.2 The source shall be normally extended from the storage container and wiped with a cotton swab. **DO NOT TOUCH THE SOURCE CAPSULE WITH YOUR HANDS**. The wipe shall then be surveyed for excessive contamination as described in 16.5 and placed in the accompanying labeled envelope.

16.7.4.3 After wiping, the source shall be immediately returned to the storage container.

16.7.5 **Special Sources** - Leak testing methods of unique sources or those presenting specialized problems will be devised by the health physics consultant as necessary.

16.8 Leak test samples shall be analyzed in the following manner:

16.8.1 Filter Paper and Cotton Swabs--The activity contained on the filter paper and cotton swabs shall be determined by direct counting in appropriate laboratory counting equipment and shall be considered to constitute the transferable activity, following corrections for detector efficiency and geometry.

16.8.2 Special Methods--As dictated by the sampling procedures, special analyses will be developed by the health physics consultant so as to adequately test specialized sources for transferable contamination.

16.9 Results of the individual leak tests shall be forwarded to the local radiation coordinator for filing. In the event that transferable activity is observed, its significance and a recommended course of action shall accompany the test results. If the test results indicate a serious problem, the local facility shall be immediately notified by phone and appropriate action shall be taken as per Section 16.6.

17. RECEIVING AND STORAGE OF RADIATION SOURCES

17.1 All radioactive materials, whether in the form of sealed or unsealed sources, shall be stored in a manner which will not present a radiation exposure hazard either internally or externally. The method of storage shall preclude unauthorized removal or handling and maintain personnel exposures as low as reasonably achievable.

17.2 When a license or an amendment is received, it will be forwarded to the coordinator at the respective facility by the health physics consultant.

17.3 Initially, as he is informed by the manufacturer, the health physics consultant will notify the radiation coordinator at a facility that new radiation devices are being prepared for shipment to his facility.

17.4 The coordinator shall then notify the Receiving Department that a radioactive shipment is anticipated and that the coordinator is to be notified upon its receipt.

17.5 The coordinator, if at all possible, should arrange with the Receiving Department to have a single truck dock assigned to receive and store radiation devices. The truck dock number should be sent to the health physics consultant for his information.

17.5.1 The storage area shall be capable of being locked. Access shall be controlled by the coordinator and the Receiving Department. All incoming shipments containing radioactive materials shall be placed in this locked storage area. This includes materials purchased by a turnkey contractor.

17.5.2 At facilities receiving shipping containers for the field exchange of industrial radiography sources, a single location shall be designated to receive and store the shipping containers while awaiting the required surveys.

17.5.2.1 The radiographer-in-charge or supervising radiographer is to be notified immediately upon arrival of the delivery truck. A qualified radiographer shall survey the shipping container and perform the required leak tests within three hours of delivery.

17.5.2.2 If the package is found to be below the limits of 17.10.1, it shall be moved to the locked area used to store radiography sources. A copy of the accompanying shipping papers shall be obtained.

17.6 All shipments containing radioactive sources should be marked, by the manufacturer, with the standard wording as described in Section 4.9. This is to alert receiving personnel of the need to notify the facility's radiation coordinator.

17.7 Upon receipt of a shipment containing a radiation device, the Receiving Department shall immediately notify the coordinator as instructed on the package. If there are no special instructions on the package, and the package contains one of the Department of Transportation shipping labels shown in Section 15.7.4, then Receiving is to also contact the coordinator.

17.7.1 If it is not possible for receiving to contact the coordinator or an alternate designated by the coordinator, then Receiving is to contact the health physics consultant in Bethlehem at 8-232-6460 or (215) 756-4153 for instructions on how to handle the shipment.

17.8 If a radioactive shipment is to be picked up by Bethlehem personnel at the freight carrier's terminal, the coordinator is to make the necessary arrangements with the carrier to be notified of the shipment's arrival at the terminal. Shipments are to be picked up as quickly as possible after notification is received. Transport back to the facility, if via public roads, must comply with requirements under Section 15.11 through 15.12.7 plus any placarding requirements.

17.9 All incoming radioactive material shipments shall be examined by the radiation coordinator to see if the radioactive material security seal is intact. If the seal is missing or broken, the package shall be examined for obvious damage or tampering. If the package shows obvious damage or tampering, it shall be noted on the shipping papers and the health physics consultant shall be immediately notified.

17.10 All incoming packages containing radioactive material shall be surveyed within 3 hours of receipt (during normal working hours), or within 18 hours if received after normal working hours. **This includes Seaman and Troxler soils gages being returned to storage following field use.**

17.10.1 The outside of the shipping container is to be monitored with a survey meter for external radiation levels at the surface and at 1 meter. The radiation level should not exceed 200 mrem/hr against the package surface or 10 mrem/hr at 1 meter (3.3 feet) from any surface. If it does, contact the health physics consultant immediately.

17.10.2 This survey can be made with an ionization chamber meter or a Geiger counter. If needed, one can be obtained from the health physics consultant. Sources containing beryllium or lithium incorporated with an alpha emitter such as americium, plutonium, polonium or radium, emit neutrons which must also be included in the survey results. Neutron emitting gages used by Corporation facilities have been surveyed by the health physics consultant and a generic survey report issued. If a gamma survey is taken of the same gage model, it can be compared to the gamma intensities listed in the generic survey for the same model performed by the health physics consultant. In this way, a correction factor can be obtained to arrive at a total dose rate including both gamma and neutron components, using only an initial gamma reading. If a portable neutron survey meter is required, one can be obtained from the health physics consultant.

17.10.3 For those packages meeting the dose rates in 17.10.1, wipe the outer surfaces of the shipping package, especially around the seams, with a cotton tipped swab. (It is not necessary to wipe the device itself unless the source housing serves as the shipping package.) Cotton swabs are available from the dispensary on short notice, or they can be provided by the health physics consultant if notified ahead of time.

17.10.4 Check each wipe with a thin end-window GM meter as in 16.5. Other detectors will not be sensitive enough for this type of check. A meter can be provided by the health physics consultant upon request, if necessary.

17.10.5 If intensities higher than those stated in 17.10.1 are encountered, restrict access to radiation levels above 2 mrem/hr, and notify the health physics consultant for further instructions.

17.10.6 Send the envelope(s) for final analysis to:

A. LaMastra
Health Physics Associates, Inc.
RD 1 Box 796
Lenhartsville, PA 19534

Indicate on the envelope, **"Receipt Wipe--Immediate Analysis".**

17.10.7 Wash your hands after making the wipe test.

17.10.8 If the shipment is intended for immediate use and the package meets the specification in Section 17.10.1 and 17.10.4, the coordinator can then release it for use. If it is not to be used or installed immediately, the shipment is to be securely stored.

17.10.9 The coordinator should receive a copy of the shipping papers and a copy of the manufacturer's leak test report. With the exception of sources used in industrial radiography, a copy of these documents is to be forwarded to the health physics consultant as soon as the shipment is received and secured. The coordinator should also update his copy of the source inventory list to show receipt of the new source and the date received. If no leak test is provided by the manufacturer, one will have to be taken before the device can be installed. The procedures listed in 16.5 through 16.5.6 and 16.7 through 16.7.5 should be followed. However, in this case the **DEVICE ITSELF MUST BE WIPED.**

17.10.10 Radiation sources may not be removed from storage without notifying and receiving the approval of the radiation coordinator.

18. DISPOSAL OF RADIATION SOURCES

18.1 Disposal or transferal of radioactive materials is not to be made without prior notification of, and approval by the health physics consultant, through the local radiation coordinator.

18.2 The health physics consultant will assist in arranging for the disposal of all radioactive materials and advise the local facility on packaging and manifesting requirements.

18.2.1 A copy of all shipping papers and radioactive material disposal records shall be forwarded to the health physics consultant, if they do not originate with him.

18.3 X-ray equipment may be scrapped as desired. Any x-ray machine to be scrapped shall be so altered that it cannot be reactivated. A memorandum describing the method of disposal and date is to be sent to the health physics consultant.

18.4 If an x-ray machine is to be transferred to another Bethlehem facility or to a non-Bethlehem concern, the health physics consultant shall be notified prior to transfer. A formal letter of transfer shall be written to the recipient with a copy forwarded to the health physics consultant through the local radiation coordinator.

19. INDUSTRIAL RADIOGRAPHY

19.1 Government agencies and the Corporate Radiation Control Program require that industrial radiography performed by Bethlehem Steel Corporation employees be conducted under an on-going program established and supported by management at the local facility and conforming to these Corporate regulations.

19.2 Industrial radiography shall be considered to include all non-destructive testing of materials for the examination of such macroscopic physical characteristics such as the incidence of cracks, holes or inclusions, by methods or procedures utilizing radiation sources, except that operations, procedures and methods employing radiation sources in laboratory analyses (for example, x-ray diffraction), thickness and coating thickness gages, level indicators or controls, density gages or other similar applications (which are covered in Sections 21 and 22) shall not be classified as industrial radiography.

19.3 All Corporation radiographers and radiographer assistants shall successfully complete the Corporation's course, "Radiation Protection for Industrial Radiographers" plus periodic annual refresher courses.

19.4 The following regulations apply to all industrial radiographic operations at any Corporation facility or Corporation controlled site, and to vendors contracted to perform industrial radiography at any Corporation facility or Corporation controlled site. These regulations shall be made a part of the service contract.

19.4.1 Radiography shall only be performed by persons or firms currently licensed or registered by the USNRC or by a State agency having jurisdiction, using currently licensed or registered equipment.

19.4.2 No radiography shall be performed unless calibrated and operable survey instrumentation having a range of at least two milliroentgens per hour through at least 1000 milliroentgens per hour is available and used.

19.4.3 All open shop radiography shall be conducted within a restricted area which shall be enclosed by some means of area definition. Such barriers or restrictions shall be located so as to enclose the entire area where radiation levels exceed 2 millirem in any one hour. No one shall enter the restricted area unless he is wearing a personnel radiation monitoring dosimeter and a pocket dosimeter. The boundary of the restricted area shall be posted with signs bearing the words, "CAUTION--RADIATION AREA."

19.4.4 Within each restricted area, signs bearing the words, "CAUTION--HIGH RADIATION AREA," shall be conspicuously placed in the area surrounding the collimator or guide tube exposure tip so that approaching persons may be warned of the location of the radiation source and surrounding high radiation area.

19.4.5 Whole body exposures of non-radiography personnel working in unrestricted areas shall not exceed two millirems in any one hour or 100 millirems in a year. Guidance on permissible exposure rates are provided in the following tables.

19.4.5.1 Person exposed for 20 hours or less in a year.

Maximum Exposure Time in Minutes in Each Hour	Maximum Radiation Intensity At Restricted Area Barrier (mR/hr)
No Limit	2
24	5
12	10
6	20

19.4.5.2 Person exposed for more than 20 hours in a year.

Maximum Exposure Time in Minutes in Each Hour	Maximum Radiation Intensity At Restricted Area Barrier (mR/hr)
No Limit	0.05
24	0.13
12	0.25
6	0.50

19.4.6 All radiographic sources shall be continually attended by a radiographer or assistant radiographer with an operating and calibrated survey meter whenever the radiographic source is in an exposed position. An exception is that radiographic sources may be used unattended with locked, shielded facilities, the doors of which are equipped with interlocking devices so that the radiation exposure is automatically terminated upon entering, or an audible alarm sounds which can be heard by the intruder and the radiographer.

19.4.7 At least one door to each locked shielded facility must be capable of being readily opened from the inside.

19.4.8 All unlocked doors, roping and other temporary restricted area boundaries shall be under the direct surveillance of a radiographer or assistant radiographer immediately preceding and during the time that the radiographic exposures are in progress.

19.4.9 When radiography is to be performed in any area other than that in which it is normally done, the radiation coordinator and Plant Patrol shall be notified as to the location of the proposed radiographic area, the approximate time and duration of the work, the type of radiation source to be used, the period of time the source will be in the area and the name of the radiographer.

19.4.10 All radioactive material sources shall be securely locked in their shielded containers when not attended by a radiographer. During periods when such sources are not required for radiography, they shall be stored within locked enclosures. Security precautions shall be such as to prevent unauthorized exposure of the source or removal of the container. The storage area shall be restricted in such a manner so as to prevent radiation intensities in unrestricted areas in excess of two millirems in any one hour and shall be conspicuously posted with a radioactive material warning sign. X-ray machines shall be locked in the "off" position when not in use and secured against unauthorized use or removal.

19.4.11 Radium shall not be used for industrial radiography.

19.4.12 All x-ray machines which are operated below 150 kVp shall have a minimum of two millimeters equivalent of aluminum filtration in the primary beam. Those machines operating above 150 kV shall have a minimum of one-half millimeter equivalent of copper filtration.

19.4.13 All portable x-ray machines shall be equipped with a cone or collimator. The cone or collimator should be matched to the size film being used, where practical. Both the cone and collimator shall be attached flush to the x-ray machine.

19.4.14 Whenever a remote controlled exposure device is used, the radiation intensity at the operator's position shall be continuously measured during the extension of the source to insure that it has not become immobile in the source guide tube.

19.4.15 Following each radiographic exposure, whether with an isotope or x-ray source, the source shield or x-ray tube port shall be surveyed to insure that the source has been returned to the shielded position or, for an x-ray machine, to insure that the radiation exposure has terminated.

19.4.15.1 In the case of radioactive sources, this survey shall include the exposure device, guide tube(s) and collimator, if used. Additionally, the source shall be locked following its return to the shielded position after each exposure.

19.4.16 When radiation sources are not used in a shielded facility, a survey of the radiation levels at the unrestricted area boundary shall be made by the radiographer or assistant radiographer immediately following exposure of the source or the energizing of the radiation machine. Roping, barricades or other means of area definition shall be repositioned, if necessary, to properly enclose the restricted area as required in 19.4.5. Surveys between individual exposures are not necessary when a number of similar exposures are to be made of the same material, thickness, beam orientation, and no change is made in the radiation source, such as an increase in x-ray voltage or current or a change in sealed source strength. Spot surveys may be made to periodically confirm adequate restricted area definition. A record shall be made by the radiographer or the assistant radiographer of all initial boundary surveys.

19.4.17 At the conclusion of a radiography assignment employing a sealed source or before moving the source shield, a radiation survey shall be made by the radiographer or the assistant radiographer to assure that the source is in the shielded position. Another survey shall be made upon securing the device in its storage location. Records shall be kept of these surveys.

19.5 The health physics consultant and the local radiation coordinator shall be notified of all jobs involving vendor radiography. This notification shall include:

- The vendor's name, address and phone number;
- The vendor's USNRC or state license number;
- The Corporate facility involved;
- The types of items to be radiographed;
- The location of the restricted area;
- The time of day radiography is to be performed;
- The intended sources and strengths;
- The length of the service contract.

19.6 All new isotope radiographic sources shall be surveyed upon receipt, in accordance with Sections 17.10.1 to 17.10.9. This survey shall be recorded on a utilization log.

19.7 The health physics consultant shall perform an initial survey of all new permanent radiographic use locations.

19.8 Written procedures shall be prepared under the direction of the radiographer-in-charge and describe the safe handling and operation of each type of radiographic device that is to be used. A copy of each procedure shall be submitted to the health physics consultant for review prior to adoption.

19.9 A utilization log shall be maintained of all uses of radiation sources for radiographic purposes. Such a log shall include a description of the exposure device or storage container, the identity of the radiographer, the kind and quantity of the radioactive material or the kVp, mA and exposure time of an x-ray, the location of and the date of use, the survey meter serial number and the pocket dosimeter readings.

19.10 The health physics consultant shall periodically review operational procedures, records, utilization logs, inventories and other pertinent information relative to radiographic operations in order to determine general compliance with Corporate regulations, operating and emergency procedures, applicable governmental regulations, and license conditions.

19.11 The radiation coordinator shall notify appropriate governmental agencies of proposed vendor radiography if required by applicable regulations.

19.12 A minimum of two persons shall be provided by vendors to perform contracted radiographic operations. Both shall have been instructed in and understand the safe method of returning the radioactive source to an adequately shielded container or how to turn off the x-ray machine, should the radiographer become unable to do so; and how to make a radiation protection survey and interpret the results.

19.13 It is the vendor's responsibility to provide personnel monitoring dosimeters to all non-Bethlehem Steel personnel entering a restricted area. In the event the vendor fails to provide dosimeters to outside inspectors, dosimeters will be provided by the Corporation. All Corporation employees shall be provided dosimeters by the radiation coordinator at each facility.

19.14 Inspectors, either Bethlehem or contractor employees, required to enter a restricted area will be given instructions that:

19.14.1 They are not to enter a restricted area during an exposure.

19.14.2 They may enter the restricted area only after they personally observe that the radiographer has returned the source to its shielded position and has made a survey of the collimator, guide tube and source shield.

19.15 All inspectors are to have an operating survey meter whenever they enter a restricted area. Meters are available on loan from the health physics consultant or the radiation coordinator. Instructions will be provided in the proper use of the meter. This instruction may be provided by the health physics consultant or by the radiation coordinator.

19.16 All vendors performing radiography for the Corporation shall be given a copy of these regulations and shall govern their operations in accordance with these as well as the regulations applicable in the State in which the radiography is being performed.

20. MEDICAL DIAGNOSTIC X-RAY

20.1 Medical diagnostic radiation for Corporation related purposes shall be applied only under the direction of a physician directly employed or retained by the Corporation.

20.2 Diagnostic x-ray procedures shall be conducted only by personnel possessing adequate training as approved by the General Manager, HSCS, and appropriate governmental agencies. In the absence of a governmental regulation specifying required training, the General Manager, HSCS shall determine necessary qualifications. This training shall include as a minimum such topics as patient positioning, protection of the patient and operator, and radiographic exposure techniques and principles.

20.3 Medical x-ray facilities shall be designed and shielded in such a manner that minimum radiation exposure will be received by operators and persons in adjacent rooms and areas.

20.4 The health physics consultant shall review and approve all proposed plans for new installations and changes to existing installations prior to design finalization.

20.5 The operator's shield shall be provided with a means of visual and audible communication between the operator and patient while the operator is protected by the shield.

20.6 Procedures and auxiliary equipment designed to minimize patient and personnel exposure commensurate with the needed diagnostic information shall be utilized. This is interpreted to include but not be limited to:

20.6.1 The speed of film or screen/film combinations shall be the fastest speed consistent with the diagnostic objective of the examination and within the ability of the equipment.

20.6.2 The radiation exposure to the patient shall be the minimum exposure required to produce images of good diagnostic quality.

20.6.3 Portable x-ray equipment may be used only for those examinations where it is impractical to transfer the patient(s) to a stationary radiographic installation. "Portable" in this instance refers to the portability of the individual x-ray machine and does not refer to mobile vehicles containing fixed radiographic equipment.

20.6.4 Gonadal shielding of not less than 0.5 mm lead equivalent shall be used for all radiographic procedures taken on patients who are of reproductive age, in which the gonads are in the direct (useful) beam, except for cases in which this would interfere with the diagnostic procedure.

20.6.5 A technique chart shall be provided in the vicinity of each x-ray system's control panel. The chart shall specify at least the following information for each examination performed.

- Patient's anatomical size versus technique factors to be utilized,
- Type and size of the film or film-screen combination to be used,
- Type of grid to be used, if any, and focal distance,
- Source to film distance to be used,
- Type and placement of gonadal shielding to be used.

20.6.6 The minimum tube target to film distance (TFD) shall not be less than 40 inches (102 cm). The ratio of skin dose to film dose increases exponentially at TFDs below 40 inches.

20.7 Only individuals required for the x-ray procedure shall be permitted in the x-ray room during exposures. If clinic personnel must be present during exposures for medical reasons, they shall be positioned so that no part of the body including extremities not protected by 0.5 mm lead equivalent will be struck by the useful beam. No one shall be used to hold film.

20.7.1 A record shall be made of all examinations requiring patient holding and shall include the name of the holder, date of the examination, number of exposures and technique factors utilized for the exposure(s).

20.8 Access to x-ray rooms shall be restricted during the time when exposures are in progress in order to prevent inadvertent entry and unnecessary exposures.

20.9 Written safety procedures and rules shall be provided to each individual operating x-ray equipment under his control, including any restrictions of the operating technique required for the safe operation of the particular x-ray system. The operator shall be able to demonstrate familiarity with these rules.

20.10 Close attention shall be paid to kVp, mA and time settings to insure that the first exposure results in a satisfactory film with minimal radiation exposure.

20.11 Proper collimation and shielding shall be carefully performed to insure that the x-ray beam is limited to the area of clinical interest, and not larger than the size of the film.

20.12 Dark-room and developing procedures shall be carefully monitored to insure that a properly exposed film is not rendered unreadable through technical or mechanical error.

20.13 All new medical diagnostic x-ray systems or replacement components shall comply with Title 21, Code of Federal Regulations, Parts 1000 to 1040 (21 CFR 1000-1040). A statement from the installer certifying that the equipment has been manufactured and installed in compliance with this regulation shall be obtained at the completion of installation of the system or components.

20.14 Stepless variable collimators with light-field localization shall be used to restrict the radiation beam to the area of clinical interest. The collimator shall provide the same degree of protection as is required for the tube housing.

20.15 The exposure switch shall be of the "dead-man" type and shall be so arranged that it can be manipulated only when the operator is within a shielded area.

20.16 The tube housing shall have a diagnostic tube rating.

20.17 The half-value thickness of the useful beam as expressed in millimeters of aluminum shall be:

- At least 0.5 mm for equipment operating below 50 kVp,
- At least 1.5 mm for equipment operating at 50-70 kVp,
- At least 2.5 mm for equipment operating above 70 kVp.

20.18 Operators should check the amount of added filtration to assure that the required total thickness is present for the kVp setting being used.

20.19 Where two or more radiographic tubes are controlled by one exposure switch, the tube selected shall be clearly indicated prior to initiation of the exposure. This indication shall be both on the x-ray control and at or near the tube housing assembly which has been selected.

20.20 Each medical x-ray facility shall maintain at least the following information for each x-ray machine:

- Maximum rating of technique factors.
- Model numbers of all certifiable components.
- Aluminum equivalent filtration of the useful beam, including any routine variation.
- Tube rating charts and cooling curves.
- Record of surveys, calibrations, maintenance, modifications (from the original schematics and drawings) performed on the x-ray machine along with the names of persons who performed the service.
- A scale drawing of the room in which a stationary x-ray system is located. The drawing shall indicate the type of materials and their thickness (or lead equivalence) for each wall, ceiling, floor, doors, windows and special shielding. The drawing shall also indicate the type of occupancy of adjacent areas. This includes areas above and below the x-ray room as well as the adjacent areas on the same floor (e.g., hallways, offices, parking lots, and toilets). Estimates of the frequency of occupancy of each adjacent area shall also be noted on the drawing. This information is to be forwarded to the health physics consultant.

20.21 Each facility shall keep a patient log which shall indicate the following information as a minimum:

- Identification of the patient, including name, clock symbol and number and Social Security number, age, and sex.
- Date of x-ray examination.
- Examination provided.
- Any deviation from the standard procedure or technique (including all repeat exposures) as denoted in the technique chart required in 20.6.5.
- The x-ray system used (if more than one is available).
- Name of technician, if more than one is available.

20.22 Fluoroscopic or photofluorographic x-ray systems shall not be procured or used at any Corporation facility.

20.23 The following policies concerning preemployment x-rays were distributed on September 10, 1975, and January 24, 1977 by the Corporate Medical Director and are incorporated as part of these regulations:

20.23.1 The employment office or hiring authority at every location should review these policies with the examining physician and, wherever appropriate, radiologist, hospital or health agency performing x-ray examinations on applicants for employment to insure that the best interests of all concerned and the applicant's right to proper radiation protection are met. Any questions regarding preemployment x-ray matters should be directed to the General Manager, HSCS.

20.23.2 **Chest X-rays** -- The following apply to all locations routinely taking chest x-rays on their own equipment or purchasing such roentgenograms from a physician, hospital or health agency:

20.23.2.1 Every applicant, except those for whom the examination is medically contraindicated and those who can provide for Bethlehem's retention, a satisfactory, current (less than 90 days) 14" x 17" PA film, will be x-rayed.

20.23.2.2 Only a single PA, six foot exposure using a 14" x 17" film will be made. Stereo and lateral exposures will not be routinely taken but will be performed only when medically indicated and ordered by the examining physician. Repeat examinations will be made only when medically indicated or when the first film is not readable and then only after the technical problem causing the unsatisfactory film has been fully corrected.

20.23.2.3 Photoroentgen (or photofluorographic) units providing 4" x 5", 70 mm or other small pictures shall not be procured.

20.23.2.4 Close attention shall be paid to kVp, mA and time settings to insure that the first exposure results in a satisfactory film with minimal radiation exposure.

20.23.2.5 Proper collimation and shielding shall be carefully performed to insure that the x-ray beam is limited to the area of clinical interest, and not larger than the size of the film.

20.23.2.6 Dark-room and developing procedures shall be carefully monitored to insure that a properly exposed film is not rendered unreadable through technical or mechanical error.

20.23.3 **Low Back X-Rays** -- Low back x-rays shall not be taken or purchased from a physician or hospital on prospective employees solely because they will or may be subjected to increased risk of episodes of low back pain allegedly due to employment. Pre-employment low back x-rays shall be taken only if there is specific medical indication that an individual has or has had a low back condition of such severity that it is medically inadvisable to subject the person to a job which is known to be physically stressful to the back until the bony structure of the low back is evaluated, and only if previous back x-rays are not available. In that event the following apply:

20.23.3.1 Low back x-rays shall not be taken on any female applicant.

20.23.3.2 Male applicants shall not be subjected to x-rays of the low back unless a gonadal shield has been properly fitted and remains in place during the entire examination.

20.23.3.3 Close attention shall be paid to kVp, mA and time settings to insure that the first exposure results in a satisfactory film with minimal radiation exposure.

20.23.3.4 Dark-room and developing procedures shall be closely monitored to insure properly exposed films are not rendered unreadable through technical or mechanical errors.

20.23.3.5 The smallest size film that will give the necessary diagnostic information shall be used. Proper collimation and shielding shall be carefully performed to insure that the x-ray beam is limited to the area of clinical interest, and not larger than the size of the film.

21. GAGING DEVICES

21.1 All new gaging systems utilizing x-ray or isotope radiation sources shall comply with the ionizing radiation gaging device specifications found in Section 29, and with all other applicable parts of these regulations.

21.2 **General Requirements:** All gaging systems shall comply with these general requirements as applicable.

21.2.1 All maintenance and calibration shall be performed by personnel meeting the training requirements of Section 8.4 and who are familiar with the equipment and the correct procedures to be followed.

21.2.2 All personnel who routinely maintain radiation producing gages shall wear radiation personnel monitoring devices as required by Section 9.

21.2.3 During external calibration, standard samples shall be inserted into the primary radiation beam by means of an extended handle which is at least 12 inches in length, unless the gage shutter has been placed in the beam path.

21.2.4 X-ray tubes shall not be energized unless installed in a shielded tube enclosure except for testing purposes by trained maintenance personnel, and only when adequate external shielding is provided or when performed in restricted areas posted with appropriate radiation warning signs.

21.2.5 All safety features such as shutters, warning lights and interlocks shall be tested at least semi-annually for reliable performance, and the date and test results documented.

21.2.6 The area near the tube housing of all x-ray gages as well as the control panel is to contain a warning sign alerting personnel to existence of an ionizing radiation beam when energized.

21.2.7 Gaging devices in which it is possible to insert any part of the body shall be posted with a warning sign(s) alerting personnel of a radiation beam in the air gap. The sign(s) shall be visible from the normal avenues of approach to the gaging device.

21.2.8 All gages containing radioactive materials shall be equipped with a durable label which bears the words, CAUTION--RADIOACTIVE MATERIAL, the kind and quantity of the radioactive material contained, the date on which the material was assayed, the device manufacturer, the model number and the serial number of the device. These labels shall be replaced when worn.

21.2.9 Bins, cupolas or conduits large enough to permit a person to enter shall have a warning sign posted at all entrance points. The sign(s) shall have wording similar to the following.

A RADIATION GAGE IS INSTALLED ON THIS BIN

CONTACT (TITLE) **AT** (PHONE EXT.)

TO LOCK OUT GAGE BEFORE ENTERING

21.2.10 Warning tags and signs shall be of durable construction and suitable for the environment in which the gage is located.

21.2.11 Installation or relocation of the device containing the radiation source shall be performed only under the supervision of the health physics consultant or a person authorized by the license.

21.2.12 When an installation having a gaging device is to be inactive for any prolonged period of time, the shutter shall be locked in the closed position.

21.2.13 JSA's or other written procedures shall be prepared for personnel performing maintenance and calibration on gaging system. The procedure shall be approved by the local radiation coordinator and the health physics consultant before final issue. It shall include whether radiation monitoring badges are required, precautions to be taken and methods of protection. The procedure shall also describe lockout procedures and procedures for bypassing and removing bypasses from safety systems, if necessary for maintenance and calibration. These procedures shall be reviewed with maintenance personnel prior to the beginning of the job.

21.2.14 JSA's or other written procedures shall be prepared for electrical, mechanical, labor, or other maintenance personnel who work on or around equipment on which gaging devices are installed. The instruction shall stress the meaning of any warning signs or lights, that maintenance crews shall not enter a restricted area with the source exposed, and whom supervision of the crew is to notify to lock out and tag the radiation source shutter when work is to be performed on or near equipment having radiation sources installed. These procedures shall be reviewed with the maintenance crew prior to their beginning the job. The procedures shall be approved by the radiation coordinator and the health physics consultant prior to final issue.

21.2.15 Personnel having occasion to enter bins, cupolas or conduits on which a radiation gage is installed shall not enter the bin, cupola or conduit until they have arranged for the gage shutter to be locked in the off position and tagged, and a radiation survey has been made of the interior to assure that the gage is off.

21.2.16 Unless it is necessary for the x-ray tube to be energized during maintenance to the tube enclosure and/or the detector, the power supply to the tube shall be positively interrupted by such means as the removal of fuses and locking and tagging main disconnect switches in the "off" position.

21.2.17 An initial survey shall be made of all new installations or relocations of gaging devices. The survey is to be made by the health physics consultant or other individual authorized by the license to make an initial survey. The initial survey shall identify nearby work stations and the frequency of personnel occupancy in nearby areas. Radiation exposure rates in these areas shall be determined. Required posting of warning signs and any restriction on personnel occupancy shall also be indicated.

21.3 **Thickness Gages** -- Thickness gages are used in plate, sheet and strip mills. The gages usually do not emit significant radiation to surrounding areas under normal conditions of use because of the small, well-defined radiation beam. The possibility of whole body radiation exposure is dependent on the size of the air gap. Exposures of concern are to the whole body or gonads and the accidental exposure of the hands and fingers to the primary beam. Whole body exposures are usually not probable with air gaps below 24 inches. Personnel exposure is most likely to occur during maintenance and manual calibration operations, and to personnel working nearby the gages who are not aware that the radiation beam is "on".

21.4 **Coating Thickness Gages** -- X-ray coating thickness gages may generate significant external scatter radiation fields, in some cases as high as several hundred milliroentgens per hour. Isotope source coating thickness gages generally do not create these intense external scatter fields.

22. X-RAY DIFFRACTION AND SPECTROSCOPY TYPE EQUIPMENT

22.1 Analytical equipment of this type is usually operated in the range of 10 to 100 kVp, and usually with minimal beam filtration. Beam currents may range in the order of 10 to 100 mA. The resultant primary beam, therefore, has an exceedingly high radiation intensity and is capable of causing severe burns to the hands and fingers from both the primary beam and secondary scatter. It is also possible for considerable stray radiation to result from scattering by the sample material or auxiliary equipment. The following shall be observed regarding this type of equipment.

22.2 No part of the body shall be placed in the sample area while the primary beam is present. In those cases where it is necessary to manually position the sample in the area of the primary beam, the x-ray tube shall be de-energized or the primary beam adequately attenuated during such sample positioning. An interlocking device of a "failsafe" design, which prevents the entry of any part of the body into the primary beam or causes the primary beam to be shut off or adequately attenuated upon entry into its path, shall be provided.

22.3 Shutters, interlocks, warning lights and other safety devices shall be tested at least once each week to insure proper operation. Such tests shall be performed by the personnel who operate or service the x-ray system.

22.4 Unless otherwise necessary, all maintenance on the system shall be performed while the power supply to the tube is positively interrupted by such means as fuse removal or tagging and locking switches in the "off" position.

22.4.1 Should it become necessary to perform maintenance with the power supply on or with any safety system bypassed, a check list shall be developed describing the step-by-step procedures for pre-maintenance, maintenance and post-maintenance work. This check list shall be completed by both the technician and supervisor and signed, dated and retained. A sign stating **"SAFETY DEVICES BYPASSED"** shall be placed at the control panel and at the x-ray tube, and not removed until the bypass is removed and the bypassed safety system restored, checked and found to be working properly.

22.5 A label bearing the words **"CAUTION--RADIATION--THIS EQUIPMENT PRODUCES RADIATION WHEN ENERGIZED"** shall be placed near any switch which energizes an x-ray tube.

22.6 A sign bearing the words **"CAUTION--HIGH INTENSITY X-RAY BEAM"** shall be placed immediately adjacent to each tube head and sample area. The sign shall be so located that it is clearly visible to any person operating, aligning or adjusting the unit or handling or changing a sample.

22.7 A light indicating the presence of an x-ray beam shall be provided on all "open beam" equipment, on or immediately adjacent to each tube head, and located so that it is clearly visible to any person operating, aligning or making adjustments to the apparatus, or changing samples. The light shall be adequately labeled as to its meaning. On equipment installed after 1986, this indicator shall be of a "fail safe" design.

22.8 On "open beam" equipment, indication of the status (i.e., open or closed) of every beam port shutter shall be provided and be so located that it is clearly visible to any person operating, aligning or making adjustments to the apparatus, or changing samples. The indicator shall be adequately labeled as to its meaning. Whenever feasible, the indicator shall be a light of a "fail safe" design.

22.9 Unused tube ports on "open beam" equipment shall be secured in such a fashion that accidental opening is not possible.

22.10 Radiation surveys using thin window detectors shall be performed to insure that operations are conducted safely following initial installation, whenever changes to the physical configuration of the equipment are made, following any maintenance or alignment procedure, following the addition of new components or any time a visual inspection reveals an abnormal condition.

22.11 No person shall be permitted to operate or maintain analytical x-ray equipment unless such person has received instruction and demonstrated competence in the:

22.11.1 Safe operation of the equipment;

22.11.2 Identification of radiation hazards associated with the use of the equipment;

22.11.3 Significance of the various radiation warning and safety devices incorporated into the equipment, or the reasons they have not been installed on certain pieces of equipment and the extra precautions required in such cases;

22.11.4 Proper operating procedures for the equipment;

22.11.5 Symptoms of an acute localized exposure, and

22.11.6 Proper procedures for reporting an actual or suspected exposure.

22.12 In cases where the primary x-ray beam is not intercepted by the experimental apparatus under all conditions of operation, protective measures shall be provided, such as auxiliary shielding, to avoid exposure to the secondary x-ray beam.

22.13 Doors to rooms containing x-ray diffraction or spectrographic x-ray devices shall be posted with a warning sign stating **"CAUTION--X-RAY EQUIPMENT"**.

22.14 All tube housings shall be interlocked so that opening the housing will interrupt current to the x-ray tube.

22.15 Records of surveys made under 22.10 or tests made under 22.3 shall be maintained for a minimum of 5 year.

22.16 A JSA or other written procedure shall be prepared for each normal operating, alignment or maintenance procedure used. The procedure shall be approved by the health physics consultant and the local radiation coordinator before final issue. It shall specify whether personnel radiation monitoring badges shall be worn, precautions to be taken, and the methods of protection to be taken. The procedures shall also describe methods of installing and removing bypasses from the various safety systems if bypassing is necessary for

alignment, maintenance or calibration. A copy shall be available to be used by operating and maintenance personnel.

23. ELECTRONIC TUBES OPERATING AT HIGH VOLTAGES

23.1 Electronic vacuum tubes operated above 10,000 volts possess all the means necessary to produce x-rays. In tubes operated at voltages below 15 keV, any x-rays produced are probably not significant since they are readily attenuated in the tube walls and in the air immediately surrounding the tube. Tubes that should be suspected of emitting radiation capable of causing significant personnel exposure are klystrons, magnetrons and thyratrons used to generate microwave, radar and other forms of radio-frequency radiation. Some pre-1974 oscilloscopes have also been known to emit x-rays in appreciable quantities from the screen.

23.2 Some electronic tubes are being manufactured which contain small quantities of radioactive materials in order to maintain a constant ionized environment within the tube. Radium is a commonly used isotope in older tubes. Newer tubes may use a weaker beta emitting radionuclide and do not present as much of a hazard. These tubes will be marked with the magenta and yellow radiation symbol and the words, **CAUTION--RADIOACTIVE MATERIAL.** Any potential hazard from small quantities of these tubes will be due to breakage and subsequent release of the radioactive material which can possibly be inhaled or otherwise enter the body through cuts or breaks in the skin. In quantities of 10 tubes or more, a potential external exposure may be produced if the tubes contain radium 226 and are stored in high personnel occupancy areas.

23.3 Where any of these potential sources of radiation are encountered and there is any doubt as to whether high voltage equipment is emitting x-rays, the health physics consultant should be contacted.

24. ACCELERATORS AND ELECTRON MICROSCOPES

24.1 **Accelerators** -- An accelerator is any radiation producing machine capable of imparting kinetic energies of 1 MeV or greater to electrons or 0.1 MeV or greater to other particles. Accelerators create specialized hazards due to their operation and thus require controls beyond those required for conventional x-ray generators. Under certain circumstances the health physics consultant may classify a device imparting kinetic energies less than those listed above as an accelerator because of the device's operating characteristics and inherent hazards.

24.1.1 Operating procedures for normal, bypass and emergency operations shall be written and all operators shall be provided a copy and be familiar with the procedures.

24.1.2 All operators shall be trained in the safe use and emergency procedures of the accelerator, survey meter operation and survey techniques to be used, radiation levels that may be encountered, biological effects of radiation exposure and associated risks, methods of protection, and applicable regulations.

24.1.3 Up-to-date wiring diagrams of the accelerator control, safety interlock and warning circuits are to be maintained and available. No modifications shall be made to the wiring circuit without a determination that the modification will not adversely affect the accelerator control, interlock, or warning circuits.

24.1.4 An independent radiation monitoring system shall be provided for all high radiation areas in which personnel can enter, so that persons entering the high radiation area are made aware of the existence of a radiation hazard. Independent monitors shall be calibrated on a semi-annual frequency.

24.1.5 Entrances to all high radiation areas shall have failsafe interlocks that cause the cessation of the production of the radiation beam if tripped and prevent the production of radiation while tripped.

24.1.5.1 It shall only be possible to resume accelerator operation by resetting the tripped interlock and then manually resetting the controls at the accelerator console.

24.1.6 An emergency power cut off switch shall be located and easily identified in all high radiation areas. The cut off switch shall include a manual reset so that it is not possible to restart the accelerator without first resetting the cut off switch.

24.1.7 Warning lights that illuminate only when radiation is being produced shall be installed at the accelerator console and in each high radiation area. The warning light circuit shall be of a failsafe design.

24.1.8 Tests of all safety and warning devices shall be made on a quarterly frequency and documented.

24.1.9 The health physics consultant shall review the design and safety systems prior to the construction of the accelerator facility. The health physics consultant shall review the operating and emergency procedures and perform an initial survey prior to the accelerator being placed into operation.

24.1.10 Interlocks shall only be bypassed if prior written authorization is given by the health physics consultant. Should it become necessary to bypass a safety system, a check list shall be developed describing the step-by-step procedures for bypassing the interlock(s), performing the necessary work, and removing the bypass.

This check list shall be completed by both the technician and supervisor and signed, dated and retained. A sign stating **"SAFETY DEVICES BYPASSED"** shall be placed at the control panel and in the high radiation areas, and not removed until the bypass is removed and the bypassed safety system restored, checked and found to be working properly.

24.1.11 Accelerators capable of causing activation shall be evaluated by the health physics consultant prior to the accelerator being placed into operation and protection measures implemented to prevent personnel exposures to external and internal radiation. If airborne radioactivity is likely, routine air sampling shall be instituted.

24.2 Electron Microscopes

24.2.1 An initial survey shall be made of each electron microscope installation.

24.2.2 Radiation surveys shall be made whenever the accelerating column is dismantled and reassembled.

24.2.3 Each electron microscope shall have a warning tag that states, "CAUTION - THIS EQUIPMENT PRODUCES RADIATION WHEN ENERGIZED" placed near the switch that initiates the production of the electron beam.

25. TRACER STUDIES

25.1 Radioactive tracer techniques involve the introduction of loose radioactive materials into a chemical or metallurgical process for the investigation of various phenomena such as the degree of wearing or erosion, degree of mixing, rates of reaction and the origin or fate of various materials.

25.2 Of concern during such operations is the possibility of the spread of contamination and the internal exposure of personnel.

25.3 Adequate preparation must be made prior to the use of radioactive materials for tracer studies. Proper handling techniques, adequate ventilation, material containment, equipment and personnel control are several of the items which must be considered. The health physics consultant shall be consulted on all such projects early in the planning stage. Prior to initiating work on any tracer study, the details of the planned project are to be brought to the attention and approved by the health physics consultant.

25.4 If the project is to be conducted under the Corporation's Broad Scope Research and Development license at Homer Research Laboratories or one of the plants, the project shall be approved by the Research Radiation Protection Committee. The health physics consultant shall be contacted well in advance of the initiation of the project.

26. INSTRUMENT CALIBRATIONS

26.1 All survey meters used for radiation protection surveys shall be calibrated at a facility approved by the health physics consultant.

26.1.1 Radiation protection surveys include all surveys in which the radiation exposure or dose rate is determined for the purpose of: (1) protecting personnel; (2) informing personnel of the intensity of a radiation field or the quantity of radioactive material in a particular location; (3) assuring that a radiation source is "off"; (4) determining personnel radiation dose; or (5) surveys of packages containing radioactive material that are being received or shipped.

26.1.2 Radiation surveys made to determine the continued presence of wear indicating sources in blast furnaces refractory are not considered radiation protection surveys. However, these instruments should also be calibrated on a quarterly frequency to assure the accuracy of the readings.

26.2 Instruments used for gamma or x-ray radiation protection surveys shall be calibrated on a quarterly frequency or following the replacement of a major component or repair.

26.2.1 A condenser R Meter or integrating ratemeter with a calibration traceable to the National Institutes of Standards and Technology (NIST) shall be used as a laboratory standard to calibrate all gamma and x-ray sources which are, in turn, used to calibrate survey instruments.

26.2.2 Cesium 137 shall be the normal calibration source for instruments used for general gamma and x-ray surveys, as follows.

26.2.2.1 Gamma intensities from the cesium 137 source shall be determined at fixed distances from the source using an instrument described in 26.2.1 and having known response characteristics at the energy in question. The data derived shall be used to create a plot of gamma intensity versus distance from the source. The source shall be checked annually and a new plot drawn if the data vary from the original by more than 5 percent.

26.2.2.2 Survey meters shall be positioned at pre-selected distances which are chosen to permit the calibration at two points on each scale, at approximately one-third and two-thirds of full scale deflection. The calibration potentiometers of the instruments shall be subsequently adjusted to agree within ± 20% of the intensity indicated by the calibration curve, as being present at the distance at which the detector is positioned. The deviation of the instrument from the known value shall be included on the calibration sticker on the instrument if the instruments response does not agree with the known value.

26.2.3 Those instruments used for low energy surveys (100 keV maximum energy) shall also be calibrated to an americium 241, 60 keV photon or to an x-ray beam.

26.2.3.1 Gamma intensities from an americium 241 source shall be determined at fixed distances from the source using an instrument described in 26.2.1 and having known response characteristics at the energy in question. The data derived shall be used to create a plot of gamma intensity versus distance from the source. A recalibration check shall be made if the physical conditions in the laboratory change. A new plot shall be drawn if the data vary from the original by more than 5 percent.

26.2.3.2 Survey meters which have been calibrated to the cesium 137 source shall be positioned at pre-selected distances which are chosen to permit the calibration at two points on each scale, at approximately one-third and two-thirds of full scale deflection, whenever practical. The corresponding meter reading in mR per hour at the distances selected shall be recorded and used to obtain a correction factor by which a cesium 137 calibrated meter response may be multiplied to give the correct exposure rate when exposed to a 60 keV Americium 241 photon. The correction factors for each scale shall be returned with the survey meter.

26.2.3.3 X-ray intensities from a Picker 110 kVp, beryllium window x-ray tube shall be determined at fixed distances from the tube target for various energies, beam currents and beam filtration using an instrument described in 26.2.1 and having known response characteristics at the energies in question. The data derived shall be used to establish parameters for the calibration of survey meters. Recalibration of the x-ray shall be performed semi-annually, or prior to use if use intervals exceed 6 months.

26.2.3.4 Survey meters which have been calibrated to the cesium 137 source shall be exposed under conditions stated on the x-ray calibration chart. If possible, a calibration will be performed on each scale of the instrument. The corresponding meter reading in mR per hour shall be recorded and used to obtain a correction factor by which a cesium 137 calibrated meter response may be multiplied to give the correct exposure rate when exposed to the beam energy and beam filtration used. The correction factors for each energy and beam filtration combination to which the survey meter has been calibrated shall be returned with the survey meter.

26.2.4 Those instruments used for high energy surveys (1000 keV or greater) shall also be calibrated to a cobalt 60 source.

26.2.4.1 Gamma intensities from a cobalt 60 source shall be determined at fixed distances from the source using an instrument described in 26.2.1 and having known response characteristics at the energy in question. The data derived shall be used to create a plot of gamma intensity versus distance from the source. A recalibration check shall be made annually and a new plot drawn if the data vary from the original by more than 5 percent.

26.2.4.2 Survey meters which have been calibrated to the cesium 137 source shall be positioned at pre-selected distances which are chosen to permit the calibration at two points on each survey meter scale at approximately one-third and two-thirds of full scale deflection whenever practical. The corresponding meter reading in mR per hour at the distances selected shall be recorded to obtain a correction factor by which a cesium 137 calibrated meter response shall be multiplied to give the correct exposure rate when exposed to a photon energy from one to three MeV. The correction factors for each scale shall be returned with the survey meter.

26.3 Instruments used for neutron surveys shall be calibrated on an annual frequency or prior to use for calibration intervals exceeding 12 months, or following the replacement of a major component or repair.

26.3.1 The flux in neutrons per square centimeter per second as supplied by the source manufacturer, and traceable to NIST shall be used to calculate the dose rate in millirem per hour at various distances. The corresponding meter reading in counts per minute or millirem per hour at the distances selected is determined by exposing the meter probe to the neutron flux at those distances. From the data obtained, a calibration curve showing the meter reading in counts per minute versus the dose rate in millirem per hour is drawn and used to interpret meter readings obtained during surveys. For rem responding instruments, the instrument will be adjusted to read directly in dose equivalent rate units (rem or millirem per hour).

27. REPORTING OF EXPOSURE INCIDENTS

27.1 Personnel shall immediately notify supervision of any unusual situation involving a radiation producing device.

27.2 Supervision shall immediately notify the local radiation coordinator if it appears that the unusual situation could have caused unnecessary radiation exposure. If the radiation coordinator is unavailable, the health physics consultant shall be notified at 8-232-6460 or (215) 756-4153.

27.3 The following incidents are required to be reported to the USNRC, OSHA or state regulatory agency, as applicable, within the reporting time limit indicated. All reports shall be made by HSCS.

27.3.1 **Immediate telephone report**--An immediate notification shall be made upon determining that one of the following situations has occurred.

27.3.1.1 Incoming shipments of radioactive materials which show excessive surface contamination, surface radiation dose rates in excess of 200 millirem per hour, or dose rates at 1 meter from the surface in excess of 10 millirem per hour.

27.3.1.2 The theft or loss of a radioactive material source.

27.3.1.3 Any incident which may have caused or threatens to cause: (1) an effective dose equivalent to radiation workers of 25 rems or more; (2) a shallow dose equivalent to the skin or extremities of 250 rems or more; (3) an eye dose equivalent of 75 rems or more; (4) release of radioactive material that could cause an intake of 5 times the occupational annual limit on intake (averaged over 24 hours); (5) a loss of 1 working week or more of any operation affected; or, (6) property damage in excess of $200,000.

27.3.2 **Twenty-four hour report**--Notification within 24 hours shall be made upon determining that one of the following incidents has occurred.

27.3.2.1 Any incident, involving a radiation source, which may have caused or threatens to cause: (1) an effective dose equivalent exceeding 5 rems.; (2) a shallow dose equivalent to the skin or the extremities exceeding 50 rems; (3) an eye dose equivalent exceeding 15 rems; (4) release of radioactive material that could cause an intake exceeding the occupational annual limit on intake; (5) a loss of 1 working day or more of any operation affected; or (6) property damage in excess of $2000.

27.3.3 **Five day report**--Notification within 5 working days shall be made upon determining that a radioactive material source capsule has lost its ability to fully contain the material (leaking source).

27.3.4 **Thirty day written report**--A written report shall be made to the applicable regulatory agency within 30 days of the discovery that a reportable incident as listed in 27.3.4.1 through 27.3.4.6 has occurred.

27.3.4.1 Any incident requiring notification as listed in Section 27.3.1 through 27.3.3.

27.3.4.2 A dose to a fetus of a declared pregnant female exceeding 0.5 rem.

27.3.4.3 Exposure of minors or the general public in excess of the annual limits for these classes.

27.3.4.4 Exposures in a restricted area exceeding any limit specified in the radioactive material license.

27.3.4.5 Radiation levels in unrestricted areas in excess of 10 times the limits specified in Sections 7.5 and 7.5.1.

27.4 Notification of the incident circumstances, the assigned dose and the potential consequences of that dose shall be made to any employee exposed during any incident described in Sections 27.3.1 through 27.3.4.5. Such notification shall be in writing and be made by HSCS, no later than the time the written report is sent to the regulatory agency.

27.5 All written reports shall be prepared in such a way that the name, social security number and date of birth of all exposed persons are on a separate and detachable part of the report.

28. REPORTING OF DEFECTS UNDER 10 CFR 21

28.1 This Section provides procedures to assure compliance with Title 10, Code of Federal Regulations, Part 21, as it pertains to the procurement, possession and use of byproduct, source or special nuclear material; devices containing byproduct, source or special nuclear material; or the procurement of services involving byproduct, source or special nuclear material, by any Corporation facility or activity.

28.2 The Vice President, Human Resources Department, is the responsible officer for the purposes of 10 CFR Part 21.21(a).

28.2.1 The Director, Occupational Health, HSCS, shall be responsible under this Section for:

28.2.1.1 Advising the Vice President of Human Resources, through the General Manager, HSCS, of a failure to comply or a defect as defined in Part 21.

28.2.1.2 Notifying the U.S. Nuclear Regulatory Commission, through the General Manager, HSCS, as required by 10 CFR Part 21.21(b).

28.2.1.3 Having the necessary investigations performed to determine if a deviation is a defect.

28.2.1.4 Having suppliers notified of suspected deviations or defects through the Purchasing Department.

28.2.1.5 Having procedures developed to assure compliance with these regulations.

28.3 Liaison between the Director, Occupation Health and the local facilities shall be through the health physics consultant and, (1) the plant environmental health engineer, where one exists, or (2) the radiation coordinator at those facilities not having an environmental health engineer.

28.4 The environmental health engineer or the radiation coordinator at each facility licensed by the U.S. Nuclear Regulatory Commission to possess or use byproduct, source or special nuclear material shall review these regulations with all affected Departments in the facility.

28.5 The local facility shall develop procedures to assure that any failure to comply with the Atomic Energy Act of 1954 as amended; any applicable rule, regulation, order, or license condition of the Commission relating to a substantial safety hazard; and all deviations are promptly reported to the health physics consultant. Some examples of deviations which shall be reported to the health physics consultant are:

- Incoming shipment significantly exceeding Transport Index values.
- Incoming shipments exceeding 200 mrem/hr at the surface of the outer shipping container or 10 mrem/hr at 1 meter from the surface.
- Newly purchased devices exceeding leakage rates of 5 mR/hr at 1 foot (30 cm) from the surface of the device.
- Incoming shipments exceeding the package surface contamination limits. In Section 15.4.8
- Incidents which could result in personnel exposures in excess of 5 rem in restricted areas or 0.1 rem in unrestricted areas.

28.6 The health physics consultant shall notify the Director, Occupational Health, of all failures to comply with the Atomic Energy Act of 1954, as amended, or any applicable rule, regulation, order, or license condition of the Commission relating to substantial safety hazards and all deficiencies. The health physics consultant shall also initiate an investigation to determine if a deficiency is a defect.

28.6.1 In those instances in which the health physics consultant is not able to make this determination, the Vice President, Human Resources Department, shall be advised.

28.6.1.1 The Director, Occupational Health, through the Purchasing Department, shall notify the supplier of the defective component or service of the deviation and request assistance from the supplier in making the determination.

28.6.1.2 If the supplier is unable or unwilling to assist in the determination, notification shall be made by the Vice President, Human Resources Department, to the U.S. Nuclear Regulatory Commission of a suspected defect.

28.6.2 In those instances in which the health physics consultant determines that a defect does exist, the Vice President, Human Resources Department, shall be notified, so that notification to the U.S. Nuclear Regulatory Commission can be made by telephone within 2 days of such determination. A written report shall be submitted to the NRC within 5 days.

28.6.2.1 The information to be submitted in the written report is:

- Identify the basic component with the defect of activity that failed to comply,
- Include the nature of the defect or failure and the safety hazard created or that could be created by the defect or failure.
- Identify the date the information was obtained.
- List all locations where the basic component or activity may be in use or take place.
- Describe corrective actions taken or being taken.
- Advice related to the defect or activity that has been, or will be given to personnel.

28.6.3 In those instances in which the health physics consultant determines that a defect does not exist, a file memorandum documenting the conclusions and all supporting information shall be forwarded to the Vice President, Human Resources Department, for concurrence.

28.7 All purchase orders for radioactive materials shall contain the clause:

> "The U.S. Nuclear Regulatory Commission Regulation 10 CFR 21 is applicable to the device, radioactive material or service included in this purchase order."

28.8 Records of evaluations and notifications performed under this Section shall be maintained and disposed of in accordance with 10 CFR 21.51.

29. IONIZING RADIATION GAGING DEVICE SPECIFICATION

29.1 **Applicability** - This specification applies to all gages containing radioactive or x-ray sources which are used at corporation facilities. Some parts of the specification apply to conditions of use and are the responsibility of the operating department.

29.2 **Referenced Standards** - The American National Standard, "Classification of Industrial Radiation Gaging Devices" N43.8-1988 or later revision, is incorporated into this specification by reference. All provisions of N43.8 are included in this specification unless specifically exempted. ANSI documents may be purchased from the American National Standards Institute, 1430 Broadway, New York, NY 10018.

29.3 **Deviations from N43.8** - The following specifications are in addition to the requirements of N43.8.

29.3.1 The source and source holder is to be designed and constructed of suitable materials and mounted so as to prevent its becoming loose or misaligned under normal intended conditions of use.

29.3.2 Consideration is to be given by engineering to providing safe access to all components of the gaging system. If reasonable safe access doesn't already exist, it is to be included in the design and construction specifications for the project.

29.3.4 A legible copy of the shipping papers and the manufacturer's leak test report is to be sent, by the manufacturer, to the radiation coordinator at the receiving facility for each shipment of x-ray or isotope gaging devices. In addition, for isotope sources, a copy of the manufacturer's leak test report is to be sent to:

A. LaMastra
Room 167, SGO Building
Bethlehem Steel Corporation
Bethlehem, PA 18016-7699

29.3.5 The outside of the package containing a radioactive source is to be marked as follows:

CONTAINS RADIATION SOURCE

NOTIFY _____ OF RECEIPT

EXTENSION_____

The name and phone extension to be inserted shall be provided in the purchase order.

29.3.6 The following classification specifications are required for gaging devices intended for the following environments:

CONDITIONS	MINIMUM SOURCE CLASSIFICATION N43.6*	MINIMUM DEVICE CLASSIFICATION N43.8**
Normal environments	43232	34354
Hot ambient environments (ambient temperature in range of 200°F, black globe)	43232	53353
Special hot ambient environments (ambient temperature exceeding 250°F, black globe)	63232	73353
Special cold ambient environments (ambient temperature routinely below -20°F)	33232	25364
Occupied areas	43232	34365

* American National Standard, N43.6-1989 - "Sealed Radioactive Sources, Classification".
** American National Standard, N43.8-1988 - "Classification of Industrial Radiation Gaging Devices".

29.3.7 If gaging devices are intended for unusual environments, the health physics consultant is to be notified before the specification on the gaging device are finalized. Such environments include, but are not limited to:

Excessive heat
Unusual vibration
Submerged in water or other liquids
Corrosive
Explosive

29.4 **External Radiation Levels** - The following exposure rates should be used to evaluate the suitability of gage systems to be installed in unrestricted areas. **Measurements are not of the primary beam!**

29.4.1 Shutter open or closed - 2 millirems per hour at 18 inches, and 0.5 millirem per hour at 3 feet from any surface of the source housing, excluding the area of the primary measurement beam.

APPENDIX A - RADIATION CONTROL AGENCY DIRECTORY

This list is intended to provide guidance to local facilities in determining which agency has legal jurisdiction over the use of ionizing radiation. The listing may be interpreted using the description of the codes provided below. Only those States in which Bethlehem has facilities which use radiation sources are listed.

ANRC: State has assumed licensing and compliance activities for all byproduct, source or special nuclear material radioactive sources from the NRC and also regulates natural and accelerator produced (NARM) radioactive material. (OSHA may also have jurisdiction over natural and accelerator produced radioactive material)

AOSHA: State has assumed compliance activities for all x-ray and NARM sources.

NARM: State is not an NRC agreement state, but inspects and licenses radium, other naturally occurring and accelerator produced radioactive material. (OSHA may still have legal authority over these sources)

IX: State regulates industrial x-ray equipment. (OSHA may also have legal jurisdiction)

MX: State regulates medical x-ray equipment. (OSHA may also have legal jurisdiction)

NRC: USNRC retains jurisdiction for licensing and compliance for byproduct, source and special nuclear radioactive material.

In the absence of the code "AOSHA", OSHA has jurisdiction over all industrial x-ray equipment. The codes "ANRC" and "NRC" are exclusive of each other as are the codes "AOSHA" and "IX or MX".

INDIANA - IX, MX, NRC, NARM

MARYLAND - ANRC, IX, MX

NEW YORK DEPT. OF LABOR - ANRC (NYS Dept. of Labor provides no compliance activities with respect to industrial x-ray equipment other than the registration of x-ray machines. Jurisdiction for this activity has been formally preempted by OSHA.)

PENNSYLVANIA - NARM, IX, MX, NRC

TEXAS - ANRC, AOSHA

WEST VIRGINIA - IX, MX, NRC

APPENDIX B - RADIATION COORDINATORS

The following are the radiation coordinators at the various facilities possessing radiation sources. Since personnel may change, the health physics consultant should be contacted for a current listing.

Steel Group	Coordinators	Beth-Com Number
Bethlehem Plant	R.E. Behler	232-4039
Burns Harbor Plant	R.F. Hurd	345-4968
Johnstown BRW	J. Hutchinson	233-7490
Lackawanna Galv. Prod.	J. Swiatkiewicz	221-3310
Sparrows Point Plant	G.T. Adams	234-4765
Steelton Plant	J.A. Davis	355-2501
BethEnergy	J.M. Gallick	228-2367
Marine Construction	G.M. Rusinovich	234-6579
All Other Facilities	A. LaMastra	232-6460, or (215) 756-4153

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