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JOHN F. KENNEDY SPACE CENTER

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RADIATION PROTECTION HANDBOOK

PREFACE

This document has been prepared as a handbook to provide guidance to all KSC, NASA and NASA contractor personnel at KSC and the Air Force Eastern Test Range (AFETR) and Western Test Range (WTR), in the procurement and safe handling of radioactive materials or radiation producing equipment. It is authorized by KMI 1860.1, "Radiation Safety - Policies and General Procedures."

The handbook is consistent with NASA, Atomic Energy Commission (AEC), and State regulations. However, it should not be interpreted as regulating any operations at NASA Centers other than KSC.

Frederic H. Miller
Director of Installation Support

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REFERENCES

(a) KMI 1860.1, Radiation Safety Policies and General Procedures.

(b) KMI 1150.9, "Radiological and Isotopes Safety Committee".

(c) KHB 6000.1, "KSC Transportation Management Handbook".

(d) AFETRM 160.1, "AFETR Manual on Ionizing Radiation Control".

(e) Air Force Manual 71-4, "Packaging and Handling of Dangerous Materials for Transportation by Military Aircraft".

(f) Florida Control of Radiation Hazard Regulation, Section 10D-56, issued pursuant to the Florida Nuclear Code and Southern Interstate Nuclear Compact Law, Chapter 290 of Florida Statutes.

(g) Code of Federal Regulations, 1968 Federal Radiation Control for Health and Safety Act (P.L. 90-602).

(h) Code of Federal Regulations, Title 10, Part 20, for standards for protection against radiation.

(i) Code of Federal Regulations, Title 10, Part 71, for certain shipment of fissile and large quantities of Atomic Energy Commission licensed material.

(j) Code of Federal Regulations, Title 14, Part 103, for shipments via air transport.

(k) Code of Federal Regulations, Title 39, Section 124.2(e), for shipment of radioactive materials via U.S. Postal Facilities.

(l) Code of Federal Regulations, Title 46, Part 146, for shipments via water transportation.

(m) Code of Federal Regulations, Title 49, Parts 170 to 179, applicable to packaging and shipment via rail, highway, or water transportation.

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SECTION I
GENERAL DESCRIPTION

1.1 PURPOSE

This handbook sets forth the Kennedy Space Center (KSC) radiation protection policy and contains administrative direction and guidance on organizational and prodecural requirements of the program. Only ionizing radiation is covered in this handbook; other types of radiation are covered in other documents.

1.2 POLICY

KSC policy is to provide centralized control over uses of radioactive materials and radiation producing machines to ensure safe practices and thus limit exposure of personnel to radiation to the absolute minimum feasible. Under no circumstances is exposure to exceed appropriate federal or state standards.

To implement this policy, the KSC radiation protection program has been established to ensure:

a. Use of all sources of radiation at KSC, or in support of KSC programs, in a manner that will minimize health and safety risk to the users, KSC employees, and the public in general

b. Minimum risk of damage or contamination of equipment by sources of nuclear radiation

c. Evaluation or radiation hazards to protect personnel

d. Maintenance of a safe work environment for KSC employees in accordance with established KSC standards, guidelines of appropriate federal and state agencies, and the principles underlying sound health physics practices

e. Immediate investigation and reporting of all radiation incidents (including near misses) and the institution of immediate corrective action to prevent their recurrence

f. Control of the release or disposal of radioactive material, keeping radiation levels consistent with appropriate standards and sound health physics practices

g. Accountability for all radioactive materials and radiation generating machines owned or operated by KSC, or by others in support of KSC programs

1.3 AUTHORITY

KMI 1860.1 - Radiation Safety - Policies and General Procedures

1.4 SCOPE

This handbook describes the organization, training, and responsibilities relating to radiation protection at KSC. It defines procedures and requirements for procurement, use, handling, storage, shipment, and disposal of sources of ionizing radiation, as well as personnel monitoring and emergency procedures. It also indicates sources from which more detailed information may be obtained when necessary.

1.5 APPLICABILITY

Provisions of this handbook cover both NASA and contractor personnel directly concerned with the procurement, handling, storage, or use of radioactive materials and radiation generating machines within KSC organizational elements. Contractor organizations at KSC are regulated by the Florida Nuclear Code.

1.6 ORGANIZATION

Figure 1-1 shows the functional structure of the KSC radiation protection program. Specific paragraphs below contain details on functions and responsibilities of these elements.

a. KSC Radiation Protection Officer (RPO)

The KSC-RPO, designated by KMI 1860.1, (a member of the Medical Services Office, Installation Support Directorate), is responsible for the administration of the Radiation Protection Program at KSC. Specifically, he is responsible for assuring that operations involving radioactive materials and radiation generating machines are conducted in accordance with applicable Federal and State regulations, and other pertinent health and safety standards. Also, he serves as the KSC laison element and focal point for formal contact and coordination on radiation protection matters with the Atomic Energy Commission and other agencies regarding licensing regulations and control.

b. Radiological and Isotopes Safety Committee (RSC)

The Radiological and Isotopes Safety Committee as established by KMI 1150.9 consists of at least three members and includes the KSC Radiation Protection Officer. Membership is by appointment for a term of two years. The Committee is responsible for the development of requirements for radiation protection to ensure that adequate facilities,

equipment, training, and operational and emergency controls are maintained for all operations utilizing radioactive materials and radiation generating machines. The Committee approves all uses of radioactive materials and radiation generating machines at KSC.

c. Environmental Health Contractor

The Occupational Medicine and the Environmental Health (OMEHS) Contractor, responsive to the Medical Services Office, acts as a functional representative for the KSC-RPO. Specific responsibilities include technical consultations with users of radioactive materials and radiation producing equipment, administration of the personnel dosimetry program, maintenance of the radioactive materials inventory and waste disposal program, and general surveillance of the KSC Radiation Protection Program.

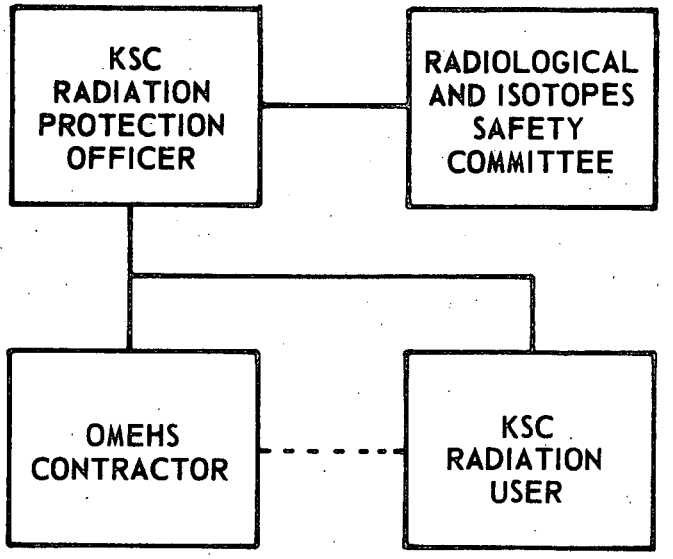


Figure 1-1. Functional Structure - KSC Radiation Protection Program

SECTION II
KSC ADMINISTRATIVE PROCEDURES FOR CONTROLLING SOURCES OF IONIZING RADIATION

2.1 OBJECTIVES

The objectives of this section of the handbook are: (1) to establish methods of obtaining approval for the use of radioactive materials and/or radiation generating machines, (2) define the approval channels for processing forms and procedures, (3) define the necessary qualifications for radiation users, and (4) assure all work with sources of ionizing radiation is performed in a manner as to ensure the health and safety of personnel.

2.2 DEFINITIONS

A radiation user is a person who has been approved by the Radiological and Isotopes Safety Committee to use specific sources of ionizing radiation for a specific purpose at a specific location.

A radiation use supervisor is, in addition to the above, the person responsible for insuring that the provisions of this handbook are followed. Also, he will serve as the custodian (i.e., accountability) for specific sources listed on the Use Authorization for which he is the use supervisor.

A radiation safety officer is a contractor employee responsible for interfacing between contractor and the KSC-RPO. He is also responsible for implementing emergency procedures.

2.3 RADIATION USE AUTHORIZATIONS

In order to utilize radioactive materials and/or radiation generating machines, a Radioactive Material Use Request/Radiation Machine Use Request must be completed and submitted to the Radiological and Isotopes Safety Committee for review and approval (see Figures B-1, B-2). Use requests should be submitted six months prior to planned usage and in no cases less than three months prior to planned usage. The request shall contain a description of operating procedures, detailed safety precautions and safety analysis reports (as applicable), the use location, and identities and qualifications of the users, including supervisors and the area radiation safety officer. Prior to, or concurrent with the preparation of the Radiation Use Request, the user shall request the Environmental Health contractor to perform a health physics review and to conduct an initial radiation protection survey, as indicated. Reports of findings shall be submitted to the Radiological and Isotopes Safety Committee, along with the Use Request.

The Committee will review the originator's proposal, the user's qualifications and recommendations made by the KSC-RPO or Environmental Health contractor staff. If satisfied that proper precautions have been established, they will approve the request, binding the users to all statements represented. A written notification shall be sent to the request originator along with a copy of the approved package. If additional requirements are considered appropriate by the committee, the request originator shall be notified of the additional requirements.

Requests for modifications to approved authorizations shall be submitted (see Figure B-3), and follow the same processing as the original request.

The RPO may temporarily modify previously approved authorizations as follows:

a. Extend an expiration date of a Radiation Use Authorization for a period not exceeding 90 days.

b. Add or delete specific users provided that all new individuals have met the standards established by the Radiological and Isotopes Safety Committee.

c. Increase the units of radioactive material available to the users providing no additional training is required, no change in facilities is needed and no significant increase in hazard would result.

d. Change the isotopes named on an approved authorization provided the isotopes added will not change the kinds of radiation emissions previously approved and the hazard from absorption into the body as defined in National Bureau of Standards Handbook 69 (Maximum Permissible Body Burdens and Maximum Permissible Concentrations of Radionuclides in Air and in Water for Occupational Exposure) does not increase.

e. Revoke the approved Use Request for safety reasons. This action will require immediate notification to available members of the Radiological and Isotopes Safety Committee as well as NASA management.

These temporary modifications shall be evaluated by the Committee, and if satisfied that the KSC-RPO action was proper, the Committee will ratify the actions at the next meeting held.

Radiation Use Authorizations shall be terminated after a one year period if a request for renewal has not been received. Approvals may be withdrawn at any time if safety violations occur or use of a regulated source is found not to be in compliance with conditions of the approved Use Request.

Figure 2-1 depicts the process for obtaining KSC radiation use approval.

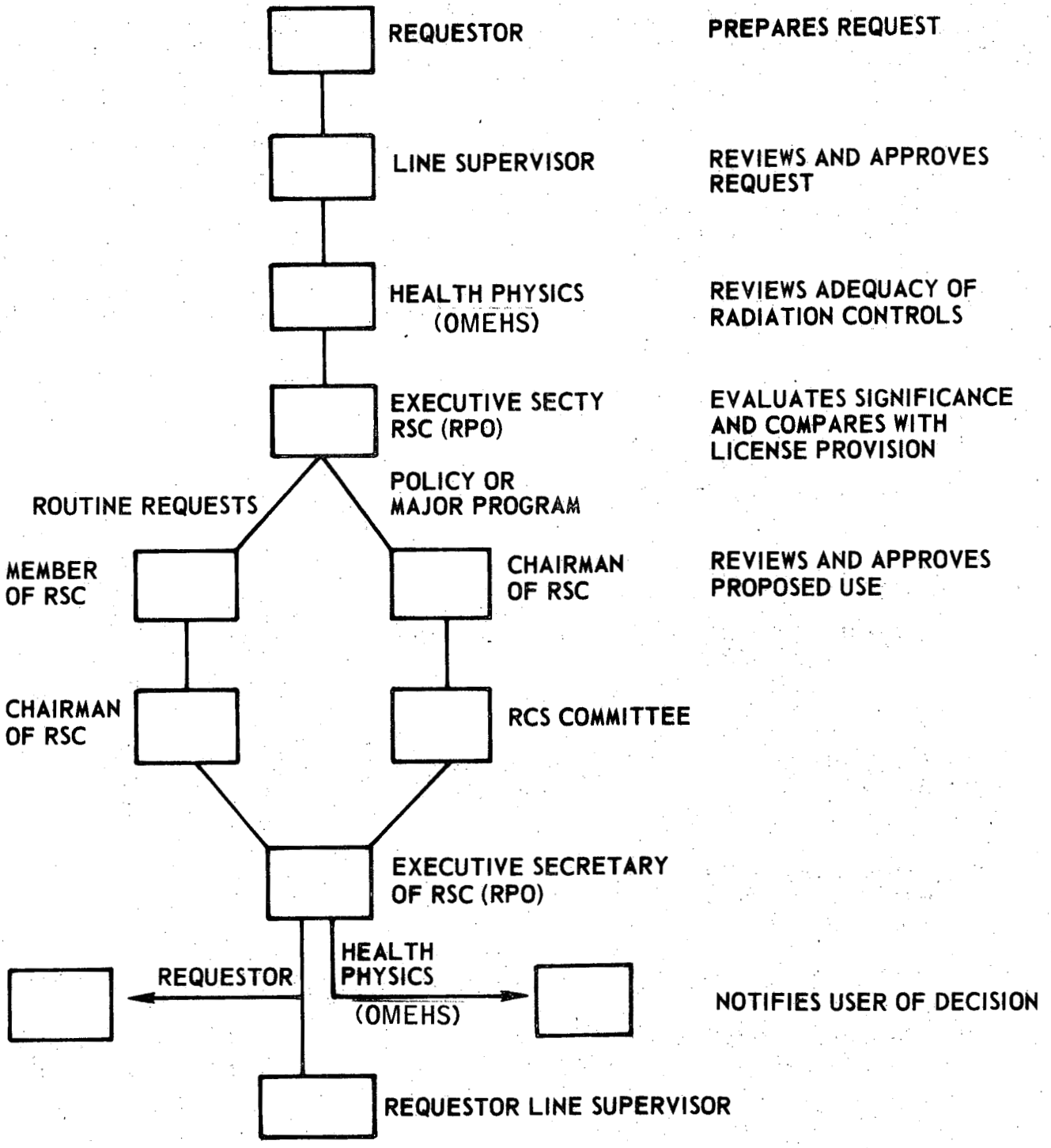


Figure 2-1. Radiation Use Request Review and Approval System

2.4 USE AUTHORIZATION FOR LICENSING CENTERS OTHER THAN KSC

This section addresses the method for obtaining a use authorization for operations at NASA-KSC facilities utilizing radioactive materials carried on an AEC/NASA license other than the one maintained by KSC. This is accomplished in much the same manner as discussed in the previous section except the following:

a. Upon receipt of the Use Request (Figure B-1) from the proposed user, the KSC-RPO will perform a review and forward the request to applicable Center.

b. The RPO, or equivalent, at the applicable center will in turn review the Use Request for any licensing action necessary and safe operating procedures.

c. The above action will be followed by submission of the Use Request to the Center's Radiological and Isotopes Safety Committee, or equivalent, for approval.

d. Upon completion of the above, the Use Request will be returned to KSC-RPO for further review and concurrence of the approval by the KSC Radiological and Isotopes Safety Committee.

2.5 RADIATION SURVEYS

a. Initial Radiation Surveys

Prior to the use of radioactive material or the operation of radiation-producing machines, an initial radiation survey shall be performed by the Environmental Health Contractor. Based on this survey, modifications to procedures for safe handling and use may be prescribed while leaving as much latitude as is safe and feasible. Operational approval of Use Requests is contingent on this survey.

b. Monthly Radiation Surveys

The Environmental Health Contractor shall make monthly inspections and radiation surveys of each facility where radiation is being used. Any unsafe practices will be called to the attention of the KSC-RPO who may revoke the Use Authorization.

c. Survey Instruments

The Environmental Health Contractor maintains on hand a variety of instrumentation for detection of the common types of radiation. Where the need arises, these instruments are available on a loan basis.

2.6 TRAINING

Instruction of personnel is of great importance to the success of a radiation protection program. As a minimum and prior to work with ionizing radiation at KSC facilities, individuals must have had radiation experience or have had a training course covering at least the following points:

a. General description of radiation and its hazards.

b. Basic principles of radiation safety.

c. Radiation safety procedures relevant to duties associated with employment.

d. KSC policies and appropriate federal or state regulations.

e. Emergency procedures.

Additional instructions by Environmental Health will be given periodically on the job. Emphasis will be placed on updating operating methods and emergency procedures. If, due to the nature of work to be done, personnel are subject to unusual hazard, they may be required to have additional training as determined by the KSC-RPO.

2.7 PROCUREMENT, STORAGE, AND TRANSFER OF RADIATION SOURCES

For the purposes of this KSC Handbook, radiation sources are interpreted to mean:

- Any concentration or quantity of radioactive material greater than the values listed in Tables 2-1 and 2-2.
- Any machine* that produces ionizing radiation or contains vacuum switches having applied voltages in excess of 17 Kilovolts.
- Microwave generators operating between 30 and 300 MHz, and other apparatus regulated by the 1968 Federal Radiation Control for Health and Safety Act (P.L. 90-602).

* Except television receivers regulated under P.L. 90-602

B

Table 2-1. Radiation Source - Exempt Concentrations

Element (atomic number)	Isotope	Column[1] I	Column[2] II
Antimony (51)	Sb 122		3×10^{-4}
	Sb 124		2×10^{-4}
	Sb 125		1×10^{-3}
Argon (18)	A 37	1×10^{-3}	
	A 41	4×10^{-7}	
Arsenic (33)	As 73		5×10^{-3}
	As 74		5×10^{-4}
	As 76		2×10^{-4}
	As 77		8×10^{-4}
Barium (56)	Ba 131		2×10^{-3}
	Ba 140		3×10^{-4}
Beryllium (4)	Be 7		2×10^{-2}
Bismuth (83)	Bi 206		4×10^{-4}
Bromine (35)	Br 82	4×10^{-7}	3×10^{-3}
Cadmium (48)	Cd 109		2×10^{-3}
	Cd 115m		3×10^{-4}
	Cd 115		3×10^{-4}
Calcium (20)	Ca 45		9×10^{-5}
	Ca 47		5×10^{-4}
Carbon (6)	C 14	1×10^{-6}	8×10^{-3}
Cerium (58)	Ce 141		9×10^{-4}
	Ce 143		4×10^{-4}
	Ce 144		1×10^{-4}
Cesium (55)	Cs 131		2×10^{-2}
	Cs 134m		6×10^{-2}
	Cs 134		9×10^{-4}
Chlorine (17)	Cl 38	9×10^{-7}	4×10^{-3}
Chromium (24)	Cr 51		2×10^{-2}
Cobalt (27)	Co 57		5×10^{-3}
	Co 58		1×10^{-3}
	Co 60		5×10^{-4}
Copper (29)	Cu 64		3×10^{-3}
Dysprosium (66)	Dy 165		4×10^{-3}
	Dy 166		4×10^{-4}
Erbium (68)	Er 169		9×10^{-4}
	Er 171		1×10^{-3}
Europium (63)	Eu 152 (T/2=9.2 Hrs)		6×10^{-4}
	Eu 155		2×10^{-3}
Fluorine (9)	F 18	2×10^{-6}	8×10^{-3}
Gadolinium (64)	Gd 153		2×10^{-3}
	Gd 159		8×10^{-4}
Gallium (31)	Ga 72		4×10^{-4}
Germanium (32)	Ge 71		2×10^{-2}
Gold (79)	Au 196		2×10^{-3}
	Au 198		5×10^{-4}
	Au 199		2×10^{-3}
Hafnium (72)	Hf 181		7×10^{-4}
Hydrogen (1)	H 3	5×10^{-6}	3×10^{-2}
Indium (49)	In 113m		1×10^{-2}
	In 114m		2×10^{-4}

Element (atomic number)	Isotope	Column[1] I	Column[2] II
Iodine (53)	I 126	3×10^{-9}	2×10^{-4}
	I 131	3×10^{-9}	2×10^{-4}
	I 132	8×10^{-8}	6×10^{-4}
	I 133	1×10^{-8}	7×10^{-4}
	I 134	2×10^{-7}	1×10^{-3}
Iridium (77)	Ir 190		2×10^{-3}
	Ir 192		4×10^{-4}
	Ir 194		3×10^{-4}
Iron (26)	Fe 55		8×10^{-3}
	Fe 59		6×10^{-4}
Krypton (36)	Kr 85m	1×10^{-6}	
	Kr 85	3×10^{-6}	
Lanthanum (57)	La 140		2×10^{-4}
Lead (82)	Pb 203		4×10^{-3}
Lutetium (71)	Lu 177		1×10^{-3}
Manganese (25)	Mn 52		3×10^{-4}
	Mn 54		1×10^{-3}
	Mn 56		1×10^{-3}
Mercury (80)	Hg 197m		2×10^{-3}
	Hg 197		3×10^{-3}
	Hg 203		2×10^{-4}
Molybdenum (42)	Mo 99		2×10^{-3}
Neodymium (60)	Nd 147		6×10^{-4}
	Nd 149		3×10^{-3}
Nickel (28)	**Ni 65**		1×10^{-3}
Niobium (Columbium (41)	**Nb 95**		1×10^{-3}
	Nb 97		9×10^{-3}
Osmium (76)	**Os 185**		7×10^{-4}
	Os 191m		3×10^{-2}
	Os 191		2×10^{-3}
	Os 193		6×10^{-4}
Palladium (46)	**Pd 103**		3×10^{-3}
	Pd 109		9×10^{-4}
Phosphorus (15)	**P 32**		2×10^{-4}
Platinum (78)	**Pt 191**		1×10^{-3}
	Pt 193m		1×10^{-2}
	Pt 197m		1×10^{-2}
	Pt 197		1×10^{-3}
Polonium (84)	**Po 210**		7×10^{-6}
Potassium (19)	**K 42**		3×10^{-3}
Praseodymium (59)	**Pr 142**		3×10^{-4}
	Pr 143		5×10^{-4}
Promethium (61)	**Pm 147**		2×10^{-3}
	Pm 149		4×10^{-4}
Radium (88)	**Ra 226**		1×10^{-7}
	Ra 228		3×10^{-7}
Rhenium (75)	**Re 183**		6×10^{-3}
	Re 186		9×10^{-4}
	Re 188		6×10^{-4}

Element (atomic number)	Isotope	Column[1] I	Column[2] II
Rhodium (45)	Rh 103m		1×10^{-1}
	Rh 105		1×10^{-3}
Rubidium (37)	Rb 86		7×10^{-4}
Ruthenium (44)	Ru 97		4×10^{-3}
	Ru 103		8×10^{-4}
	Ru 105		1×10^{-3}
	Ru 106		1×10^{-4}
Samarium (62)	Sm 153		8×10^{-4}
Scandium (21)	Sc 46		4×10^{-4}
	Sc 47		9×10^{-4}
	Sc 48		3×10^{-4}
Selenium (34)	Se 75		3×10^{-3}
Silicon (14)	Si 31		9×10^{-3}
Silver (47)	Ag 105		1×10^{-3}
	Ag 110m		3×10^{-4}
	Ag 111		4×10^{-4}
Sodium (11)	Na 24		2×10^{-3}
Strontium (38)	Sr 85		1×10^{-3}
	Sr 89		1×10^{-4}
	Sr 91		7×10^{-4}
	Sr 92		7×10^{-4}
Sulfur (16)	S 35	9×10^{-8}	6×10^{-4}
Tantalum (73)	Ta 182		4×10^{-4}
Technetium (43)	Tc 96m		1×10^{-1}
	Tc 96		1×10^{-3}
Tellurium (52)	Te 125m		2×10^{-3}
	Te 127m		6×10^{-4}
	Te 127		3×10^{-3}
	Te 129m		3×10^{-4}
	Te 131m		6×10^{-4}
	Te 132		3×10^{-4}
Terbium (65)	Tb 160		4×10^{-4}
Thallium (81)	Tl 200		4×10^{-3}
	Tl 201		2×10^{-3}
	Tl 202		1×10^{-3}
	Tl 204		1×10^{-3}
Thulium (69)	Tm 170		5×10^{-4}
	Tm 171		5×10^{-3}
Tin (50)	Sn 113		9×10^{-4}
	Sn 125		2×10^{-4}
Tungsten (Wolfram) (74)	W 181		4×10^{-3}
	W 187		7×10^{-4}
Vanadium (23)	V 48		3×10^{-4}
Xenon (54)	Xe 131m	4×10^{-6}	
	Xe 133	3×10^{-6}	
	Xe 135	1×10^{-6}	
Ytterbium (70)	Yb 175		1×10^{-3}
Yttrium (39)	Y 90		2×10^{-4}
	Y 91m		3×10^{-2}
	Y 91		3×10^{-4}
	Y 92		6×10^{-4}
	Y 93		3×10^{-4}
Zinc (30)	Zn 65		1×10^{-3}
	Zn 69m		7×10^{-4}
	Zn 69		2×10^{-2}
Zirconium (40)	Zr 95		6×10^{-4}
	Zr 97		2×10^{-4}
Beta and/or gamma emitting radioactive material not listed above with half-life less than 3 years		1×10^{-10}	1×10^{-6}

NOTE 1: Many radioisotopes disintegrate into isotopes which are also radioactive. In expressing the concentrations in Appendix B, the activity stated is that of the parent isotope and takes into account the daughters.

NOTE 2: For purposes of Section 10D-56.110 where there is involved a combination of isotopes, the limit for the combination should be derived as follows: Determine for each isotope in the product the ratio between the concentration present in the product and the exempt concentration established in Appendix B for the specific isotope when not in combination. The sum of such ratios may not exceed "1" (i.e., unity).

EXAMPLE:

$$\frac{\text{Concentration of Isotope A in Product}}{\text{Exempt concentration of Isotope A}} + \frac{\text{Concentration of Isotope B in Product}}{\text{Exempt concentration of Isotope B}} \leqq 1$$

[1] Values are given in Column I only for those materials normally used as gases; gas concentration uCi/ml.

[2] Liquid and solid concentrations; uCi/ml for liquids; uCi/gm for solids.

Table 2-2. Radiation Source - Exempt Quantities

Material	Microcuries
Antimony 122 (Sb 122)	100
Antimony 124 (Sb 124)	10
Antimony 125 (Sb 125)	10
Arsenic 73 (As 73)	100
Arsenic 74 (As 74)	10
Arsenic 76 (As 76)	10
Arsenic 77 (As 77)	100
Barium 131 (Ba 131)	10
Barium 133 (Ba 133)	10
Barium 140 (Ba 140)	10
Bismuth 210 (Bi 210)	1
Bromine 82 (Br 82)	10
Cadmium 109 (Cd 109)	10
Cadmium 15m (Cd 115m)	10
Cadmium 115 (Cd 115)	100
Calcium 45 (Ca 45)	10
Calcium 47 (Ca 47)	10
Carbon 14 (C 14)	100
Cerium 141 (Ce 141)	100
Cerium 143 (Ce 143)	100
Cerium 144 (Ce 144)	1
Cesium 131 (Cs 131)	1,000
Cesium 134m (Cs 134m)	100
Cesium 134 (Cs 134)	1
Cesium 135 (Cs 135)	10
Cesium 136 (Cs 135)	10
Cesium 137 (Cs 137)	10
Chlorine 36 (Cl 36)	10
Chlorine 38 (Cl 38)	10
Chromium 51 (Cr 51)	1,000
Cobalt 58m (Co 58m)	10
Cobalt 58 (Co 58)	10
Cobalt 60 (Co 60)	1
Copper 64 (Cu 64)	100
Dysprosium 165 (Dy 165)	10
Dysprosium 166 (Dy 166)	100
Erbium 169 (Er 169)	100
Erbium 171 (Er 171)	100
Europium 152 (Eu 152) 9.2 h	100
Europium 152 (Eu 152) 13 yr	1
Europium 154 (Eu 154)	1
Europium 155 (Eu 155)	10
Flourine 18 (F 18)	1,000
Gadolinium 153 (Gd 153)	10
Gadolinium 159 (Gd 159)	100
Gallium 72 (Ga 72)	10
Germanium 71 (Ge 71)	100
Gold 198 (Au 198)	100
Gold 199 (Au 199)	100
Hafnium 181 (Hf 181)	10
Holmium 166 (Ho 166)	100
Hydrogen 3 (H 3)	1,000
Indium 113m (In 113m)	100
Indium 114m (In 114m)	10
Indium 115m (In 115m)	100
Indium 115 (In 115)	10
Iodine 125 (I 125)	1
Iodine 126 (I 126)	1
Iodine 129 (I 129)	0.1
Iodine 131 (I 131)	1
Iodine 132 (I 132)	10
Iodine 133 (I 133)	1
Iodine 134 (I 134)	10
Iodine 135 (I 135)	10
Iridium 192 (Ir 192)	10
Iridium 194 (Ir 194)	100
Iron 55 (Fe 55)	100
Iron 59 (Fe 59)	10
Krypton 85 (Kr 85)	100
Krypton 87 (Kr 87)	10
Lanthanum 140 (La 140)	10
Lutetium 177 (Lu 177)	100
Manganese 52 (Mn 52)	10
Manganese 54 (Mn 54)	10
Manganese 56 (Mn 56)	10
Mercury 197m (Hg 197m)	100
Mercury 197 (Hg 197)	100
Mercury 203 (Hg 203)	10
Molybdenum 99 (Mo 99)	100
Neodymium 147 (Nd 147)	100
Neodymium 149 (Nd 149)	100
Nickel 59 (Ni 59)	100
Nickel 63 (Ni 63)	10
Nickel 65 (Ni 65)	100
Niobium 93m (Nb 93m)	10
Niobium 95 (Nb 95)	10
Niobium 97 (Nb 97)	10

Material	Microcuries
Osmium 185 (Os 185)	10
Osmium 191m (Os 191m)	100
Osmium 191 (Os 191)	100
Osmium 193 (Os 193)	100
Palladium 103 (Pd 103)	100
Palladium 109 (Pd 109)	100
Phosphorus 32 (P 32)	10
Platinum 191 (Pt 191)	100
Platinum 193m (Pt 193m)	100
Platinum 193 (Pt 193)	100
Platinum 197m (Pt 197m)	100
Platinum 197 (Pt 197)	100
Polonium 210 (Po 210)	0.1
Potassium 42 (K 42)	10
Praseodymium 142 (Pr 142)	100
Praseodymium 143 (Pr 143)	100
Promethium 147 (Pm 147)	10
Promethium 149 (Pm 149)	10
Rhenium 186 (Re 186)	100
Rhenium 188 (Re 188)	100
Rhodium 103m (Rh 103m)	100
Rhodium 105 (Rh 105)	100
Rubidium 86 (Rb 86)	10
Rubidium 87 (Rb 87)	10
Ruthenium 97 (Ru 97)	100
Ruthenium 103 (Ru 103)	10
Ruthenium 105 (Ru 105)	10
Ruthenium 106 (Ru 106)	1
Samarium 151 (Sm 151)	10
Samarium 153 (Sm 153)	100
Scandium 46 (Sc 46)	10
Scandium 47 (Sc 47)	100
Scandium 48 (Sc 48)	10
Selenium 75 (Se 75)	10
Silicon 31 (Si 31)	100
Silver 105 (Ag 105)	10
Silver 110m (Ag 110m)	1
Silver 111 (Ag 111)	100
Sodium 24 (Na 24)	10
Strontium 85 (Sr 85)	10
Strontium 89 (Sr 89)	1
Strontium 90 (Sr 90)	0.1
Strontium 91 (Sr 91)	10
Strontium 92 (Sr 92)	10
Sulphur 35 (S 35)	100
Tantalum 182 (Ta 182)	10
Technetium 96 (Tc 96)	10
Technetium 97m (Tc 97m)	100
Technetium 97 (Tc 97)	100
Technetium 99m (Tc 99m)	100
Technetium 99 (Tc 99)	10
Tellurium 125m (Te 125m)	10
Tellurium 127m (Te 127m)	10
Tellurium 127 (Te 127)	100
Tellurium 129m (Te 129m)	10
Tellurium 129 (Te 129)	100
Tellurium 131m (Te 131m)	10
Tellurium 132 (Te 132)	10
Terbium 160 (Tb 160)	10
Thallium 200 (Tl 200)	100
Thallium 201 (Tl 201)	100
Thallium 202 (Tl 202)	100
Thallium 204 (Tl 204)	10
Thulium 170 (Tm 170)	10
Thulium 171 (Tm 171)	10
Tin 113 (Sn 113)	10
Tin 125 (Sn 125)	10
Tungsten 181 (W 181)	10
Tungsten 185 (W 185)	10
Tungsten 187 (W 187)	100
Vanadium 48 (V 48)	10
Xenon 131m (Xe 131m)	1,000
Xenon 133 (Xe 133)	100
Xenon 135 (Xe 135)	100
Ytterbium 175 (Yb 175)	100
Yttrium 90 (Y 90)	10
Yttrium 91 (Y 91)	10
Yttrium 92 (y 92)	100
Yttrium 93 (Y 93)	100
Zinc 65 (Zn 65)	10
Zinc 69m (Zn 69m)	100
Zinc 69 (Zn 69)	1,000
Zirconium 93 (Zr 93)	10
Zirconium 95 (Zr 95)	10
Zirconium 97 (Zr 97)	10

Note: Any radioactive material not listed above other than alpha emitting radioactive material 0.1

a. Procurement

Radiation sources (isotopes and/or machines) to be used in KSC controlled facilities shall not be procured without approval by the KSC-RPO. The originator of the purchase request will provide to the KSC-RPO a detailed description of the proposed use and use location along with KSC Form 7-49 for approval. Procurement will ensure that action on purchase requests is not completed until approval by the KSC-RPO is obtained.

b. Receipt

The Environmental Health Contractor shall be notified of all arrivals of radioactive sources at KSC. Delivery of sources to the user requires approval of the Environmental Health Contractor. Upon delivery to the user, the material shall be placed in approved storage in its as received condition until such time as Environmental Health Contractor personnel are present for initial uncrating or unpacking.

For documentation purposes, the originator of the shipment shall provide a completed Radioactive Material Transfer Receipt (Figure B-4), MSC Form 1625 or equivalent, in addition to other relevant shipping documents. A copy of this form will be returned to the shipment originator.

c. Storage

All specifically licensed radioactive materials shall be stored in areas approved by the KSC-RPO. These areas shall also satisfy the requirements of the applicable regulatory agency. Exceptions shall be only those aggregate quantities of radioactive materials in generally licensed quantities or less.

Material not covered by a Use Authorization shall be stored by the Environmental Health Contractor. All storage areas shall be so constructed that only authorized users have access to the materials.

d. Shipping

All sources of radiation once registered by the Environmental Health Contractor and located in a particular facility shall not be transferred to the accountability of another organization, or transferred from one location to another without approval of the KSC-RPO or his delegate in addition to action required for property control procedures.

Off-site shipments require documentation and completion of MSC Form 1625, or equivalent, which shall be included with other relevant shipping documents.

Each shipment shall be made in accordance with Federal and/or State transportation regulations, as applicable.

These regulations include:

(1) Code of Federal Regulations, Title 49, Parts 170 to 179, applicable to packaging and shipment via rail, highway, or water transportation.

(2) Code of Federal Regulations, Title 14, Part 103, for shipments via air transport.

(3) Code of Federal Regulations, Title 10, Part 71, for certain shipments of fissile and large quantities of Atomic Energy Commission licensed material.

(4) Code of Federal Regulations, Title 39, Section 124.2 for shipment of radioactive materials via U.S. Postal Facilities.

(5) Code of Federal Regulations, Title 46, Part 146, for shipments via water transportation.

(6) Air Force Manual 71-4, "Packaging and Handling of Dangerous Materials for Transportation by Military Aircraft."

(7) KSC Transportation Management Handbook, KHB 6000.1.

(8) Florida Control of Radiation Hazard Regulation, Section 10D-56,

2.8 USE OF RADIOACTIVE MATERIALS AT CKAFS

Use of radioactive materials at Cape Kennedy Air Force Station (CKAFS) by NASA or NASA Contractor personnel shall be conducted in compliance with this document and AFETR Manual Ionizing Radiation Control, AFETRM 160.1. KSC use authorizations do not grant use at CKAFS. Pre-use documentation requirements (i.e., use and emergency procedures, qualifications of users and area radiation safety officer, safety analysis reports, and description of storage areas, locations, etc.) shall be submitted to the Air Force through the KSC-RPO.

SECTION III
RADIATION PROTECTION DEFINITIONS AND GUIDELINES

3.1 GENERAL

KSC conducts a complete control program to ensure that radiation sources are safely used to prevent unnecessary exposure to personnel. To ensure this and compliance with federal and state regulations, the following paragraphs contain basic definitions and guidelines necessary for a sound program. For simplicity, the following paragraphs refer only to AEC regulations. Contact the Environmental Health Contractor for applicable state regulations.

3.2 AREA DESIGNATIONS

The following area designations shall apply for purposes of radiation control at KSC:

a. Controlled Area

Any area to which access is controlled for purposes of protection of individuals from exposure to radiation and radioactive material. The term "controlled" is meant to be synonymous with the term, "restricted" as used in the AEC Regulations.

b. Radiation Area

Any area, accessible to personnel, in which there exists radiation at such levels that a major portion of the body could receive in any one hour a dose in excess of 5 millirem, or in any 5 consecutive days a dose in excess of 100 millirem.

c. High Radiation Area

Any area, accessible to personnel, in which there exists radiation at such levels that a major portion of the body could receive, in any one hour, a dose in excess of 100 millirem.

d. Airborne Radioactivity Area

Any room, enclosure, or operating area in which airborne radioactive materials exist in concentrations in excess of the amounts specified in Title 10, Code of Federal Regulations (CFR), U.S. Atomic Energy Commission (AEC) Part 20, Appendix B, Table I, Column 1; or any room, enclosure, or area in which concentrations, which averaged over the

number of hours in any week during which individuals are in the area, exceed 25 percent of the amounts specified in Title 10, CFR 20, Appendix B, Table I, Column 1.

e. Uncontrolled Area

Any area to which access is not controlled for purposes of protection of individuals from exposure to radiation and radioactive materials. The term "uncontrolled" is meant to be synonymous with the term "unrestricted" as used in the AEC Regulations.

3.3 RADIATION DOSE LIMITS

Radiation dose limits at KSC are based upon limits specified by the AEC in 10 CFR 20. It should be recognized that the KSC limits are established as maximum values and, in all cases, personnel exposure should be maintained at the lowest practical level.

a. Dose Limits for Controlled Areas

Personnel shall not be exposed routinely to radiation or radioactive material in such a manner that the following limits are exceeded:

	Rem/Calendar Quarter
Whole body; head and trunk; active blood forming organs; lens of eyes; or gonads	1.25
Hands and forearms; feet and ankles	18.75
Skin of whole body	7.50

In exceptional cases an individual may be permitted to receive a quarterly, whole body dose greater than 1.25 rem provided:

(1) During any calendar quarter the dose to the whole body shall not exceed 3 rem; and

(2) The dose to the whole body, when added to the accumulated occupational dose to the whole body, shall not exceed 5 (N-18) rem where N equals the individual's age in years at his last birthday, and

(3) The individual's prior accumulated exposure has been determined.

b. Dose Limits for Minors

An individual under the age of 18 years shall not be permitted to enter or be employed in controlled areas such that he will receive doses of radiation in amounts exceeding 10 percent of the limits in para. 3.3, a. Exposures shall be averaged over periods not to exceed one calendar quarter.

c. Dose Limits in Uncontrolled Areas

Radiation dose limits in uncontrolled areas shall be such that an individual will not receive a dose to the whole body in excess of 0.5 rem in any calendar year. Furthermore, radiation levels shall be such that if an individual was continuously present in the area, he would not receive a dose in excess of 100 millirem in any seven days.

3.4 AIRBORNE CONCENTRATION LIMITS

Airborne concentrations of radioactive materials to which personnel at KSC may be exposed are also based upon limits specified by the AEC in Title 10 CFR 20. Again, the KSC limits are established as maximum values, and in all cases airborne concentrations should be maintained at the lowest practical level. Special authorization by the KSC-RPO is required for work which may create airborne concentrations of radioactive material. Such operations will require the presence of the Environmental Health Contractor.

a. Controlled Areas

With no allowance made for protective clothing or equipment, no personnel shall be exposed to airborne radioactive material in average concentrations in excess of the limits specified in Title 10 CFR 20, Appendix B, Table 1. These limits are based upon an exposure to these concentrations for forty hours in any period of seven consecutive days. For exposure times, other than forty hours, the airborne concentration limits may be increased or decreased proportionately.

b. Minors

An individual under the age of 18 years shall not be exposed to airborne radioactive material in an average concentration in excess of the limits specified in Title 10 CFR 20, Appendix B, Table 2. Concentrations may be averaged over periods not greater than one week.

c. Uncontrolled Areas

No personnel in uncontrolled areas shall be exposed to airborne radioactive material in concentrations in excess of the limits specified in Title 10 CFR 20, Appendix B, Table 2. Concentrations may be averaged over a period not greater than one year.

3.5 PERSONNEL MONITORING

a. Personnel monitoring is required in any area where there is a probability that an individual may receive a radiation dose in excess of 25 percent of the limits in Section III, para. 3.3, a.

b. The details of the monitoring procedure shall be determined in each case by the Environmental Health Contractor in consultation with the Radiation Use Supervisor and with consideration of the KSC dose limits (Section III, para. 3.3).

c. Personnel monitoring procedures shall include, as a minimum, the wearing of film badges and/or pocket dosimeters. Film badges shall be changed for processing on or about the first working day of each month or as otherwise determined by the RPO or his designated alternate. Personnel monitoring devices shall be available at the Environmental Health Contractor office. When needed, the appropriate bioassay service shall be furnished by the Environmental Health Contractor.

d. The Environmental Health Contractor shall maintain a permanent record of all personnel dosimetry reports. If a report indicates an overexposure, an investigation shall be initiated to determine cause and to suggest remedial action. The overexposure shall be reported to the AEC in compliance with 10 CFR 20.

3.6 POSTING AND LABELING

The posting and labeling requirements for KSC are based on the regulations in 10 CFR 20. The radiation symbols prescribed by this section shall be the conventional magenta or purple three-bladed design on a yellow background. Any additional information that may minimize exposure to radiation or to radioactive material shall be on or near signs and labels. Posting and labeling requirements are as follows:

a. Radiation Area

Each radiation area shall be conspicuously posted with a sign or signs bearing the radiation symbol and the words:

CAUTION RADIATION AREA

b. High Radiation Area

Each high radiation area shall be conspicuously posted with a sign or signs bearing the radiation symbol and the words:

CAUTION HIGH RADIATION AREA

All high radiation areas established for a period 31 days or more shall be equipped with a control device which shall cause the level of radiation to be reduced below that at which an individual might receive a dose of 100 millirem in one hour upon entry into the area or shall energize a conspicuous, visible or audible alarm signal in such a manner that the individual entering and the supervisor of the operation are made aware of the entry.

c. Airborne Radioactivity Area

Each airborne radioactivity area shall be conspicuously posted with a sign or signs bearing the radiation symbol and the words:

CAUTION AIRBORNE RADIOACTIVITY AREA

d. Storage Area

In addition to the above, each area in which radioactive material is used or stored and which contains any radioactive material other than natural uranium or thorium in an amount exceeding 10 times the quantity of such material specified in Title 10 CFR 20 Appendix C, or which contains natural uranium or thorium in an amount exceeding 100 times the quantity specified in Title 10 CFR 20, Appendix C, shall be conspicuously posted with a sign or signs bearing the radiation symbol and the words:

CAUTION RADIOACTIVE MATERIAL(S)

e. Operating Procedures and General Information

Areas in which individuals are employed in activities covered by the KSC licenses shall be posted with the following in such a manner to be readily observable to individuals on their way to or from their place of employment, or kept in a suitable place so that they are available for examination upon request:

(1) A current copy of Title 10 CFR 20.
(2) A copy of the AEC license.
(3) A copy of operating procedures applicable under the license.

In addition to the above, Form AEC-3, "Notice to Employees," must be posted in such a manner to be readily observable in areas utilizing radioactive materials (See Figure B-7, Appendix B).

f. Containers

Each container of radioactive material shall bear a durable, clearly visible label identifying the radioactive contents as to radionuclide, quantity, and date of assay. The label shall bear the radiation symbol and the words:

CAUTION RADIOACTIVE MATERIAL(S)

or the words:

DANGER RADIOACTIVE MATERIAL(S)

g. Radiation-producing Machines or Equipment

X-ray machines, X-ray diffraction units, electron microscopes, and other similar equipment shall bear a durable, clearly visible label bearing the radiation caution symbol and the words:

CAUTION
THIS MACHINE PRODUCES X-RAY WHEN ENERGIZED

h. Exemptions to Posting and Labeling Requirements

(1) An area is not required to be posted with a sign because of the presence of a sealed source provided the radiation level twelve inches from the surface of the source container or housing does not exceed five millirem per hour.

(2) Areas containing radioactive materials for less than eight hours do not require signs provided the materials are constantly attended during such periods by an individual who shall take precautions necessary to prevent a radiation exposure to any individual in excess of KSC limits.

(3) Areas are not required to be posted with signs because of the presence of radioactive materials packaged and labeled in accordance with applicable transportation regulations.

(4) Containers that do not contain materials in quantities greater than amounts specified in Title 10 CFR 20, Appendix C.

(5) Containers containing only natural uranium or thorium in quantities no greater than 10 times amounts specified in Title 10 CFR 20, Appendix C.

(6) Containers that do not contain licensed materials in concentrations greater than amounts specified in Title 10 CFR 20, Appendix B, Table 1, Colume 2.

(7) Containers when they are attended by an individual who shall take precautions necessary to prevent the radiation exposure to any individual in excess of the KSC limits.

(8) Containers which are accessible only to individuals authorized to use them, or to work in the vicinity, provided the contents are identified to such individuals by a readily available written record.

(9) Containers when they are in transport and packaged and labeled in accordance with applicable transportation regulations.

3.7 LEAK TESTS

a. Each sealed source containing byproduct material, other than Hydrogen 3 and devices under general license as defined in Title 10 CFR 31, with a half-life greater than thirty days and in any form other than gas shall be tested for leakage and/or contamination at intervals not to exceed six months. In the absence of a certificate from the transferor indicating that a test has been made within six months prior to the transfer, the sealed source shall not be put into use until tested.

b. The periodic leak test required by this condition does not apply to sealed sources that are stored and not being used. These sources shall be tested for leakage prior to any use or transfer to another person unless they have been leak tested within six months prior to the date of use or transfer.

c. The test shall be capable of detecting the presence of 0.005 microcurie of radioactive material on the test sample. The test sample. The test sample shall be taken from the sealed source or from the surfaces of the device in which the sealed source is permanently mounted or stored on which one might expect contamination to accumulate. Records of leak test results shall be kept in units of microcuries and maintained for inspection by the U.S. Atomic Energy Commission.

d. If the test reveals the presence of 0.005 microcurie or more of removable contamination, the sealed source shall be immediately withdrawn from use, decontaminated and repaired or disposed of in accordance with AEC regulations. A report shall be filed within 5 days of the test with the Director, Division of Materials Licensing, U.S. Atomic Energy Commission, Washington, D.C., 20545, describing the equipment involved, the test results, and the corrective action taken. A copy of such report shall also be sent to the Director, Region II, Division of Compliance, USAEC, Suite 818, 230 Peaktree Street N.W., Atlanta, Georgia, 30303.

e. Tests for leakage and/or contamination shall be performed by the Environmental Health Contractor or by other persons specifically authorized by the Commission or an agreement state to perform such services.

f. Details on acceptable leak testing methods may be obtained from the Environmental Health Contractor.

3.8 RADIOACTIVE WASTE DISPOSAL

Activities at KSC with radioactive materials which may generate waste shall require special authorization by the KSC-RPO prior to the conduct of the work. All approved work of this nature shall require the presence of the Environmental Health Contractor. All waste shall be collected by the Environmental Health Contractor for storage. Disposal and waste material records shall be maintained by the Environmental Health Contractor.

3.9 INSTRUMENT POOL AND CALIBRATION

a. Portable Instrument

A pool of portable instrumentation shall be maintained by the Environmental Health Contractor. Instruments may be obtained by request to the Environmental Health Contractor.

Portable instrumentation shall be calibrated by the NASA Contractor responsible for all calibration. Where the calibration capability does not exist for a particular instrument, this Contractor shall seek off-site support.

b. Laboratory Counting Equipment

All in-place radiation counting equipment shall be calibrated by use of comparison standards.

SECTION IV
EMERGENCY PROCEDURES

4.1 GENERAL

Contamination is easily spread during an emergency situation such as a fire, explosion, accidental breakage of a container, or spilling. Radioactive materials can be spread very rapidly and easily by the air currents set up by a fire. They may also find their way into an air-conditioning system, or, if spilled on the floor, they may be tracked around by personnel. This contamination is undetectable except by the use of specific radiation-detecting devices. Since it is extremely difficult to set up adequate detection controls in an emergency, preplanned emergency procedures are included in this handbook. Personnel whose work involves the use of radioactive materials shall familiarize themselves with these procedures.

4.2 PROCEDURES AFTER SPILLAGE OF RADIOACTIVE MATERIAL

a. General Responsibilities

Immediately after the occurrence of a spill, the involved person must vacate all affected personnel to a safe area. He will then notify by telephone, or by the most rapid method of communication, the KSC-RPO and follow his instructions or those of his authorized representative.

b. Specific Precautions

Unless he has received different instructions from the KSC-RPO, the person involved in the spillage shall proceed to:

(1) Prevent all affected personnel from approaching the contaminated area, or from attempting to deal with the spillage.

(2) Close all windows and other openings such as ventilating grills.

(3) Close and lock all doors.

(4) If the spillage involves powdered or gaseous radioactive material, seal all doors and other openings after closing. Suitable sealing materials usually handy are wide masking tape, adhesive tape, or heavy wrapping paper, secured to the frames.

C

c. Rules Affecting Conduct of all Personnel

(1) No person shall enter the affected area until the KSC-RPO or his designated alternate has conducted a contamination survey and has pronounced the area safe to resume work.

(2) Unauthorized personnel shall not attempt to make a survey, or to clean up the spillage. Under special circumstances, personnel authorized by the KSC-RPO shall direct and closely supervise these tasks.

(3) Decontamination procedures shall ALWAYS be conducted under the supervision of the KSC-RPO or his designated alternate.

(4) Personnel shall be instructed to keep their movements in the contaminated area to a minimum to avoid spreading the contaminant by tracking.

4.3 FIRES IN RADIATION AREAS

In case of fire in areas where radioactive materials are in use, every practical effort should be made by the user to replace the material in its shielded container. In any event, it is the responsibility of the user to promptly notify the Fire Department and the KSC-RPO.

Fire Department personnel will be knowledgeable of radiation hazards, and the Fire Department is encouraged to contact the Environmental Health Contractor for periodic instruction. The Fire Department shall be kept notified by the Environmental Health Contractor of all locations of radioactive materials in amounts that may prove hazardous to Fire Department personnel either externally or internally or that may present a serious contamination problem. Upon call to one of these locations, the Fire Chief, in consultation with the Environmental Health Contractor, shall be responsible to see that proper procedures are implemented to minimize radiation exposure to personnel and spread of contamination.

4.4 LOST OR MISPLACED SOURCES OF RADIATION

Lost or misplaced sources of radiation should be reported immediately to the KSC-RPO.

The KSC-RPO shall report immediately to the AEC after a theft or loss of licensed material.

4.5 NOTIFICATION OF ACCIDENTS

a. Radiation users will report to the KSC-RPO immediately any incident or accident involving radiation sources or malfunction of radiation producing equipment. The KSC-RPO will promptly investigate any such report and advise NASA management of his findings.

b. The KSC-RPO will notify the AEC immediately following an accident as described in Title 10 CFR 20, para. 20.403.

c. The KSC-RPO shall submit a written report within 30 days following an overexposure to radiation levels of radiation and concentrations of radioactive material as described in Title 10 CFR 20, para. 20.405.

SECTION V
LAUNCH OPERATIONS WITH RADIOACTIVE MATERIALS

5.1 GENERAL

Radioactive material will be used in launched spacecraft when authorized by NASA Headquarters which assumes responsibility for coordination with other agencies to assure compatibility of the proposed use with national policies and objectives.

5.2 ACTIVITIES

a. Prelaunch

Activities involving sealed radioactive flight sources shall conform to the provision of this handbook in addition to the applicable license conditions.

b. Launch

(1) Manned Flights

Upon launch, the KSC-RPO shall ensure that all radioactive materials launched into space are accounted for on MSC Form 1625. When completed, these forms shall be sent to the MSC Radiological Safety Officer.

(2) Unmanned Flights

Upon launch, the KSC-RPO shall ensure that an accurate record of launch material is sent to the appropriate NASA Center.

(3) Documentation Retention

Each NASA program center has the responsibility of maintaining the permanent record of launched radioactive materials.

5.3 FLIGHT NUCLEAR ASSEMBLIES

Radiation protection criteria during prelaunch and launch activities at KSC with large nuclear assemblies (Systems for Nuclear Auxiliary Power (SNAP) devices), will be contained in documentation unique to the particular launch vehicle/device in question. Documentation of this nature is maintained by the KSC-RPO and the Environmental Health Contractor.

APPENDIX A
RADIATION SAFETY PROCEDURES

APPENDIX A
RADIATION SAFETY PROCEDURES

PART I

RADIATION SAFETY PROCEDURES FOR PERSONNEL DOSIMETRY

PART I

RADIATION SAFETY PROCEDURES FOR PERSONNEL DOSIMETRY

1. PURPOSE

Part I prescribes policies, requirements, responsibilities, and procedures for personnel dosimetry and monitoring to measure and record all occupational exposure of personnel to ionizing radiation.

2. POLICY

It is KSC policy that dosimeters (film badges, unless otherwise specified) shall be furnished to and worn by the following personnel:

a. Any individual entering a radiation area, except when study by the RPO, or his delegated alternate, has shown that it is not likely that the circumstances of entry will produce exposures exceeding 25 percent of the regulatory limit.

b. Any individual entering a high radiation area under any circumstances.

c. Any radiographer or radiographer assistant.

3. OBJECTIVE

The objective of Part I is to ensure that adequate personnel monitoring is provided so that no person covered by the provisions of this procedure receives a significant unrecorded exposure to ionizing radiation. Policies and procedures for minimizing and controlling exposures, as distinct from merely measuring and recording them, are prescribed by KMI 1860.1 and other related Instructions.

4. DEFINITIONS

Definitions for technical terms not defined herein may be found in the Appendix C, "Glossary" of this Handbook.

a. Radiation Protection Officer

A designated KSC employee of the Medical Services Office.

b. Personnel Dosimetry

The estimation of the radiation dose to an individual from physical measurements relevant to his person. This Part deals with dosimetry for external radiation.

c. Dosimeter

A radiation-sensitive device worn by a specific individual for estimating the radiation to which he has been exposed. Examples of dosimeters are:

(1) Film Badge

An arrangement of photographic film(s) of varying emulsions, and varying filters, to estimate dose by means of latent images.

(2) Thermoluminescent (TLD) Dosimeter

A chemical device to estimate dose by means of a latent liminescent effect, which must be measured by heating the dosimeter.

(3) Pocket Chamber

A device to estimate dose by measuring a cumulative electrical charge with an auxiliary reading device.

(4) Pocket Dosimeter

A variation of the pocket chamber, which may be read continuously.

d. Whole Body Dose

The dose in rems to the whole body, gonads, active bloodforming organs, head and trunk, or lens of eye.

5. RESPONSIBILITIES

a. The RPO, or his delegated alternate, will be responsible for:

(1) Reviewing and approving the specifications of dosimeters and services to be used; reviewing and approving the distribution and collection procedures to minimize losses and extraneous exposures; arranging procurement of dosimeters and related services.

(2) Reviewing results and reporting to concerned supervision any conditions needing preventive or corrective action, either relative to individuals or components.

(3) Maintaining exposure records (Form AEC-4) in a manner facilitating comparison with regulatory limits, and the making of reports to which the individual is entitled under the regulations. These exposure records shall specifically include:

(a) A summary of any investigative action taken for any exposure result exceeding a regulatory limit or an administrative working limit, with recommendations for corrective action.

(b) A summary of any investigative action which results in the deletion of any reported exposure result as not valid.

(c) An estimate of the type and extent of exposure which the individual probably received during any period in which he was working with a radiation source without a required film badge or dosimetric device in his possession, and for any period for which the film badge processor is unable to report a result.

(d) For any individual permitted to work in a radiation area without a film badge, a reference to the study on which such exemption is based. (See subpara. (1), above.)

(4) Reporting immediately to the RPO any data or circumstances of any type indicating that an employee may have been exposed above a regulatory limit, or may feel that he has received a radiation injury.

(5) Issuing all reports required by AEC or State regulations relevant to radiation incidents and exposures.

b. The Chief, Medical Services Office will be responsible for:

(1) Directing all medical examination, treatment, consultation, or other activities in response to any reports or inquiries on radiation exposures.

(2) Providing professional guidance to the RPO, and to unit, area, or contractor Radiation Safety Officers, on medical aspects of radiation exposure.

(3) Providing the exposure records of former employees, which documents are appropriately retained and made available to subsequent employers only upon receipt of authorized request.

c. Each Supervisor in an area in which film badges are required will be responsible for:

(1) Normal supervisory enforcement of individual responsibilities.

(2) Furnishing information relevant to film badge procurement and termination as discussed in paragraphs 6 and 7.

(3) Ensuring the maintenance of personnel dosimetry logs as prescribed in para. 8.

d. Each individual to whom a film badge is issued will be responsible for:

(1) Wearing the film badge on the upper part of the body at all times during working hours, except as in subpara. (3) below.

(2) Storing the film badge during non-working hours in a location free of any radiation. In some locations, to be identified by the RPO or his alternate, this may require that the film badge be taken home.

(3) Ensuring that the film badge is not worn during exposure to radiation as a medical patient.

(4) Ensuring that, the film badge is not subjected to water, chemicals, heat, pressure, or tampering.

(5) Promptly reporting any instance in which the film badge is found to be, or to have been, out of his control, other than in approved storage.

(6) Promptly exchanging film badges according to the schedule established for his activity.

e. Radiographer(s) and Radiographer assistant(s) will be responsible for using pocket chambers or pocket dosimeters in addition to their film badges, and ensuring that the records are included in the exposure record files. The RPO or his representative may require the use of such pocket chambers as supplemental or substitute dosimeters in the procedures for other specific tasks or areas.

f. The Head of the Cognizant Operating Directorate will be responsible for incorporating the requirements of this Part I in Procurement Requests (PR) and Material Requests (MR) for proposed contracts where there is a possibility of exposure to ionizing radiation in the work to be undertaken by the contractor.

6. FILM BADGE SERVICE PROCEDURES

Film badge service is provided by contract. Therefore, requests for services for individuals must reach the RPO not less than 2 weeks prior to the date the service will be required. A few extra badges will be maintained for use by visitors and for emergencies. Film badge requests will be forwarded to the RPO by memorandum. In emergencies, or for visitors, the necessary information on the wearer of the film badge may be submitted with the exposed badge. When continuous service is desired for personnel who are regularly exposed, the information should be provided in advance in order that film badges can be appropriately marked. The request shall include the following information for each person:

a. Full name.

b. Social Security number.

c. Date of birth (month, day, year).

d. Age -- to nearest full year.

e. Previous employment at other than KSC, if any, where occupationally exposed to ionizing radiation, including name of employer and dates of such employment, and written authorization to the RPO to acquire exposure records for exposure history purposes.

f. Section, branch, and division where current or proposed employment involves exposure to radiation requiring film badge service.

g. Facilities, rooms, and operations where the employee will receive exposure.

h. Name of person(s) responsible for use or supervision of use of radiation sources to which employee will be exposed.

i. List of the source(s) to which the employee will be occupationally exposed, including indication of type and energy of radiation. This list should also include locations other than KSC, if any, where the employee will be occupationally exposed.

j. Name of supervisor or unit Radiation Safety Officer and location to which the badge is to be delivered.

7. TERMINATION OF FILM BADGE SERVICE

The responsible division or office chief shall inform the RPO by memorandum as soon as it is known that film badge service will not be required beyond a certain date for a particular individual. Where exposure will be periodic, and the periods can be defined, the request for initial service or a revision thereof should specify the weeks when it is known the person will not be exposed occupationally to ionizing radiation.

8. PERSONNEL DOSIMETRY LOGS

A log shall be maintained at each laboratory or radiation area where personnel wear pocket chambers or pocket dosimeters, or where dosage to personnel is computed by carrying a survey meter during operations. The exposure for each person and the dosimeter reading or method of estimate shall be shown daily. Each device shall have a distinctive number or other marking which shall be indicated in the dosimetry log.

PART II

RADIATION SAFETY PROCEDURES FOR RADIOGRAPHIC OPERATIONS

A-2-1.1

PART II

RADIATION SAFETY PROCEDURES FOR RADIOGRAPHIC OPERATIONS

1. PURPOSE

Part II establishes responsibilities and sets forth procedures for ensuring proper radiation safety controls during radiographic operations.

2. RESPONSIBILITIES

a. The KSC-RPO will be responsible for:

(1) Coordinating with NASA and contractor personnel in the development of procedures for guiding operating personnel in radiographic operations.

(2) Advising, assisting, and providing safety engineering services as required.

(3) Providing film badges, pocket dosimeters, and other radiation safety equipment as required.

b. Supervisors in charge of operations will be responsible for ensuring that radiographic operations are conducted in accordance with this Part II.

c. The Chief, Procurement Office, will be responsible for:

(1) Arranging for prospective contractor radiographers to submit for review and approval by the KSC-RPO either a copy of license for radioactive sources or the registration information for X-ray machines required by the Florida Control of Radiation Hazards Section 10D-56.402, issued pursuant to the Florida Nuclear Code, Chapter 290 Florida Statutes.

(2) Requiring contractor radiographers to notify the KSC-RPO of thefts, unusual incidents and overexposures, in addition to the notifications to the State required by the Florida Control of Radiation Hazards Section 10D-56.221, .222, and .223, issued pursuant to the Florida Nuclear Code Chapter 290 Florida Statutes.

3. EQUIPMENT CONTROL

a. Each source of radiation shall be provided with a lock or outer locked container designed to prevent unauthorized or accidental production of radiation or removal or exposure of a sealed source and shall be kept locked at all times except when under the direct surveillance of a radiographer or radiographer assistant.

b. A calibrated and operable survey meter shall be maintained at each job site where radiographic operations are being performed. This meter shall have a range such that two milliroentgen per hour can be measured. Instruments will be calibrated at intervals not to exceed 90 days and will be tagged accordingly.

c. Each sealed source shall be tested for leakage at intervals not to exceed 6 months in accordance with the requirements specified in the license. Records of such leak tests will be kept by the licensee.

d. Each licensee shall conduct a quarterly physical inventory to account for all radioactive material received or possessed by him. Records of inventories shall be maintained for inspection by the RPO.

4. PERSONAL SAFETY

a. No licensee or registrant shall permit any individual to act as a radiographer until such individual:

(1) Has received copies of, and instruction in, the procedure contained in this Part II, the applicable sections on Standards for Radiation Protection contained in AEC and Florida regulations, the current license, and the licensee's or registrant's operating and emergency procedures, and shall have demonstrated understanding thereof.

(2) Has demonstrated competence to use the sources of radiation, related handling tools, and radiation survey instruments which will be employed in his assignment.

b. No licensee or registrant shall permit any individual to act as a radiographer assistant until such individual:

(1) Has received copies of, and instruction in, the licensee's or registrant's operating and emergency procedures, and shall have demonstrated understanding thereof.

(2) Has demonstrated competence to use, under the personal supervision of the radiographer, the sources of radiation, related handling tools, and radiation survey instruments which will be employed in his assignment.

c. The licensee's or registrant's operating and emergency procedures shall include instruction in at least the following:

(1) The handling and use of sources of radiation to be employed such that no individual is likely to be exposed to radiation doses in excess of the limits established in Title 10, CFR 20.

(2) Methods and occasions for conducting radiation surveys.

(3) Methods for controlling access to radiographic areas.

(4) Methods and occasions for locking and securing sources of radiation.

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

(6) Transportation to field locations, including packing of sources of radiation in vehicles, and control of sources of radiation during transportation.

(7) Minimizing exposure of individuals in the event of an accident.

(8) Maintenance of records.

d. All radiographers and radiographer assistants shall wear at all times during radiographic operations a film badge and either a pocket dosimeter or pocket chamber. Pocket dosimeters and pocket chambers shall be capable of measuring doses from zero to 200 milliroentgens.

5. PRECAUTIONARY PROCEDURES DURING OPERATIONS

a. During each radiographic operation, the radiographer or radiographer assistant shall maintain a direct surveillance of the operation to protect against unauthorized entry into a high radiation area.

b. A survey will be made during each exposure to ensure that no individual other than authorized personnel is in an area where he could receive, if continuously present in that area, a dose in excess of 2 mr. in any hour or 100 mr. in any 7 consecutive days.

c. Areas in which radiography is being performed shall be conspicuously posted with a sign or signs bearing the radiation caution symbol. During hours of darkness, at least one of the signs facing each approach to the radiation area shall be conspiuously illuminated by an amber or white light.

d. When work is being performed in a populated area where it can cause other work stoppages, collimators will be used whenever indicated, radiographic operations at ground level, when desired results permit, will be oriented so that the beam is focused either vertically or towards the ground.

6. NOTIFICATION AND INFORMATION REQUIRED PRIOR TO OPERATIONS

a. Radiographer shall notify the KSC-RPO of the scheduled radiographic operation with complete details as far in advance as possible to allow for appropriate support. For operations on CKAFS, the Range Contractor's Range Support Coordinator shall be notified of the operation.

b. Notification of the KSC-RPO/Range Support shall constitute automatic approval to proceed with a radiographic operation unless rescinded by the Safety Office or the Range Contractor's Pad Safety or OMEHS Environmental Health prior to start of the operation.

c. If the proposed operation is canceled, postponed, or the time changed for any reason prior to start, the radiographer shall notify the RPO or Range Support at once.

d. Details of operation should include:

(1) Name of contractor.

(2) Location, date, time, and anticipated length of operation.

(3) Item(s) to be radiographed.

(4) Type of testing (X-ray, Cobalt-60, Iridium-192, etc.).

(5) Strength of radiation source (e.g., maximum voltage and milliamperes, or curies).

(6) Number of exposures (if available).

(7) Duration of exposure (if available).

e. Upon completion of the operation, the radiographer shall notify the RPO (during duty hours) or Range Support (24 hours daily) and ensure that all barricades and hazard signs are removed.

7. REQUIRED TRAINING FOR RADIOGRAPHERS

a. Characteristics of gamma and X-radiation.

(1) Characteristics of gamma and X-radiation.

(2) Units of radiation dose (milliroentgen equivalent mammal (mrem) and quantity of radioactivity (curie).

(3) Hazards of excessive exposure or radiation.

(4) Levels of radiation from sources of radiation.

(5) Methods of controlling radiation dose.

(a) Working time.
(b) Working distances.
(c) Shielding.

b. Radiation detection instrumentation to be used:

(1) Use of radiation survey instruments.

(a) Operation.
(b) Calibration.
(c) Limitations.

(2) Survey techniques.

(3) Use of personnel monitoring equipment:

(a) Film badges.
(b) Pocket dosimeters.
(c) Pocket chambers.

c. Radiographic equipment to be used:

(1) Remote handling equipment.
(2) Radiographic exposure devices and sealed sources.
(3) Storage containers.
(4) Operation and control of X-ray equipment.

d. The requirements of pertinent Federal and State regulations.

e. The licensee or registrant's written operating and emergency procedures.

APPENDIX B

FORMS

APPENDIX B
FORMS

RADIOACTIVE MATERIAL USE REQUEST

(Prepare in original and four copies)

Reference: KMI 1860.1

FROM (NAME) (Please print)	OFFICE CODE	DATE	REF. NUMBER *
Astro Systems, Inc. Apollo, Pa. 19100	ASI-10	9/21/71	K-9980

TO: CHAIRMAN, RADIOLOGICAL CONTROL COMMITTEE (RCC), via (1) HEALTH PHYSICS SECTION (2) KSC Radiation Protection Officer

1. RADIOACTIVITY REQUIREMENTS

A. ELEMENT AND ISOTOPE	B. PHYSICAL FORM
Iridium-192 and Cobalt-60	Sealed Sources
C. TOTAL QUANTITY REQUIRED (MC OR UNITS)	**D. ESTIMATED ACTIVITY PER EXPERIMENT (MC OR UNITS)**
Ir-192 1 ea @ 100 curies ea Co-60 1 ea @ 30 curies ea	N/A

E. WASTE CONCENTRATIONS & AMOUNTS	LIQUID	SOLID
	N/A	N/A

2. TITLE OR BRIEF DESCRIPTION OF PROPOSED PROJECT

Used for Industrial Radiography on KSC and CKAFS

3. PROPOSED PROCEDURE (INCLUDING SPECIAL PRECAUTIONS)

See attached procedure No. 5-1-206 dated January 29, 1971

	3a. License No.	AEC ☐ State of

4. LOCATION OF USE	BUILDING NUMBER	ROOM NUMBER	AREA ZONE NUMBER
Various areas	K6-392-5 (Storage)	B-101 (Storage)	Various areas at CKAFS & KSC

5. USERS	6. PERIOD COVERED BY REQUEST
Robert S. Snyder Henry L. Pickering William T. Morrison	FROM 9/21/71 TO 9/21/73

7. HEALTH PHYSICS EQUIPMENT REQUIREMENTS

Film badges, ropes, signs, self reading pocket dosimeters, high & low range beta gamma dose rate instruments

ORIGINATOR		SUPERVISOR'S SIGNATURE	
James L. Parsons	9/21/71	Anthony B. Siebert	7/22/71

APPROVALS

SIGNATURE		DATE
T.L. Reasoner	(OMEHS Health Physics)	9/30/71
H.G. Wellington	KSC Radiation Protection Officer	9/30/71
Arnold P. Dougherty	SIGNATURE (CHAIRMAN RCC)	10/5/71

Original - RCC Committee Copy 2 KSC RPO Copy 1 Health Physics

* Supplied by Health Physics Section.

Figure B-1. Radioactive Material Use Request

RADIATION MACHINE USE REQUEST

(Prepare in original and four copies)

Reference: KMI 1860.1

FROM: (NAME) *(Please print)*	OFFICE CODE	DATE	REF. NUMBER*
Astrosystems, Inc. Apollo, Pa. 19100	ASI-10	September 10, 1971	K-9990

TO: CHAIRMAN RADIOLOGICAL CONTROL COMMITTEE (RCC), via (1) HEALTH PHYSICS SECTION (2) KSC Radiation Protection Officer (RPO)

1. TYPE OF RADIATION MACHINE
Industrial Radiography X-ray machine

2. MACHINE CHARACTERISTICS

A. MAKE	C. SERIAL NUMBER
Norelco	65802
B. MODEL: PG-200	D. 200 KVP AT 4.0 MA

3. AREA CHARACTERISTICS

A. KEY CONTROL	B. INTERLOCKS ON DOOR TO AREA
[X] YES [ ] NO	[ ] YES [ ] NO

4. [ ] ESTIMATED OR [ ] MEASURED RADIATION LEVEL (MAX) IN mr/hr

	D. DISTANCE TO THE 2 MR/HR CONTOUR	
A. AT SURFACE OF TUBE 1530 R/min w/o filter	NORTH SIDE: Approx 300 FT	EAST SIDE: Approx 10 FT
B. AT ONE FOOT FROM TARGET 19.2 R/min w/2.5 mm ad filter	SOUTH SIDE: Approx 10 FT	WEST SIDE: Approx 10 FT
C. AT OPERATORS POSITION (CONSOLE) < 2 mh/hr		

5. TITLE (OR BRIEF DESCRIPTION) OF PROPOSED PROJECT

General radiographic inspection of welds and castings

6. PROPOSED PROCEDURE

See attached Procedure No. 5-1-206

7. LOCATION OF USE

BUILDING	ROOM NUMBER	AREA ZONE NUMBER
Various areas	Various	Various at CKAFS & KSC

8. USERS	9. PERIOD COVERED BY REQUEST
Licensed employees of Astro Systems, Inc.	FROM 9/21/71 TO 9/21/73
SIGNATURE OF ORIGINATOR: James L. Parsons 9/21/71	SIGNATURE OF SUPERVISOR: Anthony B. Siebert 9/22/71

APPROVALS

SIGNATURE OF MEMBER,		DATE
L.L. Reasoner	OMEHS Health Physics	9/30/71
SIGNATURE OF CHAIRMAN,		DATE
H.G. Wellington	KSC Radiation Protection Officer	9/30/71
SIGNATURE OF CHAIRMAN, RCC		DATE
Arnold P. Dougherty		10/5/71

*Supplied by Health Physics Section

Figure B-2. Radiation Machine Use Request

MODIFICATION OF RADIATION USE REQUEST

1. Use only in modifying original request. 2. Prepare in original and four copies.

Reference: KMI 1860.1

FROM (NAME) *(Please print)*	CODE	DATE	REFERENCE NUMBER
Astro System, Inc. Apollo, PA 19100	ASI-10	6/20/72	K-9981

TO:

CHAIRMAN, RADIATION SAFETY COMMITTEE (RSC) via

KSC Radiation Protection Officer (RPO)

ORIGINATOR'S MODIFICATION

A second 100 curie Iridium-192 source is being obtained for use at CKAFS at KSC industrial radiographic sites. Storage as use procedures remain as in Radiation Use Request K-9980 dtd 9/21/71

SIGNATURE OF ORIGINATOR	SIGNATURE OF SUPERVISOR
Mitchell N. Carter	Paul T. Morrison

HEALTH PHYSICS COMMENTS

Same as in Radiation Use Request K-9980 dtd 9/21/71

SIGNATURE	DATE
James L. Parsons	9/21/71

APPROVALS

SIGNATURE	DATE
(KSC RPO) H.G. Wellington	9/30/71
SIGNATURE (CHAIRMAN, RSC) Arnold P. Dougherty	10/5/71

REMARKS

NASA — MSC

Figure B-3. Modification of Radiation Use Request

1181

RADIOACTIVE MATERIAL TRANSFER RECEIPT

(See instructions on reverse side of Originator Record Copy, Copy 3)

BUDGET BUREAU NO. 104-R0039
Approval expires May 31, 1972

SECTION I - ORIGINATION INFORMATION (Originator complete this section)

A. ITEM DATA

(1) NAME OF ITEM

Iridium-192

(2) SERIAL NUMBER	(3) ISOTOPE	(4) ACTIVITY (MILLICURIES)
K-9980	Cobalt-60	1 ea. @ 100 curies

(5) PHYSICAL AND CHEMICAL FORM OF RADIOACTIVE MATERIAL

Sealed source

(6) ACTIVITY DETERMINED BY *(Check one)*

[X] RECORD INFORMATION [ ] CALCULATION [ ] MEASURED BY _____

DATE DETERMINED: 9-1-72

(7) PURPOSE OF ITEM

Industrial Radiography

(8) LEAK TEST CERTIFICATE PROVIDED WITH THIS TRANSFER? [ ] YES [X] NO [ ] EXEMPT

B. ACCOUNTABILITY DATA

	LICENSE NUMBER	*(Check one)*	
(1) TRANSFERRED FROM (LICENSEE'S NAME) Astro Systems, Inc. Kennedy Space Center, Fla.	187	[ ] AEC [X] STATE OF	Florida
(2) TRANSFERRED TO (LICENSEE'S NAME) Technical Operations, Inc.	353	[ ] AEC [X] STATE OF	Ohio

C. RESPONSIBLE INDIVIDUAL (Shipper's Radiological Control Officer or equivalent)

(1) SIGNATURE	TITLE	DATE	TELEPHONE NO
J.L. Parsons	RPO Officer	9-15-72	8502

(2) ORIGINATING ORGANIZATION *(Complete address - Include Zip Code)*

KSC-RPO
Kennedy Space Center, Fla. 32899

D. SHIPPING DATA

(1) DATE SHIPPED	(2) ADDRESSED TO *(Include Zip Code)*	(3) MODE OF SHIPMENT *(Specify)*
9-18-72	Technical Operations, Inc. Apollo, Ohio 48327	Truck

(4) NAME OF CARRIER	(5) TRANSPORTATION DOCUMENTATION *(Give name & number of shipping document)*
Motor Freight Lines	Request for Supplies 7-49

SECTION II - DESTINATION INFORMATION (Receiver complete this section)

A. RECEIPT INFORMATION

(1) DATE ITEM RECEIVED	(2) CONDITION

(3) INFORMATION IN BLOCK _____ SHOULD BE CORRECTED TO.

B. RESPONSIBLE INDIVIDUAL (Receiver's Radiological Control Officer or equivalent)

SIGNATURE	TITLE	DATE	TELEPHONE NO

C. DISPOSITION OF ITEM

(1) NAME OF CUSTODIAN	TELEPHONE NO

(2) DISPOSITION AND LOCATION

MSC Form 1625 (May 67)

RADIOLOGICAL CONTROL OFFICER

Figure B-4. Radioactive Material Transfer Receipt

RADIOACTIVE MATERIAL
RECEIVING RECORD (Inbound)

1. DATE RECEIVED: 24 February 1972

2. VOUCHER NUMBER	3. CONDITION OF PACKAGE	4. NUMBER OF PIECES	6. MARKED FOR DATA
KSC-1-72	Good	1	
		5. TOTAL WEIGHT: 50 lbs.	

7. FROM (SHIPPER & ADDRESS)	8. TO (CONSIGNEE)
Defense Atomic Supply Agency Las Vegas, Nevada	Radiation Safety Officer (indicate Contractor & Symbol) Kennedy Space Center, Florida 32899

9. GBL NUMBER	10. CARRIER NAME	11. PRO NUMBER
F6,000,001	Delta Air Lines	LV-604-731-20

12. LABEL INFORMATION	13. HEALTH PHYSICIST CONTACTED (NAME)	
CONTENTS: 24 Americium NO. OF CURIES: 0.004 Ci	Dr. John W. Smith	
	14. DATE: 23 February 1972	15. TIME: 1030

16. DISPOSITION INSTRUCTIONS (FROM HEALTH PHYSICIST)

Deliver to Pad 39A

17. FREIGHT CHECKER'S SIGNATURE	18. DATE	19. SIGNATURE OF CONSIGNEE (REPRESENTATIVE)	20. DATE
Al Jones	24 Feb 72	James G. Tucker	24 Feb 72

KSC FORM OT-070 (1/72) (ONETIME FORM - REPRINT NOT AUTHORIZED) NASA/PAFB MAR/72

DISTRIBUTION

ORIGINAL - Transportation Branch *COPY 1 - RPO* *COPY 2 - Health Physicist* *COPY 3 - Consignee*

Figure B-5. Radioactive Material Receiving Record (Inbound)

FORM AEC 4
(6-60)

Form Approved.
Bureau of Budget No. 38-R1.9
Expiration Date: June 30, 1961

U.S. ATOMIC ENERGY COMMISSION

or Form FSB4-RAD 2 for Florida Licenses

OCCUPATIONAL EXTERNAL RADIATION EXPOSURE HISTORY

See Instructions on the Back

IDENTIFICATION

1. NAME (PRINT: LAST, FIRST, AND MIDDLE)
Parsons, James L.

2. SOCIAL SECURITY NO. (OR OTHER NO. IF NONE)
[redacted]

3. DATE OF BIRTH (MONTH, DAY, YEAR)
[redacted]

4. AGE IN FULL YEARS (N)
37

OCCUPATIONAL EXPOSURE—PREVIOUS HISTORY

5. PREVIOUS EMPLOYMENTS INVOLVING RADIATION EXPOSURE. LIST NAME AND ADDRESS OF EMPLOYER	6. DATES OF EMPLOYMENT (FROM TO)	7. PERIODS OF EXPOSURE	PREVIOUS DOSE HISTORY 8. WHOLE BODY (REM)	9. INSERT ONE RECORD OR CALCULATED
Orion Instrument Co. Albion, Ohio 44800	6/58 - 7/62	Same	1.20 0.60	Record Calculated
Heathrow Nuclear Science Corp. Burbank, Calif. 91100	8/62 - 5/71	Same	3.60	Record
10. REMARKS		11. ACCUMULATED OCCUPATIONAL DOSE TOTAL	5.00	

Between July and October 1961 employee received an exposure of approximately 7.5 rem to the hands and forearms from instrument calibration sources.

13. CALCULATIONS—PERMISSIBLE DOSE

WHOLE BODY

(A) PERMISSIBLE ACCUMULATED DOSE = 5(N-18) = 19.0 REM

(B) TOTAL EXPOSURE TO DATE (FROM ITEM 14) = 5.0 REM

(C) PERMISSIBLE DOSE = 14.0 REM

12. CERTIFICATION I CERTIFY THAT THE EXPOSURE HISTORY LISTED IN COLUMNS 5, 6, AND 7 IS CORRECT AND COMPLETE TO THE BEST OF MY KNOWLEDGE AND BELIEF

James L. Parsons — EMPLOYEE'S SIGNATURE
9/18/71 — DATE

14. NAME OF LICENSEE
Astro Systems, Inc.
Apollo, Pa. 19100

Figure B-6. Occupational External Radiation Exposure History

Form AEC-3
(2-72)
10 CFR 20

UNITED STATES OF AMERICA ATOMIC ENERGY COMMISSION
Washington, D.C. 20545

NOTICE TO EMPLOYEES

STANDARDS FOR PROTECTION AGAINST RADIATION

In Part 20 of its Rules and Regulations, the Atomic Energy Commission has established standards for your protection against radiation hazards from radioactive material under license issued by the Atomic Energy Commission.

YOUR EMPLOYER'S RESPONSIBILITY

Your employer is required to–

1. Apply these *AEC regulations* and the *conditions of his AEC license* to all work under the license.
2. Post or otherwise make available to you a copy of the *AEC regulations, licenses, and operating procedures* which apply to work you are engaged in, and explain their provisions to you.

YOUR RESPONSIBILITY AS A WORKER

You should familiarize yourself with those provisions of the *AEC regulations*, and the *operating procedures* which apply to the work you are engaged in. You should observe their provisions for your own protection and protection of your co-workers.

WHAT IS COVERED BY THESE AEC REGULATIONS

1. Limits on exposure to radiation and radioactive material in restricted and unrestricted areas;
2. Measures to be taken after accidental exposure;
3. *Personnel monitoring*, surveys and equipment;
4. Caution signs, labels, and safety interlock equipment;
5. Exposure records and reports; and
6. Related matters.

REPORTS ON YOUR RADIATION EXPOSURE HISTORY

1. The AEC regulations require that your employer give you a written report if you receive an exposure in excess of any applicable limit as set forth in the regulations or in the license. The basic limits for exposure to employees are set forth in Sections 20.101, 20.103, and 20.104 of the Part 20 regulation. These Sections specify limits on exposure to radiation and exposure to concentrations of radioactive material in air.
2. If you work where personnel monitoring is required pursuant to Section 20.202:
   (a) your employer must give you a written report of your radiation exposures upon the termination of your employment, if you request it, and
   (b) your employer must advise you annually of your exposure to radiation, if you request it.

INSPECTIONS

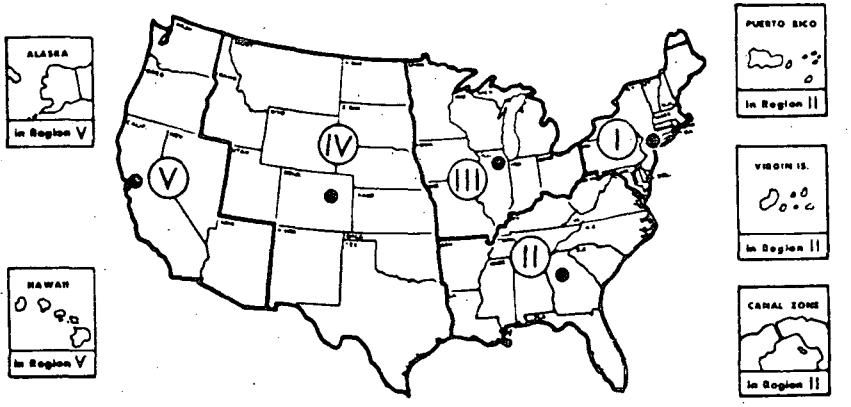
All activities under the license are subject to inspection by *representatives* of the U.S. Atomic Energy Commission.

INFORMATION

Inquiries dealing with the matters outlined above can be sent to the United States Atomic Energy Commission Compliance Office having inspection responsibility over your plant, as shown on the map at the right. Should an employee desire to inform the AEC of any unsafe conditions which involve radiation or radioactive material possessed pursuant to an AEC license, the employee can contact the responsible *Compliance office* or the Compliance inspector when he is at the facility. The name or identity of the employee who furnishes such information will not be disclosed to the employer, if the employee so requests.

POSTING REQUIREMENT

Copies of this notice must be posted in a sufficient number of places in every establishment where activities licensed by the AEC are conducted, to permit employees working in or frequenting any portion of a restricted area to observe a copy on the way to or from their place of employment.



UNITED STATES ATOMIC ENERGY COMMISSION COMPLIANCE OFFICES

REGION	ADDRESS	TELEPHONE DAYTIME	TELEPHONE NIGHTS AND HOLIDAYS
I	Region I, Division of Compliance, USAEC 970 Broad Street Newark, New Jersey 07102	201 645-3960	201 645-3960
II	Region II, Division of Compliance, USAEC Suite 818, 230 Peachtree St. NW. Atlanta, Georgia 30303	404 526-4503	404-526-4503
III	Region III, Division of Compliance, USAEC 799 Roosevelt Road Glen Ellyn, Illinois 60137	312-858-2660	312-739-7711
IV	Region IV, Division of Compliance, USAEC 10395 West Colfax Avenue Denver, Colorado 80215	303–837–4211	303-237-5095
V	Region V, Division of Compliance, USAEC 2111 Bancroft Way Berkeley, California 94704	415-841-5121 (Ext. 651)	415-841-9244

GPO 930-428

Figure B-7. Notice to Employees - Standards for Protection Against Radiation

APPENDIX C

GLOSSARY

GLOSSARY

Accelerator	A machine that accelerates electrically charged particles to high velocities. Types of accelerators include the cyclotron, linear accelerator and Van de Graaff generator.
Alpha Radiation	Positively charged particles, each identical to a helium nucleus and emitted from a nucleus during radioactive decay.
Alpha Emitter	Any nuclide that emits alpha radiation.
Beta Radiation	High speed electrons, each emitted from a nucleus during radioactive decay.
Bremsstrahlung	Secondary photon radiation produced by deceleration of charged particles passing through matter.
Byproduct Material	Any radioactive material (excluding source and fissionable material) obtained in the process of producing or using source or fissionable material; includes fission products produced in nuclear reactors.
Contamination (Radioactive)	The presence of radioactive material anywhere not desired.
Curie	The unit of radioactivity; equals 37 billion nuclear decays per second.
Decay (Radioactive)	Spontaneous disintegration of the nucleus of an unstable atome by the emission of charged particles and/or electromagnetic radiation.
Decontamination	The removal of radioactive contaminants.
Dose Rate	The radiation dose delivered per unit time.
Dosimeter	Any device that detects and measures radiation dose.

Film Badges	A packet of photographic film used for measurement of radiation dose for personnel monitoring purposes.
Fission	The splitting of a heavy nucleus into roughly equal parts, accompanied by the release of energy and frequently one or more neutrons.
Fission Products	Elements or compounds resulting from fission.
Gamma Radiation	Highly penetrating electromagnetic radiation of nuclear origin.
Half Life (Radioactive)	The time in which half the atoms in a radioactive substance decay.
Health Physics	A profession devoted to the protection of man and his environment from unwarranted radiation exposure.
Ionization Chamber	An instrument that detects and measures ionizing radiation by observing the electric current created when radiation ionizes gas in the chamber.
Ionizing Radiation	Any electromagnetic or particulate radiation capable of producing ions, directly or indirectly, in its passage through matter.
Isotope	Atoms with same atomic number but different atomic weights.
Licensed Material	Any material received, possessed, used or transferred under a general or special license issued by the Atomic Energy Commission or an agreement state.
Micro	A prefix meaning one-millionth, e.g., 1 microcurie = $1X10^{-6}$ curies.
Milli	A prefix meaning one-thousandth, e.g., 1 millicurie = $1X10^{-3}$ curies.
Nuclide	Any species of atom that exists for a measurable length of time.

Pocket Dosimeter	A self-rading, pencil-size ionization chamber used for personnel monitoring purposes.
Quality Factor	A factor used to compare the biological effectiveness of absorbed radiation doses due to different types of ionizing radiation; equivalent to the term, RBE, Relative Biological Effect.
Rad	The basic unit of absorbed dose of ionizing radiation; equals the absorption of 100 ergs of energy per gram of matter.
Radiation	a. The emission and propagation of energy through space or through a material in the form of waves. b. The energy propagated through space or through materials as waves; usually referring to electromagnetic radiation. c. By extension, particulates such as Alpha or Beta radiation or rays of mixed type.
Radioactivity	The spontaneous decay or disintegration of an unstable atomic nucleus, accompanied by the emission of radiation.
Radioassay	The process of analyzing biological material to determine its radioactive content.
Radiographer	Any individual who performs or who, while in attendance at the site where sources of radiation are being used, personally supervises radiographic operations, and who is responsible to the licensee or registrant for assuring compliance with the requirements of this Instruction and all license conditions.
Radiographer Assistant	Any individual who, under the personal supervision of a radiographer, uses sources of radiation, related handling tools, or radiation survey instruments in radiography.

Radiographic Exposure Devices	
a. Gamma Device	Any instrument containing a sealed radioactive isotope source fastened or contained therein, in which the sealed source or shielding thereof may be moved or otherwise changed from a shielded to unshielded position for purposes of making a radiographic exposure.
b. X-Ray Device	Any instrument electronically producing radiation which is emitted from an encased X-ray tube for the purpose of making a radiographic exposure.
Radiography	The use of penetrating ionizing radiation to examine solid material.
Radioisotope	An unstable isotope of an element that decays or disintegrates spontaneously, emitting radiation.
Radiology	That branch of medicine which uses ionizing radiation for diagnosis and therapy.
Rem	Roentgen equivalent man. A unit of absorbed dose in biological matter; equals the absorbed dose in rads multiplied by the quality factor of the radiation.
Roentgen	The amount of Gamma or X-radiation required to produce ions carrying one electrostatic unit of charge in one cubic centimeter of dry air under standard temperature and pressure conditions.
Source Material	Any material, except special nuclear material, which contains 0.05 percent or more of Uranium, Thorium or any combination of the two.
Special Nuclear Material	Plutonium, Uranium-233; Uranium containing more than the natural abundance of Uranium-235, or any material enriched by any of the substances.
Storage Container	Any device in which sealed sources are transported or stored.

E

Survey	An evaluation of the radiation hazards incidental to the production, use or presence of radioactive materials or other sources of radiation under a specific set of conditions.
Waste (Radioactive)	Equipment and materials which are radioactive and, having no further use, are discarded.
X-Radiation	Penetrating electromagnetic radiation of non-nuclear origin; usually produced by bombarding a metallic target with high speed electrons.

DISTRIBUTION:

Changes, additions, or deletions to this distribution may be made by contacting the KSC Environmental Health Services, 867-5453, Mail Code IS-MED-A.

STDL -C, J

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