NRC Form 313 I (12-81) 10 CFR 30

U.S. NUCLEAR REGULATORY COMMISSION

APPLICATION FOR BYPRODUCT MATERIAL LICENSE
INDUSTRIAL

1. APPLICATION FOR: *(Check and/or complete as appropriate)*

- a. NEW LICENSE
- b. AMENDMENT TO: LICENSE NUMBER 24-01113-02
- c. RENEWAL OF: LICENSE NUMBER

See attached instructions for details.

Completed applications are filed in duplicate with the Division of Fuel Cycle and Material Safety, Office of Nuclear Material Safety, and Safeguards, U.S. Nuclear Regulatory Commission, Washington, DC 20555 or applications may be filed in person at the Commission's office at 1717 H Street, NW, Washington, D. C. or 7915 Eastern Avenue, Silver Spring, Maryland.

2. APPLICANT'S NAME *(Institution, firm, person, etc.)*

Monsanto Co., J. F. Queeny Plant

TELEPHONE NUMBER: AREA CODE – NUMBER EXTENSION
622-1400 314

3. NAME AND TITLE OF PERSON TO BE CONTACTED REGARDING THIS APPLICATION

TELEPHONE NUMBER: AREA CODE – NUMBER EXTENSION

4. APPLICANT'S MAILING ADDRESS *(Include Zip Code)*
(Address to which NRC correspondence, notices, bulletins, etc., should be sent.)

Atten:A.T. Kavlick, RSO
1700 South Second St. St. Louis, Mo. 63177

5. STREET ADDRESS WHERE LICENSED MATERIAL WILL BE USED *(Include Zip Code)*

1700 South Second Street
St. Louis, Missouri 63177

(IF MORE SPACE IS NEEDED FOR ANY ITEM, USE ADDITIONAL PROPERLY KEYED PAGES.)

6. INDIVIDUAL(S) WHO WILL USE OR DIRECTLY SUPERVISE THE USE OF LICENSED MATERIAL
(See Items 16 and 17 for required training and experience of each individual named below)

	FULL NAME	TITLE
a.	Adam Thomas Kavlick	Radiation Safety Officer
b.	John R. Winkelmann	Alternate Radiation Safety Officer
c.	Larry L. Taylor	Supervisor Utilities

7. RADIATION PROTECTION OFFICER

Adam T. Kavlick

Attach a resume of person's training and experience as outlined in Items 16 and 17 and describe his responsibilities under Item 15.
(continued on attached sheet)

8. LICENSED MATERIAL

LINE NO.	A ELEMENT AND MASS NUMBER	B CHEMICAL AND/OR PHYSICAL FORM	C NAME OF MANUFACTURER AND MODEL NUMBER *(If Sealed Source)*	D MAXIMUM NUMBER OF MILLICURIES AND/OR SEALED SOURCES AND MAXIMUM ACTIVITY PER SOURCE WHICH WILL BE POSSESSED AT ANY ONE TIME
(1)	CESIUM 137	Sealed Source	Ohmart	300 millicuries
(2)	"	" "	K-RAY	300 "
(3)	"	" "	Nuclear Chicago	1000 "
(4)				

	E DESCRIBE USE OF LICENSED MATERIAL
(1)	Blanket amendment to use Ohmart Gauges - All source holders
(2)	Blanket amendment to use K-Ray Gauges - All source holders
(3)	Nuclear Chicago Model 5176 source holders
(4)	

NRC FORM 313 I (12-81)

CONTROL NO. 78407

9. STORAGE OF SEALED SOURCES

LINE NO.	A. CONTAINER AND/OR DEVICE IN WHICH EACH SEALED SOURCE WILL BE STORED OR USED.	B. NAME OF MANUFACTURER	C. MODEL NUMBER
(1)	Density and Level Gauges	Ohmart	All
(2)	" " " "	K-Ray	All
(3)	" " " "	Nuclear Chicago	5176
(4)			

10. RADIATION DETECTION INSTRUMENTS

LINE NO.	A TYPE OF INSTRUMENT	B MANUFACTURER'S NAME	C MODEL NUMBER	D NUMBER AVAILABLE	E RADIATION DETECTED (alpha, beta, gamma, neutron)	F SENSITIVITY RANGE (milliroentgens/hour or counts/minute)
(1)	Gieger Mueller Meter	Nuclear Chicago	2650	1	Alpha, Beta Gamma	.1, .3, 1, 3, 10 30 and 100
(2)						
(3)						
(4)						

11. CALIBRATION OF INSTRUMENTS LISTED IN ITEM 10

☐ a. CALIBRATED BY SERVICE COMPANY

NAME, ADDRESS, AND FREQUENCY

Monanto - St. Louis (Annually)

☐ b. CALIBRATED BY APPLICANT

Attach a separate sheet describing method, frequency and standards used for calibrating instruments.

On file with NRC

12. PERSONNEL MONITORING DEVICES

A TYPE (Check and/or complete as appropriate.)	B SUPPLIER (Service Company)	C EXCHANGE FREQUENCY
☐ (1) FILM BADGE ☐ (2) THERMOLUMINESCENCE DOSIMETER (TLD) ☐ (3) OTHER (Specify): None	None	☐ MONTHLY ☐ QUARTERLY ☐ OTHER (Specify):

13. FACILITIES AND EQUIPMENT (Check were appropriate and attach annotated sketch(es) and description(s).

☐ a. LABORATORY FACILITIES, PLANT FACILITIES, FUME HOODS (Include filtration, if any), ETC.
☐ b. STORAGE FACILITIES, CONTAINERS, SPECIAL SHIELDING (fixed and/or temporary), ETC.
☐ c. REMOTE HANDLING TOOLS OR EQUIPMENT, ETC.
☐ d. RESPIRATORY PROTECTIVE EQUIPMENT, ETC. NA

14. WASTE DISPOSAL

a. NAME OF COMMERCIAL WASTE DISPOSAL SERVICE EMPLOYED

NA

b. IF COMMERCIAL WASTE DISPOSAL SERVICE IS NOT EMPLOYED, SUBMIT A DETAILED DESCRIPTION OF METHODS WHICH WILL BE USED FOR DISPOSING OF RADIOACTIVE WASTES AND ESTIMATES OF THE TYPE AND AMOUNT OF ACTIVITY INVOLVED. IF THE APPLICATION IS FOR SEALED SOURCES AND DEVICES AND THEY WILL BE RETURNED TO THE MANUFACTURER, SO STATE.

Sealed Sources will be returned to the manufacturer.

NRC Form 313 I (12-81) 10 CFR 30

U.S. NUCLEAR REGULATORY COMMISSION

APPLICATION FOR BYPRODUCT MATERIAL LICENSE
INDUSTRIAL

See attached instructions for details.

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1. APPLICATION FOR: *(Check and/or complete as appropriate)*
   - a. NEW LICENSE
   - b. AMENDMENT TO: LICENSE NUMBER
   - c. RENEWAL OF: LICENSE NUMBER

2. APPLICANT'S NAME *(Institution, firm, person, etc.)*

   TELEPHONE NUMBER: AREA CODE – NUMBER EXTENSION

3. NAME AND TITLE OF PERSON TO BE CONTACTED REGARDING THIS APPLICATION

   TELEPHONE NUMBER: AREA CODE – NUMBER EXTENSION

4. APPLICANT'S MAILING ADDRESS *(Include Zip Code)* *(Address to which NRC correspondence, notices, bulletins, etc., should be sent.)*

5. STREET ADDRESS WHERE LICENSED MATERIAL WILL BE USED *(Include Zip Code)*

(IF MORE SPACE IS NEEDED FOR ANY ITEM, USE ADDITIONAL PROPERLY KEYED PAGES.)

6. INDIVIDUAL(S) WHO WILL USE OR DIRECTLY SUPERVISE THE USE OF LICENSED MATERIAL *(See Items 16 and 17 for required training and experience of each individual named below)*

FULL NAME	TITLE
a. Bradford D. Young	Supervisor - Dept. 55 TSCL
b. Dennis Litzsinger	Supervisor - Dept. 50 Phosphate Esters
c.	

7. RADIATION PROTECTION OFFICER

Attach a resume of person's training and experience as outlined in Items 16 and 17 and describe his responsibilities under Item 15.

8. LICENSED MATERIAL

LINE NO.	ELEMENT AND MASS NUMBER (A)	CHEMICAL AND/OR PHYSICAL FORM (B)	NAME OF MANUFACTURER AND MODEL NUMBER *(If Sealed Source)* (C)	MAXIMUM NUMBER OF MILLICURIES AND/OR SEALED SOURCES AND MAXIMUM ACTIVITY PER SOURCE WHICH WILL BE POSSESSED AT ANY ONE TIME (D)
(1)				
(2)				
(3)				
(4)				

LINE NO.	DESCRIBE USE OF LICENSED MATERIAL (E)
(1)	
(2)	
(3)	
(4)	

Applicant Mo/S-II
Check No. 001009367 $60
Amount/Fee Category 3P
Type Appl
Date Check Rec'd 3/11/85
Received By [illegible]

CONTROL NO. 78407

9. STORAGE OF SEALED SOURCES

LINE NO.	CONTAINER AND/OR DEVICE IN WHICH EACH SEALED SOURCE WILL BE STORED OR USED. A.	NAME OF MANUFACTURER B.	MODEL NUMBER C.
(1)			
(2)			
(3)			
(4)			

10. RADIATION DETECTION INSTRUMENTS

LINE NO.	TYPE OF INSTRUMENT A	MANUFACTURER'S NAME B	MODEL NUMBER C	NUMBER AVAILABLE D	RADIATION DETECTED *(alpha, beta, gamma, neutron)* E	SENSITIVITY RANGE *(milliroentgens/hour or counts/minute)* F
(1)						
(2)						
(3)						
(4)						

11. CALIBRATION OF INSTRUMENTS LISTED IN ITEM 10

☐ a. CALIBRATED BY SERVICE COMPANY

NAME, ADDRESS, AND FREQUENCY

☐ b. CALIBRATED BY APPLICANT

Attach a separate sheet describing method, frequency and standards used for calibrating instruments.

12. PERSONNEL MONITORING DEVICES

TYPE *(Check and/or complete as appropriate.)* A	SUPPLIER *(Service Company)* B	EXCHANGE FREQUENCY C
☐ (1) FILM BADGE ☐ (2) THERMOLUMINESCENCE DOSIMETER *(TLD)* ☐ (3) OTHER *(Specify)*: _____		☐ MONTHLY ☐ QUARTERLY ☐ OTHER *(Specify)*:

13. FACILITIES AND EQUIPMENT (Check were appropriate and attach annotated sketch(es) and description(s).

☐ a. LABORATORY FACILITIES, PLANT FACILITIES, FUME HOODS *(Include filtration, if any)*, ETC.
☐ b. STORAGE FACILITIES, CONTAINERS, SPECIAL SHIELDING *(fixed and/or temporary)*, ETC.
☐ c. REMOTE HANDLING TOOLS OR EQUIPMENT, ETC.
☐ d. RESPIRATORY PROTECTIVE EQUIPMENT, ETC.

14. WASTE DISPOSAL

a. NAME OF COMMERCIAL WASTE DISPOSAL SERVICE EMPLOYED

b. IF COMMERCIAL WASTE DISPOSAL SERVICE IS NOT EMPLOYED, SUBMIT A DETAILED DESCRIPTION OF METHODS WHICH WILL BE USED FOR DISPOSING OF RADIOACTIVE WASTES AND ESTIMATES OF THE TYPE AND AMOUNT OF ACTIVITY INVOLVED. IF THE APPLICATION IS FOR SEALED SOURCES AND DEVICES AND THEY WILL BE RETURNED TO THE MANUFACTURER, SO STATE.

INFORMATION REQUIRED FOR ITEMS 15, 16 AND 17

Describe in detail the information required for Items 15, 16 and 17. Begin each item on a separate page and key to the application as follows:

15. RADIATION PROTECTION PROGRAM. Describe the radiation protection program as appropriate for the material to be used including the duties and responsibilities of the Radiation Protection Officer, control measures, bioassay procedures *(if needed)*, day-to-day general safety instruction to be followed, etc. If the application is for sealed source's also submit leak testing procedures, or if leak testing will be performed using a leak test kit, specify manufacturer and model number of the leak test kit. On File

16. FORMAL TRAINING IN RADIATION SAFETY. Attach a resume for each individual named in Items 6 and 7. Describe individual's formal training in the following areas where applicable. Include the name of person or institution providing the training, duration of training, when training was received, etc. RSO - on file Alternate RSO - resume attached

    a. Principles and practices of radiation protection.

    b. Radioactivity measurement standardization and monitoring techniques and instruments.

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

    d. Biological effects of radiation.

17. EXPERIENCE. Attach a resume for each individual named in Items 6 and 7. Describe individual's work experience with radiation, including where experience was obtained. Work experience or on-the-job training should be commensurate with the proposed use. Include list of radioisotopes and maximum activity of each used.

    RSO - on file
    Alternate - RSO resume attached

18. CERTIFICATE

(This item must be completed by applicant)

The applicant and any official executing this certificate on behalf of the applicant named in Item 2, certify that this application is prepared in conformity with Title 10, Code of Federal Regulations, Part 30, and that all information contained herein, including any supplements attached hereto, is true and correct to the best of our knowledge and belief.

RECEIVED
MAR 01 1985
REGION III

WARNING.–18 U.S.C., Section 1001; Act of June 25, 1948; 62 Stat. 749; makes it a criminal offense to make a willful false statement or representation to any department or agency of the United States as to any matter within its jurisdiction.

a. LICENSE FEE REQUIRED *(See Section 170.31, 10 CFR 170)* $60.00	b. CERTIFYING OFFICIAL *(Signature)* Adam T. Kavlick
	c. NAME *(Type or print)* Adam T. Kavlick
(1) LICENSE FEE CATEGORY: Amendment	d. TITLE Radiation Safety Officer
(2) LICENSE FEE ENCLOSED: $ 60.00	e. DATE 2/21/85

CONTROL NO. 18407

OF THE AMERICAS

BOARD OF CERTIFIED SAFETY PROFESSIONALS

OF THE AMERICAS, INCORPORATED

AFFIRMS THAT

John R. Winkelmann

HAVING MADE APPLICATION FOR AND GIVEN SATISFACTORY EVIDENCE OF QUALIFICATION AS REQUIRED IN THE BY-LAWS; IS QUALIFIED TO RECEIVE AND IS HEREBY AUTHORIZED TO USE THE DESIGNATION

CERTIFIED SAFETY PROFESSIONAL

IN

COMPREHENSIVE PRACTICE

SO LONG AS THIS CERTIFICATE OF QUALIFICATION IS RENEWED ANNUALLY AND NOT REVOKED

BOARD OF EXAMINERS IN WITNESS WHEREOF WE HAVE HEREUNTO SET OUR HANDS AND AFFIXED THE SEAL OF THE BOARD THIS 1st DAY OF AUGUST, 1982

Randall T. Williams
PRESIDENT

Janet H. Faulkner
SECRETARY

SERIAL NO. 6878

The Curators of the University of Missouri

To all whom it may concern: Greeting:

Be it known that the Curators, having been advised by the Faculty that

John R. Winkelmann

has completed the Course of Study required of candidates for the degree of

Bachelor of Science in Electrical Engineering

and is qualified to receive the same, do by these presents confer said degree with all the honors and privileges appertaining thereto.

In testimony whereof the signatures of the proper officials and the seal of the University are affixed.

Done at the University in the City of Rolla, State of Missouri, this twenty-ninth day of July, in the year of our Lord one thousand nine hundred and seventy-two.

President of the Board of Curators

President of the University

Chancellor

Dean

Duplicate

CONTROL NO. 63407

Central Missouri State University

Warrensburg, Missouri

has conferred upon

John R. Winkelmann

The Degree of

Master of Science

and all the rights and privileges thereto appertaining.

In witness thereof, this diploma duly signed and the seal of the University affixed has been issued by the Board of Regents, upon recommendation of the faculty, on this 4th day of August, 1982 A.D.

Safety

James M. Horner
President of the University

Virginia D. Dixon
President of the Board of Regents

Arthur L. Walker
Commissioner of Education

Jessie B. Patton
Secretary of the Board of Regents

CONTROL NO. 73407

CENTRAL MISSOURI STATE UNIVERSITY WARRENSBURG, MISSOURI 64093

OFFICIAL RECORD--OFFICE OF THE REGISTRAR
NOT VALID WITHOUT IMPRESSION SEAL OF CMSU AFFIXED
AND ** END OF TRANSCRIPT RECORD ** AS FINAL STATEMENT

STUDENT NAME: WINKELMANN JOHN RAY

STUDENT NO: 489-54-6704 DATE PRINTED: 08/31/82

SEX: MALE BIRTHDATE: 07/15/50 BIRTHPLACE: ST LOUIS MO

ADMISSION STATUS: GRADUATE HIGH SCHOOL NAME:CLEVELAND HS

ADMISSION DATE: SPRING 1981-82 DATE OF H.S. GRADUATION: 1968

****
****** C.M.S.U. COURSEWORK ******
****

DEPT	COURSE NO.	SECT NO.	COURSE TITLE	SEM HOURS	GRADE	EARNED HOURS	GRAD CRED	GRADE POINTS	CHG TAG	CHG DATE
*** SPECIAL CREDIT										
-OTHER			--PRIN ACC PREV & CAUSE SAF		CR	3.0				
			SPECIAL CREDIT TOTAL			3.0				
*** SPRING TERM 1981										
SAFE	5010	003	ORG ADM SUP SA	3.0	B	3.0	G	9.0		
	GRADUATE		TERM GPA 3.00	3.0		3.0		9.0		
*** SUMMER TERM 1981										
IS&H	5140	003	IND VENTILAT	3.0	A	3.0	G	12.0		
	GRADUATE		TERM GPA 4.00	3.0		3.0		12.0		
*** FALL TERM 1981										
SAFE	4060	003	INTRO SYS SAFE	3.0	A	3.0	G	12.0		
SAFE	5940	004	CUR LIT RES PS	3.0	A	3.0	G	12.0		
	GRADUATE		TERM GPA 4.00	6.0		6.0		24.0		
*** WINTER TERM 1981-82										
INDM	5210	002	HU FAC ENG DES	3.0	B	3.0	G	9.0		
SAFE	4050	004	PHILOS SAFE	3.0	A	3.0	G	12.0		
	GRADUATE		TERM GPA 3.50	6.0		6.0		21.0		
*** SPRING TERM 1982										
SAFE	4020	002	LEG ASP SA SEC	3.0	B	3.0	G	9.0		
SAFE	5950	001	SEL INVEST P S	3.0	A	3.0	G	12.0		
IS&H	5120	003	PRIN INDUS HYG	3.0	B	3.0	G	9.0		
	GRADUATE		TERM GPA 3.33	9.0		9.0		30.0		
*** SUMMER TERM 1982										
IS&H	4430	003	WORK COMP	2.0	A	2.0	G	8.0		
IS&H	4020	001	FIRE SCIEN LAW	3.0	A	3.0	G	12.0		
	GRADUATE		TERM GPA 4.00	5.0		5.0		20.0		

--- CONTINUED ON PAGE 2 ---

UNDERGRADUATE

C.M.S.U. TOTALS	GPA	0.00	0.0	3.0	0.0
CUMULATIVE TOTALS	GPA	0.00	0.0	3.0	0.0

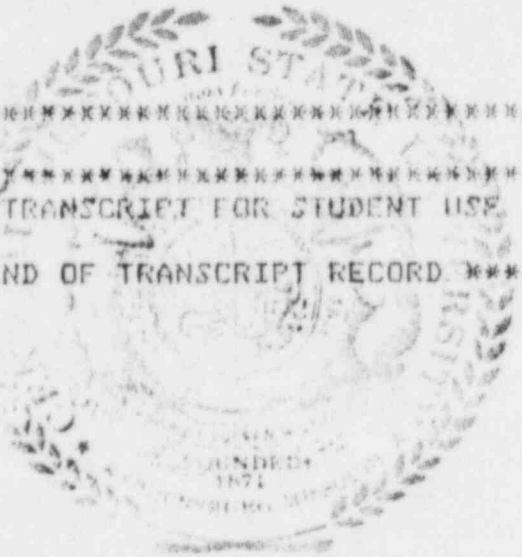
GRADUATE

C.M.S.U. TOTALS	GPA	3.62	32.0	32.0	116.0
CUMULATIVE TOTALS	GPA	3.62	32.0	32.0	116.0

--DATE--	---COMMENTS---
07/29/72	REC'D BS DEGREE FROM U OF MO ROLLA MO
05/15/81	ADMITTED TO GRADUATE SCHOOL

---- C.M.S.U. DEGREES AWARDED ----

DEGREE: MASTER OF SCIENCE
DATE RECEIVED: 08/04/82
MAJOR: SAFETY



THIS TRANSCRIPT FOR STUDENT USE

**** END OF TRANSCRIPT RECORD ****

CENTRAL MISSOURI STATE UNIVERSITY WARRENSBURG, MISSOURI

STUDENT NUMBER	YEAR TERM	CLASSIFICATION	REPORT PERIOD	GRADE REPORT
489-54-6704	83-4		FINAL	

DEPARTMENT	COURSE NUMBER	SECTION	COURSE TITLE	PASS* FAIL	INST CODE	GRADE	GRAD CRED	SEM HRS	GRADE POINTS
CHEM	5200	001	IND ENVIR MONI		2573	A	GR	3.0	12.0

This course included ionizing + non ionizing radiation

UNDERGRADUATE TOTALS

QUARTER	HRS ATTEMPTED	HRS EARNED	PASS FAIL HRS	GRADE POINTS	G P A
CUMULATIVE					

GRADUATE TOTALS

QUARTER	HRS ATTEMPTED	HRS EARNED	BELOW B HRS	GRADE POINTS	G P A
	3.0	3.0		12.0	4.00
CUMULATIVE	38.0	38.0		137.0	3.60

PROBATION STATUS IF APPLICABLE:

*X DESIGNATES PASS-FAIL COURSE
A GRADE OF N/C DENOTES NO CREDIT

TO PRESORTED FIRST CLASS
WINKELMANN JOHN
6044 TREERIDGE TRA
ST LOUIS MO 63129

CENTRAL MISSOURI STATE UNIVERSITY WARRENSBURG, MISSOURI

STUDENT NUMBER	YEAR TERM	CLASSIFICATION	REPORT PERIOD	GRADE REPORT
489-54-6704	83-3		FINAL	

DEPARTMENT	COURSE NUMBER	SECTION	COURSE TITLE	PASS* FAIL	INST CODE	GRADE	GRAD CRED	SEM HRS	GRADE POINTS
BIOL	5403	001	PHYSIO IND HYG		2470	B	GR	3.0	9.0

UNDERGRADUATE TOTALS

QUARTER	HRS ATTEMPTED	HRS EARNED	PASS FAIL HRS	GRADE POINTS	G P A
CUMULATIVE					

GRADUATE TOTALS

QUARTER	HRS ATTEMPTED	HRS EARNED	BELOW B HRS	GRADE POINTS	G P A
	3.0	3.0		9.0	3.00
CUMULATIVE	35.0	35.0		125.0	3.57

PROBATION STATUS IF APPLICABLE:

*X DESIGNATES PASS-FAIL COURSE
A GRADE OF N/C DENOTES NO CREDIT

TO PRESORTED FIRST CLASS
WINKELMANN JOHN
6044 TREERIDGE TRA
ST LOUIS MO 63129

These are additional courses taken since the Masters Degree was received

CONTROL NO. 78407

OF THE AMERICAS

BOARD OF CERTIFIED SAFETY PROFESSIONALS

OF THE AMERICAS, INCORPORATED

AFFIRMS THAT

John R. Winkelmann

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CERTIFIED SAFETY PROFESSIONAL

IN

COMPREHENSIVE PRACTICE

SO LONG AS THIS CERTIFICATE OF QUALIFICATION IS RENEWED ANNUALLY AND NOT REVOKED

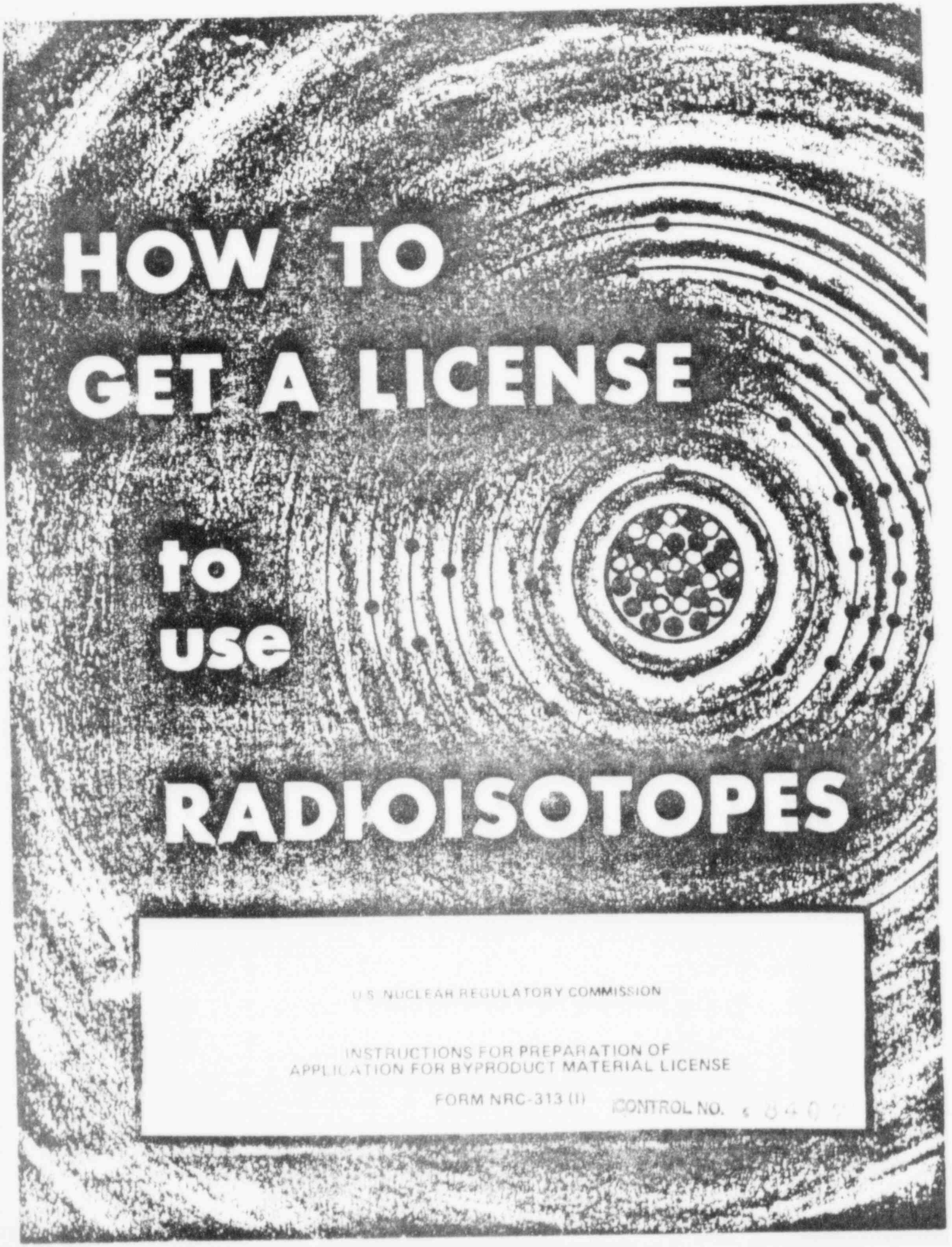
BOARD OF EXAMINERS IN WITNESS WHEREOF WE HAVE HEREUNTO SET OUR HANDS AND AFFIXED THE SEAL OF THE BOARD THIS 21st DAY OF AUGUST, 1982

Randall T. Wilhelm
PRESIDENT

Janet H. Spackman
SECRETARY

SERIAL NO. 6878

CONTROL NO. 78407



U.S. NUCLEAR REGULATORY COMMISSION

INSTRUCTIONS FOR PREPARATION OF
APPLICATION FOR BYPRODUCT MATERIAL LICENSE

FORM NRC-313 (I) CONTROL NO. 8440

CUSTOMER ASSISTANCE SAMPLE (A)

NOTE; Shows typical examples combined for DensART, LevelART, WeighART & WebART

CUSTOMER COMPLETES

FORM NRC-313 I (6-78) 10 CFR 30

U.S. NUCLEAR REGULATORY COMMISSION

APPLICATION FOR BYPRODUCT MATERIAL LICENSE
INDUSTRIAL

1. APPLICATION FOR: (Check and/or complete as appropriate)

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(B) b. AMENDMENT TO LICENSE NUMBER

(C) c. RENEWAL OF LICENSE NUMBER

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(D) 2. APPLICANT'S NAME (Institution, firm, person, etc.)
ACE CHEMICAL COMPANY

TELEPHONE NUMBER: AREA CODE – NUMBER EXTENSION
1-614-555-1212

(E) 3. NAME OF PERSON TO BE CONTACTED REGARDING THIS APPLICATION
ELMO R. SMEDLEY

TELEPHONE NUMBER: AREA CODE – NUMBER EXTENSION
1-614-555-1212

(F) 4. APPLICANT'S MAILING ADDRESS (Include Zip Code)
P. O. Box 965
Anytown, Ohio 43000

(G) 5. STREET ADDRESS WHERE LICENSED MATERIAL WILL BE USED (Include Zip Code)
123 Main Street
Anytown, Ohio 43000

(IF MORE SPACE IS NEEDED FOR ANY ITEM, USE ADDITIONAL PROPERLY KEYED PAGES.)

(H) 6. INDIVIDUAL(S) WHO WILL USE OR DIRECTLY SUPERVISE THE USE OF LICENSED MATERIAL
(See Items 16 and 17 for required training and experience of each individual named below)

	FULL NAME	TITLE
a.	Joe M. Doakes	Plant Supervisor
b.	Donald Smith	Maintenance Supervisor
c.	Susan B. Anthony	Instrument Supervisor

(I) 7. RADIATION PROTECTION OFFICER
Elmo R. Smedley

Attach a resume of person's training and experience as outlined in Items 16 and 17 and describe his responsibilities under Item 15.
List Any Training or Experience

8. LICENSED MATERIAL

OHMART FURNISHES

LINE NO.	A ELEMENT AND MASS NUMBER	B CHEMICAL AND/OR PHYSICAL FORM	C NAME OF MANUFACTURER AND MODEL NUMBER (If Sealed Source)	D MAXIMUM NUMBER OF MILLICURIES AND/OR SEALED SOURCES AND MAXIMUM ACTIVITY PER SOURCE WHICH WILL BE POSSESSED AT ANY ONE TIME
(J) (1)	Cs-137	Sealed Source	Ohmart A2102	50 mCi
(K) (2)	Cs-137	Sealed Source	Ohmart A5771	35 mCi
(L) (3)	CO-60	Sealed Source	Ohmart 17-2100	2000 mCi
(M) (4)	AM-241	Sealed Source	Ohmart A5799	1000 mCi

	E DESCRIBE USE OF LICENSED MATERIAL
(J) (1)	Used in an ED-6 to measure density in a pipe.
(K) (2)	Used in a BW-36 to weigh material on a belt.
(L) (3)	Used in a SHLM to measure level in a vessel.
(M) (4)	Used in a BG-12 to measure weight/unit area.

CONTROL NO. 18407

FORM NRC-313 I (6-78)

ASSISTANCE DIRECTIONS: Use only item (J) for Density gage license
Use only item (K) for Weigh Scale license
Use only item (L) for Level gage license
Use only item (M) for Thickness and/or Basis Weight gage license

CUSTOMER ASSISTANCE SAMP
BASED ON ASSUMPTION THAT
CUSTOMER WILL USE OHMART
FIELD SERVICE

CUSTOMER ASSISTANCE SAMPLE (B)

NOTE: Shows typical examples combined for DensART, LevelART, WeighART & WebART

OHMART FURNISHES

9. STORAGE OF SEALED SOURCES

LINE NO.	A. CONTAINER AND/OR DEVICE IN WHICH EACH SEALED SOURCE WILL BE STORED OR USED.	B. NAME OF MANUFACTURER	C. MODEL NUMBER
(J) (1)	Source Holder	Ohmart	SR-1
(K) (2)	Source Holder	Ohmart	SHRM
(L) (3)	Source Holder	Ohmart	SHLM
(M) (4)	Source Holder	Ohmart	BG-12

10. RADIATION DETECTION INSTRUMENTS

LINE NO.	A. TYPE OF INSTRUMENT	B. MANUFACTURER'S NAME	C. MODEL NUMBER	D. NUMBER AVAILABLE	E. RADIATION DETECTED (alpha, beta, gamma, neutron)	F. SENSITIVITY RANGE (milliroentgens/hour or counts/minute)
(1)	NONE REQUIRED BY THE USER. THE OHMART CORPORATION WILL PROVIDE A FIELD SERVICE REPRESENTATIVE TO DO INITIAL AND ON-GOING TESTS REQUIRED, USING PROPER INSTRUMENTATION.					
(2)						
(3)						
(4)						

11. CALIBRATION OF INSTRUMENTS LISTED IN ITEM 10

☐ a. CALIBRATED BY SERVICE COMPANY
NAME, ADDRESS, AND FREQUENCY

Not Applicable

☐ b. CALIBRATED BY APPLICANT
Attach a separate sheet describing method, frequency and standards used for calibrating instruments.

Not Applicable

12. PERSONNEL MONITORING DEVICES

A. TYPE (Check and/or complete as appropriate.)	B. SUPPLIER (Service Company)	C. EXCHANGE FREQUENCY
☐ (1) FILM BADGE ☐ (2) THERMOLUMINESCENCE DOSIMETER (TLD) ☐ (3) OTHER (Specify): NOT APPLICABLE	NONE REQUIRED BY USER. RADIATION DOES NOT EXCEED 5 MR/HR AT ONE (1) FOOT FROM GAGE OUTLINE AND 100 MR/HR FIELD IS NOT PRESENT	☐ MONTHLY ☐ QUARTERLY ☐ OTHER (Specify): NOT APPLICABLE

13. FACILITIES AND EQUIPMENT (Check were appropriate and attach annotated sketch(es) and description(s).

☐ a. LABORATORY FACILITIES, PLANT FACILITIES, FUME HOODS (Include filtration, if any), ETC.
☐ b. STORAGE FACILITIES, CONTAINERS, SPECIAL SHIELDING (fixed and/or temporary), ETC.
☐ c. REMOTE HANDLING TOOLS OR EQUIPMENT, ETC.
☐ d. RESPIRATORY PROTECTIVE EQUIPMENT, ETC.

Not Applicable

14. WASTE DISPOSAL

a. NAME OF COMMERCIAL WASTE DISPOSAL SERVICE EMPLOYED Complete as shown on Attached Byproduct Material License Attachment (Form SDFV5479)

b. IF COMMERCIAL WASTE DISPOSAL SERVICE IS NOT EMPLOYED, SUBMIT A DETAILED DESCRIPTION OF METHODS WHICH WILL BE USED FOR DISPOSING OF RADIOACTIVE WASTES AND ESTIMATES OF THE TYPE AND AMOUNT OF ACTIVITY INVOLVED. IF THE APPLICATION IS FOR SEALED SOURCES AND DEVICES AND THEY WILL BE RETURNED TO THE MANUFACTURER, SO STATE.

Complete as shown on
Attached Byproduct Material License Attachment (Form SDFV5479)

FORM NRC-313 (6-78)

ohmart radiation SAFETY

LICENSE ATTACHMENT SAMPLE

U. S. NUCLEAR REGULATORY COMMISSION

ITEM 14. WASTE DISPOSAL

Whenever the source holder is no longer needed it will be either

1. Removed and stored in a locked cupboard or room properly labeled. It will not be replaced in service without prior wipe testing, or

2. Removed and returned to the manufacturer for disposal.

In either case, the services of the manufacturer's representative will be obtained to supervise removal, reinstallation, and/or packaging for return to the manufacturer.

15. RADIATION PROTECTION PROGRAM

The source holders will be received and stored pending arrival of Manufacturer's Field Engineer. The source holders will be installed in the closed position under the supervision of the representative. A written procedure for prevention of entry into the vessel when the source is in the open (source exposed) position will be prepared. This program will be developed in consultation with the manufacturer's representative.

The initial radiation survey will be made by the representative at the time of placing the device in service. An occupancy evaluation will be made by the representative and should film badges appear to be required, they will be obtained. Form NRC-3 will be posted and should the radiation survey with the vessel(s) empty reveal radiation fields in excess of 5 mr/hr at 12 inches from the surface of the vessels, appropriate warning signs will be posted. Procedures will be adjusted to reduce the total dose to personnel to the minimum reasonably achievable. A copy of the radiation survey and written procedures will be kept on file for future reference.

In case of malfunction of the source holder or damage thereto, the services of manufacturer's representative will be obtained for repair or to supervise removal and proper packaging for return to the manufacturer for repair or replacement as required.

In case of emergency such as fire or explosion involving apparent damage to the source holder, the appropriate Retional Office of Inspection and Enforcement (10 CFR 20 Appendix D), USNRC, will be contacted for assistance. The area around the source holder will be barricaded. The services of a manufacturer's representative will be obtained to assist in inspection for damage and local health authorities will also be notified.

WIPE TEST PROCEDURE - A test will be performed on the surface of the source holder at the appropriate interval by the individual user listed in the application in accordance with the instructions of the manufacturer's representative and contained in the gage instruction manual. The wipe test kit to be used in The Ohmart Model LT nad the wipe will be evaluated for leakage by The Ohmart Corporation. Should the presence of 0.005 micorcuries of removable contamination be detected, the source holder will be withdrawn from service, the Regional Office of the USNRC notified and the device repaired or replaced by the manufacturer.

CONTROL NO. [illegible]

CUSTOMER ASSISTANCE SAMPLE (C)

NOTE: Shows typical examples combined for DensART, LevelART, WeighART & WebART

INFORMATION REQUIRED FOR ITEMS 15, 16 AND 17

Describe in detail the information required for Items 15, 16 and 17. Begin each item on a separate page and key to the application as follows:

15. RADIATION PROTECTION PROGRAM. Describe the radiation protection program as appropriate for the material to be used including the duties and responsibilities of the Radiation Protection Officer, control measures, bioassay procedures *(if needed)*, day-to-day general safety instruction to be followed, etc. If the application is for sealed source's also submit leak testing procedures, or if leak testing will be performed using a leak test kit, specify manufacturer and model number of the leak test kit. Complete as shown on attached Byproduct Material License Attachment (Form SDFV5479)

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

a. Principles and practices of radiation protection.

b. Radioactivity measurement standardization and monitoring techniques and instruments.

Attach Resume

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

d. Biological effects of radiation.

17. EXPERIENCE. Attach a resume for each individual named in Items 6 and 7. Describe individual's work experience with radiation, including where experience was obtained. Work experience or on-the-job training should be commensurate with the proposed use. Include list of radioisotopes and maximum activity of each used.

Attach Resume

18. CERTIFICATE

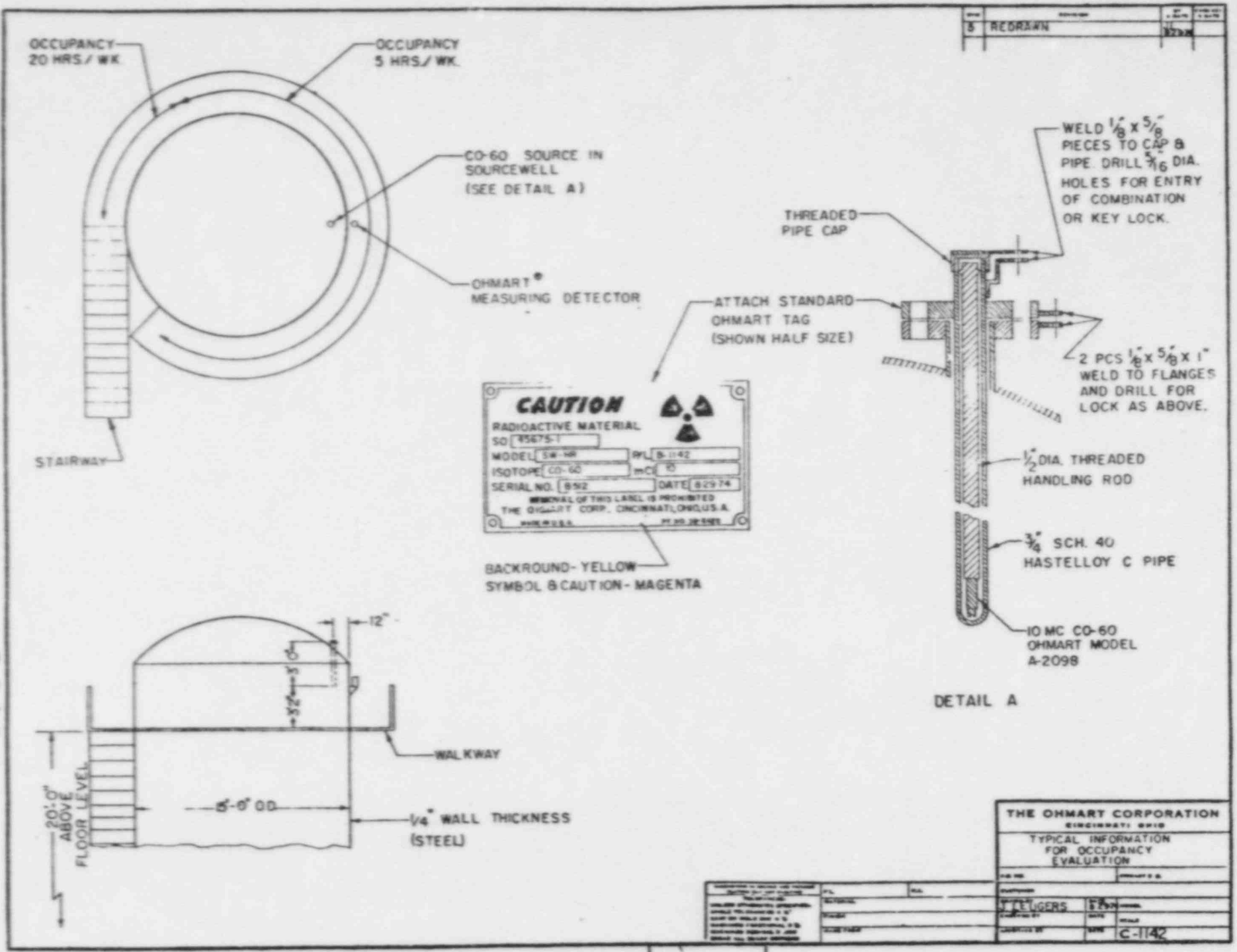
(This item must be completed by applicant)

The applicant and any official executing this certificate on behalf of the applicant named in Item 2, certify that this application is prepared in conformity with Title 10, Code of Federal Regulations, Part 30, and that all information contained herein, including any supplements attached hereto, is true and correct to the best of our knowledge and belief.

WARNING.–18 U.S.C., Section 1001, Act of June 25, 1948; 62 Stat. 749; makes it a criminal offense to make a willfully false statement or representation to any department or agency of the United States as to any matter within its jurisdiction.

a. LICENSE FEE REQUIRED *(See Section 170.31, 10 CFR 170)*	b. CERTIFYING OFFICIAL *(Signature)*
	c. NAME *(Type or print)*
(1) LICENSE FEE CATEGORY:	d. TITLE
(2) LICENSE FEE ENCLOSED: $	e. DATE

FORM NRC-313 (10-78)



CONTROL NO. 78407

U.S. NUCLEAR REGULATORY COMMISSION and

U.S. DEPARTMENT OF TRANSPORTATION

Regulations for Users of Nuclear Gages

GENERAL

The intent of this bulletin is to abstract and summarize regulations of the U.S. Nuclear Regulatory Commission concerning the use of radioactive material in gaging devices as manufactured by The Ohmart Corporation. A summary of pertinent Department of Transportation shipping regulations is also included. *

PURPOSE OF NRC REGULATIONS

To control the use and location of radioactive materials under its jurisdiction for the protection of public health and safety.

SCOPE OF THE NRC AND AGREEMENT STATE REGULATIONS

The NRC controls the ownership, use and transfer or disposal of all radioactive materials which are used or created in the atomic energy program. These include source material such as uranium and thorium and by-products such as Cesium-137, Cobalt-60, Strontium 90 and many others. Special nuclear material such as Plutonium 238 is under especially stringent regulation because it is fissionable in large quantities (many times the quantities used in gages). All control is through licensing.

* See Appendix C

The NRC does not control naturally occurring radioactive materials not connected with the program. Among these are Radium-226 and its decay series including, among others, Lead-210. The NRC does not have any regulatory authority over X-ray equipment or naturally occurring radioisotopes.

AGREEMENT STATES

The individual states are gradually taking over the regulation of all radiation emitting materials and devices including naturally occuring radioactive materials and X-ray equipment.

Under legislation enacted several years ago, it is provided that the NRC may pass control of various radioactive materials and sources of radiation to the various states, providing the state legislation meets NRC standards. The basic action here is the signing of an aggreement with the NRC by the Governor of the state. This agreement covers legislation for the control of materials which has been enacted by the State Legislature. As of February, 1980, 26 states have become Agreement States. These are:

Alabama
Arizona
Arkansas
California
Colorado
Florida
Georgia
Idaho
Kansas
Nebraska
Nevada
New Hampshire
New Mexico
New York
North Carolina
North Dakota
Oregon
South Carolina

Kentucky

Louisiana

Maryland

Mississippi

Rhode Island

Tennessee

Texas

Washington

In addition to the above twenty- six Agreement States, there are several other states in which legislation is either pending, or is being considered.

In general, the legislation passed by the states has the same provisions as the NRC regulations with the State Public Health Organization substituted for the Nuclear Regulatory Commission. However, there is one marked difference. In virtually all Agreement States so far the State Legislation has included all sources of ionizing radiation. This means that naturally occurring materials such as radium, and X-ray equipment, not covered by ARC regulations, are covered by state regulations.

In the case of Agreement States, there is no contact with the NRC. All dealings are with the state agency. We have included Appendix B showing to what organization correspondence should be addressed in each state to obtain license application forms and instructions.

In addition to the total control exercised by Agreement States, most states provide for the registration of radioactive isotopes or sources of ionizing radiation. Details of the registration requirements may be had by writing to the appropriate State Department of Public Health.

All Agreement States accept the NRC General License gages.

LICENSES

GENERAL LICENSE

The concept of a General License is very confusing and often misunderstood. We usually think of a license as something we carry in our billfolds or hang on our auto bumpers that proves we have paid a periodic fee permitting us to engage in some activity. The regulations of the USNRC (and the "Agreement States") contain numerous paragraphs such as 10CRF31.5, partially quoted below, which have the effect of issuing a license under certain conditions without any documentation. Part of 10CRF31.5 is quoted below:

> "31.5 (a) Subject to the provisions of this section, a general license is hereby issued to own, receive, acquire, possess and use by-product material when contained in devices designed and manufactured for the purpose of detecting, measuring, gauging or controlling thickness, density, level, interface location, radiation, leakage, or qualitave or quantitative chemical composition, or for producing light or an ionized atmosphere.
>
> (b) The general license contained in this section applies only to devices which have been:
>
> (1) Manufactured in accordance with the specifications and contained in specific license issued by the Commission to the manufacturer of the device pursuant to 32.51 of this chapter, or in accordance with the specifications contained in a specific license issued to the manufacturer by an Aggrement State which authorizes the manufacture of the

device for distribution to persons generally licensed by the Agreement State; and (2) Installed on the premises of the general licensee by a person authorized to install such devices under a specific license issued to the installer by the Commission pursuant to Parts 30 and 32 of this chapter or by an Agreement State if a label affixed to the device at the time of receipt states that installation by a specific licensee is required. The requirement of this subparagraph (2)does not apply while devices are held in storage in the original shipping container pending installation by a specific licensee."

OHMART GENERAL LICENSE GAGES

Note subparagraph (b) (1). The Ohmart Corporation has a specific license #34-00639-03G to distribute certain devices to General Licensees.

In general, gages manufactured for distribution to a General Licensee must have a radiation field low enough that personnel are not apt to receive a radiation dose in excess of 0.5 rem/year. 5 MR/HR at 12" from the surface in most installations meets this requirement and is the accepted criteria.

Referring to 10CFR31.5 (b) (2), quoted, gages distributed to General Licensees must bear certain labels setting forth the restrictions governing installation, leak testing and service to the source holder.

A typical label is snown on the following page.

Note in paragraph 4 that any person may mount this gage in place

FOR A DETAILED EXPLANATION OF THIS LABEL, READ OHMART INSTRUCTION MANUAL.

SECTION RS [redacted].

RECEIPT, POSSESSION, USE AND TRANSFER OF THIS DEVICE ARE SUBJECT TO A GENERAL LICENSE OR EQUIVALENT AND REGULATIONS OF THIS U.S. NRC OR AN AGREEMENT STATE.

ABANDONMENT OR DISPOSAL PROHIBITED UNLESS TRANSFERRED TO PERSONS SPECIFICALLY LICENSED BY THE NRC OR AN AGREEMENT STATE.

OPERATION PROHIBITED IF THERE IS INDICATION OF FAILURE OF OR DAMAGE TO SHIELDING, OR SOURCE CONTAINMENT.

ANY PERSON MAY MOUNT THIS DEVICE IN PLACE INITIALLY, PROVIDED THE ON-OFF MECHANISM IS LOCKED IN THE OFF POSITION. ALL OTHER DEVICE INSTALLATION, DISMANTLING, RELOCATION, REPAIR AND TESTING INVOLVING THE RADIOACTIVE MATERIAL, ITS SHIELDING AND CONTAINMENT SHALL BE PERFORMED BY PERSONS SPEC-SPECIFICALLY LICENSED BY THE NRC OR AN AGREEMENT STATE.

DEVICE SHALL BE TESTED FOR RADIOACTIVE LEAKAGE AND PROPER FUNCTIONING OF ON-OFF MECHANISM AND INDICATOR AT INSTALLATION AND AT SOURCE REPLACEMENT BY PERSONS SPECIFICALLY LICENSED BY THE NRC OR AN AGREEMENT STATE. THEREAFTER, TESTING SHALL BE DONE AT NO LONGER THAN 3 YEAR INTERVALS, USING PROCEDURES STATED IN THE INSTRUCTION MANUAL.

LOSS, THEFT OR TRANSFER OF THIS DEVICE AND FAILURE OF OR DAMAGE TO THE SHIELDING, OR THE SOURCE CONTAINMENT, MUST BE REPORTED TO THE NRC OR AN AGREEMENT STATE.

THIS LABEL SHALL BE MAINTAINED ON THIS DEVICE IN A LEGIBLE CONDITION. REMOVAL OF THIS LABEL IS PROHIBITED.

P/N LABLLI-0033568

initially. The initial tests and startup, however, must be performed by an individual specifically licensed to do so.

With most of Ohmart's Generally Licensed gages, the possessor may, after the initial startup, perform the required, periodic wipe tests and shutter mechanism checks.

SPECIFIC LICENSE

A specific License is a document issued to an applicant, authorizing a specific activity. The license outlines the activity which the licensee may pursue, type of device (or devices) the licensee may possess, and the limits within which the licensee may use such devices. It names a specific individual (or individuals) as user and names a Radiation Protection Officer who may be the same as one of the Individual Users. The Radiation Protection Officer is responsible for keeping of the various records required by the licensing authority. Requirements and instructions for making application for a Specific License are contained in Section 30.32 and 30.33. The most important requirement is 30.33 (a) which requires that the applicant be qualified by training and experience to use the material for which the license is requested. This training may be imparted by the Ohmart engineer at installation and/or start-up or at the periodic Ohmart Corporation training school.

The Specific License does not grant any privileges which are not actually stated. However, it is possible, after the required training, to have the Individual User or Users, and/or Radiation Protection Officer, granted the authority to make wipe tests or to supervise the installation, relocation or removal of gages. These privileges may be acquired in the original application,

providing they delineate training satisfactory to the NRC or Agreement State. A program satisfying these requirements is offered by The Ohmart Corporation.

TESTS TO BE PERFORMED ON NUCLEAR GAGES

There are two basic tests that must be performed on nuclear gages. The first is a radiation survey and occupancy evaluation of the installation. This is prepared immediately after installation, or placing in service, and is made by the Ohmart engineer or other licensed person. The purpose of this survey and evaluation is to obtain a radiation profile in relation to the device and to determine whether personnel monitoring is required.

The second test is a periodic test for leakage of radioactive material. This applies to all but gas sources such as KR-85. This test must be performed at intervals specified in the labelling on General Licensed gages or in the text of a Specific License. At the same time the operations of the ON/OFF mechanism (if any) must be tested. The basic interval for such tests is six months, however, most Ohmart source holders are approved for leak test at three year intervals.

Records of prescribed tests must be kept on file by the licensee and available to NRC inspectors on request.

RESTRICTED AREA AND POSTING

Section 20.202, "personnel monitoring," covers the definition of the various areas requiring personnel monitoring. The next section, 20.203, covers the posting requirements. The two areas concerning us are

"Radiation Area" and "High Radiation Area".

RESTRICTED AREA

A restricted area is an area where access is controlled for the purpose of protection from radiation.

The radiation limits defining a RESTRICTED AREA are:

Where an individual, when continuously present, would receive more than 2 mr/hr or 100 mr in seven consecutive days. This is determined from the initial field radiation survey.

Radiation Area is defined as 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 five consecutive days a dose in excess of 100 millirems. A radiation area need not be posted with "Caution, Radiation Area" signs provided the radiation level twelve inches from the source container or housing does not exceed 5 mr/hr.

High Radiation Area is defined as any area accessible to personnel where an individual could receive a dose in excess of 100 mr in any one hour to a major portion of the body.

The posting required in the areas above is, logically enough, "CAUTION-RADIATION AREA" for the radiation area and "CAUTION - HIGH RADIATION AREA" for the high radiation area. Both signs bear the standard radiation symbol, the magenta propeller on the yellow background.

In addition to the caution posting requirements, it is required that form NRC-3 (notice to employees) be posted in such locations as to assure that employees working in or frequenting restricted areas will observe the notice on the way to or from work.

Since most devices have a surface radiation level in excess of "unrestricted areas" limits, it is best to post this sign since it is not a caution sign but merely advisory in nature and not likely to cause concern.

PERSONNEL MONITORING

Personnel monitoring is required for any individual who:

Enters a "High Radiation Area"

Is apt to receive 25% of the maximum quarterly allowance of 1.25 rem (whole body). This is approximately 25 mrem/wk. and is based upon the survey and occupancy evaluation performed at time of startup.

RECORD KEEPING REQUIREMENTS

Federal or State regulation requires the following records to be kept on file for each nuclear device on site:

1. A record of the INITIAL RADIATION SURVEY made at time of start-up.

2. A record of the WIPE TEST CERTIFICATE shipped with each gage, certifying that the source has been wiped prior to shipment and found to have less than 0.005 uCi of removable contamination.

In addition to the above routine requirements there are certain reports required on accidents or unusual occurences. In the regulations these are broken down into "immediate notification" and "twenty-four hour notification" reports. For purposes of simplification, all should be considered as immediate notifications. Under these occurrences the user must notify the Director of Licensing and the appropriate Nuclear Regulatory Commission Operations Regional Office (which is listed in Appendix D Part 20 of the Regulations and Form NRC-3. After an accident or unusual occurence, the user should check the regulations. If the regulations are not available for some reason it is best to telephone the Regulatory Operations Regional Office at once. The office should be told what occurred and asked what steps should be taken. The user can also telephone The Ohmart Corporation, but is not required to do so. Basically the reports must be made as follows:

Immediate Notification. (Telephone and telegraph)

1. Theft or loss of licensed material.
2. Exposure of the whole body to 25 rems or more; or exposure of the skin to 150 rems or more; or exposure of the feet, ankles, hands or forearms to 375 rems or more.
3. The release of radioactive material which if averaged over twenty-four hours would be in excess of 5000 times the limitations in Appendix B, Table 2 of CFR Part 20.
4. A loss of one working week or more of any facilities due to a radiation incident.
5. Damage to property in excess of $100,000.00 due to a radiation incident.

3. Records of all periodic wipe tests required to be performed.

4. A. For a gage under a SPECIFIC LICENSE, the user must either post or maintain available for employees' inspection a copy of the SPECIFIC LICENSE. If the license is not posted, then a notice must be posted stating that the license is available for inspection.

   B. For a gage under a GENERAL LICENSE, the user must post or maintain available for employees' inspection a copy of the CURRENT Federal or Agreement State regulations. Regulations, in EFFECT AT SHIPMENT, are found in OHMART INSTRUCTION MANUAL shipped with the gage.

5. Records must be maintained concerning any SOURCE SHIPMENT FROM USER'S FACILITY. This record should include date of shipment, address to which the source was shipped, and any verification of receipt.

6. Records of personnel monitoring, when monitoring is required.
   Personnel monitoring is required when:

   A. A person must enter an area where 100 mr/hr field is present.

   B. A person is apt to receive more than 25% of the allowable dose of 1.25 r/quarter, based on occupancy evaluation of the installation.

   C. It is the policy of the company using the gage to do the monitoring.

Twenty-Four Hour Notification

1. Exposure of whole body to 5 rems or more, the skin to 30 rems or more or feet, ankles, hand or forearms to 75 rems or more.
2. Release of radioactive material in concentration which if averaged over twenty-four hours would be in excess of 500 5imes the limit specified in Appendix B, Table 2.

3. A loss of one day or more of operation of any facilities due to a radiation incident.

4. Damage to property in excess of $1,000.00 due to a radiation incident.

In addition to the above, where personnel monitoring is required, the employer must report to former employees, on request, the former employee's exposure to radiation as shown in the records maintained by the licensee. Naturally, if such a record is not required to be maintained, no reporting responsibility is indicated. Most Ohmart gages do not require monitoring.

The employer is also required to report, to the Director of Licensing, U.S. Nuclear Regulatory Commission, Washington, DC, 20545, with a copy to the Director of appropriate Nuclear Regulatory Commission Regulatory Operations Regional Office each exposure of an individual to radiation or concentrations of material in excess of any applicable limit in the above requirements or in the user's license. He is also required to report any incidents on which notification is required above.

There are certain other reporting requirements which govern, primarily, the use of radioactive materials other than in a sealed source. These would also apply in case of source leakage, the probability of which is quite remote. However, this information can be obtained from Section 20.405 of the regulations.

INSPECTION

The NRC maintains a staff of inspectors, called Compliance Officers, who periodically visit user's establishments and inspect their installation and their records. Any deviation from the regulations is reported by these officers to the Regulatory Operations Regional Offices. Recently, these inspections are becoming somewhat painstaking. This is good. It assures the user that his records and his installations are in good shape and protects him from possible future problems in employee relations. In some cases, it might even protect him from lawsuits. However, this stepped-up activity also requires additional care and knowledge.

DISPOSAL

When a radioactive source is no longer required, it may be disposed of by any one of a number of approved disposal agencies. The easiest thing for Ohmart customers to do is to contact The Ohmart Corporation for instructions. In the case of generally licensed gages the dismantling of the device must be done under the supervision of an Ohmart engineer, or specifically licensed person. On specifically licensed gages, the provision of the license will govern whether or not the user may dismantle the gage. By "dismantling the gage" we mean removing and packing the source holder, in the closed position, of course. The Ohmart Corporation, or authorized disposal agency, will take care of getting rid of the source in an approved manner. Most of the authorized disposal agencies are on the East and West coasts. For this reason, it might be more economical for a

for a user on the seacoast to use one of the authorized disposal agencies. It is also advisable for the user to get in touch with The Ohmart Corporation should they wish to merely store the source for a period of time. We can define to them the requirements for storage within their own plant.

U.S. DOT SHIPPING REGULATIONS PERTAINING TO SHIPMENT OF RADIOACTIVE MATERIALS (Revised 12/9/80)

This pertains to all shipping and storage containers for Radioactive Material and all gages containing Radioactive Material.

Each package of radioactive material must be labeled on two (2) opposite sides, with a distinctive warning label which is selected based upon a radiation survey of the package (49CFR172.400).

Empty label is a white label with the word EMPTY printed across it.

Empty label is to be used on shipping and storage containers only. All shipping and storage containers must be labeled. Labels must be put directly over (must cover) previous labels. No need to say that all shipping and storage containers bearing this label must be empty.

RADIOACTIVE I LABEL

Is a white label with the Radiation symbol on it and "Radioactive I" printed across it.

RADIOACTIVE II LABEL

Is a white and yellow label with the Radiation symbol on it and "Radioactive II" printed across it.

RADIOACTIVE III LABEL

Is a white and yellow label with the Radiation symbol on it and "Radioactive III" printed across it.

One of the above Radioactive classification labels is to be put on all boxes used for shipping gages containing Radioactive Materials and all shipping and storage containers used for shipping radioactive Material.

RADIOACTIVE MATERIAL PACKAGES LABEL CRITERIA
(D.O.T. 173.3999)
DOSE RATE LIMITS

LABEL	AT ANY POINT ON ACCESSIBLE SURFACE OF PACKAGE	AT THREE FEET FROM EXTERNAL SURFACE OF PACKAGE (TRANSPORT INDEX)
"RADIOACTIVE - WHITE I"	0.5 mR/hr	0
"RADIOACTIVE - YELLOW II"	50 mR/hr	1.0 mR/hr
"RADIOACTIVE - YELLOW III"*	200 mR/hr	10 mR/hr

*Requires Vehicle Placarding. (This label mandatory for fissile Class III or large quantity package, regardless of dose rate levels.) (49CFR173.389)

The type of packaging to be used depends upon the form in which the source is classified. ("Special form" 49CFR173.394 or "Normal form" 49CFR173.395) and the transport group into which the source material is placed (49CFR173.390). The special form and normal form catagories depend upon the construction of the source capsule itself.

The Transport Group is determined by the radiotoxicity of the material and other considerations. The following is a list of commonly used radioactive Isotopes and their transport groups.(49CFR173.390) Do not confuse "transport group" with the required radiation labels I, II or III. A label is selected based upon a radiation survey of the package, not based upon transport group.

MATERIAL	TRANSPORT GROUP
Cs-137	III
Co-60	III
SR-90	II
KR-85	III
AM-241	I
PB-210	II
Ra-226	I
Rm-147	IV
Fe-55	IV

The quantity of material involved and its form determines whether it must be Type A or Type B shipping container. The table below lists the upper limits for Type A and Type B quantities for the various Transport groups.

TRANSPORT GROUP	TYPE A QUANTITIES CURIES	TYPE B QUANTITIES CURIES
I	1 mCi	20
II	50 mCi	20
III	3000 mCi	200
IV	20,000 mCi	200
V	20,000 mCi	5000
VI & VII	1,000,000 mCi	50,000
*Special Form	20,000 mCi	5000

*NOTE: The table shows that you can ship up to 20 curies of "Special Form" as a type A quantity in a Type A package.

TYPE A PACKAGING (49 CFR 178.350)

Type A packaging is that which must be designed in accordance with the applicable general packaging requirements as prescribed in the regulations (49 CFR 173.393), and which must be adequate to prevent the loss or dispersal of its radioactive contents and to maintain its radiation shielding properties if the package is subjected to the defined "normal" conditions of transport. The regulations prescribe 49 CFR 173.398 the performance criteria to simulate these normal conditions of transport. Typically, as is seen, the Type A packaging provided for in the regulations is the purely performance-based DOT Spec. 7A, Type A general package, for which a shipper must make his own assessment of his particular package design against the performance requirements. The regulatory framework, therefore, provides for the use of all Type A packaging without specific regulatory approvals of the package designs via the use of

the DOT Spec. 7A performance specification. Additionally, foreign-made Type A packages are acceptable internationally, provided they are so marked as Type A, without specific approval by the competent national authority of either country.

Type A packaging is used for Type A quantities of radioactive material or up to 20 Curies in "Special" Form of Groups I, II, and III materials. Type A packaging generally means a package that will be of sufficient strength to stand the normal hazards of shipment without damage to the container, release of radioactive material or loss of shielding effectiveness. This can generally be accomplished by placing the source holder or gage in a heavy wooden box with nail closure (no hinges and padlocks) and preferably with a metal strap seal. Most Ohmart sourceholders are approved as US DOT 7A type A shipping containers.

SPECIAL FORM RADIOACTIVE MATERIALS (49 CFR 173.394)

What is meant by "special form" radioactive material? We see that "special form" materials are defined as materials, which, if released from a package, might present a hazard due to direct, external radiation, but due to their high physical integrity, would present very little hazard, if any, due to radiotoxicity as a result of spread of contamination. This high physical integrity could be the result of inherent property of the material, such as its being in massive, solid form or an acquired characteristic such as encapsulation as a sealed source.

Therefore, almost all Ohmart gages are "special form" because of the high integrity of the double encapsulated sealed source.

If there is any doubt about the gage being "special form" or if there is a question of it being of a Type B quantity, please contact The Ohmart Corporation.

Radioactive Classification labels are to be put on opposite sides of the box or container. If any previous labels exist from a previous shipment referring to Radioactive Classification they should be covered with the new labels or removed.

CONTENT BLOCK - All radioactive labels have a block that must be filled in stating the "material" and "activity" in curies.

TRANSPORT INDEX NUMBER - Radioactive II and III labels have Transport Index number blocks which must be filled in to the highest tenth of 1 MR/HR. The Transport Index Number is the number of MR/HR at 3 ft. from the surface of the box or container rounded off to the highest tenth of 1 MR/HR.

BILL OF LADING INFORMATION (49 CFR 172.200) see the attached sample bill of lading for required information. APPENDIX A.

MARKING REQUIREMENTS (49 CFR 172.300) Each package of radioactive materials which conforms to the requirements for type A or type B packages must carry the appropriate marking in ½" letters.

EXAMPLE: USA DOT 7A TYPE A
RADIOACTIVE MATERIAL

The radioactive material must be identified by proper shipping name on the package and marked with the appropriate hazardous material identification number.

EXAMPLE: RADIOACTIVE MATERIAL
SPECIAL FORM
NOS (NA9182)
(CS-137)

EXPORT SHIPMENT

Everything remains the same for Export as for Stateside with one exception. The Transport Index Number is the MR/HR at 3 ft. from the center of the box or container.

SPECIAL SOURCE MATERIAL

Some sources may have to be taken out of the gage and shipped in a special container. This pertains mostly to Beta source material such as AM, PM, LEAD, and KR. If any doubt whatsoever --- check to be sure.

Be sure that the warning labels describing the source and bearing the radiation "propeller" are removed from the gage and returned with the source. If such label is attached to the source holder, it can be sent back as is. If it is attached to the detector housing, or brackets, it must be removed and shipped with the source.

ATTENTION!

REMEMBER, THE CUSTOMER MUST COMPLY ALSO WITH THE CONDITIONS OF HIS LICENSE FROM THE NRC OR AGREEMENT STATE OR WITH GENERAL LICENSE REGULATIONS WITH REGARD TO REMOVAL AND DISPOSAL.

AN INDIVIDUAL PACKING A DEVICE FOR SHIPMENT MUST BE SPECIFICALLY LICENSED TO DO SO!

CERTIFICATION BY SHIPPER

Carriers may not accept for transport any packages of radioactive materials which have not been properly certified by the shipper pursuant to 49 CFR 172.204. This certificate is relied upon by the carrier, as evidence that the packaging is in accordance with the regulatory requirements. In the case of air shipments, one signed copy of the shipper's certificate must accompany the shipment, with the originating air carrier retaining a second copy 49 CFR 175.30 and 175.35.

SEE APPENDIX A - EXAMPLES OF SHIPPING PAPERS.

STRAIGHT BILL OF LADING — SHORT FORM

ORIGINAL — NOT NEGOTIABLE

Shipper's No. _____

Carrier's No. _____

(Name of Carrier)

RECEIVED, subject to the classifications and tariffs in effect on the date of the issue of this Bill of Lading.

THE OHMART CORPORATION

at CINCINNATI, OHIO, 19 From 4241 ALLENDORF DRIVE, CINCINNATI, OHIO 45209

the property described below, in apparent good order, except as noted (contents and condition of contents of packages unknown), marked, consigned, and destined as indicated below, which said carrier (the word carrier being understood throughout this contract as meaning any person or corporation in possession of the property under the contract) agrees to carry to its usual place of delivery at said destination, if on its route, otherwise to deliver to another carrier on the route to said destination. It is mutually agreed, as to each carrier of all or any of said property over all or any portion of said route to destination, and as to each party at any time interested in all or any of said property, that every service to be performed hereunder shall be subject to all the terms and conditions of the Uniform Domestic Straight Bill of Lading set forth (1) in Official, Southern, Western and Illinois Freight Classifications in effect on the date hereof, if this is a rail or a rail-water shipment, or (2) in the applicable motor carrier classification or tariff if this is a motor carrier shipment.

Shipper hereby certifies that he is familiar with all the terms and conditions of the said bill of lading, including those on the back thereof, set forth in the classification or tariff which governs the transportation of this shipment, and the said terms and conditions are hereby agreed to by the shipper and accepted for himself and his assigns.

Consigned to _____

(Mail or street address of consignee - For purposes of notification only.)

Destination _____ State _____ County _____ Delivery Address* _____

(*To be filled in only when shipper desires and governing tariffs provide for delivery thereat.)

Route _____

Delivering Carrier _____ Car or Vehicle Initials _____ No. _____

No. Packages	Kind of Package, Description of Articles, Special Marks, and Exceptions	*Weight (Subject to Correction)	Class or Rate	Check Column	Principal Radioactive Contents	Activity of Contents	Transport Index	Type Label
	RADIOACTIVE MATERIAL SPECIAL FORM N.O.S. (Cs-137) NA9132 RADIOACTIVE MATERIAL 1. DO NOT PLACE UNDEVELOPED FILM WITHIN 15 FEET OF THIS CONTAINER. 2. 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. 3. RADIOACTIVE MATERIAL, NOI, Item No. 164900 (The agreed or declared value of the property is hereby specifically stated by the shipper to be not exceeding 40¢ per pound). 4. PLACARDS	193 lb			Cs-137	50 mCi	.5	Yellow II
	ELECTRICAL INSTRUMENTS, NOI, Item No. 61700. RECORDING DEVICES, NOI, Item No. 58240. PRINTED MATTER CUSTOMERS P.O. NO. _____ SHOP ORDER NO. _____							

Received $ _____ to apply in prepayment of the charges on the property described hereon.

Agent or Cashier

Per _____

(The signature here acknowledges only the amount prepaid.)

Charges Advanced:

$ _____

If charges are to be prepaid, write or stamp here, "To be Prepaid."

Subject to Section 7 of conditions of applicable bill of lading, if this shipment is to be delivered to the consignee without recourse on the consignor, the consignor shall sign the following statement:

The carrier shall not make delivery of this shipment without payment of freight and all other lawful charges.

(Signature of Consignor.)

*If the shipment moves between two ports by a carrier by water, the law requires that the Bill of Lading shall state whether it is carrier's or shipper's weight.

NOTE—Where the rate is dependent on value, shippers are required to state specifically in writing the agreed or declared value of the property.

The agreed or declared value of the property is hereby specifically stated by the shipper to be not exceeding _____ per _____

†The fibre boxes used for this shipment conform to the specifications set forth in the box maker's certificate thereon, and all other requirements of the Consolidated Freight Classification.

† Shipper's imprint in lieu of stamp; not a part of Bill of Lading approved by the Interstate Commerce Commission.

THE OHMART CORPORATION, Shipper, Per _____ Received by _____

4241 ALLENDORF DRIVE, CINCINNATI, OHIO 45209

APPENDIX B 1/11/79

AGREEMENT STATES

The following is a list of Agreement States (states which have entered into agreements with the U.S. Nuclear Regulatory Commission (NRC), where NRC has relinquished authority and the states have asserted their own authority to regulate most radioactive materials within the state). Inquiries, or reports of proposed activities in these states concerning the materials listed on your NRC license, should be addressed to the State Officials listed below.

Became an Agreement State On -

10/1/66 Alabama 205-832-5992

Mr. Aubrey Godwin, Director
Division of Radiological Health
Environmental Health Adminis.
Room 314, State Office Building
Montgomery, Alabama 36130

5/15/67 Arizona 602-255-4845

Mr. Donald C. Gilbert, Exec, Dir.
Arizona Atomic Energy Commission
2929 West Indian School Road
Phoenix, Arizona 85017

7/1/63 Arkansas 501-661-2307

Mr. David D. Snellings, Jr., Dir.
Div. of Radiological Health
Arkansas Department of Health
4815 West Markham
Little Rock, Arkansas 72201

9/1/62 California 916-445-0931
License Insp.

Mr. Joe Ward, Chief - 916-322-2073
Radiologic Health Section
Department of Health
714 P. Street, Rm. 498
Sacramento, California 95814

2/1/68 Colorado 303-320-8333
Ext. 6246

Mr. Albert J. Hazle, Director
Radiation & Hazardous Waste
Control Division
Office of Health Protection
Department of Public Health
4210 East 11th Avenue
Denver, Colorado 80220

7/1/64 Florida 904-487-1004

Mr. Ulray Clark, Administrator
Radiological Health Program
Health Program Office
Dept. of Health & Rehabilitative
Service
1323 Winewood Blvd.
Tallahassee, Florida 32301

12/15/69 Georgia 404-894-5795

Mr. Charles F. Tedford, Dir
Radiological Health Unit
Department of Human Resources
47 Trinity Avenue
Atlanta, Georgia 30334

10/1/68 Idaho 208-384-3335

Mr. Robert Funderburg, Superv.
Radiation Control Section
Idaho Department of Health
and Welfare
Statehouse
Boise, Idaho 83720

1/1/65 Kansas 913-862-9360 Ext-284

Mr. Gerald W. Allen, Director
Bureau of Radiation Control
Division of Environment
Dept. of Health & Environment
Building 740, Forbes Field
Topeka, Kansas 66620

3/26/62 Kentucky 502-564-3700

Mr. Charles M. Hardin, Manager
Radiation Control Branch
Bureau for Health Services
Dept. for Human Resources
275 East Main Street
Frankfort, Kentucky 40601

5/1/67 Louisiana 504-925-4518

Mr. B. Jim Porter
Division of Radiation Control
Natural Resources and Energy
Dept. of Conservation
P.O. Box 14690
Baton Rouge, Louisiana 70808

1/1/71 Maryland 301-383-2744/2735

Mr. Robert E. Corcoran, Chief
Division of Radiation Control
Dept. of Health and Mental Hygiene
201 W. Preston Street
Baltimore, Maryland 21201

7/1/62 Mississippi 601-354-6657/6670

Mr. Eddie S. Fuente, Director
Division of Radiological Health
State Board of Health
Jackson, Mississippi 39205

10/1/66 Nebraska 402-471-2168

Mr. Ellis Simmonds, Director
Division of Radiological Health
State Department of Health
301 Centennial Mall South
P.O. Box 95007
Lincoln, Nebraska 68509

7/1/72 Nevada 702-885-4750

Al Edmundson
Radiological Health
Consumer Health Protection
Services
Rm. 103 Kinkead Bldg
Capitol Complex
Carson City, Nevada 89710

5/16/66 New Hampshire 603-271-2281

Mr. John R. Stanton, Director
Radiation Control Agency
Division of Public Health
Services
State Department of Health
& Welfare
State Laboratory Building
Hazen Drive
Concord, New Hampshire 03301

5/1/74 New Mexico 505-827-5271
Ext.-270

Dr. Ted Wolff, Chief
Radiation Protection Section
Environmental Improvement Div.
P.O. Box 968
Crown Building
Santa Fe, New Mexico 87503

10/15/62 New York 518-474-2178

Mr. T. K. DeBoer, Director
Technical Development Programs
New York State Energy Office
Agency Building 2
Empire State Plaza
Albany, New York 12223

8/1/64 North Carolina 919-733-4283

Mr. Dayne H. Brown, Chief
Radiation Protection Section
Division of Facility Service
Box 12200
Raleigh, North Carolina 27605

9/1/69 North Dakota 701-224-2374

Mr. Gene A. Christianson, Dir.
Div. of Environmental Engineering
Radiological Health Program
State Department of Health
1200 Missouri Avenue
Bismarck, North Dakota 58501

7/1/65 Oregon 503-229-5797

Marshall Parrott, D.Sc.
Manager
Radiation Control Service
Division of Health
Dept. of Human Resources
1400 South West Fifth Avenue
Portland, Oregon 97201

9/15/69 South Carolina 803-758-5548

Mr. Heyward Shealy, Chief
Bureau of Radiological Health
State Department of Health and
Environmental Control
J. Marion Sims Building
2600 Bull Street
Columbia, South Carolina 29201

9/1/65 Tennessee 615-741-7812

Mr. J. A. Bill Graham, Director
Division of Radiological Health
Department of Public Health
Cordell Hull State Office Building
Nashville, Tennessee 37219

3/1/63 Texas 512-458-7341 or 7686

David K. Lacker, Director
Division of Occupational Health
and Radiation Control
Texas Department of Health
Austin, Texas 78756

12/31/66 Washington 206-753-3459

Mr. Robert C. Will, Supervisor
Radiation Control Program
Department of Social and Health Services
Mail Stop LD-11
Olympia, Washington 98504

12/31/79 Rhode Island 401-277-2756

Mr. James E. Hickey, Chief
Division of Occupational Health
and Radiation Control
Rhode Island Department of Health
Cannon Building
75 Davis Street
Providence, Rhode Island 02908

APPENDIX C

SOURCES OF FEDERAL REGULATIONS

Title 49 — Department of Transportation's Hazardous Materials Regulations, Parts 100-199

Main Headings

- 49 CFR 170 - Rule-making Procedures of the Materials Transportation Bureau
- 49 CFR 171 - General Information, Regulations and Definitions
- 49 CFR 172 - Hazardous Materials Table and Hazardous Materials Communications Regulations
- 49 CFR 173 - Shippers-General Requirements for Shipments and Packagings
- 49 CFR 174 - Carriage by Rail
- 49 CFR 175 - Carriage by Aircraft
- 49 CFR 176 - Carriage by Vessel
- 49 CFR 177 - Carriage by Public Highway
- 49 CFR 178 - Shipping Container Specifications
- 49 CFR 179 - Specifications for Tanks Cars

Title 10 — U.S. Nuclear Regulatory Commission

- 10 CFR 71 - Packaging of Radioactive Materials for Transport and Transportation of Radioactive Material Under Certain Conditions

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Title 39 — Postal Service, U.S. Postal Service Regulations, Part 124. (Postal Regulations for Transport of Radioactive Matter are published in U.S. Postal Service Publication #6, December 1975 and in the U.S. Postal Manual.)

Form AEC-3
(12-73)
10 CFR 19
10 CFR 20

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

NOTICE TO EMPLOYEES

STANDARDS FOR PROTECTION AGAINST RADIATION (PART 20); NOTICES, INSTRUCTIONS AND REPORTS TO WORKERS; INSPECTIONS (PART 19)

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. In Part 19 of its Rules and Regulations, the Atomic Energy Commission has established certain provisions for the options of workers engaged in AEC-licensed activities.

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.
3. Post Notices of Violation involving radiological working conditions, proposed imposition of civil penalties and orders.

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;
6. Options for workers regarding AEC inspections; and
7. Related matters.

REPORTS ON YOUR RADIATION EXPOSURE HISTORY

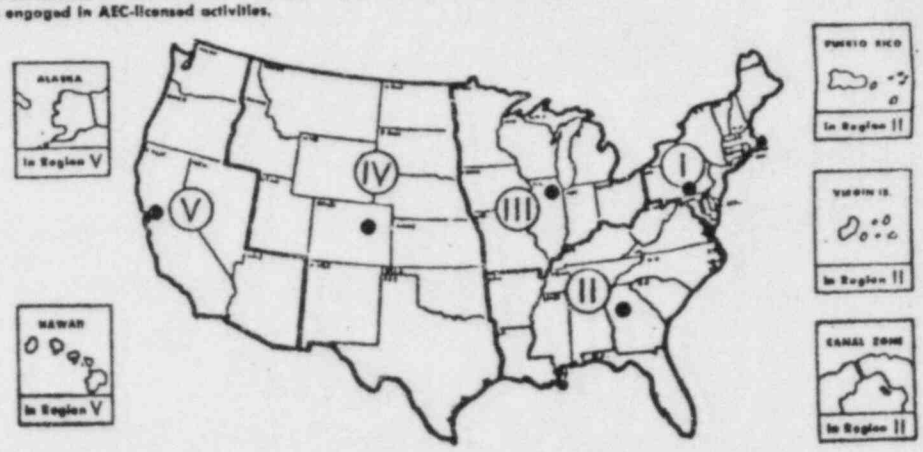
1. The AEC regulations require that your employer give you a written report if you receive an exposure in excess of any applicable limit as set forth in the regulations or in the license. The basic limits for exposure to employees are set forth in Sections 20.101, 20.103, and 20.104 of the Part 20 regulations. 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 AEC. In addition, any worker or representative of workers who believes that there is a violation of the Atomic Energy Act of 1954, the regulations issued thereunder, or the terms of the employer's license with regard to radiological working conditions in which the worker is engaged, may request an inspection by sending a notice of the alleged violation to the appropriate United States Atomic Energy Commission Regulatory Operations Office (shown on map at right). The request must set forth the specific grounds for the notice, and must be signed by the worker or the representative of the workers. During inspections, AEC inspectors may confer privately with workers, and any worker may bring to the attention of the inspectors any past or present condition which he believes contributed to or caused any violation as described above.

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 REGULATORY OPERATIONS OFFICES

REGION	ADDRESS	TELEPHONE DAYTIME	TELEPHONE NIGHTS AND HOLIDAYS
I	Region I, Directorate of Regulatory Operations, USAEC 631 Park Avenue King of Prussia, Pennsylvania 19406	215-337-1150	215-337-1150
II	Region II, Directorate of Regulatory Operations, USAEC Suite 818, 230 Peachtree St., N.W. Atlanta, Georgia 30303	404-526-4503	404-526-4503
III	Region III, Directorate of Regulatory Operations, USAEC 799 Roosevelt Road Glen Ellyn, Illinois 60137	312-858-2660	312-789-7711
IV	Region IV, Directorate of Regulatory Operations, USAEC 10395 West Colfax Avenue Denver, Colorado 80215	303-837-4211	303-237-5095
V	Region V, Directorate of Regulatory Operations, USAEC P.O. Box 1818 Berkeley, California 94701	415-486-8161	415-273-4237

Form AEC 3
(12-73)
10 CFR 19
10 CFR 20

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

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IV	Region IV, Directorate of Regulatory Operations, USAEC 10395 West Colfax Avenue Denver, Colorado 80215	303-837-4711	303 237 5095
V	Region V, Directorate of Regulatory Operations, USAEC P.O. Box 1618 Berkeley, California 94701	415-486-8161	415 273 6237

ohmart radiation SAFETY

WIPE TEST & SHUTTER CHECK

GENERAL INFORMATION

Government Regulations require that this device be subjected to a periodic wipe test at intervals determined by the source holder type. (See the Wipe Test Frequency Table on page 2 of 4).

In addition, when the source holder has a shutter mechanism, the operation of this shutter mechanism must be checked whenever the source holder is wipe tested.

Instructions for the required test(s) are given below.

Because of the extremely rugged construction of the sealed radioactive source contained in this device, the possibility of radioactive material leaking from the source capsule is very remote.

In addition, the source capsule is contained in a source holder whose construction has been evaluated and approved by the United States Nuclear Regulatory Commission. Therefore, even if the source capsule should leak, the possibility of radioactive material reaching the outside of the source holder is exceedingly remote.

INSTRUCTIONS FOR WIPE TESTING A SEALED SOURCE IN A SOURCE HOLDER

The source holder of the gage must not be disassembled for the wipe test. Testing the external surface of the source holder is adequate. Do the following:

(1) Take the plastic vial containing the swabstick to the source holder to be tested.

(2) Remove the cap, tilt the vial and grasp the swabstick by the end opposite the fiber tip. Do not touch the fiber tipped end or allow it to touch other objects as this would spread contamination if the source were leaking.

(3) Wipe the external surface of the source holder with the fiber tipped end. Wipe ALL SEAMS and around the SHAFT OF THE SHUTTER MECHANISM. The illustration figure 1 shows, in general, the areas that should be wiped. These areas are "shown in Bold".

(4) Attach the label provided with the wipe test kit. If a blank label has been provided fill in the information shown in figure 2. The wipe test kit should then be mailed to Ohmart for analysis.

NOTE: In newer kits, each transparent vial is identified with a label similar to the metal identification tag actually attached to the source holder. BE SURE TO USE THE PROPER KIT FOR THE DESIGNATED SOURCE HOLDER.

CONTROL NO. [illegible]

SDFV 9479

WIPE TEST & SHUTTER CHECK

(continued)

Upon receipt of the wipe, the Ohmart Corporation will perform a very sensitive test to determine the presence of radioactive contamination.

Results of the wipe test if found leak free are returned to the customer by mail. In case removable contamination is found less than 0.005 microcurie but significantly above background a new kit is sent for a rewipe. If contamination is evident on the rewipe but still less than 0.005 microcurie the customer is advised to consult if the source should be brought technically may not be leaking. All wipe test results should be kept on file along with the other required records. (See: Record Keeping Requirements and Recommendations for Users of Nuclear Gages, NUREG/CR-0 or Maintenance-Radiation Safety Schedule J)

If greater than 0.005 microcurie of removable contamination is measured the customer is advised to remove the source or device from service and notify the proper Agreement State Agency or the Regional Office of Inspection and Enforcement (USNRC as appropriate).

TEST OF THE SOURCE HOLDER SHUTTER MECHANISM

To test the shutter mechanism, move the actuator back and forth several times between the "OFF" and "ON" position. The actuator should move easily but not freely. There will be some resistance to movement due to bearing friction and inertia of the mechanism. Use one of the two methods below to insure that the shutter mechanism is operational.

METHOD 1

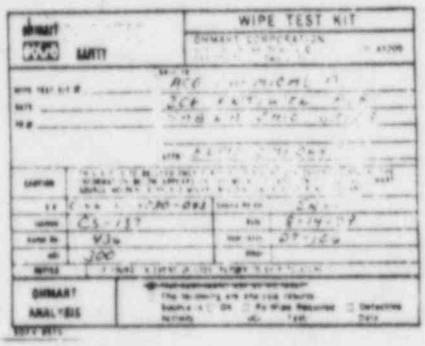
If a portable radiation survey meter is available, the radiation field intensity can be measured at the back of the detector housing with the shutter in the "OFF" position, field intensity should be very low. When the shutter is moved to the "ON" position, the field intensity should increase.

METHOD 2

Under certain conditions, the gage electronics may be used to check shutter mechanism operation. Methods 2A or 2B may be used.

2A - With the gage operating under normal process conditions assure that the panel meter is reading ON SCALE. Turning the shutter to the "OFF" position should cause the panel meter to go upscale (reading greater than 120%). Be sure to open the shutter again to return the gage to normal operation.

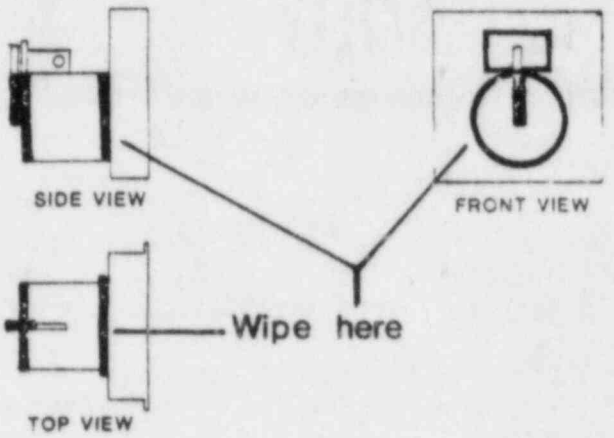
2B - With no process material between the source and detector, turn the shutter to the "OFF" position and adjust the suppression dial for a panel meter indication of 100. Opening the shutter should cause a downscale deflection of the panel meter.



(figure 2)

TYPICAL SOURCEHOLDER

See pages 3&4 for illustrations of other sourceholders



(figure 1)

CHECK YOUR WIPE TEST FREQUENCY

ohmart radiation SAFETY

SOURCEHOLDER SERIES	PRODUCT(S)	REQUIRED WIPE TEST FREQUENCY
BAL	BETA GAGES	6 MONTHS
HN	DENSITY AND LEVEL GAGES	3 YEARS
SHD	LEVEL GAGES	
SHDP		
SHGS		6 MONTHS
SHLG		
SHLH		3 YEARS
SHN	MOISTURE GAGES	6 MONTHS
SHRD	LEVEL GAGES	3 YEARS
SHRH		
SHSH		
SHSH-PA		
SHSP		
SHWA	RELTSPACES	
SN	DENSITY AND LEVEL GAGES	

ohmart®

Innovative Measurement and Control

ohmart radiation SAFETY SCHOOL

IF YOU ARE A DO-IT-YOURSELFER, REMEMBER THAT OHMART CONDUCTS MONTHLY COURSES IN RADIATION SAFETY. THESE COURSES ARE RECOGNIZED BY THE UNITED STATES NUCLEAR REGULATORY COMMISSION. CONTACT THE TRAINING DIRECTOR, OHMART FOR FURTHER INFORMATION.

SDFV 9479

ohmart radiation SAFETY

WIPE TEST & SHUTTER CHECK

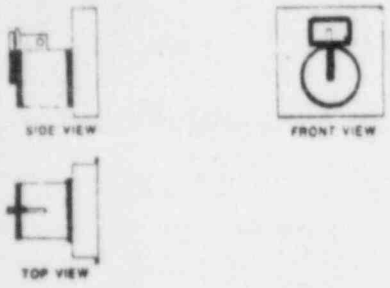
GENERAL

The source holders most commonly used by Ohmart are illustrated on this attachment by gage type and source holder model. If your source holder is not illustrated here, please contact the Radiation Safety Officer, Ohmart for additional information.

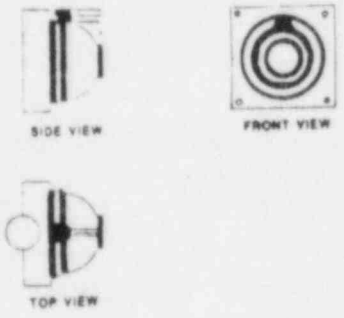
When performing a wipe test, wipe vigorously the outer surface of the source holder, especially at the seams and around the shutter mechanism on gages which have a shutter mechanism.

For Density Gages

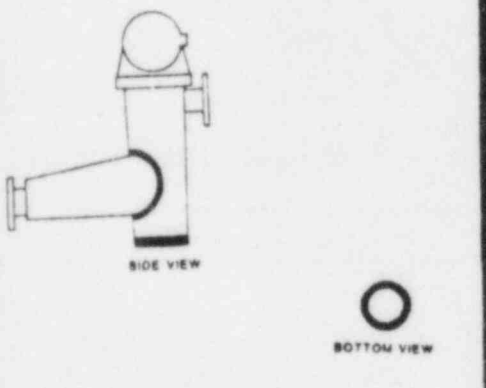
Source Holder SR Series



Source Holder HM Series

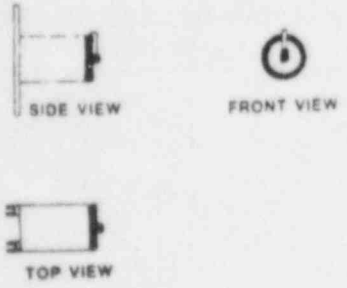


Source Holder ES Series



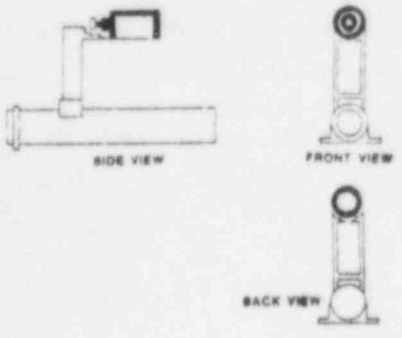
For Density Gages

Source Holder SR-1A Series



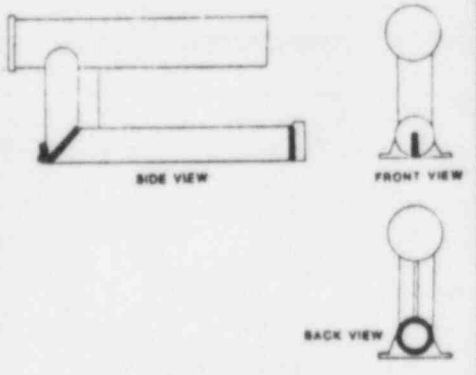
For Belt Scales

Source Holder SHWA



For Moisture (Belt) Gages

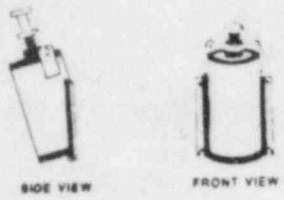
Source Holder SHRM Series



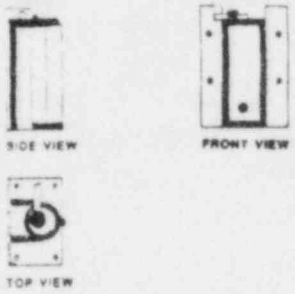
SDFV 9479

For Level Gages

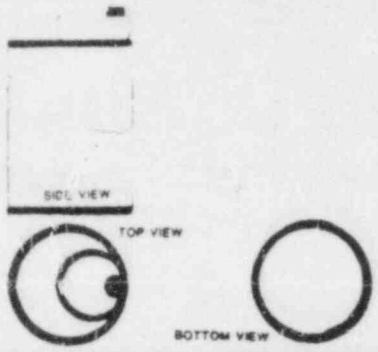
Source Holder SHLG Series



Source Holder SHRM Series

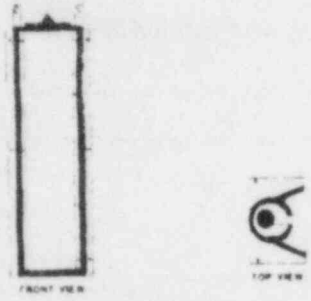


Source Holder SHRM-PA Series

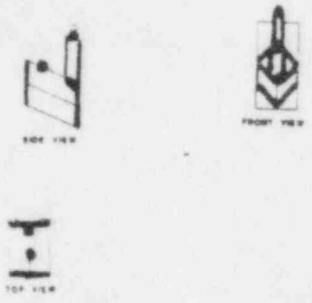


For Level Gages

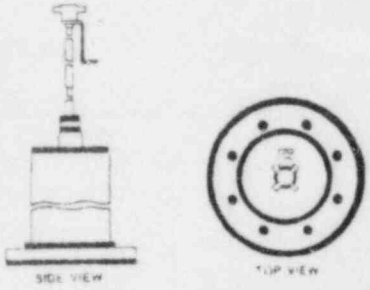
Source Holder SHRH Series



Source Holder SHD Series

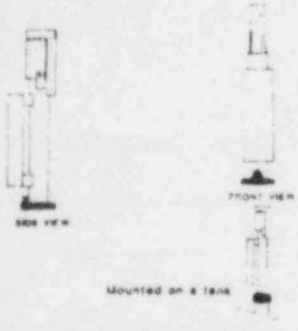


Source Holder SHLM-B Series

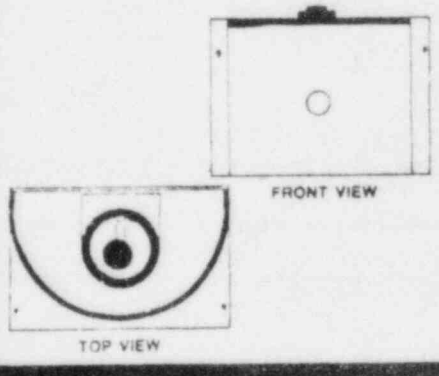


For Level Gages

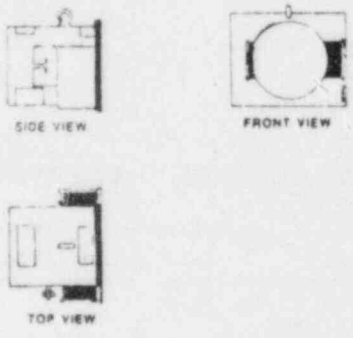
Source Holder SHLM-C Series



Source Holder SHRD Series

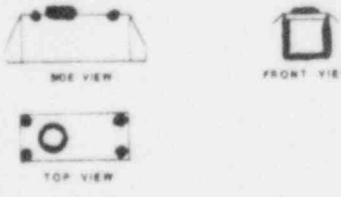


Source Holder SHGS Series

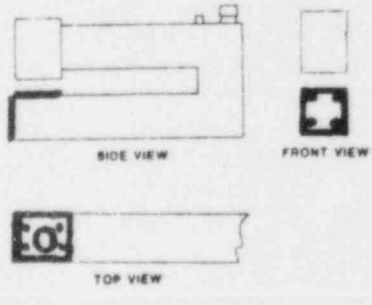


FOR BETA GAGES

Source Holder BAL Series



Source Holder BAL Series

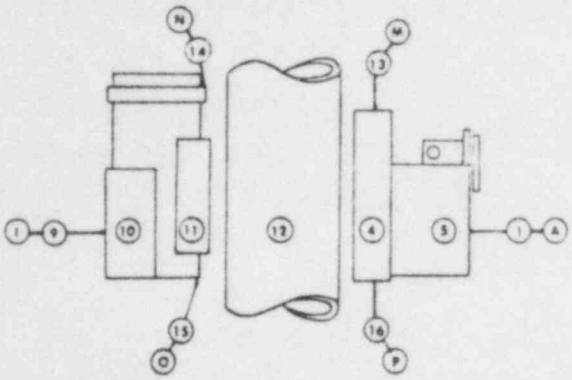


SDFV 9479

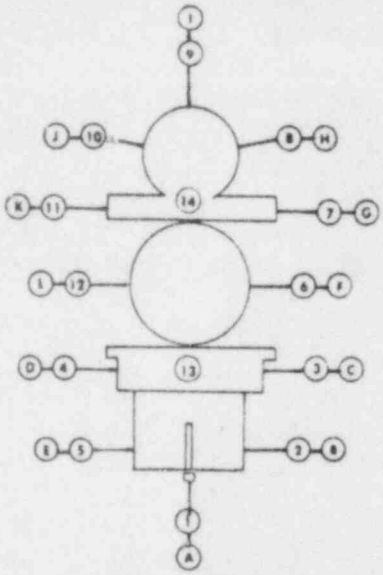
ohmart radiation SAFETY

RADIATION SURVEY

densart SERIES 3000 DENSITY GAGES



Side view



Top view

1 GENERAL INFORMATION

Ohmart SO # _____

Date _____ 19____

Person doing the survey,

_____

The Source:

Material _____

Source Size _____

Source Holder Model # _____

The Survey Instrument:

Manufacturer _____

Model _____

Serial # _____

NOTES

All readings are in milliroentgen/hr (mR/hr).

(6) on the drawing indicates where the meter should be placed at the gage surface to take that reading.

If (6) exceeds 5 mR/hr, then move back until the reading drops to 5 mR/hr, then record the distance as (F).

A reading greater than 5 mR/hr at 12" from the gage surface requires a "Radiation Area" sign.

SOURCE SHUTTER

2 Open

Reading at the surface		Distance to a reading of 5mR/hr WHEN SURFACE READING EXCEEDS 5mR/hr	
	COLUMN 1		COLUMN 2
(1)		(A)	
(2)		(B)	
(3)		(C)	
(4)		(D)	
(5)		(E)	
(6)		(F)	
(7)		(G)	
(8)		(H)	
(9)		(I)	
(10)		(J)	
(11)		(K)	
(12)		(L)	
(13)		(M)	
(14)		(N)	
(15)		(O)	
(16)		(P)	

3 Closed

(1)	(A)
(2)	(B)
(3)	(C)
(4)	(D)
(5)	(E)
(13)	(M)
(16)	(P)

(UNITED STATES OF AMERICA)
RADIOLOGICAL SURVEY INSTRUCTIONS

DENSITY & LEVEL GAGES

GENERAL

A Radiological survey is required for every gage when it is initally placed in service. The purpose of a radiological survey is to establish the levels of radiation field strength around the installation.

In the event of an incident affecting the gage, such as a fire, explosion, etc., another radiological survey must be done to assure that the source holder has not been damaged.

The person doing these surveys must be specifically licensed to do so by the U.S. Nuclear Regulatory Commission or by an Agreement State.

INSTRUCTIONS

Step 1. Please provide the indicated General Information.

Step 2. With the source holder shutter open, take the survey meter readings on the gage diagram, at the surface. Enter these readings in Column 1. If any reading at the surface is greater than 5 mR/hr, then the corresponding entry in Column 2 must be entered. This is the distance, in inches, from the surface at which the radiation field intensity measures 5 mR/hr.

EXAMPLE:	Reading at the Surface Column 1	Distance to a Reading of 5 mR/hr Column 2
	(1) 5 mR/hr	(A) -- Inches
	(2) 8 mR/hr	(B) 3 Inches

Reading number (1) is 5 mR/hr, therefore reading (A) is not taken.

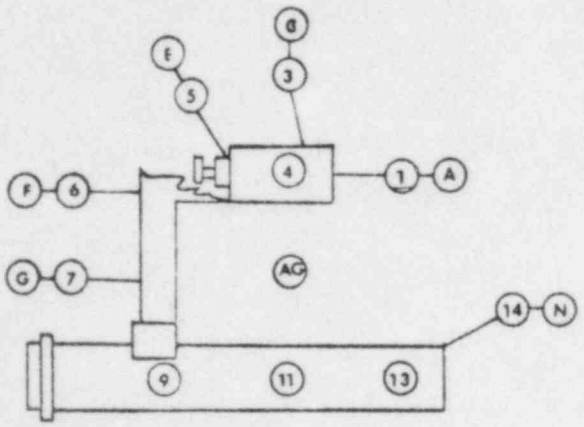
Reading number (2) is 8 mR/hr, therefore measure the distance at which the radiation field intensity measures 5 mR. (B) in this example is 3" from surface.

Step 3. With the shutter closed, once again take the measurements listed. These are recorded exactly as they were in Step 2.

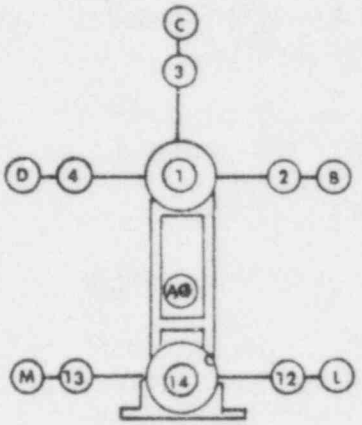
ohmart radiation SAFETY

RADIATION SURVEY

weighart SERIES 4000 SCALES



Side view



Front view

1 GENERAL INFORMATION

Ohmart SO #_____

Date _____ 19____

Person doing the survey,

_____

The Source:

Material _____

Source Size _____

Source Holder Model # _____

The Survey Instrument:

Manufacturer _____

Model _____

Serial # _____

NOTES

All readings are in milliroentgen/hr (mR/hr).

(6) on the drawing indicates where the meter should be placed at the gage surface to take that reading.

If (6) exceeds 5 mR/hr, then move back until the reading drops to 5 mR/hr, then record the distance as (F).

A reading greater than 5 mR/hr at 12" from the gage surface requires a "Radiation Area" sign.

SOURCE SHUTTER

2 Open

	COLUMN 1	COLUMN 2
	Reading at the surface	Distance to a reading of 5mR/hr WHEN SURFACE READING EXCEEDS 5mR/hr
1	_____	A _____
2	_____ V	B _____
3	_____	C _____
4	_____	D _____
5	_____	E _____
6	_____	F _____
7	_____	G _____
8	_____	H _____
9	_____	I _____
10	_____	J _____
11	_____	K _____
12	_____	L _____
13	_____	M _____
14	_____	N _____

3 Closed

	COLUMN 1		COLUMN 2
	Reading at the surface		Distance to a reading of 5mR/hr WHEN SURFACE READING EXCEEDS 5mR/hr
1	_____	AG _____	A _____
2	_____		B _____
3	_____		C _____
4	_____		D _____
5	_____		F _____

(UNITED STATES OF AMERICA)
RADIOLOGICAL SURVEY INSTRUCTIONS

GENERAL

A Radiological survey is required for every gage when it is initally placed in service. The purpose of a radiological survey is to establish the levels of radiation field strength around the installation.

In the event of an incident affecting the gage, such as a fire, explosion, etc., another radiological survey must be done to assure that the source holder has not been damaged.

The person doing these surveys must be specifically licensed to do so by the U.S. Nuclear Regulatory Commission or by an Agreement State.

INSTRUCTIONS

Step 1. Please provide the indicated General Information.

Step 2. With the source holder shutter open, take the survey meter readings on the gage diagram, at the surface. Enter these readings in Column 1. If any reading at the surface is greater than 5 mR/hr, then the corresponding entry in Column 2 must be entered. This is the distance, in inches, from the surface at which the radiation field intensity measures 5 mR/hr.

EXAMPLE:	Reading at the Surface Column 1	Distance to a Reading of 5 mR/hr Column 2
	(1) 5 mR/hr	(A) -- Inches
	(2) 8 mR/hr	(B) 3 Inches

Reading number (1) is 5 mR/hr, therefore reading (A) is not taken.

Reading number (2) is 8 mR/hr, therefore measure the distance at which the radiation field intensity measures 5 mR. (B) in this example is 3" from surface.

Step 3. With the shutter closed, once again take the measurements listed. These are recorded exactly as they were in Step 2.

Form NRC-374

U. S. NUCLEAR REGULATORY COMMISSION
MATERIALS LICENSE

Amendment No. 17

This Copy Is For Your Files

Pursuant to the Atomic Energy Act of 1954, as amended, the Energy Reorganization Act of 1974 (Public Law 93-438), and Title 10, Code of Federal Regulations, Chapter 1, Parts 30, 31, 32, 33, 34, 35, 36, 40 and 70, and in reliance on statements and representations heretofore made by the licensee, a license is hereby issued authorizing the licensee to receive, acquire, possess, and transfer byproduct, source, and special nuclear material designated below; to use such material for the purpose(s) and at the place(s) designated below; to deliver or transfer such material to persons authorized to receive it in accordance with the regulations of the applicable Part(s); and to import such byproduct and source material. This license shall be deemed to contain the conditions specified in Section 183 of the Atomic Energy Act of 1954, as amended, and is subject to all applicable rules, regulations and orders of the Nuclear Regulatory Commission now or hereafter in effect and to any conditions specified below.

Licensee	
1. Monsanto Company	In accordance with application dated March 27, 1978
2. 1700 South Second Street St. Louis, Missouri 63177	3. License number 24-01113-02 is amended in its entirety to read as follows:
	4. Expiration date September 30, 1983
	5. Docket or Reference No.

6. Byproduct, source, and/or special nuclear material	7. Chemical and/or physical form	8. Maximum amount that licensee may possess at any one time under this license
A. Cesium 137	A. Ohmart Corporation Model No. A-2102 Sealed Sources	A. No single source to exceed 300 millicuries
B. Cesium 137	B. Texas Nuclear Model 570-57157C (formerly Nuclear Chicago Model 850233) Sealed Sources	B. No single source to exceed 1 curie
C. Cesium 137	C. Ohmart Corporation Model A-2102 Sealed Sources	C. No single source to exceed 300 millicuries

9. Authorized use

A. For use in Ohmart Corporation Model SR-1 source holders to measure density and/or liquid level of materials.

B. For use in Texas Nuclear Model 5176 source holders to measure density and/or liquid level of materials.

C. For use in Ohmart Corporation Model SHLG-1 source holders to measure density and/or liquid level of materials.

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10. Licensed material shall be used only at the licensee's address stated in Item 2 above.

11. The licensee shall comply with the provisions of Title 10, Chapter 1, Code of Federal Regulations, Part 19, "Notices, Instructions and Reports to Workers; Inspections" and Part 20, "Standards for Protection Against Radiation."

12. Licensed material shall be used by, or under the supervision of, P. D. Axtell, W. H. Alumbaugh, J. H. Holtshouser, Radiation Protection Officer, or A. T. Kavlick, Alternate Radiation Protection Officer.

13. Sealed sources containing licensed material shall not be opened or removed from their respective source holders by the licensee.

14. A. Licensed sealed sources listed in Subitems A., B. and C., above shall be tested for leakage and/or contamination at intervals not to exceed three years. In the absence of a certificate from a transferor indicating that a test has been made within six months prior to the transfer, a sealed source received from another person shall not be put into use until tested.

B. The test shall be capable of detecting the presence of 0.005 microcurie of radioactive material on 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 Commission.

C. If the test reveals the presence of 0.005 microcurie or more of removable contamination, the licensee shall immediately withdraw the sealed source from use and shall cause it to be decontaminated and repaired or to be disposed of in accordance with Commission regulations. A report shall be filed within 5 days of the test with the U. S. Nuclear Regulatory Commission, Region III, Office of Inspection and Enforcement, 799 Roosevelt Road, Glen Ellyn, Illinois 60137, describing the equipment involved, the test results, and the corrective action taken.

D. Tests for leakage and/or contamination shall be performed by the licensee or by other persons specifically authorized by the Commission or an Agreement State to perform such services.

15. Installation, relocation, maintenance, repair, and initial radiation survey of devices containing licensed material and installation, replacement, and disposal of sealed sources containing licensed material used in devices shall be performed only by the device manufacturer or by other persons specifically authorized by the Commission or an Agreement State to perform such services.

MATERIALS LICENSE

Supplementary Sheet
CONDITIONS

License Number 24-01113-02

Docket or
Reference No.

(continued)

Amendment No. 17

16. Notwithstanding the requirements of Condition 15 above, the licensee is authorized to perform installation, removal from installation, relocation and radiation surveys of the devices(s) containing licensed material listed in subitem(s) A., B. and C. above. In performing these operations the licensee shall:

A. Receive detailed safety instructions from the device manufacturer's representative authorized to conduct training and shall have available for reference a copy of the device manufacturer's service and maintenance instructions.

B. Verify by visual inspection and radiation survey that the device is fully secured in the shielded position. (For example: locked).

C. Perform a radiation survey before, during and after each operation authorized by this condition for the purpose of verifying that the source is properly shielded and/or installed for operational use.

D. Verify that the survey meter used is operable, capable of detecting radiation levels generated by the unshielded source and calibrated in accordance with specified condition(s) of this license.

17. Radiation survey meters required by this license shall be calibrated to meet the following requirements.

A. Minimum frequency of calibration: every six months and following each instrument repair.

B. Calibrated at least two points on each scale with the two points separated by at least 50% of the scale.

C. Instrument readings should be within ±10% of the calculated value of the calibration source. (Readings within ±20% are acceptable if a calibration chart or graph is prepared and included with the instrument).

D. The standard source used for calibration shall be traceable to a primary standard.

18. The licensee shall conduct a physical inventory every six (6) months to account for all sealed sources received and possessed under the license. The records of the inventories shall be maintained for two (2) years from the date of the inventory for inspection by the Commission, and shall include the quantities and kinds of byproduct material, location of sealed sources, and the date of the inventory.

19. Except as specifically provided otherwise by this license, the licensee shall possess and use licensed material described in Items 6, 7, and 8 of this license in accordance with statements, representations, and procedures contained in application dated March 27, 1978 and letters dated December 22, 1977, March 28, 1978 and July 24, 1978.

For the U. S. Nuclear Regulatory Commission

Date AUG 25 1978

Earl G Wright

By Radioisotopes Licensing Branch

Division of Fuel Cycle and
Material Safety
Washington, D.C. 20555

CONTROL NO. 7 8 4 0 7

U.S. NUCLEAR REGULATORY COMMISSION

July 1981

REGULATORY GUIDE

OFFICE OF NUCLEAR REGULATORY RESEARCH

REGULATORY GUIDE 8.29
(Task OH 902-4)

INSTRUCTION CONCERNING RISKS FROM OCCUPATIONAL RADIATION EXPOSURE

A. INTRODUCTION

Section 19.12 of 10 CFR Part 19, "Notices, Instructions and Reports to Workers; Inspections," requires that all persons working in or frequenting any portion of a restricted area be instructed in the health protection problems associated with exposure to radioactive materials or radiation. This guide describes the instruction that should be provided to the worker concerning biological risks from occupational radiation exposure. Additional guides are being or will be developed to address other aspects of radiation protection training.

B. DISCUSSION

It is generally accepted by the scientific community that exposure to ionizing radiation can cause biological effects that are harmful to the exposed organism. These effects are classified into three categories:

Somatic Effects: Effects occurring in the exposed person that, in turn, may be divided into two classes:

Prompt effects that are observable soon after a large or acute dose (e.g., 100 rems[1] or more to the whole body in a few hours), and

Delayed effects such as cancer that may occur years after exposure to radiation.

Genetic Effects:[2] Abnormalities that may occur in the future children of exposed individuals and in subsequent generations.

Teratogenic Effects: Effects that may be observed in children who were exposed during the fetal and embryonic stages of development.

Concerns about these biological effects have resulted in controls on doses to individual workers and in efforts to control the collective dose (person-rems) to the worker population.

NRC-licensed activities result in a significant fraction of the total occupational radiation exposure in the United States. Regulatory action has recently focused more attention on maintaining occupational radiation exposure at levels that are as low as is reasonably achievable (ALARA). Radiation protection training for all workers who may be exposed to ionizing radiation is an essential component of any program designed to maintain exposure levels ALARA. A clear understanding of what is presently known about the biological risks associated with exposure to radiation will result in more effective radiation protection training and should generate more interest on the part of the worker in minimizing both individual and collective doses. In addition, radiation workers have the right to whatever information on radiation risk is available to enable them to make informed decisions regarding the acceptance of these risks. It is intended that workers who receive this instruction develop a healthy respect for the risks involved rather than excessive fear or indifference.

At the relatively low levels of occupational radiation exposure in the United States, it is difficult to demonstrate a relationship between exposure and effect. There is considerable uncertainty and controversy regarding estimates of radiation risk. In the appendix to this guide, a range of risk estimates is provided (see Table 1). Information on radiation risk has been included from such sources as the 1980 National Academy of Sciences' Report of the Committee on the Biological Effects of Ionizing Radiation (BEIR-80), the International Commission on Radiological Protection (ICRP) Publication 27 entitled "Problems in Developing an Index of Harm," the 1979 report of the science work group of the Interagency Task Force on the Health Effects of Ionizing Radiation, the 1977 report of the United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR report), and numerous published articles (see the bibliography to the appendix).

[1] In the International System of Units (SI), the rem is replaced by the sievert. 100 rems is equal to 1 sievert (Sv).

[2] Genetic effects exceeding normal incidence have not been observed in any of the studies of exposed humans.

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C. REGULATORY POSITION

Strong management support is considered essential to an adequate radiation protection training program. Instruction to workers performed in compliance with §19.12 of 10 CFR Part 19 should be given prior to assignment to work in a restricted area and periodically thereafter. In providing instruction concerning health protection problems associated with exposure to radiation, all workers, including those in supervisory roles, should be given specific instruction on the risk of biological effects resulting from exposure to radiation.

The instruction should be presented both orally and in printed form to all affected workers and supervisors. It should include the information provided in the appendix to this guide.[3] The information should be discussed during training sessions. Each individual should be given an opportunity to ask questions and should be asked to acknowledge in writing that the instruction has been received and understood.

[3]Copies of the appendix to this guide are available at the current Government Printing Office price, which may be obtained by writing to the U.S. Nuclear Regulatory Commission, Washington, D.C. 20555, Attention: Publications Sales Manager. This appendix is not copyrighted, and Commission approval is not required to reproduce it.

D. IMPLEMENTATION

The purpose of this section is to provide information to applicants regarding the NRC staff's plans for using this regulatory guide.

Except in those cases in which an applicant or licensee proposes an acceptable alternative method for complying with specified portions of the Commission's regulations, the methods described in this guide will be used in the evaluation of the training program for all individuals working in or frequenting any portion of a restricted area and for all supervisory personnel after December 15, 1981.

If an applicant or licensee wishes to use the material provided in this guide on or before December 15, 1981, the pertinent portions of the application or the licensee's performance will be evaluated on the basis of this guide.

U.S. NUCLEAR REGULATORY COMMISSION

APPENDIX TO REGULATORY GUIDE 8.29

INSTRUCTION CONCERNING RISKS FROM OCCUPATIONAL RADIATION EXPOSURE

This instructional material is intended to provide the user with the best available information concerning what is currently known about the health risks from exposure to ionizing radiation.[1] A question and answer format has been used. The questions were developed by the NRC staff in consultation with workers, union representatives, and licensee representatives experienced in radiation protection training. Risk estimates have been compiled from numerous sources generally recognized as reliable. A bibliography is included for the user interested in further study.

The biological effects that are known to occur after exposure to high doses (hundreds of rems[2]) of radiation are discussed early in the document; discussions of the estimated risks from the low occupational dose (<5 rems per year) follow. It is intended that this information will help develop an attitude of healthy respect for the risks associated with radiation, rather than unnecessary fear or lack of concern. Additional guidance is being or will be developed concerning other topics in radiation protection training.

• • • • • • •

1. What is meant by risk?

Risk can be defined in general as the probability (chance) of injury, illness, or death resulting from some activity. However, the perception of risk is affected by how the individual views its probability and its severity. The intent of this document is to provide estimates of and explain the basis for possible risk of injury, illness, or death resulting from occupational radiation exposure. (See Questions 9 and 10 for estimates of radiation risk and comparisons with other types of risk.)

2. What are the possible health effects of exposure to radiation?

Some of the health effects that exposure to radiation may cause are cancer (including leukemia), birth defects in the future children of exposed parents, and cataracts.[3] These effects (with the exception of genetic effects) have been observed in studies of medical radiologists, uranium miners, radium workers, and radiotherapy patients who have received large doses of radiation. Studies of people exposed to radiation from atomic weapons have also provided data on radiation effects. In addition, radiation effects studies with laboratory animals have provided a large body of data on radiation-induced health effects, including genetic effects.

The observations and studies mentioned above, however, involve levels of radiation exposure that are much higher (hundreds of rems) than those permitted occupationally today (<5 rems per year). Although studies have not shown a cause-effect relationship between health effects and current levels of occupational radiation exposure, it is prudent to assume that some health effects do occur at the lower exposure levels.

3. What is meant by prompt effects, delayed effects, and genetic effects?

a. Prompt effects are observable shortly after receiving a very large dose in a short period of time. For example, a whole-body[4] dose of 450 rems (90 times the annual dose limit for routine occupational exposure) in an hour to an average adult will cause vomiting and diarrhea within a few hours; loss of hair, fever, and weight loss within a few weeks; and about a 50 percent chance of death within 60 days without medical treatment.

b. Delayed effects such as cancer may occur years after exposure to radiation.

c. Genetic effects can occur when there is radiation damage to the genetic material. These effects may show up as birth defects or other conditions in the future children of the exposed individual and succeeding generations, as demonstrated in animal experiments. However, excess genetic effects clearly caused by radiation have not been observed in human populations exposed to radiation. It has been observed, however, that radiation can change the genes in cells of the human body. Thus, the possibility exists that genetic effects can be caused in humans by low doses even though no direct evidence exists as yet.

4. In worker protection, which effects are of most concern to the NRC?

The main concern to the NRC is the delayed incidence of cancer. The chance of delayed cancer is believed to depend

[1] Ionizing radiation consists of energy or small particles such as gamma, beta, or alpha radiation emitted from radioactive materials which, when absorbed by living tissue, can cause chemical and physical damage.

[2] The rem is the unit of measure for radiation dose and relates to the biological effect of the absorbed radiation.

[3] Cataracts differ from other radiation effects in that a certain level of dose to the lens of the eye (~200 rems) is required before they are observed.

[4] It is important to distinguish between whole-body and partial-body exposure. 100 rems to the whole body will have more effect than 100 to a hand. For example, exposure of a hand would affect a small fraction of the bone marrow and a limited portion of the skin.

on how much radiation exposure a person gets; therefore, every reasonable effort should be made to keep exposures low.

Immediate or prompt effects are very unlikely since large exposures would normally occur only if there were a serious radiation accident. Accident rates in the radiation industry have been low, and only a few accidents have resulted in exposures exceeding the legal limits. The probability of serious genetic effects in the future children of workers is estimated in the BEIR[5] report, based on animal studies, at less than one-third that of delayed cancer (5-65 genetic effects per million rems compared to 160-450 cancer cases). A clearer understanding of the cause-effect relationship between radiation and human genetic effects will not be possible until additional research studies are completed.

5. *What is the difference between acute and chronic exposure?*

Acute radiation exposure, which causes prompt effects and may also cause delayed effects, usually refers to a large dose of radiation received in a short period of time; for example, 450 rems received within a few hours or less. The effects of acute exposures are well known from studies of radiotherapy patients, some of whom received whole-body doses; atomic bomb victims; and the few accidents that have occurred in the early days of atomic weapons and reactor development, industrial radiography, and nuclear fuel processing. There have been few occupational incidents that have resulted in large exposures. NRC data indicate that, on the average, 1 accidental overexposure in which any acute symptoms are observed occurs each year. Most of these occur in industrial radiography and involve exposures of the hands rather than the whole body.

Chronic exposure, which may cause delayed effects but not prompt effects, refers to small doses received repeatedly over long time periods; for example, 20-100 mrem (a mrem is one-thousandth of a rem) per week every week for several years. Concern with occupational radiation risk is primarily focused on chronic exposure to low levels of radiation over long time periods.

6. *How does radiation cause cancer?*

How radiation causes cancer is not well understood. It is impossible to tell whether a given cancer was caused by radiation or by some other of the many apparent causes. However, most diseases are caused by the interaction of several factors. General physical condition, inherited traits, age, sex, and exposure to other cancer-causing agents such as cigarette smoke are a few possible contributing factors. One theory is that radiation can damage chromosomes in a cell, and the cell is then directed along abnormal growth patterns. Another is that radiation reduces the body's normal resistance to existing viruses which can then multiply and damage cells. A third is that radiation activates an existing virus in the body which then attacks normal cells causing them to grow rapidly.

What is known is that, in groups of highly exposed people, a higher than normal incidence of cancer is observed. Higher than normal rates of cancer can also be produced in laboratory animals by high levels of radiation. An increased incidence of cancer has not been demonstrated at radiation levels below the NRC limits.

7. *If I receive a radiation dose, does that mean I am certain to get cancer?*

Not at all. Everyone gets a radiation dose every day (see Question 25), but most people do not get cancer. Even with doses of radiation far above legal limits, most individuals will experience no delayed consequences. There is evidence that some radiation damage can be repaired. The danger from radiation is much like the danger from cigarette smoke. Only a fraction of the people who breathe cigarette smoke get lung cancer, but there is good evidence that smoking increases a person's chances of getting lung cancer. Similarly, there is evidence that the larger the radiation dose, the larger the increase in a person's chances of getting cancer.

Radiation is like most substances that cause cancer in that the effects can be seen clearly only at high doses. Estimates of the risks of cancer at low levels of exposure are derived from data available for exposures at high dose levels and high dose rates. Generally, for radiation protection purposes these estimates are made using the linear model (Curve 1 in Figure 1). We have data on health effects at high doses as shown by the solid line in Figure 1. Below about 100 rems, studies have not been able to accurately measure the risk, primarily because of the small numbers of exposed people and because the effect is small compared to differences in the normal incidence from year to year and place to place. Most scientists believe that there is some degree of risk no matter how small the dose (Curves 1 and 2). Some scientists believe that the risk drops off to zero at some low dose (Curve 3), the threshold effect. A few believe that risk levels off so that even very small doses imply a significant risk (Curve 4). The majority of scientists today endorse either the linear model (Curve 1) or the linear-quadratic model (Curve 2). The NRC endorses the linear model (Curve 1), which shows the number of effects decreasing as the dose decreases, for radiation protection purposes.

It is prudent to assume that smaller doses have some chance of causing cancer. This is as true for natural cancer-causers such as sunlight and natural radiation as it is for those that are man made such as cigarette smoke, smog, and man-made radiation. As even very small doses may entail some small risk, it follows that no dose should be taken without a reason. Thus, a principle of radiation protection is to do more than merely meet the allowed regulatory

[5] The National Academy of Sciences established a committee on the Biological Effects of Ionizing Radiation (BEIR) whose 1980 report on the effects on populations of exposure to low levels of ionizing radiation provides much of the background for this guide.

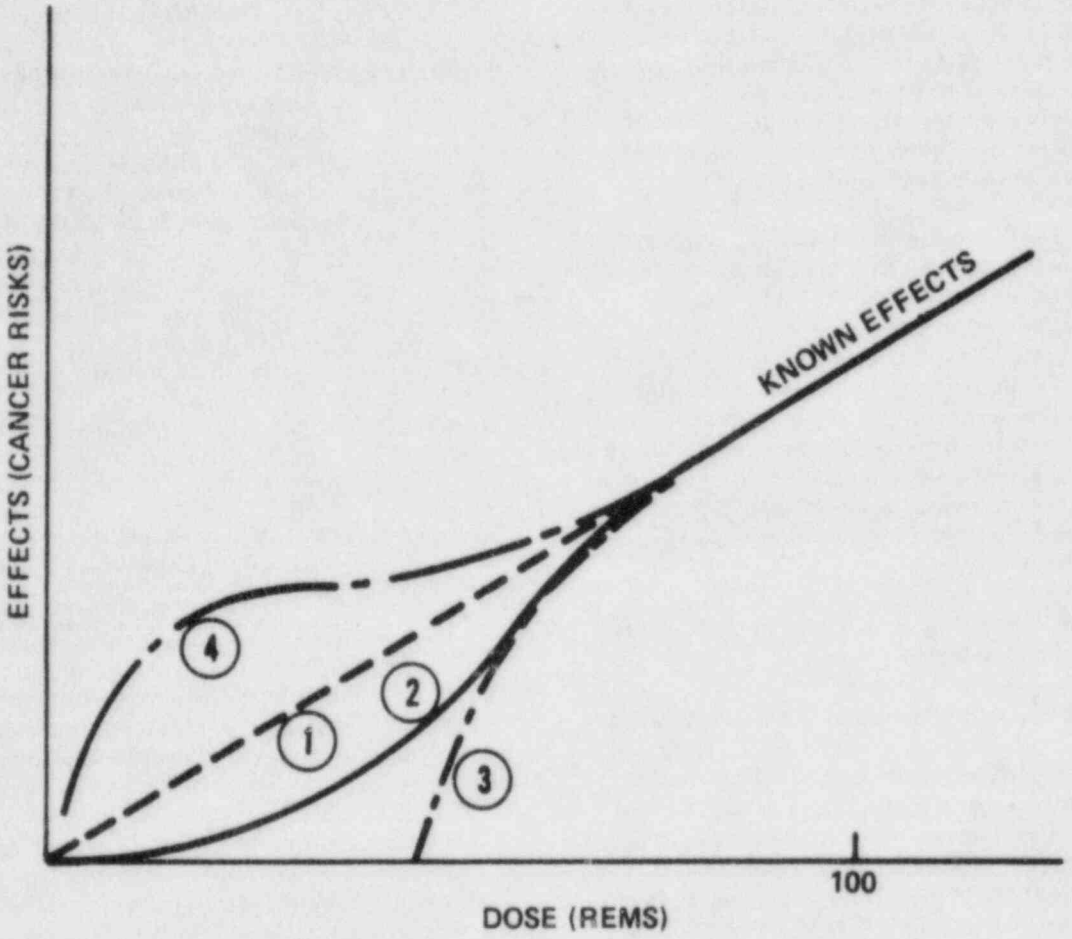

Figure 1. Some proposed models for how the effects of radiation vary with doses at low levels.

limits; doses should be kept as low as is reasonably achievable (ALARA).

We don't know exactly what the chances are of getting cancer from a low-level radiation dose, but we can make estimates based on extensive scientific knowledge. The estimates of radiation risks are at least as reliable as estimates for the effects from any chemical hazard. Being exposed to typical occupational radiation doses is taking a chance, but that chance is reasonably well understood.

It is important to understand the probability factors here. A similar question would be: If you select one card from a full deck, will you get the ace of spades? This question cannot be answered with a simple yes or no. The best answer is that your chances are 1 in 52. However, if 1000 people each select one card from full decks, we can predict that about 20 of them will get an ace of spades. Each person will have 1 chance in 52 of drawing the ace of spades, but there is no way that we can predict which persons will get the right card. The issue is further complicated by the fact that in 1 drawing by 1000 people, we might get only 15 successes and in another perhaps 25 correct cards in 1000 draws. We can say that if you receive a radiation dose, you will have increased your chances of eventually developing cancer. It is assumed that the more radiation exposure you get, the more you increase your chances of cancer.

Not all workers incur the same level of risk. The radiation risk incurred by a worker depends on the amount of dose received. Under the linear model explained above, a worker who receives 5 rems in a year incurs 10 times as much risk as another worker (the same age) who receives only 0.5 rem. The risk depends not only on the amount of dose, but also on the age of the worker at the time the dose is received. This age difference is due, in part, to the fact that a young worker has more time to live than an older worker, and the risk is believed to depend on the number of years of life following the dose. The more years left, the larger the risk. It should be clear that, even within the regulatory dose limits, the risk may vary a great deal from one worker to another. Fortunately, only a very few workers receive doses near 5 rems per year; as pointed out in the answer to Question 19, the average annual dose for all radiation workers is less than 0.5 rem.

A reasonable comparison involves exposure to the sun's rays. Frequent short exposures provide time for the skin to repair. An acute exposure to the sun can result in painful burning, and excessive exposure has been shown to cause skin cancer. However, whether exposure to the sun's rays is short term or spread over time, some of the injury is not repaired and may eventually result in skin cancer.

The effect upon a group of workers occupationally exposed to radiation may be an increased incidence of cancer over and above the number of cancers that would normally be expected in that group. Each exposed individual has an increased probability of incurring subsequent cancer. We can say that if 10,000 workers each receive an additional 1 rem in a year, that group is more likely to have a larger incidence of cancer than 10,000 people who do not receive the additional radiation. An estimate of the increased probability of cancer from low radiation doses delivered to large groups is one measure of occupational risk and is discussed in Question 9.

8. *What groups of expert scientists have studied the risk from exposure to radiation?*

In 1956, the National Academy of Sciences established advisory committees to consider radiation risks. The first of these was the Advisory Committee on the Biological Effects of Atomic Radiations (BEAR) and more recently it was renamed the Advisory Committee on the Biological Effects of Ionizing Radiation (BEIR). These committees have periodically reviewed the extensive research being done on the health effects of ionizing radiation and have published estimates of the risk of cancer from exposure to radiation (1972 and 1980 BEIR reports). The International Commission on Radiological Protection (ICRP) and the National Council on Radiation Protection and Measurement (NCRP) are two other groups of scientists who have studied radiation effects and published risk estimates (ICRP Publication 26, 1977). These two groups have no government affiliation. In addition, the United Nations established an independent study group that published an extensive report in 1977, including estimates of cancer risk from ionizing radiation (UNSCEAR, 1977).

Several individual research groups or scientists such as Alice Stewart, E.S. Gilbert, T.F. Mancuso, T.W. Anderson, to name a few, have published studies concerning low-level radiation effects. The bibliography to this appendix includes several articles for the reader who wishes to do further study. The BEIR-80 report includes analysis of the work of many independent researchers.

9. *What are the estimates of the risk of cancer from radiation exposure?*

The cancer risk estimates (developed by the organizations identified in Question 8) are presented in Table 1.

In an effort to explain the significance of these estimates, we will use an approximate average of 300 excess cancer cases per million people, each exposed to 1 rem of ionizing radiation. If in a group of 10,000 workers each receives 1 rem, we could estimate that three would develop cancer because of that exposure, although the actual number could be more or less than three.

TABLE 1

Estimates of Excess Cancer Incidence from Exposure to Low-Level Radiation

Source	Number of Additional[a] Cancers Estimated to Occur in 1 Million People After Exposure of Each to 1 Rem of Radiation
BEIR, 1980	160-450[b]
ICRP, 1977	200
UNSCEAR, 1977	150-350

[a] Additional means above the normal incidence of cancer.

[b] All three groups estimated premature deaths from radiation-induced cancers. The American Cancer Society has recently stated that only about one-half of all cancer cases are fatal. Thus, to estimate incidence of cancer, the published numbers were multiplied by 2. Note that the three groups are in close agreement on the risk of radiation-induced cancer.

The American Cancer Society has reported that approximately 25 percent of all adults in the 20- to 65-year age bracket will develop cancer at some time from all possible causes such as smoking, food, alcohol, drugs, air pollutants, and natural background radiation. Thus in any group of 10,000 workers not exposed to radiation on the job, we can expect about 2,500 to develop cancer. If this entire group of 10,000 workers were to receive an occupational radiation dose of 1 rem each, we could estimate that three additional cases might occur which would give a total of about 2,503. This means that a 1-rem dose to each of 10,000 workers might increase the cancer rate from 25 percent to 25.03 percent, an increase of about 3 hundredths of one percent.

As an individual, if your cumulative occupational radiation dose is 1 rem, your chances of eventually developing cancer during your entire lifetime may have increased from 25 percent to 25.03 percent. If your lifetime occupational dose is 10 rems, we could estimate a 25.3 percent chance of developing cancer. Using a simple linear model, a lifetime dose of 100 rems may have increased your chances of cancer from 25 to 28 percent.

The normal chance of developing cancer if you receive no occupational radiation dose is about equal to your chance of getting any spade on a single draw from a full deck of playing cards, which is one chance out of four. The additional chance of developing cancer from an occupational exposure of 1 rem is less than your chances of drawing an ace from a full deck of cards three times in a row.

Since cancer resulting from exposure to radiation usually occurs 5 to 25 years after the exposure and since not all cancers are fatal, another useful measure of risk is years of

life expectancy lost on the average from a radiation-induced cancer. It has been estimated in several studies that the average loss of life expectancy from exposure to radiation is about 1 day per rem of exposure. In other words, a person exposed to 1 rem of radiation may, on the average, lose 1 day of life. The words "on the average" are important, however, because the person who gets cancer from radiation may lose several years of life expectancy while his coworkers suffer no loss. The ICRP estimated that the average number of years of life lost from fatal industrial accidents is 30 while the average number of years of life lost from a fatal radiation-induced cancer is 10. The shorter loss of life expectancy is due to the delayed onset of cancer.

It is important to realize that these risk numbers are only estimates. Many difficulties are involved in designing research studies that can accurately measure the small increases in cancer cases due to low exposures to radiation as compared to the normal rate of cancer. There is still uncertainty and a great deal of controversy with regard to estimates of radiation risk. The numbers used here result from studies involving high doses and high dose rates, and they may not apply to doses at the lower occupational levels of exposure. The NRC and other agencies both in the United States and abroad are continuing extensive long-range research programs on radiation risk.

Some members of the National Academy of Sciences BEIR Advisory Committee and others feel that risk estimates in Table 1 are higher than would actually occur and represent an upper limit on the risk. Other scientists believe that the estimates are low and that the risk could be higher. However, these estimates are considered by the NRC staff to be the best available that the worker can use to make an informed decision concerning acceptance of the risks associated with exposure to radiation. A worker who decides to accept this risk should make every effort to keep exposure to radiation ALARA to avoid unnecessary risk. The worker, after all, has the first line responsibility for protecting himself from radiation hazards.

10. How can we compare radiation risk to other kinds of health risks?

Perhaps the most useful unit for comparison among health risks is the average number of days of life expectancy lost per unit of exposure to each particular health risk. Estimates are calculated by looking at a large number of persons, recording the age when death occurs from apparent causes, and estimating the number of days of life lost as a result of these early deaths. The total number of days of life lost is then averaged over the total group observed.

Several studies have compared the projected loss of life expectancy resulting from exposure to radiation with other health risks. Some representative numbers are presented in Table 2.

These estimates indicate that the health risks from occupational radiation exposure are smaller than the risks associated with many other events or activities we encounter and accept in normal day-to-day activities.

TABLE 2

Estimated Loss of Life Expectancy from Health Risks[a]

Health Risk	Estimates of Days of Life Expectancy Lost, Average
Smoking 20 cigarettes/day	2370 (6.5 years)
Overweight (by 20%)	985 (2.7 years)
All accidents combined	435 (1.2 years)
Auto accidents	200
Alcohol consumption (U.S. average)	130
Home accidents	95
Drowning	41
Natural background radiation, calculated	8
Medical diagnostic x-rays (U.S. average), calculated	6
All catastrophes (earthquake, etc.)	3.5
1 rem occupational radiation dose, calculated (industry average for the higher-dose job categories is 0.65 rem/yr)	1
1 rem/yr for 30 years, calculated	30

[a]Adapted from Cohen and Lee, "A Catalogue of Risks," *Health Physics*, Vol. 36, June 1979.

A second useful comparison is to look at estimates of the average number of days of life expectancy lost from exposure to radiation and from common industrial accidents at radiation-related facilities and to compare this number with days lost from other occupational accidents. Table 3 shows average days of life expectancy lost as a result of fatal work-related accidents. Note that the data for occupations other than radiation related do not include death risks from other possible hazards such as exposure to toxic chemicals, dusts, or unusual temperatures. Note also that the unlikely occupational exposure at 5 rems per year for 50 years, the maximum allowable risk level, may result in a risk comparable to the average risks in mining and heavy construction.

Industrial accident rates in the nuclear industry and related occupational areas have been relatively low during the entire history of the industry (see Table 4). This is believed to be due to the early and continuing emphasis on tight safety controls. The relative safety of various occupational areas can be seen by comparing the probability of death by accident per 10,000 workers over a 40-year working lifetime. These figures do not include death from possible causes such as exposure to toxic chemicals or radiation.

11. Can a worker become sterile or impotent from occupational radiation exposure?

Observation of radiation therapy patients who receive localized exposures, usually spread over a few weeks, has

TABLE 3

Estimated Loss of Life Expectancy from Industrial Hazards[a]

Industry Type	Estimates of Days of Life Expectancy Lost, Average
All industry	74
Trade	30
Manufacturing	43
Service	47
Government	55
Transportation and utilities	164
Agriculture	277
Construction	302
Mining and quarrying	328
Radiation accidents, death from exposure	<1
Radiation dose of 0.65 rem/yr (industry average) for 30 years, calculated	20
Radiation dose of 5 rems/yr for 50 years	250
Industrial accidents at nuclear facilities (nonradiation)	58

[a]Adapted from Cohen and Lee, "A Catalogue of Risk," *Health Physics*, Vol. 36, June 1979; and World Health Organization, *Health Implications of Nuclear Power Production*, December 1975.

TABLE 4

Probability of Accidental Death by Type of Occupation[a]

Occupation	Number of Accidental Deaths for 10,000 Workers for 40 Years
Mining	252
Construction	228
Agriculture	216
Transportation and public utilities	116
All industries	56
Government	44
Nuclear industry (1975 data excluding construction)	40
Manufacturing	36
Services	28
Wholesale and trade	24

[a]Adapted from National Safety Council, *Accident Facts*, 1979; and Atomic Energy Commission, *Operational Accidents and Radiation Exposure Experience*, WASH-1192, 1975.

shown that a dose of 500-800 rems to the gonads can produce permanent sterility in males or females (an acute whole-body dose of this magnitude would probably result in death within 60 days). An acute dose of 20 rems to the testes can result in a measurable but temporary reduction in sperm count. Such high exposures on the job could result only from serious and unlikely radiation accidents. Although high doses of radiation can affect fertility, they have no effect on the ability to function sexually. Likewise, exposure to permitted occupational levels of radiation has no observed effect on fertility and also has no effect on the ability to function sexually.

12. What are the NRC external radiation dose limits?

Federal regulations currently limit occupational external whole-body radiation dose to 1¼ rems in any calendar quarter or specified 3-month period. However, when there is documented evidence that a worker's previous occupational dose is low enough, a licensee may permit a dose of up to 3 rems per quarter or 12 rems per year. The accumulated dose may not exceed 5(N - 18) rems[6] where N is the person's age in years, i.e., the lifetime occupational dose may not exceed an average of 5 rems for each year above the age of 18.

An additional whole-body dose of approximately 5 rems per year is permitted from internal exposure. (See Question 28.)

13. What is meant by ALARA?

In addition to providing an upper limit on a person's permissible radiation exposure, the NRC also requires that its licensees maintain occupational exposures as far below the limit as is reasonably achievable (ALARA). This means that every activity at a nuclear facility involving exposure to radiation should be planned so as to minimize unnecessary exposure to individual workers and also to the worker population. A job that involves exposure to radiation should be scheduled only when it is clear that the benefit justifies the risks assumed. All design, construction, and operating procedures should be reviewed with the objective of reducing unnecessary exposures.

14. Has the ALARA concept been applied if, instead of reaching dose limits during the first week of a quarter, the worker's dose is spread out over the whole quarter?

No. For radiation protection purposes, the risk of cancer from low doses is assumed to be proportional to the amount of exposure, not the rate at which it is received. Thus it is assumed that spreading the dose out over time or over larger numbers of people does not reduce the overall risk. The ALARA concept has been followed only when the individual and collective doses are reduced by reducing the time of exposure or decreasing radiation levels in the

[6]The NRC has published a proposed rule change for public comment that would eliminate the 5(N-18) formula. This proposal is currently under consideration by a task force reviewing all of 10 CFR Part 20. Recent EPA guidance recommends eliminating the 5(N-18) formula. If adopted, the maximum allowed annual dose will be 5 rems rather than 12.

individual and collective doses are reduced by reducing the time of exposure or decreasing radiation levels in the working environment.

15. What is meant by collective dose and why should it be maintained ALARA?

Nuclear industry activities expose an increasing number of people to occupational radiation in addition to the radiation doses they receive from natural background radiation and medical radiation exposures. The collective occupational dose (person-rems) is the sum of all occupational radiation exposure received by all the workers in an entire worker population. For example, if 100 workers each receive 2 rems, the individual dose is 2 rems and the collective dose is 200 person-rems. The total additional risk of cancer and genetic effects in an exposed population is assumed to depend on the collective dose.

It should be noted that, from the viewpoint of risk to a total population, it is the collective dose that must be controlled. For a given collective dose, the number of health effects is assumed to be the same even if a larger number of people share the dose. Therefore, spreading the dose out may reduce the individual risk, but not that of the population.

Efforts should be made to maintain the collective dose ALARA so as not to unnecessarily increase the overall population incidence of cancer and genetic effects.

16. Is the use of extra workers a good way to reduce risks?

There is a "yes" answer to this question and a "no" answer. For a given job involving exposure to radiation, the more people who share the work, the lower the average dose to an individual. The lower the dose, the lower the risk. So, for you as an individual, the answer is "yes."

But how about the risk to the entire group of workers? Under assumptions used by the NRC for purposes of protection, the risk of cancer depends on the total amount of radiation energy absorbed by human tissue, not on the number of people to whom this tissue belongs. Therefore, if 30 workers are used to do a job instead of 10, and if both groups get the same collective dose (person-rems), the total cancer risk is the same, and nothing was gained for the group by using 30 workers. From this viewpoint the answer is "no." The risk was not reduced but simply spread around among a larger number of persons.

Unfortunately, spreading the risk around often results in a larger collective dose for the job. Workers are exposed as they approach a job, while they are getting oriented to do the job, and as they withdraw from the job. The dose received during these actions is called nonproductive. If several crew changes are required, the nonproductive dose can become very large. Thus it can be seen that the use of extra workers may actually increase the total occupational dose and the resulting collective risks.

The use of extra workers to comply with NRC dose limits is not the way to reduce the risk of radiation-induced cancer for the worker population. At best, the total risk remains the same, and it may even be increased. The only way to reduce the risk is to reduce the collective dose; that can be done only by reducing the radiation levels, the working times, or both.

17. Why doesn't the NRC impose collective dose limits?

Compliance with individual dose limits can be achieved simply by using extra workers. However, compliance with a collective dose limit (such as 100 person-rems per year for a licensee) would require reduction of radiation levels, working times, or both. But there are many problems associated with setting appropriate collective dose limits.

For example, we might consider applying a single collective dose limit to all licensees. The selection of such a collective dose limit would be almost impossible because of the wide variations in collective doses among licensees. A power reactor could reasonably be expected to have an average annual collective dose of several hundred person-rems. However, a small industrial radiography licensee could very well have a collective dose of only a few person-rems in a year.

Even choosing a collective dose limit for a group of similar licensees would be almost as difficult. Radiography licensees as a group had an average collective dose in 1977 of 9 person-rems. However, the smallest collective dose for a radiography licensee was less than 1 person-rem, and the largest was 401 person-rems.

Setting a reasonable collective dose limit for each individual licensee would also be very difficult. It would require a record of all past collective doses on which to base such limits. Setting an annual collective dose limit would then amount to an attempt to predict a reasonable collective dose for each future year. In order to do this, it would be necessary to be able to predict changes in each licensed activity that would increase or decrease the collective dose. In addition, annual collective doses vary significantly from year to year according to the kind and amount of maintenance required, which cannot generally be predicted in advance. Following all such changes and revising limits up and down would be very difficult if not impossible. However, these efforts would be necessary if a collective dose limit were to be reasonable and help minimize doses and risks.

18. How are radiation dose limits established?

The NRC establishes occupational radiation dose limits based on guidance to Federal agencies from the Environmental Protection Agency (EPA) and, in addition, considers NCRP and ICRP recommendations. Scientific reviews of research data on biological effects such as the BEIR report are also considered.

For example, recent EPA guidance recommended that the annual whole-body dose limit be established at 5 rems per year and indicated that exposure, year after year, to 5 rems would involve a risk to a worker comparable to the average risks incurred by workers in the higher risk jobs

such as mining. In fact, few workers ever reach such a limit, much less year after year, and the risks associated with actual exposures are considered by the EPA to be comparable to the safer job categories. A 5-rem-per-year limit would allow occasional high dose jobs to be done without excessive risk.

19. What are the typical radiation doses received by workers?

The NRC requires that certain categories of licensees report data on annual worker doses and doses for all workers who leave employment with licensees. Data were received on the occupational doses in 1977 of approximately 100,000 workers in power reactors, industrial radiography, fuel processing and fabrication facilities, and manufacturing and distribution facilities. Of this total group, 85 percent received an annual dose of less than 1 rem; 95 percent received less than 2 rems; fewer than 1 percent exceeded 5 rems in 1 year. The average annual dose of those workers who were monitored and had measurable exposures was about 0.65 rem. A study completed by the EPA, using 1975 exposure data for 1,260,000 workers, indicated that the average annual dose for all workers who received a measurable dose was 0.34 rem.

Table 5 lists average occupational exposures for workers (persons who had measurable exposure above background levels) in various occupations, based on the 1975 data.

TABLE 5

U.S. Occupational Exposure Estimates[a]

Occupational Subgroup	Average Whole-Body Dose (millirems)	Collective Dose (person-rems)
Medicine	320	51,400
Industrial Radiography	580	5,700
Source Manufacturing	630	2,500
Power Reactors	760	21,400
Fuel Fabrication and Reprocessing	560	3,100
Uranium Enrichment	70	400
Nuclear Waste Disposal	920	100
Uranium Mills	380	760
Department of Energy Facilities	300	11,800
Department of Defense Facilities	180	10,100
Educational Institutions	206	1,500
Transportation	200	2,300

[a]Adapted from Cook and Nelson, *Occupational Exposures to Ionizing Radiation in the United States: A Comprehensive Summary for 1975*, Draft, Environmental Protection Agency.

20. What happens if a worker exceeds the quarterly exposure limit?

Radiation protection limits, such as 3 rems in 3 months, are not absolute limits below which it is safe and above which there is danger. Exceeding a limit does not imply that you have suffered an injury. A good comparison is with the highway speed limit, which is selected to limit accident risk and still allow you to get somewhere. If you drive at 75 mph, you increase your risk of an auto accident to levels that are not considered acceptable by the people who set speed limits, even though you may not actually have an accident. If a worker's radiation dose repeatedly exceeds 3 rems in a quarter, the risk of health effects could eventually increase to a level that is not considered acceptable to the NRC. Exceeding an NRC protection limit does not mean that any adverse health effects are going to occur. It does mean that a licensee's safety program has failed in some respect and that the NRC and the licensee should investigate to make sure the problems are corrected.

If an overexposure occurs, the regulations prohibit any additional occupational exposure to that person during the remainder of the calendar quarter in which the overexposure occurred. The licensee is required to file an overexposure report to the NRC and may possibly be subject to a fine, just as you are subject to a traffic fine for exceeding the speed limit. In both cases, the fines and, in some serious or repetitive cases, suspension of license are intended to encourage efforts to operate within the limits. The safest limits would be 0 mph and 0 rem per quarter. But then we wouldn't get anywhere.

21. Why do some facilities establish administrative limits that are below the NRC limits?

There are two reasons. First, the NRC regulations state that licensees should keep exposures to radiation ALARA. By requiring specific approval for worker doses in excess of set levels, more careful risk-benefit analysis can be made as each additional increment of dose is approved for a worker. Secondly, a facility administrative limit that is set lower than the quarterly NRC limit provides a safety margin designed to help the licensee avoid overexposures.

22. Several scientists have suggested that NRC limits are too high and should be lowered. What are the arguments for lowering the limits?

In general, those critical of present dose limits say that the individual risk is higher than is estimated by the BEIR Committee, the ICRP, and UNSCEAR. Based on studies of low-level exposures to large groups, some researchers have concluded that a given dose of radiation may be more likely to cause biological effects than previously thought. Some of these studies are listed in the bibliography (Mancuso, Archer) and the BEIR-80 report includes a section analyzing the findings of these and other studies. Scientific opinion differs on the validity of the research methods used and the methods of statistical analysis. The problem is that the expected additional incidence of radiation-caused effects such as cancer is difficult to detect in comparison with the much larger normal incidence. It cannot be shown without question that these effects were more frequent in the exposed study group than in the unexposed group used for comparison, or that the observed effects were caused

by radiation. The BEIR committee concluded that claims of higher risk had "no substance."

The NRC staff continually reviews the results of research on radiation risks. With respect to large-scale studies of radiation-induced health effects in human populations exposed to low-level ionizing radiation, the NRC and EPA have recently concluded that there is no one population group available for which such a study could be expected to provide a more meaningful estimate of the low-level radiation risk. This is due, in large part, to the observed and estimated low incidence of radiation health effects from low doses. However, the results of ongoing studies, such as that on nuclear shipyard workers, will be carefully reviewed and the development of a radiation-worker registry is being considered as a possible data base for future studies.

23. What are the reasons for not lowering the NRC dose limits?

Assuming that the 5-rem-per-year limit is adopted, there are three reasons:

a. Health risks are already low.

The estimated health risks associated with current average occupational radiation doses (e.g., 0.5 rem/yr for 50 years) are comparable to or less than risk levels in other occupational areas considered to be among the safest. If a person were exposed to the maximum of 5 rems per year for 50 years, which virtually never occurs, he or she might incur a risk comparable to the average risks in mining and heavy construction. An occasional 5-rem annual dose might be necessary to allow some jobs to be done without a significant increase in the collective dose. If the dose limits were lowered significantly, the number of people required to complete many jobs would increase. The collective dose would then increase since more individuals would be receiving nonproductive exposure while entering and leaving the work area and preparing for the job. The total number of health effects might go up as the collective dose increased.

b. The current regulations are considered sound.

The regulatory standards for dose limits are based on the recommendations of the Federal Radiation Council. At the time these standards were developed, about 1960, it was considered unlikely that exposure to these levels during a working lifetime would result in clinical evidence of injury or disease different from that occurring in the unexposed population. The scientific data base for the standards consisted primarily of human experience (x-ray exposures to medical practitioners and patients, ingestion of radium by watch dial painters, early effects observed in Japanese atomic bomb survivors, radon exposures of uranium miners, occupational radiation accidents) involving very large doses delivered at high dose rates. The data base also included the results of a large number of animal experiments involving high doses and dose rates. The animal experiments were particularly useful in the evaluation of genetic effects. The observed effects were related to low-level radiation according to the linear model explained in Question 7. Based on this approach, the regulations in 10 CFR Part 20, "Standards for Protection Against Radiation," also state that licensees should maintain all radiation exposures, and releases of radioactive materials in effluents, as low as is reasonably achievable. More recent scientific reviews of the large body of experimental data, such as the BEIR-80 and the recent EPA guidance, continue to support the view that use of a 5-rem-per-year limit is acceptable in practice. Experience has shown that, under this limit, the average dose to workers is near 0.5 rem/yr with very few workers consistently approaching the limit.

c. There is little to gain.

Reducing the dose limits, for example, to 0.5 rem/yr has been analyzed by the NRC staff. An estimated 2.6 million person-rems could be saved from 1980 through the year 2000 by nuclear power plant licensees if compliance with the new limit were achieved by lowering the radiation levels, working times, or both, rather than by using extra workers. It is estimated that something like $23 billion would be spent toward this purpose. Spending $23 billion to save 2.6 million person-rems would amount to spending $30 to $90 million to prevent each potential radiation-induced premature cancer death. Society considers this cost unacceptably high for individual protection.

24. Are there any areas of concern about radiation risks that might result in changing the NRC dose limits?

Yes. Three areas of concern to the NRC staff are specifically identified below:

a. An independent study by Rossi and Mays and other biological research have indicated that a given dose of neutron radiation may be more likely to cause biological effects than was previously thought. Other recent studies cast doubt on the issue. The NCRP is currently studying the data related to the neutron radiation question and is expected to make recommendations as to whether neutron dose limits should be changed. Although the scientific community has not yet come to agreement on this question, workers should be advised of the possibility of higher risk when entering areas where exposure to neutrons will occur.

b. It has been known for some time that rapidly growing living tissue is more sensitive to injury from radiation than tissue in which the cells are not reproducing rapidly. Thus the embryo or fetus is more sensitive to radiation injury than an adult. The NCRP recommended in Report No. 39 that special precautions be taken when an occupationally exposed woman could be pregnant in order to protect the embryo or fetus. In 1975, the NRC issued Regulatory Guide 8.13, "Instruction Concerning Prenatal Radiation Exposure," in which it is recommended that licensees instruct all workers concerning this special risk. The guide recommends that all workers be advised that the NCRP recommended that the maximum permissible dose to the embryo or fetus from occupational exposure of the mother should not exceed 0.5 rem for the full 9-month pregnancy period. In addition, the guide suggests options

available to the female employee who chooses not to expose her embryo or fetus to this additional risk.

The United States Department of Health and Human Services is similarly concerned about prenatal exposure from medical x-rays. In 1979 they published proposed guidelines for physicians concerning abdominal x-rays for possibly pregnant women. The guidelines in effect encourage the x-ray staff to make efforts to determine whether a female patient is pregnant and to defer x-rays if possible until after the child is born.

c. Also of special interest is the indication that female workers are subject to more risk of cancer incidence than male workers. In terms of all types of cancer except leukemia, the BEIR-80 analysis indicates that female workers have a risk of developing radiation-induced cancer that is approximately one and one-half times that for males. This increased risk is primarily due to the incidence of breast and thyroid cancer in women. These types of cancer, however, have a high cure rate. Thus the difference between men and women in cancer mortality is not great. Incidence of radiation-induced leukemia is about the same for both sexes. Female workers should be aware of this difference in the risks of radiation-induced cancer in deciding whether or not to seek work involving exposure to radiation.

25. How much radiation does the average person who does not work in the nuclear industry receive?

We are all exposed from the moment of conception to ionizing radiation from several sources. Our environment, and even the human body, contains naturally occurring radioactive materials that contribute some of the background radiation we receive. Cosmic radiation originating in space and in the sun contributes additional exposure. The use of x-rays and radioactive materials in medicine and dentistry adds considerably to our population exposure.

Table 6 shows estimated average individual exposure in millirems from natural background and other sources.

TABLE 6

U.S. General Population Exposure Estimates (1978)[a]

Source	Average Individual Dose (mrem/yr)
Natural background (average in U.S.)	100
Release of radioactive material in natural gas, mining, milling, etc.	5
Medical (whole-body equivalent)	90
Nuclear weapons (primarily fallout)	5-8
Nuclear energy	0.28
Consumer products	0.03
Total	∿200 mrem/yr

[a]Adapted from a report by the Interagency Task Force on the Health Effects of Ionizing Radiation published by the Department of Health, Education, and Welfare.

Thus, the average individual in the general population receives about 0.2 rem of radiation exposure each year from sources that are a part of our natural and man-made environment. By the age of 20 years, an individual has accumulated about 4 rems. The most likely target for reduction of population exposure is medical uses.

26. Why aren't medical exposures considered as part of a worker's allowed dose?

Equal doses of medical and occupational radiation have equal risks.[7] Medical exposure to radiation should be justified for reasons quite different, however, from those applicable to occupational exposure. A physician prescribing an x-ray should be convinced that the benefit to the patient of the resulting medical information justifies the risk associated with the radiation. Each worker must decide on the acceptance of occupational radiation risk just as each worker must decide on the acceptability of any other occupational hazard.

For another point of view, consider a worker who receives a dose of 2 rems from a series of x-rays or a radioactive medicine in connection with an injury or illness. This dose and the implied risk should be justified on medical grounds. If the worker had also received a dose of 2 rems on the job, the combined dose of 4 rems would not incapacitate the worker. A dose of 4 rems is not especially dangerous and is not large compared to the cumulative lifetime dose. Restricting the worker from additional job exposure during the remainder of the quarter would have no effect one way or the other on the risk from the 2 rems already received from medical exposure. If the individual worker accepts the risks associated with the x-rays on the basis of the medical benefits and the risks associated with job-related exposure on the basis of employment benefits, it would be unfair to restrict the individual from employment in radiation areas for the remainder of the quarter.

Some therapeutic medical doses such as those received from cobalt-60 treatment can range as high as 6000 rems to a small part of the body, spread over a period of several weeks or months.

27. What is meant by internal exposure?

The total radiation dose to the worker is the external dose (measured by the film badge and reported as "whole-body dose") plus the dose from internal emitters. The monitoring of the additional internal dose is difficult. Because there is the possibility of internal doses occurring, a good air-monitoring program should be established when warranted.

The uptake of radioactive materials by workers is generally due to breathing contaminated air. Radioactive materials may be present as fine dust or gases in the workplace atmosphere. The surfaces of equipment and workbenches

[7]It is likely that a significant portion of reported medical x-ray exposure is to parts of the body only. An exposure of 100 mrem to the whole body is more significant than a 100-mrem chest x-ray.

may be contaminated. Radioactive materials may enter the body by being breathed in, taken in with food or drink, or being absorbed through the skin, particularly if the skin is broken.

After entering the body, the radioactive material will migrate to particular organs or particular parts of the body depending on the biochemistry of the material. For example, uranium will tend to deposit in the bones where it will remain for a long time. It is slowly eliminated from the body, mostly by way of the kidneys. Radium will also tend to deposit in the bones. Radioactive iodine will seek out the thyroid glands (located in the neck) and deposit there.

The dose from these internal emitters cannot be measured either by the film badge or by other ordinary dosimeters carried by the worker. This means that the internal radiation dose must be separately monitored using other detection methods.

Internal exposure can be estimated by measuring the radiation emitted from the body or by measuring the radioactive materials contained in biological samples such as urine or feces. Dose estimates can also be made if one knows how much radioactive material is in the air and the length of time during which the air was breathed.

28. *How are the limits for internal exposure set?*

Standards have been established for the maximum permissible amount of each radionuclide that may be accumulated in the critical organs[8] of the worker's body.

Calculations are made to determine the quantity of radioactive material that has been taken into the body and the total dose that would result. Then, based on limits established for particular body organs similar to 1¼ rems in a calendar quarter for whole-body exposure, the regulations specify maximum permissible concentrations of radioactive material in the air to which a worker can be exposed for 40 hours per week over 13 weeks or 1 calendar quarter. The regulations also require that efforts be made to keep internal exposure ALARA.

Internal exposure is controlled by limiting the release of radioactive material into the air and by carefully monitoring the work area for airborne radioactivity and surface contamination. Protective clothing and respiratory (breathing) protection should be used whenever the possibility of contact with loose radioactive material cannot be prevented.

29. *Is the dose a person received from internal exposure added to that received from external exposure?*

Exposure to radiation that results from radioactive materials taken into the body is measured, recorded, and reported to the worker separately from external dose. The internal dose to the whole body or to specific organs does not at this time count against the 3-rem-per-calendar-quarter limit. ICRP recommends that the internal and external doses should be appropriately added. This recommendation is currently under study by the staffs of the NRC, the EPA, and the Occupational Safety and Health Administration (OSHA).

30. *How is a worker's external radiation dose determined?*

A worker may wear three types of radiation-measuring devices. A self-reading pocket dosimeter records the exposure to incident radiation and can be read out immediately upon finishing a job involving external exposure to radiation. A film badge or TLD badge records radiation dose, either by the amount of darkening of the film or by storing energy in the TLD crystal. Both these devices require processing to determine the dose but are considered more reliable than the pocket dosimeter. A worker's official report of dose received is normally based on film or TLD badge readings, which provide a cumulative total and are more accurate.

31. *What are my options if I decide not to accept the risks associated with occupational radiation exposure?*

If the risks from exposure to radiation that may be expected to occur during your work are unacceptable to you, you could request a transfer to a job that does not involve exposure to radiation. However, the risks associated with exposure to radiation that workers, on the average, actually receive are considered acceptable, compared to other occupational risks, by virtually all the scientific groups that have studied them. Your employer is probably not obligated to guarantee you a transfer if you decide not to accept an assignment requiring exposure to radiation.

You also have the option of seeking other employment in a nonradiation occupation. However, the studies that have compared occupational risks in the nuclear industry to those in other job areas indicate that nuclear work is relatively safe. Thus, you will not necessarily find significantly lower risks in another job.

A third option would be to practice the most effective work procedures so as to keep your exposure ALARA. Be aware that reducing time of exposure, maintaining distance from radiation sources, and using shielding can all lower your exposure. Plan radiation jobs carefully to increase efficiency while in the radiation area. Learn the most effective methods of using protective clothing to avoid contamination. Discuss your job with the radiation protection personnel who can suggest additional ways to reduce your exposure.

32. *Where can I get additional information on radiation risk?*

The following list suggests sources of useful information on radiation risk:

a. Your Employer

The radiation protection or health physics office in the facility where you are employed.

[8] Critical organ refers to those parts of the body vulnerable to radiation damage such as bone, lungs, thyroid, and other systems where certain radioactive materials will concentrate if taken into the body.

b. Nuclear Regulatory Commission

Regional Offices

King of Prussia, PA 19406	215-337-5000
Atlanta, GA 30303	404-221-4503
Glen Ellyn, IL 60137	312-932-2500
Arlington, TX 76012	817-334-2841
Walnut Creek, CA 94596	415-943-3700

Headquarters

Occupational Radiation Protection Branch
Office of Nuclear Regulatory Research
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Telephone: 301-443-5970

c. Department of Health and Human Services

Office of the Director
Bureau of Radiological Health (HFX-1)
Department of Health and Human Services
5600 Fishers Lane
Rockville, MD 20857

Telephone: 301-443-4690

d. Environmental Protection Agency

Office of Radiation Programs
U.S. Environmental Protection Agency
401 M Street, SW
Washington, D.C. 20460

Telephone: 703-557-9710

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VALUE/IMPACT STATEMENT

1. PROPOSED ACTION

1.1 Description

All NRC licensees are required to provide appropriate radiation protection training for all permanent and transient personnel who work in restricted areas (§ 19.12 of 10 CFR Part 19). A clear and reasonable assessment of the biological risks associated with occupational radiation exposure is essential to effective radiation protection training. The proposed action is to provide instructional material in a suitable form describing and estimating the risks from exposure to radiation. The instructional material will be suitable for use in licensee training programs and will represent an acceptable method of complying with part of the existing training requirements.

1.2 Need for Proposed Action

One common element of those occupational areas encompassed by NRC licensing activity is worker exposure to ionizing radiation and the biological risks from exposure. Union representatives have expressed a dissatisfaction with the way in which these risks have been explained to the worker by the licensee. In addition, they feel the NRC has a responsibility to make its position on the controversial issue of radiation risk clear to the worker and the public. A meeting of NRC staff and union representatives was held on November 28, 1978, during which this matter was discussed. A transcript of the meeting is available from the Public Document Room.

The Environmental Protection Agency (EPA) has published recommendations concerning radiation protection for public comment and, in conjunction with other government agencies, will be holding public hearings on radiation risk and dose limits. This guide reflects current and proposed EPA guidance and will be helpful to workers and worker groups interested in understanding current discussion on the issues of risk and dose limits.

1.3 Value/Impact of Proposed Action

1.3.1 NRC Operations

Instructional material on radiation risk written at a level and scope understandable to the worker should contribute to increased confidence, on the part of the worker, in the NRC in general. A better understanding of the risk should elicit more worker cooperation with NRC-enforced safety programs. Impacts of the development of instructional material on risk include task completion manpower cost, estimated to be 0.2 person-year, and printing costs of approximately $400.00.

1.3.2 Other Government Agencies

Agreement States whose licensing regulations include radiation protection training requirements may benefit from the availability of an NRC guide on radiation risk suitable for inclusion in those training programs. The guide was reviewed and distributed to agreement states by the Office of State Programs. Comments have been received from the EPA and the Bureau of Radiological Health.

1.3.3 Industry

Providing a reasonable and understandable statement on worker risk should facilitate industry efforts to provide effective safety training and to better achieve as low as is reasonably achievable (ALARA) objectives. Minimal impact is expected in the form of additional cost of training programs since training requirements already exist. Comments from unions and industry in the development of instructional material on risk were encouraged. Numerous public comment letters were received from industry and three meetings were held with worker groups to review the draft guide.

1.3.4 Workers

The proposed action should improve worker protection in that reasonable understanding of radiation risk is essential to the development of safe working practices. The staff believes that an objective discussion of radiation risk may in fact reduce "over concern" and also eliminate "under concern" on the part of some workers. If improved training results in a wider recognition and respect for radiation as an industrial hazard, more attention will be given to protective procedures and a reduction in individual and collective dose should result.

1.3.5 Public

Nuclear workers are also members of the public and are generally residents of the area where facilities are located. Having a better-informed public should result in a wider range of participation in local decisionmaking concerning nuclear development. Improved training implies the added benefit of increased plant safety, thereby decreasing the probability of accidents that could involve the public.

1.3.6 Decision on Proposed Action

The NRC should develop and provide instructional material concerning risk from occupational radiation exposure.

2. TECHNICAL APPROACH

The technical approach proposed is to develop instructional material concerning risks to the worker from occupational radiation exposure and to publish the material in a form that will receive the widest dissemination among NRC-licensed facilities. An alternative is to publish the findings of the proposed hearing on dose limits and assume the relevant information will filter down to the worker. It is