WPS SAFETY PRACTICES MANUAL

ACCIDENT PREVENTION PROCEDURES

WPS RADIATION SAFETY MANUAL

The enclosed procedures (60-01-1 thru 60-05-2) outline the radiation safety program to be followed by The Western Company of North America and all personnel involved in the use of radioactive materials.

It is the responsibility of all administrative personnel within the radiation program organization to understand all sections of this manual. All other personnel involved in the use of radioactive materials shall be responsible for understanding sections 60-01-2 thru 60-05-2 only.

Any questions concerning the procedures contained within this manual should be directed to the District Radiation Safety Officer (District Manager). If he cannot answer the question the Radiation Protection Officer at Fort Worth Accident Prevention should be consulted.

RADIATION SAFETY MANUAL

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SUBJECT: Radiation Program Management Organization for Administrative Personnel

NO. SPM-60-01-1

PURPOSE

The purpose of this procedure is to outline, to administrative personnel, the functions and responsibilities of those persons working within the framework of the operations area of the WPS Radiation Program.

I. WPS Radiation Protection Officer

A. The WPS Radiation Protection Officer is the designated overall manager for the radiation program. The WPS Radiation Protection Officer is the Loss Control Engineer located at WPS Accident Prevention in Fort Worth.

B. The duties of the Radiation Protection Officer include the delegation of authority to persons responsible for carrying out the duties such as that of Radiation Safety Officer, overall responsibility for records, surveys, the forming of committees where necessary and in general the administrative procedures for the entire radiation program.

C. The WPS Radiation Protection Officer is responsible for contacting federal or state agencies to request renewals and changes to applicable licenses granted by those agencies.

II. District Radiation Safety Officer

A. The Radiation Safety Officer is responsible to the Radiation Protection Officer and in general is to conduct or cause to be conducted the programs and responsibilities delegated by the Radiation Protection Officer. The Radiation Safety Officer for each district is the District Manager. His duties shall include:

1. Site surveys.

2. Records, personnel monitoring records and compilation.

3. Vehicle survey records.

4. Training and qualifying personnel.

5. Conducting periodic safety checks to ensure that the radiation protection program is functioning properly in his district.

B. Before a District Manager can fully assume the appointment of Radiation Safety Officer by the Radiation Protection Officer, he must have successfully completed the radiation safety training course provided by Radiation Consultants, Inc., Houston, Texas, or other approved training company, within four (4) months of the initial date of appointment.

III. Radiation Supervisor

A. The Radiation Supervisor is responsible to the District Radiation Safety Officer for the overall performance of the operation to which he has been assigned such as:

1. Detailing requirements for planning and directing personnel, safety, methods and techniques used for the particular operations.

2. Responsibility for the control over the specific radioactive materials that are to be used or dispensed on a job.

3. Maintaining control of records and reports generated from required surveys of material, equipment and restricted areas on the job.

4. Must assure that all equipment and devices are maintained in working order and that sealed sources or tracer materials are properly locked and stored when not in use.

5. Responsibility for assuring the compliance of personnel and procedures as required by the federal or state license or regulations.

B. Before an employee can be classified as a Radiation Supervisor, he must successfully complete the radiation safety training course provided by Radiation Consultants, Inc. or other approved training company.

IV. Technicians

A. The technician is an employee who is directly responsible to the Radiation Supervisor for the duties assigned by the Radiation Supervisor.

B. Under the direct supervision of the Radiation Supervisor at the wellsite, the technician may handle and/or dispense tracer materials and use survey instruments.

C. Before an employee can be classed as a technician he must have successfully completed the following training:

1. Has read or received instruction on this operating manual.

2. Has demonstrated competence to use R/A material and the tools associated with its use under the personal supervision of the Radiation Supervisor.

SUBJECT: Radioactive Materials Records Management for Administrative Personnel

NO. SPM- 60-02-1

PURPOSE

Federal and state agencies require the development and retention of certain records concerning the storage, use and handling of radioactive materials. This procedure will list and describe the types of records WPS will use.

PROCEDURES

I. Recordkeeping - General

A. Records and reports required by federal and state agencies are to be preserved for periods specified in this section, or until the governing agency authorizes their disposal.

B. All records required by federal and state agencies will be transferred to the agency within 30 days following (1) the termination of a license granted by that agency, (2) such other times as the licensing agency may direct.

C. Districts which close down their operations shall transfer all of their records and reports to the WPS Radiation Protection Officer, Accident Prevention - Fort Worth.

II. Recordkeeping - Records and Reports

The following records and reports shall be completed by every district using radioactive materials and kept in an orderly filing system.

A. Radioactive Sealed Source Utilization Log (Form 60-02-1A). This record summarized the receipt, utilization and transfer of densiometer sealed sources. When this record form is used with a blender with two (2) sealed sources, both of the densiometer serial numbers will be listed at the top center of the form. The individual making the entry on the form must write his name in the indicated place beside the entry. A copy of the "Dispatcher's Job Ticket" for each usage shall be maintained in a separate file to identify the wellsite location where the instruments were utilized. (See Attachment 1). These records shall be maintained for inspection by regulatory agencies for a period of two (2) years.

B. Radioactive Tracer Material Utilization Log (Form 60-02-1B). This record summarized the receipt, utilization and final disposition of all tracer materials used. A copy of the "Dispatcher's Job Ticket" will be kept in a separate file to identify the location of tracer utilization for each job. Receiving bills of lading shall also be maintained in a separate file for tracer materials to identify receipt of materials. The column labeled "Disposition" shall be used to identify what happened to tracer materials and packaging such as: "All downhole;" "__downhole and ___returned to storage;" "empty container returned to storage;" "transferred to___;" "empty containers returned to vendor," etc. (See Attachment 2). The individual making the entry on the form must write

his name in the indicated place beside the entry. These records shall be maintained for inspection by the regulatory agencies for a period of two (2) years from the date of entry.

C. Survey Meter Calibration Log (Form 60-02-1C). This form used to record the date of each six (6) month calibration of the district survey meter(s). The district shall maintain a file of the "Certification of Calibration" test certificates and send a copy of each "Certificate of Calibration" to the WPS Radiation Protection Officer at Fort Worth (Attachment 3). Records of calibration shall be maintained for a period of two (2) years from the date of calibration for inspection by the regulatory agencies.

D. Wellsite Radiation Monitoring Report (Form 60-02-1D). This report will be completed for each tracer material wellsite job. This report is not required for densiometer sealed source jobs. The original form is to be retained in district files with a copy sent to the WPS Radiation Protection Officer at Fort Worth (Attachment 4). These reports shall be maintained for inspection by the regulatory agencies for two (2) years after completion of the surveys.

E. Storage Area Monitoring Report (Form 60-02-1E). Quarterly monitoring of the district's radioactive material storage area shall be reported using Form 60-02-1E - Storage Area Monitoring Report.

Note: The report is for all tracer material storage and densiometers in storage. (Not vehicle or trailer mounted).

The district will retain the original for inspection by the regulatory agencies for two (2) years after completion of the survey, and send a copy to the WPS Radiation Protection Officer at Fort Worth (Attachment 5).

F. Vehicle Monitoring Report (Form 60-02-1F). Quarterly monitoring of district vehicles used to transport densiometers, i.e., densiometer trailers and blenders. The district will retain the original and send a copy to the WPS Radiation Protection Officer at Fort Worth (Attachment 6). These shall be maintained for inspection by the regulatory agencies for two (2) years after completion of the survey.

G. Sealed Source Inventory Report (Form 60-02-1G). Every three (3) months, this form will be completed to account for all radioactive sealed sources received and possessed during that time period. The report will be maintained in district files for two (2) years from the date of the report. A copy of each report will be sent to the WPS Radiation Protection Officer at Fort Worth (Attachment 7).

H. Tracer Materials Inventory Report (Form 60-02-1H). Every three (3) months this form will be completed to account for all radioactive tracer materials which are on hand at the time. The report will be maintained

in district files for two (2) years from the date of the report. A copy of each report will be sent to the WPS Radiation Protection Officer at Fort Worth. (Attachment 8).

I. Temporary Use TLD Badge Log (Form 60-02-1I). This form is used to assign temporary TLD badges to personnel who are not regular personnel with permanently assigned TLD badges. A temporary badge is assigned only to one person before it is returned to the TLD badge vendor for processing and reading. Previously assigned temporary badges will not be assigned to another person. The form will be retained by a district in its TLD Badge Report Files. (Attachment 9).

J. TLD Badge Reports and personnel exposure records will be maintained in a separate file. Quarterly TLD Badge Reports from the TLD badge vendor on each person using radioactive materials will be kept at the district office. The TLD badge vendor also sends a duplicate copy of the report to the WPS Radiation Protection Officer at Fort Worth for the Company's master files. (Refer to SPM-60-03-1, Radiation Detection - Personnel Monitoring Badges, for further details.)

K. Certificate of Leak Test records on all sealed sources will be maintained on each sealed source. Leak test kits from Radiation Consultants, Inc. or other agency approved suppliers will be used each six (6) months. The district receives the original report from the vendor and the WPS Radiation Protection Officer at Fort Worth receives a copy from the vendor. An up-to-date copy of the latest Certificate of Leak Test report will always accompany and be transported with a densiometer when it is in field use on a job and when it is transferred from the district.

III. Responsibility

The District Radiation Safety Officer is responsible for assigning record-keeping duties to others in this organization and for monitoring their work to assure compliance with these procedures.

Form 60-02-1A (R-12/83)

Attachment 1

DISTRICT _____ RSO _____

RADIOACTIVE SEALED SOURCE

UTILIZATION LOG

FOR DENSIOMETER SERIAL # _____

ACTIVITY _____

Date Received at District _____ Date Transferred from District _____

From _____ To _____

Received by _____

UTILIZATION INFORMATION

Date Out of Yard	Dispatch Job Ticket Number	Date In yard for Storage	Signature of Person Making Entry

Form 60-02-1B (R-12/83)

Attachment 2

DISTRICT_____ RSO_____

RADIOACTIVE TRACER MATERIAL

UTILIZATION LOG

RECEIVED				USAGE					
Date	Amount	Type Material	Signature	Date	Amount	Type Material	Dispatch Job Ticket #	Disposition*	Signature

* Use Disposition column for any necessary remarks

Form 60-02-1C (R-12/83)

Attachment 3

SURVEY METER CALIBRATION LOG

District _____

Meter Type	Model #	Serial #	Date Calibrated	Date Calibrated	Date Calibrated	Date Calibrated	Location	Person Making Entry

Maintain in District Office

Form 60-02-1D (R-12/83) Attachment 4

WELLSITE RADIATION MONITORING REPORT

Date _____

Customer _____ Well _____

Field _____ County _____ State _____

Radiation Supervisor _____ Technician _____

Supervisor's Badge # _____ Technician's Badge # _____

Job Ticket No. _____ District _____

Survey Meter Type _____ Serial # _____ Date Calibrated _____

TRACER ISOTOPE INFORMATION

Tracer Type _____ Strength _____

Amount of Tracer Taken on Job _____ mCi Amount Used on Job _____ mCi

Disposition of Leftover Tracer _____

VEHICLE MONITORING INFORMATION

Before Leaving Shop (Vehicle Loaded)

Background _____ mR/hr
(30 feet clear of any R/A material)

Location of Survey	Reading (mR/hr)
Front Sign*	
Back Sign*	
Left Sign*	
Right Sign*	

After Return to Shop (Vehicle Empty)

Front Sign* _____ mR/hr

Left Sign* _____ mR/hr

Before Leaving Job-Site (Vehicle Loaded)

Background _____ mR/hr
(30 feet clear of any R/A material)

Location of Survey	Reading (mR/hr)
Front Sign*	
Back Sign*	
Left Sign*	
Right Sign*	

Background _____ mR/hr

Back Sign* _____ mR/hr

Right Sign* _____ mR/hr

JOB-SITE MONITORING INFORMATION

Before Operations Begin

Background Reading _____ mR/hr Wellhead Reading _____ mR/hr

Reading in Area Where Work is to be Performed _____ mR/hr

After Completing Operations

Background Reading _____ mR/hr. Wellhead Reading _____ mR/hr

Reading in Area Where Work was Performed _____ mR/hr

Thyroid Check (For Iodine-131 Use Only) _____ mR/hr

Exact Location of Any Significant Contamination _____

Steps Taken to Remedy Contamination Problem _____

Distribution: (1) District
(1) FW A/P

Signature _____

STORAGE AREA MONITORING REPORT

District _____ Date _____

All radioactive materials storage bunkers and down-hole storage facilities are to be monitored for radiation levels each quarter.

Survey Meter Type _____

Survey Meter Serial # _____

Calibration Date _____

ABOVE GROUND STORAGE

Background Reading* _____ mR/hr

Radiation levels on surface of storage area (measure each door separately -- no measurement is necessary if storage is empty -- indicate if empty)

Location of Survey	Reading (mR/hr)	Location of Survey	Reading (mR/hr)
Top	_____	Front	_____
Left	_____	Back	_____
Right	_____		

Radiation level at 1 meter from storage area

Left	_____	Front	_____
Right	_____	Back	_____

DOWN-HOLE STORAGE

Background Reading* _____ mR/hr

Highest level at surface of down-hole storage cover _____ mR/hr

* Normal background is recorded at least 30 feet from the storage area, or 6 feet from the cover of the down-hole storage facility.

Signature _____

Title _____

Make in duplicate: (1) Retain in District Office (1) Fort Worth Accident Prevention

VEHICLE MONITORING REPORT

District_____ Date _____

Survey Meter Type_____

Survey Meter Serial #_____

Calibration Date_____

Each vehicle is to be monitored quarterly, with radioactive sealed sources in place.

Vehicle #	(All readings are in mR/hr)			
	Front	Back	Left	Right

Signature_____

Title_____

Make in duplicate: (1) Retain in District Office
(1) Fort Worth Accident Prevention

RADIOACTIVE SEALED SOURCE
PHYSICAL INVENTORY REPORT

District _____ Date _____

This report is to be completed every three months to account for all sealed sources under the license.

Densiometer or Source Serial # _____ Unit # _____

Type of By-Product Material _____

Quantity of By-Product Material _____

Physical Condition of Source Holder (Visual) _____

Condition of Labels (If required) _____

Physical Location of the Sealed Source(s) _____

_____

_____

_____

Signature _____

Title _____

Make in Duplicate: (1) Retain in District Office

(1) Fort Worth Accident Prevention

Form 60-02-1G
(Alternate)

Attachment 7A

RADIOACTIVE SEALED SOURCE PHYSICAL INVENTORY REPORT

District _____
Date _____

This report is to be completed every three months to account for all sealed sources under the license.

Densiometer or Source Serial No.	Unit Number	Type By-Product Material	Quantity of By-Product Material	Physical Condition of Source Holder (visual)	Condition of Labels	Physical Location of Sealed Sources

Make in Duplicate: (1) Retain in District Office
(1) Ft. Worth Accident Prevention

Signature: _____
Title: _____

Form 60-32-1H (R-12/83) Attachment 8

RADIOACTIVE TRACER MATERIALS
PHYSICAL INVENTORY REPORT

District _____ Date _____

This report is to be completed every three months to account for all radioactive tracer material on hand.

Type of Tracer Material _____

Quantity of Tracer Material _____

Physical Location of Material _____

_____

_____

_____

Signature _____

Title _____

Make in Duplicate: (1) Retain in District Office

(1) Fort Worth Accident Prevention

Form 60-02-1H (R-12/83)

Attachment 8A

RADIOACTIVE TRACER MATERIALS
PHYSICAL INVENTORY REPORT

District _____
Date _____

Type Tracer Material	Form of Material	Quantity of Tracer Material	Physical Location of Material
Iodine (I-131)	Liquid	mCi	
Iridium (Ir-192)	Sand	mCi	
Iron (Fe-59)	Nails	mmCi	

Make in Duplicate: (1) Retain in District Office
(1) Fort Worth Accident Prevention

Signature _____
Title _____

Form 60-02-11 (R-12/83) Attachment 9

TEMPORARY USE
TLD BADGE LOG

District_____

Complete this form when assigning temporary TLD badges to personnel who are not technicians or loggers and who will be working within the 2 mR/hr restricted areas. Each TLD badge may be assigned to only one person. DO NOT assign a badge to another person after it has been previously exposed or worn by one person.

TLD Badge #	Name of Employee Assigned to Badge	Emp. #	Date Assigned	Date Returned	Logged by (Initials)

Retain in District Office after each quarter's use.

SUBJECT: Radiation Detection - Personnel Monitoring Badge

NO. SPM-60-03-1

PURPOSE

The purpose of this procedure is to safeguard the welfare of those who could possibly be exposed to radioactive materials by establishing a uniform system of wearing personnel badges and monitoring these badges to detect exposure levels. It is essential that these procedures be followed to assure that any personnel exposure be recorded on the badge, and in turn any badge exposure will be a personnel exposure.

GUIDELINES

General

1. The badge supplier will send the shipment of badges to the District Manager (Radiation Safety Officer - RSO) several days before the beginning of the quarterly period. Badge shipments should arrive within two to three days of the beginning of the monitoring period. Care should be taken to keep badges in a area free from radiation. The monitoring period is for a three (3) month period and begins on the first day of the month. The badge will come from the supplier in a holder with a badge number, last name and initial, month and year for the monitoring period, and the code for the district on the badge holder. Complete badges with holders are furnished each quarter, and the badges should not be removed from the holders. The thermoluminescense dosimeters (TLD) badges that are used are not affected by humidity, organic vapors, or heat (less than 300°C or 572°F): therefore, false readings from being wet or getting hot are eliminated. The TLD badge service will measure personnel exposure to Beta and Gamma radiation.

2. A separate badge marked "Control" with the date for the monitoring period is included with each badge shipment. The Control is not to be worn. It is used to monitor the badges while in transit and storage. It is essential that the Control badge be kept in an area free from radiation.

PROCEDURE

I. District RSO's Responsibility

A. The District RSO shall assure that an adequate supply of TLD badges are available and shall require the use of such equipment by:

1. Each individual who enters a restricted area where radiation exposure would exceed 2 mr/hr.

2. Each individual who enters a high radiation area where radiation exposure would exceed 100 mr/hr.

3. Each individual who handles tracer materials (excluding individuals who use and operate densiometers only).

B. Require that only the person whose name appears on the badge wear the badge.

C. Issue badges for each monitoring period to personnel who are required to wear badges. Visitor or numbered badges not assigned regularly to the same personnel shall be recorded.

D. Collect badges for the previous monitoring period within three days of the end of the period and return these badges and Control badge to the supplier by first class mail. This shall be handled as follows:

1. Immediately before the badges are packaged for return shipment, survey each individual badge with a survey meter, detector window open and facing the badge, as close to the badge as possible to detect any radiation emmission, above background, that might be present due to contamination.

   Note: It is very important that this survey be taken very carefully, with the survey meter on its lowest scale, because a very small amount of R/A material can give high exposure readings due to the very small distance to the badge and the long length of exposure time.

2. Separate any badge found to be emitting radiation from the rest of the badges,and immediately notifty the Radiation Protection Officer for further instructions.

3. Badges should be mailed within five days of the end of the monitoring period.

E. The district office will order badges for new employees from the TLD badge supplier by listing the full name, birth date and social security number of the new employee on the Nuclear Sources and Services "TLD Change Form" (Form 60-03-1A, Attachment 1).

F. Return badges for terminated employees with the regular shipment. The badge should be marked with the termination date of the employee and stored with the Control badge until the entire shipment is returned to the supplier.

G. Notify the supplier when employees are transferred from one location to another so the supplier can change the location of future badge shipments for that employee, if so required.

Form 60-03-1A

Attachment 1

TLD CHANGE FORM

To: Nuclear Sources and Services, Inc.
P.O. Box 34042
Houston, Texas 77034
Attn: TLD

TLD Information: (713) 641-1379
TLD Billing: (713) 641-0391

From: Facility Name _____
Mailing Address _____
City, State, Zip _____
(A/C) Phone ( ) _____

Additions

Last Name, Initials	Social Security #	Date of Birth

Deletions

Last Name, Initials	Date Terminated	Social Security #

Changes (To correct personal data or for transfers)

Last Name, Initials	Corrections/Transfer	From---------To--------

Address Changes (Fill out only lines with changes or corrections)

Facility Name _____
Mailing Address _____
City, State, Zip _____
Attention (if any) _____

_____
Signature

_____
Date

SUBJECT: Radiation Exposure - Personnel Monitoring Badge

NO. SPM- 60-04-1

GUIDELINES

The TLD badge supplier shall notify the WPS Radiation Protection Officer in Fort Worth, when any badge showing an exposure above 1,250 mrem for a quarterly period is processed.

PROCESURE

I. WPS Radiation Protection Officer's Responsibility

A. Severe Over-Exposure (above 5 rem)

1. Immediately notify the District Manager (Radiation Safety Officer-RSO) of the nature and extent of the exposure by telephone.

2. Notify the appropriate radiation regulatory agency immediately for whole body exposures over 25 rems, and within 24 hours for exposures from 5 rem to 25 rem (whole body). (New Mexico requires immediate notification for whole body exposures over 5 rem. Texas and Louisiana require 24-hour notification for whole body exposures of 5 rem or more).

3. Notify the individual in writing within 30 days of the nature and extent of the exposure.

4. Make a personal investigation of the exposure to determine how the exposure occurred, and what may be done to prevent any recurrence.

5. File a final report within 30 days of notice of the incident, to Western Management and the Radiation Regulatory Agency, giving the findings of the above investigation.

B. Over-Exposure (above 1.25 rem)

1. Notify the District RSO within five (5) days of notification by the badge supplier of the nature and extent of the exposure.

2. Notify the appropriate radiation regulatory agency, in writing, within 30 days of notice by the supplier, of the nature and extent of the exposure.

3. Notify the individual in writing, within 30 days, of the nature and extent of the exposure.

4. Review the manager's investigation of the incident and make a follow-up report if necessary.

C. High Exposure (above 400 mrem)

1. Notify the District RSO, within five (5) days of notification by the badge supplier, of the nature and extent of the exposure.

2. Notify the individual in writing of the nature and extent of the exposure.

3. Review the District RSO's and individual's reports for possible changes in procedures.

II. District RSO's Responsibility

A. Severe Over-Exposure (above 5 rem)

1. Immediately relieve the individual from job duties and have him/her examined by a doctor. The doctor should be requested to run a blood test, urinalysis, and a general examination. The individual should remain away from work associated with radioactive materials until the doctor's report is received and analyzed.

2. Make a complete and thorough investigation to determine how the over-exposure occurred and make a report, in writing, to the Fort Worth Radiation Protection Officer within five (5) days of notice of the over-exposure.

3. If the over-exposure was caused by an intentional exposure, or by a violation in policies or procedures, take disciplinary action appropriate to the violation and record the incident in the personnel files.

B. Over-Exposure (above 1.25 rem)

1. Make a complete and through investigation of the over-exposure to determine how the incident occurred. Submit a written report to the Radiation Protection Officer at Fort Worth within ten (10) days of notification of the incident.

2. If the over-exposure was caused by an intentional exposure, or by a violation in policies or procedures, take appropriate disciplinary action and record the incident in the personnel files.

SUBJECT: Personnel Bioassay Requirements when Handling Iodine (I-131)

NO. SPM- 60-05-1

PURPOSE

In order to comply with the Nuclear Regulatory Commission and State requirements concerning the use of radioactive Iodine, bioassay testing procedures are required to detect any possible exposure to employees who may use the materials. If it is detected by this testing that exposure limits have been exceeded, certain action is required to prevent further exposure and eliminate the cause of the exposure.

PROCEDURE

I. General

Personnel who open bottles and dispense quantities of liquid I-131 in excess of 50 mci at any one time are required to provide a urine sample for bioassay testing purposes. The urine sample should be taken after six (6) hours following the possible exposure to I-131.

Bioassay speciman test kits will be ordered from an approved supplier, with any order made in excess of 50 mci of I-131.

Once the urine sample has been taken, it must be mailed immediately to an approved supplier for processing. The bioassay report will be placed in the district TLD badge file for recordkeeping purposes. The processor will also send a copy of report to the WPS Radiation Protection Officer in Fort Worth for filing purposes.

At the end of each calendar year, any personnel who had opened or dispenses I-131 containers in quantities greater than 50 mci at any one time during that calendar year will submit to a thyroid check.

II. Test Result Action

A. Whenever the thyroid burden at the time of measurement exceeds 0.04 micro curies of I-131, the following actions shall be taken:

1. An investigation shall be made by the responsible District Radiation Safety Officer to determine the causes of the I-131 overexposure and to evaluate the potential for further exposures.

2. The District Radiation Safety Officer shall take steps to restrict the worker from further exposure until the source of exposure is discovered and corrected.

3. A repeat bioassay shall be taken within two (2) weeks of the previous measurement and should be evaluated within 24 hours after measurement in order to confirm the presence of internal radioiodine and to obtain an estimate of its effective half-life for use in estimating dose.

4. The WPS Radiation Protection Officer will notify the proper

SUBJECT: Personnel Bioassay Requirements When Handling Iodine (I-131)

NO. SPM- 60-05-1

governmental licensing agencies as required by regulation or conditions of the license.

B. If the thyroid burden at any time exceeds 0.14 uCi of I-131, the following action shall be taken:

1. Carry out action as in paragraph A. I. above.

2. The District Radiation Safety Officer, after consultation with the WPS Radiation Protection Officer, will refer the case to the appropriate medical/health physics consultant for recommendations regarding therapeutic procedures that may be carried out to accelerate removal of radioactive iodine from the body.

3. Carry out repeated measurement as recommended by appropriate medical/health physics specialist consulted.

SUBJECT: Radiation Exposure History NO. SPM- 60-06-1

PURPOSE

Federal and state radiation regulations require licensed users of radioactive materials to keep an updated permissible radiation dose record for employees who will be subjected to exposure above certain minimum levels. To calculate the permissible dose it is necessary to have a Radiation Exposure History.

PROCEDURE

I. Radiation Exposure Limits

Form WPS-40, Occupational External Radiation Exposure History, (Attachment-1), must be completed as follows for each employee who is permitted to be exposed to radioactive materials in any period of one calendar quarter in excess of the limits specified in the following table:

	Rems per Calendar Quarter
Whole body; head and truck; active blood-forming organs; lens of eyes; or gonads	1 1/4
Hands and forearms; feet and ankles	18 3/4
Skin of whole body	7 1/2

II. Instructions for Completion of Form WPS-40

A. Identification

Item (1) Self-explanatory.
Item (2) Self-explanatory, except that if individual has no social security number, the work "none" shall be inserted.
Item (3) Self-explanatory.
Item (4) Enter the age in full years. This is called "N" when used in calculating the Permissible Dose. N is equal to the number of years of age of the individual on his last birthday.

B. Occupational Exposure

Item (5) List the name and address of each previous employer and the address of employment. Start with the most recent employer and work back. Include only those periods of employment since the eighteenth birthday involving occupational exposure to radiation. For period of self-employment, insert the word "self-employed."
Item (6) Give the dates of employment.
Item (7) List periods during which occupational exposure to radiation occurred.

Item (8) List the dose (in rems) for each period of exposure from the two following sources:

1. Records of previous occupational exposure of the individual.
2. Assumed exposure calculated by using 3 3/4 rems per calendar quarter for exposure prior to January 1, 1961, and 1 1/4 rems per calendar quarter for exposure beginning on or after January 1, 1961.

"Dose to the whole body" shall be deemed to include any dose to the whole body, gonads, active blood forming organs, head and trunk, or lens of eye.

Item (9) After each entry in Item (8), indicate in Item (9) whether dose is obtained from records of employee or assumed and calculated by above.

Item (10) Self-explanatory.

C. Total Accumulated Occupational Dose (Whole Body)

Item (12) Upon completion of the report, the employee must certify that the information in Columns 5, 6, and 7 is accurate and complete to the best of his knowledge. The date is the date of his signature.

E. Calculations

Item (13) The permissible accumulated occupational dose for each individual is obtained by carrying out the following steps: The value for N should be taken from Item (4). Substract 18 from N and multiply the difference by 5 rem. (For example: John Smith, age 32; N=32; PAD=5(32-18)= 70 rem). Enter the Total Exposure to Date from Item (11). Substract (b) from (a) and enter the difference under (c). The value in (c) represents the unused part of the permissible accumulated dose.

Item (14) Self-examplantory.

The original shall be retained in the District files and a copy shall be sent to the WPS RPO in Fort Worth.

III. Termination Procedures

Regulations provide that employers must give a report of radiation exposures to all employees who have been occupationally exposed to radiation if they request such a report. Additionally, under certain conditions the employer is automatically required to provide such a report.

A. Exposure less than the limits - If an employee's quarterly exposure does not exceed the limits outlined in Part I above for any quarter during which they worked the Radiation Exposure Report (Form 60-06-1A-Attachment 2) shall be completed. One copy should be sent to the employee, one copy should be retained in the District files and one copy shall be sent to the WPS RPO at Fort Worth.

B. Exposures above the limits - If an employee's quarterly exposure, during any quarter which they were employed, exceeds the limits outlined in Part I above, the Radiation Exposure Report (Form 60-06-1B, Attachment 3) shall be completed. One copy should be sent to the employee and one copy should be retained in the District files, and one copy shall be sent to WPS RPO at Fort Worth.

C. Exposures to I-131 - For employees who have previously had a urinalysis performed for I-131 exposure, the Radiation Exposure Report (Form 60-06-1C, Attachment 4) shall be completed. One copy should be sent to the employee, one copy should be retained in the District files and one copy shall be sent to the WPS RPO at Fort Worth.

IV. The District Radiation Safety Officer (RSO) is responsible for assuring compliance with the above requirements.

V. The District RSO or his designate is responsible for completing and distributing the forms according to instructions given for that form.

OCCUPATIONAL EXTERNAL RADIATION DOSE HISTORY

IDENTIFICATION

1. NAME (Print—Last, first and middle)	2. SOCIAL SECURITY NUMBER
3. DATE OF BIRTH (Month, day, year)	4. AGE IN FULL YEARS(N)

OCCUPATIONAL DOSE—PREVIOUS HISTORY

5. Previous Employments Involving Radiation Exposure—List Name & Address of Employer	6. Dates of Employment (From—To)	7. Periods of Exposure	PREVIOUS DOSE HISTORY	
			8. Whole Body (rem)	9. Records or Calculated (Insert One)

10. REMARKS	11. Accumulated Occupational Dose—Total	

13. CALCULATIONS—Permissible Dose

Whole Body:

(A) Permissible Accumulated Dose = _____ rem

(B) Total Dose to Date (Form Item 11) = _____ rem

(C) Unused Part of Permissible Accumulated Dose (A—B) = _____ rem

12. CERTIFICATION: I certify that the dose history listed in Columns 5, 6, and 7 is correct and complete to the best of my knowledge and belief.

Employee's Signature *Date*

14. Name of License or Registrant

Form 60-061A (R-12/83) Attachment 2

RADIATION EXPOSURE REPORT

District _____ License # _____

Employee Name _____ Period of Employment _____ to _____

Mailing Address _____ Period of Report _____ to _____

_____ Date of Report _____

Social Security # _____

RADIATION EXPOSURE DATA

Total Exposure _____ mRem (whole body)

In no calendar quarter covered by this report did the named individual's exposure exceed the applicable limits set forth in 10 CFR 20.101.

_____
Radiation Safety Officer

Form 60-06-1B (R-12/83) Attachment 3

RADIATION EXPOSURE REPORT

District _____ License # _____

Employee Name _____ Period of Employment _____ to _____

Mailing Address _____ Period of Report _____ to _____

_____ Date of Report _____

Social Security # _____

RADIATION EXPOSURE DATA

Year	Exposure (in mRem)			
	1st Qtr.	2nd Qtr.	3rd Qtr.	4th Qtr.

This report is furnished to you under the provisions of 10 CFR 19.13. You should preserve this report for futher reference.

_____
Radiation Safety Officer

Form 60-06-1C (R-12/83) Attachment 4

RADIATION EXPOSURE REPORT

District _____ License # _____

Employee Name _____ Period of Employment _____ to _____

Mailing Address _____ Period of Report _____ to _____

_____ Date of Report _____

Social Security # _____

RADIATION EXPOSURE DATA

Sample Date	Results (uCi/ml)	Sample Date	Results (uCi/ml)

This report is furnished to you under the provisions of 10 CFR 19.13. You should preserve this report for further reference.

_____
Radiation Safety Officer

SUBJECT: Radioactive Materials - Employee Notices and Instructions

NO. SPM- 60-07-1

PURPOSE

Federal and state regulations provide certain rules pertaining to information about radiation work which must be given to affected employees.

PROCEDURE

I. Posting of "Notice to Employees"

A. Each licensed district shall post copies of that state's "Notice to Employee". Note: "Notice to Employees" posters for Louisiana, New Mexico, Texas, Mississippi, Colorado, Alabama, North Dakota and NRC licensed states are shown in Attachments 1-8 (respectively) at the end of this section.

B. A copy of the form shown in Attachment 9 shall be attached to the bottom of each of the "Notice to Employees". This form describes records which may be received and the location where they may be reviewed.

C. In addition to the above documents the "Notice of Violations" received from the most recent regulatory agency inspections shall be posted for a period of at least 30 days.

D. Documents, notices or forms listed A thru C. above shall be conspicuously posted, and appear in a sufficient number of places to permit individuals engaged in work under the license to observe them on the way to or from any particular work location to which the document applies. Defaced or altered documents shall be replaced.

II. Instructions to Workers

A. All individuals working in, or frequenting any area where source of radiation are used or stored shall be kept informed of the storage, transfer, or use of radioactive material or of radiation in these areas.

B. All individuals working in, or frequenting any area where source of radiation are used or stored shall be instructed in the health protection problems associated with exposure to such radioactive material, precautions or procedures to minimize exposure, and the functions and purpose of protective devices exployed.

C. All individuals shall be instructed in, and required to observe, to the extent within the worker's control, the applicable provisions of licensing agency regulations and company licenses for the protection of personnel from exposure to radiation or radioactive materials.

SUBJECT: Radioactive Materials - Employee Notices and Instructions

NO. SPM- 60-07-1

D. All individuals shall be instructed of their responsibility to report promptly to the license or registrant, any condition which may lead to, or cause a violation of licensing agency regulations, company licenses, or certificates of registration, or unnecessary exposure to radiation or radioactive material.

E. All individuals shall be instructed in the appropriate response to warnings made in the event of any unusual occurrence or malfunction that may involve exposure to radiation or radioactive material.

F. All individuals shall be advised as to the radiation exposure reports which workers may request.

G. The extent of these instructions shall be commensurate with potential radiological health protection problems associated with the source(s) of radiation.

DEPARTMENT OF CONSERVATION

LOUISIANA DIVISION OF RADIATION CONTROL

NOTICE TO EMPLOYEES

STANDARDS FOR PROTECTION AGAINST RADIATION

In the Louisiana Radiation Regulations, the Louisiana Division of Radiation Control has established standards for your protection against radiation hazards.

YOUR EMPLOYER'S RESPONSIBILITY

Your employer is required to—

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

YOUR RESPONSIBILITY AS A WORKER

You should familiarize yourself with those provisions of the Louisiana Radiation 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 REGULATIONS

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

REPORTS ON YOUR RADIATION EXPOSURE HISTORY

1. The Louisiana Radiation 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 or registration. The basic limits for exposure to employees are set forth in Sections D. 101, D. 103, and D. 104 of the regulations. The sections specify limits on exposure to radiation and exposure to concenstrations of radioactive material in air and water.

2. If you work where personnel monitoring is required, and if you request information on your radiation exposures,

   (a) Your employer must give you a written report, upon termination of your employment, of your radiation exposures, and

   (b) Your employer must advise you annually of your exposure to radiation.

INSPECTIONS

All licensed or registered activities are subject to inspection by representatives of the Louisiana Division of Radiation Control.

INQUIRIES

Inquiries dealing with the matters outlined above can be directed to:

LOUISIANA DIVISION OF
RADIATION CONTROL
P. O. Box 14690
Baton Rouge, Louisiana 70808

TELEPHONE
24 hour
Area Code 504
925-4518

Posting Requirement

Copies of this notice must be posted in a sufficient number of places in every establishment where employees are employed in activities licensed or registered pursuant to Parts B or C by the Louisiana Division of Radiation Control, 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.

Attachment 1
SPM 60-07

Attachment 2
SPM 60-07

STATE OF NEW MEXICO
HEALTH ENVIRONMENT

NOTICE TO EMPLOYEES

STANDARDS FOR PROTECTION AGAINST RADIATION
NOTICES, INSTRUCTIONS AND REPORTS TO WORKERS: INSPECTIONS

Part 4 of the New Mexico Radiation Protection Regulations establishes standards for your protection against radiation hazards. Part 10 establishes options for radiation workers and related matters.

YOUR EMPLOYER'S RESPONSIBILITY

Your employer is required to –

1. Apply these regulations to work involving sources of radiation.
2. Post or otherwise make available to you a copy of the Radiation Protection Regulations, licenses and operating procedures that apply to work you are engaged in, and explain their provisions to you; post Notices of Violation involving radiological working conditions and orders.

YOUR RESPONSIBILITY AS A WORKER

You should familiarize yourself with those provisions of the Radiation Protection Regulations and the operating procedures that 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 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 division inspection.
7. Related matters.

REPORTS ON YOUR RADIATION EXPOSURE HISTORY

1. The Radiation Protection 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 Part 4 of the Radiation Protection Regulations. These sections specify limits on exposure to radiation and exposure to concentrations of radioactive material in air and water.

2. If you work where personnel monitoring is required, and if you request information on your radiation exposures:
   (a) your employer must give you a written report, upon termination of your employment, of your radiation exposures, and
   (b) your employer must advise you annually of your exposure to radiation.

INSPECTIONS

All licensed or registered activities are subject to inspection by representatives of the Environmental Improvement Division. In addition, any worker or representative of workers who believes a violation of the Act, Radiation Protection Regulations or license condition exists or has occurred in work under a license or registration with regard to radiological working conditions on which the worker is engaged may request an inspection by sending a notice of the alleged violation to the address below. The request must set forth the specific grounds for the notice and must be signed by the worker or the representative of workers. During inspections, division 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.

INQUIRIES

Inquiries dealing with the matters outlined above can be sent to:

RADIATION PROTECTION BUREAU
ENVIRONMENTAL IMPROVEMENT DIVISION
P. O. BOX 968
SANTA FE, NEW MEXICO 87503

POSTING REQUIREMENT

Copies of this notice must be posted in a sufficient number of places in every establishment where employees are employed in activities licensed or registered, pursuant to Parts 2 and 3 of the Radiation Protection Regulations, to permit employees working in or frequenting any portion of a restricted area to observe a copy on the way to or from their places of employment.

EID 045 Revised 5/80 (Replaces RPS 011)

TR n 22-1
(77)

Texas Depar nt of Health
1100 West 49th Street
Austin, Texas 78756

NOTICE TO EMPLOYEES

TEXAS REGULATIONS FOR CONTROL OF RADIATION

The Texas Department of Health has established standards for your protection against radiation hazards, pursuant to the Texas Radiation Control Act, Art. 4590f, Revised Civil Statutes, State of Texas.

YOUR EMPLOYER'S RESPONSIBILITY

Your employer is required to--

1. Apply these regulations to work involving sources of radiation.
2. Post or otherwise make available to you a copy of the Texas Department of Health regulations, licenses, certificates of registration, notices of violations, and operating procedures which apply to work you are engaged in, and explain their provisions to you.

YOUR RESPONSIBILITY AS A WORKER

You should familiarize yourself with those provisions of the 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 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 Agency inspections; and
7. Related matters.

REPORTS ON YOUR RADIATION EXPOSURE HISTORY

1. The 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 21.101, 21.103, and 21.104 of the regulations. These sections specify limits on exposure to radiation and exposure to concentrations of radioactive material in air and water.
2. If you work where personnel monitoring is required.,
   (a) Your employer must give you a written report, upon termination of your employment, of your radiation exposures if that exposure exceeded 10% of any limit set forth in Sections 21.101, 21.103, or 21.104, and
   (b) Upon written request your employer must advise you annually of your exposure to radiation, or on termination of association, of your exposure regardless of the amount of exposure.

INSPECTIONS

All licensed or registered activities are subject to inspection by representatives of the Texas Department of Health. In addition, any worker or representative of workers who believes that there is a violation of the Texas Radiation Control Act, the regulations issued thereunder, or the terms of the employer's license or registration 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 Texas Department of Health. The request must set forth the specific grounds for the notice, and must be signed by the worker as the representative of the workers. During inspections, Agency 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 employees are employed in activities licensed or registered, pursuant to Part 41 or Part 42 of Texas Regulations for Control of Radiation, to permit employees to observe a copy on the way to or from their place of employment.

Attachment 3
SPM 60-07

UNITED STATES NUCLEAR REGULATORY COMMISSION
Washington, D.C. 20555

NOTICE TO EMPLOYEES

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

WHAT IS THE NUCLEAR REGULATORY COMMISSION?

The Nuclear Regulatory Commission is an independent Federal regulatory agency responsible for licensing and inspecting nuclear power plants and other commercial uses of radioactive materials.

WHAT DOES THE NRC DO?

The NRC's primary responsibility is to ensure that workers and the public are protected from unnecessary or excessive exposure to radiation and that nuclear facilities including power plants are constructed to high quality standards and operated in a safe manner. The NRC does this by establishing requirements in Title 10 of the Code of Federal Regulations (10 CFR) and in licenses issued to nuclear users.

WHAT RESPONSIBILITY DOES MY EMPLOYER HAVE?

Any company that conducts activities licensed by the NRC must comply with the NRC's requirements. If a company violates NRC requirements, it can be fined or have its license modified, suspended or revoked.

Your employer must tell you which NRC radiation requirements apply to your work and must post NRC Notices of Violation involving radiological working conditions.

WHAT IS MY RESPONSIBILITY?

For your own protection and the protection of your co-workers, you should know how NRC requirements relate to your work and should obey them. If you observe violations of the requirements, you should report them.

HOW DO I REPORT VIOLATIONS?

If you believe that violations of NRC rules or of the terms of the license have occurred, you should report them immediately to your supervisor. If you believe that adequate corrective action is not being taken, you may report this to an NRC inspector or the nearest NRC Regional Office.

WHAT IF I WORK IN A RADIATION AREA?

If you work with radioactive materials or in a radiation (controlled) area, the amount of radiation exposure that you may legally receive is limited by the NRC. The limits on your exposure are contained in sections 20.101, 20.103, and 20.104 of Title 10 of the Code of Federal Regulations (10 CFR 20). While those are the maximum allowable limits, your employer should also keep your radiation exposure as far below those limits as is "reasonably achievable."

MAY I GET A RECORD OF MY RADIATION EXPOSURE?

Yes. Your employer is required to tell you, in writing, if you receive any radiation exposure above the limits set in the NRC regulations or your employer's license. In addition, if your job involves radiation, you may request from your employer a record of your annual radiation exposures and a written report of your total exposure when you leave your job.

HOW ARE VIOLATIONS OF NRC REQUIREMENTS IDENTIFIED?

NRC conducts regular inspections at licensed facilities to assure compliance with NRC requirements. In addition, your employer and site contractors conduct their own inspections to assure compliance. All inspectors are protected by Federal law. Interference with them may result in criminal prosecution for a Federal offense.

MAY I TALK WITH AN NRC INSPECTOR?

Yes. Your employer may not prevent you from talking with an NRC inspector and you may talk privately with an inspector and request that your identity remain confidential.

MAY I REQUEST AN INSPECTION?

If you believe that your employer has not corrected violations involving radiological working conditions, you may request an inspection. Your request should be addressed to the nearest NRC Regional Office and must describe the alleged violation in detail. It must be signed by you or your representative.

HOW DO I CONTACT THE NRC?

Notify an NRC inspector on-site or call the nearest NRC Regional office collect. NRC inspectors want to talk to you if you are worried about radiation safety or other aspects of licensed activities, such as the quality of construction or operations at your plant.

CAN I BE FIRED FOR TALKING TO THE NRC?

No. Federal law prohibits an employer from firing or otherwise discriminating against a worker for bringing safety concerns to the attention of the NRC. You may not be fired or discriminated against because you:

- ask the NRC to enforce its rules against your employer;
- testify in an NRC proceeding;
- provide information or are about to provide information to the NRC about violations of requirements;
- are about to ask for or testify, help, or take part in an NRC proceeding.

WHAT FORMS OF DISCRIMINATION ARE PROHIBITED?

No employer may fire you or discriminate against you with respect to pay, benefits, or working conditions because you help the NRC.

HOW AM I PROTECTED FROM DISCRIMINATION?

If you believe that you have been discriminated against for bringing safety concerns to the NRC, you may file a complaint with the U.S. Department of Labor. Your complaint must describe the firing or discrimination and must be filed within 30 days of the occurrence.

Send complaints to:

Office of the Administrator
Wage and Hour Division
Employment Standards Administration
U.S. Department of Labor
Room S3502
200 Constitution Avenue, N.W.
Washington, D.C. 20210

or any local office of the Department of Labor, Wage and Hour Division. Check your telephone directory under U.S. Government listings.

WHAT CAN THE LABOR DEPARTMENT DO?

The Department of Labor will notify the employer that a complaint has been filed and will investigate the case.

If the Department of Labor finds that your employer has unlawfully discriminated against you, it may order you to be reinstated, receive back pay, or be compensated for any injury suffered as a result of the discrimination.

WHAT WILL THE NRC DO?

The NRC may assist the Department of Labor in its investigation. NRC may conduct its own investigation where necessary to determine whether unlawful discrimination has prevented the free flow of information to the Commission. Also, if the NRC or Department of Labor finds that unlawful discrimination has occurred, the NRC may issue a Notice of Violation to your employer, impose a fine, or suspend, modify, or revoke your employer's NRC license.

UNITED STATES NUCLEAR REGULATORY COMMISSION REGIONAL OFFICE LOCATIONS

A representative of the Nuclear Regulatory Commission can be contacted at the following addresses and telephone numbers. The Regional Office will accept collect telephone calls from employees who wish to register complaints or concerns about radiological working conditions or other matters regarding compliance with Commission rules and regulations.

Regional Offices

REGION	ADDRESS	TELEPHONE
I	U.S. Nuclear Regulatory Commission Region I 631 Park Avenue King of Prussia, PA 19406	215 337 5000
II	U.S. Nuclear Regulatory Commission Region II 101 Marietta St., N.W., Suite 2900 Atlanta, GA 30323	404 221 4503
III	U.S. Nuclear Regulatory Commission Region III 799 Roosevelt Road Glen Ellyn, IL 60137	312 790 5600
IV	U.S. Nuclear Regulatory Commission Region IV 611 Ryan Plaza Drive, Suite 1000 Arlington, TX 76011	817 860 8100
V	U.S. Nuclear Regulatory Commission Region V 1450 Maria Lane, Suite 210 Walnut Creek, CA 94596	415 943 3700

NRC FORM 3
(9-84)

Attachment 4
SPM 60-07

RH-5
Rev. 1/80

MISSISSIPPI STATE BOARD OF HEALTH

NOTICE TO EMPLOYEES

STANDARDS FOR PROTECTION AGAINST RADIATION (PART 801, SECTION D)
NOTICES, INSTRUCTIONS AND REPORTS TO WORKERS: INSPECTIONS (PART 801, SECTION J)

In Part 801, Section D, of its Rules and Regulations, the Mississippi State Board of Health has established standards for your protection against radiation hazards from radioactive material under license issued by the Mississippi State Board of Health. In Part 801, Section J, of its Rules and Regulations, the Mississippi State Board of Health has established certain provisions for the options of workers engaged in work under an Agency license or registration.

YOUR EMPLOYER'S RESPONSIBILITY

Your employer is required to—

1. Apply these regulations to work involving sources of radiation.
2. Post or otherwise make available to you a copy of the Mississippi State Board of Health regulations, licenses, and operating procedures which apply to work you are engaged in, and explain their provisions to you.
3. Post Notice 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 Mississippi State Board of Health 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 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 Agency inspection; and
7. Related matters.

REPORTS ON YOUR RADIATION EXPOSURE HISTORY

1. The Mississippi State Board of Health 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 Section D.101, D.103 and D.104 of the regulations. The sections specify limits on exposure to radiation and exposure to concentrations of radioactive material in air and water.
2. If you work where personnel monitoring is required, and if you request information on your radiation exposures,
   (a) Your employer must give you a written report, upon termination of your employment, of your radiation exposures, and
   (b) Your employer must advise you annually of your exposure to radiation.

INSPECTIONS:

All licensed or registered activities are subject to inspection by representatives of the Mississippi State Board of Health. In addition, any worker or representative of workers who believe that there is a violation of the Mississippi Radiation Protection Act of 1976, Title 45, Chapter 14, Mississippi Code of 1972, the regulations issued thereunder, or the terms of the employer's license or registration 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 Division of Radiological Health, Mississippi State Board of Health. The request must set forth the specific grounds for the notice, and must be signed by the worker as the representative of the workers. During inspections, Agency 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 EMPLOYEES ARE EMPLOYED IN ACTIVITIES LICENSED OR REGISTERED, PURSUANT TO PART B OR PART C, BY THE MISSISSIPPI STATE BOARD OF HEALTH, 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.

Attachment 5
SPM 60-07

COLORADO
DEPARTMENT OF HEALTH

NOTICE TO EMPLOYEES

STANDARDS FOR PROTECTION AGAINST RADIATION

In the Radiation Control Regulations, the Colorado Department of Health Has Established Standards for Your Protection Against Radiation Hazards.

YOUR EMPLOYER'S RESPONSIBILITY

Your employer is required to:

1. Apply these regulations to work involving sources of radiation.
2. Post or otherwise make available to you a copy of the Department of Health regulations, licenses, and operating procedures which apply to work you are engaged in, and explain their provisions to you.

YOUR RESPONSIBILITY AS A WORKER

You should familiarize yourself with those provisions of the Department of Health 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 REGULATIONS

1. Limits on exposure to radiation and radioactive material in controlled and uncontrolled 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. Notices, Instructions and reports to workers, and
7. Related matters.

REPORTS ON YOUR RADIATION EXPOSURE HISTORY

1. The Colorado Department of Health 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 RH 4.2 and RH 4.4 of the regulations. These sections specify limits on exposure to radiation and exposure to concentrations of radioactive material in air or water.
2. If you work where personnel monitoring is required, and if you request information on your radiation exposures,
   a) Your employer must give you a written report, upon termination of your employment, of your radiation exposures, and
   b) Your employer must advise you annually of your exposure to radiation.

INSPECTIONS

All licensed or registered activities are subject to inspection by the Colorado Department of Health or its duly authorized representatives.

INQUIRIES

Inquiries dealing with the matters outlined above can be sent to the Colorado Department of Health, Radiation and Hazardous Wastes Control Division, 4210 E. 11th Ave., Denver, Colorado 80220.

POSTING REQUIREMENTS

Copies of this notice must be posted in a sufficient number of places where employees are employed in activities registered or licensed pursuant to Parts II, III, and X by the Colorado Department of Health, to permit employees working in or frequenting any portion of a controlled area to observe a copy on the way to or from such area.

Form
RAD 681

NORTH DAKOTA STATE DEPARTMENT OF HEALTH

NOTICE TO EMPLOYEES

STANDARDS FOR RADIATION PROTECTION

THE NORTH DAKOTA STATE DEPARTMENT OF HEALTH HAS ESTABLISHED STANDARDS FOR YOUR PROTECTION AGAINST RADIATION HAZARDS

YOUR EMPLOYER'S RESPONSIBILITY

Your employer is required to -

1. Apply these regulations and the conditions of his North Dakota Radioactive Material License to all work under the license.
2. Post or otherwise make available to you a copy of the North Dakota State Department of Health 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.
4. Refrain from discriminatory acts against employees who provide information to the North Dakota State Department of Health.

YOUR RESPONSIBILITY AS A WORKER

You should familiarize yourself with those provisions of the North Dakota State Department of Health 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 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 Department inspections;
7. Prohibits discrimination against employees, and;
8. Related matters.

REPORTS ON YOUR RADIATION EXPOSURE HISTORY

1. The North Dakota State Department of Health 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 33-10-04-02.1, 3. and 4. of the regulations. These sections specify limits on exposure to radiation and exposure to concentrations of radioative material in air and and water.
2. If you work where personnel monitoring is required, and if you request information on your radiation exposures,
   (a) Your employer must give you a written report of your radiation exposures upon termination of your employment, and;
   (b) Your employer must advise you annually of your exposure to radiation.

INSPECTIONS

All licensed or registered activities are subject to inspection by representatives of the North Dakota State Department of Health.

EMPLOYEE PROTECTION

If an employee believes that discrimination has occurred due to engaging in activities described in Section 33-10-10-01.6. of these regulations said employee may, within 30 days of the discriminatory act, file a complaint with the Department of Labor, Employment Standards Administration, Wage and Hour Division. The Department of Labor shall conduct an investigation and shall, where discrimination has occurred, issue an order providing relief to the employee if relief is not provided by other means of settlement.

INQUIRIES

Inquiries dealing with the matters outlined above can be sent to the North Dakota State Department of Health, Division of Environmental Engineering, 1200 Missouri Avenue, Room 304, Bismarck, North Dakota 58501. Telephone (701) 224-2348.

Attachment 7
SPM 60-07

COPIES OF THIS NOTICE MUST BE POSTED IN A SUFFICIENT NUMBER OF PLACES IN EVERY ESTABLISHMENT WHERE EMPLOYEES ARE EMPLOYED IN ACTIVITIES LICENSED OR REGISTERED WITH THE NORTH DAKOTA STATE DEPARTMENT OF HEALTH, TO PERMIT EMPLOYEES WORKING IN OR FREQUENTING ANY PORTION OF RESTRICTED AREA TO OBSERVE A COPY ON THE WAY TO OR FROM THEIR PLACE OF EMPLOYMENT

FORM X
7-78

ALABAMA DEPARTMENT OF PUBLIC HEALTH

NOTICE TO EMPLOYEES

STANDARDS FOR PROTECTION AGAINST RADIATION

IN *ALABAMA REGULATIONS FOR CONTROL OF RADIATION*, THE ALABAMA DEPARTMENT OF PUBLIC HEALTH HAS ESTABLISHED STANDARDS FOR YOUR PROTECTION AGAINST RADIATION HAZARDS

Your Employer's Responsibility

Your employer is required to–

1. Apply these regulations to work involving sources of radiation;
2. Post or otherwise make available to you a copy of the Alabama Department of Public Health regulations, licenses, and operating procedures which apply to work you are engaged in and explain their provisions to you; and
3. Post any Notice of Violation involving radiological working conditions.

Your Responsibility as a Worker

You should familiarize yourself with those provisions of the Alabama Department of Public Health 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 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 Alabama Department of Public Health inspections.
7. Related matters.

Reports on Your Radiation Exposure History

1. The Alabama Department of Public Health 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 6-3.101, 6-3.103, and 6-3.104 of the regulations. These sections specify limits on exposure to radiation and exposure to concentrations of radioactive material in air and water.
2. If you work where personnel monitoring is required and if you request information on your radiation exposures,
   (a) Your employer must give you a written report, upon termination of your employment, of your radiation exposures, and
   (b) Your employer must advise you annually of your exposure to radiation.

Inspections

All licensed or registered activities are subject to inspection by representatives of the Alabama Department of Public Health. In addition, any worker or representative of workers who believes that there is a violation of Act No. 582, Regular Session, 1963, the regulations issued thereunder, or the terms of the employer's license or registration with regard to radiological working conditions in which the worker is engaged, may request an inspection by sending a notice of alleged violation to the address given below. The request must set forth the specific grounds for the notice and must be signed by the worker or by the representative of the workers. During inspections, agency inspectors may confer privately with workers, and any worker may bring to the attention of the inspectors any past or present condition which he or she believes contributed to or caused any violation as described above.

Inquiries

Inquiries dealing with the matters outlined above can be sent to the Alabama Department of Public Health, Environmental Health Administration, State Office Building, Montgomery, Alabama 36130. Telephone–(205) 832-5992.

POSTING REQUIREMENTS

COPIES OF THIS NOTICE MUST BE POSTED IN A SUFFICIENT NUMBER OF PLACES IN EVERY ESTABLISHMENT WHERE EMPLOYEES ARE EMPLOYED IN ACTIVITIES LICENSED OR REGISTERED, PURSUANT TO PARTS 6-2, 6-5, or 6-8, BY THE ALABAMA DEPARTMENT OF PUBLIC HEALTH, 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.

Prepared by Division of Primary Prevention for Division of Radiological Health

Attachment 8
SPM 60-07

Copies of the following documents can be reviewed in the Radiation Safety Officer's files in room _____ at _____.

Regulation for Control of Radiation
Copy of Radiation Materials License
Copy of Operating and Emergency Procedures
Copies of Notices of Violations

SUBJECT: Radiation Program Management Organization for Field Personnel

NO. SPM- 60-01-2

PURPOSE

The purpose of this procedure is to outline, to administrative personnel, the functions and responsibilities of those persons working within the framework of the operations area of the WPS Radiation Program.

I. WPS Radiation Protection Officer

A. The WPS Radiation Protection Officer is the designated overall manager for the radiation program. The WPS Radiation Protection Officer is the Loss Control Engineer located at WPS Accident Prevention in Fort Worth.

B. The duties of the Radiation Protection Officer include the delegation of authority to persons responsible for carrying out the duties such as that of Radiation Safety Officer, overall responsibility for records, surveys, the forming of committees where necessary and in general the administrative procedures for the entire radiation program.

C. The WPS Radiation Protection Officer is responsibile for contacting federal and state agencies to request renewals and changes to applicable licenses granted by those agencies.

II. District Radiation Safety Officer

A. The Radiation Safety Officer is responsible to the Radiation Protection Officer and in general is to conduct or cause to be conducted the programs and responsibilities delegated by the Radiation Protection Officer. The Radiation Safety Officer for each district is the District Manager. His duties shall include:

1. Site surveys.

2. Records, personnel monitoring records and compilation.

3. Vehicle survey records.

4. Training and qualifying personnel.

5. Conducting periodic safety checks to ensure that the radiation protection program is functioning properly in his district.

B. Before a District Manager can fully assume the appointment of Radiation Safety Officer by the Radiation Protection Officer, he must have successfully completed the radiation safety training course provided by Radiation Consultants, Inc., Houston, Texas, or other approved training company, within four (4) months of the initial date of appointment.

SUBJECT: Radiation Program Management Organization for Field Personnel

NO. SPM- 60-01-2

III. Radiation Supervisor

A. The Radiation Supervisor is responsible to the District Radiation Safety Officer for the overall performance of the operation to which he has been assigned such as:

1. Detailing requirements for planning and directing personnel, safety, methods and techniques used for the particular operations.

2. Responsibility for the control over the specific radioactive materials that are to be used or dispensed on a job.

3. Maintaining control of records and reports generated from required surveys of material, equipment and restricted areas on the job.

4. Must assure that all equipment and devices are maintained in working order and that sealed sources or tracer materials are properly locked and stored when not in use.

5. Responsibility for assuring the compliance of personnel and procedures as required by the federal or state license or regulations.

B. Before an employee can be classified as a Radiation Supervisor, he must successfully complete the radiation safety training course provided by Radiation Consultants, Inc. or other approved training company.

IV. Technicians

A. The technician is an employee who is directly responsible to the Radiation Supervisor for the duties assigned by the Radiation Supervisor.

B. Under the direct supervision of the Radiation Supervisor at the Wellsite, the technician may handle and/or dispense tracer material and use survey instruments.

C. Before an employee can be classed as a technician he must have successfully completed the following training:

1. Has read or received instruction on this operating manual.

2. Has demonstrated competence to use R/A material and the tools associated with its use under the personal supervision of the Radiation Supervisor.

SUBJECT: Recordkeeping Requirements for Field Personnel

NO. SPM- 60-02-2

PURPOSE

Federal and state agencies require the development and retention of certain records concerning the storage, use and handling of radioactive materials. This procedure will list and describe the types of records WPS will use.

PROCEDURES

I. Recordkeeping - General

A. Records and reports required by federal and state agencies are to be preserved for periods specified in this section, or until the governing agency authorized their disposal.

B. All records required by federal and state agencies will be transferred to the agency within 30 days following (1) the termination of a license granted by that agency, (2) such other times as the licensing agency may direct.

C. Districts which close down their operations shall transfer all of their records and reports to the WPS Radiation Protection Officer, Accident Prevention - Fort Worth.

II. Recordkeeping - Records and Reports

The following records and reports shall be completed by every district using radioactive materials and kept in an orderly filing system.

A. Radioactive Sealed Source Utilization Log (Form 60-02-1A). This record summarized the receipt, utilization and transfer of densiometer sealed sources. When this record form is used with a blender with two (2) sealed sources, both of the densiometer serial numbers will be listed at the top center of the form. The individual making the entry on the form must write his name in the indicated place beside the entry. A copy of the "Dispatcher's Job Ticket" for each usage shall be maintained in a separate file to identify the wellsite location where the instruments were utilized. (See Attachment 1). These records shall be maintained by regulatory agencies for a period of two (2) years.

B. Radioactive Tracer Material Utilization Log (Form 60-02-1B). This record summarized the receipt, utilization and final disposition of all tracer materials used. A copy of the "Dispatcher's Job Ticket" will be kept in a separate file to identify the location of tracer utilization for each job. Receiving bills of lading shall also be maintained in a separate file for tracer materials to identify receipt of materials. The column labeled "Disposition" shall be used to identify what happened to tracer materials and packaging such as: "All downhole;" "__downhole and __returned to storage;" "empty container returned to storage;" "transferred to___:" "empty containers returned to vendor," etc. (See Attachment 2). The individual making the entry on the form must write

his name in the indicated place beside the entry. These records shall be maintained for inspection by the regulatory agencies for a period of two (2) years from the date of entry.

C. Survey Meter Calibration Log (Form 60-02-1C). This form used to record the date of each six (6) month calibration of the district survey meter (s). The district shall maintain a file of the "Certification of Calibration" test certificates and send a copy of each "Certification of Calibration" to the WPS Radiation Protection Officer at Fort Worth (Attachment 3). Records of calibration shall be maintained for a period of two (2) years from the date of calibration for inspection by the regulatory agencies.

D. Wellsite Radiation Monitoring Report (Form 60-02-1D). This report will be completed for each tracer material wellsite job. This report is not required for densiometer sealed source jobs. The original form is to be retained in district files with a copy sent to the WPS Radiation Protection Officer at Fort Worth (Attachment 4). These reports shall be maintained for inspection by the regulatory agencies for two (2) years after completion of the surveys.

E. Storage Area Monitoring Report (Form 60-02-1E). Quarterly monitoring of the district's radioactive material storage area shall be reported using Form 60-02-1E - Storage Area Monitoring Report.

Note: The report is for all tracer material storage and densiometers in storage. (Not vehicle or trailer mounted).

The district will retain the original for inspection by the regulatory agencies for two (2) years after completion of the survey, and send a copy to the WPS Radiation Protection Officer at Fort Worth (Attachment 5).

F. Vehicle Monitoring Report (Form 60-02-1F). Quarterly monitoring of district vehicles used to transport densiometers, i.e., densiometer trailers and blenders. The district will retain the orginal and send a copy to the WPS Radiation Officer at Fort Worth (Attachment 6). These shall be maintained for inspection by the regulatory agencies for two (2) years after completion of the survey.

G. Sealed Source Inventory Report (Form 60-02-1G). Every three (3) months, this form will be completed to account for all radioactive sealed sources received and possessed during that time period. The report will be maintained in district files for two (2) years from the date of the report. A copy of each report will be sent to the WPS Radiation Protection Officer at Fort Worth (Attachment 7).

H. Tracer Materials Inventory Report(Form 60-02-1H). Every three (3) months this form will be completed to account for all radioactive tracer materials which are on hand at the time. The report will be maintained

in district files for two (2) years from the date of the report. A copy of each report will be sent to the WPS Radiation Protection Officer at Fort Worth. (Attachment 8).

I. Temporary Use TLD Badge Log (Form 60-02-1I). This form is used to assign temporary TLD badges to personnel who are not regular personnel with permanently assigned TLD badges. A temporary badge is assigned only to one person before it is returned to the TLD badge vendor for processing and reading. Previously assigned temporary badges will not be reassigned to another person. The form will be retained by a district in its TLD Badge Report files. (Attachment 9).

J. TLD Badge Reports and personnel exposure records will be maintained in a separate file. Quarterly TLD Badge Reports from the TLD badge vendor on each person using radioactive materials will be kept at the district office. The TLD badge vendor also sends a duplicate copy of the report to the WPS Radiation Protection Officer at Fort Worth for the Company's master files. (Refer to SPM-60-03-1, Radiation Detection - Personnel Monitoring Badges, for further details).

K. Certificate of Leak Test records on all sealed sources will be maintained on each sealed source. Leak test kits from Radiation Consultants, Inc. or other agency approved suppliers will be used each six (6) months. The district received the original report from the vendor and the WPS Radiation Protection Officer at Fort Worth receives a copy from the vendor. An up-to-date copy of the latest Certificate of Leak Test report will always accompany and be transported with a densiometer when it is in field use on a job and when it is transferred from the district.

III. Responsibility

The District Radiation Safety Officer is responsible for assigning record-keeping duties to others in this organization and for monitoring their work to assure compliance with these procedures.

(R-12/83)

DISTRICT _____ RSO _____

RADIOACTIVE SEALED SOURCE

UTILIZATION LOG

FOR DENSIOMETER SERIAL # _____

ACTIVITY _____

Date Received at District _____ Date Transferred from District _____

From _____ To _____

Received by _____

UTILIZATION INFORMATION

Date Out of Yard	Dispatch Job Ticket Number	Date In yard for Storage	Signature of Person Making Entry

Form 60-02-1B (R-12/83)

DISTRICT _____ RSO _____

RADIOACTIVE TRACER MATERIAL

UTILIZATION LOG

RECEIVED				USAGE					
Date	Amount	Type Material	Signature	Date	Amount	Type Material	Dispatch Job Ticket #	Disposition*	Signature

* Use Disposition column for any necessary remarks

Attachment 3

Form 60-02-1C (R-12/83)

SURVEY METER CALIBRATION LOG

District _____

Meter Type	Model #	Serial #	Date Calibrated	Date Calibrated	Date Calibrated	Date Calibrated	Location	Person Making Entry

Maintain in District Office

Form 60-02-1D (R-12/83)

Attachment 4

WELLSITE RADIATION MONITORING REPORT

Date _____

Customer _____ Well _____

Field _____ County _____ State _____

Radiation Supervisor _____ Technician _____

Supervisor's Badge # _____ Technician's Badge # _____

Job Ticket No. _____ District _____

Survey Meter Type _____ Serial # _____ Date Calibrated _____

TRACER ISOTOPE INFORMATION

Tracer Type _____ Strength _____

Amount of Tracer Taken on Job _____ mCi Amount Used on Job _____ mCi

Disposition of Leftover Tracer _____

VEHICLE MONITORING INFORMATION

Before Leaving Shop (Vehicle Loaded)

Background _____ mR/hr
(30 feet clear of any R/A material)

Location of Survey	Reading (mR/hr)
Front Sign*	
Back Sign*	
Left Sign*	
Right Sign*	

After Return to Shop (Vehicle Empty)

Front Sign* _____ mR/hr

Left Sign* _____ mR/hr

Before Leaving Job-Site (Vehicle Loaded)

Background _____ mR/hr
(30 feet clear of any R/A material)

Location of Survey	Reading (mR/hr)
Front Sign*	
Back Sign*	
Left Sign*	
Right Sign*	

Background _____ mR/hr

Back Sign* _____ mR/hr

Right Sign* _____ mR/hr

JOB-SITE MONITORING INFORMATION

Before Operations Begin

Background Reading _____ mR/hr Wellhead Reading _____ mR/hr

Reading in Area Where Work is to be Performed _____ mR/hr

After Completing Operations

Background Reading _____ mR/hr Wellhead Reading _____ mR/hr

Reading in Area Where Work was Performed _____ mR/hr

Thyroid Check (For Iodine-131 Use Only) _____

Exact Location of Any Significant Contamination _____

Steps Taken to Remedy Contamination Problem _____

Distribution: (1) District Office
(1) FW A/P

Signature _____

Attachment 5

Form 60-02-1E

STORAGE AREA MONITORING REPORT

District _____ Date _____

All radioactive materials storage bunkers and down-hole storage facilities are to be monitored for radiation levels each quarter.

Survey Meter Type _____

Survey Meter Serial # _____

Calibration Date _____

ABOVE GROUND STORAGE

Background Reading* _____ mR/hr

Radiation levels on surface of storage area (measure each door seperately -- no measurement is necessary if storage is empty -- indicate if empty)

Location of Survey	Reading (mR/hr)	Location of Survey	Reading (mR/hr)
Top	_____	Front	_____
Left	_____	Back	_____
Right	_____		

Radiation level at 1 meter from storage area

Left	_____	Front	_____
Right	_____	Back	_____

DOWN-HOLE STORAGE

Background Reading* _____ mR/hr

Highest level at surface of down-hole storage cover _____ mR/hr

* Normal background is recorded at least 30 feet from the storage area, or 6 feet from the cover of the down-hole storage facility.

Signature _____

Title _____

Make in duplicate: (1) Retain in District Office (1) Fort Worth Accident Prevention

Form 60-02-1F (R-12/83)

VEHICLE MONITORING REPORT

District _____ Date _____

Survey Meter Type _____

Survey Meter Serial # _____

Calibration Date _____

Each vehicle is to be monitored quarterly, with radioactive sealed sources in place.

Vehicle #	(All readings are in mR/hr)			
	Front	Back	Left	Right

Signature _____

Title _____

Make in duplicate: (1) Retain in District Office
(1) Fort Worth Accident Prevention

Form 60-02-1G

Attachment 7

RADIOACTIVE SEALED SOURCE
PHYSICAL INVENTORY REPORT

District_____ Date_____

This report is to be completed every three months to account for all sealed sources under the license.

Densiometer or Source Serial #_____ Unit #_____

Type of By-Product Material _____

Quantity of By-Product Material _____

Physical Condition of Source Holder (Visual) _____

Condition of Labels (If required)_____

Physical Location of the Sealed Source(s)_____

_____

_____

_____

Signature_____

Title_____

Make in Duplicate: (1) Retain in District Office

(1) Fort Worth Accident Prevention

Form 60-02-1G
(Alternate)

Attachment 7A

RADIOACTIVE SEALED SOURCE PHYSICAL INVENTORY REPORT

District _____
Date _____

This report is to be completed every three months to account for all sealed sources under the license.

Densiometer or Source Serial No.	Unit Number	Type By-Product Material	Quantity of By-Product Material	Physical Condition of Source Holder (visual)	Condition of Labels	Physical Location of Sealed Sources

Make in Duplicate: (1) Retain in District Office
(1) Ft. Worth Accident Prevention

Signature: _____
Title: _____

Form 60-02-1H (R-12/83) Attachment 8

RADIOACTIVE TRACER MATERIALS
PHYSICAL INVENTORY REPORT

District _____ Date _____

This report is to be completed every three months to account for all radioactive tracer material on hand.

Type of Tracer Material _____

Quantity of Tracer Material _____

Physical Location of Material _____

_____

_____

_____

Signature _____

Title _____

Make in Duplicate: (1) Retain in District Office

(1) Fort Worth Accident Prevention

Form 60-02-1H (R-12/83)

Attachment 8A

RADIOACTIVE TRACER MATERIALS
PHYSICAL INVENTORY REPORT

District _____
Date _____

Type Tracer Material	Form of Material	Quantity of Tracer Material	Physical Location of Material
Iodine (I-131)	Liquid	mCi	
Iridium (Ir-192)	Sand	mCi	
Iron (Fe-59)	Nails	mmCi	

Make in Duplicate: (1) Retain in District Office
(1) Fort Worth Accident Prevention

Signature _____
Title _____

Form 60-02-1I (R-12/83) Attachment 9

TEMPORARY USE

TLD BADGE LOG

District _____

Complete this form when assigning temporary TLD badges to personnel who are not technicians or loggers and who will be working within the 2 mR/hr restricted areas. Each TLD badge may be assigned to only one person. DO NOT assign a badge to another person after it has been previously exposed or worn by one person.

TLD Badge #	Name of Employee Assigned to Badge	Emp. #	Date Assigned	Date Returned	Logged by (Initials)

Retain in District Office after each quarter's use.

SUBJECT: Personnel Monitoring Requirements for Field Personnel

NO. SPM-60-03-2

PURPOSE

The purpose of this procedure is to safeguard the welfare of those who could possibly be exposed to radioactive materials by establishing a uniform system of wearing personnel badges and monitoring these badges to detect exposure levels. It is essential that these procedures be followed to assure that any personnel exposure be recorded on the badge, and in turn any badge exposure will be a personnel exposure. Additionally, procedures are outlined for steps to be followed in the event of an over-exposure and for personnel working with Iodine-131.

GUIDELINES

I. TLD Badge Procedures

A. The following procedures will be followed for the handling of TLD badges.

1. The badge supplier will send the shipment of badges to the District Manager (Radiation Safety Officer - RSO) several days before the beginning of the quarterly period. The monitoring period is for a three (3) month period and begins on the first day of the month. The badge will come from the supplier in a holder with a badge number, last name and initial, month and year for the monitoring period, and the code for the district on the badge holder. Complete badges with holders are furnished each quarter, and the badges should not be removed from the holders. The thermoluminescence dosimeters (TLD) badges that are used are not affected by humidity, organic vapors, or heat (less than 300°C or 375°F). Therefore, false readings from being wet or getting hot are eliminated. The TLD badge service will measure personnel exposure to Beta and Gamma radiation.

2. The district office will order badges for new employees from the TLD badge supplier, by listing the full name, birth date and social security number of the new employee on the Nuclear Sources and Services "TLD Change Form" (Form 60-03-1A, Attachment 1).

3. Return badges for terminated employees with the regular shipment. The badge should be marked with the termination date of the employee and stored with the Control badge until the entire shipment is returned to the supplier.

4. The supplier will be notified when employees are transferred from one location to another so the supplier can change the location of future badge shipments for that employee, if so required.

B. Employee's Responsibility

1. Personnel will wear badges on the front of their body (i.e., shirt pocket, or collar).

2. Employees assigned badges are required to wear the badge at all times when working in restricted areas (2mr/hr or higher radiation areas).

3. The employee, when on "days off", vacation, or in any situation except as defined above, should see that the badge is kept in a place free from radiation exposure and secured by being "locked up" so that it cannot be "tampered with".

4. See that badges are changed out as required and worn only during the current monitoring period, as required.

5. Return the badge to the District Radiation Safety Officer at the end of the wear period.

II. This section outlines the employees responsibility in the event that the TLD badge report indicates the individual has exceeded the allowable exposure limits.

A. Severe Over-Exposure (above 5 rem)

1. Submit to an examination by a doctor to determine if any biological effects have occurred.

2. Stay removed from any exposure to radioactive materials until approved for return by your manager.

3. Review your activities during the monitoring period and submit a written report within ten (10) days to the Radiation Protection Officer at Fort Worth stating how the over-exposure occurred.

B. Over-Exposure (above 1.25 rem)

Review your activities during the monitoring period and submit a written report within ten (10) days to the Radiation Protection Officer at Fort Worth stating how the over-exposure occurred.

SUBJECT: Personnel Monitoring Requirements for Field Personnel

NO. SPM- 60-03-2

III. In order to comply with the Nuclear Regulatory Commission and State requirements concerning the use of radioactive Iodine, bioassay testing procedures are required to detect any possible exposure to employees who may use the materials. If it is detected by this testing that exposure limits have been exceeded, certain action is required to prevent further exposure and eliminate the cause of exposure.

The following section outlines the procedures to be followed.

A. Personnel who open bottles and dispense quantities of liquid I-131 in excess of 50 mci at any one time are required to provide a urine sample for bioassay testing purposes. The urine sample should be taken after six (6) hours following the possible exposure to I-131.

B. At the end of each calendar year, any personnel who had opened or dispensed I-131 containers in quantities greater than 50 mci at any one time during that calendar year will submit to a thyroid check.

C. Test Result Action

Whenever the thyroid burden at the time of measurement exceeds 0.04 uci of I-131, the following actions shall be taken:

1. An investigation shall be made by the responsible District Radiation Safety Officer to determine the causes of the I-131 overexposures and to evaluate the potential for further exposures.

2. The District Radiation Safety Officer shall take steps to restrict the worker from further exposure until the source of exposure is discovered and corrected.

3. A repeat bioassay shall be taken within two (2) weeks of the previous measurement and should be evaluated within 24 hours after measurement in order to confirm the presence of internal radioiodine and to obtain an estimate of its effective half-life for use in estimating dose.

4. The WPS Radiation Protection Officer will notify the proper governmental licensing agencies as required by regulation or conditions of the license.

B. If the thyroid burden at any time exceeds 0.14 uci of I-131, the following action shall be taken:

1. Carry out action as in Paragraph A.I. above.

2. The District Radiation Safety Officer, after consultation with the WPS Radiation Protection Officer, will refer the case to the appropriate medical/health physics consultant for recommendations regarding therapeutic procedures that may be carried

out to accelerate removal of radioactive iodine from the body.

3. Carry out repeated measurement as recommended by appropriate medical/health physics specialist consulted.

IV. Termination Procedures

Regulations provide that employers must give a report of radiation exposures to all employees who have been occupationally exposed to radiation if they request such a report. Additionally, under certain conditions the employer is automatically required to provide such a report.

A. Exposure less than the limits - If an employee's quarterly exposure does not exceed the limits outlined in Part I above for any quarter during which they worked the Radiation Exposure report (Form 60-06-1A-Attachment 2) shall be completed. One copy should be sent to the employee, one copy should be retained in the District files and one copy shall be sent to the WPS RPO at Fort Worth.

B. Exposures above the limits - If an employee's quarterly exposure, during any quarter which they were employed, exceeds the limits outlined in Part I above, the Radiation Exposure Report (Form 60-06-1B-Attachment 3) shall be completed. One copy should be sent to the employee and one copy should be retained in the District files, and one copy shall be sent to WPS RPO at Fort Worth.

C. Exposures to I-131 - For employees who have previously had a urinalysis performed for I-131 exposure, the Radiation Exposure Report (Form 60-06-1C-Attachment 4) shall be completed. One copy should be sent to the employee, one copy should be retained in the District files and one copy shall be sent to the WPS RPO at Fort Worth.

V. The District Radiation Safety Officer (RSO) is responsible for assuring compliance with the above requirements.

VI. The District RSO or his designate is responsible for completing and distributing the forms according to instructions given for that form.

SUBJECT: Use of Radioactive Tracer Materials NO. SPM- 60-04-2

PURPOSE

In order to give proper safety consideration to the various radioactive materials used in tracer studies, the following procedures must be followed by all Western personnel using radioactive tracers.

GENERAL

Western is licensed to use the following radioactive isotope tracer materials for oil field tracer studies:

Type Source	Half Life	Form of Material
Iodine (I-131)	8.1 days	Liquid
Iridium (Ir-192)	75 days	Sand
Iron (Fe-59)	45 days	Nails

The radioactive tracer materials may be used in oil field studies such as: acidizing operations, cement top locations, cement channel locations, casing seat channel location, waterflood directional flow, oil injection profiles, interface markers, bottom plug markers, flow calibrations, oil slurry cement locations, recovery projects, fracturing, mud cake determination, permeability surveys and other types of surveys.

Iridium 192 in the form of radioactive sand and Iodine 131 in the form of a liquid are generally poured into a blender volume tank or a slurry hopper where they are mixed or blended and then pumped downhole. Iron 59 in the form of radioactive nails are hammered into plugs before they are set downhole. Well logging companies are contacted by the well operators to conduct downhold instrument studies on the tracer materials later on.

I. Receiving and Opening Tracer Packages

A. All packages sent from Western's suppliers containing radioactive materials are shipped according to DOT regulations. The radiation exposure limit for a single DOT package is not more than 200 mR/hr at the surface of the shipping container and not more than 10 mR/hr at a distance of three (3) feet from the surface of the container.

B. When a shipment of tracer material is delivered to a district facility, it shall be monitored on the external surfaces of the package(s) for radioactive contamination caused by possible leakage of the contents. The monitoring shall be performed as soon as practicable after receipt, but no later than three (3) hours after the package is received at the district facility if received during the normal working hours, or eighteen (18) hours if received after normal working hours.

Using a piece of Whatman filter paper or a piece of paper towel of approximately 2 square inches, wipe the exterior surface of the package using moderate pressure. In an area of low radiation background survey the filter disk or paper towel with the beta window of the survey meter in the open position. This measurement will be taken at a distance of ½" from the open beta window. If the reading exceeds 0.5 mr/hr above the background level, immediately notify the District Radiation Safety Officer.

C. After the tracer shipment has been monitored, it will immediately be placed into the district storage area for safekeeping until the time of use. At that time, the shipment will be logged into the district's Radioactive Tracer Material Log (Form 60-02-1B) and receiving records will be placed in a properly marked file.

II. District Storage Facilities

A. District storage facilities for radioactive tracer materials shall be designed or positioned so that no person in an uncontrolled area outside the storage area can receive more than 2 mR in any one hour or more then 100 mR in any seven (7) consecutive days.

B. The storage area can be a locked room or any other means which will provide physical security to the tracer material and provide radiation exposure protection to personnel working outside the storage area.

C. Only authorized personnel wearing TLD badges shall have access to the storage facility.

D. Tracer materials shall be stored in their original shipping containers while in the storage area when possible.

E. District storage pit recommendations:

1. Minimum of two feet of earth, concrete or fill separate adjacent pits.
2. Pits to be a minimum of four feet deep.
3. Lids to be screwed on or recessed in, designed to exclude water [illegible] pped with a locking device. Label top of lid with stick-[illegible] stating "Caution - Radioactive Material".
4. Maximum lid contact reading should be 2 mR/hr or less. If not, a locked fence perimeter will be established beyond the 2 mR/hr level range.

Note: Contact the WPS Radiation Protection Officer at Fort Worth for storage pit drawings.

F. All storage area doors shall be posted "Caution - Radioactive Material". On pit storage areas, the posted "Caution - Radioactive Material" signs should be on four sides of the fences controlling the area.

G. Storage facilities shall be monitored quarterly and the results recorded on the Facility Storage Monitoring Report (Form 60-02-1E) in section 60-02-1 of this manual.

III. Transportation of Tracer Materials

A. Packaging of Radioactive Materials

1. Packaging requirements for radioactive material quantities are generally based upon the aggregate radioactivity of the material as outlined below:

WPS Radioactive Material	Type "A" Packaging Quantity Limits
Iodine (I-131)	10 Curies
Iridium (Ir-192)	10 Curies
Iron (Fe-59)	30 Curies

2. All packages of radioactive materials must meet certain general packaging requirements:

a. The outside of each package must incorporate a feature such as a seal, which is not readily breakable and which, while intact, will be evidence that the package has not been illicitly opened. The smallest outside dimension of the package must be four (4) inches or greater.

b. Liquid radioactive material in Type "A" quantities must be packaged in a leak-resistant and corrosion-resistant inner containment vessel. There must be no significant removable surface contamination on the exterior of any package.

c. No person may offer for transportation aboard a passenger carrying aircraft, any radioactive material, unless that material is intended for use in, or incident to, research, medical diagnosis or treatment, or for which a specific exemption is provided.

3. Limited Quantities - Exemptions from specification packaging and general packaging requirements are allowed for limited quantities of radioactive materials, such as Iron (Fe-59), for amounts not exceeding thirty (30) millicuries (mCi).

The above exceptions from specification packaging are subject to the following (this would apply only to Western shipment of FE-59 nails):

a. Materials must be packaged in strong tight packages so that there will be no leakage of radioactive materials under conditions normally incident to transportation.

b. The radiation dose rate at any point on the external surface of the package may not exceed 0.5 millirem per hour.

c. There must be no significant removable radioactive surface contamination on the exterior of the package.

d. The outside of the inner container must be marked "RADIO-ACTIVE".

4. Due to complexities of packaging, every effort should be made to use the original packaging as received from the radioactive material supplier when forwarding the materials to the wellsite for use.

B. Shipping papers, labelling and placarding procedures

1. As a private motor carrier, Western may not transport hazardous materials such as radioactive materials unless the shipment is accompanied by proper shipping papers or documentation prepared in accordance with DOT regulations.

2. The Shipper's Certification For Radioactive Materials, Form 1-106, (Attachment 1) will be completed and carried with each shipment of tracer materials. Attachment 1 illustrates how a completed form may appear. The certification section of the form on the bottom right side must be completed only when Western permits a carrier outside of the Company to transport the shipment.

3. The Shipper's Certification For Radioactive Materials form for the tracer supplier may be used as the model for most shipments.

4. Specific requirements are outlined in the regulations concerning the driver and motor carrier responsibilities for shipping paper accessibility:

a. If the shipping paper is carried with other shipping papers or any other papers, it must be clearly distinguished by either distinctively tabbing it or by having it appear first, and

b. When the driver is at the vehicle controls, the shipping paper must be at his immediate reach when he is restrained by the lap belt, and

c. Either readily visible to a person entering the driver's compartment, or in a holder which is mounted on the inside of the door on the driver's side of the vehicle.

5. Radioactive labels - There are three hazardous materials warning labels used to identify a shipment of radioactive materials- RADIOACTIVE I, RADIOACTIVE II, and RADIOACTIVE III. Each RADIOACTIVE label contains at the lower half, a space for the shipper to add the "CONTENTS", and the "NO. OF CURIES". In addition, RADIOACTIVE II and RADIOACTIVE III include a black box which the shipper must complete with the "Transport Index: (Maximum of 50 per vehicle or area)". The entries may be completed by legible printing, using a durable weather-resistant means of marking.

Curies (Ci)
Millicuries (mCi)
Microcuries (uCi)

Name of Radionuclide

"Transport index" means the number placed on a package to designate the highest radiation dose rate, in millrem per hour at three(3) feet from any accessible external surface of the package. The number expressing the transport index shall be rounded up to the next highest tenth; e.g., 1.01 becomes 1.1.

All three types of labels used are illustrated on pages 7 & 8. The radiation rate exhibited by a package when measured with a survey meter determines the type of labeling required.

Type Label Required	Radiation Dose Rate
Radioactive White I	0.5 mR/hr or less on surface of package and o m/hr at 3 foot distance from package.
Radioactive Yellow II	More than 0.5 mR/hr on surface of package and not more than 1.0 mR/hr at 3 foot distance from surface of package.
Radioactive Yellow III	More than 50 mR/hr on surface and more than 1.0 mR/hr at 3 foot distance from surface of package.

6. Loading Requirements for Carriage by Highway

Special loading and storage requirements are outlined for materials classed as Radioactive Materials.

Packages of radioactive materials loaded into a single vehicle may not have a total transport index which exceeds 50. Transport index numbers are on packages bearing the RADIOACTIVE YELLOW II or the RADIOACTIVE YELLOW III hazardous materials warning labels.

Such packages of radioactive materials may not be placed in motor vehicles or other places closer than provided in the "transport index table" to any area which may be continously occupied by passengers or employees.

Total Transport Index	Minimum distance in feet to area of persons, or minimum distance in feet from dividing partition of cargo compartments
None	0
0.1 to 1.0	1
1.1 to 5.0	2
5.1 to 10.0	3
10.1 to 20.0	4
20.1 to 30.0	5
30.1 to 40.0	6
40.1 to 50.0	7

Note: The distance in the table must be measured from the nearest point on the packages of radioactive materials.

7. The DOT "Radioactive" placard will be placed on all four sides of any vehicle which is carrying radioactive tracers requiring the use of the RADIOACTIVE YELLOW III label. Removable magnetic DOT signs may be purchased for use on cars and pickups.

Radioactive Material Labels

Radioactive White I
(Red and Black Printing on White)

Radioactive White I labels must be affixed to each package measuring 0.5 millirem or less per hour at each point on the external surface on the package, provided package is not Fissile Class II or Class III, or does not contain a "large quantity" of radioactive material.

Radioactive Yellow II
(Yellow, Red, and Black
Printing on White)

Radioactive Yellow II must be affixed to each package measuring more than 0.5 millirem per hour at each point, and not exceeding 1.0 millirem per hour at three (3) feet from each point on external surface of the package.

Radioactive Yellow III must be affixed to each package measuring more than 50 millirem per hour at each point on the surface of the package or exceeds 1.0 millirem per hour at three (3) feet from each point on the external surface of the package.

GUIDELINES ON USE: Complete "Contents", No. of Curies" and "Transport Index". Display Labels (total 2) on each side or on each end, excluding bottom.

C. Securing tracers transported in or on Western vehicles

The tracer shipment must be secured during transit in one of the following manners:

1. Locked in the trunk of a car and braced to prevent shifting during transport.

2. Locked in the tool box of a pickup and braced to prevent shifting during transport.

D. Temporary storage in a vehicle at the wellsite.

1. Tracer materials will remain stored in their vehicle compartment until the time of their use.

2. The vehicle storage compartment shall be used to transport any unused tracers and/or their packaging materials back to the district storage facility for final disposition as required.

E. Drivers of vehicles transporting tracers

1. The drivers of vehicles transporting tracers must meet DOT requirements for age (21 years of age or older) and training (licensed and DOT certified in order to transport hazardous materials).

2. The drivers need not be authorized users of radioactive materials in order to transport the tracers and need not be issued a TLD badge if the driver's area of the cab receives less than 2 mR/hr radiation exposure.

3. The vehicle driver releases responsibility and control of his radioactive cargo at the wellsite to the district's Radiation Supervisor present on the job.

IV. Wellsite Safety Equipment

A. The following handling and safety equipment should be available and used for wellsite tracer operations:

1. Rubber or plastic gloves.

2. Organic vapor cartridge type respirator (for liquid Iodine 131 only).

3. Handling tongs or a similar device (when extended time is required by nature of the job).

4. Other protective clothing (to be determined before the job at the district office).

5. Plastic trash bags (storage bags for contaminated equipment and tracer packaging).

6. Paper towels (for clean up uses).

7. TLD badges (issued to anyone required to work in restricted- over 2 mR/hr - area).

8. Dust respirator for Ir-192 sand work.

Note: For optional use, a Radiation Emergency Anticontamination Kit, Model 6000 from the Dosimeter Corporation of America contains an MSA dust mask, coveralls, shoe covers, sponges, towels and gloves in a carrying tube for emergency use.

B. A calibrated low-level survey meter with beta window such as a Victoreen Model 493 will be available at the jobsite to conduct necessary survey activities.

V. Tracer Use Operating Procedures.

A. Pre-job knowledge and planning - the Radiation Supervisor must know:

1. Types of radiation involved.
2. Intensity of radiation.
3. Relative hazard of each type of radiation.
4. What the "stay time" (maximum allowable exposure time) is.
5. What the possible contamination problems are.
6. Any internal contamination problems.
7. What industrial nuisance removable contamination will create.
8. What controls must be dictated to protect personnel.
9. Plan methods for controlling access to radioactive material use.

B. Specific procedures will vary with the individual job applications. In general, the following procedures should be followed:

1. The job will be planned in advance and the necessary tracer material should be ordered only as needed.

2. Personnel required to work in restricted areas (over 2 mR/hr exposure) will have or be issued TLD badges prior to the start of the job from the district yard.

3. The required tracer material will be taken out of district storage and placed in the locked storage compartment of the vehicle properly placarded to transport it to the wellsite.

4. The tracer material will be logged "out" on the Radioactive Tracer Material Utilization Log (Form 60-02-1B) and hazardous materials shipping papers will be given to the tracer material vehicle driver. A second copy of the shipping papers may be carried to the wellsite by the Radiation Supervisor for the job.

5. The Radiation Supervisor will carry to the wellsite a ring binder containing:

a. Copy of radiation license.
b. Copy of Western Radiation Manual or equivalent.
c. Copy of "Notice to Employees" poster.
d. Dispatch Job Sheet.
e. Survey meter calibration.
f. Wellsite Radiation Monitoring Report (Form 60-02-1D)

6. Conduct pre-trip vehicle survey and list results on the Wellsite Radiation Monitoring Report (Form 60-02-1D).

7. Transport tracer material to the jobsite.

8. Define and select mixing locations at wellsite.

9. At pre-pumping safety meeting, tell and define to employees (also customers, etc.) what restricted area, if any, will be prohibited to unauthorized personnel during the tracer part of the job. Indicate that no eating, smoking or drinking will be allowed in any restricted area.

10. The wellsite will be monitored prior to the start of the job so as to detect any pre-existing radiation conditions before the start of Western's work and results recorded on the Wellsite Radiation Monitoring Report (Form 60-02-1D).

11. All restricted areas where radiation levels are expected to achieve 2 mR/hr will be posted with signs starting "Caution-Radiation Area". These signs will bear the radiation symbol and be magenta and safety yellow in color. The signs will be conspicuous and obvious from all directions. In the event that the levels exceed 5 mR/hr, a sign stating "Caution - High Radiation Area," magenta and safety yellow in color, will be conspicuously posted.

12. Mix radioactive material with injection fluid with special consideration given to splashing, wind conditions, and any other outside influence which could interfere with the safe handling of the material.

13. For cement work, mix the water with the concrete on location. Using plastic gloves, the tracer material is added to the cement slurry. The maximum concentration of Iodine 131 in the cement slurry should be 0.013 microcuries per milliliter. The slurry is then discharged from the Unimix trailer and pumped into the well.

14. For stimulation work, add tracer material to the blender volume tank fluid. Usually, a concentration of 0.20 to 0.33 millicuries of Iridium 192 sand per 1,000 pounds of frac sand is used. The blender fluid is then discharged to pumps and sent downhole into the well.

15. Exposure time should be controlled. If exposure approaches the maximum permissible limit, personnel should be rotated.

16. Empty tracer containers shall be placed in properly labeled and marked plastic bags for district storage or disposal purposes.

17. Following the completion of the operation, all lines will then be flushed with displace fluids. All equipment and lines will

be surveyed to check for contamination. Decontamination shall in general be accomplished by rinsing and flushing fresh water through the equipment. (See Part VII of this section for decontamination procedures. The entire area shall be monitored and the results recorded on the Wellsite Radiation Monitoring Report (Form 60-02-1D).

18. Monitoring techniques for personnel, handling tracer materials, using a survey meter with the beta window in the open position:

    a. Check hands (fingertips), shoes (soles and heels, face (nostrils) first.

    b. Remove any contaminated clothing and place in a marked plastic bag and continue monitoring.

    c. Check hands ALWAYS before eating, drinking or smoking. Cleanse hands carefully of any contamination (scrub with soap and water), and check again.

19. Unused tracer materials, if any, and contaminated tracer containers will be placed in their secured vehicle transport compartment and returned to the district storage area. Log in on Radioactive Tracer Material Utilization Log (Form 60-02-1B) after returning to the district office. Place a copy of the dispatch sheet in district radiation files.

20. The empty vehicle which transported the leftover tracer and/or contaminated empty containers will be monitored and the results will be logged on the Wellsite Radiation Monitoring Report, (Form 60-02-1D) which will then be placed in the appropriate district file.

21. Collected temporary or visitor TLD badges will be logged in and returned to their storage file which is distant from any source of radiation that might cause a false or erroneous reading when the badges are processed.

VI. Radioactive Tracer Waste Disposal

The following procedures must be adhered to in order to assure proper disposal of radioactive tracer material. Waste-contaminated bottles, tools, equipment and residual quantities of radioisotopes used in tracer studies may be disposed of only by the following methods:

A. Radioactive, or contaminated material may be stored in the district storage area until it has sufficiently decayed to the point where, upon surveying with an instrument and finding levels no higher than background, the waste can be disposed of in a normal manner. All labels indicating that the bottles, tools or equipment containing radioactive material will be removed. The labels indicating

that radioactive material was present will be defaced or destroyed. or

B. Waste-contaminated materials or radioactive materials will be placed in proper shipping containers and shipped to NSSI, Gulf Nuclear or other approved waste disposal companies for disposal after contacting them first for their approval and any other instructions necessary concerning the shipment.

VII. Contamination Survey - Decontamination Procedures

A. Surveying of Area and Equipment

The ideal mixing and pumping operation would have no spills and leave no residue of tracer material in any of the vessels or pipes through which the tracer was pumped. In practice, such an ideal may not be realized, and a survey of the area is necessary so that the proper procedures may be followed to assure that no remaining contaminant can cause harm to company personnel, the customer's personnel, or the general public.

The survey meter must be used with the beta shield on the probe, in the open position. Survey the entire area where mixing has been done, and the pipes and associated components through which the mix was conducted to the well, to be sure that no concentration remains that may cause harm, either by external radiation or by contamination of food or water supplies.

Contamination of the survey meter probe must be avoided. If any contact survey is made, the probe is to be protected with a sheet of paper between the object and probe. A contaminated probe can render the survey meter useless for a low-level measurement.

Spills should be cleaned up and, if possible, injected into the well with the main tracer unit. The area of the spill should then be surveyed with the probe approximately one inch above the surface.

Any areas or items of equipment which indicate any amount of detectable radioactivity, above background, shall be considered contaminate and appropriate measures taken to remove such concentrations.

B. Surveying of Individuals

The greatest of care should be taken when surveying items of personal equipment such as shoes, gloves, clothing and handling tools, as well as exposed portions of the body of personnel working with radioactive materials. This is because of the much greater probability of ingestion from such items.

The survey meter shall be used with the beta shield open to survey for radiation on clothing worn by individuals performing the mixture operations or any other clothes suspected of contamination. This should be

done immediately following the mixing operations. If any indication of radioactive contamination is found on items of clothing, equipment, etc., or on the body of personnel involved in the operation, every effort should be made to remove the activity.

C. Decontamination Procedures

The radiation tracer preparations are down, by factors of 50 to 200, below the dangerous levels for external radiation hazards. The major hazard involved with these tracer preparations is the factor of ingestion. The ingestion tolerance is from one part per thousand to one part per ten thousand of the typical activities used. Thus, great care should be exercised by company personnel to avoid contamination of hands, clothing and other personal items. Accidental concentrations of radioactive material should be cleaned up, dispersed, or disposed of safely.

Decontamination shall, in general, be accomplished by rinsing and flushing fresh water through the equipment, or washing and scrubbing of contaminated items of clothing or portions of the individual's body. A detergent may be added to the water to aid this process. Portions of the equipment which cannot be decontaminated by this method shall be disassembled and scrubbed with water and detergent followed, if necessary, by steam cleaning. A 15% hydrochloric acid solution may be used to remove contamination from the surface of non-porous materials. Other chemicals may be used for decontamination but their use should be limited due to their toxic nature.

Articles of clothing can normally be easily decontaminated by washing and scrubbing with water containing a strong detergent. This also applies to portions of the exposed individual's body. If efforts to decontaminate items of clothing on the job are unsuccessful, the clothing should be removed immediately to be washed after returning to the home station nearest the job location. Contaminated articles of clothing, rags, etc., shall never be laundered in a home or commercial laundry. Such washing and scrubbing is restricted to the jobsite or company base. If the contamination cannot be removed economically, the clothing shall be discarded and treated as radioactive waste.

As indicated above, every effort should be made to decontaminate any contaminated area of the body. Scrubbing should be repeated until activity is removed. The same safety precautions shall be applied to the above operations as were applicable for tracer mixing and injection in particular.

1. Rubber gloves shall be worn during decontamination procedures involving personal contact with the equipment.

2. Food, cigarettes, etc., shall be kept outside the clean-up area. Quantities of radioactive materials which present no

hazard outside the body can be very dangerous if the same amount is internal.

3. The wash water shall be treated as radioactive waste. If wash water is discharged into sanitary sewage system, the dilution of the activity by the sewage must be such that the tolerance established for such disposal by the NRC and agreement states are not exceeded.

   Since we do not have the capability of assaying the wash waste for the concentration of contaminant in microcurie per milliliter, we must use the amount of tracer material actually used on the job and the average daily water consumption at the base in determining that we are exceeding tolerances.

   Wash water shall not be discharged into a septic tank.

   If standard decontamination efforts are unsuccessful, the procedures to be followed shall depend on the value and ownership of the items involved, the degree of contaminations, and the half-life of the contamination activity. Every effort shall be made to thoroughly decontaminate rented or borrowed equipment. If all efforts to decontaminate items of equipment, clothing, etc., have failed to render the radioactive contamination to background and the measurable activity is apparently "fixed", the User in charge has three (3) alternative. They are as follows:

   a. If the "fixed" contamination measures less than 0.2 mR/hr at one centimeter, the item of equipment, article of clothing, etc., can be returned to normal use.

   b. If the "fixed" contamination measures more than 0.2 mR/hr at one centimeter, the item or items in question shall be treated as radioactive waste and disposed of accordingly.

   c. If the item containing the "fixed" contamination (which measures more than 0.2 mR/hr at one centimeter) is such that it is continually used in tracer operations, e.g., parts of a dump bailer, tracer injector, etc., and will be used in no other operation, then it may continue to be used if it is labeled properly and treated as a radioactive source and if the radiation measures less than 2.0 mR/hr at three (3) inches from the surface.

   More persistent activities remaining on pumping apparatus, customer's equipment etc., may require being steam cleaned or chemically treated for contamination.

   The Radiation Supervisor in charge of the job shall be responsible for all contaminated equipment. That is, for any equipment, waste, area, or wash water that falls within the above alternative situations.

The Radiation Supervisor in charge shall personally supervise its safe disposition either by staying on the job until the contamination is removed or transporting the equipment to the base where it may be stored awaiting further decontamination efforts.

VIII. Emergency Procedures

Emergencies vary greatly in their respective hazards. Sometimes these emergencies are in the form of spills, fires or explosions which, consequently, result in the spread of radioactive contamination. Emergency procedures contained in the National Bureau of Standards, Handbook No. 48, are given here as a guide. It must be recognized that these procedures are general and any specific emergency would certainly involve additional procedures not specifically covered in this outline.

A. Spills involving no radiation hazard to personnel:

1. Notify all personnel in the area at once.

2. Permit only a minimum number of personnel in the vicinity of the spill.

3. Confine the spill immediately.

4. Notify the District Radiation Safety Officer and the Fort Worth WPS Radiation Protection Officer.

5. Decontaminate.

6. Monitor all personnel involved in the spill and cleaning.

7. Permit no person to resume work in the area until it has been surveyed and approved by one of the approved individual Users specified on the NRC and/or agreement state radioactive material license.

B. Spills involving radiation hazard to personnel:

1. Notify all personnel not involved in the spill to vacate the area at once.

2. If the spill is liquid and the hands are protected, right the container.

3. If the spill is on the skin, flush thoroughly.

4. If the spill is on the clothing, discard outer or protective clothing at once.

5. Switch off all fans. Vacate the room.

6. Notify the Radiation Protection Officer as soon as possible.

7. Take immediate steps to decontaminate the personnel involved.

8. Decontaminate the area.

9. Permit no person to resume work in the area until a survey is made and approval of the District Radiation Safety Officer is secured.

10. Prepare a complete history of the accident and give details in the Emergency Procedures Report (Form 60-04-2A - Attachment 2).

C. Injuries to personnel involving radiation hazards:

1. Wash minor wounds immediately under running water while spreading the edges of the cut.

2. Call a physician, preferably one who is qualified to treat radiation injuries.

3. Permit no person involved in a radiation injury to return to work without approval of the attending physician.

4. Report all radiation accidents (wounds, over-exposure, ingestion, inhalation) to your supervisor.

5. Prepare a complete history of the accident and give the details in Emergency Procedures Report. (Form 60-04-2A - Attachment 2).

D. Fire and other major emergencies:

1. Notify all personnel in the area at once.

2. Attempt to put out all fires if radiation hazard is not immediately present.

3. Notify the fire department.

4. Notify the District Radiation Safety Officer.

5. Govern the fire fighting or other emergency activity by the restrictions of the District Safety Officer.

6. Following the emergency, monitor the area and determine the emergency devices necessary for safe decontamination.

7. Decontaminate.

8. Permit no person to resume work without approval of the District Radiation Safety Officer.

9. Monitor all persons involved in combating the emergency.

10. Prepare a complete history of the accident and give details in the Emergency Procedures Report (Form 60-04-2A - Attachment 2).

IX. General Guidelines for Controlling Radioactive Tracer Exposure to Personnel

A. Introduction

In order to give proper safety consideration to the various radioactive materials used in tracer surveys, the following information should be understood by all field Users. The relatively low activity levels of the tracer units allow some latitude in handling techniques such that moderate safety precautions are sufficient. The large variety of tracer preparations used, or available for use, is such that no fixed procedures can be specified for each tracer unit. In general though, the majority of tracers may be handled for a few minutes without the use of extension tools.

The major safety problem is the prevention of accumulation of radioactive material in the body. The activities typically used are from 100 to 10,000 times the tolerable limit for internal accumulation. The degree of this particular hazard depends on the biological activity of the isotope, its half-life and the nature of the tracer preparation.

B. Safety through distance

Distance can be an effective safety measure from a source. Safe distances should be known for the amounts of radioactive material being handled or stored.

Examples of exposure rates at various distances from a 100 millicurie source:

Radioactive Tracer Material	1 Ft. mR	3 Ft. mR	6 Ft. mR	9 Ft. mR
Iridium 192	590	65	16.38	7.2
Iodine 131	220	24	6.11	2.7
Iron 59	640	71	17.77	7.9

Note: Tables A through C (Attachments 3 thru 5) at the end of this section are provided for exposure rate calculation purposes.

C. Safety through shielding

Certain materials are effective shields against radiation. The half-value layer is the amount of shield necessary to reduce the radiation to one-half. In tracer work, shielding generally is only used when the materials are in storage.

Half-value layer for some tracer materials:

Radioactive Tracer Material	Lead	Steel	Concrete
Cesium - 137	0.25"	0.68"	2.1"
Iridium - 192	0.19"	0.50"	1.9"

D. Safety through stay time

The safety of an individual may be gained by controlling the amount of time he is exposed to radiation. If exposure approaches an unsafe limit, personnel shall be rotated to receive as little radiation as possible.

Charts 1-3 (Attachments 6 thru 8) at the end of this section, give the allowable handling time in minutes per week for various amounts of Iodine 131 and Iridium 192. This is based on a maximum allowable radiation exposure of 5.0 rems per year or 1.25 rems per quarter (18.75 rems for extremities) as specified in the pertinent federal and or/ agreement state regulations. We must stay within the handling times as indicated on the chart in order that we may continue to handle the unshielded tracer units without the benefit of hand-type monitoring devices such as wrist film badges, finger dosimeters, etc., or remote handling devices. However, the use of normal safety equipment such as survey meters, rubber gloves, etc., and the regular TLD badge is still required.

The allowable handling time is determined as the maximum time in minutes per week that a person can work with his hands (rubber gloved) in direct contact with unshielded tracer units. The allowable handling time as indicated on Chart A is not additive-that is, you cannot, for example, work for 18 minutes with 10 millicuries of Iridium 192 and 42 minutes with an equal amount of Iodine 131 in one week. If several hand exposures to both types of tracer materials are received during one week, the exposures must be rationed.

Example: If in one calendar week a person directly handles 20 millicuries of Iodine 131 for three (3) minutes, 10 millicuries of Iridium 192 for three (3) minutes, and 15 millicuries of Iodine 131 for four (4) minutes, these exposures are totaled as follows: From the chart, the allowable handling time for 20 millicuries of Iodine 131 is 21 minutes. Hence, the

exposure to the hands for 20 millicuries of Iodine 131 is 3 divided by 21, or .143 or the weekly allowable handling time. Similarly, the exposure for the 10 millicuries of Iridium 192 is 3 divided by 18, or 1.67; and that for the 15 millicuries of Iodine 131 is 4 divided by 28, or .143. Adding these fractions together, .143 + .167 + .143 = .453, or a little less than half the total allowable handling time for that praticular calendar week.

WHEN THE VARIOUS EXPOSURES ADD TO A TOTAL OF MORE THAN 1.00, THE WEEKLY ALLOWABLE HANDLING TIME HAS BEEN EXCEEDED AND THE FOLLOWING WEEK'S WORK MUST BE LIMITED ACCORDINGLY.

Remember that tolerances are not intended as working levels, but as maximum safe levels only, and that the objective should be to obtain minimum exposure during tracer operations. This can be accomplished by working as rapidly, yet carefully, as possible with the tracer units and also by distributing the actual direct handling of the unshielded materials among as many qualified people as possible.

X. Responsibilities

The District Radiation Safety Officer is responsible for assigning duties and assuring compliance with these procedures. He will conduct a quarterly review of these procedures with his authorized personnel and record in district records the time, date and attendance of the meeting.

Form 0-106 (Rev. 12/15/83)

Attachment 1
SPM 60-04-02

SHIPPER'S CERTIFICATION FOR RADIOACTIVE MATERIALS

NATURE AND QUANTIRY OF CONTENT				PACKAGE			
Proper Shipping Name	Radionuclide	Form	Activity		Category	Transport Index	Type
Hazardous materials descriptions and proper shipping names from 172.101 Hazardous Materials Table use: Radioactive Material .n.o.s. or Radioactive Material Special Form, n.o.s.	Name or Symbol of Principal Radioactive Content	Chemical form and physical state (gas, liquid, solid) or special form	Number of milli-curies	Number of Packages	I-White or II-Yellow or III-Yellow Label	For Yellow Label Categories only	USA DOT 7A Type A
Radioactive Material, n.o.s. UN2982	Ir-192	Solid	25 mCi	2	III Yellow	7	USA DOT 7A Type A
Radioactive Material, n.o.s. UN2982	I-131	Liquid	5 mCi	1	III Yellow	1	
Radioactive Material, n.o.s. UN2982	Fe-59	Solid	45 mCi	1	III Yellow	1	
Radioactive Material, Special Form, n.o.s. UN2974	Cs-137	Special Form	12 mCi		II Yellow	1	

EXAMPLE

Dispatch Sheet Job No. 32115

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 the applicable regulations of the Department of Transportation.

Name and full address of Shipper	Name and title of person signing Certification
The Western Company of North America	GEORGE P. SMITH
6100 Western Place	DISTRICT ENGINEER
Fort Worth, Texas	LASTSTEP, TX
Date: 12/15/83	Signature of the Shipper: George P. Smith

EMERGENCY PROCEDURES REPORT

District _____ Date _____

1. Customer _____
2. Location _____
3. Customer's Supervisor _____
4. Company Supervisor _____
5. Cause of Emergency _____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

6. Type of Isotope _____
7. Quantity of isotope (curies) believed to have been involved _____

_____

8. Safety precautions immediately enacted _____

_____

_____

_____

EMERGENCY PROCEDURES REPORT

9. List any suspected over-exposures (if there were none indicate NONE)

   1. _____ 3. _____

   2. _____ 4. _____

10. Results of personnel radiation survey for those individuals working inside the 2 mR/hr restricted area (all results in mR/hr).

NAME	HEAD	FACE	BODY	HANDS	LEGS	FEET
1. _____						
2. _____						
3. _____						
4. _____						
5. _____						
6. _____						

11. On a sketch of the job-site, mark the exact location of the spill.

12. Make a dose chart if the level of the spill is greater than 10 mR/hr at 1 foot.

    1. One foot _____ mR/hr

    2. Three feet _____ mR/hr

    3. Six feet _____ mR/hr

13. Check the air space for contamination _____

14. Results of wipe tests taken after emergency clean-up operations

    Position #1 _____ dpm

    Position #2 _____ dpm

    Position #3 _____ dpm

15. Recommendations to ensure incident does not recur in the future_____

_____

_____

_____

_____

DISTANCE -vs- EXPOSURE RATE
FOR
IRIDIUM-192 (Ir-192)

mR/hr at various distances from one (1) curie of unshielded Ir-192

Feet	mR/hr	Feet	mR/hr
1	5900.00	29	7.02
2	1475.00	30	6.56
3	655.56	31	6.14
4	368.75	32	5.76
5	236.00	33	5.42
6	163.89	34	5.10
7	120.41	35	4.82
8	92.19	36	4.55
9	72.84	37	4.31
10	59.00	38	4.09
11	48.76	39	3.88
12	40.97	40	3.69
13	34.91	41	3.51
14	30.10	42	3.34
15	26.22	43	3.19
16	23.05	44	3.05
17	20.42	45	2.91
18	18.21	46	2.79
19	16.34	47	2.67
20	14.75	48	2.56
21	13.38	49	2.46
22	12.19	50	2.36
23	11.15	51	2.27
24	10.24	52	2.18
25	9.44	53	2.10
26	8.73	54	2.02
27	8.09	55	1.95
28	7.53		

Note: For other quantities, multiply the number of curies by the mR/hr value shown here for the required distance.

Example: @ 11 feet = 48.76 mR/hr for 1 curie of Ir-192

50 millicuries = 0.05 curies

then - 0.05 Ci X 48.76 = 2.4 mR/hr

50 mCi intensity @ 11 feet = 2.4 mR/hr

DISTANCE -vs- EXPOSURE RATE
FOR
IODINE-131 (I-131)

mR/hr at various distances from one (1) curie of unshielded I-131

Feet	mR/hr
1	2200.00
2	550.00
3	244.44
4	137.50
5	88.00
6	61.11
7	44.89
8	34.37
9	27.16
10	22.00
11	18.18
12	15.27
13	13.01
14	11.22
15	9.77
16	8.59
17	7.61
18	6.79
19	6.09
20	5.50
21	4.98
22	4.54
23	4.15
24	3.81
25	3.52
26	3.25
27	3.01
28	2.80
29	2.61
30	2.44
31	2.28
32	2.14
33	2.02
34	1.90

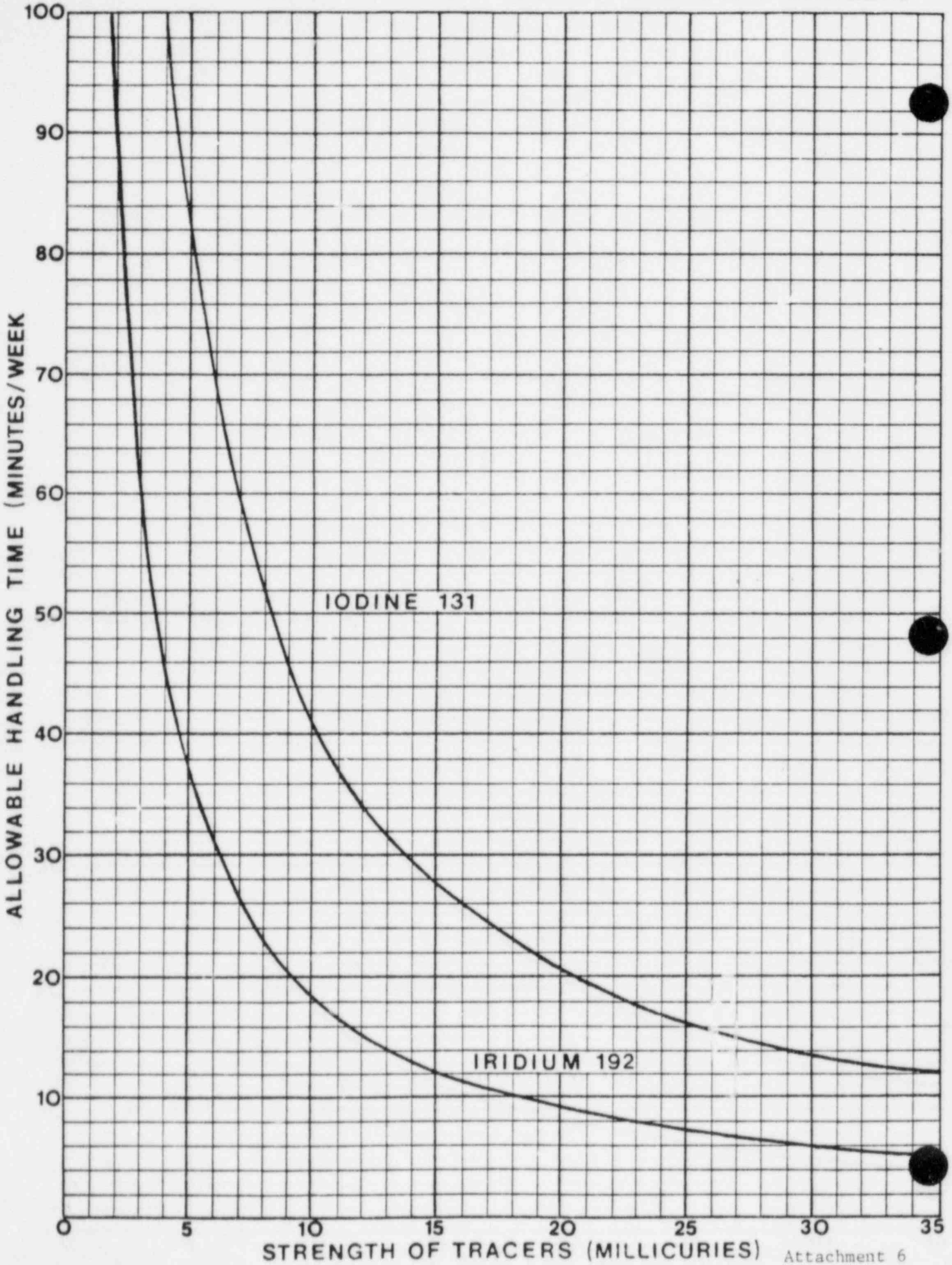
DISTANCE -vs- EXPOSURE RATE FOR IRON-59 (Fe-59)

mR/hr at various distances from one (1) curie of unshielded Fe-59

Feet	mR/hr
1	6400.00
2	1600.00
3	711.11
4	400.00
5	256.00
6	177.77
7	130.61
8	100.00
9	79.01
10	64.00
11	52.89
12	44.44
13	37.86
14	32.65
15	28.44
16	25.00
17	22.14
18	19.75
19	17.72
20	16.00
21	14.51
22	13.22
23	12.09
24	11.11
25	10.24
26	9.46
27	8.77
28	8.16
29	7.60
30	7.11
31	6.65
32	6.25
33	5.87
34	5.53
35	5.22
36	4.93
37	4.67
38	4.43
39	4.20
40	4.00

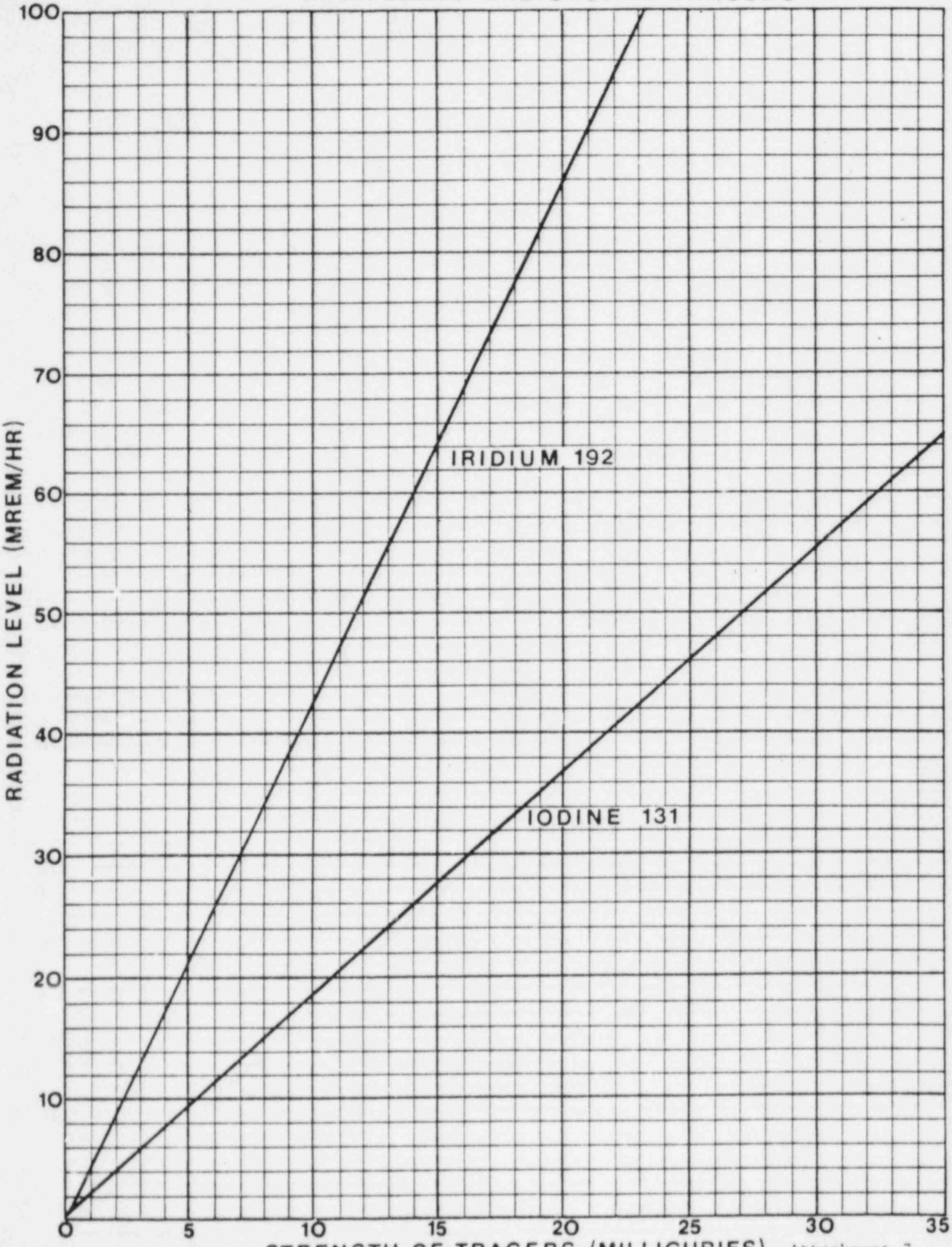
Note: 1 microcurie (uCi) = 0.000001 curie (Ci)

CHART 1 - HAND EXPOSURE FROM RADIOACTIVE TRACERS



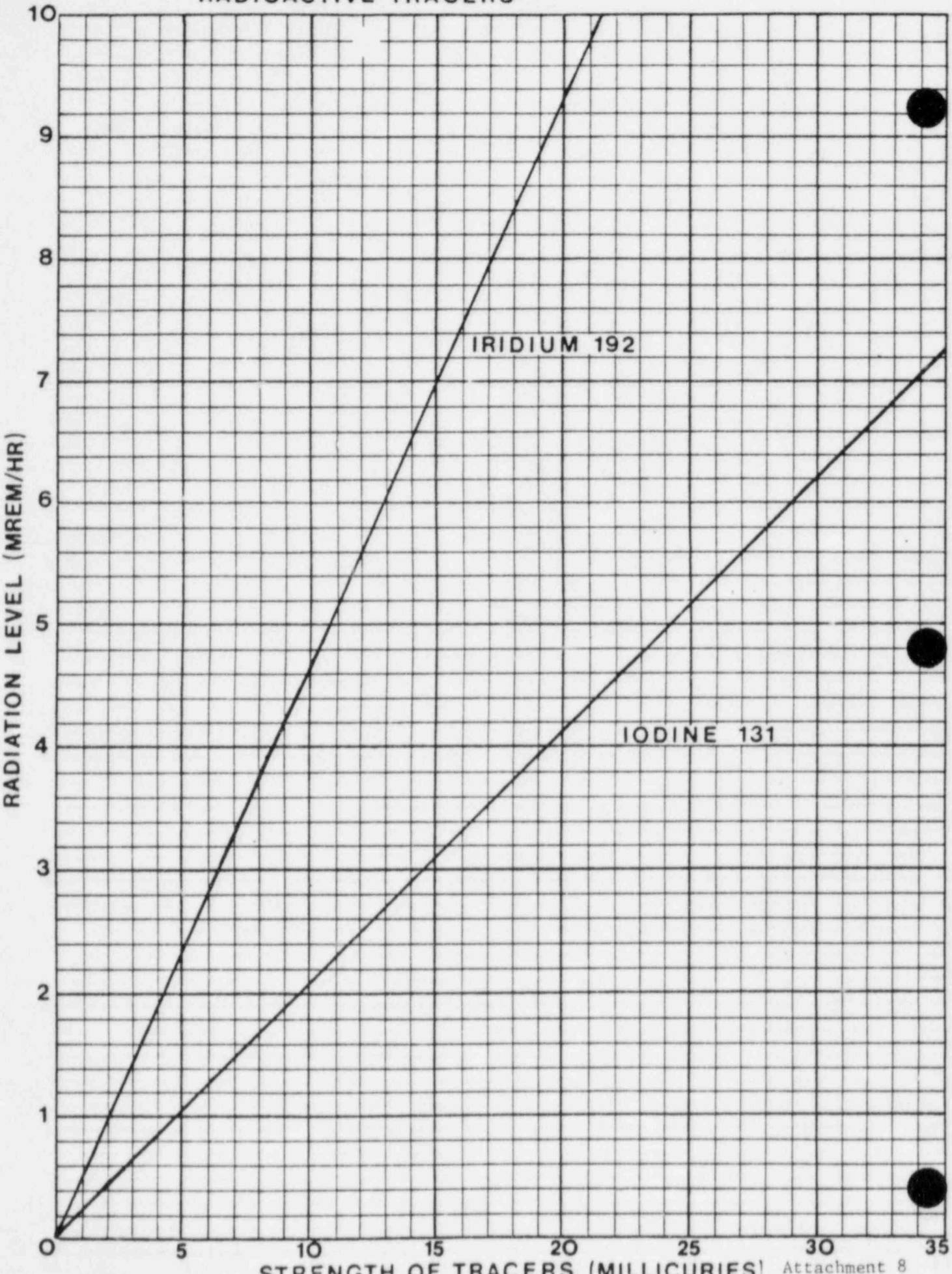
Attachment 6
SPM 60-04-2

CHART 2 - RADIATION LEVELS AT ONE FOOT FROM UNSHIELDED RADIOACTIVE TRACERS



Attachment 7
SPM 60-04-2

CHART 3 - RADIATION LEVELS AT THREE FEET FROM UNSHIELDED RADIOACTIVE TRACERS



Attachment 8
SPM 60-04-2

SUBJECT: Use of Densiometers with Sealed Sources of Radioactive Material

NO. SPM- 60-05-2

PURPOSES

Federal and State radioactive material licensing agencies require written safety procedures for the use of radioactive materials.

GENERAL DESCRIPTION

Densiometers are density gauges designed for the measurement of slurry densities. The densiometers utilize the principle of nuclear radiation transmission through materials in a pipe to measure density. The slurry substance absorbs radiation proportional to its density. The radiation transmitted through the material or substance is measured by an ion chamber electrically connected to electronics and an indicator recording system. The Western-built densiometer may be permanently assembled on a section of pipe on skid-mounted models or on pump vehicles. The Texas Nuclear Unit is a portable density gauge which must be assembled to a pipe at the wellsite.

Western-built densiometers use a 12 to 50 millicurie (mci) strength Cesium (Cs-137) radioactive sealed source while other units use a 100 millicurie (mci) strength Cs-137 sealed source. The sealed sources are contained in steel-collared lead-filled source holders which shield radioactive material and prevent excessive radiation exposure to personnel in the nearby areas.

I. Sealed Source Storage Procedures

A. Densiometers containing sealed sources must be kept in a locked and secured condition while in storage at the district yard.

B. The radioactive material sealed source holder of the densiometer is provided with a lock to prevent the source from being removed or stolen from its skid assemble when so mounted.

C. The densiometer skid assemble is located in the locked trailer when in the district yard in storage. The trailer may be secured to a post to prevent movement.

D. Densiometers which are mounted and installed as an integral portion of a pump vehicle are stored in place on the vehicle with its source holder locked in place.

E. Densiometer trailers and pump vehicles in storage in the yard will be posted with the DOT hazardous material placard if they contain sources with Yellow III labels on the source holders.

F. The portable densiometer movable source holder assemble will be stored in a locked room or chained and locked to a substantial part of a building.

G. Radiation storage area signs are not required since the radiation levels at 12 inches from the surface of the source holders are less than five (5) millirems per hour (mr/hr).

H. Every three months the Sealed Source Physical Inventory Report, (Form 60-02-1C), shall be completed, distributed and a copy maintained in the district radiation file.

II. Densiometer Transportation Procedures

A. Western-built skid-mounted densiometers are transported while secured in their trailers and pump-mounted units are carried secured in place on their vehicles.

B. Shipping papers, labeling and placarding procedures.

1. As a private motor carrier, Western may not transport hazardous materials such as radioactive materials in its vehicles unless the shipment is accompanied by proper shipping papers prepared in accordance with DOT regulations.

2. The Shipper's Certification For Radioactive Materials, (Form 0-106-Attachment 1), will be completed and will accompany every shipment of radioactive sealed source. Attachment 1 illustrates what a completed form may look like.

3. A completed Shipper's Certification For Radioactive Materials, (Form 0-106), need only be made up once and may be used with a specific densiometer until its sealed source is changed out. A copy of the form will be laminated or sealed to protect it from the elements and carried as a permanent document with the densiometer. Pump vehicles should have the form attached to the inside of the driver's door.

4. Specific requirements are outlined in the regulations concerning the driver and motor carrier responsibilities for shipping paper accessibility.

a. If the shipping paper is carried with other shipping papers or any other papers, it must clearly be distinguished by either distinctively tabbing it or by having it appear first; and
b. When the driver is at the vehicle controls, the shipping paper must be at this immediate reach when he is restrained by the lap belt; and
c. Either readily visible to a person entering the driver's compartment, or in a holder which is mounted on the inside of the door on the driver's side of the vehicle.

5. Vehicles carrying Yellow II labeled sealed sources will not be placarded.

6. A permanent hazardous material shipping label as indicated on the Shipper's Certification for Radioactive Materials, (Form 0-106), will be attached to each Densiometer sealed source holder. It is suggested that a laminated or sealed label be used on each source holder.

C. Drivers of vehicles transporting sealed sources

1. The drivers of vehicles transporting sealed source Densiometers must meet DOT requirements for age (21 years of age or older) and training (licensed and DOT certified) in order to transport the hazardous materials.

2. The drivers need not be trained authorized Users of radioactive material in order to transport the sealed sources and need not be issued a TLD badge.

3. The vehicle driver will release responsibility and control of his radioactive cargo, at the wellsite, to the district's Radiation Supervisor present on the job, when a Radiation Supervisor is required.

III. Jobsite Procedures - Densiometers

A. Western Cement Slurry and Sand Slurry Densiometers are mounted on pipe assemblies on skids or on pump trucks. The Densiometers are secured in place and do not require any manipulation in their operation which would expose any workers or the public to any radiation level in excess of 2 mr/hr.

B. Radiation Supervisors are not required to supervise the use of Densiometers at any wellsite locations.

C. The Wellsite Radiation Monitoring Report, (Form 60-02-1D), is not to be completed when using Densiometers at wellsite locations and a survey meter is not required at the wellsite.

D. In order to track the movement (history) of the Densiometers from a district, it is necessary to complete the Radioactive Sealed Source Utilization Log, (Form 60-02-1A), when the instrument leaves and returns to the district yard. A Radiation Servicer(s) will be appointed by the District Manager (RSO) to maintain this log in an up-to-date manner.

E. The District RSO will insure that WPS drivers transporting Densiometer equipment have read "Use of Densiometers With Sealed Sources of Radioactive Material", SPM-60-05-2, Section II, III and V concerning Densiometer Transportation Procedures, Jobsite Procedures and Emergency Procedures. These employees will sign their names to a register to be

maintained in the district radiation files certifying that they have read and understand the above mentioned sections of this manual.

F. As part of the vehicle driver's pre-trip/post-trip inspection of his vehicle, he will visually inspect the Densiometer mounted on his equipment to see that the equipment is in place and that the Yellow II and Yellow III Shipping Labels are readable and in place on the Densiometer case or box. Any irregularities will be reported to a Radiation Supervisor on duty at the district office.

Special Note: Under normal operations, the densiometer assemble does not require disassembly in the field or at the district yard. Only those individuals specially trained to mount, repair, relocate and/or remove the part of the gauge containing the radioactive source may do so. The Engineering and Manufacturing Departments' Radiation Safety Officer in Fort Worth is responsible for repairs and replacement to the sealed source holders.

IV. Sealed Source Leak Test Procedures

A. Leak test service for sealed sources will be provided by Radiation Consultants, Inc. Houston, Texas or other approved companies every six (6) months. The actual wipes will be made by the Radiation Safety Officer or a Radiation Supervisor utilizing instructions per vendor's kit as follows:

1. Fill out the form relating to source identification plus date, location, name, etc.

2. Dissolve dry detergent in small amount of water.

3. Dampen the cotten end of the swab in the liquid and proceed with the test according to supplier's instructions supplied with the kit.

4. Repeat the wipe dry with the second swab if two are provided.

5. Place the swab(s) back in the kit according to the supplier's instructions.

6. Survey the packaged kit with your radiation survey meter. If a reading above background is obtained, do not mail the kit; contact the District Radiation Safefy Officer immediately.

7. If no radiation is detected during the survey, mail the kit to the vendor.

B. Wipe around all externally exposed areas where contamination may be present (i.e., screws, threads, welds, base of caps, etc.).

If the wipe has significant amount of radioactive material, a leakage rate in excess of 0.005 microcuries, an emergency notification will be sent to the district (sender) via telegram or telephone advising that the source must be taken out of service and returned for repair. The emergency notification will contain detailed instructions for removal and shipment of the source.

The sealed source having an excess of 0.005 microcuries must be removed from service and provisions for decontamination shall be taken as soon as practicable. The excess leakage will be reported by the district to the licensing federal or state agency within five (5) days of the date of the test.

V. Emergency Procedures

Emergencies vary greatly in their respective hazards. These are sometimes in the form of spills, fires, explosions or vehicle wrecks which consequently result in the spread of radioactive material contamination. The National Bureau of Standards Handbook, Number 48, Emergency Guides, is used as a guide for the procedures. These procedures are general and any specific emergency would certainly involve additional procedures not covered in the outline.

A. Vehicle Wreck

In the event of an accident while transporting radioactive materials, efforts should be made to minimize the exposure of any persons. This would include roping off the area, notifying the investigating officer and the Radiation Safety Officer at the district immediately, making sure the area is not left unattended. This will enable the District Radiation Safety Officer to notify the WPS Radiation Protection Officer in Fort Worth and/or the proper governmental agency.

B. Fire and Other Emergencies

1. Notify all personnel in the area immediately.

2. Attempt to put out all fires if a radiation hazard is not immediately present.

3. Notifty the fire department.

4. Notifty the District Radiation Safety Officer.

5. The District Radiation Safety Officer will set up restrictions governing the fire fighting and other emergency activities.

6. Following the emergency, monitor the area and ascertain the emergency devices necessary for safe decontamination.

7. Decontaminate.

8. The District Radiation Safety Officer will have to approve the area before work can resume.

9. Monitor all persons involved in combating the emergency.

10. Prepare a complete history of the accident and report to the District Radiation Safety Officer who will in turn report it to the Radiation Protection Officer and/or the proper state agency.

C. Leaking Sealed Source

1. If a source is leaking, as reported by Radiation Consultants, Inc., shut the operations down.

2. Immediately notifty the District Radiation Safety Officer for instructions.

3. Set up control procedures for keeping personnel out of the immediate area until instructions are received from the District Radiation Safety Officer.

4. The District Radiation Safety Officer will immediately notify the WPS Radiation Protection Officer at Fort Worth.

VI. Responsibility

The District Radiation Safety Officer is responsible for assigning duties and assuring compliance with these procedures.

APPENDIX A

052-1063

INTER-OFFICE CORRESPONDENCE

To District Managers At

From Robert I. Slaughter At SP & SQ

Date 11/18/81

RE: NRC RADIATION RISK INSTRUCTION FOR EMPLOYEES - EFFECTIVE 12/15/81

The Nuclear Regulatory Commission (NRC) requires that all persons working in or frequenting any portion of a restricted radiation area (2 mr or more) be instructed in the health protection problems associated with exposure to radioactive materials or radiation.

I have enclosed several copies of the guide instruction hand out material that should be provided to our exposed workers concerning biological risks from occupational radiation exposure. This instruction should be given prior to assignment to work in a restricted area and periodically thereafter.

This instruction should be presented both orally and in printed form (attachments) to all affected workers and supervisors. Each individual should be given the opportunity to ask questions and should be asked to acknowledge in writing that the instruction has been received and understood.

This information will be provided to affected workers after December 15, 1981. These NRC regulations also pertain to state plan agreements WPS works under.

Bob

RIS:wcw

Attachments

cc: Region Human Resource Managers
Region Loss Control Specialists
NRC File
Mike Moseley - AP & SQ

NUCLEAR REGULATORY COMMISSION

INSTRUCTION CONCERNING RISKS FROM

OCCUPATIONAL RADIATION EXPOSURE

- -

CUT HERE

I CERTIFY THAT I ATTENDED A TRAINING SESSION ON "RISKS FROM OCCUPATIONAL RADIATION EXPOSURES" GIVEN AT _____ (LOCATION) ON _____ (DATE) AND THE INFORMATION WAS READ AND UNDERSTOOD.

SIGNED _____

FILING INSTRUCTIONS:

RETAIN THIS REPORT IN EMPLOYEE'S LOCAL PERSONNEL FILE

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.

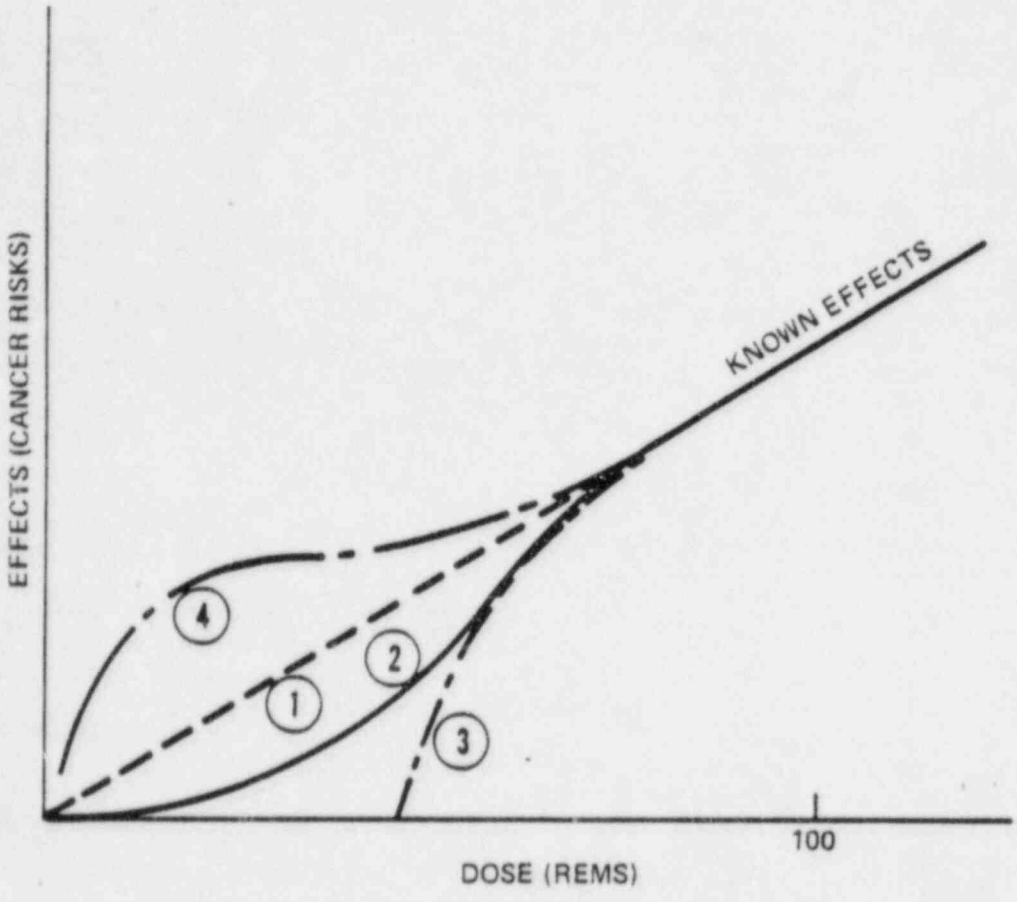


Figure 1. Some proposed models for how the effects of radiation vary with doses at low levels.

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