Form FHWA 121 (Rev. 5-73)

UNITED STATES GOVERNMENT

*Memorandum*

DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
610 EAST FIFTH STREET
VANCOUVER, WA 98661-3893



In reply refer to: HAD 17.41

August 8, 1990

SUBJECT: Reply to a Notice of Violation
NRC Report No. 90-01
Docket No. 030-19919 License No. 46-21202-01

File: 809

FROM : W. V. Pisarczyk
Executive Officer

TO : Mr. Robert J. Pate, Chief
Nuclear Materials and Fuel
Fabrication Branch

Thank you for the objective review and inspection made of our NRC License activities.

Referring to your Notice of Violation dated July 18, 1990 the following information is submitted for (1) reason for violation (2) corrective action (3) corrective steps and (4) dates for full compliance:

Violation A 10 CFR 71.5

(1) The reason for this violation is an oversight on the part of the Radiation Safety Officer. Although a process had been initiated to obtain the performance test record or certificate, the transaction was not completed. Documents were obtained from Seaman Nuclear for our inventory of 6 Seaman gauges - this led our Radiation Safety Officer to believe the same had occurred for our 4 Troxler gauges.

(2) As a corrective action we have obtained Special Form Material test records for our Troxler Model 2226 and 3241 Asphalt Content gauges. A copy of this document is now on file for each gauge and will become part of the shipping documents when gauges are shipped. See Attachment #1.

(3) Further violations in this area will not occur because our procurement policy will require the manufacturer to furnish the "Certificate of Approval of Design for Special Form Radio Active Material" at the time of purchase. We do not plan on purchasing more Troxler gauges in the forseeable future.

(4) Full compliance was achieved on June 29, 1990.

Violation B 10CFR 20.201(6) and 10CFR 20.401(6)

(1) The reason for this violation in the Radiation Safety Officer's opinion is that it was not his responsibity to establish an ongoing program to monitor radiation exposure of persons with lost or missing badges. Historically we have a very low use rate for the gauges, the gauges have never shown leakage, and the radiation exposure doses are minimal (according to quarterly reports). Any time the exposure report showed a reading it has been informally investigated (by Telecon with gauge user). Since none of these inquiries have provided any facts as to why an exposure reading existed no written report was initiated. Those employees with missing or lost badges usually did not operate a gauge.

(2) Corrective actions consist of the following:

a. Anytime a film badge is not returned for processing a questionaire will be issued and the circumstances will be investigated. An estimate of radiation exposure will be made for each instance. See Attachment #2.

b. Written reports will be initiated for all radiation exposure detected from film badge reports.

(3) By December 1990 our new Materials Manual will be issued and employees will have updated operating procedures regarding Nuclear Test Instruments. We feel this will go a long way in reinforcing the above actions. See Attachment #3.

(4) Full compliance will be achieved by December 1990 with items (a) and (b) being achieved July 1, 1990.

Relative to your concerns of our management control system the following is submitted:

In addition to the corrective action taken above it is anticipated that all gauge users will be retrained this comming winter when construction activities are shut down. This will give us an opportunity to emphasize all of our license requirements and our updated procedures.

Additionally we have changed internal procedures to provide better follow-up. The Radiation Protection Officer will report quarterly on compliance to our license conditions to the Executive Officer. This will start October 1, 1990.

All users of licensed material had received proper training. We recently conducted a review and found, however, that certificates had not always been issued. With the anticipated retraining we plan for this winter, certificates will be issued and a current list of trained personnel will be maintained by the Radiation Protection Officer.

If you have any further questions regarding this reply, please telephone Gordon Clark at FTS (206) 422-7718.

W. V. Pisarczyk
Executive Officer

c.c. G. Clark

Attachments

ATTACHMENT #1

6-29-

# COMPLIANCE WITH TRANSPORTATION REGULATIONS

## REPORT OF TESTING AND EVALUATION

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## FORWARD

The testing and evaluation of Troxler nuclear gauges and associated shipping packaging is accomplished to satisfy the requirement of Title 49, Code of Federal Regulations - Transportation and International Air Transport Association Dangerous Goods Regulations. The general regulations governing the design, integrity and shipment of packages containing radioactive material are 49 CFR-173, Subpart 1 - Radioactive Materials and IATA Section 6.3. Throughout this report references will be given to specific regulations as appropriate.

The general intent of the regulations is to provide for the safe handling of packages containing radioactive material. As the regulations apply to Troxler gauges, two (2) underlying values are considered in designing and evaluating gauges for transport. First, under normal and adverse conditions, there can be no loss or dispersal of radioactive material from the container. Second, there can be no significant increase in the external radiation exposure level if the container were subjected to adverse conditions, (reference 49 CFR-173.412(m) and IATA 6.3.18)

This report is intended to satisfy the requirement of documentation to cover the shipment of gauges by Troxler Electronic Laboratories, Inc. and its subsidiary Troxler International, Ltd., (reference 49 CFR-173.415 (a)). This report is also intended to cover the documentation requirement for customers and users of Troxler nuclear gauges.

Report prepared by:
G. Kenneth Brown, Jr.
Radiation Safety Officer
Troxler Electronic Laboratories, Inc.

Revised September, 1988, May 1989, and October 1989 by:
Elizabeth M. Franklin
Radiation Safety Officer
Troxler Electronic Laboratories, Inc.

## I. DECLARATION OF RADIOACTIVE MATERIAL FORM

All radioactive material employed in Troxler nuclear gauges must be approved as "SPECIAL FORM" radioactive material. To this end, the source manufacturer must perform the required special form tests, (reference 49 CFR-173.469 and IATA 6.4.41 thru .59) and obtain a certificate from an internationally recognized competent authority approving the specific material as "SPECIAL FORM," (reference 49 CFR-173.476, IATA 5.7.81 and 49 CFR-173.471(e), IATA 8.3) The source manufacturer must provide copies of the competent authority certificate to Troxler Electronic Laboratories, Inc. The table in Section II lists the specific special form certificate issued for the individual sources employed in Troxler gauges.

## II. DECLARATION OF PACKAGE CLASSIFICATION

All containers, except containers used for Model 3220, 3300, and 4300 Series (reference II-B below), used to transport radioactive material with regards to Troxler nuclear gauges are classified as "Type A" containers, meeting the requirements specified as U.S.D.O.T. Specification 7A, (reference 49 CFR-178.350(1) (2), IATA 6.3.2). Excepting the testing requirements for a "Type A" classification is a limit on the amount of radioactive material employed, (reference 49 CFR-173.431, IATA 5.7.33). All Troxler gauges contain either one (1) or a combination of Cesium-137, Americium-241:Beryllium or Radium-226:Beryllium. All radioactive sources are "SPECIAL FORM" and, therefore, must be within the activity limits denoted as A1, (reference 49 CFR-173.435, IATA 5.7.F). A1 for the radioactive material employed in Troxler gauges is Cesium-137 $\leq$ 30 Curies, Americium-241 $\leq$ 8 Curies and Radium-226 $\leq$ 10 Curies. All sources in Troxler nuclear gauges are rated in milliCurie strength. The following is a list of sources employed in Troxler nuclear gauges:

| Source Type | Nominal Activity | Troxler Drawing # | For Use In Gauge Model | Special Form Certificate # |
|---|---|---|---|---|
| Cs-137 | 5 mCi | A-100601 | 2376 | GB/113/S |
| Cs-137 | 8 mCi | A-102112 | 1351,1352, 3400, 3565, 4545 and 4640 | GB/140/S |
| Am-241 | 10 mCi | A-102700 | 3220, 3300 and 4300 | GB/29/S |
| Am-241 | 40 mCi | A-102451 | 3440, 3216 and 3218 | GB/7/S |
| Am-241 | 100 mCi | A-100608 | 1255, 1257 and 3241 | GB/149/S |
| Am-241 | 300 mCi | A-100337 | 2226, 3241 | GB/149/S |

| Source Type | Nominal Activity | Troxler Drawing # | For Use In Gauge Model | Special Form Certificate # |
|---|---|---|---|---|
| Ra-226 | 4 mCi | A-100600 | 2401, 2451 | GB/SFC/112 |
| Cs-137/ Am-241 | 10/50 mCi | A-100281 | 2401, 2451 | GB/SFC/113 |
| Cf-252 | 30 uCi | A-104225 | 4442 | GB/7/S |
| Co-60 | 60 uCi | A-104240 | 4442 | GB/193/S |
| Cf-252 | 100 uCi | A-105162 | 3241 | GB/7/S |
| Co-60 | 100 uCi | A-105201 | 4441 | GB/193/S |

II-B. DECLARATION OF EXCEPTED PACKAGING

Containers used for transporting Models 3220, 3300, and 4300 Series gauges have been tested and are packaged as "EXCEPTED RADIOACTIVE MATERIALS - INSTRUMENTS AND ARTICLES," (reference 49 CFR-173.422, IATA 5.7.28).

III. PACKAGE LABELING FOR TYPE A CONTAINERS

Each outer carton containing a Troxler nuclear gauge will be labeled with the following:

A. Two (2) "RADIOACTIVE YELLOW II" labels on each container, (reference 49 CFR-172.403, IATA 7.2). These labels are affixed on opposite sides of the package with neither side [illegible] the top nor bottom, (reference 49 CFR-172.403(f), IATA 7.2.24). The bl[illegible] on these labels to be completed with the content naming the radioactive [illegible] the amount denoting the activity of the source in units of Curies or milli[illegible] and the transport index denoting the radiation level at one (1) meter from the package, (reference 49 CFR-172.403(g), IATA 7.2.13).

B. Two (2) "DANGER - DO NOT LOAD ON PASSENGER AIRCRAFT" labels affixed beside the above referenced "RADIOACTIVE YELLOW II" labels except for gauges being shipped to users employing the gauge in research applications, (reference 49 CFR-172.402(b), IATA 7.2.25). This provision applies only to packages carried by air.

C. One (1) label or package marking declaring the package as U.S.D.O.T. 7A Type A, (reference 49 CFR-178.350-3, IATA 7.1.7).

III-B. PACKAGE LABELING FOR "EXCEPTED" CONTAINERS

Each outer carton containing a Troxler nuclear gauge will be labeled with the following:

"One (1) label or package marking declaring the package as EXCEPTED RADIOACTIVE MATERIALS - INSTRUMENTS AND ARTICLES."

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## IV. DOCUMENTATION

The package will be accompanied by the properly completed shipping papers. For shipment by aircraft, the shipment will be accompanied by the standard "SHIPPER'S DECLARATION FOR DANGEROUS GOODS" or other form providing the same information. For shipment by commercial motor carrier, the Bill of Lading will contain the appropriate information describing the radioactive material, (reference 49 CFR-172 Subpart C, IATA 8.1).

## V. DESIGN REQUIREMENTS FOR TYPE A PACKAGES

The shipping container and gauge have been designed to provide for the following required conditions:

A. The smallest overall external dimension of the package is in excess of four (4) inches.

B. The outside shipping carton is taped in such a manner that if tampered with could be easily damaged discernable.

C. The outside container is free of protrusions. No accountablility for decontamination of the package is considered because of the requirement for special form material.

D. Containment and shielding would be maintained during transportation and storage in a temperature range of -40°C to 70°C. For containment, consideration is given to the stainless steel used to encapsulate the material. Stainless steel has a melting point of 1600°C and a brittle point of <-269°C. For shielding, two (2) types of material are considered, depending of the gauge type. For gamma shielding, tungsten is used. For neutron shielding, polyethylene is used. Tungsten has a melting point 3400°C and is classified as a brittle metal with low temperatures having no effect. Polythylene has a melting point of 140°C and a brittle point of -76°C.

E. Effects of vibration are accouted for in Section IX, detailing the actual testing.

F. Containment of the radioactive material is accomplished by two (2) means. First, having the material meet special form requirements precludes the likelihood of release. Second, the source capsule is welded or placed inside a threaded source plug, again to prevent the likelihood of release. Additional comments concerning containment are noted in Section VIII.

G. The chemical and physical compatibility of the materials used to manufacture the gauge and materials used for the package are considered in two (2) ways. First, the types of radiation emitted by the source materials would have no effect as to any irradiation of the material used for the gauge and package. Second, in addition to being designed to meet transportation requirements, the gauge is an electronic device designed to give the customer many years of service.

H. No chemical decomposition of the material employed in the gauge or package would take place with the types of sources employed in this gauge.

I. Ambient pressure would have no effect on the gauge or container. Nothing associated with this equipment is pressurized such that an ambient pressure of 0.25 kilograms per square centimeter could cause a loss of containment.

J. When subjected to the tests as described in Section IX, the shielding characteristics of the gauge will not be negated and there will be no significant increase in the maximum recorded radiation level, (reference 49 CFR-173.412, IATA 6.3.2 thru 6.3.18).

## VI. DEMONSTRATION OF COMPLIANCE WITH TESTS

The regulations allow various methods of testing to show compliance with regulatory criteria. A combination of three (3) methods will be employed in this evaluation; these being engineering evaluation, actual testing and past performance of actual transport, (reference 49 CFR-173.461, IATA 6.4.1).

## VII. PREPARATION OF SPECIMENS FOR TESTING

To demonstrate compliance that, when subjected to the actual required testing or engineering evaluation the source will remain secured with no significant increase in radiation levels, the gauge itself will be used in the evaluation. The actual shipment of the gauge will employ some type of container such as cardboard box, polyethylene case or wood case. Notation is made that the shipping container is provided to protect the electronics of the gauge and provide means of easier handling and does not effect the containment or to a significant degree, the radiation exposure level. Gauges used in the actual testing were standard production models that were manufactured as per standard Troxler engineering specifications and acceptable by the quality control procedures employed. No divergence from the specifications, defects in construction or distortion of features were allowed. Notation is made that the electronics and detection tubes were removed from the gauge before actual testing to prevent damage to these components. Section XI details each individual gauge model on which evaluation has been conducted and the containment system employed, (reference 49 CFR-173.462, IATA 6.4.5 - 6.4.6).

## VIII. PAST PERFORMANCE WITH ACTUAL TRANSPORT

Troxler Electronic Laboratories, Inc. has been shipping and transporting gauges since the late 1950's. In this period of time of over thirty (30) years, there has never been an incident where a Troxler gauge has lost containment or demonstrated a significant increase in radiation levels while being transported, even when involved in an accident. In reviewing worst case conditions, we have seen gauges that have been runover by steel wheel rollers as used in the paving industry, gauges that have been runover by bulldozers, gauges involved in fires and gauges that have been deliberately tampered with. In all of these incidents, the source containment has held. In designing these gauges, the Troxler Engineers are always mindful that these gauges will be used in the construction industry and exposed to very rough handling. The gauges are built to withstand hard field conditions.

## IX. ACTUAL TESTING AND ENGINEERING EVALUATION

The gauges described in Section XI have undergone or been evaluated by the following tests, (reference 49 CFR-173.465, IATA 6.4.8 thru 6.4.22).

A. Water Spray Test

Containment and shielding on all gauges is provided by a combination of either stainless steel and tungsten or stainless steel and polyethylene. The stainless steel employed in the source encapsulation is Type 316. Even if immersed in water for long periods of time, this type of stainless steel does not corrode or lose its chemical composition. Tungsten also does not corrode or lose chemical composition except for oxidation at very high temperatures. Polyethylene has not corrosive possibility and if immersed in water for long periods of time would absorb a small amount of water, but would not break down in chemical composition.

B. Free Drop Test

The gauge was dropped from a height of 1.2 meters (4 feet) onto a non-yielding surface. In performing this test, the gauge was dropped onto a concrete floor. The test was performed at least four (4) times, dropping the gauge at different angles so as to sustain maximum damage.

C. Compression Test

In performing this test, we had two (2) possible methods to choose from. We could either use a weight load of five (5) time the weight of the package or a weight load of 1300 kilograms per square meter multiplied times the vertically projected area of the gauge. We chose the latter because this method provided a greater weight than the former. This test was performed by suspending the weight using a strain gauge scale to accurately determine the weight. The gauge was placed on a concrete floor and the weight lowered onto the top of the gauge until the strain gauge scale had a reading of zero. This procedure lasted for a continuous twenty-four hour period. At the end of the testing period, the strain gauge scale reading was again taken to ensure that the weight had been applied for the entire duration.

D. Penetration Test

This test was performed by placing the gauge on a concrete floor and dropping a steel bar having a rounded end, a diameter of 3.2 centimeters and weighing approximately thirteen (13) pounds onto the gauge. The bar was dropped from a distance of one (1) meter onto the surface of the gauge. At lease four (4) drops were made onto the gauge to inflict maximum damage.

E. Vibration Test

This test was performed by strapping the gauge on a machine that vibrated the gauge with a displacement of 0.1 inch at 12.5 Hz. This test was conducted for a period of twenty-four continuous hours.

## X. VERIFICATION OF TESTING RESULTS

Before each test, the gauge was visually checked to ensure that all components were in the proper place and a radiation level survey was made around the gauge. After each test, a visual check was made to again note that all components remained stable. Visual checks were made to detect any cracking or bending of the material involved. Also, after each test, a radiation survey was made. At the conclusion of all tests, the gauge was disassembled and the source capsule leak tested.

For all gauge models listed in Section XI the radiaton level survey after each test showed no significant increase in exposure levels and the leak test at the conclusion of all tests showed no removable activity, (reference 49 CFR-173.463, IATA 6.4.4).

## XI. TROXLER GAUGES TESTED

A. Model 1255, 1257 Depth Moisture Gauges

Troxler 1250 Series Depth Moisture Gauge contains a nominal 100 milliCuries of Americium-241:Beryllium in a double encapsulated stainless steel source capsule. The source capsule is placed inside a source plug in the bottom section of a brass probe having a diameter of either 11/2 or 2 inches. Shielding is accomplished by a six (6) polyethylene block mounted inside the body of the gauge.

B. Model 1351, 1352 Depth Density Gauges

Troxler Model 1350 Series Depth Density Gauges contain a nominal 8 milliCuries of Cesium-137 in a double encapsulated stainless steel source capsule. The source capsule is placed inside a source plug in the bottom section of a brass probe having a diameter of either 11/2 or 2 inches. Shielding is accomplished by a six (6) inch lead cone mounted inside the body of the gauge.

C. Model 2226 and 3241 Asphalt Content Gauges

Troxler Model 2226 and 3241 Asphalt Content Gauges contain a nominal 300 or 100 milliCuries of Americium-241:Beryllium in a double encapsulated stainless steel source capsule. The source capsule is placed inside a source plug in the dome of the gauge body. Shielding is accomplished by a six (6) inch block of polyethylene mounted in the dome of the body of the gauge. The 3241-M gauge contains 100 microcuries of Cobalt-60 and is phyiscally identical to the 3241-C gauge.

D. Model 2376 Two Probe Depth Density Gauge

Troxler Model 2376 Two Probe Depth Density Gauge contains nominal 5 milliCuries of Cesium-137 in a double encapsulated stainless steel source capsule. The source capsule is welded inside a stainless steel source plug. This source plug is stored and shipped in a six (6) inch lead pig.

E. Model 2401, 2451 Surface Moisture Density Gauges

Troxler Model 2401 and 2451 Surface Moisture Density Gauges contain either a nominal 4 milliCuries of Radium-225:Beryllium or a nominal 10 milliCuries of Cesium-137 and 50 milliCuries of Americium-241:Beryllium in a double encapsulated stainless steel source capsule. The source capsule is welded inside a stainless steel source rod. Shielding is accomplished by a two (2) inch tungsten cylinder.

F. Model 3220, 3300, and 4300 Series Depth Moisture Gauges

Troxler Model 3220, 3300, and 4300 Series Depth Moisture Gauges have been tested against the requirement for excepted radioactive material, (reference 49 CFR-173.422, IATA 5.7.28).

G. Model 3205, 3215, 3216, and 3218 Surface Moisture Gauges

Troxler Model 3205, 3215, 3216, and 3218 Surface Moisture Gauges contain a nominal 40 milliCuries of Americium-241:Beryllium in a double-encapsulated stainless steel source capsule. The source capsule is inside a source plug mounted inside the base of the gauge. Because of the inherent shielding from the lead source plug, no additional shielding material is needed.

H. Model 3565 Sediment Density Gauge

Troxler Model 3565 Sediment Density Gauge contains a nominal 8 milliCuries of Cesium-137 in a double encapsulated stainless steel source capsule. This source capsule is welded inside a stainless steel probe. For shielding, the source probe is surrounded by four (4) inches of lead.

I. Model 3400 Series Surface Moisture Density Gauge

Troxler Model 3400 Series Surface Moisture Density Gauge contain a nominal 8 milliCuries of Cesium-137 in a double-encapsulated stainless steel source capsule. This capsule is welded inside a stainless steel source rod. Shielding is provided by a two (2)-inch tungsten cylinder. This gauge also contains a nominal 40 milliCuries or Americium-241:Beryllium in a double-encapsulated stainless steel source capsule. The source capsule is inside a source plug mounted in the base of the gauge. Because of the inherent shielding from the lead source plug, no additional shielding is necessary.

J. Model 4440 Series Surface Moisture Density Gauge

Troxler Model 4442 Series Surface Moisture Density Gauge contains a nominal 60 microCuries of Cobalt-60 in a double-encapsulated stainless steel source capsule. Shielding is provided by a two (2) inch tungsten cylinder. This gauge also contains a nominal 30 microCuries of Californium-252 in a double-encapsulated stainless steel source capsule. The source capsule is inside a source plug mounted in the base of the gauge. The 4441 Surface Density Gauge contains a nominal 100 microCuries of Cobalt-60 only.

K. Model 4545 Surface Density Gauge

Troxler Model 4545 Surface Density Gauge contains a nominal 8 milliCuries of Cesium-137 in a double-encapsulated stainless steel source capsule. The gauge consists of an aluminum case which houses the gauge electronics and a lead/tungsten shielding which contains the encapsulated source material. The source capsule is placed inside a source plug housed in the base of the gauge body. Shielding is accomplished by a three (3) inch lead source housing.

L. Model 4640 Series Surface Density Gauge

Troxler Model 4640 Series Surface Density Gauge contains a nominal 8 milliCuries of Cesium-137 in a double-encapsulated stainless steel source capsule. The source capsule is placed inside a source plug housed in the base of the gauge body. Shielding is accomplished by a three (3) inch lead source housing.

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ATTCHMENT #2

SUBJ: Nuclear Badge Loss

FROM: Gordon W. Clark
Nuclear Radiation Protection Officer

TO:

Your nuclear badge for the quarter to was not returned as requested. Please furnish the following information for our records:

1. Did you lose your badge? ___yes ___no
If yes, explain: _____

_____.

If no, give the date you sent it in: _____.

2. Did you operate a Nuclear Gauge during this time period?
___yes ___no

If yes, call Gordon Clark, Radiation Protection Officer, FTS 422-7718.

_____ _____
signature date

Return to Gordon W. Clark ASAP

# CHAPTER 5 - NUCLEAR TEST INSTRUMENTS

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**EXHIBITS**

# CHAPTER 5 - NUCLEAR TEST INSTRUMENTS

## 5.00 GENERAL

Nuclear test instruments having a radioactive source are regulated by the Nuclear Regulatory Commission (NRC).

The Project Engineer is responsible for the safe use of nuclear instruments on the project including the safety of project people and the traveling public. Although the contractor is responsible for the safe and proper handling of nuclear instruments used by the contractor personnel under its license, the Project Engineer shall not permit any unsafe or unauthorized operations that would jeopardize the safety of Government or contractor project personnel or the safety of the traveling public.

## 5.10 REQUIREMENTS

Radioactive by-product materials are under the direct control of the Nuclear Regulatory Commission (NRC) within the United States. The NRC regulations are contained in 10 CFR 1 parts 19 and 20. In order for the Federal Highway Administration (FHWA) to possess and use any equipment containing radioactive by-product material, a license is required from the NRC. Contractors and contractor personnel using nuclear test instruments are also required to be licensed and follow similar licensing requirements and regulations.

In applying for the license the following information is required:

- Identify equipment and intended use.
- Identify locations where equipment will be used.
- Identify the personnel that will be authorized to use the equipment.
- List safety precautions for personnel.
- Identify person responsible for administering the program.

Each FLH Division has been granted a license for the use of nuclear instruments by Government personnel. The license requires personnel to be trained in the safe operation and transportation of nuclear devices.

Administration duties for managing this program as required by the NRC are assigned to the Division Radiation Safety Officer. Responsibilities include (but are not limited to) maintaining records of all instrument operators' exposure rates, training and licensing of personnel, maintaining equipment records, and in general, making sure that there are no violations of the terms of the license.

Part of the Division Radiation Safety Officer's responsibility includes determining that equipment is being used properly. Continual and/or excessive abuse will lead to revocation of an operator's license and/or removal of the equipment from the project.

The following documents are on file at the Federal Lands Highway Division Offices:

- Copies of the applicable NRC regulations.
- NRC license including any special licensing conditions.
- Copies of documents incorporated into the license by reference.
- Copies of operating procedures applicable to license activities.

## 5.20 SUMMARY OF PROCEDURES

Each nuclear test instrument shall have with it at all times a packet of documents containing the following:

- Copy of manufacturer's instruction manual.
- Copy of shipper's certificate.

Nuclear test instruments will be issued only to properly trained and authorized personnel that have been approved by the Division Radiation Safety Officer. See Section 5.42 and Exhibit 5.5.

Instruments containing radioactive materials are required to be checked at specified intervals for leakage. This is performed by wiping designated areas of the instrument case with a swab and having the residue tested for radioactivity. This test is called a wipe test.

Wipe tests will generally be performed by the Division Radiation Safety Officer or a trained materials technician. If the Project Engineer is requested to perform the wipe test, the necessary instructions and equipment will be provided.

Each person handling a nuclear test instrument will be provided a radiation dosimetry badge. The date on the badge is the issue date. The badge shall be returned for radiation dosage check to the Division Radiation Safety Officer immediately upon receipt of a new dosimetry badge.

Nuclear test instruments shall be transported to and from the project and between project worksites in their approved shipping containers.

Supervisors are responsible for ensuring that nuclear devices are used only by properly authorized personnel. A list of personnel who have been trained in the use of nuclear instruments and who are authorized to operate them is maintained by the Division Radiation Safety Officer.

Each person using a nuclear instrument is responsible for its proper use and proper packaging for transporting.

## 5.30 EQUIPMENT

The general operating procedures are outlined and detailed in the operation instruction manual furnished by the manufacturers. Copies of these manuals are included with each instrument.

**5.31 Batteries.** Batteries are generally rechargeable nickel cadmium (NiCad) cells. Maintenance and power loss problems experienced with nuclear test instruments when operated on battery power can often be attributed to the handling and care of the batteries. Following the proper discharging and charging procedures is important to maintaining an operational instrument. Refer to an instruments operations manual for proper battery handling procedures. If problems continue, contact your Division Radiation Safety Officer.

**5.32 Storage.** Instruments shall be stored in an area having controlled access and that can be secured. The storage area shall be identified with the appropriate radiation signs and posters. When the instrument is not in use:

- Lock the instruments probe handle in *the safe* position.
- Lock the instrument inside its shipping case.
- Keep the instrument and box in the storage area.
- Instruct project personnel to limit their presence in the area as much as possible.

The following notices and signs shall be posted:

- NRC Caution Radioactive Material signs. See exhibit 5.2.
- NRC Poster *"Notice to Employees"*. See exhibit 5.1. (Include a copy with each instrument when shipped)
- NRC Regulatory Guide 8.13. See exhibit 5.4.

**5.33 Packing Instruments.** Store and transport instruments in the containers and shipping boxes provided.

- Stand the instrument on the packing case base.
- Padlock the instrument in the safe position.
- Place the instrument in the carrying case.
- Place the instruction book and other required information in the case.
- Check to see that the instrument is locked and the accompanying equipment placed in the case. (standard block, battery chargers, etc.)
- Place and secure the carrying case cover.
- Seal the box.
- Check container labels.

**5.34 Transportation.** Contact the Division Radiation Safety Officer before shipping a nuclear test instrument to obtain the proper forms and shipping tags.

All nuclear instruments in the possession of FHWA are classed as Type II Radioactive and it is not necessary for the transporting vehicle to be placarded.

The nuclear test instrument should have been checked for radiation levels at the Division nuclear storage area prior to shipment as required by DOT Motor Carrier Safety Regulations 49 CFR 173.441, 10 CFR 71.47 and 10 CFR 71.87.

A *"Shipper's Certification for Radioactive Materials"* shall accompany a nuclear instrument when shipped from the Division office. See exhibit 5.6 for an example of a Shipper's certificate. The certification will be prepared in quadruple to be distributed as follows:

- Original to carrier.
- 1 copy retained by the originating office.
- 1 copy enclosed with instrument for the consignee (Project Engineer).
- 1 copy to Division Radiation Safety Officer

The Government Bill of Lading (GBL) and/or Shipper's Certificate must include the following information:

- The instrument serial number,
- name of the radioactive material,
- activity of the material,
- type of shipment package,
- the transport index (T.I.), and
- the following statement.

> *"This is to certify that the contents of this consignment 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."*

When the instrument is returned to the Division office, complete and distribute three copies as follows:

- Cross out the first origin and destination columns and fill in the second set with the new origin and destination.
- Sign and date the copies.
- Attach one copy to the shipping papers (GBL).
- Place a copy with the nuclear instrument.
- Keep a copy for your records.

Note: Failure to include the completed copy of the Shipper's Certificate with the nuclear instrument is a violation of a Division's licensed authority to use nuclear instruments. Be sure the required certification statement is placed on the Government bill of lading.

Generally nuclear test instruments are shipped via commercial (surface) freight. When time constraints are a factor, commercial air shipment may be the best option. This may mean that project personnel will have to transport the instrument from the project to the airport terminal. Most commercial air freight services will accept them for shipment. Before returning an instrument by commercial air freight, contact the Division Radiation Safety Officer for assistance.

When an instrument is shipped by Government vehicle, care should be taken with proper packing (see packing instructions). Lock the probe handle in the "Safe" position and then lock the shipping case. Secure the shipping case in the vehicle to prevent movement during transport. Do not place the instrument in the passenger compartment of the vehicle.

It is not necessary to mark the transporting vehicle with radiation signs while the vehicle is on the highway traveling to or from project sites, between projects, or to and from the Division office.

When transporting the instruments in Government or privately owned vehicles, plan the route carefully. Be sure the route is not restricted. It is illegal to transport hazardous materials over some highways.

## 5.40 PERSONNEL

Personnel involved with the handling and use of nuclear test instruments shall be provided appropriate training in the identification and proper handling of radioactive materials.

**5.41 Exposure Badges.** All personnel will be issued radiation exposure badges before they begin operating any nuclear instrument, including training. Exposure badges can be obtained from the Division Radiation Safety Officer. These badges are issued either on a monthly or quarterly basis. Personnel shall return their badge to the Division Radiation Safety Officer promptly after receiving a new badge.

The badge detects the amount of gamma and neutron radiation the **badge** receives. To ensure that the badge represents a person's dosage, there are a few precautions to be taken. Do not store the badge anywhere near the storage area being used for the nuclear instrument. Placing the badge in direct sunlight or near an operating **microwave oven** or television set will reflect this exposure and indicate an unusually high count when the badge is checked. Badges are to be kept in each person's possession as much as possible so an accurate exposure rate of the individual can be determined.

The rate of exposure received from the nuclear test instruments should be minimal. In the event an operator's badge indicates an unusually high exposure, the individual or the Project Engineer will be contacted by the Division Radiation Safety Officer to determine the cause. Unexplained radiation exposures greater than anticipated will result in an individual's authorization to operate nuclear instruments to be rescinded.

**5.42 Training.** Training of personnel in the operation and safety precautions of the nuclear testing instruments is the responsibility of the Division Radiation Safety Officer.

All project personnel are to receive training in the following areas before operating a nuclear test instrument:

*Radiological Safety:*

- Principles and practices of radiation protection
- Leak testing procedures
- Biological effects of radiation
- Monitoring techniques and instruments to detect radiation
- Accident and incident procedures
- Procedures for nuclear instrument storage and transportation
- General safety precautions

*Instrument Operations:*

- Operation procedures
- Maintenance
- Field use
- Instrument calibration principles
- Instrument characteristics

The Project Engineer is responsible to ensure that no personnel will handle or operate nuclear test instruments without the proper indoctrination and training. The Division Radiation Safety Officer shall be promptly notified if project personnel have not been indoctrinated and trained in nuclear radiation procedures. See exhibit 5.5 for sample memorandum documenting training. See exhibits 5.7 and 5.8 for sample documentation of operators current and past history records.

**5.43 Special Notice to Female Personnel.** Exhibit 5.4 contains information that should be provided to female personnel prior to their being trained to operate a nuclear instrument. See exhibit 5.3 for an example of transmittal memorandum format. After being provided this information, the female employee shall sign and return a copy of the memorandum to the Division Radiation Safety Officer.

## 5.50 RADIATION SAFETY

It is the Division Radiation Safety Officer's responsibility to see that all Division personnel associated with the use or storage of nuclear test instruments are provided the necessary equipment and training for the safe use, storage, and transport of the instruments.

The training shall be provided prior to assignments requiring personnel to work with nuclear instruments or to work in a radioactive environment associated with nuclear test instruments.

Control of exposure to radiation is based on the assumption that any exposure, no matter how small, involves some risk. The occupational exposure limits are set so low that medical evidence indicates that there are no observable injuries to individuals due to radiation exposures when the established radiation limits are not exceeded.

**5.51 Safety Procedures.** When used as directed, nuclear test instruments present minimal radiation hazard to an operator or to the general public. Radiation profiles indicate that the radiation level under normal operating conditions at 2 feet from the instrument will be less than 0.5 millirem per hour.

The following safety procedures should be kept in mind at all times:

- Do not operate or attempt to operate an instrument unless you have been authorized to do so by the Division Radiation Safety Officer.
- Do not attempt to repair, modify or open the sealed source under any circumstances.
- Wear a radiation exposure badge at all times while operating or transporting an instrument.
- Follow established operating procedures when using the instrument.
- Keep unauthorized persons away from the instrument.
- Keep the instrument in the "Safe" or storage position when not in use.
- Be sure that the instrument is locked within an authorized area (closet, cabinet, vehicle, etc.) when it is not in use. Security against the theft of radioisotopes is of utmost importance and must not be neglected.

  The storage area should be plainly labeled with an approved radiation warning sign. Radiation levels at the outside the storage area must not be more than 2 millirems per hour.
- A nuclear test instrument may only be transported by authorized personnel in approved vehicles. The instrument **shall not** be transported on the front or rear seats of any vehicle. If a pickup truck is used the instrument must be locked in an enclosure (cabinet, shipping case, etc.) and the enclosure tied securely (e.g., chained, bolted, etc.) to the bed of the truck to prevent loss or theft.

  Radiation levels at the driver and passenger seats and at the outside surface of the vehicle shall not exceed 2 millirems per hour. A shipper's certificate must accompany the instrument at all times.
- When in doubt, contact the Division Radiation Safety Officer.

**5.52 Accidents and Incidents.** If an accident or any incident occurs involving a nuclear instrument, the following steps shall be taken:

- In case an instrument is lost or stolen, or involved in an accident which might cause physical damage to the source, notify the Division Radiation Safety Officer IMMEDIATELY.

- The Division Radiation Safety Officer will notify the following authorities who will provide instructions and assistance applicable to the circumstances of the incident.

  - Nuclear Regulatory Commission Officer
  - Manufacturer of Instrument
  - Public Health Office (if necessary)

- In the event of the possibility of damage to the source or source control mechanism, the operator will keep unauthorized persons at least 16 feet from the instrument and prevent removal of the instrument from off the site until authorized by the Division Radiation Safety Officer or appropriate authority.

- If the instrument is lost or stolen, immediately notify the local police or other law enforcement agency within whose jurisdiction the incident occurred. Also notify the Division Radiation Safety Officer.

**5.53 Emergency Procedures.** The protection of human life is primary. The prevention of property damage due to a radiation incident is secondary. Raw radioactive material must be prevented from escaping into the atmosphere or environment. The source material is encapsulated in welded stainless steel containers that are securely mounted into the instrument enclosure.

It is highly unlikely that the radioactive material could escape in the event of a severe accident or fire. However, this must be considered and a contingency plan developed for just such an accident. Such as an accident that crushes the casing with parts strewn about and the radioactive source area visible.

The following procedures are to be rigorously adhered to in the event of such an accident.

(1) Assume the source rod is ruptured and seal or cordon off an area (16 foot radius) around the instrument. **KEEP UNAUTHORIZED PERSONS AWAY FROM THE SITE!**

(2) Maintain the cordoned off area and immediately halt all activity around the damage site. Stop all vehicles and equipment and have operators walk away from, but not through the site of the accident. (If radioactive material is free, it can be picked up and tracked elsewhere).

If the damaged instrument is a density gage and the source rod was extended at the time of the accident, visually inspect the rod for a white powdery residue. The source is ruptured if a white powder is visible. Place a 3 foot square of plastic sheeting over the source and shovel dirt on top of the plastic sheeting for shielding and to prevent the radioactive material from escaping.

Do not remain in the cordoned off area any longer than necessary.

(3) Immediately contact the Division Radiation Safety Officer and the nearest public health department office for assistance. **Do not leave the accident site unattended.** The objective is to have a qualified radiation survey technician visit the site as quickly as possible to survey the extent of the damage and to determine appropriate action.

Do not attempt to perform your own radiation survey as this operation requires substantial training and experience. Your responsibility is to secure the accident site and to contact the proper authorities.

The radiation technician will determine whether the site is safe, remove the contamination (if there is any) and prepare the instrument for shipment for repair or disposal. In the event of severe damage, it may be necessary to dispose of the source through a local disposal agency licensed for this operation. The radiation technician and local public health department will assist in this action.

A damaged nuclear instrument or shipping case cannot be legally shipped without the concurrence of local health officials.

**Do not ship any damaged equipment without the concurrence of local authorities.**

**Section 5.60 through 5.90 (RESERVED)**

# LIST OF EXHIBITS[1]

| Exhibit | Description |
|---|---|
| 5.1 | NRC Poster *"Notice to Employees"* |
| 5.2 | Warning Signs for Radioactive Materials |
| 5.3 | Sample Radiation Exposure Memorandum to Female Employees |
| 5.4 | NRC Regulatory Guide 8.13 (8) |
| 5.5 | Sample Memorandum Documenting Nuclear Training |
| 5.6 | Sample Shipper's Certificate |
| 5.7 | NRC form NRC-4 *"Occupational External Radiation Exposure History"* (2) |
| 5.8 | NRC form NRC-5 *"Current Occupational External Radiation Exposure"* (2) |

NOTE: [1] In the list of exhibits, the parenthetical number at the end of the description identifies the number of pages in the exhibit when there are more than one page.

Exhibit 5.1 - NRC Poster "Notice to Employees"

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 NRC Regulations. 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 these are the maximum allowable limits, your employer should also keep your radiation exposure as far below these 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.

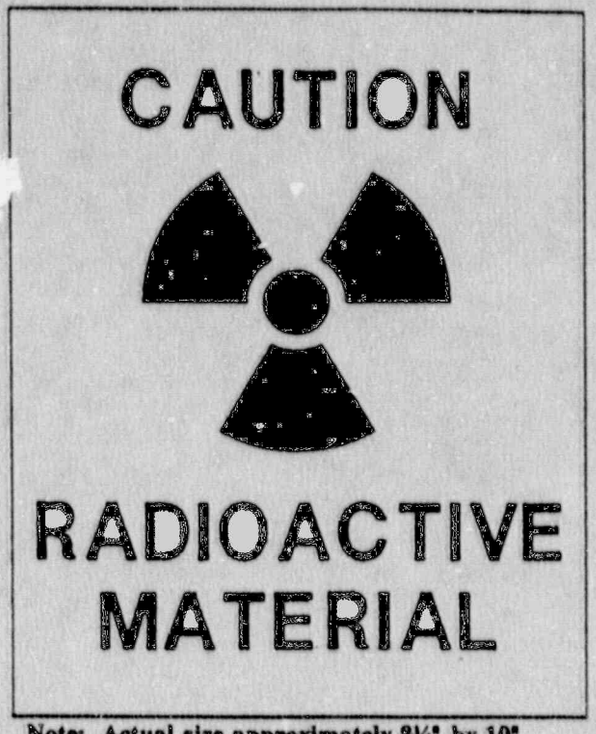
## UNITED STATES NUCLEAR REGULATORY COMMISSION REGIONAL OFFICE LOCATIONS

A representative of the Nuclear Regulatory Commission can be contacted at the following addresses and telephone numbers. The Regional Offices 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.

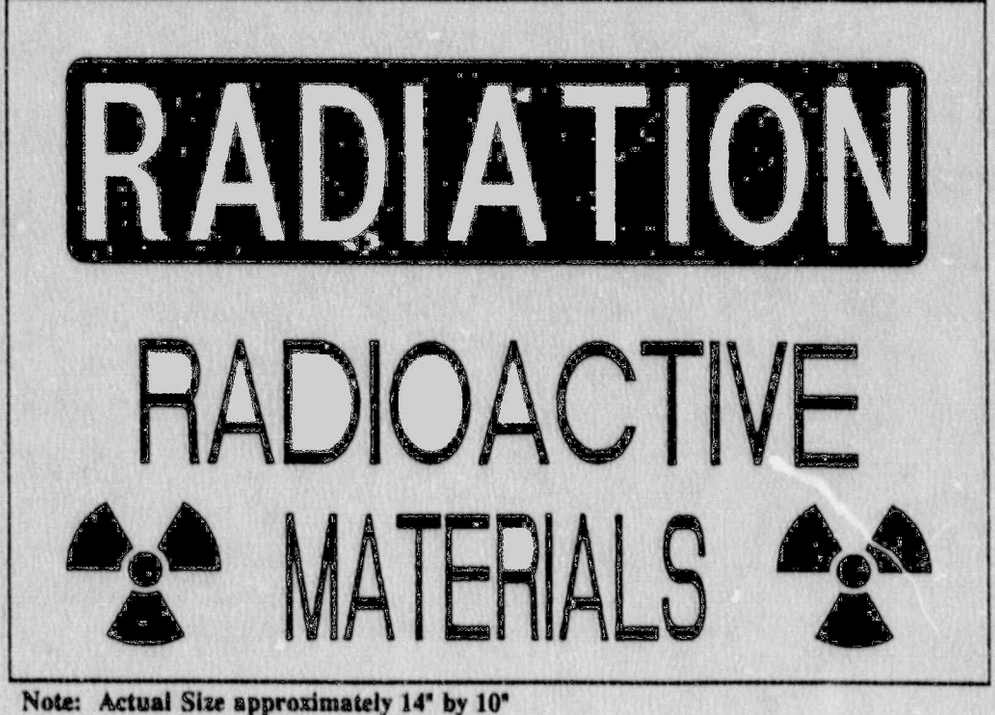

NRC FORM 3
(5-84)

Regional Offices

| REGION | ADDRESS | TELEPHONE |
|---|---|---|
| I | U.S. Nuclear Regulatory Commission<br>Region I<br>475 Allendale Road<br>King of Prussia, PA 19406 | 215 337-5000 |
| II | U.S. Nuclear Regulatory Commission<br>Region II<br>101 Marietta St., N.W.<br>Atlanta, GA 30323 | 404 331-4503 |
| III | U.S. Nuclear Regulatory Commission<br>Region III<br>799 Roosevelt Road<br>Glen Ellyn, IL 60137 | 312 790-5500 |
| IV | U.S. Nuclear Regulatory Commission<br>Region IV<br>611 Ryan Plaza Drive, Suite 1000<br>Arlington, TX 76011 | 817 860-8100 |
| V | U.S. Nuclear Regulatory Commission<br>Region V<br>1450 Maria Lane, Suite 210<br>Walnut Creek, CA 94596 | 415 943-3700 |




Note: Actual size approximately 8¼" by 10"




Note: Actual Size approximately 14" by 10"

Exhibit 5.2 - Warning Signs for Radioactive Materials

U.S. Department of Transportation
**Federal Highway Administration**

# Memorandum

Subject: Radiation exposure to women

Date:

From: Division Radiation Safety Officer
_____ Federal Lands Highway Division

Reply to Attn. of:

To:

( See note below )

Please read the attached NRC Regulatory Guide 8.13 before operating nuclear test instruments (density and/or asphalt content gauges). After reading the guide, please sign, date and return a copy of this memorandum to me.

---

I have read the NRC Regulatory Guide concerning the possible health hazards to children and women resulting from exposure to radiation during pregnancy.

_____ _____
(Employee Signature) (Date)

---

_____
(Division Radiation Safety Officer)

Attachment

Note: Send to any female employee assigned to Material testing laboratories or Construction projects.

Exhibit 5.3 - Sample Radiation Exposure Memorandum to Female Employees

U.S. NUCLEAR REGULATORY COMMISSION

Revision 2
December 1987

# REGULATORY GUIDE

OFFICE OF NUCLEAR REGULATORY RESEARCH

REGULATORY GUIDE 8.13
(Task OP 031-4)

## INSTRUCTION CONCERNING PRENATAL RADIATION EXPOSURE

### A. INTRODUCTION

Section 19.12, "Instructions to Workers," of 10 CFR Part 19, "Notices, Instructions, and Reports to Workers; Inspections," requires that all individuals working in or frequenting any portion of a restricted area[1] be instructed in the health protection problems associated with exposure to radioactive materials or radiation, in precautions or procedures to minimize exposure, and in the regulations that they are expected to observe. The present 10 CFR Part 20, "Standards for Protection Against Radiation," has no special limit for exposure of the embryo/fetus.[2] This guide describes the instructions an employer should provide to workers and supervisors concerning biological risks to the embryo/fetus exposed to radiation, a dose limit for the embryo/fetus that is under consideration, and suggestions for reducing radiation exposure.

This regulatory guide takes into consideration a proposed revision to 10 CFR Part 20, which incorporates the radiation protection guidance for the embryo/fetus approved by the President in January 1987 (Ref. 1). This revision to Part 20 was issued in January 1986 for comment as a proposed rule. Comments on the guide as it pertains to the proposed Part 20 are encouraged. If the new Part 20 is codified, this regulatory guide will be revised to conform to the new regulation and will incorporate appropriate public comments.

Any information collection activities mentioned in this regulatory guide are contained as requirements in 10 CFR Parts 19 or 20, which provide the regulatory basis for this guide. The information collection requirements in 10 CFR Parts 19 and 20 have been cleared under OMB Clearance Nos. 3150-0044 and 3150-0014, respectively.

### B. DISCUSSION

It has been known since 1906 that cells that are dividing very rapidly and are undifferentiated in their structure and function are generally more sensitive to radiation. In the embryo stage, cells meet both these criteria and thus would be expected to be highly sensitive to radiation. Furthermore, there is direct evidence that the embryo/fetus is radiosensitive. There is also evidence that it is especially sensitive to certain radiation effects during certain periods after conception, particularly during the first 2 to 3 months after conception when a woman may not be aware that she is pregnant.

Section 20.104 of 10 CFR Part 20 places different radiation dose limits on workers who are minors than on adult workers. Workers under the age of 18 are limited to one-tenth of the adult radiation dose limits. However, the present NRC regulations do not establish dose limits specifically for the embryo/fetus.

The NRC's present limit on the radiation dose that can be received on the job is 1,250 millirems per quarter (3 months).[3] Working minors (those under 18) are limited to a dose equal to one-tenth that of adults, 125 millirems per quarter. (See § 20.101 of 10 CFR Part 20.)

Because of the sensitivity of the unborn child, the National Council on Radiation Protection and Measurements (NCRP) has recommended that the dose equivalent

[1] Restricted area means any area that has controlled access to protect individuals from being exposed to radiation and radioactive materials.

[2] In conformity with the proposed revision to 10 CFR Part 20, the term "embryo/fetus" is used throughout this document to represent all stages of pregnancy.

[3] The limit is 3,000 millirems per quarter if the worker's occupational dose history is known and the average dose does not exceed 5,000 millirems per year.

USNRC REGULATORY GUIDES

Regulatory Guides are issued to describe and make available to the public methods acceptable to the NRC staff of implementing specific parts of the Commission's regulations, to delineate techniques used by the staff in evaluating specific problems or postulated accidents, or to provide guidance to applicants. Regulatory Guides are not substitutes for regulations, and compliance with them is not required. Methods and solutions different from those set out in the guides will be acceptable if they provide a basis for the findings requisite to the issuance or continuance of a permit or license by the Commission.

This guide was issued after consideration of comments received from the public. Comments and suggestions for improvements in these guides are encouraged at all times, and guides will be revised, as appropriate, to accommodate comments and to reflect new information or experience.

Written comments may be submitted to the Rules and Procedures Branch, DRA, ADM, U.S. Nuclear Regulatory Commission, Washington, DC 20555.

The guides are issued in the following ten broad divisions:

1. Power Reactors
2. Research and Test Reactors
3. Fuels and Materials Facilities
4. Environmental and Siting
5. Materials and Plant Protection
6. Products
7. Transportation
8. Occupational Health
9. Antitrust and Financial Review
10. General

Copies of issued guides may be purchased from the Government Printing Office at the current GPO price. Information on current GPO prices may be obtained by contacting the Superintendent of Documents, U.S. Government Printing Office, Post Office Box 37082, Washington, DC 20013-7082, telephone (202)275-2060 or (202)275-2171.

Issued guides may also be purchased from the National Technical Information Service on a standing order basis. Details on this service may be obtained by writing NTIS, 5285 Port Royal Road, Springfield, VA 22161.

to the unborn child from occupational exposure of the expectant mother be limited to 500 millirems for the entire pregnancy (Ref. 2). The 1987 Presidential guidance (Ref. 1) specifies an effective dose equivalent limit of 500 millirems to the unborn child if the pregnancy has been declared by the mother; the guidance also recommends that substantial variations in the rate of exposure be avoided. The NRC (in § 20.208 of its proposed revision to Part 20) has proposed adoption of the above limits on dose and rate of exposure.

In 1971, the NCRP commented on the occupational exposure of fertile women (Ref. 2) and suggested that fertile women should be employed only where the annual dose would be unlikely to exceed 2 or 3 rems and would be accumulated at a more or less steady rate. In 1977, the ICRP recommended that, when pregnancy has been diagnosed, the woman work only where it is unlikely that the annual dose would exceed 0.30 of the dose-equivalent limit of 5 rems (Ref. 3). In other words, the ICRP has recommended that pregnant women not work where the annual dose might exceed 1.5 rem.

## C. REGULATORY POSITION

Instructions on radiation risks should be provided to workers, including supervisors, in accordance with § 19.12 of 10 CFR Part 19 before they are allowed to work in a restricted area. In providing instructions on radiation risks, employers should include specific instructions about the risks of radiation exposure to the embryo/fetus.

The instructions should be presented both orally and in printed form, and the instructions should include, as a minimum, the information provided in Appendix A (Instructor's Guide) to this guide. Individuals should be given the opportunity to ask questions and in turn should be questioned to determine whether they understand the instructions. An acceptable method of ensuring that the information is understood is to give a simple written test covering the material included in Appendix B (Pregnant Worker's Guide). This approach should highlight for instructors those parts of the instructions that cause difficulties and thereby lead to appropriate modifications in the instructional curriculum.

## D. IMPLEMENTATION

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

Except in those cases in which an applicant or licensee proposes an acceptable alternative method for complying with specified portions of the Commission's regulations, the NRC will use the material described in this guide to evaluate the instructional program presented to individuals, including supervisors, working in or frequenting any portion of a restricted area.

APPENDIX A

INSTRUCTOR'S GUIDE

# EFFECTS ON THE EMBRYO/FETUS OF EXPOSURE TO RADIATION AND OTHER ENVIRONMENTAL HAZARDS

In order to decide whether to continue working while exposed to ionizing radiation during her pregnancy, a woman should understand the potential effects on an embryo/fetus, including those that may be produced by various environmental risks such as smoking and drinking. This will allow her to compare these risks with those produced by exposure to ionizing radiation.

Table 1 provides information on the potential effects resulting from exposure of an embryo/fetus to radiation and nonradiation risks. The second column gives the rate at which the effect is produced by natural causes in terms of the number per thousand cases. The fourth column gives the number of additional effects per thousand cases believed to be produced by exposure to the specified amount of the risk factor.

The following section discusses the studies from which the information in Table 1 was derived. The results of exposure of the embryo/fetus to the risk factors and the dependence on the amount of the exposure are explained.

## 1. RADIATION RISKS

### 1.1 Childhood Cancer

Numerous studies of radiation-induced childhood cancer have been performed, but a number of them are controversial. The National Academy of Science (NAS) BEIR report reevaluated the data from these studies and even reanalyzed the results. Some of the strongest support for a causal relationship is provided by twin data from the Oxford survey (Ref. 4). For maternal radiation doses of 1,000 millirems, the excess number of deaths (above those occurring from natural causes) was found to be 0.6 death per thousand children (Ref. 4).

### 1.2 Mental Retardation and Abnormal Smallness of the Head (Microcephaly)

Studies of Japanese children who were exposed while in the womb to the atomic bomb radiation at Hiroshima and Nagasaki have shown evidence of both small head size and mental retardation. Most of the children were exposed to radiation doses in the range of 1 to 50 rads. The importance of the most recent study lies in the fact that investigators were able to show that the gestational age (age of the embryo/fetus after conception) at the time the children were exposed was a critical factor (Ref. 7). The approximate risk of small head size as a function of gestational age is shown in Table 1. For a radiation dose of 1,000 millirems at 4 to 7 weeks after conception, the excess cases of small head size was 5 per thousand; at 8 to 15 weeks, it was 9 per thousand (Ref. 7).

In another study, the highest risk of mental retardation occurred during the 8 to 15 week period after conception (Ref. 8). A recent EPA study (Ref. 16) has calculated that excess cases of mental retardation per live birth lie between 0.5 and 4 per thousand per rad.

### 1.3 Genetic Effects

Radiation-induced genetic effects have not been observed to date in humans. The largest source of material for genetic studies involves the survivors of Hiroshima and Nagasaki, but the 77,000 births that occurred among the survivors showed no evidence of genetic effects. For doses received by the pregnant worker in the course of employment considered in this guide, the dose received by the embryo/fetus apparently would have a negligible effect on descendants (Refs. 17 and 18).

## 2. NONRADIATION RISKS

### 2.1 Occupation

A recent study (Ref. 9) involving the birth records of 130,000 children in the State of Washington indicates that the risk of death to the unborn child is related to the occupation of the mother. Workers in the metal industry, the chemical industry, medical technology, the wood industry, the textile industry, and farms exhibited stillbirths or spontaneous abortions at a rate of 90 per thousand above that of workers in the control group, which consisted of workers in several other industries.

### 2.2 Alcohol

It has been recognized since ancient times that alcohol consumption had an effect on the unborn child. Carthaginian law forbade the consumption of wine on the wedding night so that a defective child might not be conceived. Recent studies have indicated that small amounts of alcohol consumption have only the minor effect of reducing the birth weight slightly, but when consumption increases to 2 to 4 drinks per day, a pattern of abnormalities called the fetal alcohol syndrome (FAS) begins to appear (Ref. 11). This syndrome consists of reduced growth in the unborn child, faulty brain function, and abnormal facial features. There is a syndrome that has the same symptoms as full-blown FAS that occurs in children born to mothers who have not consumed alcohol. This naturally occurring syndrome occurs in about 1 to 2 cases per thousand (Ref. 10).

TABLE 1

EFFECTS OF RISK FACTORS ON PREGNANCY OUTCOME

| Effect | Number Occurring from Natural Causes | Risk Factor | Excess Occurrences from Risk Factor |
|---|---|---|---|
| | | **RADIATION RISKS** | |
| | | **Childhood Cancer** | |
| Cancer death in children | 1.4 per thousand (Ref. 5) | Radiation dose of 1000 millirems received before birth | 0.6 per thousand (Ref. 4) |
| | | **Abnormalities** | |
| | | Radiation dose of 1000 millirads received during specific periods after conception: | |
| Small head size | 40 per thousand (Ref. 6) | 4-7 weeks after conception | 5 per thousand (Ref. 7) |
| Small head size | 40 per thousand (Ref. 6) | 8-11 weeks after conception | 9 per thousand (Ref. 7) |
| Mental retardation | 4 per thousand (Ref. 8) | Radiation dose of 1000 millirads received 8 to 15 weeks after conception | 4 per thousand (Ref. 8) |
| | | NONRADIATION RISKS | |
| | | **Occupation** | |
| Stillbirth or spontaneous abortion | 200 per thousand (Ref. 9) | Work in high-risk occupations (see text) | 90 per thousand (Ref. 9) |
| | | **Alcohol Consumption (see text)** | |
| Fetal alcohol syndrome | 1 to 2 per thousand (Ref. 10) | 2-4 drinks per day | 100 per thousand (Ref. 11) |
| Fetal alcohol syndrome | 1 to 2 per thousand (Ref. 10) | More than 4 drinks per day | 200 per thousand (Ref. 11) |
| Fetal alcohol syndrome | 1 to 2 per thousand (Ref. 10) | Chronic alcoholic (more than 10 drinks per day) | 350 per thousand (Ref. 12) |
| Perinatal infant death (around the time of birth) | 23 per thousand (Refs. 13, 14) | Chronic alcoholic (more than 10 drinks per day) | 170 per thousand (Ref. 15) |
| | | **Smoking** | |
| Perinatal infant death | 23 per thousand (Refs. 13, 14) | Less than 1 pack per day | 5 per thousand (Ref. 13) |
| Perinatal infant death | 23 per thousand (Refs. 13, 14) | One pack or more per day | 10 per thousand (Ref. 13) |

For mothers who consume 2 to 4 drinks per day, the excess occurrences number about 100 per thousand; and for those who consume more than 4 drinks per day, excess occurrences number 200 per thousand. The most sensitive period for this effect of alcohol appears to be the first few weeks after conception, before the mother-to-be realizes she is pregnant (Refs. 10 and 11). Also, 17% or 170 per thousand of the embryo/fetuses of chronic alcoholics develop FAS and die before birth (Ref. 15). FAS was first identified in 1973 in the United States where less than full-blown effects of the syndrome are now referred to as fetal alcohol effects (FAE) (Ref. 12).

### 2.3 Smoking

Smoking during pregnancy causes reduced birth weights in babies amounting to 5 to 9 ounces on the average. In addition, there is an increased risk of 5 infant deaths per thousand for mothers who smoke less than one pack per day and 10 infant deaths per thousand for mothers who smoke one or more packs per day (Ref. 13).

### 2.4 Miscellaneous

Numerous other risks affect the embryo/fetus, only a few of which are touched upon here. Most people are familiar with the drug thalidomide (a sedative given to some pregnant women), which causes children to be born with missing limbs, and the more recent use of the drug diethylstilbestrol (DES), a synthetic estrogen given to some women to treat menstrual disorders, which produced vaginal cancers in the daughters born to women who took the drug. Living at high altitudes also gives rise to an increase in the number of low-birth-weight children born, while an increase in Down's Syndrome (mongolism) occurs in children born to mothers who are over 35 years of age. The rapid growth in the use of ultrasound in recent years has sparked an ongoing investigation into the risks of using ultrasound for diagnostic procedures (Ref. 19).

APPENDIX B

## PREGNANT WORKER'S GUIDE

## POSSIBLE HEALTH RISKS TO CHILDREN OF WOMEN WHO ARE EXPOSED TO RADIATION DURING PREGNANCY

During pregnancy, you should be aware of things in your surroundings or in your style of life that could affect your unborn child. For those of you who work in or visit areas designated as Restricted Areas (where access is controlled to protect individuals from being exposed to radiation and radioactive materials), it is desirable that you understand the biological risks of radiation to your unborn child.

Everyone is exposed daily to various kinds of radiation: heat, light, ultraviolet, microwave, ionizing, and so on. For the purposes of this guide, only ionizing radiation (such as x-rays, gamma rays, neutrons, and other high-speed atomic particles) is considered. Actually, everything is radioactive and all human activities involve exposure to radiation. People are exposed to different amounts of natural "background" ionizing radiation depending on where they live. Radon gas in homes is a problem of growing concern. Background radiation comes from three sources:

| | Average Annual Dose |
|---|---|
| Terrestrial - radiation from soil and rocks | 50 millirem |
| Cosmic - radiation from outer space | 50 millirem |
| Radioactivity normally found within the human body | 25 millirem |
| | 125 millirem* |
| Dosage range (geographic and other factors) | 75 to 5,000 millirem |

The first two of these sources expose the body from the outside, and the last one exposes it from the inside. The average person is thus exposed to a total dose of about 125 millirems per year from natural background radiation.

In addition to exposure from normal background radiation, medical procedures may contribute to the dose people receive. The following table lists the average doses received by the bone marrow (the blood-forming cells) from different medical applications.

| X-Ray Procedure | Average Dose* |
|---|---|
| Normal chest examination | 10 millirem |
| Normal dental examination | 10 millirem |
| Rib cage examination | 140 millirem |
| Gall bladder examination | 170 millirem |
| Barium enema examination | 500 millirem |
| Pelvic examination | 600 millirem |

*Variations by a factor of 2 (above and below) are not unusual.

*Radiation doses in this document are described in two different units. The rad is a measure of the amount of energy absorbed in a certain amount of material (100 ergs per gram). Equal amounts of energy absorbed from different types of radiation may lead to different biological effects. The rem is a unit that reflects the biological damage done to the body. The millirad and millirem refer to 1/1000 of a rad and a rem, respectively.

## NRC POSITION

NRC regulations and guidance are based on the conservative assumption that any amount of radiation, no matter how small, can have a harmful effect on an adult, child, or unborn child. This assumption is said to be conservative because there are no data showing ill effects from small doses; the National Academy of Sciences recently expressed "uncertainty as to whether a dose of, say, 1 rad would have any effect at all." Although it is known that the unborn child is more sensitive to radiation than adults, particularly during certain stages of development, the NRC has not established a special dose limit for protection of the unborn child. Such a limit could result in job discrimination for women of child-bearing age and perhaps in the invasion of privacy (if pregnancy tests were required) if a separate regulatory dose limit were specified for the unborn child. Therefore, the NRC has taken the position that special protection of the unborn child should be *voluntary* and should be based on decisions made by workers and employers who are well informed about the risks involved.

For the NRC position to be effective, it is important that both the employee and the employer understand the risk to the unborn child from radiation received as a result of the occupational exposure of the mother. This document tries to explain the risk as clearly as possible and to compare it with other risks to the unborn child during pregnancy. It is hoped this will help pregnant employees balance the risk to the unborn child against the benefits of employment to decide if the risk is worth taking. This document also discusses methods of keeping the dose, and therefore the risk, to the unborn child as low as is reasonably achievable.

## RADIATION DOSE LIMITS

The NRC's present limit on the radiation dose that can be received on the job is 1,250 millirems per quarter (3 months).* Working minors (those under 18) are limited to a dose equal to one-tenth that of adults, 125 millirems per quarter. (See § 20.101 of 10 CFR Part 20.)

Because of the sensitivity of the unborn child, the National Council on Radiation Protection and Measurements (NCRP) has recommended that the dose equivalent to the unborn child from occupational exposure of the expectant mother be limited to 500 millirems for the entire pregnancy (Ref. 2). The 1987 Presidential guidance (Ref. 1) specifies an effective dose equivalent limit of 500 millirems to the unborn child if the pregnancy has been declared by the mother; the guidance also recommends that substantial variations in the rate of exposure be avoided. The NRC (in § 20.208 of its proposed revision to Part 20) has proposed adoption of the above limits on dose and rate of exposure.

## ADVICE FOR EMPLOYEE AND EMPLOYER

Although the risks to the unborn child are small under normal working conditions, it is still advisable to limit the radiation dose from occupational exposure to no more than 500 millirems for the total pregnancy. Employee and employer should work together to decide the best method for accomplishing this goal. Some methods that might be used include reducing the time spent in radiation areas, wearing some shielding over the abdominal area, and keeping an extra distance from radiation sources when possible. The employer or health physicist will be able to estimate the probable dose to the unborn child during the normal nine-month pregnancy period and to inform the employee of the amount. If the predicted dose exceeds 500 millirems, the employee and employer should work out schedules or procedures to limit the dose to the 500-millirem recommended limit.

It is important that the employee inform the employer of her condition as soon as she realizes she is pregnant if the dose to the unborn child is to be minimized.

## INTERNAL HAZARDS

This document has been directed primarily toward a discussion of radiation doses received from sources outside the body. Workers should also be aware that there is a risk of radioactive material entering the body in workplaces where unsealed radioactive material is used. Nuclear medicine clinics, laboratories, and certain manufacturers use radioactive material in bulk form, often as a liquid or a gas. A list of the commonly used materials and safety precautions for each is beyond the scope of this document, but certain general precautions might include the following:

1. Do not smoke, eat, drink, or apply cosmetics around radioactive material.
2. Do not pipette solutions by mouth.
3. Use disposable gloves while handling radioactive material when feasible.
4. Wash hands after working around radioactive material.
5. Wear lab coats or other protective clothing whenever there is a possibility of spills.

Remember that the employer is required to have demonstrated that it will have safe procedures and practices before the NRC issues it a license to use radioactive material. Workers are urged to follow established procedures and consult the employer's radiation safety officer or health physicist whenever problems or questions arise.

*The limit is 3,000 millirems per quarter if the worker's occupational dose history is known and the average dose does not exceed 5,000 millirems per year.

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# Memorandum

U.S. Department of Transportation
**Federal Highway Administration**

Subject: Personnel Training - Nuclear Instruments

Date:

From: Division Radiation Safety Officer
_____ Federal Lands Highway Division

Reply to Attn. of:

To: _____

_____

_____
(Project Engineer)

This is to certify that on _____, 19__, _____ received _____ hours of training covering the following items:

- Operational Procedures
- Field Maintenance
- Field Use
- Instrument Calibration Procedures
- Instrument Characteristics

This training was conducted by _____ in accordance with our NRC Materials License No. _____.

Failure to comply with NRC rules and regulations can be cause for disciplinary action and/or disqualification from operating nuclear instruments.

_____
(Division Radiation Safety Officer)

Note: Send memorandum to project engineers to substantiate that the employee has been given the required training and is authorized to operate nuclear test instruments on the project.

Exhibit 5.5 - Sample Memorandum Documenting Nuclear Training

U.S. Department of Transportation
Federal Highway Administration
Federal Lands Highway Office

# SHIPPER'S CERTIFICATION FOR RADIOACTIVE MATERIAL

This is to certify that the contents of this consignment are properly classified, described, packaged, marked, labelled and are in proper condition for transportation according to U.S. Department of Transportation regulations.

DOT Proper Shipping Name: RADIOACTIVE MATERIAL, SPECIAL FORM - N. O. S.
Identification Number: UN 2974

| Nature and Quantity of Material | | | Package | | |
|---|---|---|---|---|---|
| Radionuclide | Activity | Description of Physical and Chemical Form | Label Category | Package Type | Transport Index |
| Cs-137 | ≤ 10 mCi | Special Form | Yellow - II | Type A | |
| Am-241:Be | ≤ 50 mCi | Special Form | Yellow - II | | |

Instrument Serial No. [redacted]

Shipped From: _____ Shipped To: _____

_____ _____

_____ _____

Signature: _____ Date: _____

Instrument Serial No. [redacted]

Shipped From: _____ Shipped To: _____

_____ _____

_____ _____

Signature: _____ Date: _____

NOTE: Original shipping papers must be maintained in the hauling vehicle within the immediate reach of the driver restrained by seat belt. Normally, a vehicle's glove compartment does not meet this requirement.

cc: Copy retained for office files
Copy enclosed with instrument for consignee
Copy for Division Radiation Safety Officer

Form FHWA-1690 (9-90)

Exhibit 5.6 - Sample Shipper's Certificate

NRC Form 4
(8-66)
10 CFR 20

U. S. NUCLEAR REGULATORY COMMISSION

Approved by OMB
2150-0006
Expires 8-31-88

# OCCUPATIONAL EXTERNAL RADIATION EXPOSURE HISTORY

See Instructions on the Back

IDENTIFICATION

| 1. NAME (PRINT – LAST, FIRST, AND MIDDLE) | 2. SOCIAL SECURITY NO. |
|---|---|
| HAILE, Frank W. | 536-86-9982 |
| 3. DATE OF BIRTH (MONTH, DAY, YEAR) 5-19-57 | 4. AGE IN FULL YEARS (N) 33 |

OCCUPATIONAL EXPOSURE – PREVIOUS HISTORY

| 5. PREVIOUS EMPLOYMENTS INVOLVING RADIATION EXPOSURE – LIST NAME AND ADDRESS OF EMPLOYER | 6. DATES OF EMPLOYMENT (FROM–TO) | 7. PERIODS OF EXPOSURE | 8. WHOLE BODY (REM) | 9. RECORD OR CALCULATED (INSERT ONE) |
|---|---|---|---|---|
| N/A | N/A | N/A | -0- | N/A |

| 10. REMARKS | 11. ACCUMULATED OCCUPATIONAL DOSE – TOTAL | ZERO |
|---|---|---|

I have been authorized to operate Nuclear density gauges and have been assigned radiation exposure badge No. 8506. I have no known previous exposure to radiation from nuclear test instruments.

13. CALCULATIONS – PERMISSIBLE DOSE WHOLE BODY:

| | | |
|---|---|---|
| (A) PERMISSIBLE ACCUMULATED DOSE = 5(N–18) | 155 | REM |
| (B) TOTAL EXPOSURE TO DATE (FROM ITEM 11) | 0 | REM |
| (C) UNUSED PART OF PERMISSIBLE ACCUMULATED DOSE (A–B) | 155 | REM |

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

Frank W. Haile Jan. 15, 1988
EMPLOYEE'S SIGNATURE DATE

14. NAME OF LICENSEE
CFLI'D
Federal Energy Admin.

# INSTRUCTIONS FOR PREPARATION OF NRC FORM 4

This form or a clear and legible record containing all the information required on this form must be prepared by each licensee of the Nuclear Regulatory Commission who, pursuant to Section 20.101, proposes to expose an individual to a radiation dose in excess of the amounts specified in Paragraph 20.101(a) of the regulations in Part 20, "Standards for Protection Against Radiation," 10 CFR. The requirement for completion of this form is contained in Section 20.102 of that regulation. The information contained in this form is used for estimating the external accumulated occupational dose of the individual for whom the form is completed. A separate NRC Form 4 shall be completed for each individual to be exposed to a radiation dose in excess of the limits specified in Paragraph 20.101(a) of Part 20 of the Commission's regulations.* Listed below by item are instructions and additional information directly pertinent to completing this form:

**Identification**

Item 1. Self-explanatory.

Item 2. Self-explanatory except that, if individual has no social security number, the word "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.

**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 periods of self-employment, insert the word "self-employed."

Item 6. Give the dates of each employment listed in Item 5.

Item 7. List periods during which occupational exposure to radiation occurred.

Item 8. List the dose recorded for each period of exposure from the records of previous occupational exposure of the individual as calculated under Section 20.102. Dose is to be given in rem.

"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 or calculated in accordance with Section 20.102.

Item. 10. Self-explanatory.

**Total Accumulated Occupational Dose (Whole Body)**

Item 11. The total for the whole body is obtained by summation of all values in Item 8.

**Certification**

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.

**Calculations**

Item 13. The lifetime accumulated occupational dose for each individual and the permissible dose under Paragraph 20.101(b) are obtained by carrying out the following steps: The value for N should be taken from Item 4. Subtract 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 total exposure to date from Item 11. Subtract (b) from (a) and enter the difference under (c). The value in (c) represents the unused part of the permissible accumulated dose. This value for permissible dose is to be carried forward to NRC Form 6, "Current Occupational External Radiation Exposure (Whole Body)."

Item 14. Self-explanatory.

*This form requires the signature of the employee concerned.

## PRIVACY ACT STATEMENT

Pursuant to 5 U.S.C. 552a(e) (3), enacted into law by section 3 of the Privacy Act of 1974 (Public Law 93-579), the following statement is furnished to individuals who supply information to the Nuclear Regulatory Commission on NRC Form 4. This information is maintained in a system of records designated as NRC-27 and described at Federal Register 45344 (October 1, 1975):

1. AUTHORITY Sections 53, 63, 65, 81, 103, 104, 161(b), and 161(o) of the Atomic Energy Act of 1954, as amended (42 U.S.C. 2073, 2093, 2095, 2111, 2133, 2134, 2201(b), and 2201(o)). The authority for soliciting the social security number is 10 CFR Part 20.

2. PRINCIPAL PURPOSE(S) The information is used by the NRC in its evaluation of the risk of radiation exposure associated with the licensed activity and in exercising its statutory responsibility to monitor and regulate the safety and health practices of its licensees. The data permits a meaningful comparison of both current and long-term exposure experience among types of licensees and among licensees within each type. Data on your exposure to radiation is available to you upon request.

3. ROUTINE USES The information may be used to provide data to other Federal and State agencies involved in monitoring and/or evaluating radiation exposure received by individuals employed as radiation workers on a permanent or temporary basis and exposure received by monitored visitors. The information may also be disclosed to an appropriate Federal, State, or local agency in the event the information indicates a violation or potential violation of law and in the course of an administrative or judicial proceeding.

4. WHETHER DISCLOSURE IS MANDATORY OR VOLUNTARY AND EFFECT ON INDIVIDUAL OF NOT PROVIDING INFORMATION It is voluntary that you furnish the requested information, including social security number; however, the licensee must have a completed NRC Form 4 on each individual whom the licensee proposes to expose to a radiation dose in excess of the amounts specified in 10 CFR 20.101(a). Failure to obtain the requested information before permitting such exposure may subject the licensee to enforcement action in accordance with 10 CFR 20.601. The social security number is used to assure that NRC has an accurate identifier not subject to the coincidence of similar names or birthdates among the large number of persons on whom data is maintained.

5. SYSTEM MANAGER(S) AND ADDRESS Director, Office of Nuclear Regulatory Research
U.S. Nuclear Regulatory Commission, Washington, D.C. 20555

NRC Form 5
(8-86)
10 CFR 20

U. S. NUCLEAR REGULATORY COMMISSION

Approved by OMB
3150-0006
Expires: 5-31-89

# CURRENT OCCUPATIONAL EXTERNAL RADIATION EXPOSURE

See Instructions on Back

IDENTIFICATION Badge No. 8506

| 1. NAME (PRINT – Last, first, and middle) | 2. SOCIAL SECURITY NO. |
|---|---|
| Haile, Frank W. | 536-86-9982 |
| **3. DATE OF BIRTH (Month, day, year)** | **4. NAME OF LICENSEE** |
| 5-19-57 | CFLHD / Fed. Hwy. Admin. |

| 5. DOSE RECORDED FOR (Specify: Whole body; skin of whole body; or hands and forearms, feet and ankles.) | 6. WHOLE BODY DOSE STATUS (rem) | 7. METHOD OF MONITORING (e.g., Film Badge – FB; Pocket Chamber – PC; Calculations – Calc.) X OR GAMMA FB BETA _____ NEUTRONS _____ |
|---|---|---|

| 8. PERIOD OF EXPOSURE (From – To) | DOSE FOR THE PERIOD (rem) | | | | 13. RUNNING TOTAL FOR CALENDAR QUARTER (rem) |
|---|---|---|---|---|---|
| | 9. X OR GAMMA | 10. BETA | 11. NEUTRON | 12. TOTAL | |
| 1/15/88 to 4/14/88 | 0 | | | 0 | |
| 4/15/88 to 7/14/88 | 0.020 | | | 0.020 | |
| 7/15/88 to 10/14/88 | 0.075 | | | 0.075 | |
| 10/15/88 to 1/14/88 | 0 | | | 0 | |
| 1/15/89 to 4/14/89 | 0 | | | 0 | |
| 4/15/89 to 7/14/89 | 0.080 | | | 0.080 | |
| 7/15/89 to 10/14/89 | 0.085 | | | 0.085 | |
| 10/15/89 to 1/14/90 | 0 | | | 0 | |
| 1/15/90 to 4/14/90 | 0 | | | 0 | |

LIFETIME ACCUMULATED DOSE

| 14. PREVIOUS TOTAL (rem) | 15. TOTAL QUARTERLY DOSE (rem) | 16. TOTAL ACCUMULATED DOSE (rem) | 17. PERM. ACC. DOSE 5(N-18) (rem) | 18. UNUSED PART OF PERMISSIBLE ACCUMULATED DOSE (rem) |
|---|---|---|---|---|
| | | | | |

Exhibit 5.8 - NRC Form NRC-5 "Current Occupational External Radiation Exposure"

## INSTRUCTIONS FOR PREPARATION OF NRC FORM 5

The preparation and safekeeping of this form or a clear and legible record containing all the information required on this form is required pursuant to Section 20.401 of "Standards for Protection Against Radiation," 10 CFR 20, as a current record of occupational external radiation exposures. Such a record must be maintained for each individual for whom personnel monitoring is required under Section 20.202. Note that a separate NRC Form 5 is to be used for recording external exposure to (1) the whole body; (2) skin of whole body; (3) hands and forearms; or (4) feet and ankles, as provided by Item 5 below.

Listed below by item are instructions and additional information directly pertinent to completing this form.

**Identification**

Item 1. Self-explanatory.
Item 2. Self-explanatory except that, if individual has no social security number, the word "none" shall be inserted.
Item 3. Self-explanatory.
Item 4. Self-explanatory.

**Occupational Exposure**

Item 5. "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. Unless the lenses of the eyes are protected with eye shields, dose recorded as whole body dose should include the dose delivered through a tissue equivalent absorber having a thickness of 300 mg/cm$^2$ or less. When the lenses of the eyes are protected with eye shields having a tissue equivalent thickness of at least 700 mg/cm$^2$, dose recorded as whole body dose should include the dose delivered through a tissue equivalent absorber having a thickness of 1,000 mg/cm$^2$ or less.

Dose recorded as dose to the skin of the whole body, hands and forearms, or feet and ankles should include the dose delivered through a tissue equivalent absorber having a thickness of 7 mg/cm$^2$ or less. The dose to the skin of the whole body, hands and forearms, or feet and ankles should be recorded on separate forms unless the dose to those parts of the body has been included as dose to the whole body on a form maintained for recording whole body exposure.

Item 6. This item need be completed only when the sheet is used to record whole body exposures and the licensee is exposing the individual under the provisions of Paragraph 20.101(b) which allows up to 3 rems per quarter to the whole body. Enter in this item the unused part of permissible accumulated dose taken from previous records of exposure, i.e., Item 18 of the preceding NRC Form 5 or Item 13 of NRC Form 4 if the individual's exposure during employment with the licensee begins with this record.

Item 7. Indicate the method used for monitoring the individual's exposure to each type of radiation to which he is exposed in the course of his duties. Abbreviations may be used.

Item 8. Doses received over a period of less than a calendar quarter need not be separately entered on the form provided that the licensee maintains a current record of the doses received by the individual which have not as yet been entered on the form. The period of exposure should specify the day the measurement of that exposure was initiated and the day on which it was terminated. For example, if only quarterly doses are entered, the period of exposure for the first calendar quarter of 1962 might be taken as running from Monday, January 1, 1962, through Friday, March 30, 1962, and would be indicated in this item as Jan. 1, 1962-Mar. 30, 1962. If weekly doses are entered, a film badge issued Monday morning, January 1, 1962, and picked up Friday, January 5, 1962, would be indicated as Jan. 1, 1962-Jan. 5, 1962.

Items 9, 10 and 11. Self-explanatory. The values are to be given in rem. All measurements are to be interpreted in the best method known and in accordance with Paragraph 20.4(c). Where calculations are made to determine dose, a copy of such calculations is to be maintained in conjunction with this record. In any case where the dose for a calendar quarter is less than 10% of the value specified in Paragraph 20.101(a), the phrase "less than 10%" may be entered in lieu of a numerical value.

Item 12. Add the values under Items 9, 10 and 11 for each period of exposure and record the total. In calculating the "Total" any entry "less than 10%" may be disregarded.

Item 13. The running total is to be maintained on the basis of calendar quarters. Paragraph 20.3(a) (4) defines calendar quarter. No entry need be made in this item if only calendar quarter radiation doses are recorded in Items 9, 10, 11 and 12.

**Lifetime Accumulated Dose (Whole Body)**

NOTE: If the licensee chooses to keep the individual's exposure below that permitted in Paragraph 20.101(a), Items 14 through 18 need not be completed. However, in that case the total whole body dose for each calendar quarter recorded in Item 13 (or Item 12 if quarterly doses are entered in Item 12) should not exceed 1 1/4 rem.

If an individual is exposed under the provisions of Paragraph 20.101 (b), complete Items 14 through 18 at the end of each calendar quarter and when the sheet is filled. Values in Item 13, when in the middle of a calendar quarter, and values in Item 18, must be brought forward to new sheet for each individual.

Item 14. Enter the previous total accumulated dose from previous dose records for the individual (e.g., from Item 16 of NRC Form 5 or Item 11 of NRC Form 4). The total occupational radiation dose received by the individual must be entered in this item, including any occupational dose received from sources of radiation not licensed by the Commission. If the individual was exposed to sources of radiation not licensed by the Commission during any calendar quarter after completing NRC Form 4 and personnel monitoring equipment was not worn by the individual, it should be assumed that the individual received a dose of 1 1/4 rems during each such calendar quarter.

Item 15. Enter the total calendar quarter dose from Item 13 (or from Item 12 if quarterly doses are entered in Item 12) and the date designating the end of the calendar quarter in which the dose was received (e.g., March 30, 1962).

Item 16. Add Item 14 and Item 15 and enter that sum.

Item 17. Obtain the Permissible Accumulated Dose (PAD) in rem for the WHOLE BODY. "N" is equal to the number of years of age of the individual on his last birthday. Subtract 18 from N and multiply the difference by 5 rem (e.g., John Smith, age 32; N = 32, PAD = 5(32-18) = 70 rem.)

Item 18. Determine the unused part of the PAD by subtracting Item 16 from Item 17. The unused part of the PAD is that portion of the Lifetime Accumulated Dose for the individual remaining at the end of the period covered by this sheet.

### PRIVACY ACT STATEMENT

Pursuant to 5 U.S.C. 552a(e) (3), enacted into law by section 3 of the Privacy Act of 1974 (Public Law 93-579), the following statement is furnished to individuals who supply information to the Nuclear Regulatory Commission on NRC Form 5. This information is maintained in a system of records designated as NRC-27 and described at 40 Federal Register 45344 (October 1, 1975).

1. AUTHORITY Sections 53, 63, 65, 81, 103, 104, 161(b), and 161(o) of the Atomic Energy Act of 1954, as amended (42 U.S.C. 2073, 2093, 2095, 2111, 2133, 2134, 2201(b), and 2201(o)). The authority for soliciting the social security number is 10 CFR Part 20.

2. PRINCIPAL PURPOSE(S) The information is used by the NRC in its evaluation of the risk of radiation exposure associated with the licensed activity and in exercising its statutory responsibility to monitor and regulate the safety and health practices of its licensees. The data permits a meaningful comparison of both current and long-term exposure experience among types of licensees and among licensees within each type. Data on your exposure to radiation is available to you upon your request.

3. ROUTINE USES The information may be used to provide data to other Federal and State agencies involved in monitoring and/or evaluating radiation exposure received by individuals employed as radiation workers on a permanent or temporary basis and exposure received by monitored visitors. The information may also be disclosed to an appropriate Federal, State, or local agency in the event the information indicates a violation or potential violation of law and in the course of an administrative or judicial proceeding.

4. WHETHER DISCLOSURE IS MANDATORY OR VOLUNTARY AND EFFECT ON INDIVIDUAL OF NOT PROVIDING INFORMATION It is voluntary that you furnish the requested information, including social security number; however, the licensee must complete NRC Form 5 on each individual for whom personnel monitoring is required under 10 CFR 20.202. Failure to do so may subject the licensee to enforcement action in accordance with 10 CFR 20.601. The social security number is used to assure that NRC has an accurate identifier not subject to the coincidence of similar names or birthdates among the large number of persons on whom data is maintained.

5. SYSTEM MANAGER(S) AND ADDRESS Director, Office of Nuclear Regulatory Research, U.S. Nuclear Regulatory Commission, Washington, D.C. 20555