

NRC INSPECTION MANUAL IMOB/NMSS

MANUAL CHAPTER 1302

ACTION LEVELS FOR RADIATION EXPOSURES AND CONTAMINATION

ASSOCIATED WITH MATERIALS EVENTS INVOLVING MEMBERS OF THE PUBLIC

1302-01 PURPOSE

To provide advice and guidance on the course of action to follow in situations involving radioactive material in the public domain. Examples include lost or stolen sources, transportation accidents, and similar situations that involve actual or potential radiation exposure to members of the public such as vehicle drivers or passers-by. It is specifically for use after actions have been taken to prevent the source of exposure from further affecting the public. It is intended for use as initial guidance, when situations arise, but the staff is encouraged to consult Headquarters, as soon as possible, to affirm or modify the chosen course of action.

1302-02 OBJECTIVES

To ensure that personnel and area contamination is bounded, restricted, and decontaminated to acceptable levels for release; identify exposed individuals, inform them of their exposures, and recommend medical evaluation, if necessary; provide data for issuing recall notices for defective products; issue press releases and notify cognizant agencies; and document the incident and provide the necessary reports.

1302-03 DEFINITIONS

03.01 Group A Members of the Public. This group includes only known pregnant women.

03.02 Group B Members of the Public. All persons other than pregnant women (i.e., men, non-pregnant women, and children).

03.03 Member of the Public. Means an individual in an unrestricted area.

03.04 Radioactive Material in the Public Domain. Any byproduct, source, or special nuclear material, subject to NRC or Agreement State jurisdiction, that is outside restricted areas.

03.05 Restricted Area. An area, access to which is limited by a licensee, for the purpose of protecting individuals against undue risks from exposure to radiation and radioactive materials.

1302-04 APPLICABILITY

This chapter and its appendices and attachments apply to the Office of Nuclear Material Safety and Safeguards (NMSS) and NRC regional offices.

1302-05 RESPONSIBILITY

The Regional Administrator shall have the lead responsibility, for followup actions, for incidents involving radioactive material in the public domain, except when NMSS has the lead. NMSS shall have the lead responsibility when the incident involves several regional offices, several States, international entities, or when NRC management decides the incident would be better handled by Headquarters, to ensure a coordinated approach among the various agencies and licensees involved.

05.01 Director, Office of Nuclear Material Safety and Safeguards

Develops policy guidance for the Headquarters and regional staff who respond to incidents involving radioactive material in the public domain. Develops and administers the program for NRC followup actions to reports of such incidents. Coordinates incident followup activities, at Headquarters, for incidents involving radioactive material in the public domain.

05.02 Director, Office for Analysis and Evaluation of Operational Data

Maintains and staffs the NRC Operations Center at Headquarters 24 hours a day. Receives and documents incident reports from NRC regional offices, licensees, or other parties. Makes initial and followup notifications within NRC, and to other Federal agencies and State agencies, coordinating with NMSS.

05.03 Regional Administrator

Completes incident response activities according to the policy guidance established by NMSS and refers questions on policy matters to NMSS, for resolution.

05.04 Director, Office of International Programs

Coordinates international aspects of incident followup activities with the State Department, International Atomic Energy Agency (IAEA), foreign governments, and other international groups.

05.05 Director, Office of State Programs

Coordinates applicable incident followup activities with State, local, and Indian tribe

organizations.

05.06 Director, Office of Public Affairs

Prepares, coordinates, and disseminates information about incidents involving radioactive material to the public and news media.

05.07 Other Federal Agencies

Roles of other Federal agencies in responding to incidents involving radioactive material are summarized in Inspection Manual Chapter (MC) 1301, "Response to Radioactive Materials Incidents That Do Not Require Activation of the NRC Incident Response Plan."

1302-06 GENERAL RESPONSE PROCEDURE

Guidance for the NRC staff in any non-emergency incident involving byproduct, source, or special nuclear material associated with the NMSS program area is provided in MC 1301, "Response to Non-Emergency Incidents Involving Radioactive Material". The guidance in MC 1301, as well as other pertinent information in other inspection procedures, should be reviewed in conjunction with the guidance provided in this manual chapter.

1302-07 GUIDANCE

Incidents involving radioactive materials are, by nature, event-specific. Because the conditions surrounding each event are unique, followup plans must be developed on a case-by-case basis. In responding to an event, regional and NMSS Headquarters staff should consider all available

information in determining the appropriate followup actions. NMSS should coordinate the decision-making process and address concerns that any action levels may have on the public. In the early stages of a response, NMSS may have to determine whether medical evaluations are warranted for members of the public who were potentially exposed to radioactive materials. **It should be noted, however, that members of the U. S. Nuclear Regulatory Commission (NRC) staff should not engage in any discussions with members of the public about medical advice in cases dealing with an overexposure. Always refer any medical questions or concerns about biological effects of radiation exposure to a physician.** In addition, NMSS may also have to decide acceptable contamination levels for release of materials or facilities affected in these incidents. In making these decisions, staff should consider the circumstances surrounding the incident, related standards, recommended procedures, written guidance, and past events that may have set precedents for radioactive material decontamination levels.

In addition to the specific guidance provided here, four documents are attached to this MC to help regional and NMSS staff in selecting the appropriate response level for radiation exposures or contamination levels, and in notifying exposed members of the public. The first document provides specific guidance on event followup; the second provides guidance on contamination levels associated with an event; the third provides examples of acceptable radiation and contamination levels used in past events; and the fourth document provides the format of the notification letter to be sent to exposed members of the public to notify them of their assessed doses (see Attachments 1 to 4). **This guidance is specifically for use after actions have been taken to prevent the source of exposure from further effecting the public.**

The following list contains examples of actions that should be considered for events involving potential radiation exposure to members of the public:

1. Characterize the risk to persons who receive exposure, and recommend that they should consult a physician.
2. Provide the services of NRC medical consultants.
3. Define the boundaries of the contaminated area and restrict access to an area.
4. Require cleanup of contaminated area(s).
5. Issue a recall notice for defective (i.e., contaminated or leaking) products.
6. Inform persons of their exposures.

7. Ensure prevention of further radioactive contamination.
8. Attempt to locate persons who may have been exposed to radioactive materials.
9. Identify other possible similar sources of radioactive material.
10. Notify all other cognizant Federal agencies of the incident.
11. Issue press releases.
12. Examine regulatory significance of the incident.
13. Document NRC analysis and findings; prepare a report to the Commission (if necessary); and prepare changes to NRC Manual Chapter and regulations, if needed.

For all incidents, regional staff should coordinate with NMSS Headquarters in making decisions on actions.

END

Attachments:

1. NMSS Guidance on Event Followup
2. Guidance on Contamination Levels Associated with
Event Followup
3. Examples of Acceptable Radiation and Contamination
Levels for Past Events
4. Format of the Notification Letter to be Sent to

Exposed members of the Public

Appendices:

1. References for Developing Guidance on Radiation Exposure and Contamination Levels Associated with Event Followup

2. Table of References for Radiation and Contamination Levels Associated with Event Followup

3. Medical Assistance in Radiation Exposure Emergencies

ATTACHMENT 1

NUCLEAR MATERIAL SAFETY AND SAFEGUARDS

GUIDANCE ON EVENT FOLLOWUP

This guidance has been prepared to assist the U. S. Nuclear Regulatory Commission (NRC) staff in determining the need for actions in response to events involving radioactive materials, including transportation events. The dose criteria given here are suggestions, not requirements. The necessity for followup actions, such as an independent medical evaluation, or notification of the exposed individual(s), must be decided on a case-by-case basis.

The guidance presented in this document applies to members of the public potentially exposed to radiation or radioactive materials. Potentially exposed members of the public will be defined here

as members of the public who may have received a dose in excess of 1 mSv (100 mrem). Decisions can be based on two broad groups of potentially exposed members of the public: Group A, which includes only pregnant women, and Group B, which includes all individuals other than pregnant women. For an individual(s) whose estimated dose exceeds recommended public dose standards, notification of the known individual(s) is appropriate, but probably does not present a significant health and safety concern. **NRC should make the estimated dose information available upon request.** For an individual(s) whose resultant dose exceeds the occupational limits, however, locating and notifying the individual(s) of their estimated dose and recommending consultation with a physician can be a high priority. In the latter case, the responsible parties, local officials, and the NRC staff should make a strong effort to notify the individual(s). A summary of the actions appropriate for each group is contained in Table (1) at the end of this attachment.

When applying the following guidance for exposed members of the public, it is important to bear several points in mind. **The first is that if the licensee is required report to the Commission under §§20.2202, 20.2203, 20.2204, the licensee is responsible, under §19.13 (d), for providing an exposure report to the exposed individual(s). The licensee should be encouraged to use a letter similar to that in Attachment 4. If the NRC believes that the licensee response is inadequate or if there is no responsible licensee, NRC should consider providing a letter similar to the one shown in Attachment 4 to the exposed individual(s).** The second point is that actual doses to members of the public are unlikely to be known with precision, particularly during the early stages of an event. The usual situation is that dose ranges or upper bound doses will be assessed for each event. This is one of the primary reasons for locating persons whose potential dose likely exceeds the occupational limits. Interviews with such persons will help establish a better estimate of dose and the need for medical consultation. For cases that appear to confirm accidental overexposure to external ionizing radiation, cytogenetic (chromosome aberration) analysis is currently the most sensitive biological method of measuring radiation exposure, because it can detect equivalent whole body exposures of about 0.1 to 0.2 Sv (10 to 20 rem) of low linear energy transfer (LET) radiation. **Due to uncertainty in measurements for doses below 0.2 Sv (20 rem), cytogenetic studies are recommended for individual(s) who received estimated doses greater than 0.2 Sv (20 rem).** The third point is that the perception of radiation risk is often greater than the risk itself. When providing dose information, NRC must be as factual as possible about characterizing both the dose and risk, based on available information, without causing undue stress. The fourth point is that while the dose guidelines are general, public concern following an event may indicate a need to locate and notify an individual(s) exposed to estimated dose levels lower than those contained in the guidelines.

GROUP A: PREGNANT WOMEN

1. Dose Range from 1 mSv (100 mrem) to 5 mSv (500 mrem)

Inform women known to be pregnant, who may have received, from an event, an estimated committed dose equivalent to the fetus of more than 1 mSv (100 mrem) but not more than 5 mSv (500 mrem). The dose to the embryo/fetus is defined in the 10 CFR 20.1208 as the sum of: (1) the deep dose equivalent to the **declared** pregnant woman; and (2) the dose to the embryo/fetus from radionuclides in the embryo fetus and radionuclides in the **declared** pregnant woman. Explain that they have been exposed to radiation within this range, and that their exposure is within the regulatory guidelines for occupational exposure of a **declared** pregnant woman [less than 5 mSv (500 mrem)]. In discussing their radiation exposure, a copy of Regulatory Guide 8.13, "Instruction Concerning Prenatal Radiation Exposure" should be provided. If any medical questions regarding the potential radiation exposure of the fetus arise, inform them that although the radiation risk from this exposure is small, they may want to consult a physician. This physician may then contact the Radiation Emergency Assistance Center/Training Site (REAC/TS) in Oak Ridge, Tennessee, for additional information on radiological effects. REAC/TS is available to provide direct medical assistance on a 24-hour basis. This group of "known pregnant women" may include women interviewed in response to an event, women exposed to such levels that contact NRC, or women residing in the vicinity of the event. Significant time or resources need not be spent trying to locate women in this lower dose range, because this value is within the allowable limit of 5 mSv (500 mrem) for **declared** pregnant women. Non-pregnant women should follow the guidance provided for Group B.

2. Dose Range Greater than 5 mSv (500 mrem)

Locate and notify all women known to be pregnant, who may have received an estimated dose equivalent to the fetus of 5 mSv (500 mrem) or greater. Recommend that these women be advised to consult a physician. **For suspected acute exposure to external ionizing radiation of the whole body approaching 200 mSv (20 rem) or more of radiation, recommend that these individual(s) consult a physician who could then contact REAC/TS. Furthermore, suggest that cytogenetic (chromosome aberration) studies be initiated by either the licensee or, if there is no apparent party responsible for the incident, an NRC medical consultant.** Licensee and NRC personnel involved in responding to this event should make a significant effort, in both time and resources, to locate and notify women in this category. Attachment 4 provides an example of the format letter that should be transmitted to the overexposed individual(s). A press release may be the appropriate method of notification for this group of women. Non-pregnant women should follow the guidance for Group B.

GROUP B: MEN, CHILDREN, OR NON-PREGNANT WOMEN

1. Dose Range from 1 mSv (100 mrem) to 50 mSv (5 rem)

Inform individual(s), known to NRC, who may have received an estimated total effective dose equivalent, from the event, of more than **1 mSv (100 mrem)**, but not more than 50 mSv (5 rem). For individual(s) who receive up to 50 mSv (5 rem), explain that they have been exposed to radiation; tell them of their probable level of exposure; and explain that the **estimated exposure should not produce any discernable health effects**. This group of "known" individuals may include people interviewed in response to an event, people exposed to such levels who contact the NRC or State authorities, or people who live in the vicinity of the event. Significant time or resources need not be spent trying to locate an individual(s) in this dose range. For women who think they may be pregnant, the more stringent dose criteria given for Group A are recommended.

2. Dose Range Greater than 50 mSv (5 rem)

These guidelines are designed to be flexible in order to be adapted for the particular population affected. The following ranges define a lower level of dose below which wide-spread notification is not warranted and an upper level of dose for which implementation of this guidance should be carried out. They have been set at levels below those that would produce detectable short-term biological effects and at levels that would minimize long-term biological effects. In the event of an accident, they should be considered as criteria against which available options for various types of emergency actions can be weighed.

For doses that appear to be over 50 mSv (5 rem), assess the potential hazard in terms of quantity and type of radioactive material, area affected, radiation hazard, and potential for spread of contamination. Make every effort to identify the licensee or other party responsible for the radioactive material. Characterize the dose to an individual(s) who may have been in the area at the time of the incident. If the calculated effective dose equivalent from the event is between 50 and 100 mSv (5 and 10 rem), notify the individual(s) and explain that they have been exposed to radiation within this range, and that although this exposure exceeds the annual occupational exposure limits for workers, this exposure should not produce any discernable radiation health effects. Attachment 4 provides an example of the notification letter that should be transmitted to the overexposed individual(s).

If the calculated effective dose equivalent from the event is more than 100 mSv (10 rem), identify, locate, and notify the individual(s) that may have received greater than this dose. Recommend that the individual(s) be advised to consult a physician who could then contact REAC/TS. For suspected acute exposure to external ionizing radiation of the whole body approaching 200 mSv (20 rem) or more of radiation, suggest that cytogenetic (chromosome aberration) studies be initiated by either the licensee or, if there is no apparent party responsible for the incident, an NRC medical consultant.

In the event of an incident, involving NRC-licensed activities, that has the potential of including fixed contamination that could deliver an effective dose equivalent of greater than 10 mSv (1 rem) to members of the public, the NRC Incident Response Plan (NRC Management Directive 8.2) provides specific guidance on the threshold levels for emergency response. In addition, EPA's Manual of Protective Actions for Nuclear Incidents (EPA 400-R-92-001, May 1992) provides information for health and other governmental authorities in deciding when a radiation hazard in the environment constitutes a basis for initiating emergency protective actions (see Appendix 1).

TABLE 1

ACTIONS ASSOCIATED WITH EVENT FOLLOWUP

DOSE EQUIVALENT	GROUP A (Pregnant Women)	GROUP B (Men, Children and Non-Pregnant Women)
0-1 mSv (0-0.1 rem)	No Action	No Action
1-5 mSv (0.1-0.5 rem)	Inform, if identified	Inform, if identified
5-50 mSv (0.5-5 rem)	Recommend followup [†]	Recommend followup [†]
50-200 mSv (5-20 rem)	Recommend followup [†] with cytogenetic studies	Recommend followup [†] with cytogenetic studies

[†] When followup is recommended, expend resources as directed by NRC senior management to

identify and locate the members of the public involved.

ATTACHMENT 2

GUIDANCE ON CONTAMINATION LEVELS ASSOCIATED WITH EVENT FOLLOWUP

This guidance has been prepared to assist U. S. Nuclear Regulatory Commission (NRC) staff in determining the need for remedial actions in response to contamination from events involving radioactive materials, including transportation events. The final rule on radiological criteria for license termination was published on July 21, 1997 (62 FR 39057) with an effective date of August 20, 1997. **In accordance with 10 CFR 20.1402, a site** is acceptable for unrestricted use if the residual activity that is distinguishable from background radiation results in a total effective dose equivalent (TEDE) to an average member of the critical group that does not exceed 0.25 mSv (25 mrem) per year. Revised guidance for implementing this rule is expected to be available by February 1998. Until the revised guidance is available, staff should continue to use the existing guidance in Regulatory Guide 1.86⁽¹⁾ and analogous Nuclear Material Safety and Safeguards (NMSS) guidance that is referenced in this section. Therefore, the necessity for remedial actions, such as decontamination, demolition, or disposal, must be determined on a case-by-case basis, guided by these recommendations.

The following guidance can be used to recommend actions to be taken for various levels of radioactive surface contamination resulting from events involving radioactive materials.

1. Fixed contamination that could deliver an effective dose equivalent of less than 0.25 mSv (25 mrem) per year to members of the public does not require further remedial action.

2. Fixed contamination that could deliver an effective dose equivalent of between 0.25 to 1 mSv (25 to 100 mrem) per year to members of the public may require further remedial action. A cost-benefit or ALARA (As Low As Reasonably Achievable) analysis should be performed for these cases, to determine the extent of the decontamination efforts.

3. Fixed contamination that could deliver an effective dose equivalent of between 1 mSv (100 mrem) and 10 mSv (1 rem) to members of the public requires further remedial action, such as decontamination or disposal of contaminated materials. Regional staff should coordinate all remedial actions through headquarters, for these levels of contamination. NRC contractors, such as Oak Ridge Institute of Science and Education (ORISE), may be used to evaluate the contaminated site, and to provide independent analysis and recommendations for remedial actions.

4. In the event of an incident, involving NRC-licensed activities, that has the potential of involving fixed contamination that could deliver an effective dose equivalent of greater than 10 mSv (1 rem) to members of the public, the NRC Incident Response Plan (NRC Management Directive 8.2) provides specific guidance on the threshold levels for emergency response. In addition, EPA's Manual of Protective Actions for Nuclear Incidents (EPA 400-R-92-001, May 1992) provides information for health and other governmental authorities in deciding when a radiation hazard in the environment constitutes a basis for initiating emergency protective actions (see Appendix 1). Although each incident would be addressed on a case-by-case basis, any incident that could generate broad public concern should be coordinated by NRC headquarters.

A summary of the references for developing guidance on radiation and contamination levels associated with event followup are in Appendices 1 and 2.

END

ATTACHMENT 3

EXAMPLES OF ACCEPTABLE RADIATION AND CONTAMINATION LEVELS FOR PAST EVENTS

Guidance is provided in this section on typical situations or accident scenarios. These scenarios represent the type of transportation accidents/incidents that the U. S. Nuclear Regulatory Commission (NRC) or State authorities are likely to encounter.

Scenario No. 1: Contaminated Rebar

On January 17, 1984, Region IV was informed that Los Alamos National Laboratory (LANL) had detected some radioactive reinforcing bars (rebar) in a shipment mistakenly delivered to LANL. The rebar was determined to have been inadvertently contaminated with cobalt-60 (Co-60) and that the shipment had come from a supplier in Mexico through a broker in Phoenix, Arizona.

Guidance on dose levels for members of the public who might occupy structures containing the contaminated rebar was established by the Office of Nuclear Material Safety and Safeguards (NMSS). Because the exposure to Co-60 was considered similar to Ra-226, the guidance in 40 CFR Part 192 was selected as a basis for remedial action. Remedial action, for gamma radiation in buildings, is addressed in 40 CFR 192.12 (b)(2). This section, in part, requires that the: "level of gamma radiation shall not exceed the background level by more than 20 microroentgens per hour." Using this as a reference point and an occupancy factor of 0.75, the total exposure is within 1.3 mGy/yr (130 mrad/yr). The NRC guidance also noted that the 1.3 mGy/yr (130 mrad/yr) level: "should, in most circumstances, maintain doses within 5 mSv/yr (500 mrem/yr) from all sources of radiation as recommended by the ICRP and, considering the 5.3 year half-life of Co-60 contamination, will not likely cause the average annual lifetime dose to exceed 1 mGy (100 mrad)."

Related Notes. Because of the implementation of the revised 10 CFR Part 20 (effective January 1, 1994), however, the NMSS recommended guidance for situations of this type in the future is to limit exposures to within 1 mSv (100 mrem) per year.

Scenario No. 2: Contaminated Pipe Fittings

On April 12, 1985, Region II was informed that several sections of well casing pipe found in drinking water wells in a community in eastern Florida had detectable levels of radioactivity (approximately 0.3 Gy/hr (30 rad/hr) on contact). Laboratory analysis showed the contaminant to be Co-60, with a concentration of 962 Bq/g (26 pCi/g). After further investigation, it was determined that the pipe had been imported from Brazil. Calculations to determine the health hazard from drinking water contamination demonstrated that the concentration of Co-60 was less than 0.03 percent of U. S. Environmental Protection Agency's (EPA's) recommended maximum permissible concentration of 3.7 Bq/l (100 pCi./l).

Although the highest radiation level detected, 0.8 Gy/hr on contact (80 rad/hr) was calculated to cause no significant hazard to public health (because of the nature of the material and its probable use), NMSS provided guidance to Federal and State authorities for pipe that was not installed or already installed in unshielded locations. Contaminated pipe that was already installed could be left in place if shielded to the point where exposure to the public would be below 10 Gy/hr at 1 cm (1 mrad/hr). If the pipe exceeded 10 Gy/hr at 1 cm (1 mrad/hr), it was segregated for special handling. Disposal of the pipe by means other than transfer to a low-level waste repository had to be justified and approved before disposal. In formulating this guidance, 10 CFR Part 20, ICRP Report 26, and the Branch Technical paper on "Guidelines for Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use" were used.

Related Notes: NUREG/CR-5512, "Residual Radioactive Contamination from Decommissioning," released as a draft report for comment in January 1990, and NUREG/CR, Vol. 1 (issued in October 1992), provide a technical basis for translating contamination levels to annual total effective dose equivalent.

Scenario No. 3: Contaminated Steel Plant

On February 21, 1983, the New York State Department of Health was notified of excessive radiation levels at a steel plant. Extensive areas of the steel mill were contaminated with Co-60. The plant was decontaminated based on New York State Department of Labor limits. These limits specified permissible levels, for removable contamination, of Co-60 averaging 3.7 Bq (100 pCi) per 100 cm², with a maximum of 18.5 Bq (500 pCi) per 100 cm². The fixed contamination limits were 2.5 Sv/hr (0.25 mrem/hr) at 1 cm from the surface. Acceptable concentration in soil for this contaminant is 18.5 Bq/g (500 pCi/g).

Scenario No. 4: Contaminated Pipe Fittings

On August 29, 1984, Region V was informed by GA Technologies, La Jolla, California, of radioactive contamination in pipe fittings. The radioactivity was identified as Co-60 as the only contaminant and was measured as 0.5 to 0.7 Sv/hr (0.05 to 0.07 mrem/hr) at the surface. The highest concentration of Co-60 was 7.8 Bq/g (0.21 nCi/g). The fittings had been imported from Taiwan. A later analysis of the incident estimated that a 740 MBq (20 mCi) source of Co-60 had

been mixed with 76.8 tons of scrap in a single batch of steel that was cast into products (such as the pipe fittings) exported to the United States. The maximum radiation dose that any person would have been likely to receive might have come from where the pipe fittings were stored, or were installed in a plumbing system. The dose rate drops to less than 10 percent of the surface dose when the distance from the surface of the contaminated fittings is 5.1 cm (two inches) or more. Given this information, the maximum radiation dose would be 0.88 mSv/yr (88 mrem/yr).

A second exposure pathway was evaluated for drinking water exposure because of leaching of Co-60. Based on the maximum activity of 37 Bq/g (1 nCi/g), and the total quantity of Co-60, in the pipe, of 350 grams, a body burden of 13 kBq (350 nCi) was calculated. At the time of this incident, this was less than one-tenth of the occupational maximum permissible body burden of 370 Bq (10 mCi) from ICRP 2. The maximum exposure to any individual possessing one or more contaminated pipe fittings was determined to be very low and NRC concluded that there was no threat to public health and safety.

Related Notes: As required by 10 CFR 20.1202(c), if an occupationally exposed individual ingests greater than 10 percent of the applicable oral annual limit on intake (ALI), the licensee shall assess and include the internal exposure from this intake. The methods that may be used for determining the committed effective dose equivalent from an oral intake, such as the example of water contaminated with Co-60, above, are similar to some of the methods used for estimation of inhalation dose. Because we know the amount of radioactive material that could be ingested 13 kBq (350 nCi), the oral ingestion ALIs from 10 CFR Part 20, Appendix B, Table 1, Column 1, may be used.

Using the following equations, the total effective dose equivalent may be calculated:

$$H_E = H_D + H_{E,50}$$

$$H_{E,50} = 5 \text{ rem} \times \sum_i (I_i / \text{ALI}_{i,E,50})$$

where,

H_E = the total effective dose equivalent (rem)

H_D = the deep dose equivalent (rem)

$H_{E,50}$ = the committed dose equivalent (rem)

I_i = the intake of radionuclide i by oral ingestion

during the calendar year (Ci)

$ALI_{i,E,50}$ = the value of the oral ingestion ALI for radionuclide

i for the committed effective dose equivalent

from 10 CFR Part 20, App. B, Table 1, Col. 1 (Ci)

For this example, the committed effective dose equivalent would be:

$$H_{E,50} = 5 \text{ rem} \times 0.35 \text{ (Ci)}/200 \text{ (Ci)}$$

$$= 8.75 \text{ mrem}$$

Thus, assuming that the deep dose equivalent (whole body dose) is zero; the committed effective dose equivalent is 87.5 Sv (8.75 mrem); and the total effective dose equivalent is 87.5 Sv (8.75 mrem). Since the total effective dose equivalent is less than 50 mSv (5 rems), the 10 CFR Part 20 limits have not been exceeded.

A second calculation needed for demonstrating compliance with the dose limit of 10 CFR 20.1201(a)(1)(ii) is the organ-specific committed dose equivalent. The difference between the determination of the committed effective dose equivalent and the committed dose equivalent is

the fact that the determination of the organ specific dose does not use an organ weighting factor.

The method of determining the committed dose equivalent from an oral intake is as discussed above, except that the deterministic (non-stochastic) oral ingestion ALIs should be used. The following equation is applicable:

$$H_{C,50} = 50 \text{ rem} \times (I_i / \text{ALI}_{i,C,50})$$

$H_{C,50}$ = the committed dose equivalent (rem)

I_i = the intake of radionuclide i by oral ingestion during
the calendar year (C_i)

$\text{ALI}_{i,C,50}$ = the value of the oral ingestion ALI for radionuclide
 i for the committed dose equivalent from 10 CFR Part 20,
App. B, table 1, Col. 1 (C_i)

Note that the stochastic ALI may be used if a non-stochastic ALI is not provided in 10 CFR Part 20,
App. B, as is the case with Co-60.

For this example, the maximum committed dose equivalent can be determined by:

$$H_{E,50} = 50 \text{ rem} \times 0.35 \text{ (Ci)} / 200 \text{ (Ci)}$$

= 87.5 mrem

Thus, the maximum committed dose equivalent is 87.5 mrem.

Scenario No. 5: Failure of 3M Static Elimination Devices

On January 22, 1988, the Ashland Chemical Company (Ashland) reported, to NRC, the presence of radioactive contamination at its plant in Easton, Pennsylvania. The radioactive contamination appeared to have been caused by leakage or ejection of the polonium-210 (Po-210) microspheres from static elimination devices manufactured by Minnesota Mining and Manufacturing (3M). From follow-up investigations, NRC learned that numerous other instances of facility contamination by Po-210 microspheres existed. Extensive efforts were quickly taken by both the Agreement States and NRC staff to survey licensee plants, find out the extent of the problem, and initiate remedial actions.

Beginning in February 1988, NRC issued a series of orders relative to 3M static elimination devices. One order suspended immediately the authority of general licensees to use the 3M devices containing Po-210. A second order required 3M to notify all its generally licensed customers, by first-class mail, of the Order suspending use, and to instruct the users to return their devices as soon as was feasible, but within 90 days. There was a provision made for users to keep those devices that were essential to occupational safety. Several applications were identified where continued use was necessary for the elimination of static electricity, in order to avoid fires or explosions.

Consideration was given to several items regarding the inherent public health and safety of the 3M static eliminators. Reports of the results of NRC and Agreement State surveys at general licensee facilities were coordinated; information was disseminated to the States promptly, through an electronic mail service of the Conference of Radiation Control Program Directors; and devices were analyzed by an independent NRC contractor (Brookhaven National Laboratory), to ascertain the cause of the problem. These analyses were published in two separate reports, "Failure Investigation of 3M Series 900 Static Eliminators" (NUREG/CR-5145, July 1988) and "Examination of Two 3M Type 902F Static Eliminators" (NUREG/CR-5266, January 1989).

Related Notes: In taking regulatory action when the potential health and safety hazards are relatively small, NRC should carefully quantify health and safety risks before recalling a licensed device. When it becomes apparent that a problem involves more than one or two plant sites, NMSS should perform a dose evaluation assessing both internal and external doses (as described in Scenario 4) as a first approximation. All further response actions should be based on actual or potential dose rather than on detectability of radiation or perceived media interest.

END

ATTACHMENT 4

FORMAT OF THE NOTIFICATION LETTER

TO BE SENT TO EXPOSED

MEMBERS OF THE PUBLIC

Dear (Name of Person)

The regulations of the U. S. Nuclear Regulatory Commission (NRC) require that members of the public who received unintended exposure to radiation or radioactive material be informed of their exposure. This requirement is specified in the U.S. Code of Federal Regulations, Chapter 10, Part 19, Section 13(d). This letter is being furnished to you in compliance with this requirement.

As you may be aware, the NRC has conducted an investigation of the incident in which you received the radiation exposure. This incident occurred (place and date of incident). Our investigation resulted in a radiation dose estimate for you of between (Range of Doses in sievert (rems)). A range is provided because the dose estimation involved unavoidable uncertainties that made it impossible to provide a single, accurate number. You may view the higher number in the range as the maximum dose that you may have received. Much more likely, your dose is somewhere between the two numbers given.

Since you may not be familiar with the units in which radiation dose is given, that is, the sievert or the rem, the following is provided to help you put your dose in perspective. NRC regulations specify a maximum dose to any member of the public of 1 millisievert (0.1 rem) per year (excluding background radiation and medical administration). A millisievert is one thousandth of a sievert. Occupational radiation workers, such as nurses, technicians, and doctors in x-ray and nuclear medicine departments in hospitals, are allowed to receive a dose of up to 50 millisieverts (5 rems) per year. A chest x-ray gives about 0.1 millisieverts (0.01 rem), and a flight on a commercial airline across the continental United States gives about 0.025 millisieverts (0.0025 rem). The average dose from natural background radiation in the United States is about 3.6 millisievert (0.36 rem) per year and ranges from 1 millisievert (0.1 rem) to 10 millisievert (1 rem) per year.

There are no expected clinical effects resulting from the radiation dose you received. However, in the absence of scientific uncertainty between low doses and health effects, the NRC assumes that any exposure to radiation may be harmful. At the dose level you received, this risk is very slight and indistinguishable on an individual basis from the risk of developing cancer from all other causes. However, if you feel that you need further information, you may contact (REAC/TS,

Medical Consultant, Phone No., and Hours). When calling, please indicate that your inquiry is related to the (Name of Incident) incident. Note also that the radiation dose information contained in this letter is exempt from disclosure to the public in accordance with 10 CFR 2.790(a). This means that this information may not be released to any member of the public without your permission.

If you need additional information regarding this incident, please call (Name of Contact) at our headquarters Offices in Rockville, Maryland, (Phone Number to Call headquarters). If it is more convenient, you may also call (Name of Regional Contact) at our Region (Region Number) Offices in (Location of Regional Offices) at (Regional Phone No.).

Sincerely,

Regional Administrator

APPENDIX 1

REFERENCES FOR DEVELOPING GUIDANCE ON RADIATION EXPOSURE AND CONTAMINATION LEVELS ASSOCIATED WITH EVENT FOLLOW-UP

The following recommendations from scientific organizations and regulatory agencies were considered in developing guidance on radiation and contamination action levels associated with event followup. It should be noted, however, that members of the U. S. Nuclear Regulatory

Commission staff should not engage in any discussions with members of the public about medical advice in cases dealing with an overexposure. Always refer any medical questions or concerns about biological effects of radiation exposure to a physician.

I. INTERNATIONAL COMMISSION ON RADIATION PROTECTION (ICRP)

The 1990 recommendations of the ICRP were finalized during its November 1990 meeting, and appeared in Volume 21, No. 1-3 of the Annals of the ICRP, as Publication 60. The ICRP recommends that the limit for public exposure should be expressed as an effective dose of 1 mSv (100 mrem) a year. However, in special circumstances, a higher value of effective dose could be allowed in a single year, provided that the average over 5 years does not exceed 1 mSv (100 mrem) per year.

For occupational dose limits, the ICRP recommends an effective dose of 20 mSv (2 rem) per year, averaged over 5 years [100 mSv (10 rem) in 5 years], with the further provision that the effective dose should not exceed 50 mSv (5 rem) in any single year. For the occupational exposure of declared pregnant women, ICRP recommends that the fetus should be protected by applying a supplementary dose equivalent to the surface of the woman's abdomen (lower trunk) of 2 mSv (200 mrem) for the remainder of the pregnancy and by limiting intakes of radionuclides to about one-twentieth of the Annual Limit on Intake (ALI).

II. NRC

1. NRC's current 10 CFR Part 20 establishes an explicit dose limit of 1 mSv (100 mrem) per calendar year, resulting from any licensed activity, to any individual in an unrestricted area, with 5 mSv (500 mrem) per year allowed in certain temporary NRC pre-approved situations. Part 20 also establishes a dose limit of 5 mSv (500 mrem) to the embryo-fetus for the occupational exposure of a declared pregnant woman. If the fetal dose has exceeded that level before the pregnancy is declared, other limits apply.

2. NRC's Draft Regulatory Guide 8.13, Revision 3, "[Instruction Concerning Prenatal Radiation Exposure](#)" provides occupationally exposed women with guidance on the biological effects of radiation on the embryo-fetus and whether or not to declare pregnancy.

3. NRC's "[Guidelines for Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use or Termination of Licenses for Byproduct, Source, or Special Nuclear Material \(1987\)](#)" provides guidelines for decontamination of materials before release for unrestricted use. The guidance for average and maximum radiation levels associated with surface contamination resulting from beta-gamma emitters should not exceed 2 Gy/hr (0.2 mrad/hr) at 1 cm and 10 Gy/hr (1.0 mrad/hr) at 1 cm, respectively, measured through not more than 7 milligrams per square centimeter of total absorber. The document's main guidance is a table that lists the acceptable levels of contamination for four groups of radionuclides. For each group, acceptable surface contamination levels are given for average, maximum, and removable contamination. For most beta-gamma emitters, the acceptable levels are 300 kBq/100 cm² (5000 dpm/100 cm²) average, 900 kBq/100 cm² (15,000 dpm/100 cm²) maximum, and 60 kBq/100 cm² (1000 dpm/100 cm²) removable contamination. For more specific information regarding other radionuclides, refer to Table I-1 of this aforementioned document.

III. NATIONAL COUNCIL ON RADIATION PROTECTION AND MEASUREMENTS (NCRP)

NCRP Report No. 116, "[Limitation of Exposure to Ionizing Radiation](#)" recommends a maximum annual effective dose equivalent of 5 mSv (500 mrem) for infrequent exposures of members of the public. The NCRP also recommends a remedial action level of 5 mSv (500 mrem) annual effective dose equivalent "... for all external sources other than medical." NCRP Report No. 116 further states "NCRP recommends a monthly equivalent dose limit of 0.5 mSv (50 mrem) to the embryo-fetus (excluding medical, and natural background radiation) once a pregnancy becomes known."

IV. U. S. ENVIRONMENTAL PROTECTION AGENCY (EPA)

EPA's Manual of Protective Actions for Nuclear Incidents (EPA 400-R-92-001, May 1992) was introduced to radiological emergency planning to assist public health and other governmental authorities in deciding how much of a radiation hazard in the environment constitutes a basis for initiating emergency protective actions. These protective action guides (PAGs) are expressed in terms of radiation dose (Sv or rem) and represent trigger or initiation levels, which warrant pre-selected protective actions for the public if the projected (future) dose received by an individual in the absence of a protective action exceeds the PAG. PAGs are defined or definable for all pathways of radiation exposure to persons and are proposed as guidance to be used as a basis for taking action to minimize the impact on individuals.

The EPA Manual recommends PAGs for emergency response of 10 to 50 mSv (1 to 5 rem) for the case of whole body gamma external exposure to the general population of radioactive material. In addition, the manual recommends relocating the general population as protective action when the first year's projected effective dose equivalent from contamination equals or exceeds 20 mSv (2 rem). This recommendation was established to assure that the dose in any single year after the first year does not exceed 5 mSv (0.5 rem) and the 50-year cumulative dose does not exceed 50 mSv (5 rem).

Chapter 3 of this EPA Manual contains basic criteria for both preventative and emergency PAGs regarding accidental radioactive contamination of human food and animal feeds. The preventative PAG is (i) 15 mSv (1.5 rem) projected dose commitment to the thyroid, or (ii) 5 mSv (0.5 rem) projected dose commitment to the whole body, bone marrow, or any other organ. The emergency PAG is (i) 150 mSv (15 rem) projected dose commitment to the thyroid, or (ii) 50 mSv (5 rem) projected dose commitment to the whole body, bone marrow, or any other organ. These recommendations were originally published by the Food and Drug Administration (FDA) in 1982 (47 FR 47073). The response levels are given for five radionuclides (Cs-134, Cs-137, I-131, Sr-89, and Sr-90) and for three specific types of contamination (initial-activity area deposition, forage concentration, and peak milk activity). PAGs for drinking water are currently under development by EPA.

In discussing the threshold dose levels for acute effects, this **EPA Manual** references sources that indicate that "5 rad [50 milligray (mGy)] is about the lower limit of whole body dose which causes a cellular effect detectable by chromosome or other special analysis." **This limit is consistent with the recommendations of** the United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR, 1986) **which** also recommends 50 mGy (5 rad) as the starting point for biological dosimetry. EPA states, further, that other scientists have "... reported a lower limit of detection of chromosome aberrations of 40 mGy (4 rad) for x-rays and 100 mGy (10 rad) for gamma rays."

Beta/Gamma Contamination (Maximum) 10 Gy/hr (1 mrad/hr) @ 1 cm
Beta/Gamma Contamination (Average) 7 Gy/hr (0.7 mrad/hr) @ 1 cm
Beta/Gamma Maximum Surface Contamination 900 kBq/100 cm ² (15,000 dpm/100 cm ²) (Sr-90 3,000 dpm/100 cm ₂)
Beta/Gamma Average Surface Contamination 300 kBq/100 cm ² (5,000 dpm/100 cm ²) (Sr-90 1,000 dpm/100 cm ₂)
Beta/Gamma Removable Contamination 60 kBq/100 cm ² (1,000 dpm/100 cm ²) (Sr-90 200 dpm/100 cm ₂)

END

APPENDIX 3

MEDICAL ASSISTANCE IN RADIATION EXPOSURE EMERGENCIES

If medical advice is needed, or if the exposed person's physician is not trained in the effects of radiation exposure and the treatment of such effects, call or refer the physician to the Radiation Emergency Assistance Center/Training Site (REAC/TS). REAC/TS is a Department of Energy response asset that maintains a radiological emergency response team consisting of physicians, nurses, health physicists, coordinators, and necessary support personnel. It is on 24-hour call to provide first-line responders with consultative or direct medical and radiological assistance at the REAC/TS facility or at the accident site. They have expertise in, and are equipped to conduct (1) medical and radiological triage; (2) decontamination procedures and therapies for external contamination and internally deposited radionuclides, including DPTA chelation therapy; (3) diagnostic and prognostic assessment of radiation-induced injuries; and (4) radiation dose estimates by methods that include cytogenetic analysis, bioassay, and in-vivo counting. ⁽²⁾ The

REAC/TS day time telephone number is (615) 576-3131 and the 24 hour telephone number (Methodist Medical Center) is (615) 481-1000. If the telephone numbers have changed, the NRC Emergency Operations Center should be called for the new number at (301) 816-5100.

END

1. "Guidlines for Decontamination of Facilities and Equipment prior to Release for Unrestricted Use or Termination of Licenses for Byproduct, Source, or Special Nuclear Material." August 1987.

2. 2 NRC's Response Technical Manual, RTM-93, page O-1.

