NUREG-1712

Nuclear Byproduct Material Risk Review: Results of Survey of NRC and Agreement State Materials Licensing and Inspection Personnel

Final Report

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Prepared by
D. Serig, J. Lubinski, E. Ullrich, J. Randall, N. Daugherty*

*State of Colorado, Department of Public Health and Environment

Division of Industrial and Medical Nuclear Safety
Office of Nuclear Material Safety and Safeguards
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

ABSTRACT

This project responded to NRC's Direction Setting Issue 12, Risk-Informed, Performance-Based Regulation. Its scope was limited to nuclear byproduct materials as defined in Section 11.e(1) of the Atomic Energy Act of 1954 and Title 10 of the Code of Federal Regulations (CFR), Section 30.4. 10 CFR Parts 30 through 36 and 39 address regulation of those materials. The goal was to confirm and augment information on nuclear byproduct material systems obtained from other sources. The process involved (1) use of a list of nuclear byproduct material systems based on how the nuclear byproduct material was used, (2) a survey of NRC and Agreement State materials licensing and inspection personnel concerning typical annual doses to workers for the various systems, safety of each system under various conditions, the types and frequencies of incidents occurring at each system, definitions of safety, and opinions about the appropriate bases for regulatory decision making, and (3) summarization of the respondent's answers to those questions.

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1 RESPONSES TO QUESTIONS ABOUT ANNUAL WORKER DOSES, SAFETY UNDER VARIOUS CONDITIONS, AND EVENTS THAT OCCUR BY SYSTEM

This section summarizes the respondent's opinions about typical annual worker doses for each system, the safety of each system under various conditions, and the most frequent non-reportable incidents for each system. It is important to note that NUREG-1712 uses many of the same system categories as shown in NUREG/CR-6642, "Risk Analysis and Evaluation of Regulatory Options for Nuclear Byproduct Material Systems," Table 1.4-1, but the systems listed in this NUREG are not identical to those in this NUREG/CR-6642. The numbering of the systems in NUREG-1712 is also different from NUREG/CR-6642. Also, the results from NUREG-1712 were not used in NUREG/CR-6642.

Item 1, under each system, summarizes the respondent's opinions about the number of workers typically receiving annual doses below specific levels (e.g., 50 mrem/yr, 500 mrem/yr, etc.). Respondents were asked to indicate what percentage of workers typically received doses in various ranges. They could choose a single range for all workers or distribute workers over several dose ranges. Respondents exercised both options. Thus, the distribution of doses over various ranges reflects both the individual opinions of respondents as well as the opinions of respondents as a group.

Item 2, under each system, summarizes the respondent's opinions of whether a system was very safe, somewhat safe, somewhat unsafe, or very unsafe under normal operations and off-normal operations both with and without current regulations. "Safety" was not predefined for the respondents (i.e., their opinions about the safety of systems were expected to reflect their personal definitions of safety). A subsequent question asked respondents for their own definitions of very safe, somewhat safe, somewhat unsafe, and very unsafe. Tables based on modal responses and median responses are both provided. Both tables frequently are the same, but for some systems the tables differ and the ability to compare the two appears to offer additional value.

Item 3, under each system, summarizes the respondent's opinions about the most typical non-reportable events occurring under that system. Respondents were asked to indicate the event that they felt was most likely. Thus, the set of events for each system reflects the opinions of the respondents as a group rather than the opinions of individual respondents. The lists of events may be reflective of the respondents' opinions about what "off-normal" operations mean for each system and, thus, the safety of the various systems under off-normal conditions. The respondents' views about typical events may also have influenced estimates of the percentage of persons falling into various dose ranges. Respondents were also asked to provide an opinion about the frequency of the events that they indicated. That information is also summarized in Item 3.

1.1 SYSTEM 1: RESEARCH AND DEVELOPMENT SYNTHESIS LABORATORIES

1. Estimated percentage of workers receiving doses at various levels (N=29):

   - 75% < 50 mrem/yr
   - 98% < 500 mrem/yr
   - 99% < 1000 mrem/yr
   - 1% > 1000 mrem/yr

2. Responses to questions about safety under various conditions.

Table 1.1 Modal Selections on Questions Related to the Safety of Research and Development Synthesis Laboratories Under Various Conditions (Ns =30 to 34)

	With Current Regulations	Without Current Regulations
Normal (barriers intact)	Very safe, 50%	Somewhat safe, 45%
Off-normal (barrier failure)	Somewhat safe, 50%	Somewhat unsafe, 41%

Table 1.2 Median Selections on Questions Related to the Safety of Research and Development Synthesis Laboratories Under Various Conditions (Ns = 30 to 34)

	With Current Regulations	Without Current Regulations
Normal (barriers intact)	Very safe/somewhat safe	Somewhat safe
Off-normal (barrier failure)	Somewhat safe	Somewhat unsafe

3. Responses to question about most frequent non-reportable event (N = 27):

   - contamination, frequency varied from 1 time per week to less often than 1 time per year (9 of 27)
   - spills, frequency varied from 1 time per month to 1 time per year (14 of 27)
   - spills and contamination, frequency varied from 1 time per week to 1 time per month (3 of 27)
   - loss of hood containment, 1 time per month (1 of 27)

1.2 SYSTEM 2: RESEARCH AND DEVELOPMENT LABORATORIES USING CARBON, HYDROGEN, IODINE, PHOSPHOROUS, AND SULFUR

1. Estimated percentage of workers receiving doses at various levels (N = 36):

   - 87% < 50 mrem/yr
   - 100% < 500 mrem/yr

2. Responses to questions about safety under various conditions.

Table 1.3 Modal Selections on Questions Related to the Safety of Research and Development Laboratories Using Carbon, Hydrogen, Iodine, Phosphorous, and Sulfur Under Various Conditions (Ns = 37 to 39)

	With Current Regulations	Without Current Regulations
Normal (barriers intact)	Very safe, 51%	Somewhat safe, 53%
Off-normal (barrier failure)	Somewhat safe, 59%	Somewhat safe, 42%

Table 1.4 Median Selections on Questions Related to the Safety of Research and Development Laboratories Using Carbon, Hydrogen, Iodine, Phosphorous, and Sulfur Under Various Conditions (Ns = 37 to 39)

	With Current Regulations	Without Current Regulations
Normal (barriers intact)	Very safe	Somewhat safe
Off-normal (barrier failure)	Somewhat safe	Somewhat unsafe

3. Responses to question about most frequent non-reportable event (N = 36):

   - contamination, frequency varied from 1 time per week to 1 time per year (15 of 36)
   - spills, frequency varied from 1 time per week to less often than 1 time per year (17 of 36)
   - spills and contamination, frequency varied from 1 time per week to 1 time per month (4 of 36)

1.3 SYSTEM 3: *IN VITRO* TESTING

1. Estimated percentage of workers receiving doses at various levels (N = 36):

   - 96% < 50 mrem/yr
   - 100% < 100 mrem/yr

2. Responses to questions about safety under various conditions.

Table 1.5 Modal Selections on Questions Related to the Safety of *In Vitro* Testing Under Various Conditions (Ns = 37 to 39)

	With Current Regulations	Without Current Regulations
Normal (barriers intact)	Very safe, 87%	Very safe, 50%
Off-normal (barrier failure)	Very safe, 51%	Somewhat safe, 42%

Table 1.6 Median Selections on Questions Related to the Safety of *In Vitro* Testing Under Various Conditions (Ns = 37 to 39)

	With Current Regulations	Without Current Regulations
Normal (barriers intact)	Very safe	Very safe/somewhat safe
Off-normal (barrier failure)	Very safe	Somewhat safe

3. Responses to question about most frequent non-reportable event (N = 33):

   - contamination, frequency varied from 1 time per month to less often than 1 time per year (15 of 33)
   - spills, frequency varied from 1 time per month to less often than 1 time per year (12 of 33)
   - spills and contamination, frequency of 1 time per month (1 of 33)
   - loss of material, frequency varied from 1 time per year to less often than 1 time per year (5 of 33)

1.4 SYSTEM 4: 10 CFR 35.100 — NUCLEAR MEDICINE AND HUMAN USE RESEARCH

1. Estimated percentage of workers receiving doses at various levels (N = 31):

   - 39% < 50 mrem/yr
   - 99% < 500 mrem/yr
   - 100% < 1000 mrem/yr

2. Responses to questions about safety under various conditions.

Table 1.7 Modal Selections on Questions Related to the Safety of 10 CFR 35.100 - Nuclear Medicine and Human Use Research Under Various Conditions (Ns = 35 to 38)

	With Current Regulations	Without Current Regulations
Normal (barriers intact)	Very safe, 58%	Somewhat safe, 37%
Off-normal (barrier failure)	Somewhat safe, 41%	Somewhat unsafe, 34%

Table 1.8 Median Selections on Questions Related to the Safety of 10 CFR 35.100 - Nuclear Medicine and Human Use Research Under Various Conditions (Ns = 35 to 38)

	With Current Regulations	Without Current Regulations
Normal (barriers intact)	Very safe	Somewhat safe
Off-normal (barrier failure)	Somewhat safe	Somewhat safe

3. Responses to question about most frequent non-reportable event (N = 27):

   - contamination, frequency varied from 1 time per week to 1 time per year (11 of 27)
   - spills, frequency varied from 1 time per week to less often than 1 time per year (15 of 27)
   - spills and contamination, frequency of 1 time per year (1 of 27)

1.5 SYSTEM 5: 10 CFR 35.200 — NUCLEAR MEDICINE WITH GENERATOR(S)

1. Estimated percentage of workers receiving doses at various levels (N = 33):

   - 13% < 50 mrem/yr
   - 82% < 500 mrem/yr
   - 97% < 1000 mrem/yr
   - 3% > 1000 mrem/yr

2. Responses to questions about safety under various conditions.

Table 1.9 Modal Selections on Questions Related to the Safety of 10 CFR 35.200 — Nuclear Medicine with Generator(s) Under Various Conditions (Ns = 36 to 38)

	With Current Regulations	Without Current Regulations
Normal (barriers intact)	Somewhat safe, 61%	Somewhat safe, 36%
Off-normal (barrier failure)	Somewhat unsafe, 50%	Somewhat unsafe, 39%

Table 1.10 Median Selections on Questions Related to the Safety of 10 CFR 35.200 — Nuclear Medicine with Generator(s) Under Various Conditions (Ns = 36 to 38)

	With Current Regulations	Without Current Regulations
Normal (barriers intact)	Somewhat safe	Somewhat unsafe
Off-normal (barrier failure)	Somewhat unsafe	Somewhat unsafe

3. Responses to question about most frequent non-reportable event (N = 33)

   - contamination, frequency varied from 1 time per week to 1 time per year (14 of 33)
   - spills, frequency varied from 1 time per week to less often than 1 time per year (16 of 33)
   - spills and contamination, frequency varied from 1 time per week to 1 time per quarter (2 of 33)
   - misadministration, frequency of 1 time per month (1 of 33)

1.6 SYSTEM 6: 10 CFR 35.200 — NUCLEAR MEDICINE WITHOUT A GENERATOR

1. Estimated percentage of workers receiving doses at various levels (N = 36):

   - 28% < 50 mrem/yr
   - 95% < 500 mrem/yr
   - 100% < 1000 mrem/yr

2. Responses to questions about safety under various conditions.

Table 1.11 Modal Selections on Questions Related to the Safety of 10 CFR 35.200 — Nuclear Medicine Without a Generator Under Various Conditions (Ns = 35 to 38)

	With Current Regulations	Without Current Regulations
Normal (barriers intact)	Very safe, 53%	Somewhat safe, 49%
Off-normal (barrier failure)	Somewhat safe, 40%	Somewhat unsafe, 39%

Table 1.12 Median Selections on Questions Related to the Safety of 10 CFR 35.200 — Nuclear Medicine Without a Generator Under Various Conditions (Ns = 35 to 38)

	With Current Regulations	Without Current Regulations
Normal (barriers intact)	Very safe	Somewhat safe
Off-normal (barrier failure)	Somewhat safe	Somewhat unsafe

3. Responses to question about most frequent non-reportable event (N = 33)

   - contamination, frequency varied from 1 time per week to 1 time per year (17 of 33)
   - spills, frequency varied from 1 time per week to less often than 1 time per year (14 of 33)
   - spills and contamination, frequency of 1 time per quarter (1 of 33)
   - misadministration, frequency of 1 time per month (1 of 33)

1.7 SYSTEM 7: 10 CFR 35.300 — NUCLEAR MEDICINE

1. Estimated percentage of workers receiving doses at various levels (N = 29):

   - 22% < 50 mrem/yr
   - 92% < 500 mrem/yr
   - 98% < 1000 mrem/yr
   - 2% > 1000 mrem/yr

2. Responses to questions about safety under various conditions.

Table 1.13 Modal Selections on Questions Related to the Safety of 10 CFR 35.300 — Nuclear Medicine Under Various Conditions (Ns = 35 to 38)

	With Current Regulations	Without Current Regulations
Normal (barriers intact)	Somewhat safe, 45%	Somewhat unsafe, 40%
Off-normal (barrier failure)	Somewhat unsafe, 46%	Somewhat unsafe, 47%

Table 1.14 Median Selections on Questions Related to the Safety of 10 CFR 35.300 — Nuclear Medicine Under Various Conditions (Ns = 35 to 38)

	With Current Regulations	Without Current Regulations
Normal (barriers intact)	Somewhat safe	Somewhat unsafe
Off-normal (barrier failure)	Somewhat unsafe	Somewhat unsafe

3. Responses to question about most frequent non-reportable event (N = 29)

   - contamination, frequency varied from 1 time per week to less often than 1 time per year (17 of 29)
   - spills, frequency varied from 1 time per week to time per year (9 of 29)
   - misadministration, frequency varied from 1 time per year to less often than 1 time per year (2 of 29)
   - loss of material, of 1 time per quarter (1 of 29)

1.8 SYSTEM 8: BRACHYTHERAPY — USING SEEDS

1. Estimated percentage of workers receiving doses at various levels (N = 28):

   - 30% < 50 mrem/yr
   - 93% < 500 mrem/yr
   - 99% < 1000 mrem/yr
   - 1% > 1000mrem/yr

2. Responses to questions about safety under various conditions.

Table 1.15 Modal Selections on Questions Related to the Safety of Brachytherapy — Using Seeds Under Various Conditions (Ns = 36 to 37)

	With Current Regulations	Without Current Regulations
Normal (barriers intact)	Somewhat safe, 51%	Somewhat unsafe, 42%
Off-normal (barrier failure)	Somewhat unsafe, 54%	Very unsafe, 47%

Table 1.16 Median Selections on Questions Related to the Safety of Brachytherapy — Using Seeds Under Various Conditions (Ns = 36 to 37)

	With Current Regulations	Without Current Regulations
Normal (barriers intact)	Somewhat safe	Somewhat unsafe
Off-normal (barrier failure)	Somewhat unsafe	Very unsafe

3. Responses to question about most frequent non-reportable event (N = 26)

   - loss of material, frequency varied from 1 time per year to less often than 1 time per year (24 of 26)
   - misadministration, frequency of less often than 1 time per year (1 of 26)
   - drop and survey, frequency of 1 time per year (1 of 26)

1.9 SYSTEM 9: BRACHYTHERAPY — MANUAL AFTERLOADING

1. Estimated percentage of workers receiving doses at various levels (N = 22):

   - 35% < 50 mrem/yr
   - 87% < 500 mrem/yr
   - 94% < 1000 mrem/yr
   - 6% > 1000 mrem/yr

2. Responses to questions about safety under various conditions.

Table 1.17 Modal Selections on Questions Related to the Safety of Brachytherapy — Manual Afterloading Under Various Conditions (Ns = 33 to 34)

	With Current Regulations	Without Current Regulations
Normal (barriers intact)	Somewhat safe, 44%	Very unsafe, 41%
Off-normal (barrier failure)	Somewhat unsafe, 47%	Very unsafe, 64%

Table 1.18 Median Selections on Questions Related to the Safety of Brachytherapy — Manual Afterloading Under Various Conditions (Ns = 33 to 34)

	With Current Regulations	Without Current Regulations
Normal (barriers intact)	Somewhat safe	Very unsafe
Off-normal (barrier failure)	Somewhat unsafe	Very unsafe

3. Responses to question about most frequent non-reportable event (N = 17)

   - inadequate shielding, frequency of less often than 1 time per year (1 of 17)
   - loss of material, frequency varied from 1 time per year to less often than 1 time per year (7 of 17)
   - misadministration, frequency varied from 1 time per year to less often than 1 time per year (7 of 17)
   - recordable incident, frequency varied from 1 time per year to less often than 1 time per year (2 of 17)

1.10 SYSTEM 10: BRACHYTHERAPY — LOW DOSE RATE REMOTE AFTERLOADING

1. Estimated percentage of workers receiving doses at various levels (N = 19):

   - 65% < 50 mrem/yr
   - 95% < 100 mrem/yr
   - 100% < 1000 mrem/yr

2. Responses to questions about safety under various conditions.

Table 1.19 Modal Selections on Questions Related to the Safety of Brachytherapy — Low Dose Rate Remote Afterloading Under Various Conditions (Ns = 32 to 34)

	With Current Regulations	Without Current Regulations
Normal (barriers intact)	Somewhat safe, 53%	Somewhat unsafe, 44%
Off-normal (barrier failure)	Somewhat unsafe, 41%	Very unsafe, 50%

Table 1.20 Median Selections on Questions Related to the Safety of Brachytherapy — Low Dose Rate Remote Afterloading Under Various Conditions (Ns = 32 to 34)

	With Current Regulations	Without Current Regulations
Normal (barriers intact)	Somewhat safe	Somewhat unsafe
Off-normal (barrier failure)	Somewhat unsafe	Somewhat unsafe/very unsafe

3. Responses to question about most frequent non-reportable event (N = 12)

   - interruption of treatment, frequency varied from 1 time per quarter to 1 time per year (2 of 12)
   - loss of material, frequency of lees than 1 time per year (1of 12)
   - misadministration, frequency varied from 1 time per year to less often than 1 time per year (4 of 12)

- device malfunction/failure, frequency of less often than 1 time per year (2 of 12)
- recordable incident, frequency varied from 1 time per quarter to less often than 1 time per year (2 of 12)
- stuck source, frequency of less often than 1 time per year (1 of 12)

1.11 SYSTEM 11: BRACHYTHERAPY — HIGH DOSE RATE REMOTE AFTERLOADING

1. Estimated percentage of workers receiving doses at various levels (N = 27):

   - 68% < 50 mrem/yr
   - 96% < 500 mrem/yr
   - 100% < 1000 mrem/yr

2. Responses to questions about safety under various conditions.

Table 1.21 Modal Selections on Questions Related to the Safety of Brachytherapy — High Dose Rate Remote Afterloading Under Various Conditions (Ns = 36 to 38)

	With Current Regulations	Without Current Regulations
Normal (barriers intact)	Somewhat safe, 59%	Very unsafe, 39%
Off-normal (barrier failure)	Very unsafe, 45%	Very unsafe, 64%

Table 1.22 Median Selections on Questions Related to the Safety of Brachytherapy — High Dose Rate Remote Afterloading Under Various Conditions (Ns = 36 to 38)

	With Current Regulations	Without Current Regulations
Normal (barriers intact)	Somewhat safe	Somewhat unsafe
Off-normal (barrier failure)	Somewhat unsafe	Very unsafe

3. Responses to question about most frequent non-reportable event (N = 16)

   - interruption of treatment, frequency of 1 time per quarter (1of 16)
   - loss of material, frequency of less often than 1 time per year (1of 16)

- misadministration, frequency of 1 time per month (5 of 16)
- device malfunction/failure, frequency varied from 1 time per year to less often than 1 time per year (4 of 16)
- recordable incident, frequency varied from 1 time per quarter to 1 time per year (2 of 16)
- stuck source, frequency of less often than 1 time per year (3 of 16)

1.12 SYSTEM 12: BRACHYTHERAPY — EYE APPLICATOR

1. Estimated percentage of workers receiving doses at various levels (N = 23):

   - 82% < 50 mrem/yr
   - 100% < 500 mrem/yr

2. Responses to questions about safety under various conditions.

Table 1.23 Modal Selections on Questions Related to the Safety of Brachytherapy — Eye Applicator Under Various Conditions (Ns = 31 to 32)

	With Current Regulations	Without Current Regulations
Normal (barriers intact)	Very safe, 49%	Somewhat safe/very unsafe, 29% each
Off-normal (barrier failure)	Somewhat unsafe, 42%	Somewhat unsafe, 41%

Table 1.24 Median Selections on Questions Related to the Safety of Brachytherapy — Eye Applicator Under Various Conditions (Ns = 31 to 32)

	With Current Regulations	Without Current Regulations
Normal (barriers intact)	Somewhat safe	Somewhat unsafe
Off-normal (barrier failure)	Somewhat unsafe	Somewhat unsafe

3. Responses to question about most frequent non-reportable event (N = 11)

   - exposure, frequency of less often than 1 time per year (1 of 11)
   - loss of material, frequency varied from 1 time per year to less often than 1 time per year (6 of 11)
   - misadministration, frequency varied from 1 time per quarter to less often than 1 time per year (4 of 11)

1.13 SYSTEM 13: 10 CFR 35.400 — DIAGNOSTIC DEVICES[1]

1. Estimated percentage of workers receiving doses at various levels (N = 19):

   - 84% < 50 mrem/yr
   - 99% < 500 mrem/yr
   - 100% < 1000 mrem/yr

2. Responses to questions about safety under various conditions.

Table 1.25 Modal Selections on Questions Related to the Safety of 10 CFR 35.400 — Diagnostic Devices Under Various Conditions (Ns = 22 to 25)

	With Current Regulations	Without Current Regulations
Normal (barriers intact)	Very safe, 68%	Somewhat safe, 46%
Off-normal (barrier failure)	Somewhat safe, 58%	Somewhat safe, 48%

[1] This system is the result of an error in the survey form. The form read "10 CFR 400 — Diagnostic Devices" instead of "10 CFR 500 — Diagnostic Devices" as it should have. Some respondents noted the error in the survey form. Their responses are recorded under system 13a. The responses of those who did not note the error were recorded under this system (13).

Table 1.26 Median Selections on Questions Related to the Safety of 10 CFR 35.400 — Diagnostic Devices Under Various Conditions (Ns = 22 to 25)

	With Current Regulations	Without Current Regulations
Normal (barriers intact)	Very safe	Somewhat safe
Off-normal (barrier failure)	Somewhat safe	Somewhat safe/somewhat unsafe

3. Responses to question about most frequent non-reportable event (N = 4)

- Loss of material, frequency of less often than 1 time per year (2 of 4)
- Not secured, frequency of less often than 1 time per year (1 of 4)
- spill, frequency of 1 time quarter (1 of 4)

1.14 SYSTEM 13A: 10 CFR 35.500 — DIAGNOSTIC DEVICES

1. Estimated percentage of workers receiving doses at various levels (N = 7):

- 84% < 50 mrem/yr
- 100% < 100 mrem/yr

2. Responses to questions about safety under various conditions.

Table 1.27 Modal Selections on Questions Related to the Safety of 10 CFR 35.500 — Diagnostic Devices Under Various Conditions (Ns = 7 to 8)

	With Current Regulations	Without Current Regulations
Normal (barriers intact)	Very safe, 88%	Somewhat safe, 38%
Off-normal (barrier failure)	Somewhat safe, 50%	Very safe, 43%

Table 1.28 Median Selections on Questions Related to the Safety of 10 CFR 35.500 — Diagnostic Devices Under Various Conditions (Ns = 7 to 8)

	With Current Regulations	Without Current Regulations

Normal (barriers intact)	Very safe	Somewhat safe
Off-normal (barrier failure)	Somewhat safe	Somewhat safe

3. Responses to question about most frequent non-reportable event (N = 2)

   - exposure, frequency of less often than 1 time per year (1 of 2)
   - loss of material, frequency of less often than 1 time per year (1 of 2)

1.15 SYSTEM 14: TELETHERAPY DEVICES

1. Estimated percentage of workers receiving doses at various levels (N = 29):

   - 81% < 50 mrem/yr
   - 96% < 500 mrem/yr
   - 99% < 1000 mrem/yr
   - 1% > 1000 mrem/yr

2. Responses to questions about safety under various conditions.

Table 1.29 Modal Selections on Questions Related to the Safety of Teletherapy Devices Under Various Conditions (Ns = 35 to 36)

	With Current Regulations	Without Current Regulations
Normal (barriers intact)	Somewhat safe, 44%	Somewhat unsafe, 37%
Off-normal (barrier failure)	Very unsafe, 50%	Very unsafe, 63%

Table 1.30 Median Selections on Questions Related to the Safety of Teletherapy Devices Under Various Conditions (Ns = 35 to 36)

	With Current Regulations	Without Current Regulations
Normal (barriers intact)	Somewhat safe	Somewhat unsafe
Off-normal (barrier failure)	Somewhat unsafe/very unsafe	Very unsafe

3. Responses to question about most frequent non-reportable event (N = 17)

- loss of material, frequency of less often than 1 time per year (1 of 17)
- misadministration, frequency varied from 1 time per year to less often than 1 time per year (5 of 17)
- device malfunction/failure, frequency of 1 time per month (1 of 17)
- loss of material, frequency of less often than 1 time per year (2 of 17)
- recordable incident, frequency varied from 1 time per quarter to 1 time per year (2 of 17)
- stuck source, frequency varied from 1 time per quarter to less often than 1 time per year (7 of 17)

1.16 SYSTEM 15: GAMMA STEREOTACTIC SURGERY

1. Estimated percentage of workers receiving doses at various levels (N = 29):

- 68% < 50 mrem/yr
- 93% < 500 mrem/yr
- 99% < 1000 mrem/yr
- 1% > 1000 mrem/yr

2. Responses to questions about safety under various conditions.

Table 1.31 Modal Selections on Questions Related to the Safety of Gamma Stereotactic Surgery Under Various Conditions (Ns = 24 to 25)

	With Current Regulations	Without Current Regulations
Normal (barriers intact)	Very safe/somewhat safe, 40% each	Somewhat unsafe, 36%
Off-normal (barrier failure)	Very unsafe, 50%	Very unsafe, 64%

Table 1.32 Median Selections on Questions Related to the Safety of Gamma Stereotactic Surgery Under Various Conditions (Ns = 24 to 25)

	With Current Regulations	Without Current Regulations

Normal (barriers intact)	Somewhat safe	Somewhat unsafe
Off-normal (barrier failure)	Somewhat unsafe/very unsafe	Very unsafe

3. Responses to question about most frequent non-reportable event (N = 7)

   - misadministration, frequency of less often than 1 time per year (4 of 7)
   - device malfunction/failure, frequency of less often than 1 time per year (3 of 4)

1.17 SYSTEM 16: NUCLEAR PHARMACIES

1. Estimated percentage of workers receiving doses at various levels (N = 34):

   - 15% < 50 mrem/yr
   - 75% < 500 mrem/yr
   - 95% < 1000 mrem/yr
   - 5% > 1000 mrem/yr

2. Responses to questions about safety under various conditions.

Table 1.33 Modal Selections on Questions Related to the Safety of Nuclear Pharmacies Under Various Conditions (Ns = 34 to 37)

	With Current Regulations	Without Current Regulations
Normal (barriers intact)	Somewhat safe, 61%	Somewhat unsafe, 49%
Off-normal (barrier failure)	Somewhat unsafe, 44%	Very unsafe, 50%

Table 1.34 Median Selections on Questions Related to the Safety of Nuclear Pharmacies Under Various Conditions (Ns = 34 to 37)

	With Current Regulations	Without Current Regulations
Normal (barriers intact)	Somewhat safe	Somewhat unsafe
Off-normal (barrier failure)	Somewhat unsafe	Somewhat unsafe/very unsafe

3. Responses to question about most frequent non-reportable event (N = 33)

- contamination, frequency varied from 1 time per week to less often than 1 time per year (18 of 33)
- loss of material, frequency varied of 1 time per year (1 of 33)
- spill, frequency varied from 1 time per week to 1 time per year (9 of 33)
- spill and contamination, frequency varied from 1 time per week to 1 time per quarter (3 of 33)
- wrong label, frequency varied from 1 time per quarter to less often than 1 time per year (2 of 33)

1.18 SYSTEM 17: VETERINARY USE

1. Estimated percentage of workers receiving doses at various levels (N = 22):

   - 49% < 50 mrem/yr
   - 96% < 500 mrem/yr
   - 97% < 1000 mrem/yr
   - 3% > 1000 mrem/yr

2. Responses to questions about safety under various conditions.

Table 1.35 Modal Selections on Questions Related to the Safety of Veterinary Use Under Various Conditions (Ns = 28 to 33)

	With Current Regulations	Without Current Regulations
Normal (barriers intact)	Somewhat safe, 52%	Somewhat safe, 46%
Off-normal (barrier failure)	Somewhat safe, 64%	Somewhat unsafe, 48%

Table 1.36 Median Selections on Questions Related to the Safety of Veterinary Use Under Various Conditions (Ns = 28 to 33)

	With Current Regulations	Without Current Regulations
Normal (barriers intact)	Somewhat safe	Somewhat safe
Off-normal (barrier failure)	Somewhat safe	Somewhat unsafe

3. Responses to question about most frequent non-reportable event (N = 20)

- contamination, frequency varied from 1 time per week to less often than 1 time per year (14 of 20)
- contaminated animal waste, frequency of 1 time per week (1 of 20)
- Early release of animal, frequency of less often than 1 time per year (1 of 20)
- Spill, frequency varied from 1 time per quarter to less often than 1 time per year (4 of 20)

1.19 SYSTEM 18: RESEARCH AND DEVELOPMENT ON ANIMALS

1. Estimated percentage of workers receiving doses at various levels (N = 22):

   - 71% < 50 mrem/yr
   - 100% < 500 mrem/yr

2. Responses to questions about safety under various conditions.

Table 1.37 Modal Selections on Questions Related to the Safety of Research and Development on Animals Under Various Conditions (Ns = 29 to 34)

	With Current Regulations	Without Current Regulations
Normal (barriers intact)	Very safe/somewhat safe, 47% each	Somewhat safe, 39%
Off-normal (barrier failure)	Somewhat safe, 62%	Somewhat safe, 50%

Table 1.38 Median Selections on Questions Related to the Safety of Research and Development on Animals Under Various Conditions (Ns = 29 to 34)

	With Current Regulations	Without Current Regulations
Normal (barriers intact)	Somewhat safe	Somewhat safe
Off-normal (barrier failure)	Somewhat safe	Somewhat safe/somewhat unsafe

3. Responses to question about most frequent non-reportable event (N = 25)

- contamination, frequency varied from 1 time per week to less often than 1 time per year (20 of 25)
- contaminated animal waste, frequency varied from 1 time per month to 1 time per quarter (2 of 25)
- spill, frequency varied from 1 time per month to 1 time per quarter (3 of 25)

1.20 SYSTEM 19: WELL-LOGGING — TRACERS AND FIELD FLOOD STUDIES

1. Estimated percentage of workers receiving doses at various levels (N = 15):

   - 36% < 50 mrem/yr
   - 96% < 500 mrem/yr
   - 99% < 1000 mrem/yr
   - 1% > 1000 mrem/yr

2. Responses to questions about safety under various conditions.

Table 1.39 Modal Selections on Questions Related to the Safety of Well Logging — Tracers and Field Flood Studies Under Various Conditions (Ns = 27 to 28)

	With Current Regulations	Without Current Regulations
Normal (barriers intact)	Somewhat safe, 50%	Somewhat safe/somewhat unsafe, 33% each
Off-normal (barrier failure)	Somewhat safe/somewhat unsafe, 35% each	Somewhat unsafe, 39%

Table 1.40 Median Selections on Questions Related to the Safety of Well Logging — Tracers and Field Flood Studies Under Various Conditions (Ns = 27 to 28)

	With Current Regulations	Without Current Regulations
Normal (barriers intact)	Somewhat safe	Somewhat unsafe
Off-normal (barrier failure)	Somewhat unsafe	Somewhat unsafe

3. Responses to question about most frequent non-reportable event (N = 15)

- contamination, frequency varied from 1 time per week to less often than 1 time per year (10 of 15)
- spills, frequency varied from 1 time per quarter to less often than 1 time per year (4of 15)
- spills and contamination, frequency of 1 time per year (1 of 15)

1.21 SYSTEM 20: WELL LOGGING — USING SEALED SOURCES

1. Estimated percentage of workers receiving doses at various levels (N = 18):

- 48% < 50 mrem/yr
- 93% < 500 mrem/yr
- 99% < 1000 mrem/yr
- 1% > 1000 mrem/yr

2. Responses to questions about safety under various conditions.

Table 1.41 Modal Selections on Questions Related to the Safety of Well Logging — Using Sealed Sources Under Various Conditions (Ns = 28 to 30)

	With Current Regulations	Without Current Regulations
Normal (barriers intact)	Somewhat safe, 61%	Somewhat unsafe, 45%
Off-normal (barrier failure)	Somewhat safe, 40%	Very unsafe, 41%

Table 1.42 Median Selections on Questions Related to the Safety of Well Logging — Using Sealed Sources Under Various Conditions (Ns = 28 to 30)

	With Current Regulations	Without Current Regulations
Normal (barriers intact)	Somewhat safe	Somewhat unsafe
Off-normal (barrier failure)	Somewhat unsafe	Somewhat unsafe

3. Responses to question about most frequent non-reportable event (N = 16)

- source disconnect, frequency of less often than 1 time per year (1 of 16)
- exposure, frequency of less often than 1 time per year (1 of 16)
- loss/damage of source, frequency of less often than 1 time per year (1 of 16)
- loss of material, frequency varied from 1 time per year to less often than 1 time per year (10 of 16)
- failure to survey, frequency of 1 time per month (1 of 16)
- stuck source, frequency of 1 time per year (2 0f 16)

1.22 SYSTEM 21: RADIOGRAPHY — PERMANENT INSTALLATION

1. Estimated percentage of workers receiving doses at various levels (N = 31):

   - 32% < 50 mrem/yr
   - 86% < 500 mrem/yr
   - 92% < 1000 mrem/yr
   - 8% > 1000 mrem/yr

2. Responses to questions about safety under various conditions.

Table 1.43 Modal Selections on Questions Related to the Safety of Radiography — Permanent Installation Under Various Conditions (Ns = 37 to 38)

	With Current Regulations	Without Current Regulations
Normal (barriers intact)	Somewhat safe, 50%	Somewhat unsafe, 57%
Off-normal (barrier failure)	Somewhat unsafe, 44%	Very unsafe, 54%

Table 1.44 Median Selections on Questions Related to the Safety of Radiography — Permanent Installation Under Various Conditions (Ns = 37 to 38)

	With Current Regulations	Without Current Regulations
Normal (barriers intact)	Somewhat safe	Somewhat unsafe
Off-normal (barrier failure)	Somewhat unsafe	Very unsafe

3. Responses to question about most frequent non-reportable event (N = 21)

- source disconnect, frequency of less often than 1 time per year (1 of 21)
- exposure, frequency varied from 1 time per week to less often than 1 time per year (5 of 21)
- failed warning device, frequency of 1 time per year (1 of 21)
- source not shielded, frequency of 1 time per year (1 of 21)
- loss of material, frequency of less often than 1 time per year (3 of 21)
- device malfunction/failure, frequency varied from 1 time per quarter to less often than 1 time per year (5 of 21)
- failure to survey, frequency of 1 time per month (1 of 21)
- failure to secure, frequency of 1 time per quarter (1 of 21)
- stuck source, frequency varied from 1 time per quarter to less often than 1 time per year (3 of 16)

1.23 SYSTEM 22: RADIOGRAPHY — FIELD USE

1. Estimated percentage of workers receiving doses at various levels (N = 36):

- 9% < 50 mrem/yr
- 65% < 500 mrem/yr
- 87% < 1000 mrem/yr
- 13% > 1000 mrem/yr

2. Responses to questions about safety under various conditions.

Table 1.45 Modal Selections on Questions Related to the Safety of Radiography — Field Use Under Various Conditions (Ns = 38 to 39)

	With Current Regulations	Without Current Regulations
Normal (barriers intact)	Somewhat safe, 44%	Very unsafe, 58%
Off-normal (barrier failure)	Very unsafe, 68%	Very unsafe, 79%

Table 1.46 Median Selections on Questions Related to the Safety of Radiography — Field Use Under Various Conditions (Ns = 38 to 39)

	With Current Regulations	Without Current Regulations
Normal (barriers intact)	Somewhat safe	Very unsafe
Off-normal (barrier failure)	Very unsafe	Very unsafe

3. Responses to question about most frequent non-reportable event (N = 27)

- source disconnect, frequency varied from 1 time per year to less often than 1 time per year (6 of 26)
- exposure, frequency varied from 1 time per week to 1 time per year (5 of 26)
- personnel inattention, frequency of less often than 1 time per year (1 of 26)
- source not shielded, frequency of 1 time per year (1 of 26)
- loss of material, frequency varied from 1 time per year to less often than 1 time per year (3 of 26)
- device malfunction/failure, frequency of 1 time per quarter (2 of 26)
- failure to survey, frequency of 1 time per month (1 of 26)
- failure to secure, frequency of 1 time per month (1 of 26)
- restricted area/boundary violation, frequency of 1 time per month (3 of 26)
- stuck source, frequency of 1 time per year (1 of 26)
- untrained user, frequency of less often than 1 time per year (1 of 26)
- unauthorized user, frequency of 1 time per year (1 of 26)

1.24 SYSTEM 23: POOL IRRADIATORS

1. Estimated percentage of workers receiving doses at various levels (N = 29):

   - 77% < 50 mrem/yr
   - 98% < 500 mrem/yr
   - 100% < 1000 mrem/yr

2. Responses to questions about safety under various conditions.

Table 1.47 Modal Selections on Questions Related to the Safety of Pool Irradiators Under Various Conditions (Ns = 35 to 37)

	With Current Regulations	Without Current Regulations
Normal (barriers intact)	Very safe, 40%	Very unsafe, 43%
Off-normal (barrier failure)	Very unsafe, 49%	Very unsafe, 64%

Table 1.48 Median Selections on Questions Related to the Safety of Pool Irradiators Under Various Conditions (Ns = 35 to 37)

	With Current Regulations	Without Current Regulations
Normal (barriers intact)	Somewhat safe	Somewhat unsafe
Off-normal (barrier failure)	Somewhat unsafe	Very unsafe

3. Responses to question about most frequent non-reportable event (N = 20)

   - contamination, frequency varied from 1 time per year to less often than 1 time per year (2 of 20)
   - exposure, frequency of less often than 1 time per year (1 of 20)
   - loss of material, frequency of less often than 1 time per year (1 of 20)
   - device malfunction/failure, frequency varied from 1 time per week to less often than 1 time per year (8 of 20)
   - failure to secure, frequency of 1 time per year (1 of 20)
   - restricted area/boundary violation, frequency of less often than 1 time per year (1 of 20)

- stuck source, frequency varied from 1 time per year to less often than 1 time per year (6 of 20)

1.25 SYSTEM 24: SELF-SHIELDED IRRADIATORS

1. Estimated percentage of workers receiving doses at various levels (N = 32):

   - 96% < 50 mrem/yr
   - 100% < 500 mrem/yr

2. Responses to questions about safety under various conditions.

Table 1.49 Modal Selections on Questions Related to the Safety of Self-shielded Irradiators Under Various Conditions (Ns = 34 to 38)

	With Current Regulations	Without Current Regulations
Normal (barriers intact)	Very safe, 79%	Somewhat safe, 47%
Off-normal (barrier failure)	Somewhat safe, 58%	Somewhat safe,38%

Table 1.50 Median Selections on Questions Related to the Safety of Self-shielded Irradiators Under Various Conditions (Ns = 34 to 38)

	With Current Regulations	Without Current Regulations
Normal (barriers intact)	Very safe	Somewhat safe
Off-normal (barrier failure)	Somewhat safe	Somewhat safe

3. Responses to question about most frequent non-reportable event (N = 16)

   - exposure, frequency varied from 1 time per year to less often than 1 time per year (3 of 16)
   - device falls on your foot, frequency of less often than 1 time per year (1 of 16)
   - loss of material, frequency of less often than 1 time per year (1 of 16)
   - device malfunction/failure, frequency varied from 1 time per year to less often than 1 time per year (6 of 16)
   - failure to secure, frequency of 1 time per year (1 of 16)

- restricted area/boundary violation, frequency of less often than 1 time per year (1 of 20)
- stuck source, frequency of 1 time per quarter (1 of 20)
- unauthorized user/uses, frequency of 1 time per quarter (2 of 16)

1.26 SYSTEM 25: FIXED GAUGES — GAMMA EMITTERS

1. Estimated percentage of workers receiving doses at various levels (N = 38):

   - 96% < 50 mrem/yr
   - 100% < 500 mrem/yr

2. Responses to questions about safety under various conditions.

Table 1.51 Modal Selections on Questions Related to the Safety of Fixed Gauges — Gamma Emitters Under Various Conditions (Ns = 37 to 38)

	With Current Regulations	Without Current Regulations
Normal (barriers intact)	Very safe, 55%	Somewhat safe, 57%
Off-normal (barrier failure)	Somewhat safe, 58%	Somewhat safe, 38%

Table 1.52 Median Selections on Questions Related to the Safety of Fixed Gauges — Gamma Emitters Under Various Conditions (Ns = 37 to 38)

	With Current Regulations	Without Current Regulations
Normal (barriers intact)	Very safe	Somewhat safe
Off-normal (barrier failure)	Somewhat safe	Somewhat unsafe

3. Responses to question about most frequent non-reportable event (N = 27)

   - damaged gauge, frequency of less often than 1 time per year (2 of 27)
   - exposure, frequency of less often than 1 time per year (1of 27)
   - failure to close shutter and working close by, frequency of 1 time per month (1 of 27)
   - loss of material, frequency varied from 1 time per year to less often than 1 time per year (10 of 27)

- device malfunction/failure, frequency varied from 1 time per year to less often than 1 time per year (7 of 27)
- maintenance problem, frequency of less often than 1 time per year (1 of 27)
- failure to secure, frequency of 1 time per year (1 of 27)
- unauthorized maintenance, frequency of 1 time per year (1of 27)
- untrained maintenance worker, frequency of less often than 1 time per year (2 of 27)
- unauthorized removal, frequency of 1 time per year (1 of 27)

1.27 SYSTEM 26: FIXED GAUGES — BETA EMITTERS

1. Estimated percentage of workers receiving doses at various levels (N = 35):

   - 96% < 50 mrem/yr
   - 100% < 500 mrem/yr

2. Responses to questions about safety under various conditions.

Table 1.53 Modal Selections on Questions Related to the Safety of Fixed Gauges — Beta Emitters Under Various Conditions (Ns = 36 to 37)

	With Current Regulations	Without Current Regulations
Normal (barriers intact)	Very safe, 70%	Somewhat safe, 58%
Off-normal (barrier failure)	Somewhat safe, 81%	Somewhat safe, 47%

Table 1.54 Median Selections on Questions Related to the Safety of Fixed Gauges — Beta Emitters Under Various Conditions (Ns = 36 to 37)

	With Current Regulations	Without Current Regulations
Normal (barriers intact)	Very safe	Somewhat safe
Off-normal (barrier failure)	Somewhat safe	Somewhat safe

3. Responses to question about most frequent non-reportable event (N = 22)

   - device damaged, frequency of less often than 1 time per year (2 of 22)
   - exposure, frequency of less often than 1 time per year (1of 21)

- loss of material, frequency varied from 1 time per year to less often than 1 time per year (8 of 22)
- device malfunction/failure, frequency varied from 1 time per year to less often than 1 time per year (7 of 22)
- failure to secure, frequency of 1 time per year (1 of 22)
- unauthorized maintenance, frequency of 1 time per year (1of 22)
- untrained maintenance worker, frequency of less often than 1 time per year (1 of 22)
- unauthorized removal, frequency of less often than 1 time per year (1 of 22)

1.28 SYSTEM 27: PORTABLE GAUGES

1. Estimated percentage of workers receiving doses at various levels (N = 38):

   - 71% < 50 mrem/yr
   - 99% < 500 mrem/yr
   - 100% < 1000 mrem/yr

2. Responses to questions about safety under various conditions.

Table 1.55 Modal Selections on Questions Related to the Safety of Portable Gauges Under Various Conditions (Ns = 37 to 38)

	With Current Regulations	Without Current Regulations
Normal (barriers intact)	Very safe/somewhat safe, 50%	Somewhat safe, 43%
Off-normal (barrier failure)	Somewhat safe, 59%	Somewhat unsafe, 43%

Table 1.56 Median Selections on Questions Related to the Safety of Portable Gauges Under Various Conditions (Ns = 37 to 38)

	With Current Regulations	Without Current Regulations
Normal (barriers intact)	Very safe/somewhat safe	Somewhat safe
Off-normal (barrier failure)	Somewhat safe	Somewhat unsafe

3. Responses to question about most frequent non-reportable event (N = 28)

   - device damaged, frequency varied from 1 time per year to less often than 1 time per year (12 of 28)
   - exposure, frequency of less often than 1 time per year (2 of 28)
   - loss of material, frequency varied from 1 time per year to less often than 1 time per year (9 of 28)
   - device malfunction/failure, frequency of 1 time per quarter (1of 28)
   - maintenance problem, frequency of 1 time per year (1 of 28)
   - failure to secure, frequency varied from 1 time per month to 1 time per quarter (2 of 28)
   - unauthorized user/uses, frequency of 1 time per year (1of 28)

1.29 SYSTEM 28: X-RAY FLUORESCENCE DEVICES

1. Estimated percentage of workers receiving doses at various levels (N = 33):

   - 84% < 50 mrem/yr
   - 100% < 500 mrem/yr

2. Responses to questions about safety under various conditions.

Table 1.57 Modal Selections on Questions Related to the Safety of X-ray Fluorescence Devices Under Various Conditions (Ns = 36 to 37)

	With Current Regulations	Without Current Regulations
Normal (barriers intact)	Very safe, 81%	Somewhat safe, 38%
Off-normal (barrier failure)	Somewhat safe, 51%	Very safe/somewhat safe, 33% each

Table 1.58 Median Selections on Questions Related to the Safety of X-ray Fluorescence Devices Under Various Conditions (Ns = 36 to 37)

	With Current Regulations	Without Current Regulations
Normal (barriers intact)	Very safe	Somewhat safe
Off-normal (barrier failure)	Somewhat safe	Somewhat safe

3. Responses to question about most frequent non-reportable event (N = 11)

   - exposure, frequency of 1 time per year (2 of 11)
   - source not shielded, frequency of less often than 1 time per year (1 of 11)
   - loss of material, frequency varied from 1 time per year to less often than 1 time per year (3 of 11)
   - leaking source, frequency of less often than 1 time per year (2 of 11)
   - failure to secure, frequency varied from 1 time per month to 1 time per year (2 of 11)
   - stuck source, frequency of 1 time per year (1of 11)

1.30 SYSTEM 29: GAS CHROMATOGRAPHS

1. Estimated percentage of workers receiving doses at various levels (N = 40):

   - 100% < 50 mrem/yr

2. Responses to questions about safety under various conditions.

Table 1.59 Modal Selections on Questions Related to the Safety of Gas Chromatographs Under Various Conditions (Ns = 37 to 40)

	With Current Regulations	Without Current Regulations
Normal (barriers intact)	Very safe, 90%	Very safe, 58%
Off-normal (barrier failure)	Very safe, 59%	Very safe, 54%

Table 1.60 Median Selections on Questions Related to the Safety of Gas Chromatographs Under Various Conditions (Ns = 37 to 40)

	With Current Regulations	Without Current Regulations
Normal (barriers intact)	Very safe	Very safe
Off-normal (barrier failure)	Very safe	Very safe

3. Responses to question about most frequent non-reportable event (N = 20)

- contamination, frequency of 1 time per year (1of 20)
- exposure, frequency of less often than 1 time per year (1 of 20)
- loss of material, frequency of less often than 1 time per year (13 of 20)
- leaking source, frequency of less often than 1 time per year (1 of 20)
- device malfunction/failure, frequency of less often than 1 time per year (1 of 20)
- maintenance problem, frequency of less often than 1 time per year (1 of 20)
- failure to secure, frequency of 1 time per quarter (1 of 20)
- Failure to vent for H-3, frequency of less often than 1 time per year (1 of 20)

1.31 SYSTEM 30: OTHER MEASURING SYSTEMS

1. Estimated percentage of workers receiving doses at various levels (N = 27):

- 99% < 50 mrem/yr
- 100% < 500 mrem/yr

2. Responses to questions about safety under various conditions.

Table 1.61 Modal Selections on Questions Related to the Safety of Other Measuring Systems Under Various Conditions (Ns = 29 to 30)

	With Current Regulations	Without Current Regulations
Normal (barriers intact)	Very safe, 76%	Somewhat safe, 53%
Off-normal (barrier failure)	Somewhat safe, 55%	Somewhat safe, 38%

Table 1.62 Median Selections on Questions Related to the Safety of Other Measuring Systems Under Various Conditions (Ns = 29 to 30)

	With Current Regulations	Without Current Regulations
Normal (barriers intact)	Very safe	Somewhat safe
Off-normal (barrier failure)	Somewhat safe	Somewhat safe

3. Responses to question about most frequent non-reportable event (N = 12)

- device damage, frequency of less often than 1 time per year (1of 12)
- exposure, frequency of 1 time per year (1 of 12)
- loss of material, frequency of less often than 1 time per year (8 of 20)
- device malfunction/failure, frequency of 1 time per year (1 of 12)
- failure to secure, frequency of 1 time per quarter (1 of 20)
- Failure to vent for H-3, frequency of 1 time per year (1 of 12)

1.32 SYSTEM 31: SMALL SEALED SOURCES OR DEVICES (e.g., Those Used Under a General License)

1. Estimated percentage of workers receiving doses at various levels (N = 29):

- 97% < 50 mrem/yr
- 99% < 500 mrem/yr
- 100% < 1000 mrem/yr

3. Responses to questions about safety under various conditions.

Table 1.63 Modal Selections on Questions Related to the Safety of Small Sealed Sources or Devices Under Various Conditions (Ns = 37 to 38)

	With Current Regulations	Without Current Regulations
Normal (barriers intact)	Very safe, 66%	Very safe, 35%
Off-normal (barrier failure)	Somewhat safe, 45%	Very safe, 32%

Table 1.64 Median Selections on Questions Related to the Safety of Small Sealed Sources or Devices Under Various Conditions (Ns = 37 to 38)

	With Current Regulations	Without Current Regulations
Normal (barriers intact)	Very safe	Somewhat safe
Off-normal (barrier failure)	Somewhat safe	Somewhat safe

3. Responses to question about most frequent non-reportable event (N = 23)

   - loss of material, frequency varied from 1 time per month to less often than 1 time per year (21 of 23)
   - maintenance problem, frequency of 1 time per month (1 of 23)
   - failure to secure, frequency of 1 time per month (1 of 23)

1.33 SYSTEM 32: VERY SMALL SEALED SOURCES OR DEVICES (e.g., Those Used Under Exemption)

1. Estimated percentage of workers receiving doses at various levels (N = 26):

   - 100% < 50 mrem/yr

2. Responses to questions about safety under various conditions.

Table 1.65 Modal Selections on Questions Related to the Safety of Very Small Sealed Sources or Devices Under Various Conditions (Ns = 36 to 37)

	With Current Regulations	Without Current Regulations
Normal (barriers intact)	Very safe, 89%	Very safe, 60%
Off-normal (barrier failure)	Very safe, 51%	Very safe, 56%

Table 1.66 Median Selections on Questions Related to the Safety of Very Small Sealed Sources or Devices Under Various Conditions (Ns = 36 to 37)

	With Current Regulations	Without Current Regulations
Normal (barriers intact)	Very safe	Very safe
Off-normal (barrier failure)	Very safe	Very safe

3. Responses to question about most frequent non-reportable event (N = 20)

   - fire, frequency varied of less often than 1 time per year (1 of 20)
   - loss of material, frequency varied from 1 time per year to less often than 1 time per year (19 of 20)

1.34 SYSTEM 33: MANUFACTURING OR DISTRIBUTION OF DEVICES CONTAINING SEALED SOURCES

1. Estimated percentage of workers receiving doses at various levels (N = 26):

   - 55% < 50 mrem/yr
   - 91% < 500 mrem/yr
   - 95% < 1000 mrem/yr
   - 5% > 1000 mrem/yr

2. Responses to questions about safety under various conditions.

Table 1.67 Modal Selections on Questions Related to the Safety of Manufacturing or Distribution of Devices Containing Sealed Sources Under Various Conditions (Ns = 37 to 38)

	With Current Regulations	Without Current Regulations
Normal (barriers intact)	Somewhat safe, 53%	Somewhat safe, 35%
Off-normal (barrier failure)	Somewhat unsafe, 38%	Very unsafe, 41%

Table 1.68 Median Selections on Questions Related to the Safety of Manufacturing or Distribution of Devices Containing Sealed Sources Under Various Conditions (Ns = 37 to 38)

	With Current Regulations	Without Current Regulations
Normal (barriers intact)	Somewhat safe	Somewhat unsafe
Off-normal (barrier failure)	Somewhat unsafe	Somewhat unsafe

3. Responses to question about most frequent non-reportable event (N = 18)

   - contamination, frequency varied from 1 time per week to less often than 1 time per year (6 of 18)
   - defective merchandise, frequency of 1 time per quarter (1 of 18)
   - handling failure, frequency of 1 time per year (1 of 18)
   - loss of material, frequency varied from 1 time per year to less often than 1 time per year (9 of 18)
   - Leaking source, frequency of less often than 1 time per year (1 of 18)

1.35 SYSTEM 34: MANUFACTURING OF RADIOACTIVE SOLIDS

1. Estimated percentage of workers receiving doses at various levels (N = 13):

   - 36% < 50 mrem/yr
   - 74% < 500 mrem/yr
   - 88% < 1000 mrem/yr
   - 12% > 1000 mrem/yr

2. Responses to questions about safety under various conditions.

Table 1.69 Modal Selections on Questions Related to the Safety of Manufacturing of Radioactive Solids Under Various Conditions (Ns = 23 to 26)

	With Current Regulations	Without Current Regulations
Normal (barriers intact)	Somewhat safe, 48%	Very unsafe, 42%
Off-normal (barrier failure)	Very unsafe, 39%	Very unsafe, 46%

Table 1.70 Median Selections on Questions Related to the Safety of Manufacturing of Radioactive Solids Under Various Conditions (Ns = 23 to 26)

	With Current Regulations	Without Current Regulations
Normal (barriers intact)	Somewhat safe/somewhat unsafe	Somewhat unsafe
Off-normal (barrier failure)	Somewhat unsafe	Somewhat unsafe

3. Responses to question about most frequent non-reportable event (N = 18)

   - contamination, frequency varied from 1 time per week to less often than 1 time per year (13 of 18)
   - loss of material, frequency varied from 1 time per year to less often than 1 time per year (2 of 18)
   - leaking source, frequency of less often than 1 time per year (1 of 18)
   - spill, frequency less often than 1 time per year (2 of 18)

1.36 SYSTEM 35: MANUFACTURING OF SOURCES CONTAINING LIQUIDS

1. Estimated percentage of workers receiving doses at various levels (N = 10):

   - 49% < 50 mrem/yr
   - 84% < 500 mrem/yr
   - 97% < 1000 mrem/yr
   - 3% > 1000 mrem/yr

2. Responses to questions about safety under various conditions.

Table 1.71 Modal Selections on Questions Related to the Safety of Manufacturing of Sources Containing Liquids Under Various Conditions (Ns = 20 to 23)

	With Current Regulations	Without Current Regulations
Normal (barriers intact)	Somewhat safe, 50%	Very unsafe, 39%
Off-normal (barrier failure)	Very unsafe, 40%	Somewhat unsafe, 48%

Table 1.72 Median Selections on Questions Related to the Safety of Manufacturing of Sources Containing Liquids Under Various Conditions (Ns = 20 to 23)

	With Current Regulations	Without Current Regulations
Normal (barriers intact)	Somewhat safe	Somewhat unsafe
Off-normal (barrier failure)	Somewhat unsafe	Somewhat unsafe

3. Responses to question about most frequent non-reportable event (N = 17)

- contamination, frequency unknown (11 of 17)
- loss of material, frequency unknown (1 of 17)
- spills, frequency unknown (5 of 17)

1.37 SYSTEM 36: MANUFACTURING OF SOURCES CONTAINING GASES

1. Estimated percentage of workers receiving doses at various levels (N = 6):

- 54% < 50 mrem/yr
- 87% < 500 mrem/yr
- 95% < 1000 mrem/yr
- 5% > 1000 mrem/yr

2. Responses to questions about safety under various conditions.

Table 1.73 Modal Selections on Questions Related to the Safety of Manufacturing of Sources Containing Gases Under Various Conditions (Ns = 18 to 21)

	With Current Regulations	Without Current Regulations
Normal (barriers intact)	Somewhat safe, 63%	Somewhat safe, 48%
Off-normal (barrier failure)	Somewhat safe, 44%	Very unsafe, 38%

Table 1.74 Median Selections on Questions Related to the Safety of Manufacturing of Sources Containing Gases Under Various Conditions (Ns = 18 to 21)

	With Current Regulations	Without Current Regulations
Normal (barriers intact)	Somewhat safe	Somewhat unsafe
Off-normal (barrier failure)	Somewhat safe/somewhat unsafe	Somewhat unsafe

3. Responses to question about most frequent non-reportable event (N = 10)

   - contamination, frequency varied from 1 time per year to less often than 1 time per year (4 of 10)
   - leak, frequency varied from 1 time per quarter to less often than 1 time per year (3 of 10)
   - loss of material, frequency of 1 time per year (1 of 10)
   - spill, frequency of less often than 1 time per year (1 of 10)
   - uptake, frequency of 1 time per year (1 of 10)

1.38 SYSTEM 37: INCINERATION OF WASTE

1. Estimated percentage of workers receiving doses at various levels (N = 19):

   - 70% < 50 mrem/yr
   - 100% < 500 mrem/yr

2. Responses to questions about safety under various conditions.

Table 1.75 Modal Selections on Questions Related to the Safety of Incineration of Waste Under Various Conditions (Ns = 25 to 27)

	With Current Regulations	Without Current Regulations
Normal (barriers intact)	Somewhat safe, 48%	Somewhat safe, 42%
Off-normal (barrier failure)	Somewhat safe, 48%	Somewhat unsafe, 39%

Table 1.76 Median Selections on Questions Related to the Safety of Incineration of Waste Under Various Conditions (Ns = 25 to 27)

	With Current Regulations	Without Current Regulations
Normal (barriers intact)	Somewhat safe	Somewhat safe
Off-normal (barrier failure)	Somewhat safe	Somewhat unsafe

3. Responses to question about most frequent non-reportable event (N = 13)

   - contamination, frequency varied from 1 time per week to 1 time per year (5 of 13)
   - leak, frequency of 1 time per year (1 of 13)
   - loss of material, frequency of less often than 1 time per year (1 of 13)
   - device malfunction/failure, frequency varied from 1 time per year to less often than 1 time per year (2 of 13)
   - wrong material, frequency varied from 1 time per month to less often than 1 time per year (4 of 13)

1.39 SYSTEM 38: COMPACTING OF WASTE

1. Estimated percentage of workers receiving doses at various levels (N = 21):

   - 50% < 50 mrem/yr
   - 99% < 500 mrem/yr
   - 100% < 1000 mrem/yr

2. Responses to questions about safety under various conditions.

Table 1.77 Modal Selections on Questions Related to the Safety of Compacting of Waste Under Various Conditions (Ns = 25 to 28)

	With Current Regulations	Without Current Regulations
Normal (barriers intact)	Somewhat safe, 57%	Somewhat unsafe, 44%
Off-normal (barrier failure)	Somewhat safe, 48%	Somewhat safe, 48%

Table 1.78 Median Selections on Questions Related to the Safety of Compacting of Waste Under Various Conditions (Ns = 25 to 28)

	With Current Regulations	Without Current Regulations
Normal (barriers intact)	Somewhat safe	Somewhat unsafe
Off-normal (barrier failure)	Somewhat safe	Somewhat unsafe

3. Responses to question about most frequent non-reportable event (N = 16)

- contamination, frequency varied from 1 time per week to 1 time per year (9 of 16)
- exposure, frequency of 1 time per year (1 of 16)
- leak, frequency varied from 1 time per year to less often than 1 time per year (3 of 16)
- spill, frequency varied from 1 time per quarter to 1 time per year (2 of 16)
- uptake, frequency of 1 time per year (1 of 16)

1.40 SYSTEM 39: PACKAGING OF WASTE

1. Estimated percentage of workers receiving doses at various levels (N = 29):

- 45% < 50 mrem/yr
- 96% < 500 mrem/yr
- 99% < 1000 mrem/yr
- 1% > 1000 mrem/yr

2. Responses to questions about safety under various conditions.

Table 1.79 Modal Selections on Questions Related to the Safety of Packaging of Waste Under Various Conditions (Ns = 24 to 28)

	With Current Regulations	Without Current Regulations
Normal (barriers intact)	Somewhat safe, 46%	Somewhat safe, 48%
Off-normal (barrier failure)	Somewhat safe, 58%	Somewhat unsafe, 44%

Table 1.80 Median Selections on Questions Related to the Safety of Packaging of Waste Under Various Conditions (Ns = 24 to 28)

	With Current Regulations	Without Current Regulations
Normal (barriers intact)	Somewhat safe	Somewhat safe
Off-normal (barrier failure)	Somewhat safe	Somewhat unsafe

3. Responses to question about most frequent non-reportable event (N = 14)

   - contamination, frequency varied from 1 time per week to 1 time per year (11 of 14)
   - spills, frequency varied from 1 time per quarter to 1 time per year (2 of 14)
   - transportation incident, frequency of less often than 1 time per year (1 of 14)

1.41 SYSTEM 40: SOLIDIFICATION OF WASTE

1. Estimated percentage of workers receiving doses at various levels (N = 7):

   - 34% < 50 mrem/yr
   - 100% < 500 mrem/yr

2. Responses to questions about safety under various conditions.

Table 1.81 Modal Selections on Questions Related to the Safety of Solidification of Waste Under Various Conditions (Ns = 19 to 22)

	With Current Regulations	Without Current Regulations
Normal (barriers intact)	Very safe, 46%	Somewhat safe, 53%
Off-normal (barrier failure)	Somewhat safe, 45%	Somewhat unsafe, 50%

Table 1.82 Median Selections on Questions Related to the Safety of Solidification of Waste Under Various Conditions (Ns = 19 to 22)

	With Current Regulations	Without Current Regulations
Normal (barriers intact)	Somewhat safe	Somewhat safe
Off-normal (barrier failure)	Somewhat safe/somewhat unsafe	Somewhat unsafe

3. Responses to question about most frequent non-reportable event (N = 8)

   - contamination, frequency varied from 1 time per week to 1 time per year (5 of 8)
   - device malfunction/failure, frequency of 1 time per year (1 of 8)
   - spill, frequency varied from 1 time per quarter to 1 time per year (2 of 8)

1.42 SYSTEM 41A: NUCLEAR LAUNDRIES

1. Estimated percentage of workers receiving doses at various levels (N = 1):

   - 0 % < 50 mrem/yr
   - 100% < 500 mrem/yr

1.43 SYSTEM 41B: DECONTAMINATION SERVICES

1. Estimated percentage of workers receiving doses at various levels (N = 1):

   - 0% < 50 mrem/yr
   - 10% < 500 mrem/yr
   - 80% < 1000 mrem/yr
   - 10% > 1000 mrem/yr

RESPONSES TO QUESTIONS ABOUT ANNUAL WORKER DOSES, SAFETY UNDER VARIOUS CONDITIONS, AND EVENTS THAT OCCUR BY SYSTEM

2 RANK ORDERING OF NUCLEAR BYPRODUCT MATERIAL SYSTEMS

Table 2.1 Survey Results: Nuclear Byproduct Material Systems Rank Ordered With Respect To Mean Annual Estimated Dose to Workers in Millirem For Comparison With Modal and Median Dose Estimates And With Responses Related To Perceived Safety Under Various Conditions.

		Question 1			"Safety" Modal Selection				"Safety" Median Selection			
System Number	**Operation**	mean* est. annual worker dose (mrem)	modal est. annual worker dose	median est. annual worker dose	question 3	question 4	question 5	question 6	question 3	question 4	question 5	question 6
41b	decontamination services	785	501-1000	501-1000								
22	radiography - field use	482	201-500	201-500	ss	vu	vu	vu	ss	vu	vu	vu
34	manufacturing of sources containing solids	362	ND-50	101-200	ss	vu	vu	vu	ss	su	su	su
16	nuclear pharmacies	355	101-200	101-200	ss	su	su	vu	ss	su	su	su/vu
5	10 CFR 35.200 - nuclear medicine with generator(s)	294	201-500	101-200	ss	su	ss	su	ss	su	su	su
21	radiography - permanent installation	262	ND-50	101-200	ss	su	su	vu	ss	su	su	vu
35	manufacturing of sources containing liquids	236	ND-50	51-100	ss	vu	vu	su	ss	su	su	su
9	brachytherapy - manual afterloading	231	ND-50	51-100	ss	su	vu	vu	ss	su	su	vu
36	manufacturing of sources containing gases	223	ND-50	ND-50	ss	ss	ss	vu	ss	ss/su	su	su
7	10 CFR 35.300 - nuclear medicine	211	101-200	101-200	ss	su	su	su	ss	su	su	su
41a	nuclear laundries	210	101-200	101-200								
19	well logging - tracers and field flood studies	171	201-500	51-100	ss	ss/su	ss/su	su	ss	su	su	su
33	manufacturing or distribution of devices containing sealed sources	167	<ND	ND-50	ss	su	ss	vu	ss	su	su	su
6	10 CFR 35.200 - nuclear medicine without a generator	155	101-200	101-200	vs	ss	ss	su	vs	ss	ss	su
8	brachytherapy using seeds	154	51-100	51-100	ss	su	su	vu	ss	su	su	su

RANK ORDERING OF NUCLEAR BYPRODUCT MATERIAL SYSTEMS

		Question 1			"Safety" Modal Selection				"Safety" Median Selection			
System Number	**Operation**	mean* est. annual worker dose (mrem)	modal est. annual worker dose	median est. annual worker dose	question 3	question 4	question 5	question 6	question 3	question 4	question 5	question 6
20	well logging - using sealed sources	135	ND-50	51-100	ss	ss	su	vu	ss	su	su	su
39	packaging of waste	129	ND-50	51-100	ss	ss	ss	su	ss	ss	ss	su
17	veterinary use	125	ND-50	51-100	ss	ss	ss	su	ss	ss	ss	su
40	solidification of waste	111	ND-50	51-100	vs	ss	ss	su	ss	ss/su	ss	su
4	10 CFR 35.100 - nuclear medicine and human use research	102	101-200	51-100	vs	ss	ss	su	vs	ss	ss	ss
10	brachytherapy - low dose rate remote afterloading	91	ND-50	ND-50	ss	su	su	vu	ss	su	su	su/vu
38	compacting of waste	89	ND-50	ND-50 / 51-100	ss	ss	ss	su	ss	ss	ss	su
15	gamma stereotactic surgery	88	ND-50	ND-50	vs/ss	vu	su	vu	ss	su/vu	su	vu
11	brachytherapy - high dose rate remote afterloading	76	ND-50	ND-50	ss	vu	vu	vu	ss	su	su	vu
1	R&D synthesis laboratories	66	<ND	ND-50	vs	ss	ss	su	vs/ss	ss	ss	su
23	pool irradiators	65	ND-50	ND-50	vs	vu	vu	vu	ss	su	su	vu
18	R&D on animals	63	ND-50	ND-50	vs/ss	ss	ss	ss	ss	ss	ss	ss/su
27	portable gauges	58	ND-50	ND-50	vs/ss	ss	ss	su	vs/ss	ss	ss	su
12	brachytherapy - eye applicator	56	ND-50	ND-50	vs	su	ss/vu	su	ss	su	su	su
14	teletherapy devices	56	<ND	ND-50	ss	vu	su	vu	ss	su/vu	su	vu
37	incineration of waste	44	ND-50	ND-50	ss	ss	ss	su	ss	ss	ss	su
13	10 CFR 35.400 - diagnostic devices	42	<ND	ND-50	vs	ss	ss	ss	vs	ss	ss	ss
28	x-ray fluorescence devices	27	<ND	<ND	vs	ss	ss	vs/ss	vs	ss	ss	ss
2	R&D laboratories using carbon, hydrogen, iodine, phosphorus, and sulfur	26	<ND	ND-50	vs	ss	ss	ss	vs	ss	ss	su
13a	10 CFR 35.500 - diagnostic devices	25	ND-50	ND-50	vs	ss	ss	vs	vs	ss	ss	ss

		Question 1			"Safety" Modal Selection				"Safety" Median Selection			
System Number	**Operation**	mean* est. annual worker dose (mrem)	modal est. annual worker dose	median est. annual worker dose	question 3	question 4	question 5	question 6	question 3	question 4	question 5	question 6
31	small sealed sources or devices (e.g., those used under a general license)	21	<ND	<ND	vs	ss	vs	vs	vs	ss	ss	ss
25	fixed gauges - gamma emitters	20	<ND	<ND	vs	ss	ss	ss	vs	ss	ss	su
24	self-shielded irradiators	13	<ND	<ND	vs	ss	ss	ss	vs	ss	ss	ss
26	fixed gauges - beta emitters	11	<ND	<ND	vs	ss	ss	ss	vs	ss	ss	ss
30	other measuring devices	11	<ND	<ND	vs	ss	ss	ss	vs	ss	ss	ss
3	in vitro laboratory testing	9	<ND	<ND	vs	vs	vs	ss	vs	vs	vs/ss	ss
29	gas chromatographs	6	<ND	<ND	vs	vs	vs	vs	vs	vs	vs	vs
32	very small sealed sources of devices (e.g., those used under an exemption)	5	<ND	<ND	vs	vs	vs	vs	vs	vs	vs	vs

Question 3: Normal operating conditions, current regulations.

Question 4: Off-normal operating conditions, current regulations.

Question 5: Normal operating conditions, without current regulations.

Question 6: Off-normal operating conditions, without current regulations

Codes: vs = very safe
ss = somewhat safe
su = somewhat unsafe
vu = very unsafe

*The review group recognized that, in calculating means using the unequal class intervals for dose provided to the respondents, low dose estimates received less weight than high dose estimates.

While this was recognized as reducing the value of the mean as an indicator of the annual dose to workers, it was judged to be "close enough" for developing a "ballpark" ranking of systems for comparison with other survey results.

3 RESPONDENTS DEFINITIONS OF “SAFE” ETC.

Table 3.1 Each Respondent’s Definition of “Very Safe,” “Somewhat Safe,” “Somewhat Unsafe,” and “Very Unsafe”

Respondent Number	Very Safe	Somewhat Safe	Somewhat Unsafe	Very Unsafe
1	Individual probably will not receive recordable dose	Individual probably will receive recordable dose - 2.5 R	Individual will receive 2.5 R - 5R	Prob. of overexposure is high
2	No harm possible	No permanent/noticeable harm	Not life threatening	Life threatening
3	Can be unregulated	Not much danger to users	Possibility of overexposures and personnel contamination	Possibility of injuries to personnel
4	Inherently safe, little need for regulation, worst case scenario nothing to lose sleep over	Need to exercise some controls, can receive regulatory significant exposure but operator would have to have to completely drop the ball	Can significantly expose however safety systems in place rather than depend on human compliance with procedures	Very dependent on strict compliance with safety procedures to provide safety, when deviations from compliance occur, actual potential for significant exposures , including death
5	No harm to public or employees as long as procedures are followed	Public is safe but puts employees at risk	Both public and employees are at risk	Harm to both public and employees
6	No exposure	Some exposure	More exposure	Over exposure
7	<ND	<ND to 20 mRem	21 mRem to 50 mRem	> 50 mRem
8	0 - Low probability of biological risk to occupational workers and/or general public	Low to medium probability of biological risk to occupational workers and/or general public	medium to high probability of biological risk to occupational workers and/or general public	High + probability of biological risk to occupational workers and/or general public
9	Within occupational radiation exposure limit, adequately trained employees, strong oversite, compliance with all regs	Small potential to possibility of adverse health effects, substantial compliance with reg, within occupational exposure limits	Could exceed exposure limits, lack of supervision, lack of training	Exceeds exposure limits, lack of control of radioactive material, loss of material, no training of personnel

RESPONDENTS DEFINITIONS OF "SAFE" ETC.

Respondent Number	Very Safe	Somewhat Safe	Somewhat Unsafe	Very Unsafe
10	Very low doses & little contamination, I considered the health risk to be minimal	A greater possibility of exposure to workers but still unlikely	Likely to have higher exposures/contaminatio n but only if licensee does not follow procedures	High probability of contamination or exposure
11	No health effect	Minimal health effect	Possible minor health effect	Possible major health effect
12	no definition provided	no definition provided	no definition provided	no definition provided
13	With minimal exposure to any individual	Low probability of any unusual or high exposures to any individual	Possibility of an unnecessary or high exposure to any individual	Moderate to high probability of an unnecessary of high exposure to any individual
14	Fool proof	Not likely to result in health impacts, low exposure, less than 500 mR	May cause high exposure up to 2 rem	Likely to receive exposures or uptakes above 2 rem
15	Very little threat to public health & safety, very little threat to occupational safety	A small threat to occupational safety, very little threat to public health & safety	Threat to occupational safety, somewhat of a (or a possible) threat to public health & safety	A threat to occupational safety, a threat to public health and safety
16	Exposures to workers & public not likely to be > 100 mrem/year under normal operations	Potential for public member to receive a dose > 100 mrem/year	Potential for workers to receive a dose of > 500 mrem/yr.	Potential for injury to worker and/or public (rad. burns, death, injury) if significant controls not in place
17	Little or no chance of exposure > 50 mrem	Exposure between 50 - 100 mrem	Exposure between 100 - 500 mrem public exposure potential injury	Exposure > 500 mrem damage to property public exposure potential injury and/or death
18	Very little potential of radiation exposure	Potential of exposure < 200 mrem/year (W.B.)	Potential of exposure > 200 mrem/year (W.B)	Potential of > 5000 mrem/yr. (W.B.)
19	Exposures to workers and public not normally likely to exceed 100 mrem/year under normal circumstances	Potential for public exposure to exceed 100 mrem/year if not controlled projects - workers normally required to be monitored for exposure (1.e. > 500 mrem/year likely)	Potential for worker exposures to exceed 5 rem/year absent proper controls	Potential for harm (radiation burns, organ impairment, etc.) from radiation exposure if significant controls not implemented

Respondent Number	Very Safe	Somewhat Safe	Somewhat Unsafe	Very Unsafe
20	No impact on worker safety, even in accident situation, very unlikely workers or public to receive dose	As above [to the left] except during accident situation worker could possibly receive small doses [with] no effect to public	Potential for dose to workers during normal operations & certainly during accident situations	Highly probable that worker could receive dose during normal operations & potential for exposure to public if operations are not strictly controlled
21	Very safe if there is no chance of significant exposure/contaminatio n occurring	Somewhat safe if there is only a small chance of significant exposure/contaminatio n occurring	Somewhat unsafe if there is a moderate chance of significant exposure/contamination occurring	Very unsafe if it is likely that significant exposure/contaminatio n may occur
22	Little or no rad. exposure above background	Some chance of exposure, but below threshold for acute effects	Chance of significant acute effects (e.g., loss of fingers in some radiography exposures)	lethal
23	Little or no radiological dose to individuals	Radiological dose measurable but probably less than 100 mrem	Radiological dose greater than public limit but less than worker limit	Radiological dose approaches or exceeding worker limit (*from a risk standpoint, none of the operations would pose a significant risk)
24	No significant or likely safety consequence little to no potential for occurrence	Some potential likely not significant	greater potential could be significant	Significant safety consequence high potential of occurrence
25	Would cause no one to receive a dose in excess of 5 rem to the whole body, 50 rem to an extremity, etc.	Would cause one person to receive a dose in excess of 5 rem every few years	Would cause one or two people per year to receive doses in excess of 5 rem	Would cause several people per year to receive doses in excess of 5 rem
26	Adequate controls in place to keep exposures ALARA, meet below public dose limits, meet and follow regs, have procedures in place that are adequate to protect public health and safety	Have adequate procedures, meet intent of regs	Inadequate procedures, inadequate controls, meet intent of regs	None of the above [to left]

RESPONDENTS DEFINITIONS OF "SAFE" ETC.

Respondent Number	Very Safe	Somewhat Safe	Somewhat Unsafe	Very Unsafe
27	Minimum chance of any radiation exposure under any circumstance	Slight to moderate probability of some radiation exposure; but not exceeding regulatory limits	Moderate to high probability of some exposure to radiation slight chance of exceeding regulatory limits	High probability of excessive radiation exposure; slight to high possibility of life threatening or damaging radiation exposure
28	No risk of radiation exposure	Slight potential for exposure or contamination	greater potential for exposure	high risk for exposure
29	No risk of radiation exposure if device or RAM is used correctly (to operator, user or public)	Limited risk of radiation exposure if device or RAM is used correctly (operator, user or public)	Minimal risk of radiation exposure if device or RAM is used correctly (operator, user or public)	Unnecessary risk of radiation exposure if device or RAM is used correctly (operator, user or public)
30	Chance of incident low to non-existent, lowest of activities, exposure rates, minimal to no handling considerations	Mod. to low chance of inc., small act./exp., minimal handling	Real probability to mod., medium activity/exp. (mCi-Ci), daily handling	High chance for inc., high act./exp. (Ci-MCi), daily handling w/ daily handling - tools only
31	Safe "no matter what happens"	Could result in loss of material control w/ very low consequence	Could result in loss of material control with minor consequence	If control of material is lost would probably result in real public hazard
32	No or little chance of radiological consequences	Consequences of event not likely to result in exposure in excess of part 20 limits	Consequences of event likely to significantly to result in exposure sufficient to result in some physiological damage (i.e., chromosomal)	Consequences of event likely to
33	Very little chance of exposure or contamination during operations, even with error by operator/user	Safe during normal operations, small chance of exposure/contamination, User can create hazard by not following procedures or bypassing safety features - even with this, operator not likely to be seriously hurt	Safe during normal operations, but any change in procedures or error by operator can create hazard, safeguards not in place of poor	Operations unsafe at any level.

Respondent Number	Very Safe	Somewhat Safe	Somewhat Unsafe	Very Unsafe
34	Virtually no dose to users or public	Less that 100 mrem to public annually, less than 500 mrem to users annually	Greater than doses above [to the left] in "b"	nonstochastic effects possible
35	no definition provided	no definition provided	no definition provided	no definition provided
36	Whole body exposure/internal exposure/exposure to lens of eye, etc. <10% of established limits	Annual exposures to personnel do not exceed 25% of any limit	Reasonable potential for exceeding an exposure limit if situation is not corrected in a timely fashion	High probability of an overexposure occurring if situation is not corrected very quickly (within an hour)
37	In a worst case scenario the possibility of injury or adverse health effects are remote.	In the case of an incident or accident the possibility of an injury or adverse health effects are unlikely.	In the case of an incident or accident an injury or adverse health effects are possible.	In the case of and incident or accident an injury or adverse health effects are likely and without normal operating conditions and regulatory controls injury and adverse health effects are possible.
38	no definition provided	no definition provided	no definition provided	no definition provided
39	No or very little chance for radiation exposure, internal nor external in excess of 50 mR over normal background.	Chance for exposure to personnel that is or can be 2 to 5 times normal background.	Excessive radiation exposure that can or will cause physical effects but are undetectable.	Personnel exposures that can cause or does cause physical effects from radiation exposure.
40	small chance of failure, low significance of exposure, well controlled program	middling chance of failures of process, chance of exposure <500mRem per incident, controlled program.	process/equipment failure whether from design or abuse, lack of concern by employees, no real management support.	Personnel uncooperative, cavalier, equipment contains large sources which can be exposed to personnel. no management support for safety. Bottom line — get the job done.
41	Even without good controls in place and work practices the material use is safe	With good controls in place and good work practices contamination or dose could occur through carelessness or accident.	material amount or use could be dangerous without close attention to practices & controls.	Inherently dangerous due to amount/material unless controls & practices are rigorously implemented & enforced.

RESPONDENTS DEFINITIONS OF "SAFE" ETC.

4 RESPONSES TO QUESTIONS ABOUT REGULATORY DECISION-MAKING

Table 4.1 Responses to Questions Concerning About Regulatory Agencies Should Make Decisions

	Very Important	Important	Not Important	Should not be Considered
Consensus Opinion of the Public	0	12	15	9
Financial Burden of Regulation to the Licensee	1	23	9	3
Financial Burden of Regulation to the Public	2	19	13	2
Evaluation of Radiological Risk	36	0	0	0
Benefit of the Use of Material to Society	18	18	1	0
Other (supplied by respondents):				
Opinion of Licensees, Their Societies and Standards Organizations	0	1	0	0
Historical Data (licensee compliance)	0	1	0	0
NRC Efficiency/Capability @ Task (considers limited resources - personnel, budget)	0	1	0	0
Generation of Long-lived Waste	0	1	0	0
Generation of Mixed Waste	0	1	0	0
Manpower of Regulator	0	0	1	0
Burden Imposed vs Risk Averted (risk of harm & financial risk)	1	0	0	0
Public Participation - to the extent that public feels that they are being adequately protected, because in reality the **are** being adequately protected	1	0	0	0

Appendix A

Questionnaire

Questionnaire

The survey administered to the NRC and agreement States materials licensing and inspection personnel appears on the following pages.

APPENDIX A

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

MEMORANDUM TO: A. Randolph Blough, Director
Division of Nuclear Materials Safety, Region I

Douglas M. Collins, Director
Division of Nuclear Materials Safety, Region II

Cynthia D. Pederson, Director
Division of Nuclear Materials Safety, Region III

Ross A. Scarano, Director
Division of Nuclear Materials Safety, Region IV

FROM: Frederick C. Combs, Acting Director
Division of Industrial and
Medical Nuclear Safety, NMSS

SUBJECT: SURVEY BY THE NUCLEAR BYPRODUCT MATERIAL RISK REVIEW GROUP

As you are aware, the Division of Industrial and Medical Nuclear Safety has formed a nuclear byproduct material risk review working group composed of NRC employees and an employee of the State of Colorado. The group's goals are to identify and document the technical basis for a risk-informed approach to nuclear byproduct material regulation and to develop plans for a graded approach to regulation of that material based on risk information. The working group has obtained the services of a contractor, SCIENTECH, Inc., to perform the majority of the technical work necessary to meet those goals.

The information resources available to SCIENTECH have been largely limited to published reports, the experience and training of its own staff and consultants, and the responses of members of the regulated community to a web page survey. In addition, the review group believes that information beyond that available to SCIENTECH will be valuable in meeting its goals and that, collectively, nuclear material licensing and inspection personnel have an unparalleled breadth and depth of knowledge about the systems of interest. As a result, the working group has developed a survey for distribution to NRC and Agreement State personnel involved in licensing and inspection of materials regulated under 10 CFR Parts 30 through 39 or equivalent state regulations. The intent is to capture the "corporate knowledge" of those personnel and to augment and confirm information provided by SCIENTECH.

CONTACT: Dennis Serig, NMSS/IMNS
(301) 415-7901

We ask that you distribute copies of the attached survey to several (e.g., 5 or 6) of your experienced licensing and inspection personnel. A test of the survey indicated that it takes on the order of 1.5 to 3 hours to complete. The selected respondents should return the completed survey by August 14, 1998, to Dennis Serig at mail stop T8F5. Time for completing the survey should be charged against regional or headquarters FTE allocated to RITS code 222BA, TAC Number L21136, Risk Assessment.

Attachment: Survey of Licensing and Inspection Personnel

SURVEY OF LICENSING AND INSPECTION PERSONNEL

BACKGROUND. The Nuclear Regulatory Commission's (NRC's) Office of Nuclear Material Safety and Safeguards (NMSS) has established a Nuclear Byproduct Material Risk Review Group, composed of representatives from the NRC and an Agreement State. The group's goals are: (1) to identify and document a technical basis for a risk-informed approach to the regulation of nuclear byproduct material, and (2) to develop plans for a graded approach to nuclear byproduct material regulation based on risk information. The effort encompasses byproduct materials that are currently defined in Section 11.e(1) of the Atomic Energy Act of 1954, and Title 10 of the Code of Federal Regulations (CFR) Section 30.4 and addressed by 10 CFR Parts 30-36 and 39, or the equivalent regulations of an Agreement State.

NRC has contracted SCIENTECH, Inc. to assist the group in its effort. The attached survey was developed to confirmand augment information gathered by Scientech and to assist in development of plans for a graded approach to nuclear byproduct material regulation informed by risk. The survey is designed to be completed by NRC and Agreement State licensing and inspection personnel, and it has been discussed with NRC Regional Management, NRC's Office of State Programs, and the Executive Council of the Organization of Agreement States. It asks about the typical radionuclides and quantities of material possessed and used by certain types of regulated entities (e.g., research and development synthesis laboratories, fixed gauge users, owners of exempt products), types and frequency of incidents that occur at various facilities (e.g., non-reportable incidents such as spills, contamination), typical annual doses received by various personnel, and the respondent's perception of the risk associated with various regulated activities.

INSTRUCTIONS. Please limit your answers to byproduct materials (see paragraph 1). Please answer based on your memory of experience in licensing and inspection activities. Do not review license files, inspection reports, etc. and do not consult with other staff. If you do not have experience or information about a particular subject or question, indicate that fact in the space provided. Partial responses may, however, be valuable. If you can answer parts of a question, but not all, please answer what you can. It should take approximately 1.5 to 3.0 hours to complete the survey. When complete, please return the survey to:

Dennis Serig
NMSS
Mail Stop: T8F5

FOR NRC PERSONNEL: Charge time expended completing the survey to the following RITS code:

222FB L21136 RISK ASSESSMENT

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

July 23, 1998

ALL AGREEMENTS STATES
OHIO, OKLAHOMA, PENNSYLVANIA

TRANSMITTAL OF STATE AGREEMENTS PROGRAM INFORMATION (SP-98-065)

Your attention is invited to the enclosed correspondence which contains:

INCIDENT AND EVENT INFORMATION.....

PROGRAM MANAGEMENT INFORMATION.....

TRAINING COURSE INFORMATION.....

TECHNICAL INFORMATION.....

OTHER INFORMATION.....**XX** **REQUESTED RESPONSE TO SURVEY**

Supplementary Information: As you were informed by SP-98-028, the U.S. Nuclear Regulatory Commission's Office of Nuclear Material Safety and Safeguards has formed a nuclear byproduct material risk review working group composed of NRC employees and an employee of the State of Colorado. The group's goals are to identify and document the technical basis for a risk-informed approach to nuclear byproduct material regulation and to develop plans for a graded approach to regulation of that material based on risk information. The effort encompasses byproduct materials that are currently defined in Section 11.e(1) of the Atomic Energy Act of 1954, and Title 10 of the Code of Federal Regulations (CFR) Section 30.4 and addressed by 10 CFR Parts 30-36 and 39, or the equivalent regulations of an Agreement State. The working group has obtained the services of a contractor, SCIENTECH, Inc., to perform the majority of the technical work necessary to meet its goals.

The information resources available to SCIENTECH have been largely limited to published reports, the experience and training of its own staff and consultants, and the responses of members of the regulated community to a web page survey. The review group believes that information beyond that available to SCIENTECH will be valuable in meeting its goals and that, collectively, nuclear material licensing and inspection personnel have an unparalleled breadth and depth of knowledge about the systems of interest. As a result, the working group has developed a survey for distribution to NRC and Agreement State personnel involved in licensing and inspection of materials within the scope of its review (enclosed). The intent is to capture the "corporate knowledge" of those personnel and to augment and confirm information provided by SCIENTECH.

Agreement States are asked to participate by distributing copies of the survey to several (e.g., 2 or 3) of your experienced licensing and inspection personnel. A test of the survey indicated that it takes on the order of 1.5 to 3 hours to complete. The selected respondents should return the

completed survey by August 14, 1998, to the individual named below. Any questions concerning the survey may be directed to Dr. Serig.

U.S. Nuclear Regulatory Commission
ATTN: Dennis I. Serig
Mail Stop T8F5
Washington, D.C. 20555-0001
Phone: 301-415-7901
Fax: 301-415-5369
E-Mail: dis@nrc.gov

This information request has been approved by OMB 3150-0029, expiration April 30, 2001. The estimated burden per response to comply with this voluntary collection is 1.5-3.0 hours. Forward any comments regarding the burden estimate to the Information and Records Management Branch (T-6 F33), U.S. Nuclear Regulatory Commission, Washington, DC 20555-0001, and to the Paperwork Reduction Project (3150-0029), Office of Management and Budget, Washington, DC 20503. If a document does not display a currently valid OMB control number, the NRC may not conduct or sponsor, and a person is not required to respond to a collection of information.

Paul H. Lohaus, Deputy Director
Office of State Programs

Enclosure:
As stated

SURVEY OF LICENSING AND INSPECTION PERSONNEL

BACKGROUND. The Nuclear Regulatory Commission's (NRC's) Office of Nuclear Material Safety and Safeguards (NMSS) has established a Nuclear Byproduct Material Risk Review Group, composed of representatives from the NRC and an Agreement State. The group's goals are: (1) to identify and document a technical basis for a risk-informed approach to the regulation of nuclear byproduct material, and (2) to develop plans for a graded approach to nuclear byproduct material regulation based on risk information. The effort encompasses byproduct materials that are currently defined in Section 11.e(1) of the Atomic Energy Act of 1954, and Title 10 of the Code of Federal Regulations (CFR) Section 30.4 and addressed by 10 CFR Parts 30-36 and 39, or the equivalent regulations of an Agreement State.

NRC has contracted SCIENTECH, Inc. to assist the group in its effort. The attached survey was developed to confirm and augment information gathered by Scientech and to assist in development of plans for a graded approach to nuclear byproduct material regulation informed by risk. The survey is designed to be completed by NRC and Agreement State licensing and inspection personnel, and it has been discussed with NRC Regional Management, NRC's Office of State Programs, and the Executive Committee of the Organization of Agreement States. It asks about the typical radionuclides and quantities of material possessed and used by certain types of regulated entities (e.g., research and development synthesis laboratories, fixed gauge users, owners of exempt products), types and frequency of incidents that occur at various facilities (e.g., non-reportable incidents such as spills, contamination), typical annual doses received by various personnel, and the respondent's perception of the risk associated with various regulated activities. However, when responding to the survey, please do not consider doses, intended or unintended, to patients during medical diagnosis or treatment. Specifically, doses to patients is outside the scope of the Nuclear Material Risk Review Group.

INSTRUCTIONS. Please limit your answers to byproduct materials (see paragraph 1). Please answer based on your memory of experience in licensing and inspection activities. Do not review license files, inspection reports, etc. and do not consult with other staff. If you do not have experience or information about a particular subject or question, indicate that fact in the space provided. Partial responses may, however, be valuable. If you can answer parts of a question, but not all, please answer what you can. It should take approximately 1.5 to 3.0 hours to complete the survey. When complete, please return the survey to:

U.S. Nuclear Regulatory Commission
ATTN: Dennis Serig
Mail Stop: T8F5
Washington, DC 20555-0001
E-Mail: dis@nrc.gov
Fax: 301-415-5369

Section 1 - Questions About All Types of Operations

1. Based on your experience, indicate the percentage of workers that **typically** receive annual whole-body doses in the indicated ranges for each type of operation listed below under current regulations and policies for licensing and inspection. Percentages in each row should sum to 100. Mark an X in the "don't know" column if you're unfamiliar with the operation.

ND = NON-DETECTABLE

Operation	< ND	ND to 50 mrem	51 to 100 mrem	101 to 200 mrem	201 to 500 mrem	501 to 1000 mrem	> 1000 mrem	don't know
R&D synthesis laboratories								
R&D laboratories using carbon, hydrogen, iodine, phosphorus, and sulfur								
in vitro laboratory testing								
10 CFR 35.100 - nuclear medicine and human use research								
10 CFR 35.200 - nuclear medicine with generator(s)								
10 CFR 35.200 - nuclear medicine without a generator								
10 CFR 35.300 - nuclear medicine								
brachytherapy - using seeds								
brachytherapy - manual afterloading								
brachytherapy - low dose rate remote afterloading								
brachytherapy - high dose rate remote afterloading								
brachytherapy - eye applicator								
10 CFR 35.400 - diagnostic devices								
teletherapy devices								
gamma stereotactic surgery								
nuclear pharmacies								
veterinary use								
R&D on animals								
well logging - tracers and field flood studies								
well logging - using sealed sources								
radiography - permanent installation								
radiography - field use								
pool irradiators								

Operation	< ND	ND to 50 mrem	51 to 100 mrem	101 to 200 mrem	201 to 500 mrem	501 to 1000 mrem	> 1000 mrem	don't know
self-shielded irradiators								
fixed gauges - gamma emitters								
fixed gauges - beta emitters								
portable gauges								
x-ray fluorescence devices								
gas chromatographs								
other measuring devices								
small sealed sources or devices (e.g. those used under a general license)								
very small sealed sources or devices (e.g., those used under an exemption)								
manufacturing or distribution of devices containing sealed sources								
manufacturing of radioactive solids								
manufacturing of radioactive liquids								
manufacturing of radioactive gases								
incineration of waste								
compacting of waste								
packaging of waste								
solidification of waste								
other Part 30 operation (describe each):								

2. Based on your experience, specify in the space provided what you believe to be the non-reportable incident (e.g., spill, contamination, loss of material) that is most frequent for each type of operation listed below under current regulations and policies for licensing and inspection. Once you have specified an incident, mark an X in the column that is your best estimate of the frequency of that incident per licensee. Mark an X in the "don't know" column if you're unfamiliar with the operation.

Operation	Most Frequent Type of Incident	1 time /week	1 time /month	1 time /quarter	1 time /year	less often	don't know
R&D synthesis laboratories							
R&D laboratories using carbon, hydrogen, iodine, phosphorus, and sulfur							
in vitro laboratory testing							
10 CFR 35.100 - nuclear medicine and human use research							
10 CFR 35.200 - nuclear medicine with generator(s)							
10 CFR 35.200 - nuclear medicine without a generator							
10 CFR 35.300 - nuclear medicine							
brachytherapy - using seeds							
brachytherapy - manual afterloading							
brachytherapy - low dose rate remote afterloading							
brachytherapy - high dose rate remote afterloading							
brachytherapy - eye applicator							
10 CFR 35.400 - diagnostic devices							
teletherapy devices							
gamma stereotactic surgery							
nuclear pharmacies							
veterinary use							
R&D on animals							
well logging - tracers and field flood studies							
well logging - using sealed sources							
radiography - permanent installation							
radiography - field use							
pool irradiators							
self-shielded irradiators							
fixed gauges - gamma emitters							

Operation	Most Frequent Type of Incident	1 time /week	1 time /month	1 time /quarter	1 time /year	less often	don't know
fixed gauges - beta emitters							
portable gauges							
x-ray fluorescence devices							
gas chromatographs							
other measuring devices							
small sealed sources or devices (e.g. those used under a general license)							
very small sealed sources or devices (e.g., those used under an exemption)							
manufacturing or distribution of devices containing sealed sources							
manufacturing of radioactive solids							
manufacturing of radioactive liquids							
manufacturing of radioactive gases							
incineration of waste							
compacting of waste							
packaging of waste							
solidification of waste							
other Part 30 operation (describe each):							

3. Based on your experience, indicate what you believe to be the radiological safety of each type of operation listed below under **normal operating conditions and current regulations** and policies for licensing and inspection. Mark an X in the column that is your best estimate. Mark an X in the "don't know" column if you're unfamiliar with the operation.

Operation	very safe	somewhat safe	somewhat unsafe	very unsafe	don't know
R&D synthesis laboratories					
R&D laboratories using carbon, hydrogen, iodine, phosphorus, and sulfur					
in vitro laboratory testing					
10 CFR 35.100 - nuclear medicine and human use research					
10 CFR 35.200 - nuclear medicine with generator(s)					
10 CFR 35.200 - nuclear medicine without a generator					
10 CFR 35.300 - nuclear medicine					
brachytherapy - using seeds					
brachytherapy - manual afterloading					
brachytherapy - low dose rate remote afterloading					
brachytherapy - high dose rate remote afterloading					
brachytherapy - eye applicator					
10 CFR 35.400 - diagnostic devices					
teletherapy devices					
gamma stereotactic surgery					
nuclear pharmacies					
veterinary use					
R&D on animals					
well logging - tracers and field flood studies					
well logging - using sealed sources					
radiography - permanent installation					
radiography - field use					
pool irradiators					
self-shielded irradiators					
fixed gauges - gamma emitters					
fixed gauges - beta emitters					
portable gauges					
x-ray fluorescence devices					
gas chromatographs					
other measuring devices					

Operation	very safe	somewhat safe	somewhat unsafe	very unsafe	don't know
small sealed sources or devices (e.g. those used under a general license)					
very small sealed sources or devices (e.g., those used under an exemption)					
manufacturing or distribution of devices containing sealed sources					
manufacturing of radioactive solids					
manufacturing of radioactive liquids					
manufacturing of radioactive gases					
incineration of waste					
compacting of waste					
packaging of waste					
solidification of waste					
other Part 30 operation (describe each):					

4. Based on your experience, indicate what you believe to be the radiological safety of each type of operation listed below under **off-normal operating conditions** (e.g., incidents, accidents, failure of administrative controls) and **current regulations** and policies for licensing and inspection. Mark an X in the column that is your best estimate. Mark an X in the "don't know" column if you're unfamiliar with the operation.

Operation	very safe	somewhat safe	somewhat unsafe	very unsafe	don't know
R&D synthesis laboratories					
R&D laboratories using carbon, hydrogen, iodine, phosphorus, and sulfur					
in vitro laboratory testing					
10 CFR 35.100 - nuclear medicine and human use research					
10 CFR 35.200 - nuclear medicine with generator(s)					
10 CFR 35.200 - nuclear medicine without a generator					
10 CFR 35.300 - nuclear medicine					
brachytherapy - using seeds					
brachytherapy - manual afterloading					
brachytherapy - low dose rate remote afterloading					
brachytherapy - high dose rate remote afterloading					
brachytherapy - eye applicator					
10 CFR 35.400 - diagnostic devices					
teletherapy devices					
gamma stereotactic surgery					
nuclear pharmacies					
veterinary use					
R&D on animals					
well logging - tracers and field flood studies					
well logging - using sealed sources					
radiography - permanent installation					
radiography - field use					
pool irradiators					
self-shielded irradiators					
fixed gauges - gamma emitters					
fixed gauges - beta emitters					
portable gauges					
x-ray fluorescence devices					
gas chromatographs					
other measuring devices					

Operation	very safe	somewhat safe	somewhat unsafe	very unsafe	don't know
small sealed sources or devices (e.g. those used under a general license)					
very small sealed sources or devices (e.g., those used under an exemption)					
manufacturing or distribution of devices containing sealed sources					
manufacturing of radioactive solids					
manufacturing of radioactive liquids					
manufacturing of radioactive gases					
incineration of waste					
compacting of waste					
packaging of waste					
solidification of waste					
other Part 30 operation (describe each):					

5. Based on your experience, indicate what you believe to be the radiological safety of each type of operation listed below under **normal operating conditions**, but **without current regulations** and policies for licensing and inspection. Mark an X in the column that is your best estimate. Mark an X in the "don't know" column if you're unfamiliar with the operation.

Operation	very safe	somewhat safe	somewhat unsafe	very unsafe	don't know
R&D synthesis laboratories					
R&D laboratories using carbon, hydrogen, iodine, phosphorus, and sulfur					
in vitro laboratory testing					
10 CFR 35.100 - nuclear medicine and human use research					
10 CFR 35.200 - nuclear medicine with generator(s)					
10 CFR 35.200 - nuclear medicine without a generator					
10 CFR 35.300 - nuclear medicine					
brachytherapy - using seeds					
brachytherapy - manual afterloading					
brachytherapy - low dose rate remote afterloading					
brachytherapy - high dose rate remote afterloading					
brachytherapy - eye applicator					
10 CFR 35.400 - diagnostic devices					
teletherapy devices					
gamma stereotactic surgery					
nuclear pharmacies					
veterinary use					
R&D on animals					
well logging - tracers and field flood studies					
well logging - using sealed sources					
radiography - permanent installation					
radiography - field use					
pool irradiators					
self-shielded irradiators					
fixed gauges - gamma emitters					
fixed gauges - beta emitters					
portable gauges					
x-ray fluorescence devices					
gas chromatographs					
other measuring devices					

Operation	very safe	somewhat safe	somewhat unsafe	very unsafe	don't know
small sealed sources or devices (e.g. those used under a general license)					
very small sealed sources or devices (e.g., those used under an exemption)					
manufacturing or distribution of devices containing sealed sources					
manufacturing of radioactive solids					
manufacturing of radioactive liquids					
manufacturing of radioactive gases					
incineration of waste					
compacting of waste					
packaging of waste					
solidification of waste					
other Part 30 operation (describe each):					

6. Based on your experience, indicate what you believe to be the radiological safety of each type of operation listed below under **off-normal operating conditions** (e.g., incidents, accidents, failure of administrative controls) but **without current regulations** and policies for licensing and inspection. Mark an X in the column that is your best estimate. Mark an X in the "don't know" column if you're unfamiliar with the operation.

Operation	very safe	somewhat safe	somewhat unsafe	very unsafe	don't know
R&D synthesis laboratories					
R&D laboratories using carbon, hydrogen, iodine, phosphorus, and sulfur					
in vitro laboratory testing					
10 CFR 35.100 - nuclear medicine and human use research					
10 CFR 35.200 - nuclear medicine with generator(s)					
10 CFR 35.200 - nuclear medicine without a generator					
10 CFR 35.300 - nuclear medicine					
brachytherapy - using seeds					
brachytherapy - manual afterloading					
brachytherapy - low dose rate remote afterloading					
brachytherapy - high dose rate remote afterloading					
brachytherapy - eye applicator					
10 CFR 35.400 - diagnostic devices					
teletherapy devices					
gamma stereotactic surgery					
nuclear pharmacies					
veterinary use					
R&D on animals					
well logging - tracers and field flood studies					
well logging - using sealed sources					
radiography - permanent installation					
radiography - field use					
pool irradiators					
self-shielded irradiators					
fixed gauges - gamma emitters					
fixed gauges - beta emitters					
portable gauges					
x-ray fluorescence devices					
gas chromatographs					
other measuring devices					

Operation	very safe	somewhat safe	somewhat unsafe	very unsafe	don't know
small sealed sources or devices (e.g. those used under a general license)					
very small sealed sources or devices (e.g., those used under an exemption)					
manufacturing or distribution of devices containing sealed sources					
manufacturing of radioactive solids					
manufacturing of radioactive liquids					
manufacturing of radioactive gases					
incineration of waste					
compacting of waste					
packaging of waste					
solidification of waste					
other Part 30 operation (describe each):					

7. Describe your criteria for the following terms as used in the above questions:

   a. "very safe"

   b. "somewhat safe"

   c. "somewhat unsafe"

   d. "very unsafe"

Section 2 - Questions Concerning Specific Operations

8. Questions 8.1 through 8.4 pertain to gamma emitting byproduct material in fixed gauges and small calibrators. If you are not familiar with the use of these types of devices, mark an X in the box below and skip to question 9.

☐ Not familiar

8.1 The following table lists isotopes and ranges of quantities that might be used in fixed gamma gauges and small calibrators. Please mark an X in the appropriate column indicating whether, based on your knowledge, you agree or disagree that the information is correct. If you disagree, please indicate why in the comment area. If you believe additional isotopes should be considered, please add them to the table with their appropriate quantity range.

Isotope	Range of Quantity	Agree	Disagree	Comment
Am-241	12 mCi to 6 Ci			
Ba-133	10 mCi to 125 mCi			
Cd-109	50 mCi to 300 mCi			
Co-60	30 μCi to 100 Ci			
Cs-137	10 μCi to 110 Ci			
Fe-55	2 mCi to 350 mCi			

8.2 Please rate the importance of the following barriers to worker and public dose as they apply to fixed gamma gauges and small calibrators (1 is the most important and 4 is the least important).

Barrier	Rating
Training, knowledge, and experience of personnel in radiation safety principles.	
Training, knowledge, and experience of personnel in handling and use of the gauge or calibrator.	
Limits on the quantity of byproduct material that is incorporated in gauges and calibrators.	
Inherent safety features in the design of the gauges or calibrators.	
Typical installation of gauges in locations that are not usually accessible to workers or the public.	

8.3 Many licensees implement "good practices" when using and handling byproduct material. "Good practices" are actions that are not specifically required by the regulations but may be included as license conditions or performed voluntarily to reduce exposures or the likelihood of accidents. Based on your experience, indicate the percentage (0 to 100) of all users of fixed gamma gauges and small calibrators that you believe follow the "good practices" indicated below. Mark every box. Use an X if you are unsure of a percentage.

Good Practice	Percentage
Posting signs indicating the presence of radioactive material and advising people not to frequent the area.	
Restricting access to the gauge or calibrator by use of locks or other physical barriers.	
Training workers in the importance of appropriate handling of the gauge or calibrator.	
Auditing workers and operations to ensure activities are carried out in an appropriate manner.	
Performing periodic inventories to verify accountability of the gauge or calibrator.	
Other (please specify):	

8.4 Please rate the importance of the following regulatory controls as they are, or could be, used to regulate fixed gamma gauges and small calibrators. Consider exposures during normal operations, incidents (including both the probability of occurrence and consequences of those incidents), and costs of regulation to NRC/Agreement States and licensees in your rating (1 is the most important and 4 is the least important).

Regulatory Controls	Rating
Preapproval review of licensee's knowledge and training and experience of personnel.	
Preapproval of licensee's radiation safety program.	
Preapproval of procedures for the safe use of the material.	
Preapproval of facilities and operations.	
Preapproval of the equipment (sealed sources and devices) used during operations.	
On-site inspections of the licensees facility and operations to verify safety and compliance at the following frequency (mark your recommended frequency below and rate the importance of your selection in the box at the right): □ every year □ every 2 years □ every 3 years □ every 5 years □ other (specify): _____	

Regulatory Controls		Rating
Mail or telephone inspections to verify safety and compliance at the following frequency (mark your recommended frequency below and rate the importance of your selection in the box at the right): □ every year □ every 2 years □ every 3 years □ every 5 years □ other (specify): _____		
Periodic on-site inspections to verify accountability of radioactive material at the following frequency (mark your recommended frequency below and rate the importance of your selection in the box at the right): □ every year □ every 2 years □ every 3 years □ every 5 years □ other (specify): _____		
Periodic mail inspections to verify accountability of radioactive material at the following frequency (mark your recommended frequency below and rate the importance of your selection in the box at the right): □ every year □ every 2 years □ every 3 years □ every 5 years □ other (specify): _____		
Periodic telephone inspections verify accountability of radioactive material at the following frequency (mark your recommended frequency below and rate the importance of your selection in the box at the right): □ every year □ every 2 years □ every 3 years □ every 5 years □ other (specify): _____		
NRC/Agreement State maintenance of an independent inventory of users' material and NRC/Agreement State cross check of the inventory with users by performing periodic (rate each selection in the box to it's right):	on-site inspections	
	mail inspections	
	telephone inspections	
Vendor maintenance of an independent inventory of users' material and vendor cross check of the inventory with users by performing periodic (rate each selection in the box to it's right):	on-site inspections	
	mail inspections	
	telephone inspections	
No regulatory controls should be placed on fixed gamma gauges and small calibrators.		
Other (please specify):		

9. Questions 9.1 through 9.4 pertain to byproduct material in portable gauges. If you are not familiar with the use of these types of devices, mark an X in the box below and skip to question 10.

☐ Not familiar

9.1 The following table lists isotopes that might be used in portable gauges. Please indicate what you believe to be the typical quantity, or range of quantities, of each used in portable gauges. If, based on your experience, you disagree that a particular isotope is actually used in portable gauges, mark an X in the "disagree" column and indicate why in the comment area. If you believe additional isotopes should be considered, please add them to the table with their appropriate quantity or range of quantities.

Isotope	Typical Quantity	Disagree	Comment
Am-241			
Ba-133			
Cd-109			
Co-60			
Cs-137			
Fe-55			
Gd-153			
I-125			

9.2 Please rate the importance of the following barriers to worker and public dose as they apply to portable gauges (1 is the most important and 4 is the least important).

Barrier	Rating
Training, knowledge, and experience of personnel in radiation safety principles.	
Training, knowledge, and experience of personnel in handling and use of the portable gauge.	
Limits on the quantity of byproduct material that is incorporated in portable gauges.	
Inherent safety features in the design of portable gauges.	
Securing of portable gauges in locked areas when not in use or maintaining constant surveillance of portable gauges.	

9.3 Many licensees implement "good practices" when using and handling byproduct material. "Good practices" are actions that are not specifically required by the regulations but may be included as license conditions or performed voluntarily to reduce exposures or the

likelihood of accidents. Based on your experience, indicate the percentage (0 to 100) of all users of portable gauges that you believe implement the "good practices" indicated below. Mark every box. Use an X if you are unsure of a percentage.

Good Practice	Percentage
Posting signs indicating the presence of radioactive material and advising people not to frequent the area.	
Restricting access to the portable gauge by use of locks or other physical barriers.	
Training workers in the importance of appropriate handling of the portable gauge.	
Auditing workers and operations to ensure activities are carried out in an appropriate manner.	
Performing periodic inventories to verify accountability of the portable gauge.	
Other (please specify):	

9.4 Please rate the importance of the following regulatory controls as they are, or could be, used to regulate portable gauges. Consider exposures during normal operations, incidents (including both the probability of occurrence and consequences of those incidents), and costs of regulation to NRC/Agreement States and licensees in your rating (1 is the most important and 4 is the least important).

Regulatory Controls	Rating
Preapproval review of licensee's knowledge and training and experience of personnel.	
Preapproval of licensee's radiation safety program.	
Preapproval of procedures for the safe use of the material.	
Preapproval of facilities and operations.	
Preapproval of the equipment (sealed sources and devices) used during operations.	
On-site inspections of the licensees facility and operations to verify safety and compliance at the following frequency (mark your recommended frequency below and rate the importance of your selection in the box at the right): □ every year □ every 2 years □ every 3 years □ every 5 years □ other (specify): _____	

Regulatory Controls		Rating
Mail or telephone inspections to verify safety and compliance at the following frequency (mark your recommended frequency below and rate the importance of your selection in the box at the right): □ every year □ every 2 years □ every 3 years □ every 5 years □ other (specify): _____		
Periodic on-site inspections to verify accountability of radioactive material at the following frequency (mark your recommended frequency below and rate the importance of your selection in the box at the right): □ every year □ every 2 years □ every 3 years □ every 5 years □ other (specify): _____		
Periodic mail inspections to verify accountability of radioactive material at the following frequency (mark your recommended frequency below and rate the importance of your selection in the box at the right): □ every year □ every 2 years □ every 3 years □ every 5 years □ other (specify): _____		
Periodic telephone inspections to verify accountability of radioactive material at the following frequency (mark your recommended frequency below and rate the importance of your selection in the box at the right): □ every year □ every 2 years □ every 3 years □ every 5 years □ other (specify): _____		
NRC/Agreement State maintenance of an independent inventory of users' material and NRC/Agreement State cross check of the inventory with users by performing periodic (rate each selection in the box to it's right):	on-site inspections	
	mail inspections	
	telephone inspections	
Vendor maintenance of an independent inventory of users' material and vendor cross check of the inventory with users by performing periodic (rate each selection in the box to it's right):	on-site inspections	
	mail inspections	
	telephone inspections	
No regulatory controls should be placed on portable gauges.		
Other (please specify):		

10. Questions 10.1 through 10.4 pertain to <u>laboratory operations using unsealed byproduct material</u>. If you are not familiar with such operations, mark an X in the box below and skip to question 11.

☐ Not familiar.

10.1 The following table lists isotopes and typical quantities that might be used in laboratory operations using unsealed byproduct material. Please mark an X in the appropriate column indicating whether, based on your knowledge, you agree or disagree that the information is correct. If you disagree, please indicate why in the comment area. If you believe additional isotopes should be considered, please add them to the table with their appropriate quantity.

Isotope	Typical Quantity	Agree	Disagree	Comment
C-14	5 mCi			
Ca-45	1 mCi			
Cr-51	10 mCi			
Fe-59	1 mCi			
H-3	25 mCi			
I-125	10 mCi			
P-32	10 mCi			
P-33	10 mCi			
S-35	15 mCi			

10.2 Please rate the importance of the following barriers to worker and public dose as they apply to laboratory operations using unsealed materials (1 is the most important and 4 is the least important).

Barrier	Rating
Training, knowledge, and experience of personnel in radiation safety principals.	
Training, knowledge, and experience of personnel in handling and use of unsealed radioactive materials in a laboratory setting.	
Most laboratory use of unsealed byproduct material is with low-energy beta-emitters such as C-14, H-3, P-32, and S-35, and sometime other radionuclides, which are easily shielded.	
Most laboratory use of unsealed byproduct material involves small quantities (microcuries to a few millicuries) that is usually in a non-volatile form.	
Persons handling unsealed byproduct material in laboratories usually wear protective gloves and laboratory coats.	
Access to the unsealed byproduct material is controlled by physical security, or by maintaining visual oversight.	

10.3 Many licensees implement "good practices" when using and handling byproduct material. "Good practices" are actions that are not specifically required by the regulations but may be included as license conditions or performed voluntarily to reduce exposures or the likelihood of accidents. Based on your experience, indicate the percentage (0 to 100) of all persons performing laboratory operations using unsealed material that you believe implement the "good practices" indicated below. Mark every box. Use an X if unsure of a percentage.

Good Practice	Percentage
Wearing protective gloves, laboratory coats, or other protective clothing.	
Using shielding (e.g., around stock vials and storage areas, portable shields in work areas).	
Using hoods or glove boxes if potentially volatile materials are handled.	
Perform surveys for radiation and contamination after each use or the end of each day of use.	
Maintaining an inventory of unsealed byproduct material in the laboratory.	
Auditing work areas and maintenance of records by Radiation Safety Officer or management.	
Other (please specify):	

10.4 Please rate the importance of the following regulatory controls as they are, or could be, used to regulate laboratory operations using unsealed material. Consider exposures during normal operations, incidents (including both the probability of occurrence and consequences of those incidents), and costs of regulation to NRC/Agreement States and licensees in your rating (1 is the most important and 4 is the least important).

Regulatory Controls	Rating
Preapproval review of licensee's knowledge and training and experience of personnel.	
Preapproval of licensee's radiation safety program.	
Preapproval of procedures for the safe use of the material.	
Preapproval of facilities and operations.	
Preapproval of the equipment (sealed sources and devices) used during operations.	

Regulatory Controls		Rating
On-site inspections of the licensees facility and operations to verify safety and compliance at the following frequency (mark your recommended frequency below and rate the importance of your selection in the box at the right): □ every year □ every 2 years □ every 3 years □ every 5 years □ other (specify): _____		
Mail or telephone inspections to verify safety and compliance at the following frequency (mark your recommended frequency below and rate the importance of your selection in the box at the right): □ every year □ every 2 years □ every 3 years □ every 5 years □ other (specify): _____		
Periodic on-site inspections to verify the persons' accountability of radioactive material at the following frequency (mark your recommended frequency below and rate the importance of your selection in the box at the right): □ every year □ every 2 years □ every 3 years □ every 5 years □ other (specify): _____		
Periodic mail inspections to verify the persons' accountability of radioactive material at the following frequency (mark your recommended frequency below and rate the importance of your selection in the box at the right): □ every year □ every 2 years □ every 3 years □ every 5 years □ other (specify): _____		
Periodic telephone inspections to verify accountability of radioactive material at the following frequency (mark your recommended frequency below and rate the importance of your selection in the box at the right): □ every year □ every 2 years □ every 3 years □ every 5 years □ other (specify): _____		
NRC/Agreement States maintenance of an independent inventory of the users' material and NRC/Agreement State cross check of the inventory with users by performing periodic (rate each selection in the box to it's right):	on-site inspections	
	mail inspections	
	telephone inspections	
Vendor maintenance of an independent inventory of the users' material and the vendor cross check of the inventory with users by performing periodic (rate each selection in the box to it's right):	on-site inspections	
	mail inspections	
	telephone inspections	
No regulatory controls should be placed on laboratory operations using unsealed material.		

Regulatory Controls	Rating
Other (please specify):	

11. Questions 11.1 through 11.4 pertain to packaging byproduct material waste. If you are not familiar with such operations, mark an X in the box below and skip to question 12.

☐ Not familiar.

11.1 The following table lists isotopes that might be involved in packaging byproduct material waste. Please indicate what you believe to be the typical quantity of each in the packaging of byproduct material waste. If, based on your experience, you disagree that a particular isotope is actually involved in the packaging of byproduct material waste, mark an X in the "disagree" column and indicate why in the comment area. If you believe additional isotopes should be considered, please add them to the table with their appropriate quantity.

Isotope	Typical Quantity	Disagree	Comment
Ac-225			
Ag-110m			
Am-241			
Au-195			
Ba-133			
Ba-140			
C-14			
Ca-45			
Cd-109			
Cf-252			
Ce-141			
Ce-144			
Cl-36			
Co-58			
Co-60			
Cr-51			
Cs-134			

Isotope	Typical Quantity	Disagree	Comment
Cs-137			
Eu-152			
Fe-55			
Fe-59			
Gd-153			
H-3			
I-125			
I-129			
I-131			
Ir-192			
Kr-85			
La-140			
Mn-54			
Nb-95			
Ni-59			
Ni-63			
P-32			
P-33			
Pa-234			
Pb-210			
Pm-147			
Po-210			
Rb-86			
Ru-103			
Ru-106			
S-35			
Sb-124			
Sb-125			
Sc-46			
Se-75			
Sn-113			

Isotope	Typical Quantity	Disagree	Comment
Sr-85			
Sr-89			
Sr-90			
Tc-99			
Tc-99m			
Tl-204			
Xe-131m			
Xe-133			
Y-90			
Zn-65			
Zr-95			

11.2 Please rate the importance of the following barriers to worker and public dose as they apply to packaging byproduct material waste (1 is the most important and 4 is the least important).

Barrier	Rating
Training, knowledge, and experience of personnel in radiation safety principals.	
Limiting operations to sealed sources.	
Limiting operations to small quantities of byproduct material.	
Wearing protective gloves and other types of protective clothing when handling unsealed byproduct material.	
Controlling access to byproduct material through physical security or by maintaining visual oversight.	

11.3 Many licensees implement "good practices" when using and handling byproduct material. "Good practices" are actions that are not specifically required by the regulations but may be included as license conditions or performed voluntarily to reduce exposures or the likelihood of accidents. Based on your experience, indicate the percentage (0 to 100) of all packagers of byproduct material waste that you believe implement the "good practices" indicated below. Mark every box. Use an X if unsure of a percentage.

Good Practice	Percentage
Wearing protective gloves or other protective clothing.	

Using shielding (e.g., around stock vials and storage areas, portable shields in work areas).	
Using hoods or glove boxes if potentially volatile materials are handled.	
Performing surveys for radiation and contamination after handling unsealed material or at the end of each work day.	
Performing periodic inventories of all byproduct material at the facility.	
Auditing work areas and maintenance of records by Radiation Safety Officer or management.	
Other (please specify):	

11.4 Please rate the importance of the following regulatory controls as they are, or could be, used to regulate packaging byproduct material waste. Consider exposures during normal operations, incidents (including both the probability of occurrence and consequences of those incidents), and costs of regulation to NRC/Agreement States and licensees in your rating. (1 is the most important and 4 is the least important).

Regulatory Controls	**Rating**
Preapproval review of licensee's knowledge and training and experience of personnel.	
Preapproval of licensee's radiation safety program.	
Preapproval of procedures for the safe use of the material.	
Preapproval of facilities and operations.	
Preapproval of the equipment (sealed sources and devices) used during operations.	
On-site inspections of the licensees facility and operations to verify safety and compliance at the following frequency (mark your recommended frequency below and rate the importance of your selection in the box at the right): □ every year □ every 2 years □ every 3 years □ every 5 years □ other (specify): _____	
Mail or telephone inspections to verify safety and compliance at the following frequency (mark your recommended frequency below and rate the importance of your selection in the box at the right): □ every year □ every 2 years □ every 3 years □ every 5 years □ other (specify): _____	

Periodic on-site inspections to verify the persons' accountability of radioactive material at the following frequency (mark your recommended frequency below and rate the importance of your selection in the box at the right): □ every year □ every 2 years □ every 3 years □ every 5 years □ other (specify): _____		
Periodic mail inspections to verify the persons' accountability of radioactive material at the following frequency (mark your recommended frequency below and rate the importance of your selection in the box at the right): □ every year □ every 2 years □ every 3 years □ every 5 years □ other (specify): _____		
Periodic telephone inspections to verify the persons' accountability of radioactive material at the following frequency (mark your recommended frequency below and rate the importance of your selection in the box at the right): □ every year □ every 2 years □ every 3 years □ every 5 years □ other (specify): _____		
NRC/Agreement State maintenance of an independent inventory of users' material and NRC/Agreement State cross check of the inventory with users by performing periodic (rate each selection in the box to it's right):	on-site inspections	
	mail inspections	
	telephone inspections	
Vendor maintenance of an independent inventory of the users' material and vendor cross check of the inventory with users by performing periodic (rate each selection in the box to it's right):	on-site inspections	
	mail inspections	
	telephone inspections	
No regulatory controls should be placed on packaging byproduct material waste.		
Other (please specify):		

12. Questions 12.1 through 12.4 pertain to use of byproduct material in a nuclear medicine department. If you are not familiar with such operations, mark an X in the box below and skip to question 13.

☐ Not familiar.

12.1 The following table lists isotopes and typical quantities that might be used in a nuclear medicine department. Please mark an X in the appropriate column indicating whether, based on your knowledge, you agree or disagree that the information is correct. If you disagree, please indicate why in the comment area. In cases where a quantity is not stated, please indicate what you believe to be the typical quantity used in a nuclear

medicine department. If you believe additional isotopes should be considered, please add them to the table with their appropriate quantity.

Isotope	Range of Quantity	Agree	Disagree	Comment
Au-198	100 to 140 mCi			
Dy-165				
Er-169				
Ho-166				
I-131	3 to 300 mCi			
Mo-99	2 Ci			
P-32	2.3 to 22.3 mCi			
Pd-109				
Re-186	25 to 35 mCi			
Sm-153				
Sn-117m				
Sr-89	1 to 10.8 mCi			
Tc-99m	50 mCi to 2 Ci			
Xe-133	10 to 100 mCi			
Y-90				

12.2 Please rate the importance of the following barriers to worker and public dose as they apply to use of byproduct material in a nuclear medicine department (1 is the most important and 4 is the least important).

Barrier	Rating
Training, knowledge, and experience of personnel in radiation safety principals.	
Training, knowledge, and experience of personnel in handling and use of byproduct material in a nuclear medicine department that may include use of a generator.	
Most byproduct material used in a nuclear medicine department that may include use of a generator have short half-lives.	
Most byproduct material, used in a nuclear medicine department that may include use of a generator is in a non-volatile form, in quantities ranging from microcuries to tens of millicuries.	

Persons handling byproduct material in a nuclear medicine department that may include use of a generator usually wear protective gloves and laboratory coats.	
Access to the byproduct material in a nuclear medicine department that may include use of a generator is controlled by physical security, or by maintaining visual oversight.	

12.3 Many licensees implement "good practices" when using and handling byproduct material. "Good practices" are actions that are not specifically required by the regulations but may be included as license conditions or performed voluntarily to reduce exposures or the likelihood of accidents. Based on your experience, indicate the percentage (0 to 100) of all persons performing nuclear medicine operations that you believe implement the "good practices" indicated below. Mark every box. Use an X if unsure of a percentage.

Good Practice	Percentage
Wearing protective gloves, laboratory coats, or other protective clothing.	
Using shielding (syringe shields, L-blocks, etcetera).	
Using hoods or glove boxes if potentially volatile materials are handled.	
Using long-handled tools when handling large-activity vials.	
Performing surveys for radiation and contamination after each use or at the end of each day of use.	
Maintaining an inventory of byproduct material in the nuclear medicine department that may include use of a generator.	
Isolating injected patients from other patients and members of the public.	
Auditing work areas and maintenance of records by Radiation Safety Officer or management.	
Other (please specify):	

12.4 Please rate the importance of the following regulatory controls as they are, or could be, used to regulate nuclear medicine departments. Consider exposures during normal operations, incidents (including both the probability of occurrence and consequences of those incidents), and costs of regulation to NRC/Agreement States and licensees in your rating (1 is the most important and 4 is the least important).

Regulatory Controls	Rating
Preapproval review of licensee's knowledge and training and experience of personnel.	
Preapproval of licensee's radiation safety program.	
Preapproval of procedures for the safe use of the material.	
Preapproval of facilities and operations.	

Regulatory Controls		Rating
Preapproval of the equipment (sealed sources and devices) used during operations.		
On-site inspections of the licensees facility and operations to verify safety and compliance at the following frequency (mark your recommended frequency below and rate the importance of your selection in the box at the right): □ every year □ every 2 years □ every 3 years □ every 5 years □ other (specify): _____		
Mail or telephone inspections to verify safety and compliance at the following frequency (mark your recommended frequency below and rate the importance of your selection in the box at the right): □ every year □ every 2 years □ every 3 years □ every 5 years □ other (specify): _____		
Periodic on-site inspections to verify the person's accountability of radioactive material at the following frequency (mark your recommended frequency below and rate the importance of your selection in the box at the right): □ every year □ every 2 years □ every 3 years □ every 5 years □ other (specify): _____		
Periodic mail inspections to verify the persons' accountability of radioactive material at the following frequency (mark your recommended frequency below and rate the importance of your selection in the box at the right): □ every year □ every 2 years □ every 3 years □ every 5 years □ other (specify): _____		
Periodic telephone inspections to verify the persons' accountability of radioactive material at the following frequency (mark your recommended frequency below and rate the importance of your selection in the box at the right): □ every year □ every 2 years □ every 3 years □ every 5 years □ other (specify): _____		
NRC/Agreement State maintenance of an independent inventory of users' material and NRC/Agreement State cross check of the inventory with users by performing periodic (rate each selection in the box to it's right):	on-site inspections	
	mail inspections	
	telephone inspections	
Vendor maintenance of an independent inventory of users' material and vendor cross check of the inventory with users by performing periodic (rate each selection in the box to it's right):	on-site inspections	
	mail inspections	
	telephone inspections	

Regulatory Controls	Rating
No regulatory controls should be placed on nuclear medicine departments that may include use of a generator.	
Other (please specify):	

13. Questions 13.1 through 13.4 pertain to manufacturers or distributors of gaseous sources containing byproduct material. If you are not familiar with such operations, mark an X in the box below and skip to question 14.

☐ Not familiar.

13.1 The following table lists isotopes and typical quantities that might be used by manufacturers or distributors of gaseous sources containing byproduct material. Please mark an X in the appropriate column indicating whether, based on your knowledge, you agree or disagree that the information is correct. If you disagree, please indicate why in the comment area. In cases where a quantity is not stated, please indicate what you believe to be the typical quantity used by manufacturers/distributors of gaseous sources containing byproduct material. If you believe additional isotopes should be considered, please add them to the table with their appropriate quantity.

Isotope	Quantity	Agree	Disagree	Comment
Br-82				
H-3	1 to 25 Ci			
Kr-85	up to 25 μCi			
Xe-133				

13.2 Please rate the importance of the following barriers to worker and public dose as they apply to manufacturers or distributors of gaseous sources (1 is the most important and 4 is the least important).

Barrier	Rating
Training, knowledge, and experience of personnel in radiation safety principals.	
Training, knowledge, and experience of personnel in manufacture of gaseous sources of byproduct material.	
Most manufacturers/distributors of gaseous sources of byproduct material handle H-3, a low-energy beta-emitter or noble gases such as Kr-85 and Xe-133.	

Barrier	Rating
Using remote handling systems for transfer of gaseous byproduct material during the manufacture of gaseous sources of byproduct material.	
Air monitoring in facilities which manufacture gaseous sources of byproduct material.	
Controlling access to the byproduct material in a facility which manufactures gaseous sources of byproduct material by physical security, or by maintaining visual oversight.	

13.3 Many licensees implement "good practices" when using and handling byproduct material. "Good practices" are actions that are not specifically required by the regulations but may be included as license conditions or performed voluntarily to reduce exposures or the likelihood of accidents. Based on your experience, indicate the percentage (0 to 100) of all manufacturers or distributors of gaseous sources that you believe implement the "good practices" indicated below. Mark every box. Use an X if unsure of a percentage.

Good Practice	Percentage
Wearing protective gloves, laboratory coats, or other protective clothing.	
Using shielding (e.g., around storage areas, or portable shields in work areas).	
Using hoods, glove boxes, hot cells, or other remote-handling systems during handling of gaseous byproduct material.	
Performing surveys for radiation and airborne byproduct material during each day of use.	
Maintaining an inventory of unsealed byproduct material in the laboratory.	
Auditing work areas and maintenance of records by Radiation Safety Officer or management.	

Good Practice	Percentage
Other (please specify):	

13.4 Please rate the importance of the following regulatory controls as they are, or could be, used to regulate manufacturers or distributors of gaseous sources containing byproduct material. Consider exposures during normal operations, incidents (including both the probability of occurrence and consequences of those incidents), and costs of regulation to NRC/Agreement States and licensees in your rating. (1 is the most important and 4 is the least important).

Regulatory Controls	Rating
Preapproval review of licensee's knowledge and training and experience of personnel.	
Preapproval of licensee's radiation safety program.	
Preapproval of procedures for the safe use of the material.	
Preapproval of facilities and operations.	
Preapproval of the equipment (sealed sources and devices) used during operations.	
On-site inspections of the licensees facility and operations to verify safety and compliance at the following frequency (mark your recommended frequency below and rate the importance of your selection in the box at the right): □ every year □ every 2 years □ every 3 years □ every 5 years □ other (specify): _____	
Mail or telephone inspections to verify safety and compliance at the following frequency (mark your recommended frequency below and rate the importance of your selection in the box at the right): □ every year □ every 2 years □ every 3 years □ every 5 years □ other (specify): _____	
Periodic on-site inspections to verify the persons' accountability of radioactive material at the following frequency (mark your recommended frequency below and rate the importance of your selection in the box at the right): □ every year □ every 2 years □ every 3 years □ every 5 years □ other (specify): _____	
Periodic mail inspections to verify the persons' accountability of radioactive material at the following frequency (mark your recommended frequency below and rate the importance of your selection in the box at the right): □ every year □ every 2 years □ every 3 years □ every 5 years □ other (specify): _____	

Periodic telephone inspections to verify the persons' accountability of radioactive material at the following frequency (mark your recommended frequency below and rate the importance of your selection in the box at the right): □ every year □ every 2 years □ every 3 years □ every 5 years □ other (specify): _____		
NRC/Agreement State maintenance of an independent inventory of users' material and NRC/Agreement State cross check of the inventory with users by performing periodic (rate each selection in the box to it's right):	on-site inspections	
	mail inspections	
	telephone inspections	
Vendor maintenance of an independent inventory of users' material and vendor cross check of the inventory with users by performing periodic (rate each selection in the box to it's right):	on-site inspections	
	mail inspections	
	telephone inspections	
No regulatory controls should be placed manufacturers or distributors of gaseous sources.		
Other (please specify):		

Section 3 - Questions Concerning How You Think Regulatory Agencies Should Make Decisions

14. Indicate what you believe is the level of importance of the factors that might be considered in regulating manufacturing, distribution, receipt, possession, use, handling, transfer, and disposal of radioactive materials. Rank each factor according to the following scale: 1 - very important; 2 - important; 3 - not important; 4 - should not be considered. Please list under "other" any additional factors that should be considered.

Regulation of Persons Possessing Material Should Be Based On:	**Rating**
Consensus opinion of the public	
Financial burden of regulation to the licensee	
Financial burden of regulation to the public	
Evaluation of radiological risk	
Benefit of the use of material to society	
Other considerations (describe any other considerations):	

Section 4 - Information About Yourself

The following information is optional, but your response would be helpful to the survey:

15. My information regarding safe operations with radioactive materials is based on:

☐ performing operations with radioactive materials _____ years

- ☐ R&D/laboratory use
- ☐ industrial use (gauges, radiography, etc.)
- ☐ medical use
- ☐ manufacturing
- ☐ reactor (power or non-power)
- ☐ Other (please specify):

☐ performing radiation safety oversight of operations by others _____ years

- ☐ R&D/laboratory use
- ☐ industrial use (gauges, radiography, etc.)
- ☐ medical use
- ☐ manufacturing
- ☐ reactor (power or non-power)
- ☐ Other (please specify):

☐ performing licensing of radioactive materials _____ years

☐ performing inspection of radioactive materials _____ years

☐ performing other regulatory review of radioactive materials use _____ years

☐ formal education in health physics or radiation science
Degree: _____ BA/BS _____ MA/MS _____ Ph.D.

☐ work-related training courses

☐ Other (please specify):

Appendix B

Correspondence Related to the Questionnaire

Correspondence Related to the Questionnaire

Correspondence related to the Questionnaire appears on the following pages.

APPENDIX B

STATE OF TENNESSEE
DEPARTMENT OF ENVIRONMENT AND CONSERVATION
Division of Radiological Health
3rd Floor, L & C Annex
401 Church Street
Nashville, TN 37243-1532
615-532-0360
INTERNET: **mmobley@mail.state.tn.us**

August 14, 1998

U.S. Nuclear Regulatory Commission
ATTN: Dennis I. Serig
Mail Stop T8F5
Washington, D.C. 20555-0001

Dear Mr. Serig:

The survey contained in transmittal SP-98-065 was provided to members of our staff having experience in licensing and inspections. It is our feeling that a response to this survey will require a period of time significantly longer than the 1.5 to 3 hours of your estimation- by each respondent. Given the response time requested, sufficient time to formulate the response was not available.

Among our concerns regarding any response to this is the necessity for each respondent to create individual definitions to terms such as "very safe, somewhat safe...etc". How will the different definitions which will result be reconciled with one another? Also, it is almost certain that any response by each individual would be more appropriate, and considerably different, if given an opportunity for file review. There, again, time investment would be considerable.

We must regretfully defer response to your survey at the present time. Hopefully, some of these issues can be resolved and another opportunity to participate provided.

Sincerely,

Michael H. Mobley
Director

STATE OF NEW YORK
DEPARTMENT OF LABOR
DIVISION OF SAFETY AND HEALTH
Radiological Health Unit
Building #12, Room 134-A
State Office Building Campus
Albany, NY 12240

August 24, 1998

Mr. Paul Lohaus
Deputy Director
Office of State Programs
United States Nuclear Regulatory Commission
Washington, D.C. 20555

Dear Mr. Lohaus:

I have completed the survey referred to in your letter SP-98-065 and returned it to Dennis Serig. However, this survey instrument was seriously flawed and I do not see how the responses received could be used as indicated in your letter to capture the "corporate knowledge" of regulatory personnel.

It is unclear what pieces of the data gathered through this survey will be treated as factual and what will be treated as opinion. Since participants were instructed not to review files or other sources, and not to consult with other staff, it would appear that all of the responses should be regarded as anecdotal. It is also apparent that responses should not be regarded as the professional opinions of the respondents, since they are responses to carefully framed questions with a limited choice of answers.

I would be very interested in knowing how the survey responses will be used to "augment and confirm information provided by Scientech." What information has Scientech provided and how will responses to this survey augment or confirm them?

Sincerely,

Rita Aldrich

Rita Aldrich
Principal Radiophysicist

RA:jmp

Telephone: 518-457-1202
FAX: 518-485-7406

APPENDIX B

August 25, 1998

TO: R. Bangart

FROM: A. Godwin

SUBJECT: Bias in the questionnaire (SP-98-065)

I offer the following as comments indicating a possible biasing in the subject document.

1. The context of the document is to better establish risk based regulations. The document appears to be poorly phrased. For example, question 4, does not clarify "off-normal." Does this mean, slightly delaying surveys or totally not doing surveys. The document attempts to correct this by letting the writer define "safe....etc." Even with the writer's definitions, the questioner cannot know what type of accident or "off-normal" condition was envisioned by the responder. Without that knowledge, the reviewer has to assume the conditions to match up the responses. Thus if one responder is envisioning an "off-normal" nuclear pharmacy condition as a failure to survey the sink one night. While the reviewer may be thinking of a leaking and contaminated shipment being made off-site.

2. Even worse is question 6. The responses to this are pure speculation, since most regulators responding do not have any experience of how things would operate without regulations. A mere glance at the conditions exiting in x-ray departments prior to state regulation would show that one cannot adequately envision the possible problems. For example, we found fluoroscopic units with an output of > 30R/min. twenty years after the recommendation was to be less than 10 R/min. Because the regulations have existed, we do not have a concept of what conditions may occur if they did not exist.

3. Questions 8.1 and 8.2 play against each other. Inherent safety features are very important around a 100 Ci cobalt 60 fixed gauge, yet not very important with a 30 microcurie one.

4. Similarly, 8.1 verses 8.4, the quantity being considered radically changes the response.

5. Questions 9.1, 9.2, 9.4, 10.1, 10.2, 10.4, 11.1, 11.2, and 11.4 are somewhat better in that the responder indicates what quantity to which they are responding.

These are examples of what I felt were questions that could lead to some false conclusions be the reviewers. Since they were a significant portion of the total questionnaire, I would be concerned about the validity of the conclusions reached.

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

October 21, 1998

Ms. Rita Aldrich, Principal Radiophysicist
Radiological Health Unit
Division of Safety and Health
New York State Department of Labor
State Office Building Campus
Building 12, Room 134A
Albany, New York 12240

Dear Ms. Aldrich:

This is in response to your letter of August 24, 1998, which referenced the risk review working group's nuclear byproduct material survey (SP-98-065, dated July 23, 1998). You asked what information NRC's contractor, Scientech, has provided and how the survey responses augments or confirms that information. Presently, NRC is awaiting receipt of Scientech's final report to which the survey results will be compared.

As way of background, the survey of licensing and inspection personnel was designed to assist the risk review working group in identifying and documenting a technical basis for a risk-informed approach to nuclear byproduct material regulation and in development of plans for a graded approach to regulation of such material based on risk information. The survey asked inspection and licensing personnel about typical doses, typical events and frequencies, perceptions of safety, materials and quantities typical to various systems, the existence and value of various barriers to dose, and the value of particular regulatory options. Scientech's report will address most of those same areas. The working group received 41 responses to its survey of licensing and inspection personnel. Data from the responses have been entered into a spread sheet for analysis. The spread sheet was modified as data entry progressed in order to accommodate the fullest possible range of responses (e.g., to expand coding of data to include responses that were not consistent with instructions but that appeared to be useful). Comments that could not be entered into the spread sheet, but that could affect the data analysis, were noted.

Based on the review to date, respondents appear to have provided information in which they had confidence, to admit that they were unfamiliar with some systems and that they could not provide information about them with confidence, and to indicate when they believed that response alternatives were too limited. The review group believes that each individual respondent's answers reflect their own professional opinions based on their experience in licensing and/or inspection (i.e., their exposure to facts). The review group does, however, recognize that some questions could not be answered solely on the basis of experience. Such situations will be kept in mind during analysis of survey responses. The review group understands the limitations of the survey, but believes that there will be useful information that reflects the licensing and inspection community's informed opinions, i.e., its corporate knowledge.

The survey is intended as only one of several sources of information used to satisfy the working group's charter. Results will be compared with contractor information about doses, events and frequencies, materials and quantities. Perhaps more importantly, the informed opinions of licensing and inspection personnel about the existence and effectiveness of barriers to dose and the value of particular regulatory options will be compared with contractor developed views on those same subjects.

Should you have additional comments or questions, please feel free to contact Dennis Serig at 301-415-7901 or via e-mail at dis@nrc.gov.

Sincerely,

Paul H. Lohaus, Deputy Director
Office of State Programs

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Appendix C
Responses to Comments on Draft NUREG-1712

APPENDIX C

Introduction
NUREG-1712, "Results of Survey of NRC and Agreement State Materials Licensing and Inspection Personnel," was published for public comment on August 25, 1999 (64 FR 46456). In response to the request for comments, NRC received 4 comments, 3 from Agreement States, and 1 from a private company. All comments are available for review in the NRC Public Document Room.

Comment: One commenter stated that much of the content is based on terminology or definitions that are very different from one participant to the next. This makes the specific results nebulous at best. The one thing of value is the table that "ranks the various systems. The commenter stated that the State will expend resources based more on state-specific or site specific criteria rather than a table reflecting an averaging of "best guesses," even if they are from experienced regulators.

Response: The survey was intended to gather information from NRC and Agreement State materials licensing and inspection personnel concerning typical annual doses to workers for the various systems, safety of each system under various conditions, the types and frequencies of incidents occurring at each system, definitions of safety, and opinions about the appropriate bases for regulatory decision making. The NRC did not intend for the States to use the results in making decisions related to their programs. The staff reviewed the results in line with results of the nuclear byproduct material risk study, NUREG/CR-6642, "Risk Analysis and Evaluation of Regulatory Options for Nuclear Byproduct Material Systems," for comparison purposes. The staff recognizes the limitations of the survey, but believes that there is useful information that reflects informed opinions.

Comment: The survey provides a good subjective summary of the most knowledgeable professionals' views as to the safety and the impact of NRC licensed activities. However, since safety was not predefined and allowed to reflect each respondents personal definition, the four categories of safety were arbitrary and of questionable value.

Response: Again, the survey was intended to gather information on nuclear byproduct material systems obtained from other sources, specifically NRC and Agreement State materials licensing and inspection personnel. The survey was not intended to be an absolute scientific survey, but more a gathering of information from knowledgeable personnel. The results were also compared to the results of NUREG/CR-6642, but were not used in the preparation of the NUREG.

Comment: A commenter from a private company providing nuclear laundry services provided additional information regarding the percentage of doses in 2 different dose categories.

Response: Only regulatory personnel were included in this survey, and actual data from licensees was not solicited in the survey process. Although activities involving the use of byproduct material at nuclear laundries were not included in the original survey, one survey respondent noted nuclear laundries as an activity which should be considered separately, and

applied the survey questions to this activity. The information regarding nuclear laundries in this survey is based only on the information provided by that individual. The staff appreciates the effort of the private company to provide data from their activities as a nuclear laundry.

***Comment**:* The survey results compiled in NUREG-1712 are subjective and anecdotal opinions of survey respondents. The survey was poor designed, encouraged subjective opinion, and lacked definitions and explanations. The so-called "data" in NUREG-1712 cannot be viewed as objective, precise, or accurate.

***Response**:* Again, the survey was not intended to be a "hard" scientific survey. It was intended to gather information, which staff recognized would be subjective and based on opinion. The results of the survey were not used in NUREG/CR-6642.