BEFORE THE
NUCLEAR REGULATORY COMMISSION

Vera M. English and General Electric Company	NRC Inspection Reports Nos. 70-1113/84-17 70-1113/84-18

SUPPLEMENTAL PETITION UNDER 10 CFR § 2.206 FOR WITHDRAWAL OF REPORTS 84-17 and 84-18, ISSUED JANUARY 18, 1985; ISSUANCE OF NEW REPORTS CORRECTLY DOCUMENTING AND FINDING ALLEGED VIOLATIONS AT THE WILMINGTON FACILITY IDENTIFIED HEREIN; ISSUANCE OF NOTICE OF VIOLATION ON ALL SUBSTANTIATED ALLEGATIONS, ASSIGNMENT OF APPROPRIATE SEVERITY LEVELS TO EACH FOUND VIOLATION, AND COMMENCEMENT BY NRC OF APPROPRIATE ENFORCEMENT ACTION, INCLUDING THE ASSESSMENT OF CIVIL PENALTIES

CHAPTER I

This petition supplements our petition of December 13, 1984, incorporated herein by reference, as contemplated therein, p. 2, by discussing reports thus far issued subsequent to the filing thereof. The new reports were received by counsel on February 11, 1985. See letter of Deputy Director James M. Taylor to Ratner, dated January 10, 1985 with enclosures. As of thi writing, we have not yet received Mr. Ed Clay's report, base on his investigation of December 3-6, 1984, and his subsequent inspections, nor have we received any report of 01 investigations of Mrs. English's allegations which are within the "area of its expertise." (App. 1, infra).[1/]

1/ Reports 84-15 and 84-16 were received on February 25, 1985. Because of the exigencies of time, we defer comment on those reports and submit this document, which is only a fraction of our petition relating to 84-17 and 84-18, labelled Chapter I.

I. INTRODUCTION

A. Report Errors and Deficiencies

Before turning to No. 84-17, it is important to observe (1) that this report itself establishes that earlier reports, insofar as they find no violation in many allegations, are factually and legally in error; (2) that the reports often erroneously excuse failure to find a violation on the ground that "the commitment involved has not been made a legally binding requirement" (49 F.R. 8591, E (2); (3) that the reports show that no attention was paid to the fact that several of the violations previously found were repeat and/or uncorrected offenses which require civil penalties (49 F.R. 8589, B, 4, 5); (4) that such offenses, and offenses which should have been found, reflect deliberate or at least "careless disregard of requirements," i.e., "willfulness," (49 F.R. 8588), and were not identified by the licensee or reported to the Commission as required (id., at 8588-8591); and (5) that the findings clearly demonstrate "dereliction of duty on the part of [highest management] personnel involved in licensed activities" (id. 8591, VII, Supplement I, C, 3). Yet, even those findings which were made were illegally assigned the lowest categories of severity levels. The severity level assigned to the offenses found was never more than IV or V.

Moreover, it is patent that the findings were carefully drafted to make it appear that the violations found were only "technical." In none of the reports, including 84-17, was the

actual effect on worker health and safety of the found breakdown of protective systems and of avoidable uranium contamination evaluated or considered in the light of "the cumulative total for all violations." Id. at 8590. Nor was a crucial factor, "economic advantage * * * gained [by management] as a result of the violation[s]," anywhere considered. Yet it is self-evident that the only explanation of highest management's willful non-implementation of G.E.'s radiation protection program, for which Stohr naively requested an explanation in his letter of January 3, 1985 to Vaughan enclosing Report No. 84-17, is solely economic benefit to G.E. resulting from disregard of safety requirements in the interest of meeting production schedules.

B. Defects In NRC Investigation Procedures And Assumptions

Some general observations concerning the methodology of the NRC inspections are also required. The Inspectors assume that because their visits were not announced in advance, management had no opportunity to "clean up" and alert the workers to be on good behavior, and that, therefore, the conditions they observed during inspections were normal. This is a totally false assumption. The inspectors must identify themselves at the guard house. The guards immediately notify management of their presence. It takes at least fifteen minutes for the inspectors to get from the guard house to the wet lab. That is plenty of time for management to "cover up"

and instruct workers to comply with regulations while the inspectors are at the plant.

Moreover, the Inspectors reports almost invariably speak of conditions as they existed on the dates of investigation; not as they existed on the dates referred to in the charges. Such "investigations" are meaningless, because management may meanwhile have changed procedures, destroyed evidence, instructed workers to "clean up" and "shape up" during NRC investigations, or "corrected" conditions. The investigations typically occur only many months after the charges. When the investigators are unable to find physical evidence which was under the control of management, they conclude that they are unable to prove the case, instead of applying the universal legal principle, "contra spoliator," under which management is presumed guilty of spoliation if it cannot produce evidence which once existed or should have existed.

The Inspectors' conclusions are discussed only with management at an "Exit Interview"; neither the conclusions nor management's "explanations" are discussed with the complainant. This prevents complainant from pointing out factual errors and erroneous inferences drawn by the Inspectors from information supplied by management and by G.E.-intimidated employees and by employees hostile to complainant.

To the extent employees are interviewed, they are seen on the plant site, in the company of a representative of

management. Knowing management's vindictiveness, employees typically fear management reprisal, in the form of selection for layoff and other means, if they tell the truth about management-laxity, cover-ups and subtle threats of reprisal.

Further, the covering letters from NRC to the licensee forwarding investigation reports (particularly those finding any violations), virtually always assume that the report is "privileged and confidential" and invite the licensee to forward his response as a separate document to avoid disclosure. We submit that practice is in flagrant violation of 10 CFR § 2.790(b).

Lastly, although NRC was officially notified on September 26, 1984, that Mrs. English waived confidentiality, every report written after that date still refers to her as "alleger" (84-17, par. 4 "note"), sometimes, in context, to the confusion, if not mystification, of the reader.

C. The Reports Reveal Region II Inspectors' And Supervisors' Bias and Prejudice In Favor of G.E. And Against Complainant

On the basis of our analysis of defects in No. 84-17 (and the prior reports analyzed in our original petition), which we discuss in detail below, we charge that (1) the technical inspectors who issued, and the supervisors who signed, these six reports are guilty of cover up; of shielding and protecting G.E. against, <u>inter alia</u>, required civil penalties and accompanying press releases (49 F.R. 8591 (VI,

second and third sentences);[2] and (2) tailoring their findings to create evidence against complainant in her current DOL hearing not only by minimizing the nature, number and significance of the violations found, but by making it appear that Mrs. English's charges were largely unsubstantiated and that Mrs. English is, therefore, an unreliable witness.

A material allegation of Mrs. English's Complaint in DOL Case No. 85-ERA-2 is that "General Electric's violations of safety standards were endemic and constant" (Tr. 412). DOL issued a probable cause finding in that case that Mrs. English was discriminatorily transferred out of the Chemet Lab and subsequently discharged for revealing G.E.'s violations to NRC, in violation of Section 210 of the ERA. If sustained, that is a Severity I violation. 49 F.R. 8593, Supp. VII, A, 4.

II. NO. 84-17 ESTABLISHES A PER SE HIGH SEVERITY VIOLATION OF MANAGEMENT'S (ALARA) OBLIGATION

A. The ALARA Obligation

NRC rules, 10 CFR § 20.1(c), require that "in addition to complying with the requirements set forth in this part, [management must] make every reasonable effort to maintain radiation exposures, and releases of radioactive materials in effluents to unrestricted areas, as low as is reasonably achievable." (Emphasis added.) This obligation is

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2/ Appendix 2, infra, Attachment 2, shows Region II NRC Director J. P. O'Reilly's improper concern for shielding G.E. from "potential inquiry by the press or others" about a serious safety incident.

known as ALARA. According to the Supreme Court in Silkwood v. Kerr-McGee Corp., 81-2159, 52 L.W. 4043, 4044 (January 11, 1984), ALARA is the "standard" to which licensees must conform their conduct. Not one of the reports we have been furnished so far so much as mentions this obligation.

G.E.'s Criticality Safety Control, Chemet Lab, C 2.0-QA-201, in effect since at least 1976, provides, p. 1, 2.1 (App. 3, infra), "procedures must be written as part of the criticality safety program and become a part of the license. The procedures shall be strictly adhered to in order to comply with safety requirements and to assure criticality safety in our operations." (Emphasis added.) 10 C.F.R. § 19.12 requires that licensees not only instruct workers "in precautions and procedures to minimize exposure" to radioactive materials or radiation, but instruct them to report to management "any condition which may lead to or cause unnecessary exposure to radiation or to radioactive material." See also, § 20.206. Section 19.11 requires management to post copies of "the operating procedures applicable to licensed activities." Section 21.6 requires posting of "procedures adopted pursuant to the regulations in that part."

Appendix to NRC Regulatory Guide 8.29, "Instructions Concerning Risks from Occupational Radiation Exposure" App. 4, infra) defines ALARA to require (p. 8, par. 13, see also, p. 14, par. 7, last sentence):

"All * * * operating procedures should be reviewed with the objective of reducing unnecessary exposures."

The Instruction explains the health risks involved in acute and chronic exposure to radiation, pp. 3-4. At par. 5, p. 4, the Instructions state:

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

Further (p. 6, par. 9), "cancer resulting from exposure to radiation usually occurs 5 to 25 years after the exposure * * *."

The Instructions warn (p. 7, par. 9):

> "A worker * * * should make every effort to keep exposure to radiation ALARA to avoid unnecessary risk. The worker, after all, has the first line responsibility for protecting himself from radiation hazards."

B. <u>The Radiation Hazards Against Which Licensees Must Establish and Enforce Protective Systems, e.g., Air-Intake Monitoring; Rad Safety Inspections; Body Monitoring and Frisking</u>

10 CFR (rev'd as of January 1, 1984), §§ 20.101-3, specifies the maximum "occupation dose" of radiation to which workers may be subjected, i.e., 1 1/4 rems per calendar quarter, or 5 rems per year. The "air dose" must be "<u>measured by a properly calibrated appropriate instrument in air at or near the body surface in the region of highest dosage rate</u>." 10 CFR 20.4(d). (Emphasis added.)

"[I]ntakes must be evaluated and accounted for by techniques and procedures as may be appropriate to the circumstances of the occurrence. Exposures so evaluated shall be included in determining whether the limitation on individual exposures in § 20.103(a)(1) has been exceeded." (10 CFR § 20.103, n. 4). (Emphasis added.)

10 C.F.R. § 20.103(a)(3) provides:

> "For purposes of determining compliance with the requirements of this section the licensee shall use suitable measurements of concentrations of radioactive materials in air for detecting and evaluating airborne radioactivity in restricted areas and in addition, as appropriate, shall use measurements of radioactivity in the body, measurements of radioactivity excreted from the body, or any combination of such measurements as may be necessary for timely detection and assessment of individual intakes of radioactivity by exposed individuals." (Emphasis added.)

§ 20.103(b)(1) provides:

> "(b)(1) The licensee shall, as a precautionary procedure, use process or other engineering controls, to the extent practicable, to limit concentrations of radioactive materials in air to levels below those which delimit an airborne radioactivity area as defined in § 20.203(d)(1)(ii)." (Emphasis added.)

The licensee must also maintain the records required by § 20.103(b)(2), last sentence, and § 20.405. Subsections 405(a)(1), (i) and (2), require reports to individuals and to NRC of exposure in excess of applicable limits. § 20.405 (c)(2) requires that reports "must describe

> "(i) The extent of exposure of individuals to radiation or to radioactive material;
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> (ii) Levels of radiation and concentrations of radioactive material involved;
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> (iii) The cause of the exposure, levels, or concentrations; * * *."

Subsection 405(a) (iii) requires that the licensee report to NRC

> "Levels of radiation or concentrations of radioactive material in a restricted area in excess of any other applicable limit in the license."

10 C.F.R. § 20.201(b)(1) and (2) requires that every licensee make "measurements of levels of radiation or concentrations of radioactive material present" as "are reasonable under the circumstances to evaluate the extent of radiation hazards * * *."

10 C.F.R. § 21.21 (Reporting of * * * Non-Compliance) requires licensees to "adopt [and post § 21.6] appropriate procedures for (i) [e]valuating deviations [(ii)(b)(1)]," notifying [within two days, § 21.21(b)(2)] NRC of "information reasonably indicating a failure to comply * * * affecting (i) * * * an activity subject to, <u>inter</u> <u>alia</u>, Parts 30, 50, 70, 71, 72 of this chapter; and reporting to NRC the "[n]ature of the * * * failure to comply and the safety hazard which <u>is created or could be created</u> by such * * * failure to comply." § 21.21(3)(iv). 10 CFR § 21.51 requires the licensee to maintain records "as may be required to assure compliance with the regulations in this part," including inspections and testing of any facility.

In short, it is not only the legal obligation of management <u>to minimize</u> (ALARA) the danger to workers of contamination by radiation, but, to that end, to adhere absolutely to the NRC's requirements to maintain and use

accurate systems for measuring and testing of worker radiation intake levels, accurate record keeping and reporting. The five earlier reports virtually ignore not only the former but the latter obligation. The findings in 84-17, and earlier reports, properly analyzed, demonstrate that G.E.'s highest management wilfully, calculatedly or by "careless disregard," and by deception, for its own profit, destroyed the utility of at least four of the systems it was required by law to maintain to guard against exposure to radiation hazards (1) air intake monitoring; (2) Rad. Safety Inspections; (3) frisking and (4) body counts. In consequence, G.E. was, at the time of Mrs. English's complaints, and at least until December 6, 1984, unable to ascertain or accurately to report the intake of radioactive contamination by wet lab employees. The NRC's entire employee protection program was aborted.

C. The Findings In No. 84-17 Establish Willful Per Se Violations of the Entire Contamination Control Program

The Report (p. 1, par. 2) finds "weaknesses in the contamination control program in the Chemet Lab." The "weaknesses" found relate to the "frequency and scope of contamination surveys, survey requirements for removing paperwork, samples and personal items from the lab, and management attention and commitment to a radiologically clean working environment in the laboratory." (Emphasis added.) As we shall demonstrate below, these "weaknesses" are amply supported by the subsidiary findings. Indeed, Stohr's covering

letter to Lees of January 31, 1985, voices NRC's concern "about the implementation of your radiation protection program that permitted this situation to develop." (Emphasis added.)

But these "weaknesses" are reported only in the "Exit Interview," and there only in the context of management's agreement "to review this area and to take appropriate action to improve the program." And the "concern" expressed in Stohr's letter likewise merely invites a response from G.E. which "describe[s] those particular actions taken or planned to improve the effectiveness of your program."

Now, possibly, management's willingness or commitment to take remedial action in the future might be relevant if the issue were whether G.E.'s license should be "modified, suspended or revoked" (10 C.F.R. 70.61(d)), or whether a projected civil penalty should be reduced. 49 F.R. 8589, B 2. But that is not the issue. The issue is what formal violation findings and civil penalties should be imposed for the past and current violations found and reported in the exit interview, reflecting top "management's [in]attention and [non]commitment to a radiologically clean working environment," supra, p. 11. If only top management's "careless disregard" for a "radiologically clean working environment" were shown, that itself would be a willful, per se, violation of ALARA. 49 C.F.R. 8588, III, "Severity of Violations." Management's willingness and commitment to reform, to take corrective action in the future, is not a defense but an admission of willful

violation, inherent in management's attitude, "which permitted this situation to develop," unremedied and unreported by G.E. to NRC.

Indisputable proof that management was not only well aware of the deficiencies in operation of its safety protection and quality control systems, but that "inattention" and "careless disregard" was a management policy deliberately adopted and enforced upon the employees to increase production and adhere to delivery schedules, for G.E.'s profit, is a memo from Supervisor Coke McLamb to Chemet Lab Manager Preston Winslow, dated 10/21/83, attached hereto as App. 5. That memo shows that management knew that Chemet Lab personnel felt under inordinate pressure to cover up OAL and OCL results and to release only results "acceptable" under "biased" standards established "in order to satisfy production oriented egos." Yet the violations documented in these reports all continued after that date.

Moreover, after NRC Safeguards Engineer, Ed Clay, on December 3, 1984, discovered chaotic contamination in the off-Rad-Safety-inspection-limits isotopic room, the room in which the LEA measurement system is located, and vast contamination on a wet lab wall, floor and work benches, management's so-called "clean up" effort was designed to "cover up" rather than "clean up." A portion of the flooring in the lab was ripped out, but it was found that the foundation

actually was "hotter" than the floor. The foundation was not torn out, instead, a new floor was laid on the "hot" base.

G.E. personnel worked overtime all night to clean contamination from the wall. They did not succeed in removing a substantial portion. Instead of stripping the plaster, McLamb instructed the workers to paint over the still heavily contaminated wall. A Rad Safety man observed that NRC would require that the paint be removed, and effective action taken to remove the contamination. When Ed Clay asked supervisor Sutton why they had painted the wall, he replied "to cover up <u>rust</u> spots." (Emphasis added.) Clay apparently swallowed this lie, because he did not require that the paint be removed.

One employee, having been alerted to the presence of excessive contamination everywhere in the Chemet Lab, on December 5, 1984, inspected six chairs on which employees sat virtually all day to perform their work. He discovered they were "hot." An employee asked McLamb what he was going to do about the hot chairs. McLamb became agitated and angry, denied the chairs were "hot," and said, "whoever discovered they were hot had better clean them up."

We infer, although without putting Clay and Bates under oath, and comparing their contemporary notes and the drafts of 84-15 and 84-16 they submitted to McAlpine with the final drafts of the reports in those cases that <u>he signed on their behalf</u>, we are obviously unable to prove, that the reason

McAlpine signed those reports when Clay and Bates were out of town is that they may have objected, had they seen those reports, to sign such a "white wash." McAlpine's motive for playing down the findings is self-evident. He was in charge of investigators and his investigators should have uncovered the obvious defects and deficiencies in health safety protections over the years before Mrs. English made her changes. He was covering up to save his own skin, and to disguise the immunity he had unlawfully give G.E. over the years.

D. Low Severity Levels Were Illegally Assigned To the Violations Found and Which Should Have Been Found

We reiterate that, whether intentional or deliberately careless, management's disregard for proper implementation of G.E.'s radiation protection systems defeated NRC's entire regulatory safety program, and must, therefore, be treated as the most serious possible violation. The NRC Rules recognize (49 F.R. 8588) that "the severity level of a violation may be increased if the circumstances surrounding the violation involve careless disregard of requirements, deception or other indications of willfulness." (Emphasis added.) Without considering the pending allegations of G.E. deception and other indications of willfulness, top management's careless disregard for "implementation of the radiation protection system" is itself willful breach of ALARA and of each and every "requirement" which was not observed. Because G.E.'s found actions frustrated not only a single protection system, but

NRC's entire radiation protection function, it is necessary to consider all together, and to "aggregate" all violations which were, or as herein shown, should have been, found, before assigning them a severity level. Id. Applying the "relative importance" and "significant regulatory concern" standards, 49 F.R. 8588, the violations should all have been assigned Severity Level I, and Civil Penalties of multiples of $100,000 per day assessed for the entire period, thus far unascertained, of management's "careless disregard for implementation of the radiation protection system." Id. at 5889-5890.

NRC's policy on "Civil Penalties" states (49 F.R. 8589):

> "NRC attaches great importance to comprehensive licensee programs for detection, correction, and reporting of problems that may constitute, or lead to violation of regulatory requirements."

Because that is so (id.)

> "ineffective licensee programs for problem identifiction or correction are unacceptable. In cases involving willfulness, flagrant NRC-identified violations, repeated poor performance in an area of concern, or serious breakdown in management controls, NRC intends to apply its full enforcement authority * * *."

At minimum, the "careless disregard" violation should have been assigned severity category II, for that violation disabled (id., at 8591, B, 1), "a system designed to prevent or mitigate serious safety events [from] being able to perform its intended function." In G.E.'s case, however, several systems were disabled.

NRC states, at 49 F.R. 8590, B(3), that:

> "to focus on the fundamental underlying causes of a problem for which enforcement action appears to be warranted, the cumulative total for all violations which contributed to or were unavoidable consequences of that problem may be based on the amount shown in the table for a problem of that Severity Level, as adjusted. If an evaluation of such multiple violations shows that more than one fundamental problem is involved, each of which, if viewed independently, could lead to civil penalty action by itself, then separate civil penalties may be assessed for each such fundamental problem. In addition, the failure to make a required report of an event requiring such reporting is considered a separate problem and will normally be assessed a separate civil penalty, if the licensee is aware of the matter that should have been reported."

Under this test, the "laxity" violation should have been assigned Severity Level I, under Supplement IV, "Health Physics," A, 1, 2, 5 (id. at 8592), because it disabled management from ascertaining and reporting how much radiation exposure a worker was subject to. (Cf. "B, Severity II (6), and C. Severity III, 7-9).3/ Severity IV and V were arbitrarily and illegally assigned by McAlpine, Barr and Stohr to save their own skins and to justify their historical nonfeasance against G.E.

3/ Under Health Physics, Supp. IV, Severity III level is assigned (id. 8593, par. 9) to:

> "9. Cumulative worker exposure above regulatory limits when such cumulative exposure reflects a programmatic, rather than an isolated weakness in radiation protection;" (Emphasis added.)

E. The "Management Disregard" Conclusion Is Supported By Subsidiary Findings in 84-17

Par. 4 (f), pp. 5-6 of 84-17, finds that the allegation that "Radiation Safety Personnel were lax on monitoring for contamination and requiring cleanup * * * was partially substantiated." The allegation specified (id.): "Radiation safety people * * * do not know what to look for." The report identifies some sources of licensee's obligations in this area.

> "License Condition 9 requires that licensed material be used in accordance with statements, representations and conditions of Part I of the licensee's application. Part I, Section 3.2.4.6 discusses the minimum frequency, action limits for removable surface contamination, and maximum delay permitted in initiating decontamination action. Plant Procedure Nuclear Safety Instruction 0-6.0, Rev. 14, Contamination Measurement and Control, provides the guidelines for the conduct of the contamination measurement program, evaluation and documentation of the results and the required action based upon the contamination survey findings." (Emphasis added.)

The section does not mention the obligation, delegated by management to Rad Safety, to make accurate "surveys," 10 CFR § 20.201, although in "n" at p. 13, the Inspector acknowledges that management is obliged under § 20.103(a)(3), to use "suitable measurements." Nevertheless, the Report concludes "no violations or deviations were identified."

What the Report calls "partial substantiation" are the following findings:

- "[s]urveys performed by the radiation safety technicians are generally in the same locations which are often not the areas with the highest potential for becoming contaminated. The inspector stated that the licensee should familiarize the

radiation safety technicians with the operations in the CHEMET Lab so that they can ensure that they survey those areas where the potential for spills exist (sample preparation area, weighing area, etc.). Random surveys for contamination should be performed at least daily and detailed surveys of the entire lab should be performed weekly since the licensee utilizes the same administrative limits for contamination as are required for uncontrolled areas and there is a greater potential for a contaminating event."4/ (Emphasis added.)

In short, Rad Safety inspectors monitor frequently enough, but only in the wrong places. In addition, G.E. uses improperly excessive administrative limits for contamination. Thus, the results of Rad Safety inspections and surveys are utterly useless for NRC's intended purpose. Like the one air sampler in the main work area of the Chemet Lab (par. 5, pp. 17-18), these procedures provide an illusion of radiation safety protection which belies reality.

At p. 13, first sentence, the Inspector found:

"The licensee uses an assigned airborne exposure value derived from the time spent in the work area to determine compliance with 10 CFR 20.103(b) and to calculate the internal dose assigned to the individual."

The inspector does not compare the performance of Rad. Safety Inspectors, or G.E.'s use of improper administrative

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4/ Under Supp. IV, Health Physics, Par. 10 assigns to Severity Category III, "Conduct of licensee activities by a technically unqualified persons." If we accept the Inspector's inference that Rad Safety personnel did not know where to look for contamination (rather than the fact that management instructed them to shut their eyes) (p. 17, last par.) the inescapable conclusion is that the Rad Safety Inspectors were "unqualified" or inadequately trained under 10 CFR § 19.12, and § 20.206.

limits for contamination, with the obligations imposed by the documents he cites. Moreover, as noted, the obligations imposed by 10 C.F.R. § 20.101-103, and particularly by § 20.103(a)(3) and (b)(2), are not considered in this connection. Only in another connection does the Report acknowledge the obligation imposed by 10 C.F.R. § 20.103(a)(3), upon every licensee, to "use suitable measurements of concentrations of radioactive materials in air for detecting and evaluating airborne radioactivity in restricted areas." The ALARA obligation imposed by § 20.103(b)(2) is never mentioned.

The Report shows that the Inspector merely undertook to instruct or counsel management as to what it should do in the future, as if management, by its failure to do what it knew or must have known was required by its license and by law, had not violated any legal obligation.

The Inspector's assumption, albeit unarticulated, is that management did not know what it should have done, and, therefore, was not culpable and merited instruction. That assumption is utterly false, as we now demonstrate. NRC was told by Mrs. English and other employees a long time ago that G.E. management, as well as the Chemet Lab employees, knew that the isotopic room was the "hottest" spot in the lab. She had never seen a Rad Safety inspector in that room. On December 3, 1984, NRC's Ed Clay inspected the Chemet Lab in the company of Coke McLamb, Chemet Lab supervisor, and Earl Rouse, Safety

Technician. Ed Clay instructed Rouse to accompany him into the Isotopic Room, where they discovered enormous visible contamination. Two days later, Bob Torres, Manager of Rad Safety, asked Rouse "Why were you investigating in an unassigned area?" He replied, "because NRC asked me to do it." This incident was reported to Mr. Bruno Uryc, Region II, Supervisor of Investigations. Torres' admission that the isotopic area was "unassigned," and his displeasure over its entry by a Rad Safety inspector, demonstrates that G.E. deliberately concealed from Rad Safety and forbade monitoring of the hottest spot in the lab. So much for the pretense that G.E.'s "careless disregard" was innocent! On the contrary, what Torres' questioning of Rouse proves is that G.E. fraudulently concealed from NRC that its Rad Safety inspection system, like its air monitoring system, its body count system and its compulsory self-frisking system was a fraud. This requires that the violations be assigned Severity Level I, under "Miscellaneous matters," 1, 2, 3; 10 CFR § 21.21(b)(3)(iv).

F. The Inspector's Finding No. 84-17, p. 6 That G.E. Has No Policy Requiring Notification of Radiation Safety in the Event of a Spill In the Lab" Is Demonstrably False

The Inspector does not point to <u>any</u> G.E. document as the source of this finding. Obviously, he must have accepted G.E. management's representation to this effect.

Official G.E. documents belie the finding. G.E.'s "Job Hazard Analysis Chemet Lab-970" dated 10/1/81, revised 3/1/84 and 3/1/85, App. 6, hereto, provides: "6. Clean spills immediately and notify radiation protection." (Emphasis added.) G.E.'s "Course for Hourly Workers," in effect since 11/13/72, when Mrs. English began working in the lab (App. 7, hereto, p. 4), details the steps to follow in the event of a spill: "Step 2: Warn other personnel - Call Radiation Protection." (Emphasis added.) Page 5, 6 I, says "For a know[n] or possible radioactive spill, minimize its spread and notify Radiation Protection." (Emphasis added.)

Had the Inspector found that G.E. did have the policy it disclaimed, he could not have escaped finding that its widespread violation, testified to by Mrs. English and acknowledged by G.E. management, was a serious and major violation. Nor, had he inspected the documents Mrs. English offered in proof of the policy, could he have failed to find G.E.'s denial fraudulent.

G. The Inspector's Finding h, p. 7, That G.E. "Does Not Have a Procedural Requirement, Nor Do They Rope Off Or Otherwise Mark Contaminated Areas" Is Demonstrably False

The Inspector found that while Mrs. English's complaint was factually substantiated, it constituted no violation because "the marking off of contaminated areas is not required by NRC regulations, license conditions or licensee procedures." (Emphasis added.) The Course for Hourly Workers

(App. 7, infra), p. 4, par. 5. B. specifies "procedures to be followed after a spill of material (liquid or solid)" and details the "basic steps":

> "Step 1. Stop the spill
> Step 2. Warn other personnel - Call Radiation Protection
> Step 3. Isolate the area." (Emphasis added.)

Page 2, B, 1 (id.) provides: "Contaminated areas [should be] roped off - control signs." (Emphasis added.) The Course Outline defines "Dead Zone" as a "safety zone, usually 12" in width, surrounding all limit areas. It is designated with a 2" wide red tape." G.E.'s Criticality Safety Control Chemet Lab, C. 2.0-QA-201, in effect since at least 1976 (App. 3, hereto), p. 1, 2.3.2 provides "Dead zone - a safety zone shall be marked with a two inch wide red border surrounding all limit areas." Par. 4.5.1, p. 4, says "Stay 12 inches away from any limit area."

Had the inspector consulted the relevant documents, instead of naively accepting management's fraudulent verbal misrepresentation, he could not have failed to find wilful violation of the license requirements on both the substantiated practice and management's misrepresentation to him.

H. The Inspector's Conclusion (p. 8, i) That Allowing "Heated Uranium Scintered Pellets To Cool In Uncovered Containers Outside a Vented Hood" Is Neither Prohibited Nor "A Radiological * * * Safety Problem" Is False

The only sources the Inspector claimed to have examined in connection with this allegation are identified in

the first three lines of the second paragraph of his "Discussion." He also missed the factual point. The cooling scintered pellets emit visible particles of uranium dust, which settles on counters, instruments, etc., where they are inescapably inhaled and ingested by lab personnel through breathing.

When originally established, the system called for covering the stainless steel container into which the pellets were dumped with a air-tight cover. Lab personnel were told by supervision that the covered containers were to be placed under a vented hood. The covers disappeared after a time and the open containers were never placed under a vented hood. The supervisors' instructions to cool scintered pellets under a vented hood are legally binding on G.E. under its license.

The Inspector looked for rules requiring cooling material containing uranium under vented hoods in the wrong place. Safety Operating Procedure, No. 0.3.4, issued 4/2/73, p. 2, H, App. 8, *infra*, provides:

> "All compounds of uranium that could become airborne shall be handled inside of hoods with air flow of 80-120 LFM through the apertures. Examples of this is (1) Opening of powder sample containers (2) Crushing of pellets, weighing, etc., (3) Dumping and compositing samples for return to Shop Operations, (4) Dissolution and concentration of uranium samples by heating." (Emphasis added.)

CO1 Instruction #409, April 9, 1982 (App. 9, *infra*), p. 3, pt. 3.11, provides: "Remove tray from microwave oven and place in

hood to cool." (Emphasis added.) Nuclear Safety Release 1CR04, Rev. 3 issued April 22, 1982, (App. 10, infra), provides (p. 1, pt. 5), "take extra care to prevent airborne contamination." Pt. 1, p. 2, provides: "Conduct all activities which could generate airborne contamination * * * under * * * vented hoods." (Emphasis added.)

Analytical Test Method 5.2.9.6. Rev. 2, dated Dec. 1, 1979 (App. 11, infra), states (pt. 5.1, p. 2): "Proper radiation protection precautions should be taken to prevent inhalation of solid or liquid samples containing uranium during all handling operations."

Appendix to NRC Regulatory Guide 8.29, "Instruction Concerning Risks from Occupational Radiation Exposure," undated, but published after 1980, which was distributed to all Chemet Lab personnel (App. 4, infra), explains, pp. 12-13:

> "The uptake of radioactive materials by workers is generally due to breathing contaminated air. Radioactive materials may be present as fine dust or gases in the workplace atmosphere. The surfaces of equipment and workbenches may be contaminated. Radioactive materials may enter the body by being breathed in, taken in with food or drink, or being absorbed through the skin, particularly if the skin is broken.
>
> "After entering the body, the radioactive material will migrate to particular organs or particular parts of the body depending on the biochemistry of the material. For example, uranium will tend to deposit in the bones where it will remain for a long time. It is slowly eliminated from the body, mostly by way of the kidneys. Radium will also tend to deposit in the bones. Radioactive iodine will seek out the thyroid glands (located in the neck) and deposit there.

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

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

* * *

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

In short, contrary to the Inspector's conclusion, "cooling scintered pellets in the open and not in a vented hood" is "a radiological * * * safety" hazard. It is not only a violation of ALARA, but of management's obligation under 10 CFR § 19.12, to avoid "<u>unnecessary</u> exposure to radiation or to radioactive material," (emphasis added), as well as of the specific rules quoted above.

It is especially noteworthy that dosage from "internal emitters cannot be measured either by the film badge or other ordinary dosimeters carried by the worker." Since there was no air-intake monitor over the uncovered containers, and Rad Safety did not "<u>carefully</u>" monitor the cooling area, if it monitored that area at all, G.E. had <u>no</u> way of measuring

the air contaimination content of the cooling area or the dose of contamination to which workers in the Chemet Lab were subject as a result of cooling the scintered pellets in the open, except by measuring samples of urine. Incredibly, G.E. never made any tests for contamination by examining feces. G.E. took care to assure that these measures would be unrepresentative, <u>inter alia</u>, because it took body samples only after the absence of the worker for several days from the lab and did not make or keep required historical records. The violation is of the highest severity level.

I. <u>The Inspector's Conclusion (pt. J, pp. 8-9) That "Neither NRC Regulations, Nor License Conditions" Prohibit "Dichromate Titrations Outside A Hood" Is False</u>

The Inspector admits that G.E.'s referenced Manual (p. 8, par. 1, "Discussion"), requires that "<u>proper</u> radiation protection" should be taken to prevent inhalation or ingestion of * * * uranium during all handling operations." He also found that the titration <u>did</u> release not only acid fumes but radioactive uranium fumes into the atmosphere. He discounted the latter on the ground that the "airborne radioactivity hazard" was minimal. The only evidence he offered for that was the weekly radiological contamination surveys performed by Rad Safety in 1984 did not "identify contamination above the action level at this work station." Given the Inspector's findings under (f), p. 6, that Rad Safety inispected only in the wrong places; used inappropriate

measures for "administrative limits for contamination," and under 5, p. 17, that review of contamination surveys during 1984 showed contamination <u>above</u> G.E.'s allowable limit, this finding is utterly unsupportable.

The Inspector concluded that no violation was shown, because he found no "<u>specific</u> requirement that dichromate titrations should be done under a vented hood." The demand for such specificity is misguided. It overlooks the general requirement that licensees use all "proper" and "necessary" means of protection against airborne radioactivity hazards, which G.E. was therefore required by ALARA and its license to do. Performance of dichromate titrations under a vented hood is the most obvious measure imaginable to reduce the hazards of airborne uranium contamination. G.E. violated the law by failing to do this.

The Inspector also found that because "the procedure contains no precaution concerning the inhalation of acid fumes that evolve from the titration," G.E. was not obligated by its license to take any precautionary action against that danger. But he overlooked Part 20, App. B, footnote 4.

The authorities cited in G above apply to handling of <u>all</u> radioactive materials which emit radioactive fumes or dust. The Inspector ignored <u>all</u> of these obligations, which, of course, are legally binding on G.E. Moreover, a memorandum dated November 9, 1981, from Bowman to Hendry (App. 12, <u>infra</u>), states that "analyses of the 9 air sampler filters in the ADU

vaporization room" showed airborne contamination levels "exceed 300 times the maximum permissible concentration." How did it get that way if weekly Rad Safety surveys were indicative?

In short, the substantiated allegations of pars. 4 (i) and (j) establish that unknown, unmeasured and unmeasurable by G.E.'s processes, amounts of radiation contamination were inhaled or ingested by wet lab employees on a daily basis. Moreover, the amounts were not timely measured by full body counts. Is this not inescapably a Severity Level I violation under Supplement IV, A, 49 F.R. 8592?

END OF CHAPTER I

More To Follow

Respectfully submitted,

Mozart G. Ratner
Suite 610
1900 M Street, N.W.
Washington, D. C. 20036
(202) 223-9472

Arthur M. Schiller
Suite 1300
1000 Connecticut Avenue, N.W.
Washington, D. C. 20036
(202) 331-8508

Counsel for Vera M. English

February 28, 1985

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

JAN 10 1985

Mozart G. Ratner, Esq.
Suite 610
1900 M Street, NW
Washington, DC 20036

Dear Mr. Ratner:

This letter acknowledges receipt of the Petition of Ms. Vera M. English filed on her behalf by yourself and Mr. Arthur M. Schiller on December 13, 1984. The Petition makes reference to five Inspection Reports reviewing activities at the Wilmington, North Carolina facility of the General Electric Company (Licensee). The Petition asserts that these Inspection Reports are deficient for failing to identify a variety of deviations and violations in the activities of the Licensee at its Wilmington facility. The Petition requests that all five Inspection Reports be withdrawn, that new Inspection Reports be issued correctly documenting the alleged violations and deviations at the Wilmington facility as identified in the Petition and its attachments, that Notices of Violation be issued, and that the Nuclear Regulatory Commission commence appropriate enforcement action, including the assessment of civil penalties, consistent with the Commission's General Policy and Procedure for NRC Enforcement Actions, 10 CFR Part 2, Appendix C, as revised, 49 Federal Register 8583 (March 8, 1984). The Petitioner also requests the institution of proceedings pursuant to 10 CFR § 2.202 and the scheduling of hearings on the matters raised in the Petition.

The Petition, which has been referred to my Office for action, is being treated under 10 CFR 2.206 of the Commission's regulations. The NRC staff will review the Petition and I will issue a formal decision with regard to it within a reasonable time. A copy of the notice that is being filed for publication for the Office of the Federal Register is enclosed for your information.

Sincerely,

James M. Taylor

James M. Taylor, Deputy Director
Office of Inspection and Enforcement

Enclosure: as stated

cc w/encl.:
Arthur M. Schiller, Esq.
Suite 1300
1000 Connecticut Avenue, NW
Washington, DC 20006

General Electric Company
Wilmington, NC

Appendix 1

[7590-01]

NUCLEAR REGULATORY COMMISSION
Docket No. [70-1113]

GENERAL ELECTRIC COMPANY

(Wilmington, North Carolina Facility)

REQUEST FOR ACTION UNDER 10 CFR 2.206
REGARDING ACTIVITIES AT THE WILMINGTON, NORTH CAROLINA
FACILITY OF THE GENERAL ELECTRIC COMPANY

Notice is hereby given that, by her Petition of December 13, 1984, Ms. Vera M. English (Petitioner) requests that the Nuclear Regulatory Commission review and withdraw certain Inspection Reports which allegedly improperly dismiss certain alleged violations and/or deviations associated with the activities of the General Electric Company at its Wilmington, North Carolina facility. The Petition requests that new Inspection Reports be issued properly documenting violations and deviations in the activities carried out at the Wilmington facility. The Petition also requests that the Commission issue Notices of Violation and take enforcement action as appropriate including the imposition of civil penalties. Petitioner further requests the institution of proceedings pursuant to 10 CFR 2.206 and the scheduling of hearings on the matters raised in the Petition.

The Petition is being treated pursuant to 10 CFR 2.206 of the Commission's regulations and appropriate action will be taken on the

request within a reasonable time. A copy of the Petition is available for inspection in the Commission's Public Document Room, 1717 H Street, N.W., Washington, D.C. 20555, and at the local Pubic Document Room for the Wilmington facility located at [insert address].

Dated at Bethesda, Maryland this 11th day of January 1985

FOR THE NUCLEAR REGULATORY COMMISSION

James M. Taylor

James M. Taylor, Deputy Director
Office of Inspection and Enforcement

MEMO TO DISTRIBUTION - November 9, 1981 ATTACHMENT 2

GENERAL ELECTRIC

DIAL COMM• 8*292-5748 DATE• September 17, 1981 COPIES•

DEPT• WILMINGTON MANUFACTURING DEPARTMENT

ADDRESS• M/C J-02

SUBJECT• ITEM OF INTEREST

J. A. Long, General Manager
Wilmington Manufacturing Department

FOLLOWUP ON UF6 GAS RELEASE

As reported earlier, a UF6 gas release occurred Tuesday morning in the FMO vaporization area. Although the release was well contained, the incident had to be reported to the NRC within 24 hours because of the time required for cleanup activities. The report was made Wednesday morning within the required time period. Subsequently, J. P. O'Reilly, Director - USNRC Region II, called to inquire for more information, including details of employee exposures, stack measurements, and site boundary conditions. We supplied the information, which clearly indicated that there had been no exposures to employees or the public in excess of allowable limits. It is apparent that Mr. O'Reilly was concerned for the potential inquiry by the press or others, and he wished to be well prepared for it. To the best of our knowledge, there has been no external interest in the incident.

R. J. Henderson
E. A. Lees, Manager
Quality Assurance

/sbm

Appendix 2

Firm at law 1976, pp 2,3,4

[illegible] FUELS MANUFACTURING	QUALITY ASSURANCE [illegible] INSTRUCTION TITLE: CRITICALITY SAFETY CONTROL CHEMET LAB	ISSUE DATE SUPERSEDES ISSUE DATED:	INSTRUCTION NO. C 2.0 - QA - 201 PAGE 1 OF 5
ISSUING UNIT: Process Control Eng.	APPROVALS:		

1.0 PURPOSE AND SCOPE

The purpose of this procedure is to establish and outline the general criticality safety rules, practices, and precautions for the Chemet Laboratory necessary to comply with AEC regulations, license requirements and General Electric policy to protect the health of employees and company property. Separate instructions are prepared for specific work or operations where special requirements pertaining to criticality safety are necessary. This procedure applies to the wet Chemistry Lab, the Spectroscopic Lab, QC Corner, and the PCE Dispatchers Office.

2.0 DEFINITIONS

2.1 General

Uranium enriched in the U-235 isotope to a maximum of 4.0 weight percent is a fissile material and is processed in the fuels manufacturing shop. It is capable of undergoing a nuclear chain reaction much the same as in nuclear reactor without benefit of reactor controls. Due to the potentially lethal nature of the resulting nuclear radiation, physical and procedural controls are established to minimize the probability of such an occurrence. Because fissile material is processed in this plant, all operations must be licensed by the Atomic Energy Commission. Due to the nature of our license, procedures must be written as part of the criticality safety program and become a part of the license. The procedures shall be strictly adhered to in order to comply with the license requirements and to assure criticality safety in our operations.

2.2 Primary Concepts

2.2.1 Physical control-retains material in a specific location, operation, or geometry.

2.2.2 Adminstrative control-limits the material to a specific operation by approved procedures ONLY where physical controls are not practical.

2.2.3 Area Manager-the lowest supervisory position fully responsible for the specific activity or function with which the term is associated (i.e., Manager, Quality Assurance).

2.3 Applications

2.3.1 Limit Area-an identified location in which uranium can be handled, processed, or stored in accordance with specific posted criticality safety limitations. Limit areas for portable equipment shall be marked with a solid red line two inches wide.

2.3.2 Dead zone-a safety zone shall be marked with a two inch wide red border surrounding all limit areas. Uranium shall not be handled, stored, or processed in dead zones. Uranium shall pass through a dead zone only to [illegible]

2.3.3 Safe batch-the allowable quantity of uranium one may handle in any one place in the lab is defined to be:

2.3.3.1 A total of 635 samples.

2.3.3.2 A total of 35 UO_2 fuel rods.

2.3.3.3 45 percent of a minimum critical mass.

NOTE: IN A VOLUME OF 23 QUARTS, A LIMIT OF 3.0 WEIGHT % U-235 IS ASSUMED IN SETTING THESE LIMITS.

2.3.4 Criticality limit sign-method of posting limits and instructions concerning type of material to be handled, type of criticality control for a specific area. Each safe batch controlled area must have a criticality limit sign.

3.0 CRITICALITY SAFETY RESPONSIBILITIES

3.1 Responsibilities

✓ 3.1.1 Each individual is responsible to know and observe the rules and procedures established to assure nuclear criticality safety.

3.1.2 The Area Manager shall assure that safe procedures and designs are established and maintained. He shall [illegible] only those [illegible] which [illegible] approved by an [illegible] modifications from a Request.

3.1.3 The Manager, Chemet Lab shall correct and resolve all nuclear safety procedural deviations discovered by NS&L audits, requesting training, consultation, etc. as necessary.

4.0 PROCEDURE

4.1 The Spec Lab is limited to one safe batch.

4.1.1 All incoming samples shall be placed into the slots in the marked drawers in the desk on the south wall of the room. These slots hold a total of 635 samples. Do not store samples anywhere else in the lab. Do not accept any more samples into the lab when the drawers are full.

4.1.2 In the hood remove as much uranium as necessary from each sample to perform lab tests as directed.

4.1.3 Return the empty or partially empty containers to the drawers. When testing is complete, take the vial, remaining contents, and all removed portions of the sample to the sample return can in the wet lab. Check paperwork to assure all portions of the sample are accounted for.

NOTE: Do not overfill the sample return can. Empty vials, i.e., those which have only trace amounts of uranium so that you can see through the sample vial may be reused or placed in plastic bags in the wet lab near the hallway for disposal.

4.1.4 Inventory the lab weekly disposing of any excess.

4.2 The Wet Lab is limited to three safe batches:

4.2.1 One of these is UO_2 rods. Do not accept more than 35 rods into the Wet Lab. All rods shall be stored in the southwest portion of the lab.

4.2.2 One safe batch is the sample return can located under the MICS Terminal.

4.2.2.1 Use a standard pail (23 quart pail). Do not overfill the can. Store it in the limit area.

4.2.2.2 Weigh the can (or add the weight added if known) each time samples are put in the can. Record the weight on the sheet of the can; do not exceed 44.5 Kg.

4.2.3 The other safe batch is at large through the area and is controlled by number of samples. A total of 635 samples in vials or in maximum 1 gallon bottles of liquids in any combination constitutes one safe batch.

4.2.3.1 Enter each group of samples on the Wet Lab Sample Sheet (Exhibit I). Do not exceed a running total of 635 samples. These samples may be stored anywhere in the Wet Lab except in the rod batch area.

4.2.3.2 In a hood remove as much uranium as needed from the sample containers and perform laboratory tests as directed. Split portions of samples may likewise be stored at will in the area.

4.2.3.3 When through, dump samples:

a. If solids-into a beaker in either the sample receiving hood or the Gadolinia hood. (A maximum of three maximum 600 ml beakers may be in each hood.)

b. If liquids-into a maximum five gallon bottle. A maximum of one bottle per hood as above.

c. Place 5 pint bottles on the tray near the hallway entrance to the lab.

4.2.3.4 Transfer solids to the sample return can (weighing the beaker and adjusting can weight) and liquids to the process area as needed.

4.2.3.5 Indicate the number of samples dumped on the wet lab sample sheet and figure the balance. Check paperwork to assure all portions of the split samples have been dumped.

4.2.3.6 Inventory the lab weekly disposing of any excess.

4.3 The QC corner is limited to eight safe batches, seven on the floor in the marked areas, one in the hood.

4.3.1 Keep the seven safe batches on the floor in standard product pails in the limit areas. Do not overfill the cans or double stack them or place smaller containers of uranium on them, etc. Weigh the can with each addition (or if you know the weight being added just add it) and record the new weight on the sheet on the can. Do not exceed 44.5 Kg. per can or 3.0 w/o U-235.

4.3.2 Place incoming sample vials and liquids in maximum 1 gallon containers in the hood splitting, transferring, and disposing of samples using the procedure for the wet lab as above except that any of the seven limit areas may be used for the sample return can.

4.3.3 Inventory weekly following the same procedure as for the wet lab.

4.4 The hallway is limited to one safe batch. Place all incoming samples and liquids in maximum 5 gallon containers in the limit area on the counter. Do not double stack samples or bags of samples. Do not accept any more samples when this area is full.

4.5 [illegible] units in transit in and out of the lab as needed.

4.5.1 [illegible] 12 inches away from any limit area or any other intransit unit.

4.5.2 The following may be transported together as one intransit unit.

a. Any number of loose sample vials

b. One bag of sample vials

c. One 5 gallon (23 quart) or smaller vessel

d. Six capped fuel rods

4.5.3 Only one intransit unit may be moved per person per trip. Do not leave intransit units unattended.

4.6 Posting, labeling, and marking

4.6.1 All areas shall be posted using the format shown in Exhibit-2 to reflect the limits given in this procedure.

4.6.2 Follow all posted instructions. When in doubt refer to this procedure for details or contact your supervisor.

4.6.3 All containers of uranium shall be identified with enrichment tape.

4.6.4 Observe limit area and dead zone markings for:

a. Rod storage area-limit area and dead zone around the southwest portion of the wet lab.

b. Each product pail storage area-a limit area around each pail and a dead zone around each pail or group of pails.

c. QC corner-dead zone markings around the entire QC corner.

4.6.5 Do not store material in dead zones. Uranium may pass through a dead zone only to enter or leave a limit area.

4.7 Emergency Situations (see Exhibit 3)

4.7.1 Nuclear warning alarm will sound a continuous loud tone in the event of a criticality accident.

4.7.2 All personnel shall evacuate as quickly as possible to the nearest exit.

4.7.3 Go directly away from the building and proceed to the staging area shown on the attached diagram.

4.7.4 Protective clothing shall not be removed.

4.7.5 Personnel shall remain until the staging area supervisor declares the emergency to be over.

WET LAB SAMPLES

DATE	TIME	RECEIVED	DUMP	BALANCE	BY

Exhibit 2

[illegible]

PROJECT: ______________________

LOCATION: ______________________

ENRICHMENT: ______________________

MATERIAL: ______________________

[illegible]

________	Kgs.	________	Segments
________	Boats	________	Rods
________	Trays	________	Bundles

Special Instructions: ______________________

____

____

____

NUCLEAR SAFETY BULLETIN

CRITICALITY EMERGENCY PROCEDURE

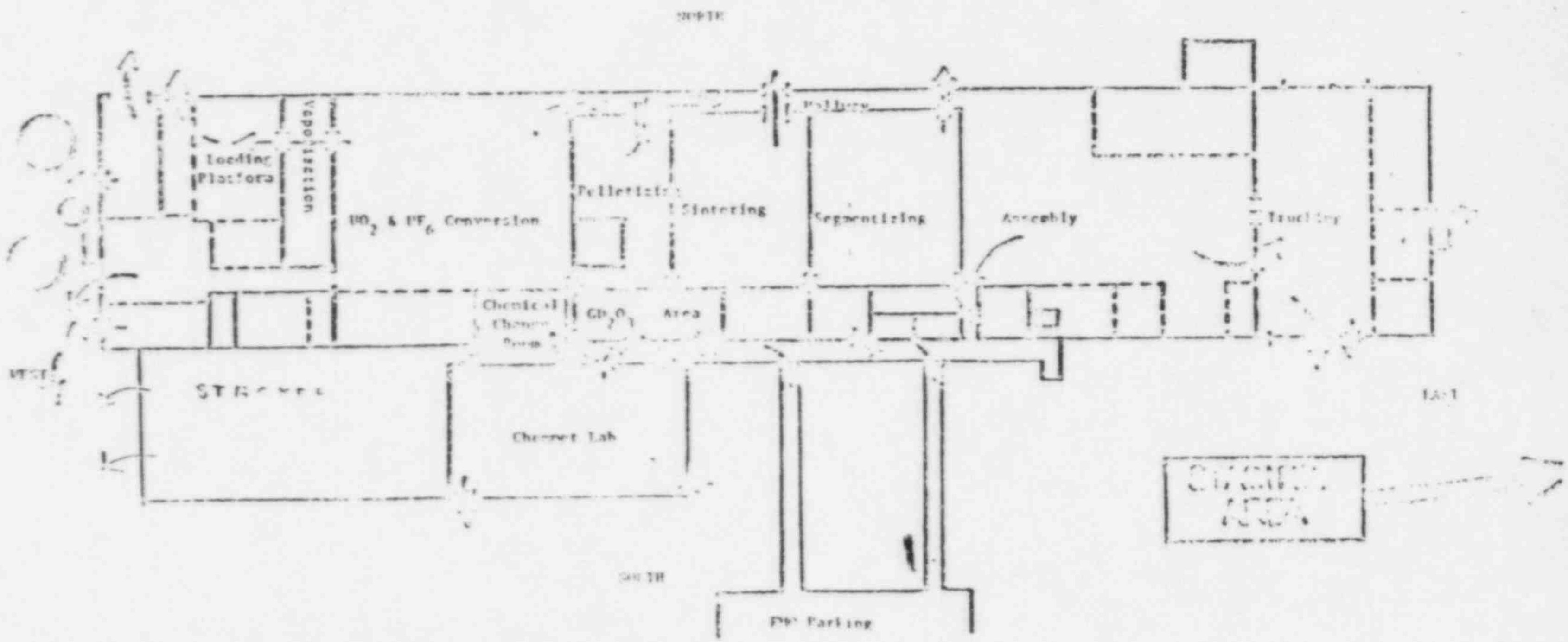
Low enriched Uranium is processed into nuclear fuel in this building.

Enriched Uranium, a fissile material, is capable of sustaining a chain reaction.

With low enrichments involved, and safeguards that are in place, the probability of a criticality accident occurring is extremely remote;

However, the possibility remains --------

Therefore, if the Criticality Alarm (a piercing continuous howl) sounds, evacuate immediately.



STEPS TO FOLLOW:

Run, do not walk.

Do not bother to remove protective clothing.

Get out of the building by the most direct route.

Go directly away from the building.

Go directly to the Staging Area, located off the SE corner of the building, and remain there until released by the Staging Area Supervisor.

APPENDIX TO REGULATORY GUIDE 8.29

INSTRUCTION CONCERNING RISKS FROM OCCUPATIONAL RADIATION EXPOSURE

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

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

• • • • • • •

1. *What is meant by risk?*

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

6. How does radiation cause cancer?

How radiation causes cancer is not well understood. It is impossible to tell whether a given cancer was caused by radiation or by some other of the many apparent causes. However, most diseases are caused by the interaction of several factors. General physical condition, inherited traits, age, sex, and exposure to other cancer-causing agents such as cigarette smoke are a few possible contributing factors.

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

One theory is that radiation can damage chromosomes in a cell, and the cell is then directed along abnormal growth patterns. Another is that radiation reduces the body's normal resistance to existing viruses which can then multiply and damage cells. A third is that radiation activates an existing virus in the body which then attacks normal cells causing them to grow rapidly.

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

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

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

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

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

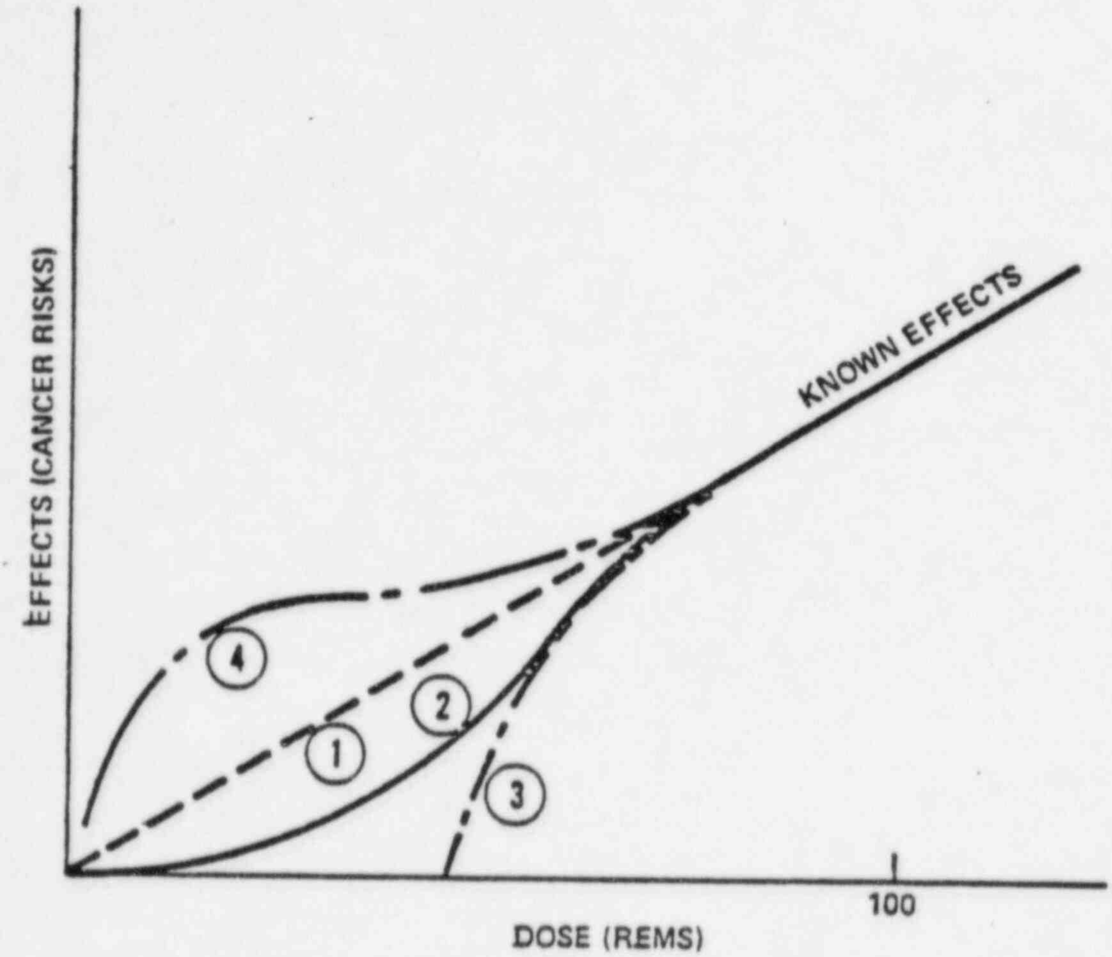


Figure 1. Some proposed models for how the effects of radiation vary with doses at low levels.

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

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

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

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

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

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

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

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

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

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

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

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

TABLE 1

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

TABLE 2

Estimated Loss of Life Expectancy from Health Risks[a]

Health Risk	Estimates of Days of Life Expectancy Lost, Average
Smoking 20 cigarettes/day	2370 (5.5 years)
Overweight (by 20%)	985 (2.7 years)
All accidents combined	435 (1.2 years)
Auto accidents	200
Alcohol consumption (U.S. average)	130
Home accidents	95
Drowning	41
Natural background radiation, calculated	8
Medical diagnostic x-rays (U.S. average), calculated	6
All catastrophes (earthquake, etc.)	3.5
1 rem occupational radiation dose, calculated (industry average for the higher-dose job categories is 0.65 rem/yr)	1
1 rem/yr for 30 years, calculated	30

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

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

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

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

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

TABLE 3

Estimated Loss of Life Expectancy from Industrial Hazards[a]

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

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

TABLE 4

Probability of Accidental Death by Type of Occupation[a]

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

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

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

12. *What are the NRC external radiation dose limits?*

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

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

13. *What is meant by ALARA?*

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

18. How are radiation dose limits established?

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

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

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

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

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

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

TABLE 5

U.S. Occupational Exposure Estimates[a]

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

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

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

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

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

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

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

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

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

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

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

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

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

a. Health risks are already low.

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

b. The current regulations are considered sound.

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

c. There is little to gain.

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

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

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

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

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

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

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

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

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

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

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

TABLE 6

U.S. General Population Exposure Estimates (1978)[8]

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

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

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

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

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

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

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

27. What is meant by internal exposure?

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

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

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

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

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

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

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

28. How are the limits for internal exposure set?

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

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

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

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

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

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

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

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

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

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

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

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

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

a. Your Employer

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

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

b. Nuclear Regulatory Commission

Regional Offices

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

Headquarters

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

Telephone: 301-443-5970

c. Department of Health and Human Services

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

Telephone: 301-443-4690

d. Environmental Protection Agency

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

Telephone: 703-557-9710

BIBLIOGRAPHY

American Cancer Society, *1979 Cancer Facts and Figures*, 1978.

Anderson, T.W., "Radiation Exposure of Hanford Workers: A Critique of the Mancuso, Stewart, and Kneale Report," *Health Physics*, Vol. 35, December 1978.

Archer, V.E., "Effects of Low-Level Radiation: A Critical Review," *Nuclear Safety*, Vol. 21, No. 1, January-February 1978.

Atomic Energy Commission, *Operational Accidents and Radiation Exposure Experience*, WASH-1192, Fall 1975.

Barnett, M.H., *The Biological Effects of Ionizing Radiation: An Overview*, Department of Health, Education, and Welfare Publication (FDA) 77-8004, October 1976.

Cohen, B.L., and Lee, I.S., "A Catalog of Risks," *Health Physics*, Vol. 36, June 1979.

Cook, J., and Nelson, D., *Occupational Exposures to Ionizing Radiation in the United States: A Comprehensive Summary for 1975*, EPA 520/4-80-001, Environmental Protection Agency.

Department of Health, Education, and Welfare, *Biologic Effects of Ionizing Radiation*, Report of the Science Work Group of the Interagency Task Force on Radiation, June 1979.

Dreyer, N.A., et al., *The Feasibility of Epidemiologic Investigations of the Health Effects of Low-Level Ionizing Radiation*, NUREG/CR-1728, Nuclear Regulatory Commission, November 1980.

Gilbert, E.S., "Assessment of Risks from Occupational Exposure to Ionizing Radiation," in *Energy and Health Proceedings of the Conference on Energy and Health*, June 26-30, 1978, SIAM Publication, Philadelphia, 1979.

Gofman, J.W., "The Question of Radiation Causation of Cancer in Hanford Workers," *Health Physics*, Vol. 37, November 1979.

Gotchy, R.L., "Estimation of Life Shortening Resulting from Radiogenic Cancer per Rem of Absorbed Dose," *Health Physics*, Vol. 35, October 1978.

Hall, E.J., *Radiation and Life*, Pergamon Press, 1976.

International Commission on Radiological Protection, *Problems Involved in Developing an Index of Harm, Annals of the ICRP*, ICRP Publication 27, Pergamon Press, May 1977.

International Commission on Radiological Protection, *Radiation Protection*, Recommendations of the International Commission on Radiological Protection, ICRP Publication 26, Pergamon Press, January 1977.

Kelsey, C.A., "Comparison of Relative Risk from Radiation Exposure and Other Common Hazards," *Health Physics*, Vol. 35, August 1978.

Lapp, R.E., *The Radiation Controversy*, Reddy Communications, Inc., Greenwich, Connecticut, 1979.

Lapp, R.E., *A Worker's Guide to Radiation*, Atomic Industrial Forum, August 1979.

Linos, A., et al., "Low Dose Radiation and Leukemia, Mayo Clinic and Foundation, Rochester, Minn.," *New England Journal of Medicine 1980*; Vol. 302, pp. 1101-1105.

Mancuso, T.F., Stewart, A., and Kneale, G., "Radiation Exposures of Hanford Workers Dying from Cancer and Other Causes," *Health Physics*, Vol. 33, November 1977.

Muller, R., "Natural Radiation Background vs. Radiation from Nuclear Power Plants," *Journal of Environmental Sciences*, August 1972.

Najarian, T., and Colton, T., "Mortality from Leukemia and Cancer in Shipyard Nuclear Workers," *Lancet*, I: May 1978.

National Academy of Sciences, *The Effects on Populations of Exposure to Low Levels of Ionizing Radiation*, Report of the Committee on the Biological Effects of Ionizing Radiation (BEIR), 1980.

Rossi and Mays, "Leukemia Risk from Neutrons," *Health Physics*, Vol. 34, pp. 353-360, 1978.

Schottenfeld, D., and Haas, J., "Carcinogens in the Workplace," *CA-A Cancer Journal for Clinicians*, Vol. 29, No. 3, May-June 1979.

United Nations Scientific Committee on the Effects of Atomic Radiation, 1977, *Sources and Effects of Ionizing Radiation*, Report to the General Assembly, UN Publication No. E.77.IX.I, 1977.

Upton, Arthur C., "Radiation from Nuclear Power Exaggerated," *New England Journal of Medicine*, Vol. 302, pp. 1205-1206, May 22, 1980.

World Health Organization, *Health Implications of Nuclear Power Production*, Report of a Working Group, December 1975.

TO Preston

DATE 10-24-83

CC: Bob Carnell
Chemist Supervisors

SUBJECT Concerns of Chemist Weekly Review

Significant Concern: Personnel feel they are being pressured to meet production needs and are finding themselves running standards until they are acceptable to release results.

"H2 alarm" "L" "17 mod"

Personnel also feel that the individual that runs OHL & OCL values is looked at differently from those who seldom have OHL + OCL values.

Personnel understand how limits are established, but feel standard results limits are biased in order to satisfy production oriented areas.

I feel a meeting is needed to address employees' concerns and reduce self imposed pressure to produce.

Cole

YOUR NAME PLAINLY

COMPLETE MAILING ADDRESS

Appendix 5

JOB HAZARD ANALYSIS	COMPONENT: Chemet Laboratories - 970	NUMBER: CL-JHA-01
	PROCESS: Nuclear Materials	5 (1)

	Name	Date		
Prepared by:	PR Jasinski	9/18/79	Date issued:	10/01/81
Reviewed by:	[signature] 9/28/79	(Indust. Safety)	Review date:	~~3/1/84 C.D.~~ ~~3/01/83~~ 3/1/85 C.D.
Approved by:	[signature]	(Manager)	Replaces:	New

PERSONNEL PROTECTIVE EQUIPMENT REQUIRED:

1. Safety Glasses (Minimum)
2. Rubber or Polyvinyl Chloride Gloves
3. Laboratory Coat
4. Safety Shoes
5. Face Mask (Half) when scribing pellets or working with airborne materials in unusual circumstances.

POTENTIAL HAZARDS	SAFETY REQUIREMENTS
1. Radioactive contamination of skin. 2. Biological injury from radiation. 3. Inhalation of Airborne radioactive materials. 4. Introduction of Radioactive material into cuts or abrasions.	1. Pass Radiation Safety Test before working in a controlled Lab Section. 2. Protective clothing, glasses, safety equipment are to be used. 3. Follow radiation and criticality safety requirements. 4. Wear radiation monitoring badges as required. 5. Control limits are not to be exceeded (safe batch). 6. Clean spills immediately and notify radiation protection. 7. Bioassay sample must be submitted when required. 8. Only qualified personnel should handle radioactive material 9. Monitor feet and hands before leaving controlled areas. 10. Notify supervision and Medical Unit of all injuries. 11. Notify supervision of all unsafe conditions and practices. 12. If in doubt, contact your supervisor. See Also: JHA # CL-JHA-04, SEALED RADIOACTIVE SOURCES AND X-RAY

C-12

Appendix 6

11/13/72

COURSE OUTLINE FOR HOURLY EMPLOYEES

1. Radiation exposure control

   A. Limits

      1. Radiation

         External Radiation for radiation worker 5 rem/year
         1250 mrem/quarter

         rem = unit of biological measurement of radiological exposure
         year = 52 weeks
         quarter = 13 consecutive weeks 96.15/wk.

         Non-radiation worker = 500 mrem/year

      2. Release Limits

         a. Air & Water

            10×10^{-11} µCi/cc airborne limit for 40 hour week 400×10^{-11} µCi-hr/

            3×10^{-5} µCi/cc water limit

            3×10^{-12} µCi/cc air released to the environment

         b. Contamination

            200 dpm/100cm^2 loose surface contamination

            2200 dpm/100 cm^2 fixed surface contamination

   B. Seriousness of violating instructions on radiation warning signs

      i) exposure
      ii) contamination
      iii) punitive measure
      iv) dismissed from the company
      v) loss of confidence

   C. Discuss procedures and methods for minimizimg exposure

      i) time - distance - shielding
      ii) internal

   D. Potential sources of radiation/contamination exposure associated with work performed by the employee.

   E. Discuss where film badge and dosimeters should be placed upon individuals body.

2. Contamination Control

   A. Discuss how contamination is controlled during radioactive work.

      1. Disposition of contaminated materials
      2. Use of glove boxes

Appendix 7

3. Work tents
4. Personnel protection from contamination by wearing protective clothing.

    a. Lab coats - caps - rubbers - gloves
    b. Coveralls

        i) no street clothes under coveralls

    c. Respirators

        i) half mask
        ii) full face mask
        iii) chemical mask
        iv) fresh air

    d. Proper collection and disposal of radioactive solid waste
    e. Liquid waste must be collected, treated and disposed of properly

        i) poly bottles
        ii) cans/buckets

    f. A well trainer worker
    g. Detected in order to control it

        1. Methods to detect

            i. Swipes
            ii. Instruments
            iii. Air samplers
            iv. Water/soil samples

        2. Detected on personnel

            i) Self frisking

B. Discuss procedures for preventing contamination of pexsonnel and how contamination is detected on personnel.

1. Contaminated areas roped off - control signs
2. Wearing of proper protective clothing
3. Proper removal of protective clothing.

    1) Tape
    2) Cap
    3) Gloves
    4) Lab coat/coveralls
    5) Rubbers
    6) Frisk

4. Street clothes not worn under protective coveralls.

5. Contamination is detected on personnel with a "frisker"

    a) proper frisking technique
    b) location of probe away from body
    c) detect contamination - actions?

C. Discuss removal of contamination from objects and personnel

1. Normally removed from objects with a cloth dampened in plain water.
2. Normally removed from personnel by washing with soap and water.

D. Discuss the surface contamination limit and the meaning of the units of the limit.

E. Demonstrate proper procedure for putting on and removing protective clothing and mask.

F. Demonstrate proper procedures for entering and leaving contaminated area - SOP

G. Explain what radioactive contamination is.
Where it can exist - surface
air
water

3. Criticality

A. Definitions

Criticality - uncontrolled fission

Fission - the splitting of the atomic nucleus into two or more parts with the release of energy and neutrons. This may occur with a neutron striking the nucleus and, thus, initiating the fission.

Safe batch - the allowable quantity of uranium one may handle. 45% of minimum critical mass of uranium for a given enrichment. as the enrichment increases, the safe batch size decreases.

Limit Area - an identified location in which uranium can be handled, processed, or stored in accordance with specific posted criticality safety limitations.

Dead Zone - a safety zone, usually 12" in width, surrounding all limit areas. It is designated with a 2" wide red tape.

B. Rules

1. Any time uranium is handled outside of process vessels always handle one safe batch at a time.

   1. Limit area
   2. Dead zone

2. The limit area is the only place where you may store a safe batch.

3. Never place any uranium in a dead zone.

4. Always move safe batches in marked aisleways

5. Never use an aisleway to "temporarily store" uranium.

Geometry - limits size and location.

6. Never make any equipment changes without specification authorization of your immediate supervisor.

Procedureal or Adminstrative

7. Obey all posted and written criticality rules

8. If in doubt about anything - ask before you act.

4. Waste Disposal

Discuss how the individual workers can reduce the amount of radioactive liquid and solid waste

A. One of the best ways is to minimize radioactive waste is to teach the worker the characteristics of radioactive contamination and the proper methods for controlling contamination.

B. Good housekeeping

C. Take only material absolutely needed to do a job into control areas.

D. Liquids of different types segregated - HUF - ADU - laundry - grinders, etc

E. Liquid waste not normally radioactively contaminated should be collected separately.

F. Do not dump contaminated liquids into sinks or showers that are not specifically designated for radioactive contamination.

5. Radiological Incidents

A. Discuss the need for consulting radiation protection personnel when questions or incidents occur.

1. Common sense

2. Radiation protection personnel are trained to cope with the situation.

a. They have the material, equipment, and tools to handle the problem.

B. Discuss procedures to be followed after a spill of material (liquid or soli

1. Action must be taken after a spill has occurred otherwise contaminatior could be spread around.

2. If action is not taken after a spill

a. Personnel could track contamination around
b. It could become airborne

3. There are five basic steps to be followed in the event of a spill.

Step 1: Stop the spill
Step 2: Warn other personnel - Call Radiation Protection
Step 3: Isolate the area
Step 4: Minimize your own contamination
Step 5: Secure unfiltered ventilation

C. Discuss procedure to be followed when notified that airborne radioactivity is above the limit.

1. Stop any operation that may be causing airborne radioactivity
2. Leave area immediately or put on respirator.
3. Follow Radiation Protection's instructions.

6. Responsibilities of Individuals

Rules to minimize radiological problems

A. Obey stop work or evacuation orders

B. Obey posted, oral and written radiation protection instructions

C. Wear film badge and/or dosimeter and/or lapel sampler where required.

D. Do not loiter in controlled areas

E. Do not smoke, eat, drink, or chew in controlled areas.

F. Wear protective clothing and respirators properly and when they are required.

G. Remove protective clothing and respirators properly.

H. Frisk yourself when leaving a control area

I. For a know or possible radioactive spill, minimize its spread and notify Radiation Protection.

J. Do not unnecessaryily touch a contaminated surface or allow your clothing, tools, or equipment to do so.

K. Place contaminated tools, equipment and solid waste on disposal surfaces when no in use, and inside of bags when work is finished.

L. Limit the amount of material to be decontaminated or disposed of as radioactive waste.

M. Report the presence of open wounds to Radiation Protection prior to work and report immediately if a wound occurs while in the area.

N. Obey all Criticality Rules.

REDUCTION OF AIRBORNE EXPOSURE

1. Use of Containment
2. Proper air flows in Hoods, work stations, and/or duct work
3. Air sampling to control exposure
4. Notification when systems break down
5. Preventative maintenance
6. Following Procedures
7. Containing all contaminated Materials
8. Cleaning up Spills immediately
9. Obey barriers and flashing lights
10. Common Sense
11. Use of Mask as a last resort

FUELS MANUFACTURING OPERATION

GENERAL ELECTRIC

STANDARD OPERATING PROCEDURE

REACTOR AND FUELS MANUFACTURING OPERATION

SUBJECT	NUMBER 0.3.4
Radiation Safety - Lab Operating Procedure	PROJECT

1.0 PURPOSE

The purpose of this procedure is to establish and outline the general radiation safety rules, practices, and precautions necessary to prevent airborne exposures, personal contamination, and spread of contamination within the Lab.

2.0 SCOPE

The scope of this procedure is to cover the radiation safety rules and practices and precautions of a very general nature for the Wet Chemical and Spectrography Labs. Special requirements outlined in the General Radiation Safety Procedure Ø1.2.2-8.2.2 and SOP C-2.0-QA-201 shall be followed.

3.0 POLICY

A. Eating, storing, or preparing food is not permitted in any areas where uranium is handled.
B. Smoking and storing of Tobacco is not permitted in the controlled area.
C. The use of food containers (milk bottles, thermos, etc.) for handling or storing uranium is not permitted.
D. Employees working with uranium and all other personnel leaving the Lab must completely survey themselves for uranium contamination before leaving the work area. A separate log is provided for individual clearance of small personal items such as clipboards and paperwork.
E. White labcoats, completely buttoned, and gloves, either rubber or disposable plastic type, is required for working or handling uranium or touching potentially contaminated equipment.

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F. All spills or leakage of uranium must be cleaned immediately.

G. Radiation Protection must be contacted to perform release surveys of all equipment leaving the controlled areas.

H. All compounds of uranium that could become airborne shall be handled inside of hoods with air flow of 80-120 LFM through the apertures. Examples of this is (1) Opening of powder sample containers (2) Crushing of pellets, weighing, etc., (3) Dumping and compositing samples for return to Shop Operations, (4) Dissolution and concentration of uranium samples by heating.

Prepared By George a Pen 4/2/73

Authorized By L. A. Berry 4/2/73

Engineering Concurrence D F MacMillan 4/9/73

Nuclear Safety Concurrence ABHaverty [illegible] 4/12/73

Appendix 9 omitted - contains information protected under 10 CFR 2.790.

Conduct

1. No food, drinks, gum or tobacco are permitted in the Controlled Area.

2. Report all injuries to your Supervisor, to the Medical Unit (X-5333) and to Radiation Protection (X-5858).

3. Cuts and skin abrasions must be properly treated by the Medical Unit before working in the Controlled Area.

4. Assume that all surfaces and objects are contaminated unless Radiation Protection advises otherwise.

5. Take extra care to prevent airborne contamination.

6. If working under a Radiation Work Permit (RWP), carefully read and follow the requirements. Note any special instructions. If there are any questions, contact your Supervisor or the Radiation Protection office (X-5858).

7. Removal of tools, equipment or materials from the Controlled Area requires a release by Radiation Protection (X-5858).

8. Prevent spread of contamination -- clean up spills of uranium or uranium-bearing liquids as soon as possible. Report large spills to Radiation Protection (X-5858).

9. Limit the amount of material to be contaminated or to be disposed of as contaminated waste.

10. Immediately report incidents of gross personnel contamination to your Supervisor and to Radiation Protection (X-5858).

11. Protective hearing devices (ear plugs, ear muffs, etc.) are not to be worn due to the potential for personnel contamination.

NUCLEAR SAFETY ENGINEERING [signature] DATE ISSUED 4/22/82

[signature] 4/23/82 [signature] 4/23/82

AREA MANAGER(S)

PLEASE RETURN THIS PROCEDURE TO ITS PROPER LOCATION AFTER READING

NF4-048A (6/81)

- Warning Signs/Flashing Lights

For conditions causing a high airborne contamination area, a contaminated area or a high radiation area, one or more of the following may be used to alert personnel:

1. Yellow and magenta (reddish purple) rope or tape and

   Yellow and magenta signs displaying various warnings or protection requirements (Example: full face mask required).

2. Flashing yellow light

   Only authorized personnel wearing appropriate protective clothing/equipment are permitted within the marked off area.

- Containment Requirements

1. Conduct all activities which could generate airborne contamination, such as transfer or sampling of uranium, inside glove boxes or vented hoods.

2. If it is necessary to break containment when making equipment changes, wear appropriate respiratory protection devices and take extreme care not to spread contamination to the surrounding area, to the air or to the ventilation system.

3. For work which may cause gross contamination, cover the immediate area with paper and establish a step-off-pad to minimize contamination spread. Contact Radiation Protection for assistance (X-5858) prior to start of work.

4. Keep containment hoods securely closed during normal operations, and assure that hood filters are changed as scheduled.

5. Open containers of radioactive materials only inside of approved hoods. Wipe visible contamination from containers immediately upon removal from hoods.

6. A full face mask must be worn when breaking containment on equipment or when opening a hood; unless specifically authorized by your Supervisor or Radiation Protection to use a half mask.

Appendix II omitted - contains
information protected under 10 CFR 2.790.

GENERAL ELECTRIC

DIAL COMM• 5369 DATE• September 15, 1981 COPIES• B. F. Bentley
A. Dada
G. W. McKenzie
G. E. Powers
C. F. Shipp
W. B. Smalley
C. M. Vaughan

DEPT• WMD QA Regulatory Compliance

ADDRESS• M/C J-26

SUBJECT• SEPTEMBER 15, 1981
UF_6 GAS RELEASE

W. J. Hendry, Manager
Regulatory Compliance

Based on chemical analyses of the 9 air sampler filters in the ADU vaporization room, preliminary results reported by Ed Powers indicate that airborne levels averaged over a twenty-four hour period probably exceed 300 times the maximum permissible concentration. In accordance with P/P 40-12 criteria "Airborne levels in a restricted area averaged over a 24 hour period in excess of 300 times MPC. (MPC is 1×10^{-10} µCi/cc)", this has been classified as a Class II incident.

G.M. Bowman

G. M. Bowman, Acting Manager
Nuclear Safety Engineering

dh