NFS QUESTIONS & ANSWERS

This information is presented in response to questions raised at a public meeting, conducted by the U.S. Nuclear Regulatory Commission, on December 4, 1980, at Erwin, Tennessee. A copy of the transcript of this meeting has been provided to the Mayor of Erwin, Tennessee; the County Supervisor, of Unicoi County, Tennessee; and to the local news media. Additional copies the transcript are available for a fee from the U.S. Nuclear Regulatory Commission, Region II, Suite 3100, 101 Marietta Street, Atlanta, Georgia 30303.

The questions presented herein were developed from over 60 questions raised during the public meeting. The questions are followed by a short "answer" which is then expanded upon in the "discussion". The generic questions were designed to answer several related specific questions raised at the public meeting.

NFS QUESTIONS AND ANSWERS OUTLINE

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Appendix A. Exposure and Risk Data

I.A. What radioactivity is associated with NFS and the NFS fuel?

ANSWER:

Uranium is the principal radioactive element associated with the NFS processing. Natural uranium has three principal isotopes: U-238, U-235, and U-234. The uranium processed at NFS is enriched in the isotopes U-234 and U-235. Most of the radioactivity is due to U-234. The principal radiation of interest is alpha radiation, although weak gamma radiation is also present.

DISCUSSION:

In nature, uranium-ore contains the isotopes U-238, U-235, and U-234. However, in uranium-ore almost all of the uranium by weight is U-238, although all the isotopes are actually natural. After the mining of the uranium-ore and prior to processing by NFS, the ore has been processed to selectively increase the relative percentages of U-235 and U-234. This process of increasing the relative concentration of uranium-235 is called "enrichment". (the more enriched a fuel, the higher the relative percentage of U-235)

The ratios of U-238, U-235, and U-234 in uranium ore, were once very different. When the earth was created, several billion years ago, the U-235 and U-234 were more abundant in uranium-ore. These isotopes have halflives, which mean they disintegrate randomly at a rate such that only half is left after: 4 billion years (U-238), 700 million years (U-235), or 250,000 years (U-234).

Several years ago, NFS also processed plutonium, a man-made element. However, NFS no longer processes plutonium and is planning to decommission the facility which was used to process plutonium.

When uranium undergoes radioactive decay the principal radiation is emitted alpha radiation. Alpha radiation has an effective range in air of only a few millimeters, and can be absorbed by a sheet of paper or the dead layer of cells which comprise the outer layer of the skin.

Thus, alpha radiation is not dangerous unless the radioactive element (uranium) enters the body. Once in the body, alpha radiation is in close enough proximity to live cells to cause damage. Some low-energy gamma and beta radiation are also emitted by uranium, but these produce relatively little damage compared to the alpha radiation.

Uranium-235 atoms fission when they absorb thermal neutrons. When a uranium atom fissions (breaks apart by splitting), gamma rays, neutrons, and fission products (other radioactive isotopes) are produced. If sufficient quantities of U-235 are assembled in the proper geometry, volume, concentration, and moderation, a chain reaction can result. An uncontrolled chain reaction is a criticality

I.B. What are the NFS exposure pathways and how are doses calculated?

ANSWER:

The principal radiation exposure pathway for individuals in the community is by the inhalation of uranium particulates from NFS airborne effluents. The individual most affected by these effluents would be a child, and the organ of the body affected the most would be the bone. Exposures are calculated by determining the amount of uranium inhaled (based on stack and environmental sample results, and meteorology) and applying dose factors (based on ICRP dose models). The nearest inhabited location is 250 meters SE from the facility.

DISCUSSION:

The materials released from NFS routinely and those materials which could be released during an accident due to the materials processed, are forms (chemical) of uranium. If a criticality accident occurred, a spectrum of fission products (gamma radiation emitters) would be produced and a burst of gamma radiation and neutrons would occur.

Materials released in water are well below regulatory limits, and with the added dilution of the Nolichucky River, do not contribute significantly to doses (less than 0.1 millirem per year). Levels of radioactivity in fish and other organisms in the Nolichucky which can be eaten by humans, show no increases above the levels found further upstream or downstream. It should be noted that the Nolichucky does contain a natural "background" level of uranium and other radioactivity, (from erosion of rocks containing trace amounts of uranium, thorium, radium and other radionuclides).

A minor exposure pathway is from the ingestion of food products which have been contaminated by material deposited directly on plants or from the uptake of material deposited on the ground. However, if the food is washed, some of the material deposited will be removed. Only a small fraction of uranium deposited on the ground will be ingested, because plants do not "uptake" heavy metals such as uranium, readily. Therefore, the food chain is not a principal pathway for human exposure (less than 1 millirem per year).

The chemical form of the uranium released to the atmosphere from NFS is dependent on the chemical process preceeding the release. Preliminary results from studies currently underway indicate the fraction of released uranium which is soluble is around 70-80%. If it dissolves in lung fluids, the bone is the highest exposed body organ. If the material is insoluble, the lungs are the highest exposed organs.

Dose factors have been developed based on the International Commission on Radiation Protection (ICRP), Task Group Lung Model, for converting the quantity of material inhaled into resultant doses to various organs. The NRC uses these dose factors in a computer code to assess accident which will terminate itself by expansion to a noncritical configuration.

Special precautions are required by the NRC and are taken by NFS to preclude even approaching a situation where enough fissionable material (U-235) could come together to have a "criticality".

each effluent pathway which results in exposure to humans. The computer code is "DACRIN" - A Computer Program for Calculating Organ Doses From Acute or Chronic Radionuclides Inhalation", BNWL-B-389, 1975.

In reviewing the ICRP dose factors for uranium, the critical organ, that is the organ which receives the highest exposure level, is the bone for soluble forms of uranium. Also, the member of the population most affected would be a child.

In determining the exposure to uranium inhaled or ingested into the body, consideration is given as to the total dose which results from the material, rather than just an annual dose. Once in the body, uranium is biologically removed by the body's metabolic and circulatory system. For example, if a given amount of uranium is in the bone on day 1, within 300 days the body has eliminated half of the material, and in another 300 days half of the remaining material is removed, etc. Therefore, at the end of one year a person would be exposed at about one half the original dose rate; by the end of the second year, a little less than one fourth of the original rate, and so forth. Dose factors are normally used to compute the total dose which will be delivered over a 50 year period, although for uranium, most of the resultant dose is received within a few years.

II.A. What is the NRC inspection program at NFS?

ANSWER:

The NRC inspection program at NFS consists of: a permanent resident inspector at NFS; periodic unannounced inspections by technical specialists from the NRC Region II office; confirmatory measurements by the NRC; use by NRC of consultants (experts) and contracted special programs. These various methods are used to independently review and assess the adequacy of NFS programs and NFS's compliance to NRC license conditions.

DISCUSSION:

The permanent resident inspector, Mr. Tom Lee, was assigned to NFS in August 1978. Mr. Lee has daily contact with NFS management and personnel. As resident inspector, he performs inspections and observes operations. He is the NRC focal point for onsite activities.

The NRC Region II office has technical specialists who perform unannounced inspections of facilities in areas of their technical expertise. Some of the areas inspected at least annually include: environmental protection; emergency planning; radiation control; radiation monitoring; security; criticality; fire protection; personnel exposure monitoring; special nuclear materials control and accountability; and radiological laboratory analysis. The frequency of the inspections is determined by licensee performance, with more inspections of areas needing improvements.

The NRC, Region II, has two mobile laboratories which have been to NFS. One laboratory is equipped to confirm the NFS measurements relating to accountability of special nuclear materials. The second laboratory is equipped to perform measurements of plant effluent and environmental samples, such as air, water, soil, and vegetation.

Finally, the NRC Region II uses consultants (experts) and performs contracted studies on NFS. Some recent examples of this include: aerial monitoring of the site and nearby environment for radioactivity; special studies of the NFS stack air cleanup system (stack scrubber) and air sampling system (stack sampler); and periodic sampling of air, water, soil, and vegetation in the environment by the State of Tennessee's Department of Public Health.

The NRC reviews data and records prepared by NFS, and compares them with information independently determined to assure that NFS

I.C. What are the maximum possible release and exposure limits?

ANSWER:

The maximum permissible airborne release limits for NFS are governed by the maximum allowable average annual concentrations in air for unrestricted areas (fenceline). These concentrations are specified in Part 20 Appendix B of the Code of Federal Regulations (10 CFR 20) and apply to all NRC licensed facilities. Emissions must be controlled so that the air concentrations in the unrestricted area do not exceed these concentrations. At NFS the radionuclide resulting in highest radiation exposure is U-234 and the annual average air concentration which may be inhaled by individuals in unrestricted areas is limited to $2X10^{-11}$ microcuries/ml. Continuous exposure for one year to this concentration would result in a dose commitment of 16 Rem to the bone for a child and 8 Rem to the bone for an adult. For comparison purposes, the risks associated with these doses are the same as risks for whole body doses of 2 Rem and 1 Rem for a child and adult, respectively (see Table A2).

Internal exposure of radiation workers from inhalation is limited by restricting exposure during any calendar quarter to the quantity that would result from inhalation for 40 hours per week for 13 weeks at concentrations specified in 10 CFR 20 Appendix B, Table I, Colummn I. For U-234, the concentration corresponds to $6X10^{-10}$ microcuries/ml.

DISCUSSION:

The release limits and exposure limits discussed above refer to the maximum limits and these would not normally be approached during routine operations. NFS is expected to keep actual doses as far below limits as is reasonably achievable. NFS license conditions require that action be taken to reduce gaseous emissions if the monthly average radioactivity concentrations exceed $8X10^{-14}$ microcuries/ml at any of the environmental air sampling locations. This concentration is 250 times lower than the maximum allowable air concentration for U-234 as specified in 10 CFR 20, Appendix B, Table II, Column 1. This air concentration of U-234 would lead to a dose commitment of .06 Rem and .03 Rem to the bone of a child and adult, respectively assuming continuous exposure for a year.

Corrective action by NFS is also required if the U-234 concentration at the stack exceeds $1X10^{-10}$ microcuries/ml for any seven-day period. In addition to these specific conditions to limit releases, NFS management is required to provide a semiannual review of employee exposures and effluent release data to determine if exposures and effluents may be lowered under the concept of as low as reasonably achievable.

For purposes of clarification and ease of comparison, the following table presents current release limits, action levels, and maximum permissible concentrations (MPC) and their associated doses as appropriate.

Limits And Action Levels	Associated Dose*	Remarks
Worker MPC (10 CFR 20) Table 1, Column 1) $6X10^{-11}$ micro-curies/ml	65 rem to bone 7.8 rem whole body	Exposure to MPC for 52 weeks, 40 hours per week
Unrestricted area MPC (10 CFR 20) Table 2, Column 1) $2X10^{-11}$ micro-curies/ml	Child-16 rem to bone, 2 rem whole body, Adult-8 rem to bone, 1 rem to whole body	Continuous exposure to MPC for 365 days per year
Environmental Action Level $8X10^{-14}$ micro-curies/ml	Child-.06 rem to bone, .008 rem to whole body, Adult-.03 rem to bone, .004 rem to whole body	Continuous exposure 365 days per year. If this concentration is exceeded, corrective action required.
Stack Action Level $1X10^{-10}$ microcuries/ml	Not applicable	If this concentration is exceeded corrective action is required

*Doses base

complies with regulatory requirements. At the end of the inspection, the inspector discusses his findings with licensee management and identifies areas which need managment attention. The inspector then writes a report. Unsafe practices and items of noncompliance are recorded and this report is forwarded to the licensee. The licensee must respond in writing to safety issues. If the safety issues are of great significance, the NRC may issue an order terminating the licensee's activity or may impose a monetary civil penalty to ensure that corrective actions are taken and that licensee management takes sufficient steps to prevent recurrence. The civil penalty is based both on the licensee's ability to pay and the seriousness of the violation. NFS was issued a $53,000 civil penalty in 1977 because of violations of security program requirements.

In the event that a licensee has a history of poor performance, the inspection frequency may be increased until the licensee demonstrates an ability to operate safely. As a final enforcement action, the licensee may have his license modified or revoked by the NRC.

All inspection activity is documented and copies of inspection reports and related correspondence are sent to a public document room in Washington, D.C. and also the State of Tennessee.

III.A. What is the NFS Facility manufacturing and for whom?

ANSWER:

The NFS facility manufactures nuclear fuel for the U.S. Navy. Additionally, the NFS facility recovers uranium from commercial nuclear fuel scrap.

DISCUSSION:

The NFS facility was initially licensed by the Atomic Energy Commission and began operation in 1957. The NFS facility primarily makes enriched uranium fuel for the U.S. Navy and recovers uranium from nuclear fuel scrap. Some fuel related work was done in the past with plutonium and thorium, but currently the NFS facility is only processing uranium.

Highly enriched uranium (i.e., uranium enriched in the isotope U-235) is used to prepare most of NFS fuels. High enriched uranium fuel that does not meet specifications, and various scrap materials generated in the fabrication uranium fuel, are reprocessed to reclaim the uranium. Similarly, a low enriched scrap recovery process is also conducted. An inactive processing facility onsite was once used to fabricate low enriched uranium, thorium, or thorium and uranium blend fuel rods. Uranium hexaflouride cylinder cleaning is also performed for various customers.

II.B. What is the NRC doing to assure the protection of the health and safety of the public?

ANSWER:

The NRC reviews plant operational experience and the results of new studies relating to radiation, health effects, process control, and effluent treatment systems, and when improvements are required, the NRC will modify, change, or revise portions of the NFS license.

DISCUSSION:

As cited in answer II.A., the NRC conducts a comprehensive inspection program, and improvements have resulted from these inspections.

The NRC is also looking at the industry in general, and many times information generated from the experiences of other similar plants, or studies which relate to NFS activities, will be used by the NRC to revise, on a generic basis, the NFS facility license. Two major areas of this type are effluent control and monitoring, and the maximum permissible concentrations of radionuclides in effluents and the environment. A specific example of this type is emergency planning, which is discussed in more detail in question VI.

In the area of effluent control and monitoring, the NRC has been reviewing recent improvements in the technology of making radiation measurements and the technology of effluent treatment. Since the plant was first built in 1957, improvements have been made in these areas. Currently, the NRC is looking into state-of-the-art detection equipment to determine if it would be beneficial to require NFS to install such a device in the main plant stack. NFS has agreed with the NRC, and has installed a pilot-study device. The NRC is considering imposing a requirement for such a device and giving performance specifications to be met. In addition, an amendment to the NFS license is being considered, to significantly reduce the gaseous effluent limits.

In the area of effluent treatment, NFS has installed a waste-water treatment system. This was done because the technology of waste-water treatment was such that NFS could improve the quality of liquid discharges to the Nolichucky River. The NRC is currently evaluating various alternatives for NFS to reduce the airborne emissions from NFS stacks.

When information becomes available which relates to NRC standards, the NRC reviews this data and determines if the standards should be revised up or down. An example of this is the maximum permissible levels of radionuclides in effluents and in the environment.

Currently, the NRC is using the limits established in Title 10, Code of Federal Regulations, Part 20, (10 CFR 20), which were derived over 20 years ago by the Atomic Energy Commission based on recommendations from the National Council on Radiation Protection (NCRP) and the International Council on Radiological Protection (ICRP). However, over the years, data has been developed which suggested that changes to the limits were prudent or that lower exposures were technologically achievable. The NRC has subsequently revised some of the 10 CFR 20 limits.

II.C What happens during an NFS strike?

ANSWER:

When a stike occurs at NFS, the NRC increases surveillance of NFS activities. If the plant can operate safely and in accordance with all license conditions, the NRC will allow continued operation; if the facility can not be run safely or in accordance with the license conditions, the NRC orders suspension of operations until compliance can be assured.

DISCUSSION:

During the last strike at NFS, in the spring of 1979, the NRC issued an order for NFS to cease operations pending a review of their ability to operate the plant safely using management personnel. Following this review and the NRC's determination that the plant could operate safely, the order to cease operation was rescinded. The NRC review included an onsite evaluation by technical specialists of the potential effects on safety and compliance with NRC regulations in the areas of security, physical protection, critciality control, effluent control, and special nuclear material control and accountability.

III.B. What is the NFS inplant monitoring program?

ANSWER:

NFS continuously samples plant exhausts, stacks, and building air, periodically monitors waste-water quality, and performs radiation monitoring of plant employees with personal radiation monitors and periodically by bioasssay tests.

DISCUSSION:

NFS has continuous air samplers on the process building stacks. These samplers collect air particulates on a particulate filter with an efficiency of over 90% for particulates greater than .5 micron. Uranium particulates are typically between .5 and 10 microns. The air filters are collected and analyzed daily for radioactivity.

NFS continuously monitors building air with samplers placed at work stations throughout the buildings. The air samplers are similar to the stack sampler and collect particulate radioactivity. The samples are collected daily and analyzed for radioactivity.

Criticality monitors are also placed throughout the process areas. These monitors will alarm if a criticality accident event occurs, and personnel would immediately evacuate by the fastest route.

Liquid wastes are routed to the plant wastewater treatment facility. The wastes are treated to conform with USEPA and the State of Tennessee's water quality standards and NRC radiation limits, and are sampled and analyzed prior to release to the Nolichucky River. Liquids from drains and laundry waste below radiation limits are discharged to the sanitary sewer system. Plant runoff is collected in storm sewer lines which are sampled periodically.

Plant employees are provided personnel dosimetry monitoring devices which measure gamma radiation. Periodically, plant employees provide urine samples which are analyzed for uranium content. If a high level of uranium is found, the employee is restricted from further exposure immediately, and a sensitive whole body radiation analysis is performed to determine the amount of uranium or other nuclide present in his body. Periodically, whole body counts are administered to selected employees. Plant employees are furnished annually with an exposure record and are furnished with a complete report upon employment termination. The NRC routinely reviews all exposure records and all monitoring results.

III.C. What is the NFS environmental monitoring program?

ANSWER:

The NRC requires NFS to conduct a comprehensive monitoring program of air, water, soil, and vegetation. Additional samples to confirm the NFS results are routinely made by NRC and the State of Tennessee. These programs indicate no significant buildup of radioactivity in the environment.

DISCUSSION:

Effluents from the NFS facility are released from stacks and through the waste-water treatment facility. The NRC requires NFS to monitor the releases for radioactivity, as discussed in answer III.B., and also requires NFS to monitor the environment surrounding the plant.

Air concentrations are monitored at five (5) locations around the plant at the inside perimeter fence at 100 meters from the main plant stack. These locations have continously running air samplers. Analysis of the filters are made weekly, with special isotopic analysis performed periodically. Currently, three (3) air samplers are also located offsite, with two nearby (at 300 and 800 meters) and one six (6) miles away as a background sample. One offsite sampler is on Carolina Avenue, the other is located on Little Mountain. Improvements pending to this system are discussed in answer VII.

Water samples from Banner Springs, upstream and downstream in the Nolichucky River where the wastewater treatment facility discharges, are taken monthly.

Periodically, soil (top ½ inch) and vegetation (grass, tobacco, vegetables) samples are taken from locations adjacent to air samplers or water sampling locations.

The NRC, as discussed in answer II.A., has also sampled various environmental media, and performed isotopic analysis on them. Also, as discussed in the answer II.A., the NRC funds the State of Tennessee's Department of Public Health, Division of Radiological Health, to monitor offsite locations where NFS routinely samples. The State of Tennessee's results are reviewed by the NRC and compared with NFS sample results to assure validity. Additionally, the NRC has provided NFS with "spiked" samples (a known quantity of radioactivity added), to verify the accuracy of the NFS laboratory. Finally, the NRC periodically has had aerial overflights made of the NFS site with sophisticated radiation sensing devices to "map" radiation levels of the site and nearby environment (1000-1500 meters), and detect any buildup of material in the environment.

With the exception of an area by the railroad tracks northwest of the site, the results of these monitoring programs have not indicated a significant buildup of material in the environment above background radiation levels. The contaminated area near the railroad tracks resulted from dredging of a former discharge ditch. Corrective action taken by NFS involved removal of the contaminated soil.

IV.B. What radiation related effects have been observed or are expected from the radioactive releases on the local population?

ANSWER:

No effects have been observed, and it is not expected that there will be any. What is generally expected from low doses to radiation is a small increased risk of deleterious health effects, including cancer. The relative risk from radioactive material in effluents from NFS is considerably less than that accepted as normal in day to day life. (See Table A2).

DISCUSSION:

The critical pathway for exposure of the local population is inhalation of uranium with subsequent deposition in the bone. The primary effect from additional exposure of the bone will be a probable increased risk of bone cancer.

As shown in Table A2, any increased risk of cancer for the general population in the vicinity of NFS is quite low. The average annual dose commitment to the maximum exposed individual has been calculated to be 200 mrem per year to the bone of a child. The increased risk for cancer of the bone is estimated to be about one in a million. Actual doses received by individuals in the vicinity of NFS are significantly lower since the dose would decrease rapidly as the distance from the plant increases. In addition the NRC has used conservative assumptions in the dose calculations which tend to overestimate doses.

It is important to realize that risk numbers are only estimates. Many difficulties are involved in designing research studies that can measure any small increase in cancer incidence due to low exposures to radiation as compared to the normal incidence of cancer. There is still uncertainty and 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 the lower doses that radiation workers are exposed to or the still lower doses that the general public is exposed to. At low dose levels, it is quite possible that the risk is zero. However, particularly for purposes of setting radiation protection standards, it has been considered prudent to extrapolate the relative effects per unit dose observed at higher dose levels to an expectation of the same relative effect per unit dose at lower dose levels. The NRC and other agencies both in the United States and abroad are continuing long-range research programs on radiation risk.

Appendix A contains additional information on risk and the relative risks associated with everyday activities.

IV.A. What have been the routine releases from NFS since its' initial operation in 1957?

ANSWER:

Since 1972, routine releases from NFS have averaged approximately 500 grams of uranium per year for an average maximum individual yearly exposure of approximately 200 millirem to the bone (child at 250 meters). Prior to 1972, information on the release totals is not well documented, as this was not required.

Inspection reports indicate that release limits were met, but the limited information available on quantities released is not sufficient to permit precise dose assessment.

DISCUSSION:

Prior to 1975, the NRC did not require NFS to submit reports on the releases of radioactive material. Information obtained by the NRC, prior to this time was limited to that gathered during inspection visits by NRC personnel. Records were not maintained by the AEC, but they are now by the NRC. Information has been received from NFS for the 1972-1975 period.

The NRC, has reviewed the results of NFS release information for the period 1972-1980. This period is considered representative of the NFS uranium operations prior to this period. Thorium and plutonium were also processed by NFS prior to 1972. The information available within the Regional Office does not allow extrapolation for assessment of doses for these nuclides for 1957-1972 period. However, the review if inspection reports for this period indicates that the average annual limits on releases, i.e., environmental concentrations, were not exceeded.

In reviewing the routine releases for 1972-1980, the NRC has performed preliminary dose assessments on the effects of the uranium released. The calculations indicate a range of values, calculated for the maximium exposed individual (child at 250 meters), of between 70 millirem and 300 millirem per year bone-dose. The average exposure during this period may be considered to be approximately 200 millirem per year dose to the bone of a child at 250 meters.

As mentioned in the public meeting on December 4, the Center for Disease Control (CDC) of the Department of Health, Education, and Welfare (HEW), conducted a study in 1978 of the incidence of cancer in the areas around the NFS site. This epidemiological study reviewed the death records for Unicoi County and the surrounding counties from 1955-1965, 1965-1975, and 1975-1977. They concluded:

> "In the summer of 1978, a study of cancer mortality in Unicoi County, Tennessee, was conducted after an apparent two-fold increase in cancer deaths was reported to be possibly associated with the nuclear fuel manufacturing facility in the county. No significant excess in cancer mortality was apparent when the effective age in the population was considered. Cases were not clustered in plant employees or in residents living near the plant. No statistically significant incidences were found for digestive cancers, respiratory cancers, or leukemia."

V.B. What happened August 7, 1979, and how did the NRC investigate it?

ANSWER:

On August 7, 1979, NFS had an accidental release of airborne uranium as uranium hexafluoride. Due to unknown problems at that time, the release was underestimated by NFS. Subsequent NRC investigations unravelled a series of conflicting information and disclosed that a much larger release had occured.

DISCUSSION:

On August 7, 1979, NFS had an accidental release of uranium. At 1:50 p.m. the material was discovered because of the splitting of a flexible tubing which released a visible uranium gas (Hydrolized uranium hexafluoride into the process building, which was seen by plant employees, who terminated the release. Immediately, NFS began taking samples and performing analysis. By 5 p.m., sampling had indicated that the release was minor and no offsite problems existed.

The NRC was notified on August 8, 1979, of the accident. NFS was cited for failure to promptly report. NFS provided the information it had, and the NRC resident inspector began reviewing the situation.

The NRC inspectors then (September) discovered that some problems existed with the plant stack sampling program. An item of noncompliance was issued for failure to take a proper sample and NFS was required to investigate and recalculate the August 7 release. Shortly thereafter, NFS, in an unrelated audit, reported an inventory difference in the amount of special nuclear material unaccounted for in the plant's total operation, and the NRC launched an investigation of this matter in October 1979.

During the inventory investigation period it was discovered by the NRC that the air treatment system was not properly operating and material passing through the system would not be efficiently removed. Special consultants from the Department of Energy's contractors were utilized by the NRC to investigate this situation. In May 1980, the contractor's report was finished and analyzed by the NRC, Region II staff.

Recognizing the seriousness of having more material released than was initially reported, the NRC rescheduled an environmental inspection to investigate the 1979 monitoring data and the environmental data taken during the accident. This inspection (IE Inspection Report 70-143/80-18) conducted June 15-17 and July 13-17, 1980 disclosed that environmental data indicated a larger release than initially reported. The NRC, Region II also performed detailed technical evaluations of the release and

V.A. What accidents has NFS had and what accidents could happen?

ANSWER:

NFS has had three significant releases of uranium hexafluoride. No criticality accidents have happened at NFS. No significant radiological related fires or natural events (floods, tornados) have occured.

DISCUSSION:

The NFS process operation has been reviewed by the NRC, to determine the various potential accidents and to assess the NFS facility from a hazards evaluation standpoint. The NRC has determined that accidents at NFS could involve: criticality, release of material (i.e., uranium hexafluoride fire.

A criticality accident at NFS has never happened. See answer I.A. for more information on criticality accidents. If a criticality accident should occur at NFS, the NRC has reviewed data which indicates the expected production of fission products would result in a dose to the nearest adult at 250 meters of: approximately 28 Rems to the thyroid from the isotopes of iodine; and approximately 8 Rems to the whole body from the noble gases (krypton and xenon isotopes).

NFS has had three significant (greater than 100 grams) releases of uranium hexafluoride since 1957. The most recent, and well documented, is the August 7, 1979 release which is discussed in more detail in Answer V.B and V.C. The other releases occured in May 1962 and March 1964.

The May 24, 1962 release was the largest releast at NFS. Fifteen (15) kilograms were released into the metals processing building in five minutes. Within 15 minutes, 10 kilograms had been released from the building by the building exhaust fan. Five kilograms were recovered from the scrubber system and building walls/floors. The 1962 release occured at approximately 5:45 a.m. on May 1962. The wind direction (to the NW) was such that no individuals were present immediately downwind.

The March 20, 1964 release involved the release of less than 1 kilogram.

The potential dose to the nearest individual (SE at 250 m) from atmospheric releases has been calculated for "worst-case" meteorology. This represents the maximum exposure and corresponds to a child bone dose of 7 rem per Kg of uranium hexafluoride released.

A fire at NFS or a natural disaster (tornado, flood), to cause nuclear-related releases has not occured at NFS. Small localized fires (some involving less than 10 grams of uranium have occured but no significant fire involving uranium has occured.

V.C. What would the dose for the August 7, 1979 release, have been if the weather had been "terrible"?

ANSWER:

Release of 3000g under "worst-case" meteorological conditions would have resulted in a bone dose of 21 Rem to a child at the location of the nearest resident.

DISCUSSION:

The meteorology could have been better or worse. Concentrations downwind from the plant could have been much lower (resulting in a lower dose) if there had been higher wind speeds, less stable wind conditions, or more fluctuating wind direction. Concentrations downwind from the plant could have been much higher (resulting in a higher dose) if there had been lower wind speeds, more stable wind conditions, or less fluctuating wind directions.

In performing accident assessment, the NRC defines a "worst-case" configuration of wind speed and stability class, and the wind direction is assumed to blow directly toward the nearest person all the time. These conditions normally occur between 1% and 5% of the time at NFS, i.e., 95% to 99% of the time conditions at NFS are "better" than "worst-case". The "worst-case" conditions are a 0.5 meter per second wind speed; constant direction, with a fumigative atmospheric stability class (F); and a small correction for minor plume meander (M-4). If the 3000g release had occured worst-case meteorology, the dose to the bone of a child at the nearest residence would have been 21 Rem.

meteorology of August 7, 1979. In September 1980, the NRC completed the reanalysis of the August 7 accident and briefed the Commission. Also, a special unannounced emergency planning inspection (IE Inspection Report 70-143/80-39) was conducted December 8-11, 1980.

VI. What emergency plans are in effect and what changes are planned?

ANSWER:

The NFS current emergency plan has been in effect since 1977 and has been periodically updated since then. Current NRC plans are to improve all fuel facility emergency plans (see answer VII).

DISCUSSION:

NFS has had contingency plans for responding to emergencies since it was built in 1957. Formal emergency plans were developed in 1977, and incorporated into the NFS license by the NRC in 1978. Since then, NFS has had minor revisions to various plans and procedures. The NFS plan currently addresses reacting to the emergency onsite, and for notifying the State of Tennessee for offsite support. Currently, the State of Tennessee will provide all notifications to nearby people. The NRC is currently upgrading (see answer VII) emergency planning at all fuel facility installations.

VII. What requirements or improvements resulted from the lessons learned from the August 7, 1979 accident and the Three Mile Island nuclear plant accident?

ANSWER:

Significant improvements to upgrade emergency planning and radiation monitoring are currently being considered for NFS.

DISCUSSION:

Based on the NRC review of the NFS August 7, 1979 accident (as discussed in section V.B), the NRC recognized deficiencies in the NFS stack sampling, monitoring, and air treatment systems. Also, the length of time NFS requires to assess the accident event, the time the State of Tennessee requires to notify local residents, are identified weaknesses in the NFS emergency plan.

The NRC recognizes that the failures of the stack equipment must be corrected. Currently, the NRC is considering additional license conditions to the NFS license to improve stack sampling, monitoring, and air treatment systems.

The offsite doses from the NFS August 7, 1979 accident and the potential for larger doses, caused a comprehensive review by the NRC of the NFS emergency plan. Several areas needing improvement were identified, and the NRC is currently considering additional license conditions to correct identified weaknesses. Also, the location of air samplers in the environment were recognized, during the NRC Emergency Planning review of the local meteorology, to be improperly placed. The NRC will require NFS to install additional air samplers in more suitable locations.

The NRC, in January 1980, convened a "Task Action Plan" Committee for the agency to review the lessons-learned from the nuclear plant accident at Three Mile Island, Pennsylvania. This committee identified tasks which groups within the agency were to plan to implement. In regard to fuel facilities, the NRC inititated a Task Action Plan to upgrade all fuel facility emergency plans and procedures. This action is being coordinated with the current NRC imposition of license conditions specific to NFS.

VIII. Why are some people excluded from some information relating to NFS?

ANSWER:

Congressionally passed laws forbid the disclosure of information relating to classified materials and proprietary information on processes, and protects the rights of privacy individuals have with the federal government. All other information is made available to any member of the public.

DISCUSSION:

Some of the material relating to NFS is considered classified material, of a sensitive nature to the U.S. Navy nuclear program. Access to the information is restricted to individuals with a proper security clearance level and a "need to know". Some NRC Commission meetings have been closed to the public, or to public representatives, on this basis.

Some of the material relating to the physical-protection security measures and plant processes are considered NFS proprietary information, and are protected by federal statute from public disclosure. Access to this information is controlled in a manner similar to that of classified material.

Additionally, plant employees are protected from federal disclosure of personal information without their express permission. Such items would include exposure history information and allegations made with a request to remain anonymous. The NRC controls access to this information in a manner similar to that for proprietary information.

Other than for the above all inspection reports and correspondence are placed in the public document room and copies are provided to the State of Tennessee.

APPENDIX A

EXPOSURE AND RISK DATA

APPENDIX A

TABLE A1

Whole Body Radiation Doses to Individuals in the United States from Various Sources

Nuclear Power	0.003	(b) (1970)	BEIR-I
Smoke Detector	0.03-1.5	(a)	NCRP-56
Aircraft Transportation Radioactive Material	0.2	(a)	NCRP-56
Wristwatch-Luminous Dial-Tritium	0.6	(a)	NCRP-56
Occupational Exposure to Radiation	0.8	(b)	BEIR-I
Medical Use of Radio-pharmaceuticals	1.	(b)	BEIR-I
Global Fallout From Nuclear Weapons Tests	4.	(b)	BEIR-I
Exposure From Building Products	7.	(a)	NCRP-56
Natural Radionuclides Inside the Body	18.	(b)	BEIR-I
Natural External Gamma Radiation	40.	(b)	BEIR-I
Cosmic Radiation	44.	(b)	BEIR-I
Medical Diagnostic X-Ray	72.	(b)	BEIR-I
Total	189		

(a) Average dose to the exposed population
(b) Average dose to the U.S.population

TABLE A-2

Radiation Risk and Relative Risk

- The average risk of dying of cancer is about 1/5 (20%) in the U.S. (Ref. 1)

- The average risk of inducing a fatal cancer from radiation exposure is taken as being in the region of 10^{-4} (1 in 10,000) per rem (10^{-7} per mrem) for moderately low doses of most types of radiation (that is x-rays and gamma-rays rather than of alpha rays and neutrons). (Ref. 2).

- The average risk of inducing a non-fatal cancer is about the same as the risk of inducing a fatal cancer. (Ref. 2).

- The following activities all have an estimated lifetime risk of death to an average individual of 10^{-5} (or 10 in a million).

  - 100 mrem of radiation exposure (Ref. 3)
  - smoking 15 cigarettes (Ref. 4)
  - 2500 miles of air travel (Ref. 4)
  - driving a car 500 miles (Ref. 4)
  - rock climbing for 15 minutes (Ref. 4)
  - drinking 5 bottles of wine (Ref. 4)

- The following activities all have approximately the same estimated risk of death of 10^{-6} (or 1 in a million).

  - 10 mrem of radiation exposure (Ref. 3)
  - 2 months of living with a cigarette smoker (Ref. 6)
  - 40 tablespoons of peanut butter (cancer caused by aflotoxin) (Ref. 6)
  - 30 cans of diet soda (cancer caused by saccharin) (Ref. 6)
  - 3 hours in a coal mine (accident)
  - 1 hour in a coal mine (black lung disease) (Ref. 6)

- Smoking a cigarette has the risk of 7 mrem of radiation. (Ref. 5)

- An overweight person eating a pie a-la-mode runs a risk equal to that of 35 mrem of radiation. (Ref. 5)

- People's perceptions of probabilities are frequently in gross error. There is evidence that many people recognize little difference between probabilities of 10^{-3}, 10^{-6}, and 10^{-5}. To provide an expression of risk that is more understandable risk is expressed in minutes or days of life lost. These estimates are made by considering a large number of individuals, the different ages at which death occurs from different causes, and estimating the total number of minutes or days lost as a result of early death from each cause. The total number of minutes or days of life lost is then averaged over the total number of people in the group.

References

1. Cancer Facts & Figures-1980, "Mortality for Leading Causes of Death: United States, 1977," p. 13, American Cancer Society, 1979.

2. Sources and Effects of Ionizing Radiation, United National Scientific Committee on the Effects of Atomic Radiation (UNSCEAR) - 1977 Report to the General Assembly, with Annexes.

3. The radiation exposure of 100 mrem corresponding to the 10^{-5} risk is taken from the UNSCEAR-77 (Ref. 1) risk value of 10^{-4} per rem for fatal cancers; this is also consistent with the statement below that smoking one cigarette sas risk of 7 mrem and that smoking 15 cigarettes has a risk of 10^{-5} (7 mrem/cigarette x 15 cigarettes = 105 mrem).

4. The non-radiation risks are from E. E. Pochin, "The Acceptance of Risk," Br. Med. Bull. 31 (#3), pp. 184-190 (1975) as given in SECY-78-560 (10/26/78), proposed response to the Honicker petition.

5. Bernard L. Cohen, "A Catalog of Risks," Health Physics 36, 707-722, June 1979.

6. Richard Wilson, "Risks Caused by Low Levels of Pollution." The Yale Journal of Biology and Medicine 51, 37-51 (1978).